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SAN/0499-82
MDC G9705

10 MWe Solar Thermal
Central Receiver Pilot Plant

SOLAR FACILITIES DESIGN INTEGRATION

PLANT MAINTENANCE/TRAINING MANUAL (RADL ITEM 2-37) SECTION 2 — STATIONARY APPARATUS

Revised September 1982
July 1981

WORK PERFORMED UNDER
CONTRACT DE-AC03-79SF10499

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CA 92647

U.S. Department of Energy

MCDONNELL DOUGLAS CORPORATION | Rockwell International Rocketdyne Division | Stearns-Roger | Solar Energy

SAN/0499-82
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10 MWe Solar Thermal Central Receiver Pilot Plant Solar Facilities Design Integration

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PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
SOLAR ENERGY
UNDER CONTRACT DE-AC03-79SF10499

UPDATE FOR PLANT MAINTENANCE/TRAINING MANUAL (RADL ITEM 2-37)

SECTION 2 - STATIONARY APPARATUS

INSTRUCTIONS:

1. This update is issued to incorporate corrections and additions to the July 1981 issue of Section 2 of the Maintenance Manual.

2. Please remove Cover sheet, Preface, Table of Contents, Index pages 2.1-1 and -2, 2.2-1 and -2, 2.2.1-1 and -2, 2.3-1 and -2, 2.3-3, 2.7-1 and -2, 2.7.3-1 and -2, 2.7.3-5, 2.7.3-7, 2.12-1, 2.15-1 and 2.16-1, and replace with corresponding updated sheets and pages attached hereto.

3. Add the following new pages:

   - New Receiver Module Painting - Pages 2.2.1-5
   - Receiver Module Removal - Pages 2.2.3-1 through 2.2.3-3
   - Tanks and Pressure Vessels - Pages 2.3-4 through 2.3-7
   - Main Steam Dump Desuperheater - Pages 2.6.2-1 through 2.6.2-8
   - Aux Steam Desuperheater - Pages 2.6.3-1 through 2.6.3-13
   - Index - Page 2.7-3
   - Permanent Strainers - Pages 2.7.9-1 through 2.7.9-5
   - Temporary Strainers - Pages 2.7.10-1 through 2.7.10-7
   - Oil Water Separator - Pages 2.11.2-1 through 2.11.2-46
   - O_2 Analyzer - Gas Chromatograph - Pages 2.12.4-1 through 2.12.4-190
   - Expansion Joints - Pages 2.15.3-1 through 2.15.3-5
   - Flow Orifices - Pages 2.16.5-1 through 2.16.5-12

PREFACE

This document is provided by the McDonnell Douglas Astronautics Company (MDAC) in accordance with Department of Energy Contract Number DE-AC03-79SF10499, Reports and Deliverables List Item 2-37. The material presented here is intended for training and maintenance usage by Southern California Edison Operations Personnel.

Specific notes on the organization and content of the document are as follows:

1. This document is organized in major sections that reflect the top level breakdown of the Master Equipment List as defined in RADL Item 2-19. This is in contrast to the subsystem approach used in designing the plant, however, is consistent with the Southern California Edison operating plant equipment lists.

   Section 1 - Rotating Apparatus
   Section 2 - Stationary Apparatus
   Section 3 - Electrical Apparatus
   Section 4 - Valves
   Section 5 - Instrumentation
   Section 6 - Control and Data Systems
   Section 7 - Collector System
   Section 8 - Special Heliostat Instrumentation and Meteorological Measurements Equipment
   Section 9 - Heating Ventilating and Air Conditioning
   Section 10 - Facilities

2. Assignments to categories are made on the basis of the lowest level tag numbers. For example, maintenance information for the thermal storage extraction pump skid assembly (SA-309) is not listed in the stationary apparatus section, but broken down to the generic categories as defined by the tag number; i.e., pumps (Section 1.2), air operated stop valves (Section 4.2), pressure transmitter (Section 5.2), etc.

3. The Process Instrumentation Section (Section 5.0) is organized on the basis of sensor type as defined by the first letter of the designating tag number. It contains sensor-related information only. Signal conditioning equipment is treated in Section 6.0.

4. The information on the Collector System, which was provided by the Martin Marietta Corp. (MMC) and the major items of the Electrical Power Generation System equipment, provided by Southern California Edison is not provided herein. However, the various sections were structured for their inclusion where applicable.

Technical questions concerning this RADL Item should be directed to Mr. R. G. Riedesel at (714) 896-3357 or Mr. R. J. Perkins at (714) 896-3073.

TABLE OF CONTENTS

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
E-201	BCS Target Heat Exchanger	2.1.1*	5163163
E-202	BCS Target Heat Exchanger	2.1.1*	5163163
E-301	Thermal Storage Condenser Oil/Steam & Water	2.1.2	5163144 5163142
E-302	Thermal Storage Condenser Oil/Steam & Water	2.1.2	5163144 5163142
E-303	Steam Generation Preheater Oil/Water	2.1.3	5163145 5163146
E-304	Steam Generation Preheater Oil/Water	2.1.3	5163145 5163146
E-305	Steam Generation Kettle Boiler Oil/Steam & Water	2.1.4	5163145 5163146
E-306	Steam Generation Kettle Boiler Oil/Steam & Water	2.1.4	5163145 5163146
E-307	Steam Generation Superheater Oil/Steam	2.1.5	5163145 5163146
E-308	Steam Generator Superheater Oil/Steam	2.1.5	5163145 5163145

*Included in Section 1, paragraph 1.2.36

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
E-311	Thermal Storage Subcooler Oil/Steam & Water	2.1.6	5163144 5163142
E-312	Thermal Storage Subcooler Oil/Steam & Water	2.1.6	5163144 5163142

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
RP-201	Receiver Preheat Panel	2.2.1	5163133
RP-202	Receiver Preheat Panel	2.2.1	5163133
RP-203	Receiver Preheat Panel	2.2.1	5163133
RB-204	Receiver Boiler Panel	2.2.2	5163134
RB-205	Receiver Boiler Panel	2.2.2	5163134
RB-206	Receiver Boiler Panel	2.2.2	5163134
RB-207	Receiver Boiler Panel	2.2.2	5163135
RB-208	Receiver Boiler Panel	2.2.2	5163135
RB-209	Receiver Boiler Panel	2.2.2	5163135
RB-210	Receiver Boiler Panel	2.2.2	5163136
RB-211	Receiver Boiler Panel	2.2.2	5163136
RB-212	Receiver Boiler Panel	2.2.2	5163136
RB-213	Receiver Boiler Panel	2.2.2	5163137
RB-214	Receiver Boiler Panel	2.2.2	5163137
RB-215	Receiver Boiler Panel	2.2.2	5163137
RB-216	Receiver Boiler Panel	2.2.2	5163138
RB-217	Receiver Boiler Panel	2.2.2	5163138

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
RB-218	Receiver Boiler Panel	2.2.2	5163138
RB-219	Receiver Boiler Panel	2.2.2	5163139
RB-220	Receiver Boiler Panel	2.2.2	5163139
RB-221	Receiver Boiler Panel	2.2.2	5163139
RP-222	Receiver Preheat Panel	2.2.1	5163133
RP-223	Receiver Preheat Panel	2.2.1	5163133
RP-224	Receiver Preheat Panel	2.2.1	5163133
All Modules	Receiver Module Removal	2.2.3	——

2. 2. 1 RECEIVER PREHEATER PANEL

2. 2. 1.1 Identification

Tag Number	Description
RP-201	Receiver Preheater Panel
RP-202	Receiver Preheater Panel
RP-203	Receiver Preheater Panel
RP-222	Receiver Preheater Panel
RP-223	Receiver Preheater Panel
RP-224	Receiver Preheater Panel

2. 2. 1.2 Description

Manufacturer	:	Rocketdyne, 6633 Canoga Ave, Canoga Park, CA 91304
Part Number	:	40M2005131658
Specification No.	:	None
Material	:	
Weight	:	7000 lb

2. 2. 1.3 Prescribed Service

Water, 2000 psia, 600°F.

2. 2. 1.4 Vendor

Rocketdyne, Canoga Park, CA 91304

2. 2. 1.5 Special Cautions

Check pressure and temperature before disonnecting module from system. Remove 3 heat flux sensors (protect tips) before painting. Use protective plastic tips on sensors when reinstalling.

2. 2. 1.6 Periodic Service

None

2. 2. 1.7 Parts List

None

2. 2. 1.8 Special Tools

Grit blasting and spray painting equipment.

2. 2. 1.9 Maintenance Instructions

Paint panel tubes in accordance with Rocketdyne Specification RA1608-003 (following). See paragraph 2.2.1.11.

PREPARED BY	
J. Nozzi	
APPROVALS	
1-28-81	
PROJ	TS
ST 1/23/81	M&P 1/27/81 M.I.
QA	MFG 1-28-81

FSCM NO. 02602

Rockwell International Corporation
Rocketdyne Division
Canoga Park, California

SPECIFICATION

NUMBER	RA1608-003
TYPE	MATERIAL PROCESSING
DATE	22 January 1981
SUPERSEDES SPEC. DATED:	
REV. LTR.	PAGE 1 of 3

TITLE

COATING, RECEIVER BOILER AND PREHEATER PANEL SURFACES, 10MWe SOLAR PILOT PLANT

RELEASED DOCUMENT

FORM R 131-H-1 REV. 2-78

(ϕ - INDICATES CHANGE)

2. 2. 1.10 Acceptance Tests

2. 2. 1.11 Panel Tube Painting

The purpose of the coating on the tubes is to enhance the absorption of incident solar energy. The tubes do not require a protective coating. Therefor the frequency of painting is an economical decision to be made by the operator based on current costs. Complete loss of the coating degrades the absorptivity of the panel by about ten percent.

The panels may be painted in place.

Painting should be done by an experienced contractor familiar with the general technical and safety requirements of the task.

e.g. Lundeen Coating
10251 Calabash Ave.
P. O. Box 427
Fontana, CA 92335

Prior to initiating painting the first time, a conference should be arranged with the CAL OSHA Consultation Services, 6151 Fairmont Extension, San Diego, CA 92120, (phone (714) 280 5304) to discuss OSHA requirements relative to scaffolding, respirators, abrasives, etc.

Details of the actual sandblasting and painting requirements are contained in Rocketdyne Specification RA 1608-003 (following).

2.2.3 Receiver Module Removal

2.2.3.1 Pre-removal Procedure

Drain panel. All panel drain valves are operated by a single command signal (HS 2913). Verify low pressure receiver purge is on (HS 2016) and pressure (PI 2017) is 10 ± 5 psig. Disconnect drain line FLH-CO-203-202 carefully as it will have the abovementioned pressure in it. Continue to purge until the outflowing GN_2 has a moisture content less than 30 percent relative humidity or 1000 ppm of water. Cap the drain on the module side.

2.2.3.2 Electrical Disconnects

Remove all electrical connections at the core terminal boxes on the nineteenth level for the module to be removed.

Assure that the wire ends are properly identified and protected.

Store the flexible conduit neatly and securely within the module structure.

2.2.3.3 Mechanical Disconnects

Remove sufficient insulation to enable cutting, weld preparing, and rewelding the pipes. Cut the following lines being careful not to get debris in the pipes or tubes:

Module Type	Line	P&ID Line No.	Elevation	Schedule	Material
Boiler	Water Inlet	1"-FW-2xx-MBX	348'0"	80	ASTM-A106 GR B
Boiler	Steam Outlet	2"-FW-2xx-RNX	369'0"	80	ASME SB 407
Boiler	Condensate	1"-CO-2xx-RNX	364'2"	80	ASME SB 407
Preheater	Water Inlet	2½"-FW-2xx-MBX	338'9"	80	ASTM-A106 GR B
Preheater	Water Outlet	2½"-FW-2xx-MBX	370'9"	80	ASTM-A106 GR B
Both	Panel Drain*	3/4"-CO-203-MBX	333'0"	80	ASTM-A106 GR B

* Removal is optional

Disconnect the valve air lines. The lines are to be cut at a convenient point near the module interface. Cover the water, steam, condensate, and drain lines with plastic or rubber gasket material and seal with duct tape to keep debris out and retain the GN_2 blanket. Plug the valve air inlets with 1/4 inch flared tube fitting caps.

2.2.3.4 Structural Disconnect

Remove the core structure bolted cross bracing in the twentieth level as necessary to prevent their interference with the cut module pipes as the module is being removed.

Attach two 250 ft. guy ropes to the bottom of the module structural frame. Remove the top heat shield.

Using a crane and the module lifting lugs and fixture shown on drawing 40M2005131967, Rev. 2., take the weight of the module on the crane. Remove the 16 3/4" bolts and nuts at levels 18, 19, 20, and 21. Be careful not to damage the insulation on the sides of the panels. Pull the module out and lower the module to the vicinity of the ground. Using another crane, rotate the module to the horizontal attitude. If required, mobile cranes and/or fork lifts may be used to move the module from the base of the tower.

2.2.4 Receiver Module Installation

2.2.4.1 Structural Connection

Use mobile cranes and/or fork lifts to position the module horizontally at the base of the receiver tower. Attach the lifting fixtures shown in drawing 40M2005131697 to the module and attach the hook of a crane tall enough to lift the module to its position on the receiver core. Attach two 250 ft. guy ropes to the bottom of the module frame. Engage the bottom of the module with a sling attached to a mobile crane. Using the cranes rotate the module to the vertical attitude.

Lift the module to its place on the receiver core structure. Guide the module with the ropes and exercise caution to avoid damaging the insulation on the sides of the module being lifted and the adjacent modules. Install the 16 3/4 inch bolts and nuts (two each at levels 19, 20, 21). Install the top heat shield, and core structure cross bracing.

2.2.4.2 Mechanical Connection

Weld-prepare and weld the lines cut in paragraph 2.2.3.3.

Reconnect air lines to the valves. In order to insure the code integrity of the receiver, all welding and related operations must be done in accordance with Section I of the ASME Boiler & Pressure Vessel Code.

Attach the module drain line FLH-CO-2xx.

2.2.4.3 Electrical Connections

Connect the wires of the module cables to the receiver core terminal boxes on level nineteen.

2.2.4.4 Post Installation Checks

Leak and pressure check per ASME B&PV requirements. Reinstall pipe insulation. Functional check/valves and instrumentation.

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
V-201	Receiver Flash Tank	2.3.1	5163150
V-303	Thermal Storage Tank (Oil)	2.3.2	5163147
V-304	Thermal storage Flash Tank Steam/Water	2.3.3	5163143
V-305	Thermal Storage Steam Trap	2.3.4	5163144
V-306	Thermal Storage Steam Trap	2.3.4	5163144
V-308	Thermal Storage Blowdown Tank	2.3.5	5163146
V-309	TSS Surge Tank Steam and Water	2.3.6	5163144
V-310	TSS Surge Tank Steam and Water	2.3.6	5163144
V-704	Diaphragm Foam Tank	2.3.7*	5163161
V-901	In-line Demineralizer Vessel	2.3.8	5163158
V-902	In-line Demineralizer Vessel	2.3.8	5163158
V-903	Regeneration Vessel	2.3.9	5163158
V-904	Air Receiver	2.3.10	5163167
TK-301	Fluid Makeup Tank	2.3.11	5163163
TK-302	Ullage Storage Tank	2.3.12	
TK-701	Raw Water Storage Tank	2.3.13	5163159
TK-702	Demineralized Water Storage Tank	2.3.14	5163160

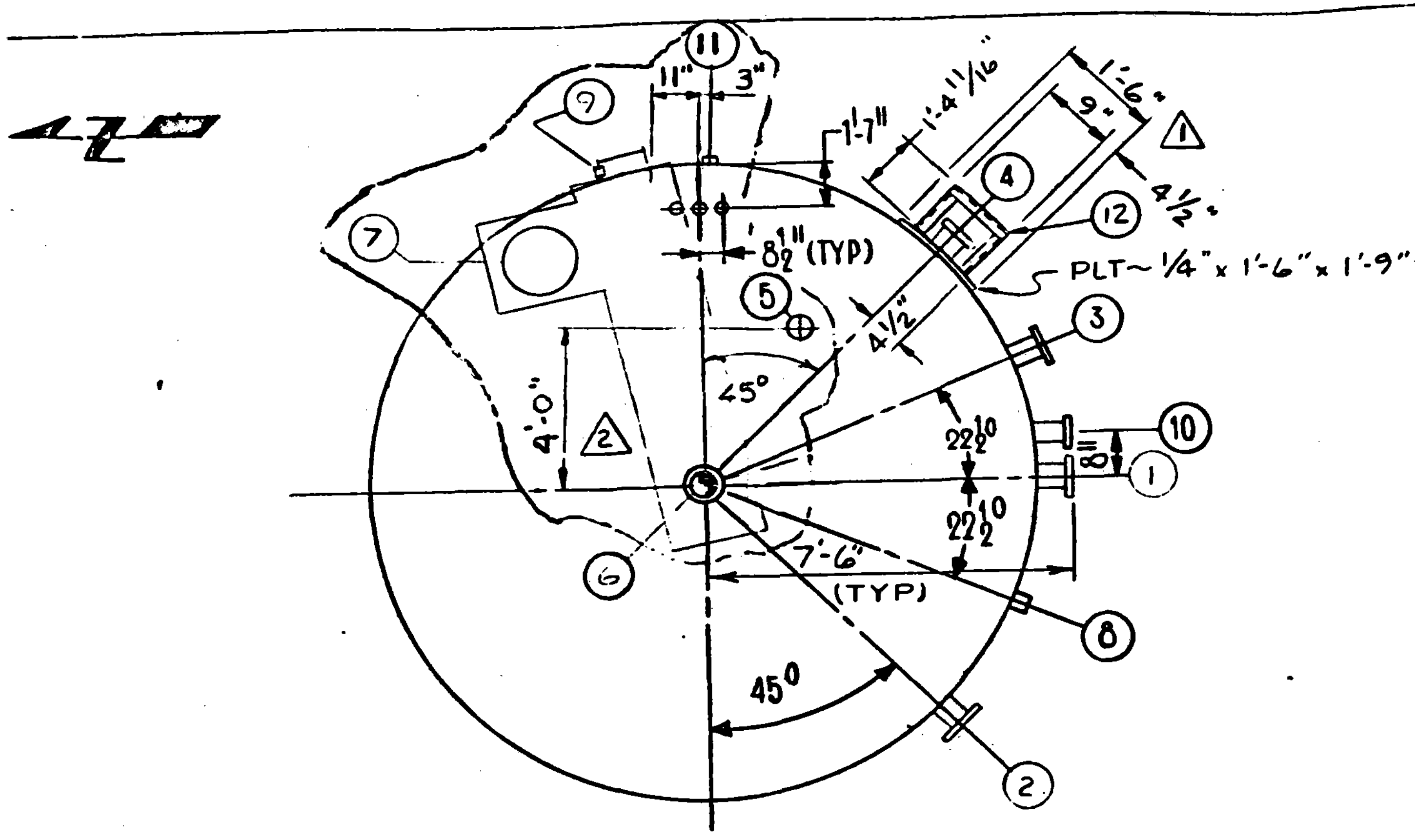
*See Section 10 - Faculties, Paragraph 10.1, Fire Protection

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
TK-901	Cooling Water Surge Tank	2.3.15	5163150
TK-902	Condensate Storage Tank	2.3.16	5163151
TK-904	Cooling Tower Acid Tank	2.3.17	5163154
TK-905	Cooling Tower Polyacrylate Feed Day Tank	2.3.18	5163154
TK-906	Turbine Lube Oil Reservoir	2.3.19	5163156
TK-908	Acid Day Tank	2.3.20	5163158
TK-909	Caustic Day Tank	2.3.21	5163158
TK-913	Hydrazine Tank	2.3.22	5163158
TK-914	Ammonia Tank	2.3.22	5163158
TK-915	Condensate Polisher Acid Storage Tank	2.3.23	5163158
TK-916	Caustic Storage Tank	2.3.24	5163158
TK-922	Sodium Hypochlorite Storage Tank	2.3.25	5163154
TK-923	Hydraulic Oil Reservoir	2.3.26	5163156
TK-924	Safety Relief Blowdown Tank	2.3.27	

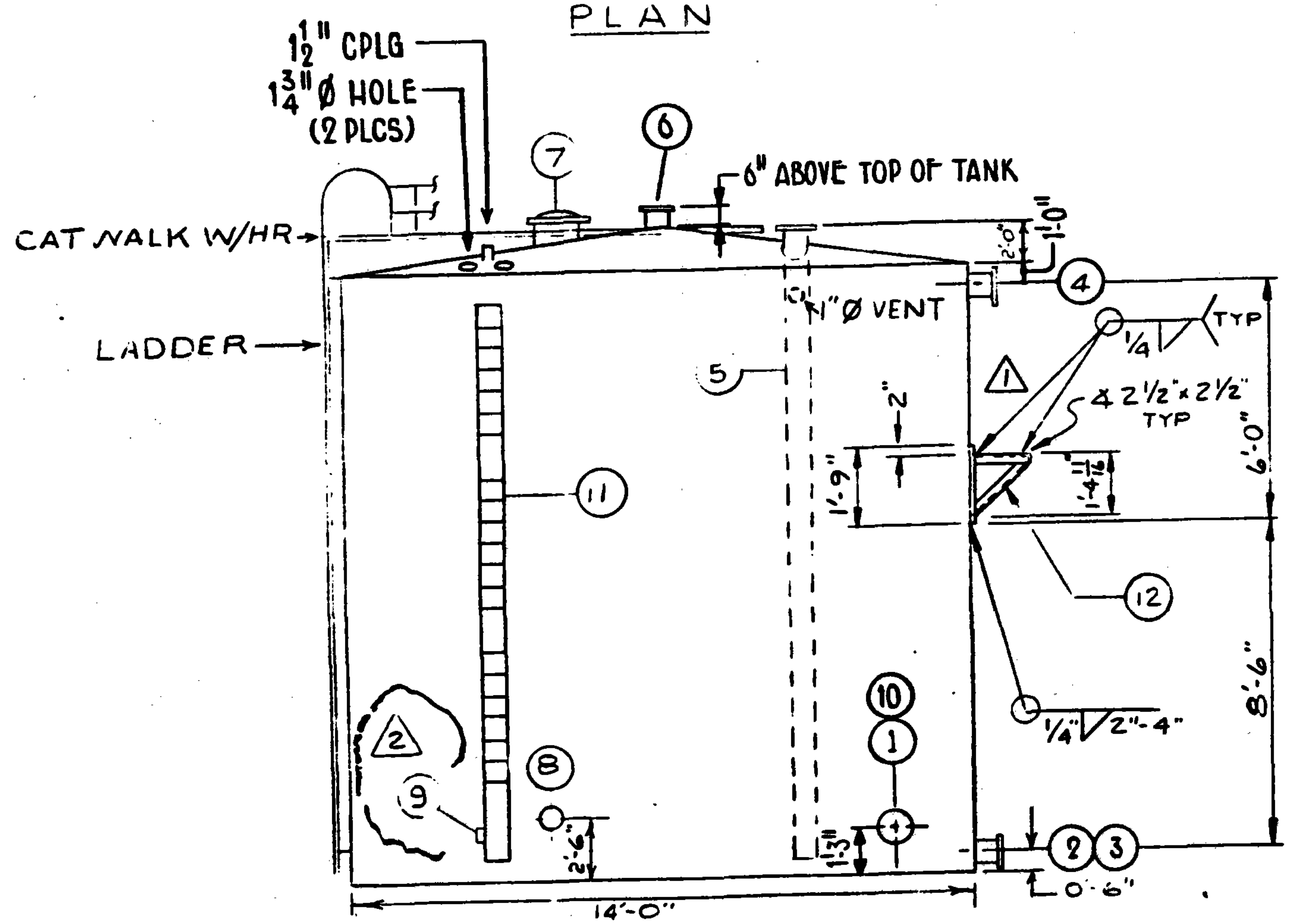
2.3 TANKS AND PRESSURE VESSELS

Para#	Tag No.	Nomenclature	Specification Number	Drawing Number
2.3.1	V-201	Receiver Flash Tank	ESR 31080	D-B1589
2.3.2	V-303	Thermal Storage Tank (Oil)	40-M300-35	
2.3.3	V-304	Thermal Storage Flash Tank Steam/Water	GA000-90907-M33 GA000-90907-M34	D-B1590
2.3.4	V-305	Thermal Storage Steam Trap	GA000-90907-M38	D-B1591
2.3.4	V-306	Thermal Storage Steam Trap	GA000-90907-M38	D-B1591
2.3.5	V-308	Thermal Storage Blowdown Tank	40P3002132009	P25-5
2.3.6	V-309	Thermal Storage Surge Tank	GA000-90907-M39	C-B1592
2.3.6	V-310	Thermal Storage Surge Tank	GA000-90907-M39	C-B1592
2.3.11	TK-301	Fluid Makeup Tank	40P7002133186	P25-4
2.3.12	TK-302	Ullage Storage Tank (Refer to paragraph 2.12.1, Ullage Maintenance Unit)		SA-311,
2.3.13	TK-701	Raw Water Storage Tank	40P7002133184	P25-2
2.3.14	TK-702	Demineralized Water Storage Tank	40P7002133178	P25-1

These vessels have been fabricated and are to be used and maintained according to ASME Pressure Vessel Code, Section VIII Unfired Pressure Vessels. Design service is specified on each vessel drawing or specification.



PLAN



ELEVATION

VESSEL (~~HORZ.~~-VERT.) 16'-0"			
SHELL DIA. (I.D.-~~O.D.~~) 14'-0"			
HEADS (S.E.-C.D.) CONICAL ROOF FLAT BOTTOM			
VESSEL CONTENTS DEMINERALIZED WATER			
SHELL LENGTH (SEAM TO SEAM) 16'-0"			
SUPPORT COMPACTED SAND BY OTHERS			
DESIGN CONDITIONS CODE AWWA D100 STAMP N/A			
PRESS. (PSIG)	OPER.	DESIGN	ALLOW.
	ATMOS.	ATMOS	———
TEMP. (°F)	N/A	9°F TO 117°F	N/A
CORR. ALLOW. SHELL NONE HEADS NONE			
X-RAY AS PER SPEC. STRESS RELIEF NOT REQ'D			
WIND LOAD UBC 25 PSF WIND PRESSURE AREA			
SEISMIC LOAD SEE SPEC. PARA. 6.2.1.9			
ICE & SNOW LOAD 5 PSF			
HYDROSTATIC TEST PRESS. NOT REQUIRED			
JOINT EFFICIENCY NO LEAK			
MATERIALS			
~~HEADS~~ ROOF-CS ASTM A36			
SHELL CS ASTM A36			
NOZZLES & FLANGES CS ASTM A36			
COVERS CS ASTM A36			
GASKETS 1/8" NEOPRENE FOR MANWAYS			
SKIRT N/A			
SADDLE N/A			
BASE PLATE N/A			
LIFTING LUGS N/A			
BOLTS ———			
FLANGES PER ANSI B16.5			
EXTERNAL LADDERS & PLATF. CS ASTM A53 GR B			
WEAR PLATES N/A			
INTERNAL LADDERS CS A53 GR B			
INTERNAL N/A			
INTERNAL BARS & PLATES N/A			
LINING PLASITE No 7155 OR EQUAL			

NO.	DATE	BY	REVISION	CK
A	8 OCT 79	RS	FOR APPROVAL	
B	7 DEC 79	RS	FOR BID	TEO
C	3-25-80	TM	① EL WAS 6" ③ ORIENTATION WAS 45°	TEO
0	5-23-80	TM	APPROVED FOR CONSTRUCTION	TEO
1	6-24-80	CWB	ADDED PT. NO. 12	KW
2	1-28-82	BKE	REVISED RECORD DWG	

NOZZLES & CONNECTIONS	NO. REQD	SIZE-RATING-FACE SLIP-ON FLANGES
1 OUTLET	1	3"-150# FLG. RF
2 INLET	1	2"-150# FLG. RF
3 DRAIN	1	3"-150# FLG. RF
4 OVERFLOW	1	4"-150# FLG. RF
5 STILLING WELL	1	4"-150# FLG. RF
6 VENT	1	4"-150# FLG. RF
7 MANHOLE	1	24" SEE SPEC. PARA. 6.2.3.2
8 SAMPLING CONN.	1	1" 3000# HALF CPLG
9 GROUNDING LUG	1	SEE SPEC. PARA 6.2.3.6
10 MIN FLOW INLET	1	2" 150# FLG. RF
11 LEVEL IND.	1	SEE SPEC. PARA. 6.2.3.4
12 SUPPORT BEAM	1	AS NOTED
13		
14		
15		
16		
17		
18		

ACCESSORIES	FURN. BY VESSEL FAB.	FURN. BY OTHER
LADDERS	X	
PLATFORMS (CATWALK)	X	
LADDER & ~~PLATF.~~ CLIPS	X	
DAVITS	-	
INSUL. RINGS	NONE	
SANDBLAST	X	
PRIMER REQ'D.	X	
LINING	X	

WEIGHT: VESSEL	-
LADDERS & PLATF.	-
	-
TOTAL	-

VESSEL- DEMINERALIZED WATER TANK TK-702

FOR DEPARTMENT OF ENERGY

PLANT 10 MWe SOLAR PILOT PLANT DAGGETT, CALIFORNIA

ORDER NO. C-21700

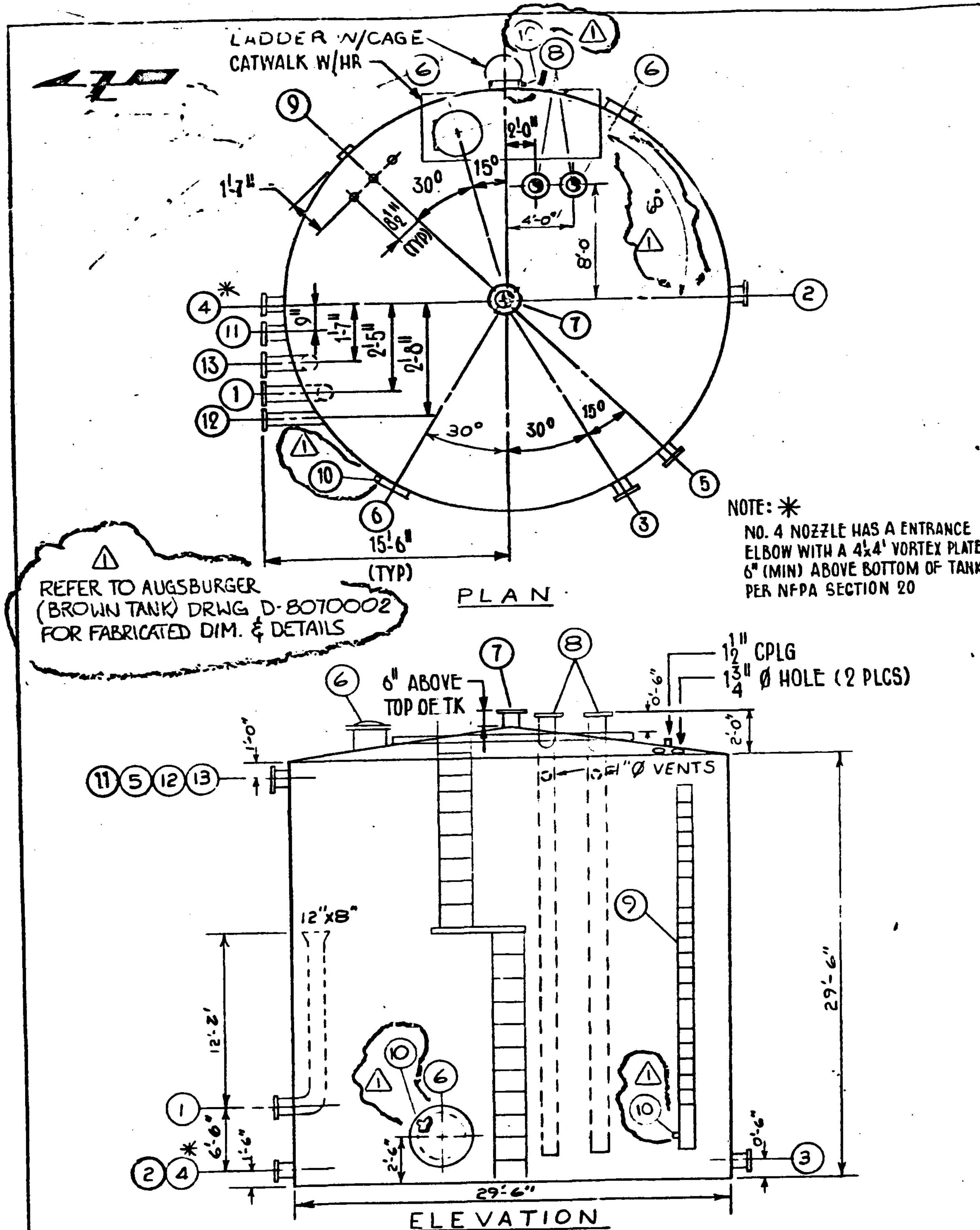
MANUFACTURER CONSTRUCTION PKG NO. 10A

DATE 6-26-79 BY RRS

Stearns-Roger INCORPORATED

DRAWING NO. 40P7002133178
S-R DWG #9033/4
P25-1

S-R FORM 10775



NOTE: *
NO. 4 NOZZLE HAS A ENTRANCE ELBOW WITH A 4'x4' VORTEX PLATE 6" (MIN) ABOVE BOTTOM OF TANK PER NFPA SECTION 20

VESSEL (~~HORZ.~~-VERT.) 29'-6"			
SHELL DIA. (I.D.-~~O.D.~~) 29'-6"			
HEADS (S.E.-C.D.) CONICAL ROOF-FLAT BOTTOM			
VESSEL CONTENTS RAW WATER			
SHELL LENGTH (SEAM TO SEAM) 29'-6"			
SUPPORT COMPACTED SAND BY OTHERS			
DESIGN CONDITIONS			
CODE AWWA D100 STAMP N/A			
PRESS. (PSIG)	OPER.	DESIGN	ALLOW.
	ATMOS	ATMOS	—
TEMP. (°F)	N/A	9°F TO 117°F	N/A
CORR. ALLOW. SHELL NONE HEADS NONE			
X-RAY AS PER. SPEC STRESS RELIEF NOT REQ'D			
WIND LOAD UBC 25 PSF WIND PRESSURE AREA			
SEISMIC LOAD SEE SPEC. PARA. 6.1.1.8			
ICE & SNOW LOAD 5 PSF			
HYDROSTATIC TEST PRESS. NOT REQ'D			
JOINT EFFICIENCY NO LEAK			
MATERIALS			
~~HEADS~~ ROOF - CS ASTM A283 GrC			
SHELL CS ASTM A283 GrC			
NOZZLES & FLANGES CS ASTM A283 GrC			
COVERS CS ASTM A36			
GASKETS ⅛" NEOPRENE FOR MANWAYS			
SKIRT N/A			
SADDLE N/A			
BASE PLATE N/A			
LIFTING LUGS N/A			
BOLTS ———			
FLANGES PER ANSI B16.5			
EXTERNAL LADDERS & PLATF. CS ASTM A53 GrB			
WEAR PLATES N/A			
INTERNAL LADDERS CS ASTM A53 GrB			
INTERNAL ———			
INTERNAL BARS & PLATES N/A			
LINING AMERCOAT 71 (OR APPROVED EQUAL)			

NO.	DATE	BY	REVISION	CK
A	8OCT79	RS	FOR APPROVAL	[illegible]
B	7DEC79	RS	FOR BID	TEO
C	3-25-80	TM	③⑤ ORIENTATION WAS WEST ℄ OF TANK	—
0	5-21-80	TM	APPROVED FOR CONSTRUCTION	TEO
1	3-19-82	[illegible]	REVISED RECORD DRWG.	TEO

NOZZLES & CONNECTIONS	NO. REQD	SIZE-RATING-FACE SLIP-ON FLANGES
1 OUTLET (RW)	1	8"-150# FLG. RF
2 INLET (RW)	1	8"-150# FLG. RF
3 DRAIN	1	4"-150# FLG. RF
4 OUTLET (FP)	1	8"-150# FLG. RF
5 OVERFLOW	1	10"-150# FLG. RF
6 MANHOLE	3	24"-SEE SPEC PARA. 6.1.3.4
7 VENT	1	6"-150# FLG. RF
8 STILLING WELL	2	4"-150# FLG. RF
9 LEVEL IND.	1	SEE SPEC. PARA. 6.1.3.5
10 GROUNDING LUG	2	SEE SPEC. PARA. 6.1.3.7
11 FP FLOW MTR RET	1	6"-150# FLG. RF
12 SW MIN FLOW RET	1	3"-150# FLG. RF
13 FP MIN FLOW RET	1	2"-150# FLG. RF
14		
15		
16		
17		
18		

ACCESSORIES	FURN. BY VESSEL FAB.	FURN. BY OTHER
LADDERS	X	
PLATFORMS (CATWALK)	X	
LADDER & PLATF. CLIPS	X	
DAVITS	X	
INSUL. RINGS	NONE	
SANDBLAST	X	
PRIMER REQ'D.	X	
LINING	X	

WEIGHT: VESSEL -
LADDERS & PLATF. -
-
TOTAL -

VESSEL- RAW WATER STORAGE TANK TK-701

FOR DEPARTMENT OF ENERGY

PLANT 10 MWe SOLAR PILOT PLANT DAGGETT, CALIFORNIA

ORDER NO. C-21700

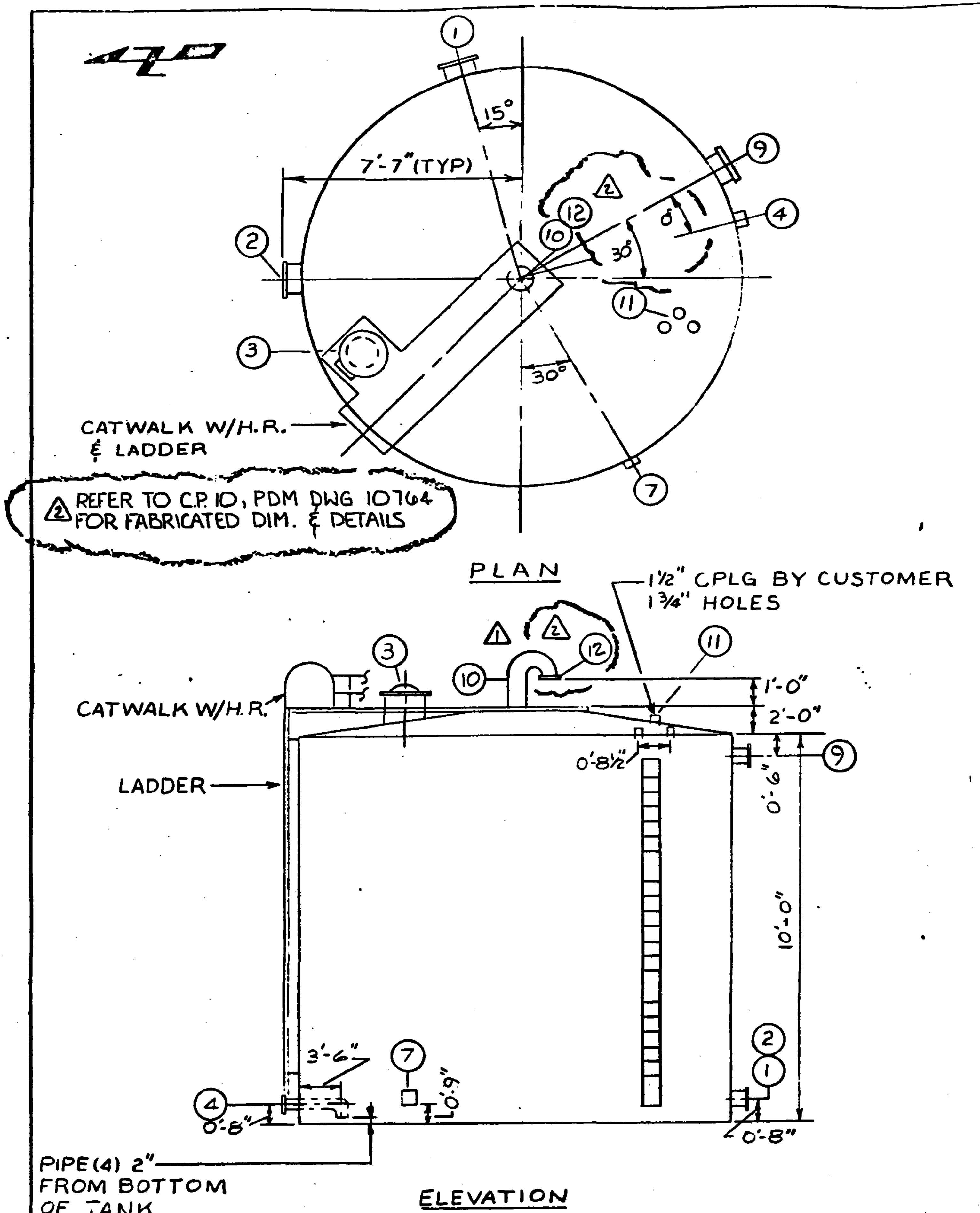
MANUFACTURER CONSTRUCTION PKG NO. 1CA

DATE 6-26-79 BY RRS

Stearns-Roger INCORPORATED 2.3.5

DRAWING NO. 40P7002133184
S-R DWG #9033/4
P25-2

S-R FORM 10775



VESSEL (~~HORZ.~~-VERT.)	12'-0"
SHELL DIA. (I.D.-~~O.D.~~)	14'-0"
HEADS (S.E.-C.D.)	CONICAL ROOF FLAT BOTTOM
VESSEL CONTENTS	EXXON HT43 HEAT TRANS OIL
SHELL LENGTH (SEAM TO SEAM)	10'-0"
SUPPORT	CONCRETE PAD (BY OTHERS)

DESIGN CONDITIONS

CODE API-650 STAMP PER API-650

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	ATMOS	ATMOS	—
TEMP. (°F)	N/A	9° TO 117°	N/A

CORR. ALLOW. SHELL	NONE HEADS NONE
X-RAY	PER API-650 STRESS RELIEF NOT REQ'D
WIND LOAD	UBC 25 PSF WIND PRESSURE AREA
SEISMIC LOAD	SEE SPEC. PARA.
ICE & SNOW LOAD	5PSF
HYDROSTATIC TEST PRESS.	NOT REQ'D
JOINT EFFICIENCY	NO LEAK

MATERIALS

HEADS	CS ASTM-A283 GrC
SHELL	CS ASTM-A283 GrC
NOZZLES & FLANGES	CS ASTM-A181 Gr I
COVERS	CS ASTM-A283 GrC
GASKETS	1/8" NEOPRENE FOR MANHOLE
SKIRT	N/A
SADDLE	N/A
BASE PLATE	N/A
LIFTING LUGS	N/A
BOLTS	—
FLANGES	CS ASTM-A181 GrI
EXTERNAL LADDERS & PLATF.	CS ASTM-A36
WEAR PLATES	N/A
INTERNAL LADDERS	N/A
INTERNAL	N/A
INTERNAL BARS & PLATES	N/A
LINING	N/A

NOZZLES & CONNECTIONS	NO. REQD	SIZE-RATING-FACE SLIP-ON FLANGE
1 OUTLET	1	4" 150# FLG R.F.
2 FILL CONN.	1	4" 150# FLG R.F.
3 MANHOLE	1	24" SEE SPEC PARA. 6.1.3.4
4 DRAWOFF PIPE	1	2" SCH 80 (MIN) ASTM-106 Gr B
5 N/A		
6 DELETED		
7 GROUNDING LUG	1	SEE SPEC PARA. 6.1.3.6
8 DELETED		
9 OVERFLOW	1	4" 150# FLG R.F.
10 VENT	1	12" 180° ELBOW
11 LEVEL INDICATOR	1	SEE SPEC. PARA. 6.1.3.5
12 VENT FLG W/SS SCREEN	1	12" 150# RF FLG
13		
14		
15		
16		
17		
18		

ACCESSORIES	FURN. BY VESSEL FAB.	OTHER
LADDERS	X	
PLATFORMS (CATWALK)	X	
LADDER & PLATF. CLIPS	X	
DAVITS	X	
INSUL. RINGS	NONE	
SANDBLAST	X	
PRIMER REQ'D. (OUTSIDE)	X	
LINING	NONE	

WEIGHT: VESSEL	-
LADDERS & PLATF.	-
	-
TOTAL	-

VESSEL- CALORIA MAKE-UP TANK TK-301

FOR DEPARTMENT OF ENERGY

PLANT 10MWe SOLAR PILOT PLANT DAGGETT, CALIFORNIA

ORDER NO. C-21700

MANUFACTURER

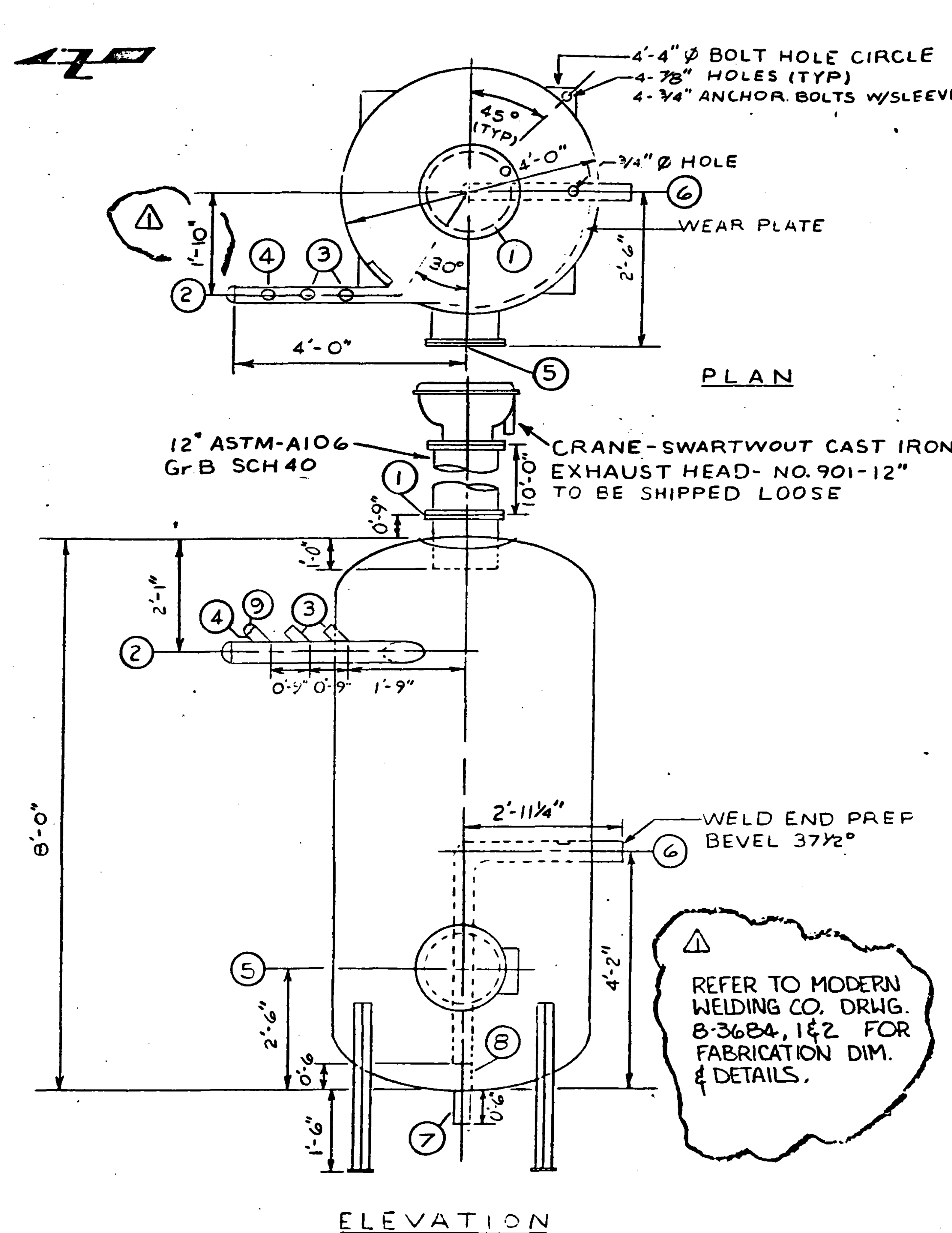
DATE 11-8-79 BY RRS

NO.	DATE	BY	REVISION	CK
A	2-1-80	RS	FOR APPROVAL	ENG
B	2-26-80	RS	FOR BID	TEO
O	3-13-80	RS	APPROVED FOR CONST.	KEN
1	7-14-80	RS	CHANGED VENT SIZE	KEO
2	3-19-82	LKB	REVISED RECORD DRWG	KEO

Stearns-Roger INCORPORATED 2.3-6

DRAWING NO. 40P7002133186
S-R DWG #9033/4
P25-4

S-R FORM 10775



VESSEL (~~HORZ.~~-VERT.) 8'-0"	
SHELL DIA. (I.D.-~~O.D.~~) 4'-0"	
HEADS (S.E.-C.D.) ELLIPTICAL	
VESSEL CONTENTS CONDENSATE	
SHELL LENGTH (SEAM TO SEAM) BY CONTRACTOR	
SUPPORT 4 LEGS	

DESIGN CONDITIONS

CODE ASME SECT VIII STAMP YES

	OPER.	DESIGN	ALLOW.
PRESS. (PSIG)	5 PSIG	100 PSIG	—
TEMP. (°F)	225°F	445°F	—

CORR. ALLOW. SHELL 1/16"	HEADS 1/16"
X-RAY PER CODE	STRESS RELIEF PER CODE
WIND LOAD UBC 25 PSF WIND PRESSURE AREA	
SEISMIC LOAD SEE SPEC. PARA. 5.2.4	
ICE & SNOW LOAD 5 PSF	
HYDROSTATIC TEST PRESS. PER CODE	
JOINT EFFICIENCY PER CODE	

MATERIALS

HEADS	ASTM-A285 Gr C
SHELL	ASTM-A285 Gr C
NOZZLES & FLANGES	ASTM-A181 Gr I
COVERS	N/A
GASKETS	1/8" SPIRAL WOUND ASBESTOS FIBER
SKIRT	N/A
SADDLE	PER CODE
BASE PLATE	N/A
LIFTING LUGS	N/A
BOLTS	—
FLANGES	ASTM-A181 Gr I
EXTERNAL LADDERS & PLATF.	N/A
WEAR PLATES	ASTM-A285 Gr C
INTERNAL LADDERS	N/A
INTERNAL	N/A
INTERNAL BARS & PLATES	N/A
LINING	N/A

NO.	DATE	BY	REVISION	CK
0	6-20-80	RS	AFC CP #0	[illegible]
1	3-19-82	[illegible]	REVISED RECORD DRWG.	[illegible]

NOZZLES & CONNECTIONS	NO. REQD	SIZE-RATING-FACE
1 EXHAUST HEAD	1	12"-150# FLG RF
2 BLOWOFF LINE	1	4"-XXS ASTM-A106 Gr B
3 LATROLET	2	1"-45°
4 LATROLET	1	2"-45°
5 MANHOLE	1	18" (HINGED)
6 DISCHARGE LINE	1	2½"-40 ASTM-A106 Gr B
7 DRAIN LINE	1	6"-80 ASTM-A106 Gr.
8 VORTEX PLATE	1	BY FABRICATOR
9 CAP	1	2" 3000#
10		
11		
12		
13		
14		
15		
16		
17		
18		

ACCESSORIES	FURN. BY VESSEL FAB.	FURN. BY OTHER
LADDERS	NONE	
PLATFORMS	NONE	
LADDER & PLATF. CLIPS	NONE	
DAVITS	NONE	
INSUL. RINGS (2" INSULATION)	X	
SANDBLAST	X	
PRIMER REQ'D.	X	
LINING	NONE	

WEIGHT: VESSEL	-
LADDERS & PLATF.	-
	-
TOTAL	-

VESSEL- TSS BLOWDOWN TANK V-308

FOR DEPARTMENT OF ENERGY

PLANT 10 MWe SOLAR PILOT PLANT

ORDER NO. C-21700

MANUFACTURER CONST. PACK #9

DATE 4-4-80 BY RRS

Stearns-Roger INCORPORATED 2.3-7

DRAWING NO. 40P3002132009
S-R DWG #9033/4
P25-5

S-R FORM 10775

2.6.2 Main Steam Dump Desuperheater

2.6.2.1 Identification

Tag Number	Description
DS-901	Main steam dump desuperheater

2.6.2.2 Description

Manufacturer:	Graham Mfg. Co., Inc. Batavia, N.Y. 14020
Part No.	10"-SA-2000 Special

2.6.2.3 Prescribed Service

Steam

2.6.2.4 Vendor

Graham Mfg. Co., Inc.

2.6.2.5 Piping Connections

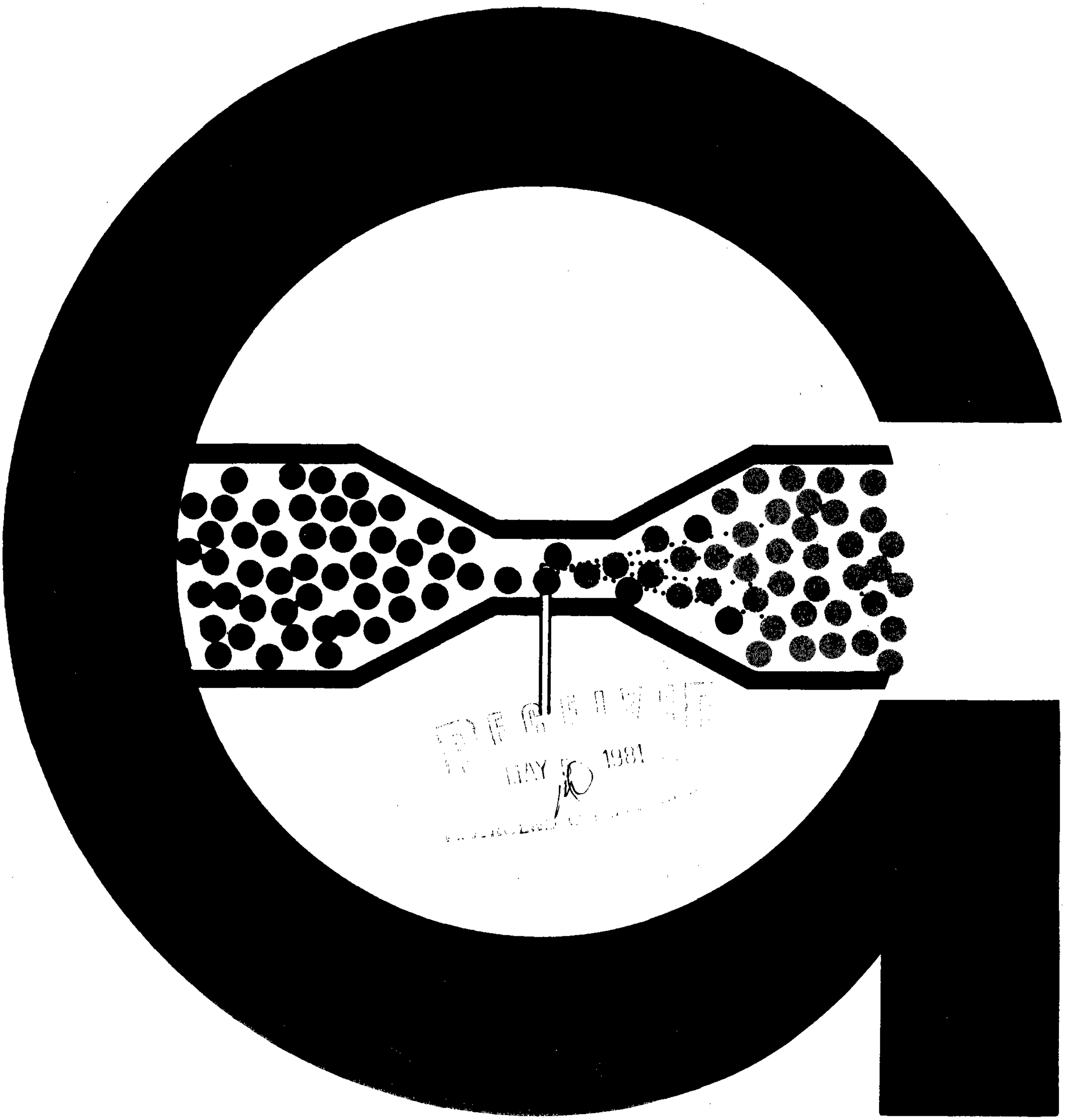
DOE Dwg No. 40P2005131905, CP 9

2.6.2.6 Operation/Maintenance

See attached Graham bulletin 9167/A

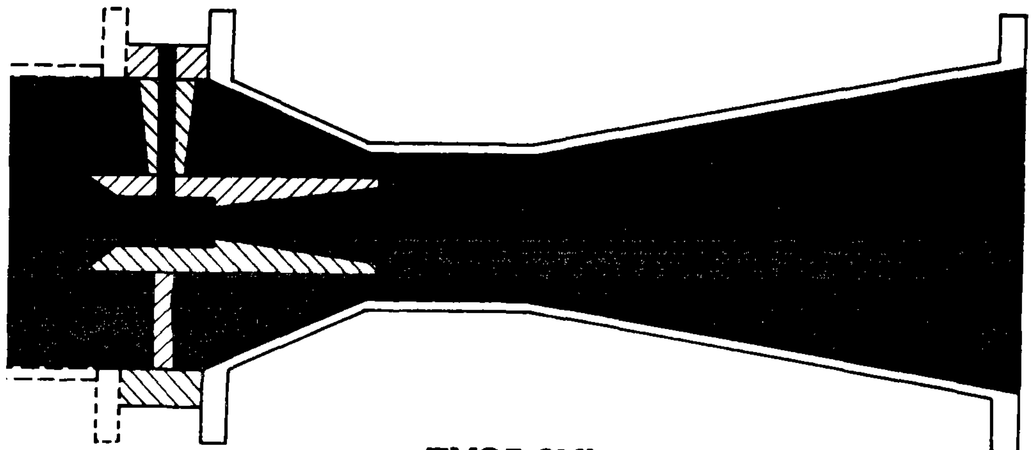
Bulletin 9167/A

Graham Desuperheaters



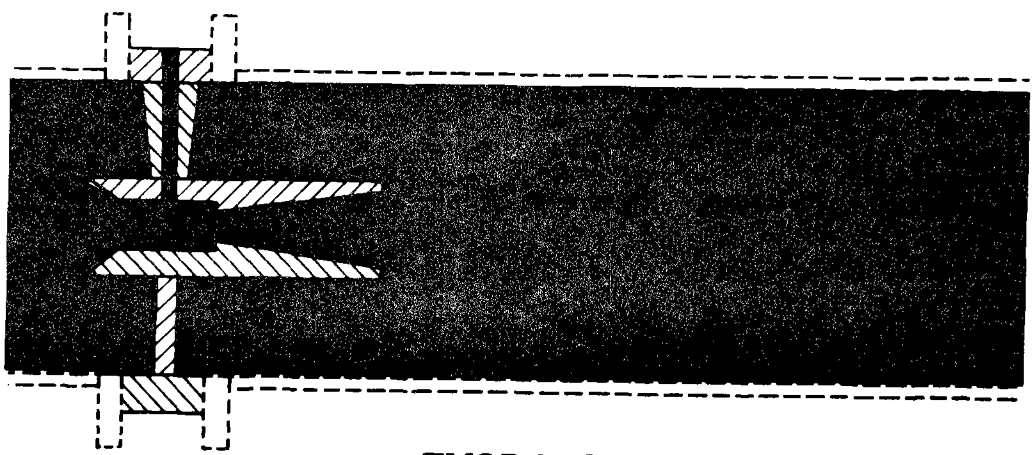
As the pioneer of the modern steam jet ejector, Graham has an unequalled background in the design and application of the venturi—the key to stable and efficient operation of the atomizing type of steam desuperheater. Graham's desuperheaters are backed by the extensive application knowhow Graham has acquired in more than 30 years of serving the process industries with vacuum and heat transfer equipment. And backed by the organization Graham has built for prompt, effective service. And by Graham's uncompromising guarantee of performance in accordance with specifications.

Graham desuperheaters reduce the temperature of superheated steam for process use and operation of auxiliaries, through evaporative cooling by direct contact with water. As opposed to spray-type desuperheaters, expert design of the venturi and combining section produces



TYPE SVI

A highly-flexible general-purpose venturi desuperheater for steady or variable flow application. Water is supplied at the small venturi throat where it is atomized by the accelerated steam flow. Thorough mixing and evaporation, with consequent reduction of steam temperature, occurs when this mist joins the main stream in the throat and diverging section of the main venturi. Pressure is substantially restored in the diffuser section by conversion of velocity to static head, so pressure drop across the desuperheater is low. Water pressure need only be equal to inlet steam pressure. Designed for flanged connection to steam piping, with no separate support required. May be installed horizontally or vertically with flow upward.



TYPE SV2

A simple and low cost venturi desuperheater, with lowest steam pressure drop since it has a straight-through steam passage. For applications in which steam flow does not vary significantly. Flanged for direct connection in steam piping, with no separate support required. May be installed horizontally, or vertically with flow upward. As with other Graham desuperheaters, because of the fine atomization of water there is no erosive effect on the pipeline walls.

INSTALLATION AND OPERATING INSTRUCTIONS

STEAM ATOMIZING DESUPERHEATER

I. INSTALLATION

A. The desuperheater can be installed in a horizontal or vertical position.

B. A strainer should be installed upstream of the water control valve. This prevents foreign matter from clogging valve and desuperheater internals.

C. The atomizing steam and water valves should be installed as close to the desuperheater as is practical.

D. To install automatic control apparatus, see instructions provided by manufacturer.

E. The temperature sensing point should be at least 30 feet from the discharge end of the desuperheater. Temperature sensing element should be completely exposed to the steam flow.

II. OPERATION

A. Manual Operation

1. Drain steam line before main steam pressure reducing valve, if used, as well as the desuperheater line.

2. Open atomizing steam valve fully, cracking the water valve at the same time.

3. Open main steam valve, increasing flow slowly. The water flow should be increased at the same time, if desuperheating is desired during the start up.

4. When desired steam flow is reached, adjust water valve to give the desired discharge steam temperature.

B. Automatic Operation

1. Open all stop valves.

2. Follow instructions for manual start up, omitting step #2.

3. Set control apparatus per instructions provided by the manufacturer.

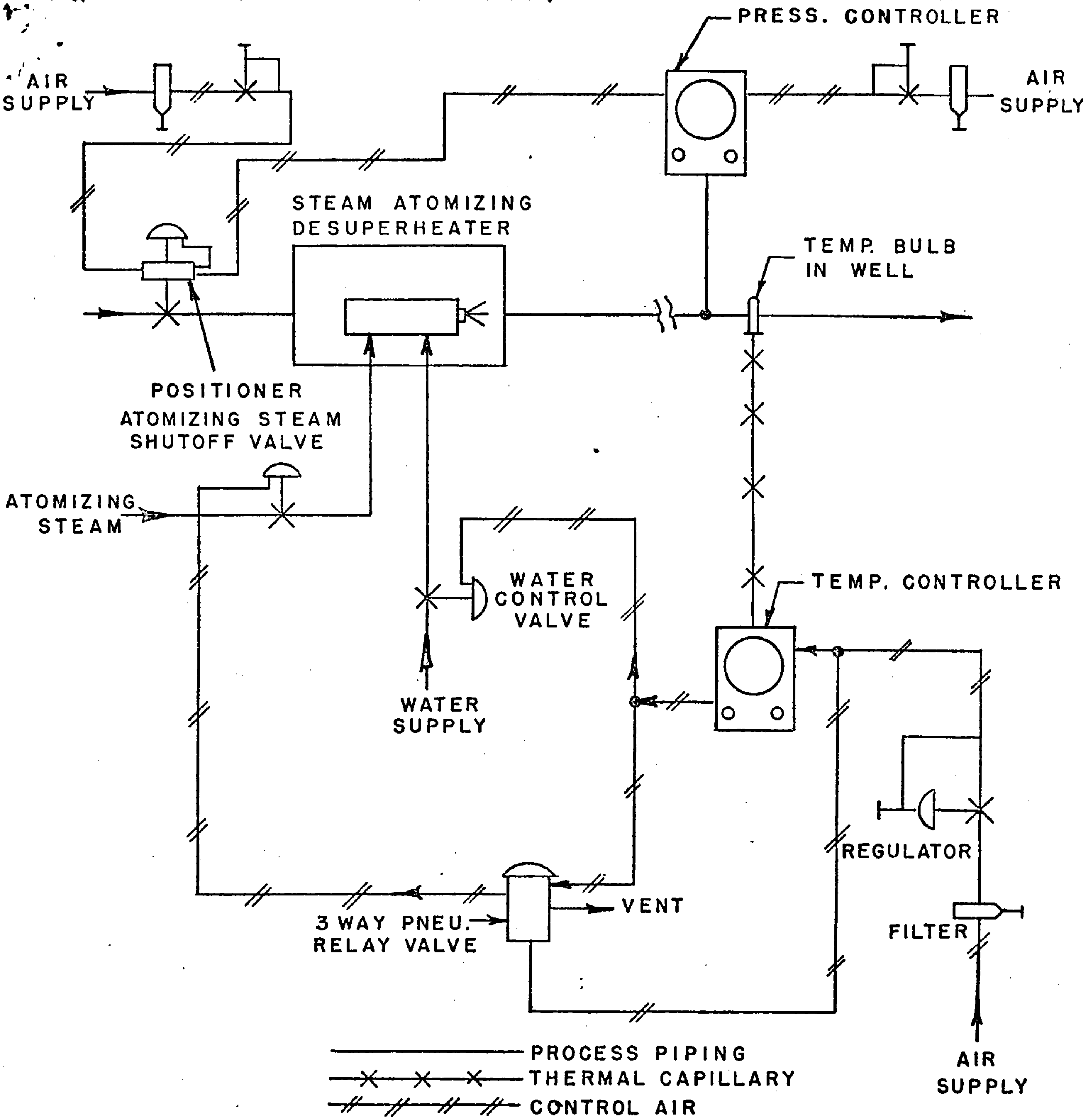
VII. MAINTENANCE

A. The desuperheater should not ordinarily require maintenance under normal conditions, but it may be necessary to remove scale formed by evaporation of water. Remove unit from steam line. Unscrew cap (Part #3), unscrew nozzle (Part #2). Clean scale from all parts and re-assemble.

B. Maintenance of valves and control apparatus should be performed per the instructions of the manufacturer.

GRAHAM MANUFACTURING CO., INC.

BATAVIA, N.Y.



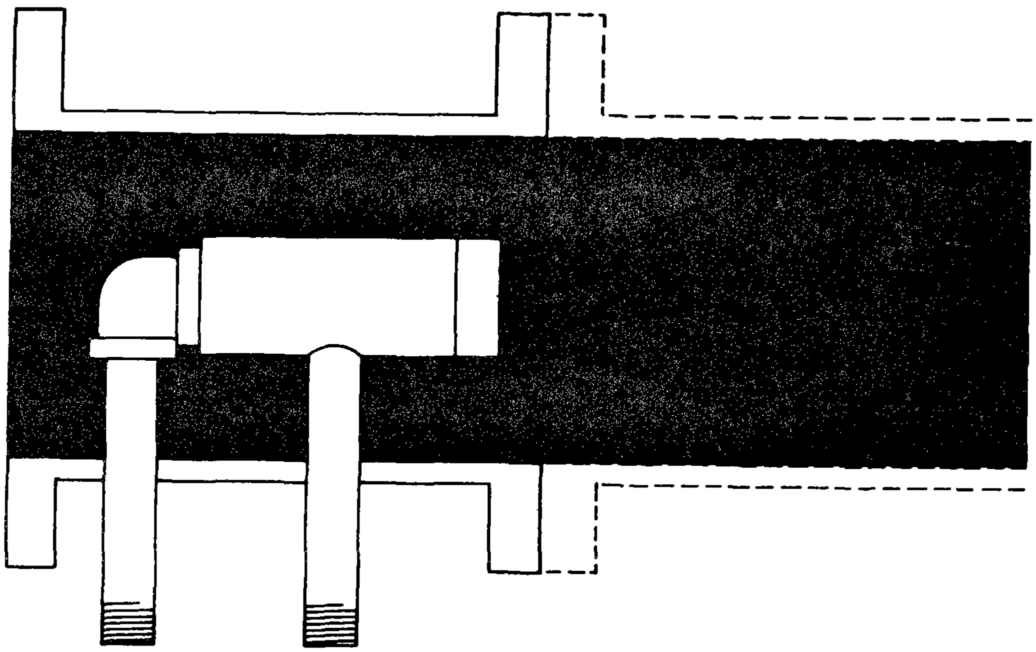
NOTE: PRESSURE & TEMPERATURE CONTROLLERS MAY BE INCORPORATED IN ONE CASE.

CONTROL DIAGRAM
FOR
STEAM ATOMIZING DESUPERHEATER
WITH PRESSURE REDUCING VALVE AND CONTROLLER

a mist that mixes directly with steam in a controlled pattern that avoids the erosion and reduced cooling effect caused by water contact with sidewalls. And it is not necessary that water supply pressure be greater than desuperheater steam line pressure.

Three basic types of Graham desuperheaters are available in a range of sizes and materials of construction, to meet a wide variety of application requirements. All are manufactured under the strict quality control which makes possible our no-nonsense guarantee. Alloys used, and hydrostatic test techniques employed, are those appropriate to the specified service conditions and the applicable codes.

All Graham desuperheaters are designed for operation under automatic control.



TYPE SA

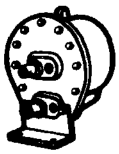
An uncomplicated, low-cost steam atomizing desuperheater for stable operation in applications where steam flow rates can vary considerably. With automatic control this design offers stable and effective operation with turndown ratios as high as 50:1. *This is possible because a small quantity of steam at a* minimum of 1½ times desuperheater line pressure is used for atomization, so that creation of an efficient mixture of steam and water mist is not dependent on main steam line velocity nor on water flow rate. As with other Graham desuperheaters, water pressure need only be equal to desuperheater steam line pressure.

During turndown operation water will tend to settle out in the exit pipe due to lower pipe line velocity, and must be removed in a downstream trap-out pot. This is particularly important if proper control is to be maintained at approach to the *saturation temperature.*

This design is ideal for combination pressure-reducing and desuperheating operations, and is recommended whenever high pressure steam for atomizing is available. Pressure drop is negligible. Provided for clamping between flanges, for welding into piping, or flanged.

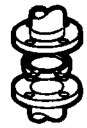
Other precision-built Graham products

Fume Scrubbers

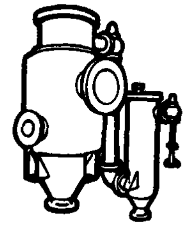


Heliflow® Heat Exchangers

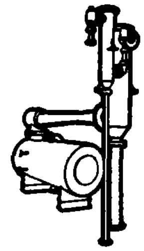
Relief Valves



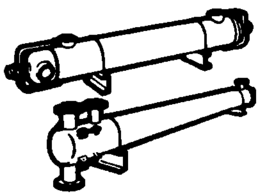
Graphite Rupture Discs
(in North America only)



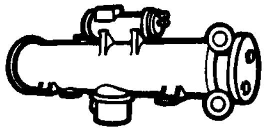
Barometric Condensers



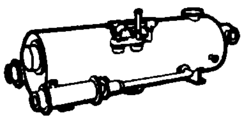
Jet Vacuum
Refrigeration



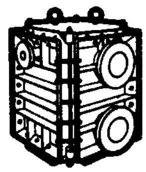
Monobolt® and Swing-Lok®
Heat Exchangers



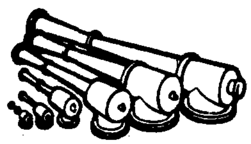
Surface Condensers



Flash-Vac Packaged
Evaporator-Condensers



Graphite Heat Exchangers
(in North America only)



Steam Jet Ejectors

graham
since 1936

Graham Manufacturing Co., Inc. Sales Headquarters: 20 Florence Avenue, Batavia, N.Y. 14020. Tel: 716-343-2216. Graham Manufacturing (Canada) Ltd. Graham Manufacturing Limited, England. Gramex, S. A. Mexico. Plants in U.S.A., United Kingdom, and Canada.

Representatives throughout the world.

2.6.3 Aux Steam Desuperheater

2.6.3.1 Identification

Tag number	Description
DS-902	Aux steam desuperheater

2.6.3.2 Description

Manufacturer: Copes-Vulcan Inc.
Lake City, Penn. 16423

Part no. VO-76

2.6.3.3 Prescribed Service

Steam

2.6.3.4 Vendor

Copes-Vulcan Inc.

2.6.3.5 Piping Connections

DOE dwg. no. 40P2005131905, CP 9

2.6.3.6 Operation/Maintenance

See following Copes-Vulcan, Inc. manuals form 60:37:30 and form 01:P120:37

P.O. BOX 577
LAKE CITY, PENNSYLVANIA 16423
PHONE: 814/774-3151
TELEX: 91-4414

COPES-VULCAN, Inc.

One of the White Consolidated Industries

C.V.I. JOB: 8110-21624

CUSTOMER ORDER: CM-0100-062

CUSTOMER: Waldinger Corporation
5132 Bolsa Suite 103
Huntington Beach, California

ULTIMATE USER: Solar 1 Power Plant
Santa Fe Road
Daggett, California

EQUIPMENT: Copes-Vulcan VO-76 Desuperheater

INSTALLATION OPERATION & MAINTENANCE INSTRUCTIONS

C.V.I. INSTRUCTION MANUAL
REPLACEMENT PRICE - $5.50

(Prices not firm. Price invoiced will be that obtaining at time of shipment.)

Form SRV 2 Rev. 8/77

NOTE:

BE SURE THIS INSTRUCTION MANUAL REACHES THE PERSONNEL RESPONSIBLE FOR THE OPERATION, INSTALLATION, AND MAINTENANCE OF THIS EQUIPMENT.

THIS MANUAL HAS BEEN PREPARED FOR USE BY COMPETENT AND KNOWLEDGEABLE PERSONNEL. IT IS IMPORTANT THAT THIS EQUIPMENT NOT BE INSTALLED, OPERATED OR MAINTAINED WITHOUT READING, UNDERSTANDING, AND FOLLOWING THE PROPER COPES-VULCAN PROCEDURES, OTHERWISE PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

COPES-VULCAN, INC.
One of the White Consolidated Industries
WCI

TABLE OF CONTENTS

for

CV JOB #8110-21624

Form SRV3, Rev. 10/77

COPES-VULCAN

One of the White Consolidated Industries

FORM 60:37:30
10/79

GENERAL INFORMATION

No control system will operate satisfactorily if it is not properly installed, operated and maintained.

These instructions outline the correct procedure. Follow them closely to be sure of best operating results, trouble free operation and long service life.

We want your Copes-Vulcan equipment to give you the best possible service. If you ever have any questions about operation, maintenance or related problems, please feel free to write to us.

Check the Material

Do not start installation until material has been carefully checked against the list furnished by Copes-Vulcan. Be sure the unpacked material is for the boiler on which it is to be installed.

A WORD OF CAUTION

Carelessness in repairing steam or air control equipment can cause serious injuries. Accidents can be prevented by taking simple precautions.

Always get permission and a release from the proper authority before starting to repair any equipment. Use proper lifting equipment for heavy equipment. Do not attempt repairs beyond your ability.

Before repairing any equipment operated by steam or air, make sure all supply valves have been closed, tagged or locked. If steam or air supply lines must be energized, for purpose of test, use extreme caution.

Ordering Repair Parts

In ordering parts, always give the following:

Name and number of parts as found on the parts list drawing.

Serial number as found on the brass name plate attached to the unit.

If your company name has changed since your Copes-Vulcan equipment was ordered, please give the old name. This is the name listed in Copes-Vulcan files.

Parts prices are not listed in this booklet. A quotation will be submitted on request or we will bill for them at the lowest prevailing prices.

Material & Workmanship Guarantee

Copes-Vulcan guarantees the control equipment for a period of one year from date of shipment against defects in material and workmanship and will replace any defective parts F.O.B. Lake City, Pennsylvania, if such parts be returned to the Copes-Vulcan plant with shipping charges prepaid.

Copes-Vulcan Service Policy

Copes-Vulcan maintains a staff of competent Service Engineers strategically placed in territories about the United States and Canada. These Engineers are available on receipt of a written purchase order to provide the following types of service:

1. Supervision of erection.
2. Make initial start-up of equipment.
3. Assist in repair or maintenance.
4. Instruction of operating and maintenance personnel.

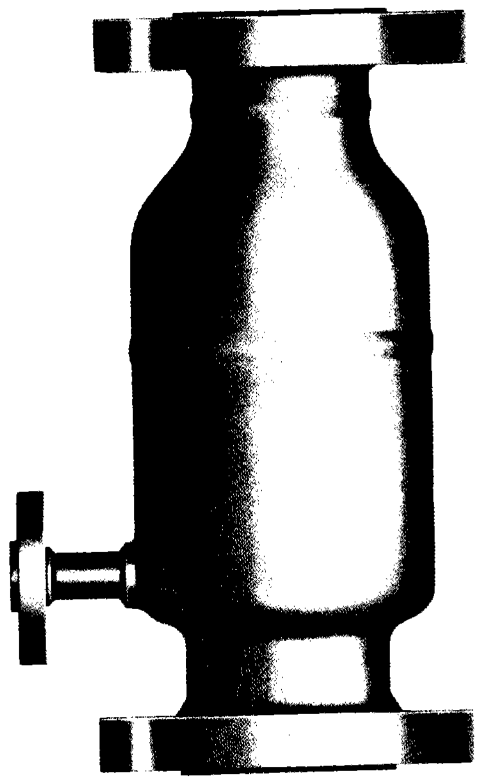
Service Engineers regularly inspect all installations of Copes-Vulcan equipment on water tube boilers. There is no charge to the user for these inspections, however, they are scheduled at Copes-Vulcan's convenience. Usually when an Engineer is in a specific area he will, time permitting, schedule inspection calls on all customers in that area.

Copes-Vulcan service makes sure that its equipment performs at peak efficiency and that the user's operators are taught preventive maintenance to assure effective operation at lowest possible cost.

Requests for emergency service calls will be handled as quickly as possible if addressed to Copes-Vulcan's MANAGER OF SERVICE. Such calls are generally made at the customer's expense, at a fixed per-diem rate plus traveling expenses.

INSTALLATION and MAINTENANCE INSTRUCTIONS

V76



DESUPERHEATER

1. PURPOSE

The purpose of a desuperheater is to introduce cooling water into superheated steam, cause the steam and water to mix, and reduce the total steam temperature to any temperature above saturated and below initial.

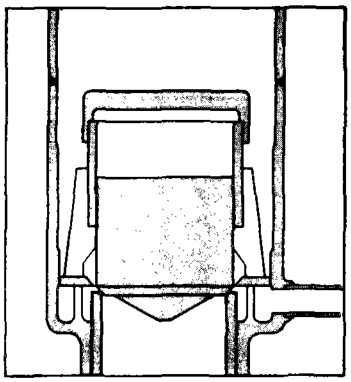
To produce rapid absorption of water by the steam, it is necessary to break the water up into fine droplets, hence the area of water exposed to steam is very great and evaporation is rapid.

2. FUNCTION

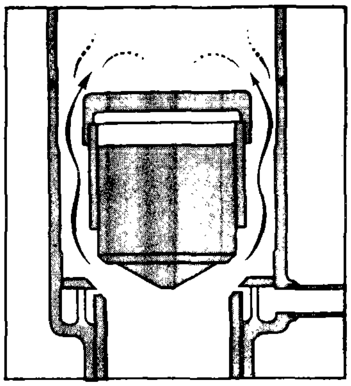
One method of achieving the break up of water is to subject the mixture of steam and water to a pressure drop by introducing a restriction in the path of flow.

The characteristic of the drop across a restriction is, however, undesirable, due to the fact that in order to have enough drop to cause turbulence at low loads we must take a high drop at increased loads.

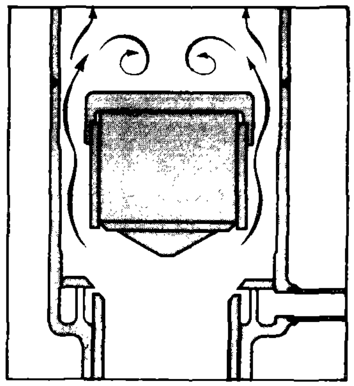
The variable orifice desuperheater nullifies this undesirable characteristic, in that it permits a relatively constant drop through the full load range.



No load: Plug has seated itself on the ring. There is no flow of steam — and no flow of cooling water into the steam.



Light load: Plug opens orifice slightly. Cooling water is instantly and intimately mixed with the steam.



Full load: Orifice fully opened. There is the same pressure drop and high turbulence at all loads over the full range.

3. INSTALLATION

This desuperheater must be mounted in a vertical position. The direction of steam flow is from bottom to top. As steam flows against and around the flow plug, it is lifted. The greater the steam flow, the higher the flow plug is lifted. The ΔP across a variable orifice desuperheater is similar to that of other restrictions in pipe lines, and can be so calculated. The desuperheater will cause a pressure loss equal to that which occurs in a specific length of pipe during unrestricted flow. The maximum pressure loss depends on the minimum throat diameter of the desuperheater. The formula for calculating this ΔP is $L = D \times 122$, where D is the diameter in feet of the desuperheater throat, and L is the length of unrestricted pipe which will undergo a pressure drop equivalent to the desuperheater.

IMPORTANT: To avoid the possibility of a waterhammer on the inlet port of the desuperheater, C.V.I. recommends the installation of a steam trap at the lowest point in the line before the inlet port of the desuperheater.

Cooling water is introduced just upstream of the restriction and enters the steam flow pattern around the seat.

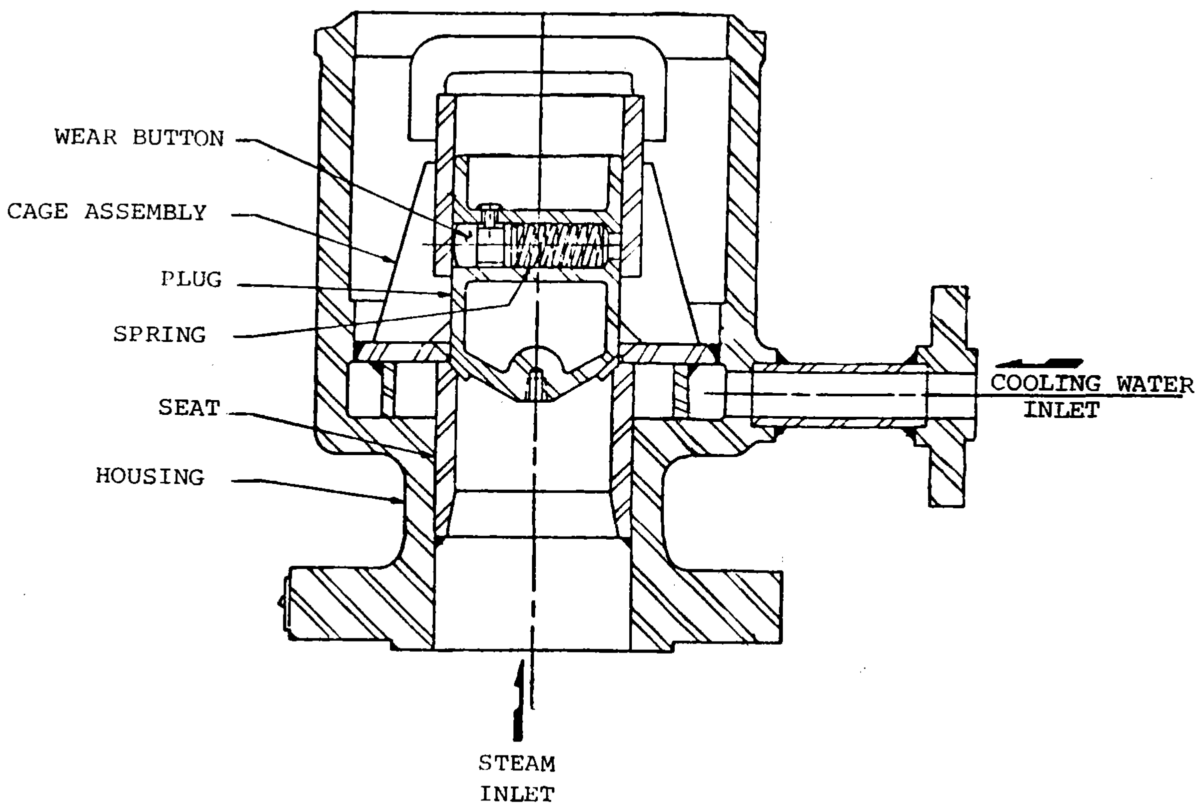
The reduced steam temperature is measured by a control instrument, whose sensing element is usually about 20 feet downstream of the desuperheater outlet. The pneumatic control signal from this instrument positions a cooling water control valve which regulates the flow of water in response to the measured temperature.

4. MAINTENANCE

The VO-76 Desuperheater should not require removal of its internals, but if for any reason it should be necessary, the complete unit should be removed from the line.

With the desuperheater upside down, carefully grind out the weld fillet at the inlet end and remove the seat. The seat can be reused if it has not been damaged. The plug, spring, and wear button can now be removed.

If the desuperheater is welded in the line, the plug can also be removed in the following manner. Cut the unit at the butt weld of the desuperheater housing outlet and at the reducer outlet. Remove the reducer from the line. This will allow access to the stop bar which, in turn, can be removed by either grinding or burning. This will permit removal of the plug, spring, and wear button.



5. RECOMMENDED SPARE PARTS

There are no recommended spare parts for the VO-76 Desuperheater, only periodic inspection is advised.

NOTE: For further instructions on water flow control, refer to instructions covering the valve and other instruments.

COPES-VULCAN, Inc.

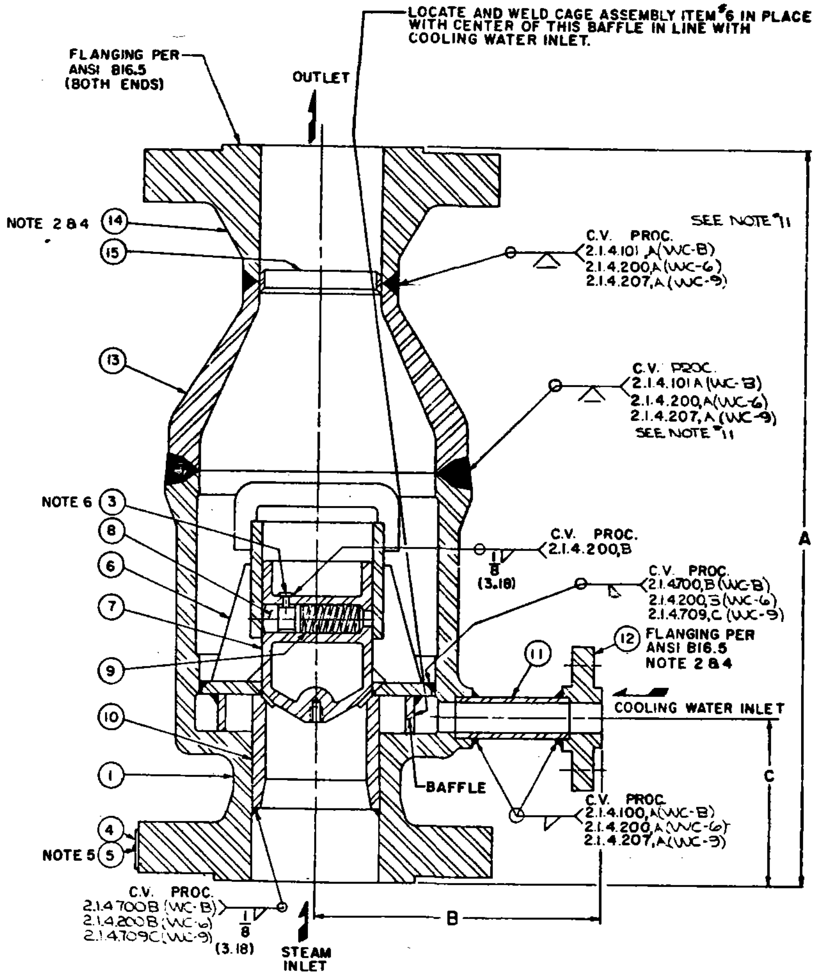
Lake City, Pennsylvania 16423

One of the White Consolidated Industries

NOTES CONT'D.

9. SEAT NOZZLE AREAS ARE SIZED FOR SERVICE CONDITIONS PER CVI ENGINEERING STANDARD #50-2.5.14, SEAT PART NUMBERS MUST BE CALLED FOR ON SHOP ORDER.

10. THE MAXIMUM ALLOWABLE INLET TEMPERATURE IS 800°F FOR WCB AND 1050°F FOR WC6 & FOR WC9



DIMENSIONS							
C ±3/8" (9.52)	5-11/16" (144.46)	5-11/16" (144.46)	5-11/16" (144.46)	5-11/16" (144.46)	6-3/16" (157.16)	7-3/16" (182.56)	
B ±3/8" (9.52)	8-3/4" (222.25)	9-1/8" (231.78)	9-3/8" (238.12)	9-3/8" (238.12)	10-3/16" (258.76)	13-1/16" (331.79)	
A ±3/4" (19.05)	24" (609.60)	24-3/8" (619.12)	24-3/4" (628.65)	25 1/4" (641.35)	26-1/4" (666.75)	27-5/8" (701.68)	
	150	300	400	600	900	1500	2500

PRESSURE CLASS

NOTES:

11. FOR CLASS 150, 300, 400, 600 USE PROC. 2.1.4100 A (WC-B) 2.1.4200 A (WC-6) 2.1.4207 A (WC-9)
12. WELDING OF ONLY PRESSURE RETAINING PARTS PER CHAPTER V OF ANSI B-31.1 ANY PRESSURE RETAINING WELD WITH A THICKNESS OF GREATER THAN 3/4" MUST HAVE PWHT.

NOTES:

1. DESUPERHEATER MUST OPERATE IN A VERTICAL LINE WITH FLOW UPWARD.
2. ALL FLANGE BOLT HOLES STADDLE ℄'S.
3. DIMENSION TABLE ON DWG. L-178763
4. INLET, OUTLET, AND COOLING WATER FLANGE PRESSURE STANDARD SAME AS DESIGNATED PRESSURE STANDARD OF DESUPERHEATER.
5. FOR DRIVE STUD NO. 37 DRILL, 3/16 DEEP, 2 HOLES, AT ASSEMBLY.
6. BEFORE INSTALLING FLOW PLUG, INSERT SPRING & WEAR BUTTON IN FLOW PLUG WELD PIN IN PLACE.
7. ASSEMBLY SEQUENCE OF INTERNALS: WELD CAGE ASSEMBLY ITEM #6 INTO HOUSING ITEM #1, INSTALL FLOW PLUG ASSEMBLY FROM NOTE #6, WELD SEAT ITEM #10 INTO HOUSING ITEM #1, SEAT SHOULD BUTT AGAINST BOTTOM SURFACE OF CAGE ASSEMBLY.
8. IN ORDER TO REMOVE PLUG, THE FILLET WELD BELOW THE SEAT MUST BE MACHINED OFF AND THE SEAT REMOVED.

DIMENSIONS IN INCHES AND (MILLIMETERS)

REVISION STATUS OF SHEETS							
SHT 1	1	2	3	4	5	6	7
SHT 2	1	2	3	4	4	6	-

NO.	DATE	REVISIONS	BY	CHK
1	[illegible]	ADDED REV. STATUS BLOCK [illegible]	[illegible]	[illegible]
2	[illegible]	[illegible] REV. STATUS BLOCK [illegible]	[illegible]	[illegible]
3	[illegible]	CLASS 600 [illegible] REV. STATUS [illegible]	[illegible]	[illegible]
4	5-17-77	ADDED NOTE 9 & UPDATED REV. STATUS BLOCK E.C. 6226	GSC	[illegible]
5	[illegible]	ADDED NOTE 10 PER E.C. 6268	[illegible]	[illegible]
6	[illegible]	UPDATED REV. STATUS BLOCK PER E.C. 6318	JHR	[illegible]
7	4-28-80	WELD GENERAL REVISION & ADDED NOTES #11,12 PER ENG. C. 6397	[illegible]	[illegible]

REPRO FROM

PART CODE 3

COPES-VULCAN, INC.

LAKE CITY (ERIE CO.) PA. U.S.A.

4"-VO-76 ASSEMBLY
VARIABLE ORIFICE DESUPERHEATER
ARRANGEMENT NO. 3

DFTSMN. [illegible] DATE [illegible] JOB NO.
CHECKED [illegible] DATE [illegible] SCALE
APP'D T.R.S. DATE [illegible]

DWG. NO. E-177939 SHT. 1 OF 2 REV. 7

ARRG'T. PART NO.	178193	178194	178195	178196	178197	178198	178199	178200	178201	178202	178203	178204	178205	178206
CONSTR	WC-8	WC-6	WC-8	WC-6	WC-8	WC-6	WC-8	WC-6	WC-9	WC-6	WC-9	WC-6	WC-8	WC-6
PRESS CLASS	150	150	300	300	400	400	600	600	900	900	1500	1500	2500	2500
SIZE	4"													

NUMBER REQUIRED

ITEM NO.	PART NO.	PART CODE	DESCRIPTION	MAT'L.	MAT'L. SPEC	DWG. NO.	REMARKS
1	176977-R	3	HOUSING	STEEL	ASTM-A-216	E-176977	GR. WC-8
	176977-S	3	HOUSING	STEEL	ASTM-A-217	E-176977	GR. WC-6
	176978-R	3	HOUSING	STEEL	ASTM-A-216	E-176978	GR. WC-8
	176978-S	3	HOUSING	STEEL	ASTM-A-217	E-176978	GR. WC-6
	191750-R	3	HOUSING	STEEL	ASTM-A-216	E-191750	GR. WC-8
	191750-S	3	HOUSING	STEEL	ASTM-A-217	E-191750	GR. WC-6
	176979-R	3	HOUSING	STEEL	ASTM-A-216	E-176979	GR. WC-8
	176979-S	3	HOUSING	STEEL	ASTM-A-217	E-176979	GR. WC-6
	176980-T	2	HOUSING	STEEL	ASTM-A-217	E-176980	GR. WC-9
	176980-S	3	HOUSING	STEEL	ASTM-A-217	E-176980	GR. WC-6
	18 8 -T	2	HOUSING	STEEL	ASTM-A-217	E-181811	GR. WC-9
	8 8 -S	2	HOUSING	STEEL	ASTM-A-217	E-181811	GR. WC-6
			HOUSING	STEEL	ASTM-A-216	E-	GR. WC-8
			HOUSING	STEEL	ASTM-A-217	E-	GR. WC-6
2							
3	177066	3	LOCK PIN	STEEL		S-177066	SAE-4140
4	97971	3	IDENT. PLATE.	BRASS	ASTM-B-36	M-97971	
5	64341	3	NO. 4-DRIVE STUD	STEEL	COM'L		3/16"-LG RD HD.
6	177314	3	CAGE ASSEMBLY			177314	
7	177334	3	FLOW PLUG	STEEL	ASTM-A-217	177334	GR. WC-6
8	177374	3	WEAR BUTTON	ST. STEEL	ASTM-A-479	M-177374	TYPE 410
9	177472	3	SPRING	ALY. ST'L	ASTM-A-286	M-177472	
10	NOTE-9	3	SEAT	STEEL	ASTM-A-335	E-189445	GR. P-11
11	64092	3	MANIFOLD	STEEL	ASTM-A-53	S-64092	GR. A
	86408	3	MANIFOLD	STEEL	ASTM-A-335	S-64092	GR. P-11
	182410 G	2	MANIFOLD	STEEL	ASTM-A-335	S-64092	GR. P-22
	132 6	3	MANIFOLD	STEEL	ASTM-A-335	S-132161	GR. P-11
	1824093	2	MANIFOLD	STEEL	ASTM-A-335	S-132161	GR. P-22
			MANIFOLD	STEEL	ASTM-A-335	S-	GR. P-11
12	70181	3	SOC. WELD FLANGE	STEEL	ASTM-A-181		GR. 1
	88380	3	SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-11
	70182	3	SOC. WELD FLANGE	STEEL	ASTM-A-181		GR. 1
	88381	3	SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-11
			SOC. WELD FLANGE	STEEL	ASTM-A-105		
	70183	3	SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-11
	88382	3	SOC. WELD FLANGE	STEEL	ASTM-A-105		
	132079	3	SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-11
	16 8 8	3	SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-22
			SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-11
			SOC. WELD FLANGE	STEEL	ASTM-A-105		
			SOC. WELD FLANGE	STEEL	ASTM-A-182		GR. F-11
13	177403	3	REDUCER	STEEL	ASTM-A234		GR. B
	1773[illegible]	3	REDUCER	STEEL	ASTM-A234		GR. WP-11
	177349	3	REDUCER	STEEL	ASTM-A234		GR. B
	177262	3	REDUCER	STEEL	ASTM-A234		GR. WP-11
	177350	3	REDUCER	STEEL	ASTM-A234		GR. WP-22
	177263	3	REDUCER	STEEL	ASTM-A234		GR. WP-11
			REDUCER	STEEL	ASTM-A-		GR
			REDUCER	STEEL	ASTM-A-		GR
			REDUCER	STEEL	ASTM-A-		GR
			REDUCER	STEEL	ASTM-A-		GR

ARRG'T. PART NO.	178193	178194	178195	178196	178197	178198	178199	178200	178201	178202	178203	178204	178205	178206
CONSTR	WC-8	WC-6	WC-8	WC-6	WC-8	WC-6	WC-8	WC-6	WC-9	WC-6	WC-9	WC-6	WC-8	WC-6
PRESS CLASS	150	150	300	300	400	400	600	600	900	900	1500	1500	2500	2500
SIZE	4"													

NUMBER REQUIRED

ITEM NO.	PART NO.	PART CODE	DESCRIPTION	MAT'L.	MAT'L. SPEC	DWG. NO.	REMARKS
14	65341	3	OUTLET FLANGE	STEEL	ASTM-A-105		
	86351	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-11
	65342	3	OUTLET FLANGE	STEEL	ASTM-A-105		
	86352	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-11
	177420	3	OUTLET FLANGE	STEEL	ASTM-A-105		
	177359	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-11
	65344	3	OUTLET FLANGE	STEEL	ASTM-A-105		
	86353	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-11
	177625	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-22
	177360	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-11
	177635	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-22
	132560	3	OUTLET FLANGE	STEEL	ASTM-A-182		GR. F-11
15	177224	3	DIFFUSER RING	STEEL	AISI-1015	M-177224	
	177225	3	DIFFUSER RING	STEEL	AISI-1015	M-177225	
	177226	3	DIFFUSER RING	STEEL	AISI-1015	M-177226	
			DIFFUSER RING	STEEL	AISI-1015		

NO.	DATE	REVISIONS	BY	CHK
1		[illegible]		
2		[illegible] ON CLASS 900 [illegible] WAS WC-B [illegible]	EP	SG
2		[illegible] ITEM [illegible] PER ENG. CHG 5994.	EP	GG
4		ITEM #10, P/N [illegible]		
4		[illegible] 177135 PER ENG. [illegible]		
6		[illegible] CLASS 400 ASSEMBLIES PER E-C 6318.		

COPES-VULCAN, INC.
LAKE CITY (ERIE CO.) PA. U.S.A.

4"-VO-76 ASSEMBLY
VARIABLE ORIFICE DESUPERHEATER
ARRANGEMENT NO. 3
BILL OF MATERIAL

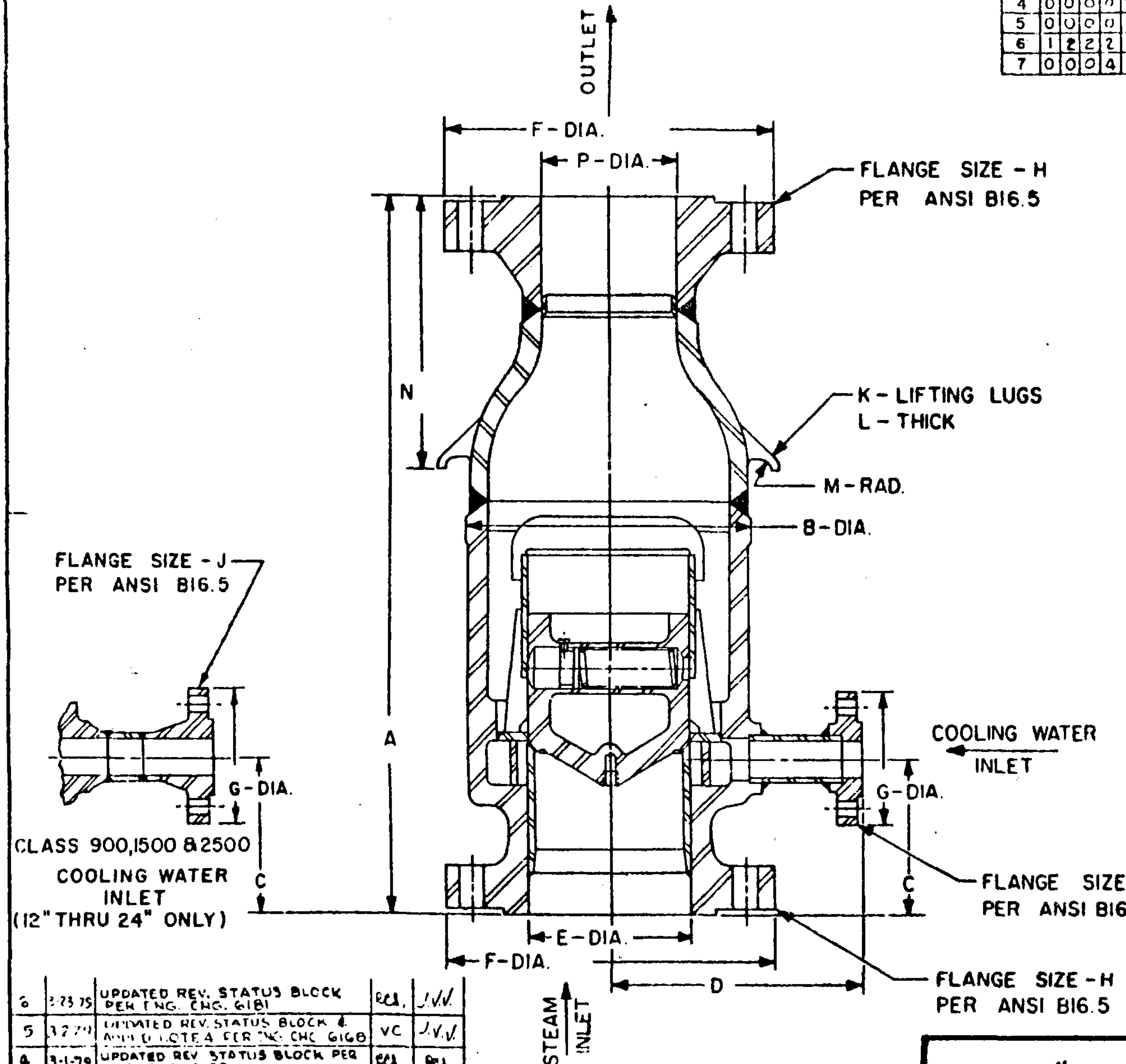
DFTSMN [illegible] DATE [illegible] JOB NO.
CHECKED [illegible] DATE [illegible] SCALE
APP'D [illegible] DATE [illegible]

REPRO FROM
PART CODE 3

DWG. NO. E-177939 (SHT 2 OF 2) REV. 6

2.6.3-12

REVISION STATUS						
SHT NO.	REVISION NO.					
1	1	2	3	4	5	6
2	1	2	3	3	3	3
3	1	1	2	2	5	6
4	0	0	0	0	5	5
5	0	0	0	0	5	5
6	1	2	2	2	5	5
7	0	0	0	4	5	5



NOTES:

1. DESUPERHEATER MUST OPERATE IN A VERTICAL LINE WITH FLOW UPWARD.
2. ALL BOLT HOLES STRADDLE CENTER LINES.
3. COOLING WATER INLET FLANGE, INLET AND OUTLET FLANGE PRESSURE CLASS, SAME AS DESIGNATED PRESSURE CLASS OF DESUPERHEATER.
4. FOR SIZES 2" THRU 6", THE LIFTING LUGS ARE ATTACHED TO THE HOUSING RATHER THAN TO THE REDUCER AS SHOWN.

DIMENSIONS IN INCHES AND (MILLIMETERS)

NO.	DATE	REVISIONS	BY	CHK
6	3-23-79	UPDATED REV. STATUS BLOCK PER ENG. CHG. 6181	ecl.	J.V.V.
5	3-7-79	UPDATED REV. STATUS BLOCK & ADDED NOTE 4 PER ENG. CHG. 6168	VC	J.V.V.
4	3-1-79	UPDATED REV. STATUS BLOCK PER ENG. CHG. 6158	ecl.	ecl.
1	5-20-77	ADDED REVISION STATUS BLOCK & COOLING WATER INLET DETAIL PER ENG. CHG. [illegible]	GG	[illegible]

NO	DATE	REVISIONS	BY	CHK
2	9-12-77	UPGRADED REV. STATUS BLOCK PER ENG. CHG 5950	EP	[illegible]
3	11-30-77	UPGRADED REV. STATUS BLOCK PER ENG. CHG. 5996.	EP	JVV

CV JOB# 8110-21624
4" 300# (WCL) VO-76

COPES-VULCAN, INC.
One of the White Consolidated Industries
LAKE CITY (ERIE CO.) PA. U.S.A.

VARIABLE ORIFICE DESUPERHEATER
MODEL VO-76 DIMENSIONAL
ARRANGEMENT NO. 3

DFTSMN W.J.	DATE 2-11-77	DSGN T.R.S.	DATE 3-11-77
CHECKED [illegible]	DATE 3-15-77	MFG	DATE
	DATE		DATE

SCALE | DWG. NO. L-178763 | SHT. 1 OF 7 | REV. 6

2.6.3-13

	SIZE - 4"						
CLASS	~~150~~	300	~~400~~	~~600~~	~~900~~	~~1500~~	~~2500~~
A ± 3/4" (19.05)	24" (609.60)	24-3/8" (619.12)	24-3/4" (628.65)	25¼ (641.35)	26-1/4" (666.75)	27-5/8" (701.68)	
B-DIA	11-1/8" (282.58)	11-1/8" (282.58)	11-15/16" (303.21)	11-15/16" (303.21)	10-1/4" (260.35)	11-1/8" (282.58)	
C ± 3/8" (9.52)	5-11/16" (144.46)	5-11/16" (144.46)	5-11/16" (144.46)	5-11/16" (144.46)	6-3/16" (157.16)	7-3/16" (182.56)	
D ± 3/8" (9.52)	8-3/4" (222.25)	9-1/8" (231.78)	9-3/8" (238.12)	9-3/8" (238.12)	10-3/16" (258.76)	13-1/16" (331.79)	
E-DIA.	4-3/8" (111.13)	4-3/8" (111.13)	4-3/8" (111.13)	4-3/8" (111.13)	4-3/8" (111.13)	4-3/8" (111.13)	
F-DIA	9" (228.60)	10" (254.00)	10" (254.00)	10-3/4" (273.05)	11-1/2" (292.10)	12-1/4" (311.15)	
G-DIA.	4-1/4" (107.95)	4-7/8" (123.82)	4-7/8" (123.82)	4-7/8" (123.82)	5-7/8" (149.22)	5-7/8" (149.22)	
H-FLANGE	4" (101.60)	4" (101.60)	4" (101.60)	4" (101.60)	4" (101.60)	4" (101.60)	
J-FLANGE	1" (25.40)	1" (25.40)	1" (25.40)	1" (25.40)	1" (25.40)	1" (25.40)	
K-NO. LUGS	2	2	2	2	2	2	
L-THICK	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	
M-RAD.	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	
N	17" (431.80)	17-3/8" (441.33)	*	17-5/8" (447.68)	18-1/4" (463.55)	*	
P-DIA.	4.026 (102.26)	4.026 (102.26)	3.826 (97.18)	3.826 (97.18)	3.438 (87.33)	3.438 (87.33)	

	~~SIZE 6"~~						
~~CLASS~~	~~150~~	~~300~~	~~400~~	~~600~~	~~900~~	~~1500~~	~~2500~~
A ± 1" (25.40)	28" (711.20)	28-3/8" (720.72)	28-13/16" (731.84)	29-3/8" (746.12)	30-1/4" (768.35)	34-1/4" (869.95)	39-3/16" (995.36)
B-DIA.	13-3/16" (334.96)	13-3/16" (334.96)	13" (330.20)	13" (330.20)	12-3/8" (314.32)	13-1/2" (342.90)	15-5/8" (396.88)
C ± 3/8" (9.52)	7" (177.80)	7" (177.80)	7" (177.80)	7" (177.80)	6-3/4" (171.45)	9-3/4" (247.65)	13-3/8" (339.72)
D ± 3/8" (9.52)	10-7/8" (276.23)	11-3/16" (284.16)	11-5/8" (295.28)	11-5/8" (295.28)	12-3/8" (314.32)	15" (381.00)	17-1/4" (435.17)
E-DIA.	6-1/2" (165.10)	6-1/2" (165.10)	6-1/2" (165.10)	6-1/2" (165.10)	6-1/2" (165.10)	6-1/2" (165.10)	6-1/2" (165.1)
F-DIA.	11" (279.00)	12-1/2" (317.50)	12-1/2" (317.50)	14" (355.60)	15" (381.00)	15-1/2" (393.70)	9" (228.6)
G-DIA	5" (127.00)	6-1/8" (155.58)	6-1/8" (155.58)	6-1/8" (155.58)	7" (177.80)	7" (177.80)	8" (203.2)
H-FLANGE	6" (152.40)	6" (152.40)	6" (152.40)	6" (152.40)	6" (152.40)	6" (152.40)	6" (152.4)
J-FLANGE	1-1/2" (38.10)	1-1/2" (38.10)	1-1/2" (38.10)	1-1/2" (38.10)	1-1/2" (38.10)	1-1/2" (38.10)	1-1/2" (38.10)
K-NO LUGS	2	2	2	2	2	2	2
L-THICK	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)	3/4" (19.05)
M-RAD	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)	5/8" (15.88)
N	17-3/4" (450.85)	18-1/8" (460.38)	18-5/16" (465.14)	18-7/8" (479.43)	20" (508.00)	21¼" (539.75)	22-9/16 (573.09)
P-DIA.	6.065 (154.05)	6.065 (154.05)	5.761 (146.33)	5.761 (146.33)	5.187 (131.75)	5.187 (131.75)	4.897 (124.38)

* TO BE DETERMINED

DIMENSIONS IN INCHES AND (MILLIMETERS)

NO	DATE	REVISIONS	BY	CHK
6	3-13-79	6" CLASS 1500 'A' DIM. WAS 31½, ADDED 'N' DIM. 21¼, CLASS 2500 'D' DIM. WAS 17½ PER ENG. CHG 6181	FCL	JVV
1	5-20-77	ADDED 6" CLASS 2500 DIMENSIONS	GG.	FCL
2	11-30-77	'C' DIM'N. FOR 6" CLASS 900 WAS 7" (177.80) ENG. CHG. 5996	EP	
5	3-12-79	4" CLASS 600 'A' DIM. WAS 25" & 6" CLASS 1500 WAS 34¼ PER ENG. CHG. 6168	FCL	JVV

CV JOB #8110-21624
4" 300# (WC6) VO-76

COPES-VULCAN, INC.
One of the White Consolidated Industries
LAKE CITY (ERIE CO.) PA. U S A

VARIABLE ORIFICE DESUPERHEATER MODEL VO-76 DIMENSIONAL ARRANGEMENT NO 3

DFTSMN W.J.	DATE 2-11-77	DSGN T.R.S.	DATE 3-11-77
CHECKED RG	DATE 3-15-77	MFG.	DATE
	DATE		DATE
SCALE	DWG. NO. L-178763 SHT. 3 OF 7	REV. 6	

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
F-901	Instrument Air Afterfilter	2.7.1	5163162
F-902	Instrument Air Afterfilter	2.7.1	5163162
F-903	Instrument Air Prefilter	2.7.1	5163162
F-904	Instrument Air Prefilter	2.7.1	5163162
PF-FW-200-201	Feedwater Filter	2.7.2	5163133
PF-FW-204-204	Boiler Feedwater Filter	2.7.3	5163134
PF-FW-205-205	Boiler Feedwater Filter	2.7.3	5163134
PF-FW-206-206	Boiler Feedwater Filter	2.7.3	5163134
PF-FW-207-207	Boiler Feedwater Filter	2.7.3	5163135
PF-FW-208-208	Boiler Feedwater Filter	2.7.3	5163135
PF-FW-209-209	Boiler Feedwater Filter	2.7.3	5163135
PF-FW-210-210	Boiler Feedwater Filter	2.7.3	5163136
PF-FW-211-211	Boiler Feedwater Filter	2.7.3	5163136
PF-FW-212-212	Boiler Feedwater Filter	2.7.3	5163136
PF-FW-213-213	Boiler Feedwater Filter	2.7.3	5163137
PF-FW-214-214	Boiler Feedwater Filter	2.7.3	5163137
PF-FW-215-215	Boiler Feedwater Filter	2.7.3	5163137
PF-FW-216-216	Boiler Feedwater Filter	2.7.3	5163138

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
PF-FW-217-217	Boiler Feedwater Filter	2.7.3	5163138
PF-FW-218-218	Boiler Feedwater Filter	2.7.3	5163138
PF-FW-219-219	Boiler Feedwater Filter	2.7.3	5163139
PF-FW-220-220	Boiler Feedwater Filter	2.7.3	5163139
PF-FW-221-221	Boiler Feedwater Filter	2.7.3	5163169
PF-MS-4-301	Condenser Steam Line Strainer	2.7.4	5163144
PF-MS-4-302	Condenser Steam Line Strainer	2.7.4	5163144
PF-N-200-201	Nitrogen Filter	2.7.5	5163140
PF-TO-3-301	Charging Pump Oil Filter	2.7.6	5163142
PF-TO-3-302	Charging Pump Oil Filter	2.7.6	5163142
PF-TO-3-305	Aux. Pump Oil Strainer	2.7.7	5163145
(THSST-1)	TS Heater Steam Line Strainer	2.7.8	
(THSST-2)	TS Heater Steam Line Strainer	2.7.8	
PF-SW-28-1	Service Water Strainer	2.7.9	5133152
PF-TO-1-1	TSS-Thermal Oil Strainer	2.7.9	5133152
TF-CO-15-1	Condensate Strainer-Temporary	2.7.10	5132193
TF-DW-2-1	Demineralized Water Strainer-Temporary	2.7.10	5132193
TF-TO-4-1	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132192
TF-TO-5-2	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132192
TF-TO-25-3	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132194
TF-TO-26-4	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132194
TF-TO-12-5	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132194
TF-TO-13-6	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132194

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
TF-TO-10-7	TSS-Thermal Oil Strainer-Temporary	2.7.10	5132196
TF-SP-1-1	Special Strainers-Temporary	2.7.10	5133151
TF-SP-2-2	Special Strainers-Temporary	2.7.10	5133151
TF-SP-9-3	Special Strainers-Temporary	2.7.10	5133151
TF-SP-12-4	Special Strainers-Temporary	2.7.10	5133151

2.7.3 Receiver Boiler Panel Feedwater Filter

2.7.3.1

Identification Tag Number	Description
PF-FW-204-204 thru PF-FW-221-221	Receiver Boiler Water Filter

2.7.3.2 Description

Manufacturer	:	Capital Westward, Paramount, Ca.
Part Number	:	10137
Rocketdyne Specification No.	:	SP42-046 (following)
Material	:	
Weight	:	30 lb.

2.7.3.3 Prescribed Service

Water

2.7.3.4 Vendor

Capital Westward

2.7.3.5 Special Cautions

Verify safe pressure and temperature before opening filter body.

2.7.3.6 Periodic Service

None

2.7.3.7 Parts List

See Rocketdyne drawings ROD12893 and ROD12894 (following)

2.7.3.8 Special Tools

None

2.7.3.9 Maintenance Instructions

1. Close feedwater inlet manual valve V-FW-200-201 to assure there will be no water inflow.

2. Shut off nitrogen blanket gas flow to preheaters RP-1 thru RP-3 and RP-22 thru RP-24 by closing the manual valve in nitrogen line 1"-N-202-KBA near pressure gauge P1-2017.

3. Energize SOV-2007 to open AOV-2007 and depressurize the preheater panels. Deenergize SOV-2007 when the pressure indicated by PI-2017 is less than 1 psig.

4. Remove the filter body and quickly remove the filter element. Install a clean replacement filter element. Torque to 25-30 ft-lbs. Seal can be reused 5 or more times. Replace seal if damaged. Replace sump and torque bolts to 45-50 ft-lbs.

5. Open the manual valve in the nitrogen line to reapply nitrogen blanket pressure.

6. Ultrasonic clean the removed filter element and return it to spare parts stock.

2.7.3.10 Acceptance Tests

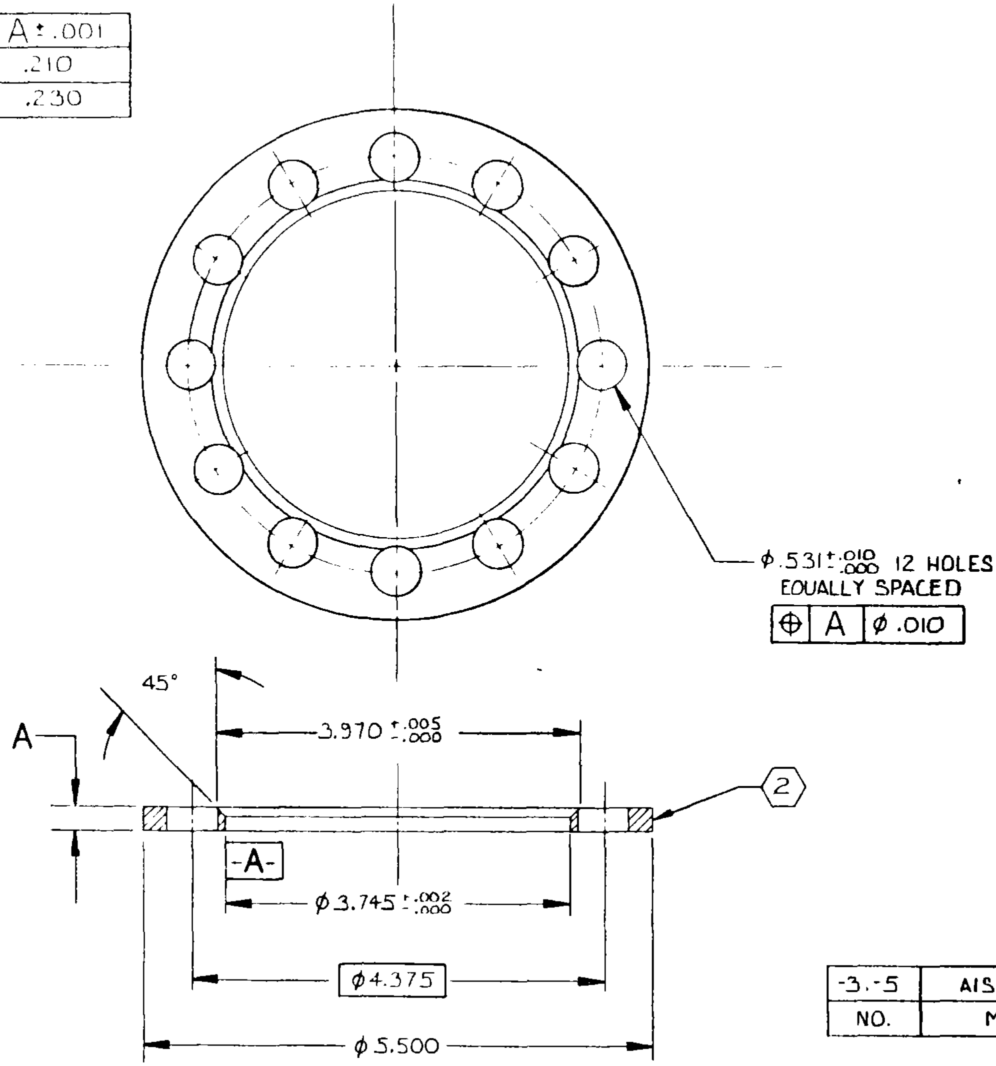
Check for leaks and retorque after the first and tenth thermal cycles.

2.7.3-5

REVISIONS

REV	DESCRIPTION	DISPN	DATE	APPROVED
	1. MAY BE REWORKED 2. CANNOT BE REWORKED 3. RECORD CHANGE 4. NOW SHOP PRACTICE 5. PARTS MADE OK			

DASH NO.	A ±.001
-3	.210
-5	.230



B/P FILES

THIS PRINT REDUCED
RELEASED DOCUMENT

-3,-5	AISI 1020 STL	———	ASTM-A-36
NO.	MATERIAL	SIZE	SPECIFICATION

(2) ELECTROCHEMICAL ETCH IDENTIFY PER RA0104-008 WITH PART NUMBER, DASH NUMBER AND "A" DIMENSION

1. MACHINE PER RA0103-016

NOTE: UNLESS OTHERWISE SPECIFIED

HEAT TREAT

FINISH

MATL NOTED

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES AND APPLY PRIOR TO FINISH.

125/ MACH. SURF. ROUGHNESS

TOLERANCES ON: ANGLES ± 0° 30' DECIMALS .XX ± .03 .XXX ± .010

HOLES NOTED "DRILL"

OVER	THRU	TOLERANCE	
.0000	.0400	+ .0015	— .0010
.0400	.1300	+ .0030	— .0010
.1300	.2290	+ .0045	— .0010
.2290	.5000	+ .0060	— .0010
.5000	.7500	+ .0070	— .0010
.7500	1.0000	+ .0090	— .0010
1.0000	2.0000	+ .0120	— .0010

DO NOT SCALE PRINT

CONTR —		
DWN D.E. Amo	DATE 82-1-26	
CHK W. Biller (DC)	DATE 82-1-28	
DSGN W. Biller		
MATL —		
STRUCT —		
DESIGN ACTIVITY APVD	DATE	

Rockwell International Corporation
Rocketdyne Division
Canoga Park, California

SHIM, FILTER ASSY

SIZE	FSCM NO	DWG NO
C	02602	R0012893

SCALE 1/1 SHEET

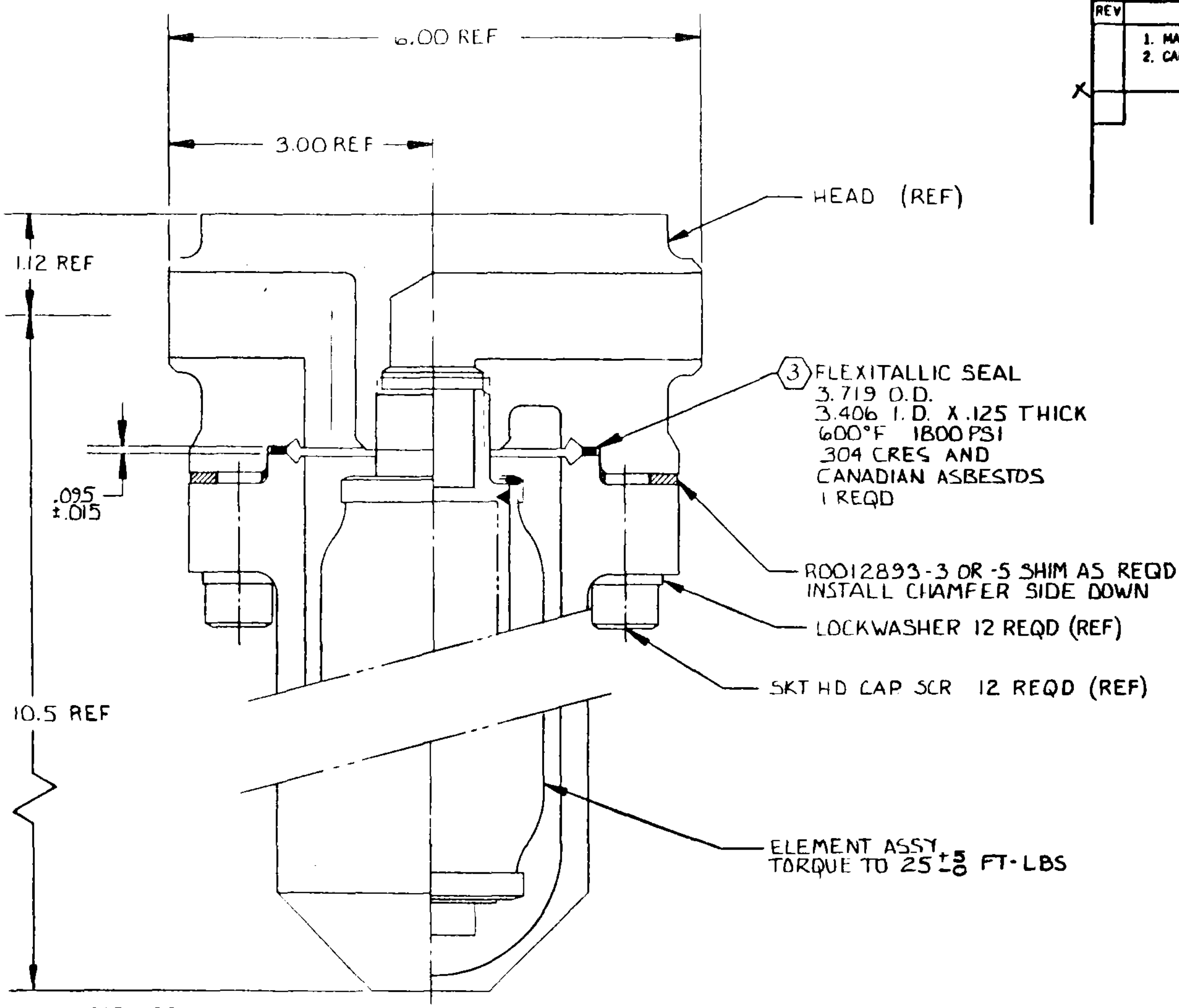
DWG NO R0012893

DIETERICH POST CLEARPRINT 1020

Dn-2

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	1. MAY BE REWORKED 3. RECORD CHANGE 2. CANNOT BE REWORKED 4. NOW SHOP PRACTICE 5. PARTS MADE OK		

DISPN



B/P FILES

THIS PRINT REDUCED - RELEASED DOCUMENT -

4. BOLT UP PROCEDURE
CLEAN THDS ON SKT HD CAP SCRS AND IN HEAD. THEN LUBRICATE THDS BY SPRAYING WITH MOLYKOTE SPRAY NO. 435 (M^c KAY MFG. CO.). LUBRICATE TOTAL LENGTH OF THD AND BOTH SIDES OF LOCKWASHERS. RUN UP ALL SKT HD CAP SCRS FINGERTIGHT. USING A CROSS-BOLTING TECHNIQUE, TORQUE ALL SKT HD CAP SCRS TO 12 ± 2 FT-LBS, REPEAT TORQUING TO 24 ± 2 FT-LBS, FINISH TORQUING TO 42 ± 2 FT-LBS

(3) FLEXITALLIC GASKET CO. INC., CAMDEN NJ

2. REWORK BY REPLACING SK118-3-805 SEAL WITH SEAL AND SHIM SHOWN

(1) CAPITAL WESTWARD, INC.

NOTE: UNLESS OTHERWISE SPECIFIED

ALTERED ITEM DWG

HEAT TREAT

FINISH

MATL
(1) MAKE FROM 10137

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES AND APPLY PRIOR TO FINISH.
125/ MACH. SURF. ROUGHNESS
TOLERANCES ON: ANGLES ± 0° 30' DECIMALS .XX ± .03 .XXX ± .010
HOLES NOTED "DRILL"

OVER	THRU	TOLERANCE
.0000	.0400	+ .0015 — .0010
.0400	.1300	+ .0030 — .0010
.1300	.2290	+ .0045 — .0010
.2290	.5000	+ .0060 — .0010
.5000	.7500	+ .0070 — .0010
.7500	1.0000	+ .0090 — .0010
1.0000	2.0000	+ .0120 — .0010

DO NOT SCALE PRINT

CONTR —		
DWN D E Disano	DATE 82-1-21	
CHK W. Gillen (DC)	DATE 82-1-21	
DSGN W Gillen		
MATL		
STRUCT		
DESIGN ACTIVITY APVD E Cohen	DATE 4/22/82	

Rockwell International Corporation
Rocketdyne Division
Canoga Park, California

FILTER ASSEMBLY

SIZE	FSCM NO	DWG NO
C	02602	R0012894
SCALE 1/1		SHEET

DIETERICH POST CLEARPRINT 1020

SR-2

2.7.3-7

DWG NO R0012894

2.7 FILTER AND STRAINERS

2.7.9 Permanent Strainers

2.7.9.1

Identification Tag Number	Description
PF-SW-28-1	Stearns-Roger Strainers
PF-TO-1-1	

2.7.9.2 Maintenance Instructions

See following data sheets

Stearns-Roger

PERMANENT STRAINERS

P26-4

DOE NO. 40P70081

ORDER NO. C-21700

CUSTOMER

DEPARTMENT OF ENERGY
10MWe SOLAR PILOT PLANT
DAGGETT CALIFORNIA

REVISION NO.	A	O	1									
ISSUE DATE	5/9/80	4/20/80	9/12/80									
FOR												
MDAC												
ROCKETDYNE												
SCE												
STMPO												

2.7.9-2

SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES
AC	ACID CLEANING		
AS	AUXILIARY STEAM		
BD	BLOW DOWN		
BO	BLOW OUT		
BW	BEARING COOLING WATER		
CO	CO2		
CF	CONDENSATE CYCLE FLUSH		
CH	CHEMICAL		
CG	CONDENSATE		
CW	CIRCULATING WATER		
DL	DRAINS TO DAYLIGHT		
DM	DOMESTIC WATER		
DO	DIESEL OIL		
DR	PLANT DRAINS		
DW	DEMINERALIZED WATER		
ED	EQUIPMENT DRAINS		
EW	EQUIPMENT COOLING WATER		
FP	FIRE PROTECTION		
FW	FEEDWATER		
HC	HEATING CONDENSATE		
HS	HEATING STEAM		

SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES
HW	HOT WATER DOMESTIC		
HY	HYDROGEN		
LO	LUBE OIL		
MM	MISCELLANEOUS		
MS	MAIN STEAM		
N	NITROGEN		
NA	INSTRUMENT AIR		
OW	OILY WATER DRAINS		
RD	ROOF DRAINS		
RW	RAW WATER		
SA	SERVICE AIR		
SP	SPECIAL		
SS	SANITARY SEWER		
ST	STEAM (INCL TRAPS)		
SW	SERVICE WATER	1	1
TO	THERMAL OIL	0	2
TW	TREATED WATER		
VT	VENTS (INCL RELIEF VALVES)		
WD	WASTE DRAINS		
XW	CHILLED WATER		

2.7.9-3

REV.	DATE	
△		Stearns-Roger
△		PERMANENT STRAINERS P26-4 LIST INDEX
△		
△		DEPARTMENT OF ENERGY 10MWe SOLAR PILOT PLANT DAGGET, CALIFORNIA
1	9-12-80	
0	6-20-80	
		ORDER NO. C-21700

	TAG NO.	SPEC. NO.	SIZE	TYPE	PRESS RATE	TEMP °F	ENDS	BODY MTL	STRAINER MTL	% OPN	SIZE OPN	FLUID	ΔP	MFG & NO.	REMARKS
△1	PF-SW-28-1	ABA	1"	Y-TYPE	150	100	THRD	CS	SS	36	0.015"	WATER	~1 PSI		REF. SH9, C.P.

REV	DATE
5	
4	
3	
2	
1	9-12-80
0	6-20-80

Stearns-Roger

PERMANENT STRAINERS

CUSTOMER DEPARTMENT OF ENERGY

PROJECT 10 MWe SOLAR PILOT PLANT

LOCATION DAGGETT, CALIFORNIA

ORDER NO. C-21700 PAGE 1 OF 1

E0.65 1-68

2794

TAG NO.	SPEC. NO.	SIZE	TYPE	PRESS RATE	TEMP °F	ENDS	BODY MTL	STRAINER MTL	% OPN	SIZE OPN	FLUID	ΔP	MFG & NO.	REMARKS
PE-TO-1-1	BBA	4"	SINGLE	150	60	RF	CS	SS	36	0.015"	OIL			REF [illegible], C.P.#9

2.7.9-5

Stearns-Roger

PERMANENT STRAINERS

REV	DATE	
5		
4		
3		
2		
1		
0	6-20-80	

CUSTOMER DEPARTMENT OF ENERGY

PROJECT 10 MWe SOLAR PILOT PLANT

LOCATION DAGGETT, CALIFORNIA

ORDER NO. C-21700 PAGE 1 OF 2

2.7 FILTER AND STRAINERS

2.7.10 Temporary Strainers

2.7.10.1

Identification Tag Number	Description
TF-CO-15-1	Stearns-Roger Strainers
TF-DW-2-1	
TF-TO-4-1	
TF-TO-5-2	
TF-TO-25-3	
TF-TO-26-4	
TF-TO-12-5	
TF-TO-13-6	
TF-TO-10-7	
TF-SP-1-1	
TF-SP-2-2	
TF-SP-9-3	
TF-SP-12-4	

2.7.10.2 Maintenance Instruction

See following data sheets.

Stearns-Roger

TEMPORARY STRAINERS

P26-5

DOE NO. 40P70091

ORDER NO. C-21700

CUSTOMER

DEPARTMENT OF ENERGY
10MWe SOLAR PILOT PLANT
DAGGETT CALIFORNIA

REVISION NO.	A	0	1	2								
ISSUE DATE	5/13/80	6/20/80	9/12/80	12/5/80								
FOR												
MDAC												
ROCKETDYNE												
SCE												
STMPO												

2.7.10-2

SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES
AC	ACID CLEANING		
AS	AUXILIARY STEAM		
BD	BLOW DOWN		
BO	BLOW OUT		
BW	BEARING COOLING WATER		
CD	CO_2		
CF	CONDENSATE CYCLE FLUSH		
CH	CHEMICAL		
CO	CONDENSATE	0	1
CW	CIRCULATING WATER		
DL	DRAINS TO DAYLIGHT		
DM	DOMESTIC WATER		
DO	DIESEL OIL		
DR	PLANT DRAINS		
DW	DEMINERALIZED WATER	0	1
ED	EQUIPMENT DRAINS		
EW	EQUIPMENT COOLING WATER		
FP	FIRE PROTECTION		
FW	FEEDWATER		
HC	HEATING CONDENSATE		
HS	HEATING STEAM		
HW	HOT WATER DOMESTIC		
HY	HYDROGEN		
LO	LUBE OIL		
MM	MISCELLANEOUS		
MS	MAIN STEAM		
N	NITROGEN		
NA	INSTRUMENT AIR		
OW	OILY WATER DRAINS		
RD	ROOF DRAINS		
RW	RAW WATER		
SA	SERVICE AIR		
SP	SPECIAL	2	1
SS	SANITARY SEWER		
ST	STEAM (INCL TRAPS)		
SW	SERVICE WATER		
TO	THERMAL OIL	0	1
TW	TREATED WATER		
VT	VENTS (INCL RELIEF VALVES)		
WD	WASTE DRAINS		
XW	CHILLED WATER		

27.10-3

REV.	DATE
2	12-4-80
1	9-12-80
0	6-20-80

Stearns-Roger

TEMPORARY STRAINERS P26-5
LIST INDEX

DEPARTMENT OF ENERGY
10MWe SOLAR PILOT PLANT
DAGGET, CALIFORNIA

ORDER NO. C-21700

TAG NO.	SIZE	TYPE	PRESS RATE	ENDS	BODY MTL.	STR MTL.	% OPNG	SIZE OPNG	FLOW	Δ P	MANUFACTURER	FIG. NO.	REMARKS
TF-CO-15-1	6"	CONE	150		CS	SS	200	.015"	lb/hr 117,500	~1 PSI			REF 2193, C.P. #2

2.7.10-4

REV.	DATE
5	
4	
3	
2	
1	
0	6-20-80

Stearns-Roger INCORPORATED

TEMPORARY STRAINERS

CUSTOMER DEPARTMENT OF ENERGY

PROJECT 10 MWe SOLAR PILOT PLANT

LOCATION DAGGETT, CALIFORNIA

ORDER NO. C-21700 PAGE 1 OF 1

FORM 02.232
REV. 1.76

TAG NO.	SIZE	TYPE	PRESS RATE	ENDS	BODY MTL.	STR MTL.	% OPNG	SIZE OPNG	FLOW	ΔP	MANUFACTURER	FIG. NO.	REMARKS
1F-DW-2-1	3"	CONE	125		SS	SS	200	0.015"	GPM 75	~1 PSI			[illegible] C.R. # [illegible]

2.7.10-5

REV.	DATE	
5		**Stearns-Roger** INCORPORATED
4		TEMPORARY STRAINERS
3		CUSTOMER DEPARTMENT OF ENERGY
2		
1	9-12-80	PROJECT 10 MWe SOLAR PILOT PLANT
0	6-20-80	LOCATION DAGGETT, CALIFORNIA
		ORDER NO. C-21700 PAGE 1 OF 1

FORM 02.232
REV. 1.76

TAG NO.	SIZE	TYPE *	PRESS RATE	ENDS	BODY MTL.	STR MTL.	% OPNG	SIZE OPNG	FLOW	ΔP	MANUFACTURER	FIG. NO.	REMARKS
TF-TO-4-1	8"	TEE	150	BW	CS	SS	36	0.015"	lb/hr 550,000				REF [illegible], C.P.
TF-TO-5-2	8"	TEE	150	BW	CS	SS	36	0.015"	550,000				REF [illegible]2, C.P.
TF-TO-25-3	8"	TEE	150	BW	CS	SS	36	0.015"	550,000				REF [illegible]4, C.P.
TF-TO-26-4	8"	TEE	150	BW	CS	SS	36	0.015"	550,000				REF [illegible]4, C.P.
TF-TO-12-5	8"	TEE	150	BW	CS	SS	36	0.015"	550,000				[illegible]4, C.P.
TF-TO-13-6	8"	TEE	150	BW	CS	SS	36	0.015"	550,000				[illegible]4, C.P.
TF-TO-10-7	10"	TEE	150	BW	CS	SS	36	0.015"	550,000				REF [illegible], C.P.

* ANGLE FLOW BASKET

2.7.10-6

REV.	DATE
5	
4	
3	
2	
1	
0	6-20-80

Stearns-Roger INCORPORATED

TEMPORARY STRAINERS

CUSTOMER DEPARTMENT OF ENERGY

PROJECT 10MWe SOLAR PILOT PLANT

LOCATION DAGGETT, CALIFORNIA

ORDER NO. C-21700 PAGE 1 OF 1

FORM 02.232 [illegible] 1-76

TAG NO.	SIZE	TYPE	PRESS RATE	ENDS	BODY MTL.	STR MTL.	% OPNG	SIZE OPNG	FLOW	P	MANUFACTURER	FIG. NO.	REMARKS
TE-SP-1-1	4"	CONE	150		CS	SS	200	0.015"					[illegible] 1 C.P.
TE-SP-2-2											DELETED		
TE-SP-9-3	4"	CONE	150		CS	SS	200	0.015"					REF 3[illegible]A C.P.
TE-SP-12-4	6"	CONE	150		CS	SS	200	0.015"					REF 3[illegible]C C.P.

2.7.10-7

REV.	DATE
5	
4	
3	
2	12-4-80
1	9-12-80
0	

Stearns-Roger
INCORPORATED

TEMPORARY STRAINERS

CUSTOMER DEPARTMENT OF ENERGY

PROJECT 10 MWe SOLAR PILOT PLANT

LOCATION DAGGETT, CALIFORNIA

ORDER NO. C-21700 PAGE 1 OF 1

FORM 02.232
REV. 1.76

2.11.2 Oil Water Separator

2.11.2.1 Identification

Tag Number	Description
SE-701	Oil Water Separator

2.11.2.2 Description

Manufacturer:	Fram Industrial Filter Corp. Tulsa, Oklahoma 74135
Part No:	VPS
Spec No:	DOE Dwg 40M7006S, CP 9
Material:	Tank mild steel plates, polyproplyene
Weight:	

2.11.2.3 Prescribed Service

Oil/water mixture

2.11.2.4 Vendor

Fram Industrial Filter Corp.

2.11.2.5 Special Cautions

See Fram Operation and Maintenance Manual (following)

2.11.2.6 Periodid Service

See Fram Operation and Maintenance Manual (following)

2.11.2.7 Parts List

See Fram Operation and Maintenance Manual (following)

2.11.2.8 Special Tools

None

2.11.2.9 Maintenance Instructions

See Fram Operation and Maintenance Manual (following)

2.11.2.10 Acceptance Tests

None

FRAM

Fram Industrial

Filtration & Separation

A Bendix Company

SOLAR ONE POWER PLANT
DAGGETT, CA

WALDINGER CORPORATION
PURCHASE ORDER NO. DM-09025

FRAM S.O. No. 81006

Fram Industrial Filter Corporation • P. O. Box 33210 • Tulsa, Oklahoma 74135 • Tel. (918) 663-0161

FRAM INDUSTRIAL FILTER CORPORATION

VPS OIL/WATER SEPARATOR

OPERATION AND MAINTENANCE MANUAL

April 15, 1980

Any persons operating or working with this oil/water separator should be provided instructions with regard to the safety and protection requirements (Section 3.0).

TABLE OF CONTENTS

I. INTRODUCTION

The FRAM CORPORATION Oil/Water Separator*, shown on the drawing in the Appendix is a passive system for the separation of oil and solids from waste water. It is a land based unit which utilizes gravity and the coalescing action of the plates for oil removal and gravity for the removal of solids. The tank is made from mild steel, while the coalescing plates inside the tank are made from polypropylene. The unit weight (pounds) is as follows:

		MAX. FLOW RATE	DRY	WET
VPS	2	100 GPM	1,700	5,500
VPS	3	225 GPM	2,700	11,500
VPS	4	500 GPM	5,100	25,000

The waste water flows into the separator and enters the coalescing plates, where the oil is separated and rises to the top and the solids drop into the troughs. The oil then flows out through the adjustable "skimmir " devices into a customer provided receptacle. The solids can be removed through pipe connections on the side of the tank, The clean processed water is discharged into the customer lines.

* U.S. Patent No. 3,847,813

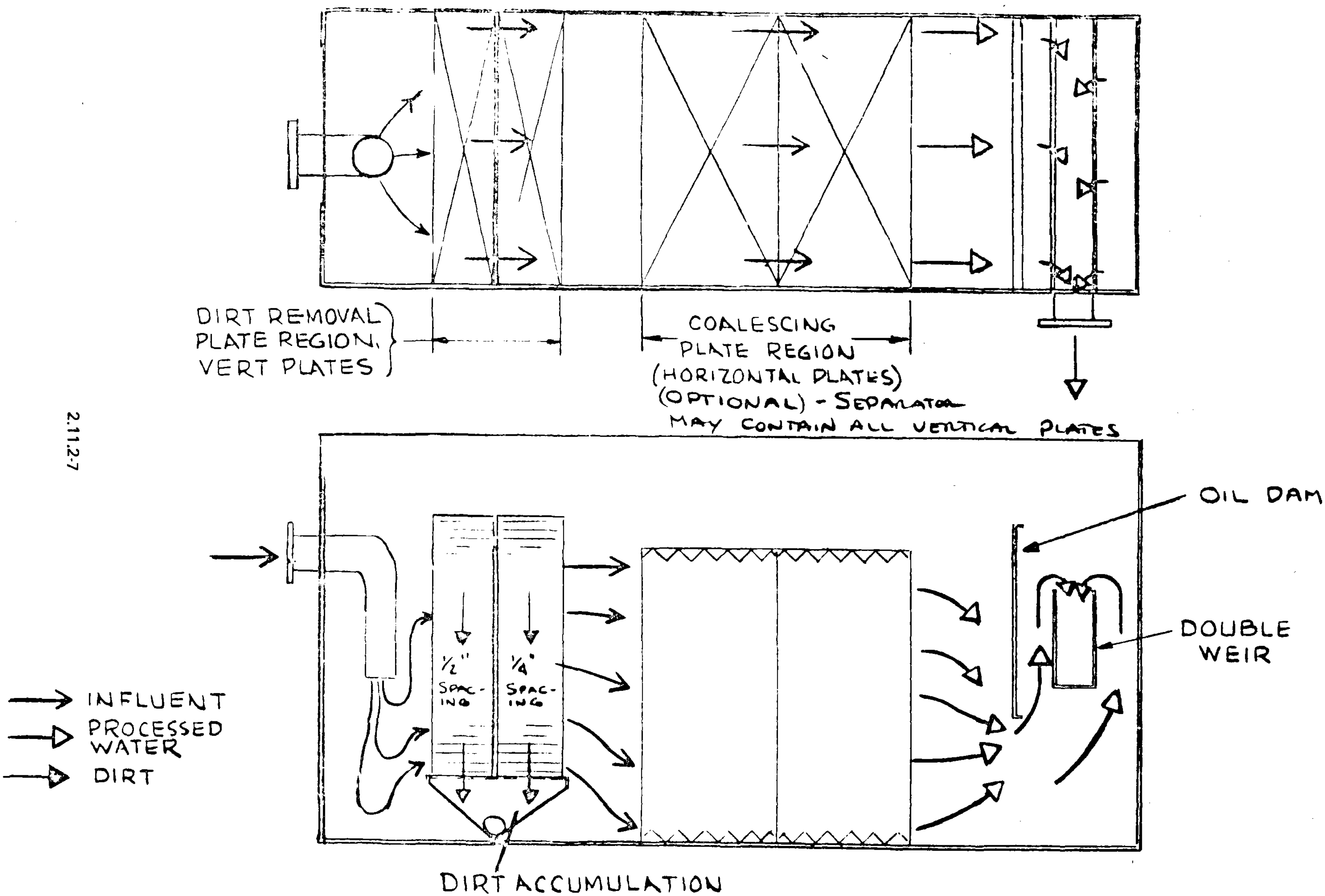
2.0 SYSTEM DESCRIPTION AND REQUIREMENTS

2.1 Internal Configuration

A cross sectional flow schematic of a VPS separator is shown in Figure 2-1. The separator consists of an inlet section, vertical coalescing plates, horizontal coalescing plates (optional), oil dam and exit weir.

The waste water enters the separator through the inlet pipe located on the end of the tank, and then turns 90° down into the tank so that the incoming fluid momentum can be dissipated in the inlet section. The flow then turns 180° and oil already separated in this upward moving liquid will rise directly to the top. The remainder of the waste water will flow into the coalescing plate region.

The coalescing plate region consists of a vertical plate section followed possibly by a horizontal plate section (see Figure 2-2) The vertical plate section contains one row of 1/2 inch spaced plates for coarse oil and solids separation followed by one or more rows of 1/4 inch spaced plates. The small oil droplets rise and coalesce on the plates from which large oil droplets detach and rise to the top of the liquid surface to form an oil layer. The oil layer flows to the oil removal "skimmers" from which it flows by gravity into a customer supplied receptacle. The solids drop to the trough at the bottom of the vertical plates where they can then be removed through the pipe fittings on the side of the tank.



CROSS SECTIONAL FLOW SCHEMATIC
FIG 2-1

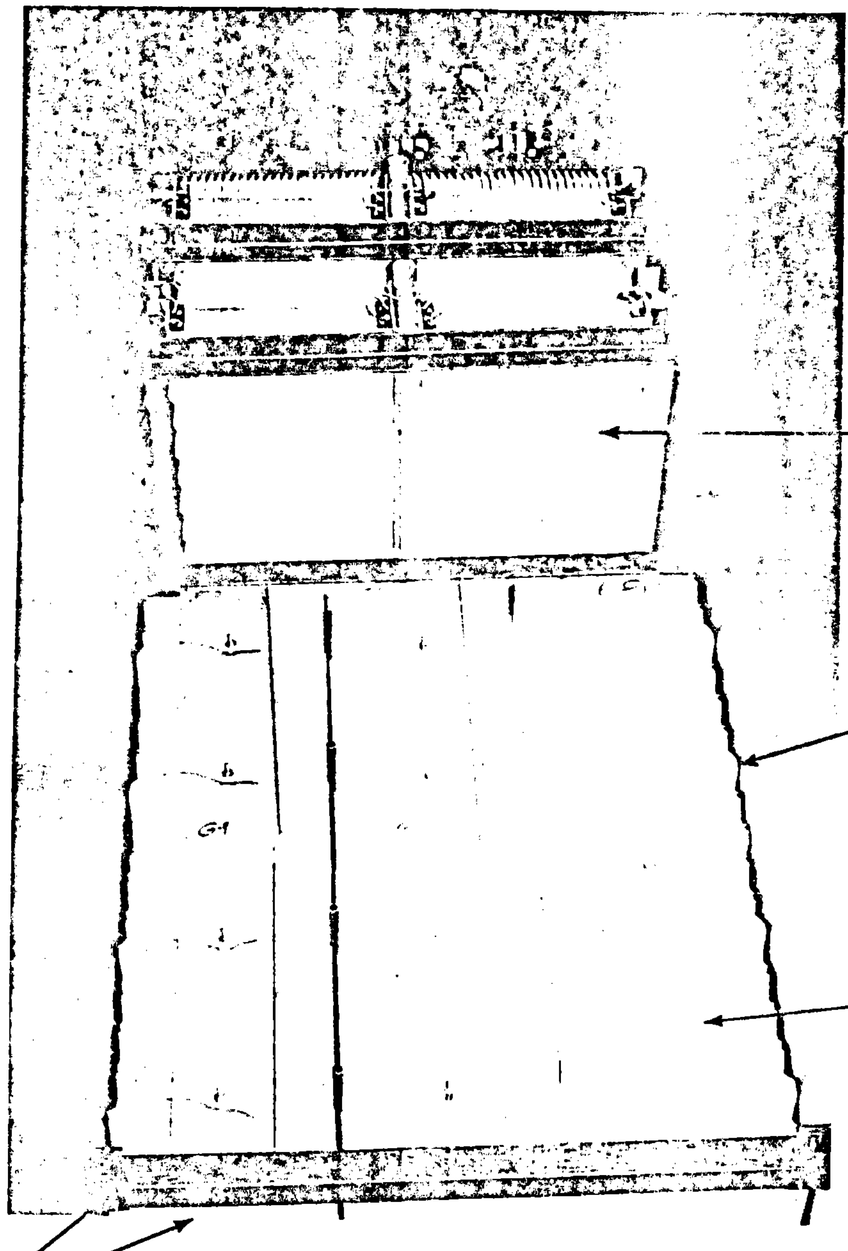

VERTICAL PLATE PACK ½" SPACING
VERTICAL PLATE PACK ¼" SPACING
SEALING STRIPS
HORIZONTAL PLATE STACKS
HOLD DOWN ANGLE & CLIP

FIGURE 2-2

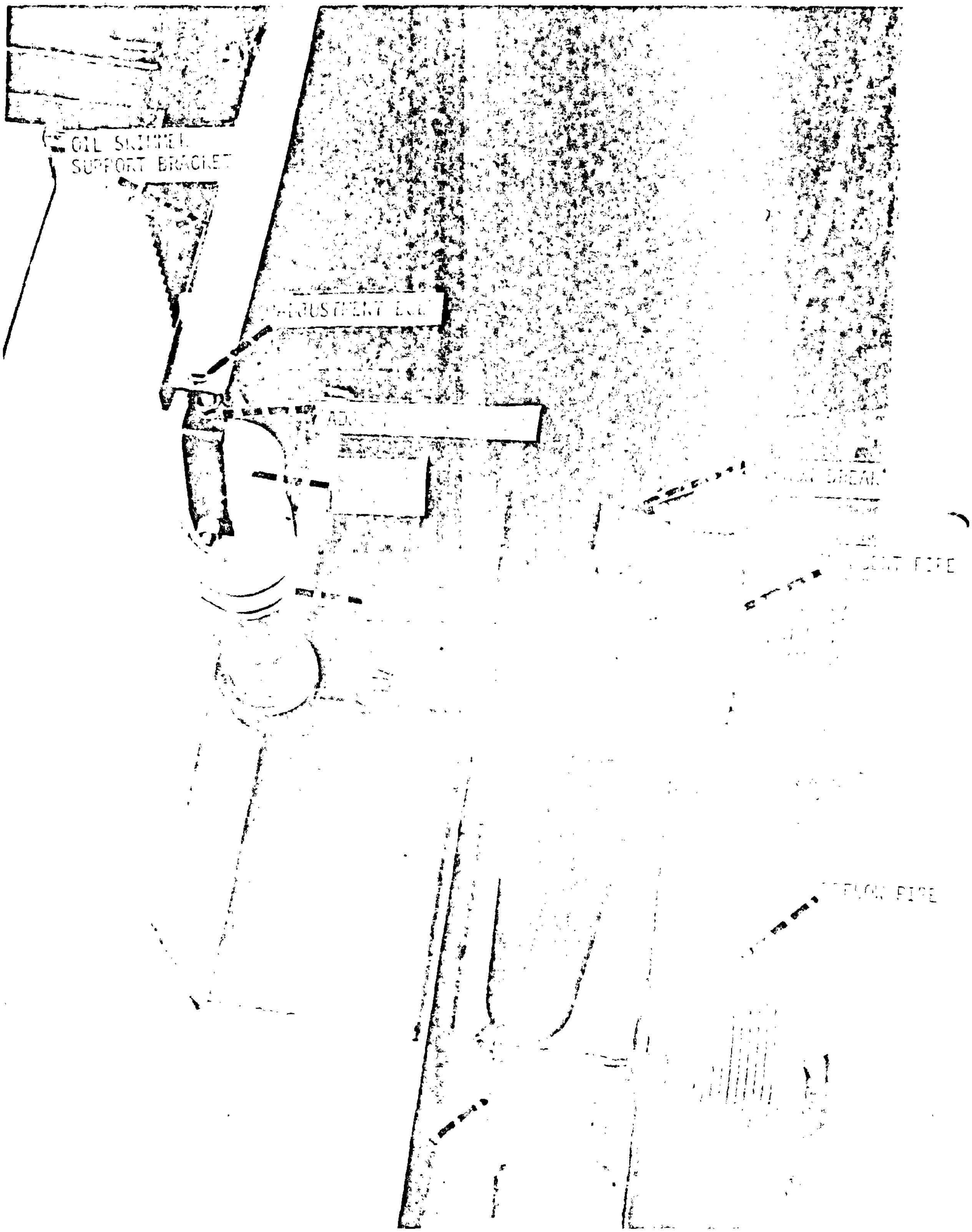


FIGURE 2-3 OIL SKIMMER

The horizontal plate section (if provided) removes the remainder of the oil droplets, as most of the solids have been removed in the vertical plate section. As the oil/water mixture passes through the separator, the small oil droplets rise and coalesce on the plates, the oil film rises by gravity to the high point or crest of each corrugation.

Bleed holes along the crest provide passages through which the collected oil rises to form an oil layer.

The processed water flows out of the coalescing plate region under the oil dam which keeps the separated oil in the plate region and then over a "U" shaped weir before flowing out of the separator. The "U" shaped weir distributes the flow and keeps the liquid level in the separator at the proper height.

The oil skimmer shown in detail in Figure 2-3 allows the oil to flow out of the separator. It is adjustable to allow for variations in applications. The outlet pipe is adjustable up or down by turning the locknuts on the supporting bracket. When adjusting the skimmer, first rotate the expansion joint to loosen it before adjusting with the locknuts. The inner tube thus moves inside the outer pipe to get the necessary adjustment. The oil flows into the skimmer and down the connecting pipe and to the customer supplied receptacle. The skimmer should be adjusted so that the top of the skimmer is 1/4" above the liquid level with very little oil accumulated and normal flow rate. Access to the skimmer adjustment is through the access cover located directly above the oil skimmer.

In case the flow rate exceeds the maximum rating, there is an overflow pipe. The overflow pipe is the same size as the inlet pipe and is situated just above the inlet pipe. This safety feature allows any excess water to flow out of the separator and into a receptacle instead of over the top of the separator.

2.2 EXTERNAL CONFIGURATION

The VPS separator is a rectangular tank. The tank is mild steel (1/4" thick), coated internally with a coal tar epoxy for corrosion resistance and has an external epoxy corrosion retardant paint coating. The dimensions of the separator are shown on the interface drawing in the appendix.

2.3 ENVIRONMENTAL REQUIREMENTS

The separator will function efficiently within the following conditions. If these conditions are exceeded, efficiency may decrease.

Operating Environments

(a)	Air temperature	40 - 125° F
(b)	Water Temperature	40 - 140° F
(c)	Installation pad	level within 1/16"/Ft.
(d)	Specific gravity of oils	.8 - 9*
(e)	Viscosity of oils	1-20,000 SSU
(f)	Solids concentration	1,000 mg/l-max.
(g)	Detergents	100 ppm-max.

(*) Specific applications may permit higher specific gravity oils.

3 SAFETY

There are no electrical or rotating parts on the unit, so hazards are at a minimum.

Care should be taken in keeping the area cleansed as oil/water mixtures can be hazardous. Normal fire prevention measures should be enforced around oil.

4. SYSTEM INSTALLATION

The influent flow shall be controlled at the recommended flow rate or less for the particular application. The tank is vented to atmosphere through the overflow pipe and flow through the separator is by gravity. The pressure drop through the separator is less than 6 inches of water.

If a pump is used for the inlet waste water, it is recommended that a positive displacement pump, such as an air diaphram pump be used. This will minimize the emulsification so the performance of the separator will not be adversely affected.

To achieve the desired flow, excessive throttling of the input should be avoided as this will cause emulsification of the oil which will a adversely affect the separator performance. The support pad for the separator tank should be level to within 1/16 inch per foot. It can be made of any material, but must be capable of supporting a load as follows:

VPS-4	25,000	LBS.	@	430 LBS/FT^2
VPS-2	5,500	LBS.	@	303 LBS/FT^2
VPS-3	11,500	LBS.	@	304 LBS/FT^2

It is recommended that output lines including the water effluent line, the oil skimmer line, and the overflow line be gravity flow. The pressure loss for the water effluent pipe, the overflow pipe, and oil skimmer line shall not exceed the drop in elevation of the customer lines. The piping should be supported if it is more than 6 ft. from the separator.

To install the separator, follow these steps: (see drawing in Appendix)

1) Connect the waste water inlet piping to the inlet flange.

2) Connect oil outlet piping to separator

3) Connect water outlet piping to water outlet flange. No valving is necessary as the weir will control the height of the oil/water mixture in the separator.

4) Connect to the solids removal fittings.

5) It is recommended that drain piping and a gate valve be installed to the drains to help when draining the system.

6) Connect overflow piping. Overflow liquid is an oil/water mixture and should be piped back to the holding tank. Do not discharge overflow liquid without treating.

NOTE: The waste water inlet flange and overflow flange are on the same end of the separator and are both the same in diameter. Make sure the waste water inlet piping is connected to the lower flange.

5. SYSTEM OPERATION

5.1 Initial Startup

This procedure is to be followed after the installation of a separator or after the separator has been drained and is ready to be restarted. (Refer to interface drawing)

1) Cap the drain pipes or close the valves if installed.

2) Close valves on solids removal piping.

3) Make sure there are no obstructions in the oil outlet or water outlet piping.

4) Remove skimmer access cover.

5) Fill the tank with clean water to avoid contaminating the separator plates with oil.

6) Open the user supplied valve to allow the waste water into the tank and adjust for the desired flow.

7) With the desired flow established and little oil accumulation set the oil skimmer to 1/4 inch above the water level.

8) Check for leaks.

9) See if effluent meets requirements after 15 minutes.

10) See if effluent meets requirements after 15 minutes.

5.2 NORMAL OPERATION

Maintain the flow rate at the established level. At this rate there should be no overflow.

Oil will flow out once a sufficient quantity of oil (1 to 3 inches) has accumulated in the separator. Only oil should be removed since the oil outlet skimmer is set to be above the water level. Oil is lighter than water so the oil will rise higher than the water level and be skimmed off if the skimmer is adjusted properly.

The frequency of solids removal is dependent on the solids concentration in the influent and can best be determined in the field. Solids can be removed while the separator is in operation.

5.3 MAINTENANCE

A. After approximately 4000 hours of operation, the separator tank and plates should be cleaned. The quantity of sludge found in the plate stacks should be used as basis for determining the next interval before cleaning. If 20% or less of the passages are blocked with sludge, the interval should be extended but if 60% or more are blocked, the interval should be shortened.

The vertical plates can be cleaned in place utilizing the following procedure:

1. Remove access covers
2. Lower oil skimmers to remove all the accumulated oil
3. Remove accumulated solids in the hoppers
4. Drain Tank
5. Remove large covers

6. Clean the vertical plate assemblies by flushing with water from both the front and back. A 1 1/2" fire hose at 10-15 psi or standard garden hose at normal house pressure (30-35 psi) are effective methods.

7. Hose down the tank interior and drain sediment out.

8. Examine tank interior for damage to coating and repair with coal tar epoxy.

9. If vertical plates only required cleaning, restart separator as outlined in Section 5.1, initial start-up.

Cleaning of horizontal plates require that they be removed. To remove them, follow steps 1 through 5 of the previous precedure and then:

1. Remove angle and clip which hold plate pack assembly down. (See Figure 2-2)

2. Remove PVC Pipe spacers between plate packs

3. Remove a center plate stack assembly by attaching a cable or suitable sling to the 6 inch channel.

4. Using a crane or suitable lifting device, lift the plate pack vertically.

NOTE: Disassembly of the plates is not necessary

5. Clean the plate pack assemblies by flushing with water from the sides. A 1 1/2" fire hose at 10-15 psi or a standard garden hose at normal house pressure (30-35 psi) are

effective cleaning tools. Continue the above procedure until all plate pack assemblies have been removed and flushed clean.

6. Hose down the interior of the tank and pump out the sediment.

7. Examine tank interior for damage to coating and repair with coal tar epoxy.

5.4 INSTALLATION OF HORIZONTAL PLATE PACK ASSEMBLIES (See Figure 2-2)

1. Plate packs with sealing strips on the side are to be placed next to the tank wall with the sealing strips bearing against the tank wall.

2. Apply a coating of grease to the sealing strips and assure that they are nested within the plate convolutions especially at the bottom.

3. Install first plate pack against tank wall and position pack so that it rests against front retaining tabs and tank wall. Assure that the pack is resting on the bottom of the tank.

4. Install a center plate pack (no sealing strips) and position it against the first pack installed.

5. Install final plate pack in row with sealing strip against tank wall. As an aid, flat metal stock temporarily placed between pack being installed and adjacent pack may simplify installation of final pack in a row.

INSTALLATION OF HORIZONTAL PLATE PACK ASSEMBLIES

6. Install PVC pipe spacers between plate packs with tapered end going in first. If spacers cannot be readily inserted, smaller diameter PVC schedule 80 pipes can be substituted.

7. Re-install angles and clips which hold plate packs down.

8. Re-start the separator as outlined in Section 5.1, initial start-up.

5.5 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	DIAGNOSTIC TECHNIQUE	CORRECTIVE ACTION
Processed Water has oil in it	Flow too great for application	Check flow	Slow the flow rate
	Leakage Past Oil Dam	Remove cover and inspect oil Dam	Fix leakage Cause
	Too much oil in unit	Remove cover and inspect	Lower skimmer
No oil discharged	skimmer too high	check oil layer thickness	Lower skimmer
Tank is Overflowing	Output line Restricted	Check output flow	Remove Restriction
	Flow is greater than maximum separation capacity	Check flow rate	Reduce flow

6.0 PARTS LIST

MODEL NO.	PART NAME	DWG. NUMBER	
VPS 2	Vertical Plate Pack (1/2" Spacing)	47E521484	G-6
VPS 2	Vertical Plate Pack (1/4" Spacing)	47E521484	G-5
VPS 2 VPS 3	Horizontal Plate Pack	47E520122	G-1
VPS-3	Vertical Plate Pack (1/4" Spacing)	47E521484	G-4
VPS 3	Vertical Plate Pack (1/4" Spacing)	47E521484	G-3
VPS-4	Vertical Plate Pack (1/2" Spacing)	47E521496	G-3
VPS-4	Vertical Plate Pack (1/4" Spacing)	47E521496	G-4
VPS-4	Horizontal Plate Pack	47E520122	G-9

NOTE: There are no recommended spare parts for these units.

AFL industries, inc.

PROCTOR & GAMBLE

FAIR OAKS, CALIFORNIA

AFL Industries, Inc.
Rivera Beach, Florida

AFL Contract No. 1031
March 17, 1981

PROCTOR & GAMBLE

FAIR OAKS, CALIFORNIA

TABLE OF CONTENTS

CONTRACTOR - PLEASE READ THIS INSTRUCTION CAREFULLY

AFL Industries provided you with several valuable erection aids, and the few minutes you spend reading this instruction will save you hours later. The purpose of this instruction is to acquaint you with the equipment erecting knowledge which you now have at your fingertips.

THE INFORMATION CONTAINED IN THESE INSTRUCTIONS ARE BASED ON YEARS OF EXPERIENCE WITH THE ERECTION OF OUR EQUIPMENT, BUT ARE INTENDED AS A GUIDE ONLY. THE EQUIPMENT WHICH YOU HAVE AVAILABLE TO YOU MAY DICTATE OTHER, MORE CONVENIENT, PROCEDURES, BUT THE FINAL RESPONSIBILITY FOR SELECTION OF ERECTION PROCEDURES OR TOOLS IS NOT BORNE BY AFL INDUSTRIES, INC.

IOM BROCHURE:

This brochure contains the heart of the information necessary to erect the equipment. It is structured as follows:

1. Title Page and General Instructions;
2. Table of Contents - listing of descriptions and reference numbers for all drawings;
3. Specific Contract Information.

The complete section of information provided for each contract includes;

1. Contract Equipment Specification - a written description of the equipment;
2. Installation Instructions - a general erection instruction for the equipment provided;
3. Assembly Drawings - showing the unit and its various components;
4. Operation and Maintenance Instructions;
5. Spare Parts Lists;
6. Information on our buy-out items (pumps, motors, etc.) - certified prints, special operation and maintenance instructions.

RECEIVING MATERIAL:

The equipment pieces and components you receive may have been shipped from:

1. The AFL Industries Factory in Riviera Beach, Florida;
2. A fabricator acting under AFL instruction;
3. A "buy-out" distributor such as a motor or pump manufacturer.

Since there may be more than one shipment to the job site, it is important to coordinate the receiving and storage of the goods accordingly.

Upon receipt of a shipment, you immediately should check goods received. If you find that certain items are missing, make a note of this on the shipping papers to protect your interests. Also, IMMEDIATELY notify AFL Industries of this shortage.

All material has been thoroughly checked and inspected before shipment. If the equipment is received in bad condition or if the packages are broken, make a bad order notation on the shipping papers to this effect. THIS PROTECTS YOU since it will enable you to place the proper claims against the freight company. Notify AFL IMMEDIATELY if any parts are found broken or damaged during shipment.

Please handle the equipment properly when unloading and erecting. All cartons, electrical equipment, and gear drives, shipped separately or mounted on tank, should be stored under cover and protected from moisture, grit, and mud. AFL Industries will not be responsible for material deterioration due to improper handling, exposure, or inadequate protection during storage.

PROCEDURE FOR ORDERING SPARE OR REPAIR PARTS:

1. Identify your equipment using the AFL contract number shown on equipment specification sheets.
2. Identify the part by name and give the number of the drawing on which this part or assembly appears. If it is a part for a motor, pump, electrical control or any part not manufactured by AFL, the information will be found in the manufacturer's reference data included in this brochure, or on the manufacturer's nameplate.

3. Show the part number. (Information can be gained in the same manner.)

4. Show the size, and include all pertinent dimensions (such as diameter, length, thickness, bore, pitch, etc.) whenever possible.

5. If parts being ordered are electrical in nature, give all pertinent data; voltage, amperage, wattage, cycle, speed power factor or other information given on a nameplate or in the brochure.

6. Submit your written purchase order or request for quotation, both signing and printing your full name so that we will know whom to contact should further clarification of the order be necessary. ALL VERBAL ORDERS MUST BE CONFIRMED IN WRITING.

7. Give return address, and shipping address.

8. Give preferred method of shipping: parcel post, truck freight, rail freight, air express, etc.

9. Show quantity desired.

10. Give directions on where to send invoice.

11. ALL SPARE OR REPAIR PARTS ORFERS ARE SUBJECT TO A $75.00 MINIMUM ORDER CHARGE.

BACKCHARGES:

AFL Industries, Inc. will not accept any charge for modification, servicing, adjusting or for any other item without written authority in the form of a PURCHASE ORDER issued from the home office at Riviera Beach, Florida IN ADVANCE of doing the work. This authority will only be given when satisfactory proof is submitted and the authority will only then be issued providing the price is agreed upon and the authority is given as outlined above BY OUR TECHNICAL SERIVCE MANAGER.

ANY BACKCHARGE SUBMITTED CONTRARY TO THIS AGREEMENT WILL BE REJECTED IN TOTAL WITHOUT CONSIDERATION.

FURTHER ASSISTANCE:

The erection aids material provided by AFL should enable you to install, operate, and maintain the equipment. This instruction is provided to help you to help yourself and therefore to save you time and expense. If a problem is encountered in installing or operating the equipment which cannot be solved by referring to the available material, please feel free to contact us. Address your inquiry to our Technical Service Department, AFL Industries, Inc., 3361 West Blue Heron Blvd., Riviera Beach, Florida 33404 or call us at 305-844-5200.

HANDLING AND STORING PLASTIC PIPE

Plastic pipe does not require "kid-glove" treatment; however normal precautions should be taken to prevent excessive mechanical abuse. When unloading pipe from a truck, for example, it is unwise to drag a length off the tailgate and allow the free end to crash to the ground. Remember, too, that scratches and gouges on the pipe surface can lead to reduced pressure-carrying capacity. Standard pipe wrenches should not be used for making up threaded connections since they can deform or scar the pipe; use strap wrenches instead. When using a pipe vise or chuck, wrap jaws with emery cloth or soft metal.

Pipe should be stored on racks that afford continuous support and prevent sagging or draping of longer lengths. Burrs and sharp edges of metal racks should be avoided. Plastic fittings and flanges should be stored in separate bins of boxes and never mixed with metal piping components. The storage area should be clean and have adequate ventilation. Plastic pipe should not be stored or installed near a stem line or other source of heat that could overheat the pipe.

CUTTING PLASTIC PIPE

Plastic pipe can be cut easily with a power or hand hacksaw, circular or band saw. For best results, use fine-tooth blades with relatively little set. A circumferential speed of about 6,000 ft/min is suitable for circular saws; band saw speed should be approximately 3,000 ft/min. Carbide-tipped blades are preferable when quantities of pipe are to be cut. Pipe and tube cutters are not recommended since they might cause excessive heat and pressure that can result in cracked or irregular ends. To ensure square-end cuts, a mitre box, hold-down or jig should be used. All burrs should be removed with a fine-tooth file, deburring tool or sharp knife. Chips, burrs, filings, etc., should be removed from the pipe I.D. before installation.

BENDING PLASTIC PIPE

Bending leaves residual stresses in plastic pipe and, consequently, use of bends is not recommended, particularly when the line is to operate at or near maximum rated pressures and temperatures. Factory-made fittings and straight lengths of pipe invariably give better performance.

When field bending is necessary to meet special condition or to provide for expansion and contraction of the pipe, the following technique should produce good results:

1. Seal both ends of the pipe length with plumber's test plugs and introduce sufficient air pressure to maintain ovality of the pipe during bending. The same purpose can be achieved by filling the pipe with pre-heated sand.

2. Heat the pipe uniformly by immersing it in hot oil or water, or by rotating it in front of a hot-air gun. An open flame should not be used.

3. When the pipe becomes soft and pliable, it should be placed in a wooden forming jig or form, and the bend should be made as quickly as possible to prevent weakening or deforming the pipe. The minimum radius to which a bend should be made is 5 to 6 diameters, but the initial forming bend should be slightly greater to allow for springback.

4. The bend should be kept in the forming jig until the pipe cools and becomes rigid; then it should be cooled quickly by immersion in water. Air pressure should not be relieved or sand removed until after final cooling.

(Thermoset plastics such as glass-reinforced epoxy cannot be field bent by heating, of course.)

SOLVENT WELDING PLASTIC PIPING

The preferred method for joining rigid thermoplastics such as PVC and PVDC, solvent welding provides stronger and tighter joints than threading. Here are tips that should be useful.

1. Use the proper solvent cement: PVC cement with PVC pipe and PVDC cement with PVDC pipe.

2. When solvent welding PVC pipe, apply PVC cement liberally to the pipe O.D. and to the fitting I.D.

3. Leave a fillet bead between pipe and fitting when solvent welding PVC and PVDC piping, but remove excess cement from ABS and CAB.

4. Use a natural (hog) bristle brush for applying solvent cement; Nylon and other synthetic materials are attacked by solvents in the cement.

5. Use a ½" wide brush for pipe ½" through 1"; a 1" brush for 1¼" through 2" pipe; and a 2" brush for pipe 3" and larger.

6. An ordinary oil can is an excellent container for acetone or cleaner. Excessive evaporation is prevented and the solvent is always handy.

7. Never allow water to come into contact with solvent cement. Wrap a handkerchief around your forehead in hot weather to keep perspiration from dripping into the cement. When not using cement keep covered.

8. Allow solvent cement to cure 5 to 15 minutes before handling and wait 24 hours before introducing full line pressure in a solvent cemented piping system.

9. At end of day, place brush in solvent and cover cement tightly. When re-using brush, shake excess solvent out before dipping it into cement.

SOLVENT CEMENT REQUIREMENTS

NOMINAL SIZE OF PIPE	AVG. NUMBER OF JOINTS PER QT.	NOMINAL SIZE OF PIPE	AVG. NUMBER OF JOINTS PER QT.
1/2"	700	2"	90
3/4"	400	3"	70
1"	300	4"	50
1 1/4"	220	6"	32
1 1/2"	160	8"	20

THREADED JOINTS

Take-down piping systems and temporary lines usually are installed with threaded connections. Threading reduces the effective wall thicknesses of the pipe and results in lower pressure ratings. Threaded connections should be used only with Sch. 80 or heavier pipe.

"Tite-Joint" Thread Tape should be used for all threaded connections since screwed fittings tend to bind after long periods of service. Wrap tape around male threads, overlapping about ¼", until thread length is covered. "Teflon"-base until thread lubricant also can be used. It is inert and retains its lubricating qualities indefinitely. Squeeze a small amount on pipe male threads, spread with a brush and screw fitting onto pipe.

FLANGED JOINTS

One of the earliest methods for joining plastic pipes, flanging continues to be used extensively, especially for process lines that must be dismantled frequently. Plastic flanges and flanged fittings are available in a full size range and may be attached to pipe by solvent welding, threading or fusion welding.

Flanging is the preferred method of joining plastic-lined piping.

Soft rubber gaskets generally should be used between the flanges.

RECOMMENDED FLANGE BOLT TORQUE FOR PLASTIC FLANGES

FLANGE SIZE	BOLT DIAMETER	TORQUE FT-LB PSI*	FLANGE SIZE	BOLT DIAMETER	TORQUE FT-LB PSI*
1/2"	1/2"	10-15	2 1/2"	5/8"	20-30
3/4"	1/2"	10-15	3"	5/8"	20-30
1"	1/2"	10-15	4"	5/8"	20-30
1 1/4"	1/2"	10-15	6"	3/4"	33-50
1 1/2"	1/2"	10-15	8"	3/4"	33-50
2"	5/8"	20-30	10"	7/8"	53-75

To give bolt stress of 10,000-15,000 psi. Bolt torque refers to a well lubricated bolt.

GENERAL

Refer to oil stop valve assembly drawing located in this brochure, standard assembly drawing number 2S10 and OSV components drawing number 3D112. It will be helpful to become familiar with part names and their location.

NOMENCLATURE

The number following the AFL-OSV designates the nominal float diameter and the diameter of the outlet pipe. The size of the valve also determines the maximum flow the valve can pass.

> **WARNING**
>
> If the valve is operated at greater than design or recommended flows it may shut-off automatically and may be required to be reopened manually.

INSTALLATION

Depending on contract requirements, the OSV assembly may be shipped factory installed in an AFL process tank or separately for field installation in a designated location. Check equipment specifications and drawings and determine how the OSV was ordered and follow accordingly:

A. Factory Installed Oil Stop Valves

1. Install and level the tank, see tank installation instructions in this brochure and connect all required piping, controls, valves, etc.

2. Remove tape and support brackets

3. Check the OSV for any visual damage. Report damage immediately to AFL.

4. Level valve base by adjusting leveling legs, item 4, drawing number 2S10. Use spirit level for ease of adjustment.

5. Check OSV float, item 1, drawing number 2S10, to assure proper vertical movement, by lifting and lowering the float by float guide rod, item 13, drawing number 2S10. The float should move freely up and down within the housing. This movement can be adjusted by screwing float alignment bolts, item 3, drawing number 2S10, in and out very gradually. Make sure that the horizontal float movement is minimal.
   NOTE: If the guide rod is not straight it will cause the float to hang up. Remove rod from float by unscrewing it from the float assembly and straighten it. Reinstall rod when done.

6. If the OSV is installed in a deep chamber and cannot be easily accessible, attach flexible cable to the float guide rod (fishing line, less than 1/8" diameter may be used for this purpose). Make sure the cable does not restrict float movement when tied off.
   NOTE: The manual release cable may be used to reopen the valve after shut-down due to surge flows.

7. Remove the siphon plug at top of discharge elbow, item 10, drawing number 2S10, and attach 1" diameter siphon breaker pipe by threading it into the discharge elbow.
   CAUTION: The siphon breaker pipe must be long enough to extend at least 6" above maximum expected liquid level in the chamber. Valve will not operate if top of siphon breaker pipe is below water level.

8. Valve is now ready for operation.

B. Field Installation

1. If the OSV has been supplied for a specified outlet elevation, alteration of the outlet pipe is not required.

2. If the discharge pipe, item 8, drawing number 2S10, has been shipped separately for field assembly, cut the pipe to required length, glue it to the base coupling and glue the discharge elbow to required orientation.
   CAUTION: Do not increase discharge pipe length and discharge elbow centerline. See OSV drawing in this brochure for required elevations. Increase in discharge elevation will affect valve operation and decrease flow through valve.

3. Locate the OSV and level at the proper elevation by adjusting the four leveling bolts in the valve base.

4. Connect the OSV outlet pipe to the system effluent pipe. The OSV has been provided with a socket weld type 90° elbow, or a flange connection. If a socket weld is used, allow sufficient time for weld to set before using the valve. Refer to section 0.03 for assembly of plastic piping.

   NOTE: A flexible joint is recommended between AFL system piping and customer supplied process piping.

OSV OPERATION

The AFL/Clark Oil Stop Valve (OSV) is designed for easy, efficient operation in confining oil spills to the premises. It is used in oil/water gravity differential separators, coalescing type separators and oil interceptors to prevent the entry of oil into the effluent. Features of the valve include:

OSV OPERATION (continued)

1. Dependable gravity operation
2. Corrosion resistant construction
3. Only one moving part
4. Clean out plug
5. Outlet vent connection (siphon breaker)

The valve is available in a variety of sizes to meet a wide range of flow conditions.

The valve is supplied as an option on AFL oil/water separators and oil interceptors. It can also be provided independently for existing applications for similar equipment.

PRINCIPLE OF OPERATION

The valve operates on a simple buoyancy principle. The only moving part, a ballasted float, is weighted specifically for each application. In water, the float keeps the valve open. An accumulation of oil down to the level of the float decreases the buoyant force on the float causing it to float lower in the liquid. The greater the oil accumulation, the more the float sinks. Finally, the float will seat on the outlet and contain the outflow before the oil level decreases to the outlet elevation.

NOTE: The stop valve is designed to contain the oil spill but is not a positive shut-off device. A minimal amount of contaminant may pass through the valve during shut down.

The weight used for each float depends on the specific gravity of the oil. When more than one oil type is present, the greatest specific gravity will determine the weight used for each float; however the optimum operation will be accomplished within 0.05 specific gravity differential. The greater the differential the less accurate the actuation will be.

Figures 1.0 through 5.0 show the total float weight to specific gravity relationship for various valve sizes.
NOTE: In case a change in total float weight is required, the total weight may be established by use of proper graph, and adjusted as described below:

1. Remove float housing by loosening the housing set screws, item 5, drawing number 2S10.
2. Remove float.
3. Unscrew fill plug located at top of float, see item 8, drawing number 3D112.
4. Remove or add ballast.

NOTE: Use fine dry sand for ballasting.

5. Replace fill plug.
6. Reassemble float's housing. Make sure float moves freely. See Installation Procedure, section A items 3 and 4.

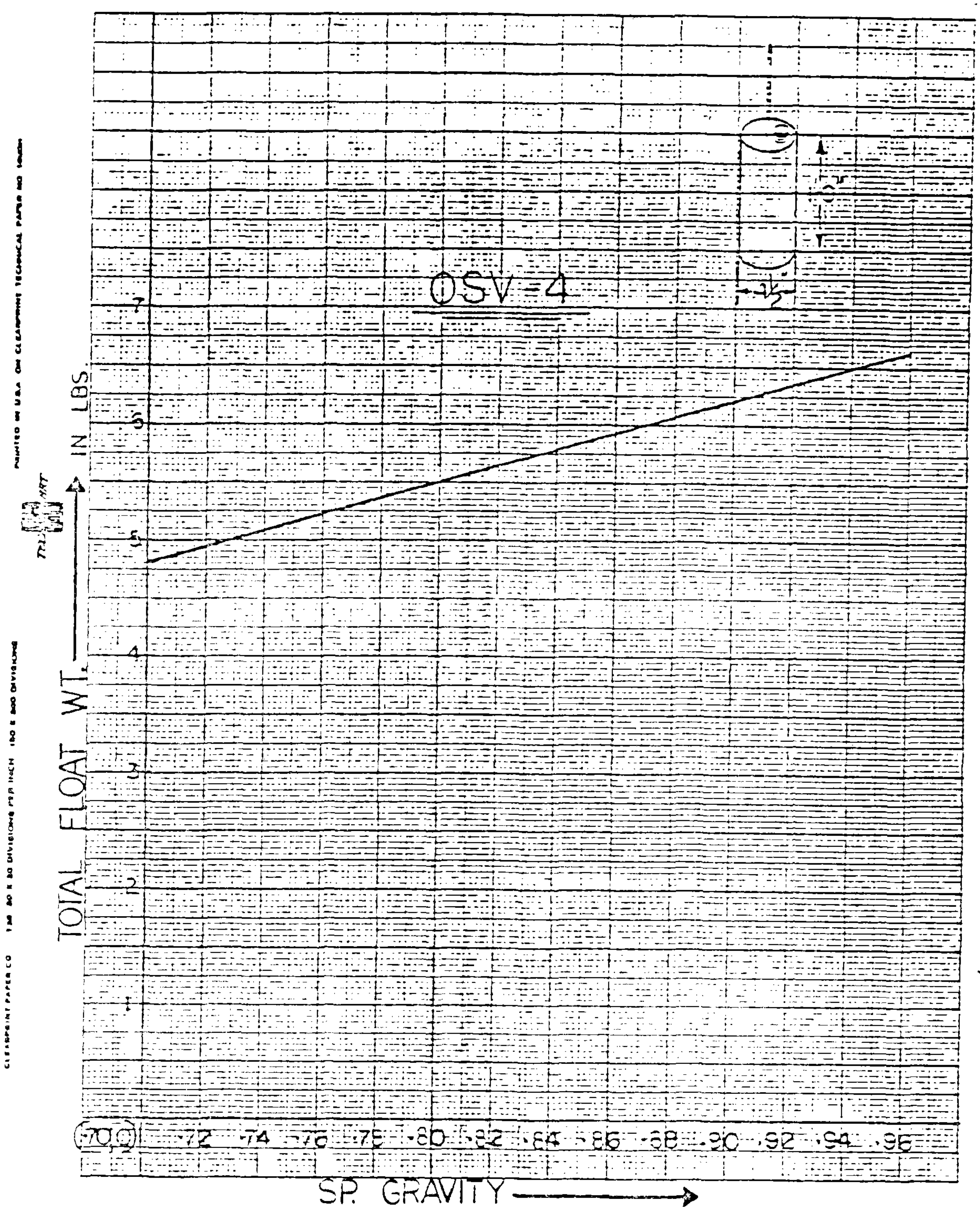


Fig 1.0

2.11.2-33

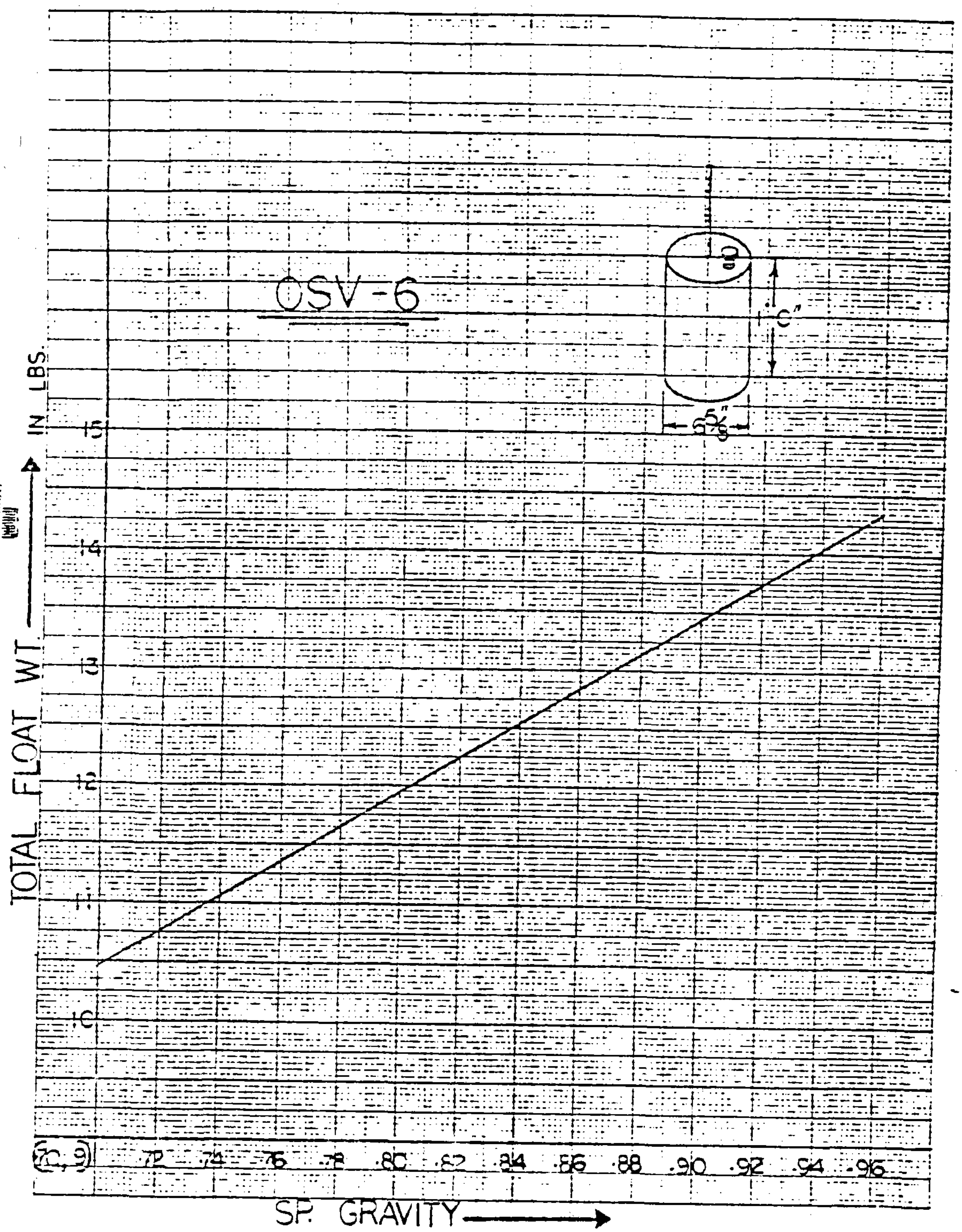


Fig 2.0

2.11.2-34

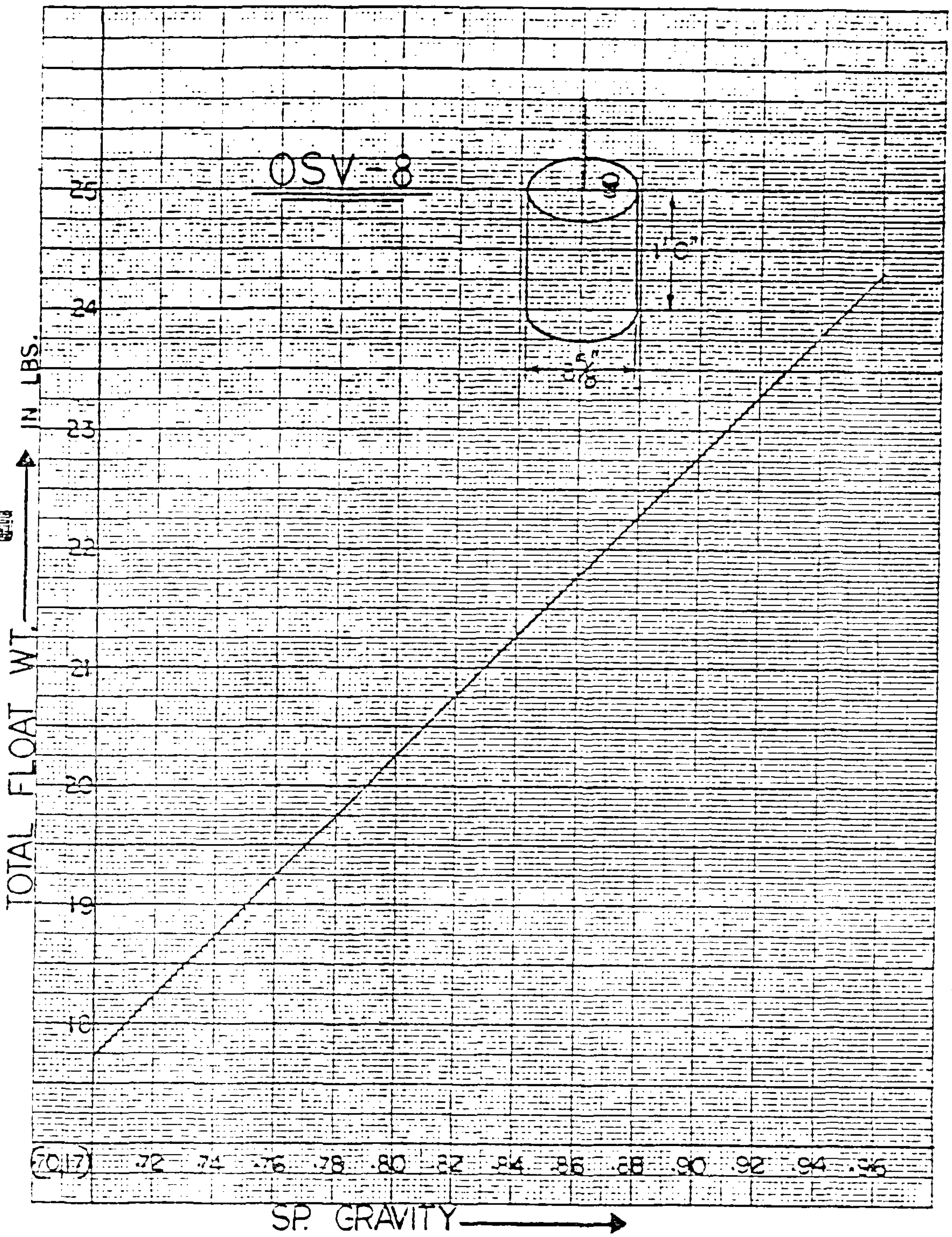

OSV-8
TOTAL FLOAT WT. IN LBS.
25
24
23
22
21
20
19
18
.70
.72
.74
.76
.78
.80
.82
.84
.86
.88
.90
.92
.94
.96
SP. GRAVITY

Fig 3.0

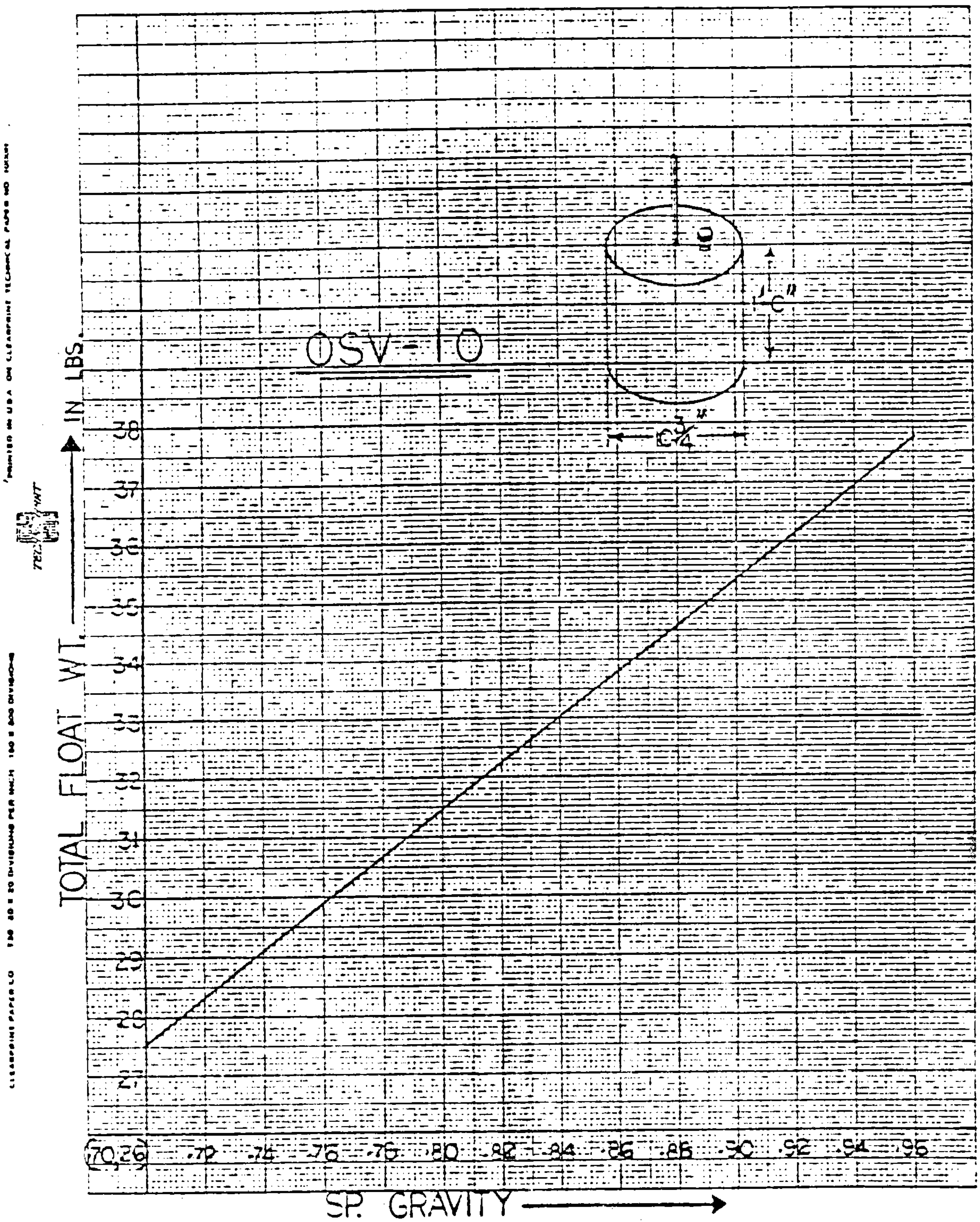


Fig 4.0

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	PRODUCT: OIL STOP VALVE		ISSUED MARCH '80

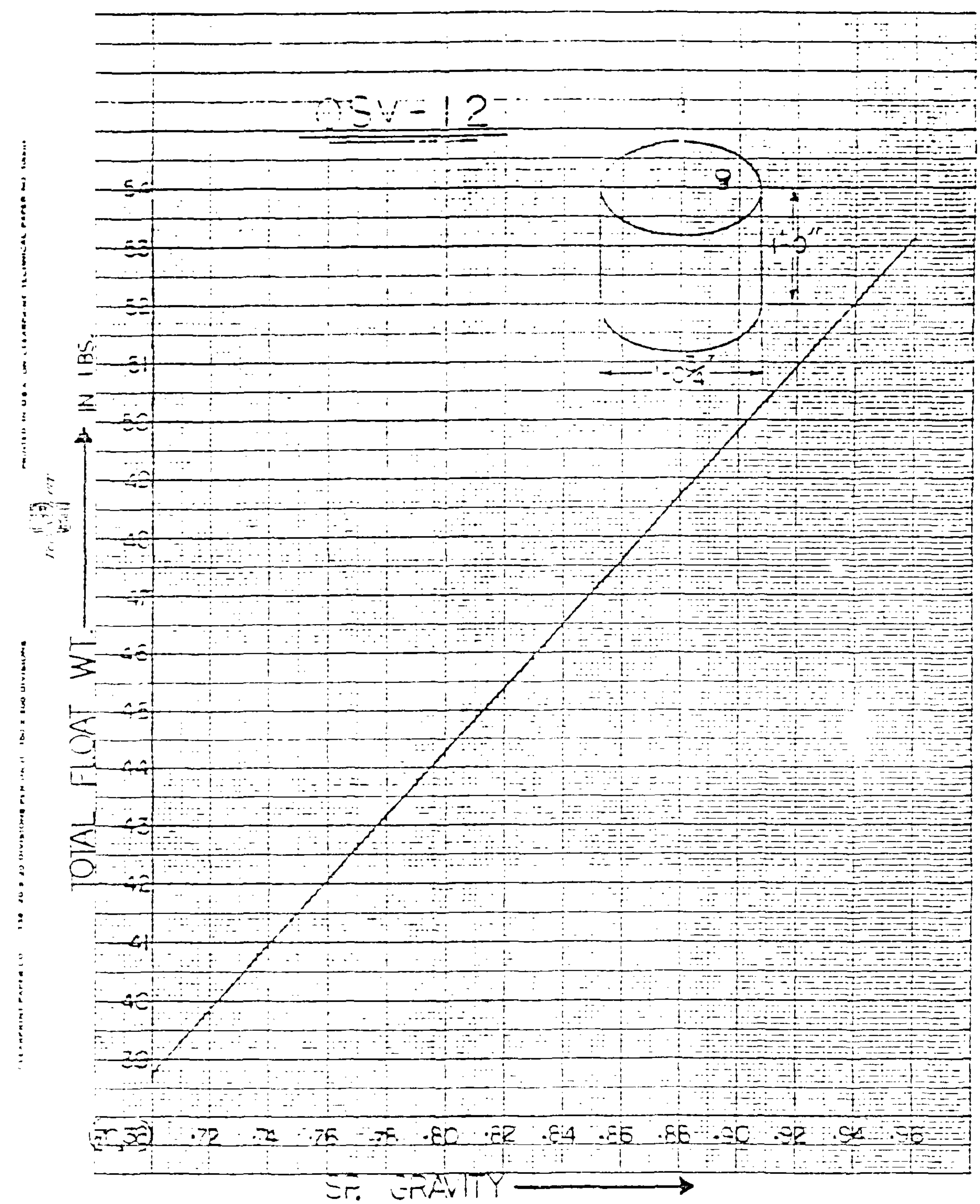


Fig 6.0
2.11.2-37

SUPERSEDES:	I-O-M: 8.05

770420

CAPACITY

A minimum recommended water level, sufficient to completely submerge the float housing, is required for proper operation of the OSV. Operation at less than the minimum recommended water level will reduce the capacity of the OSV.

The recommended operating flow rate for the various oil stop valves together with its associated head loss is shown in Figures 6, 7, 8, 9 and 10.

NOTE: For the valve to operate properly at required flow(s) the valve discharge pipe centerline must be below the liquid level a distance equal to (or greater) the associated head loss.

Example: In order for OSV-10 to pass 400 gpm flow the discharge center line of the valve must be 0.9' below liquid level. (See Fig. 9).

Example: On the same valve the discharge center line must be submerged a minimum of 0.7' to pass 350 gpm flow.

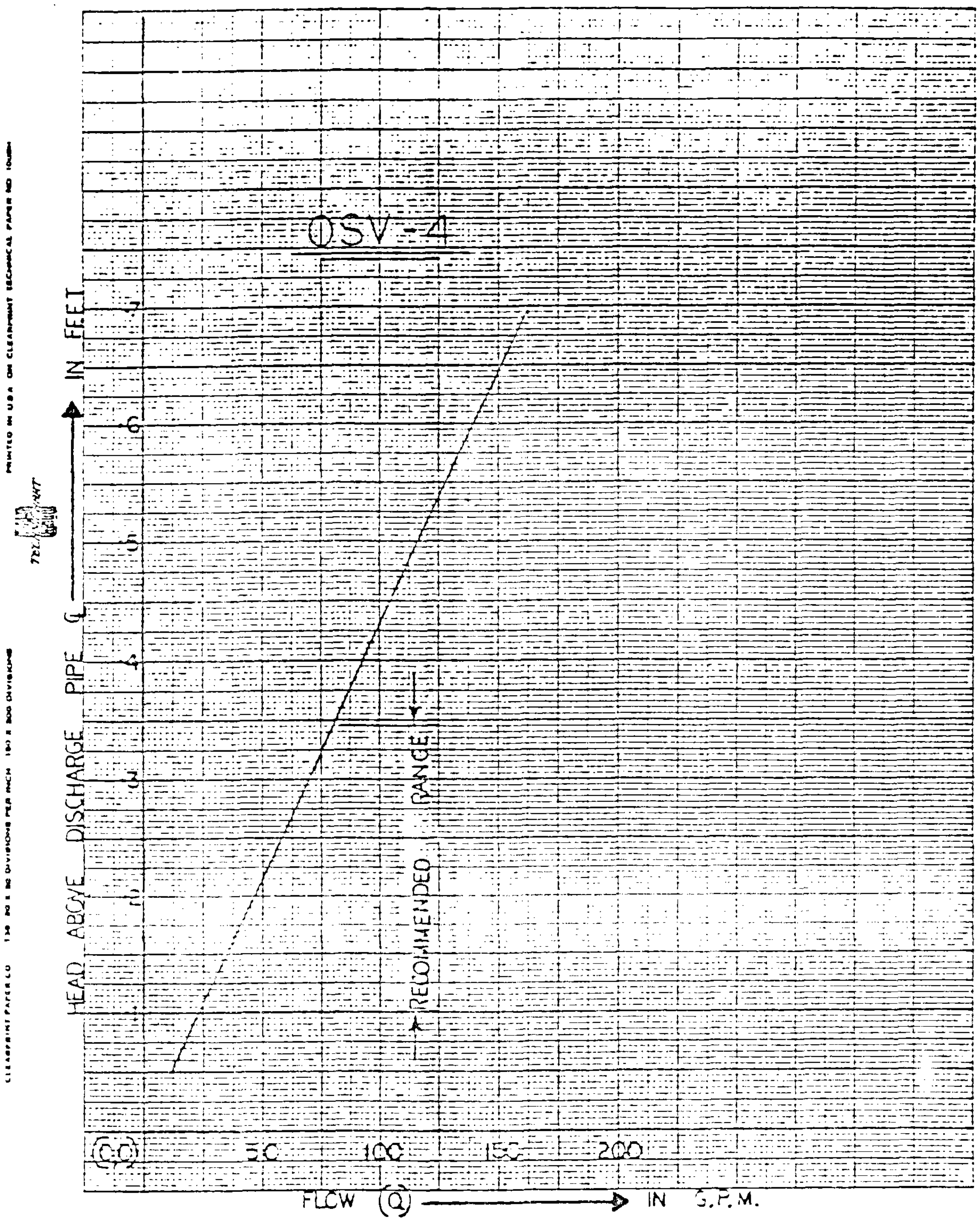


Fig 6.0

2.11.2-39

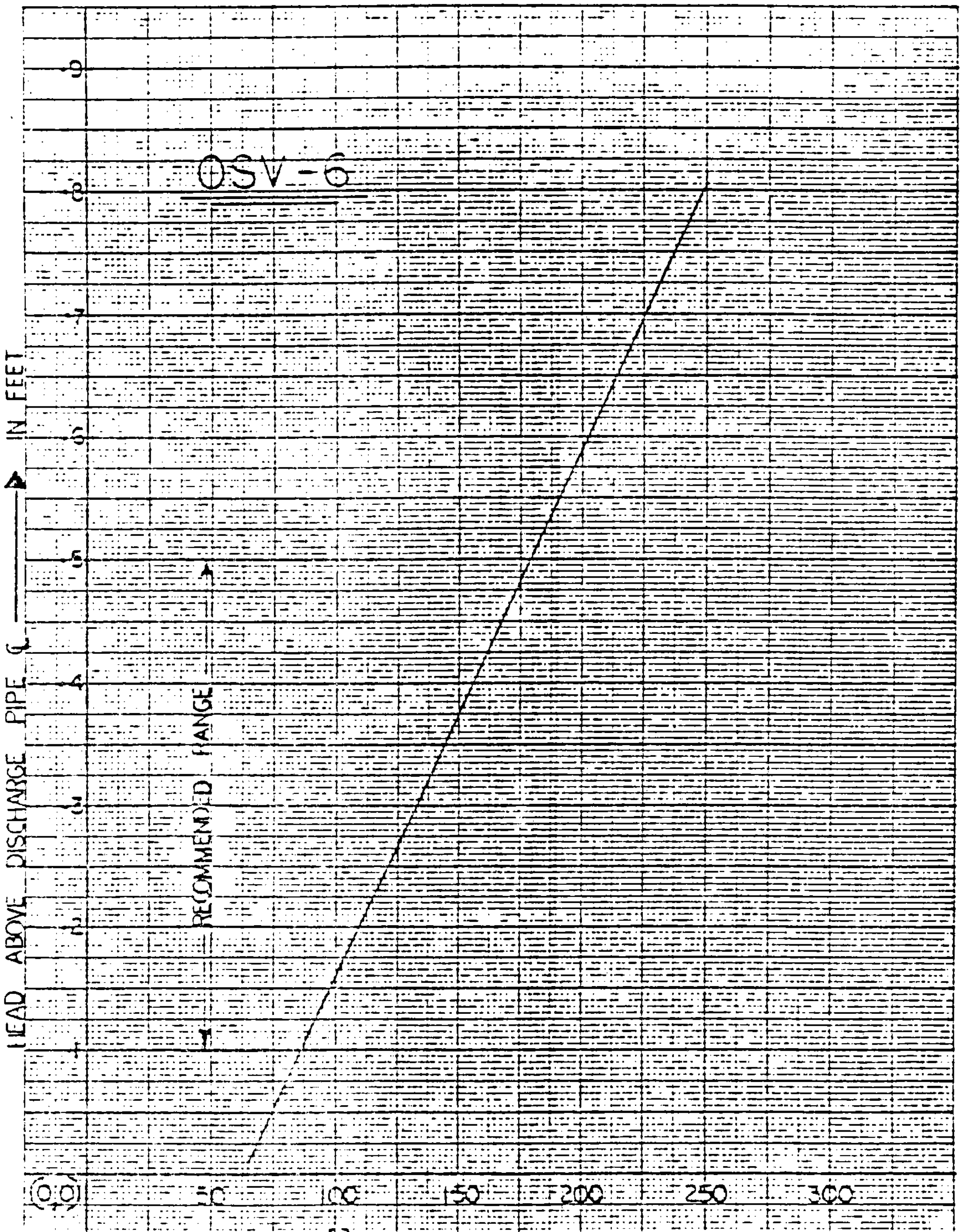

OSV-6
HEAD ABOVE DISCHARGE PIPE ℄ → IN FEET
RECOMMENDED RANGE
FLOW (Q) → IN G.P.M.
(0,0)
50
100
150
200
250
300
1
2
3
4
5
6
7
8
9

Fig 7.0

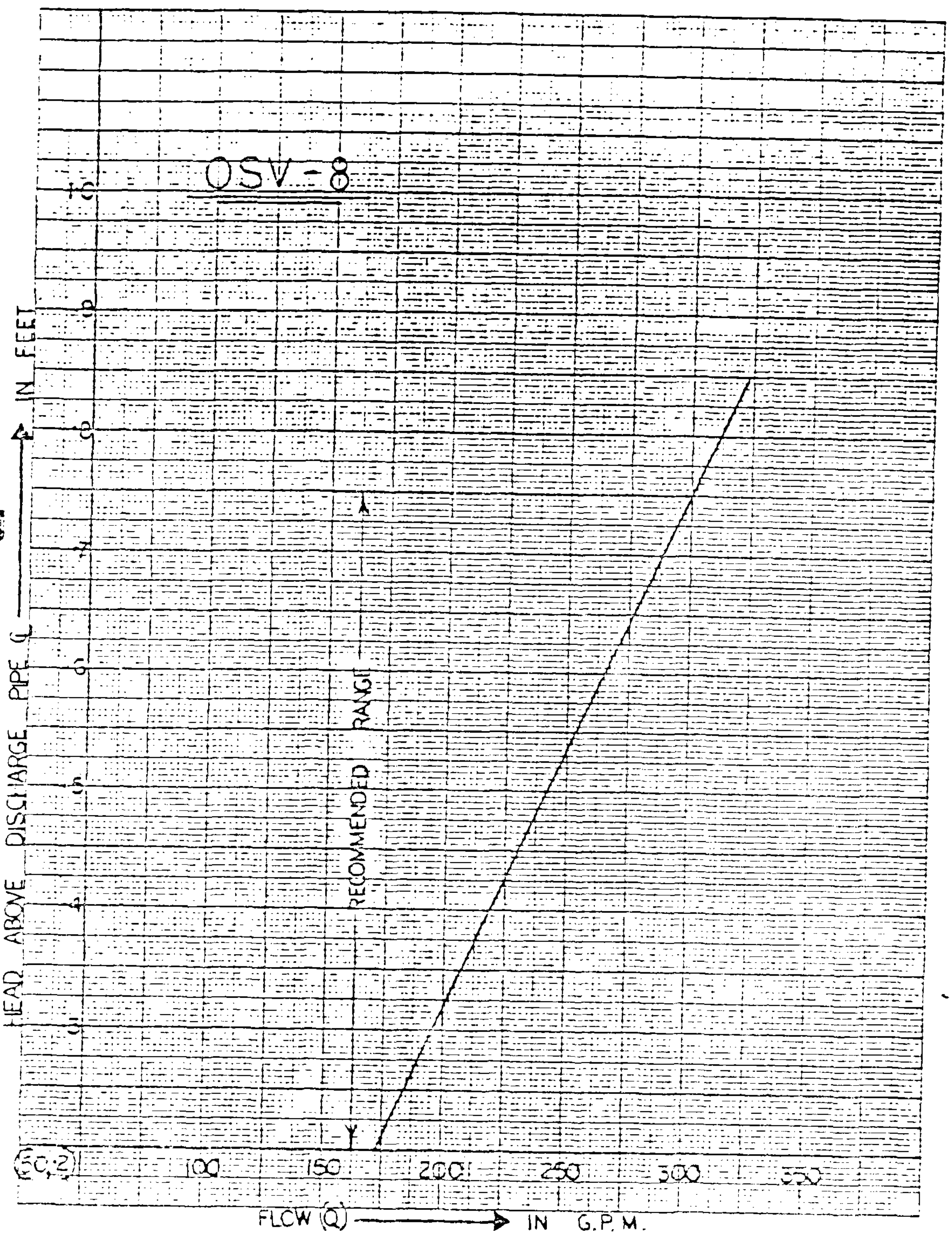


Fig 8.0

2.11.2-41

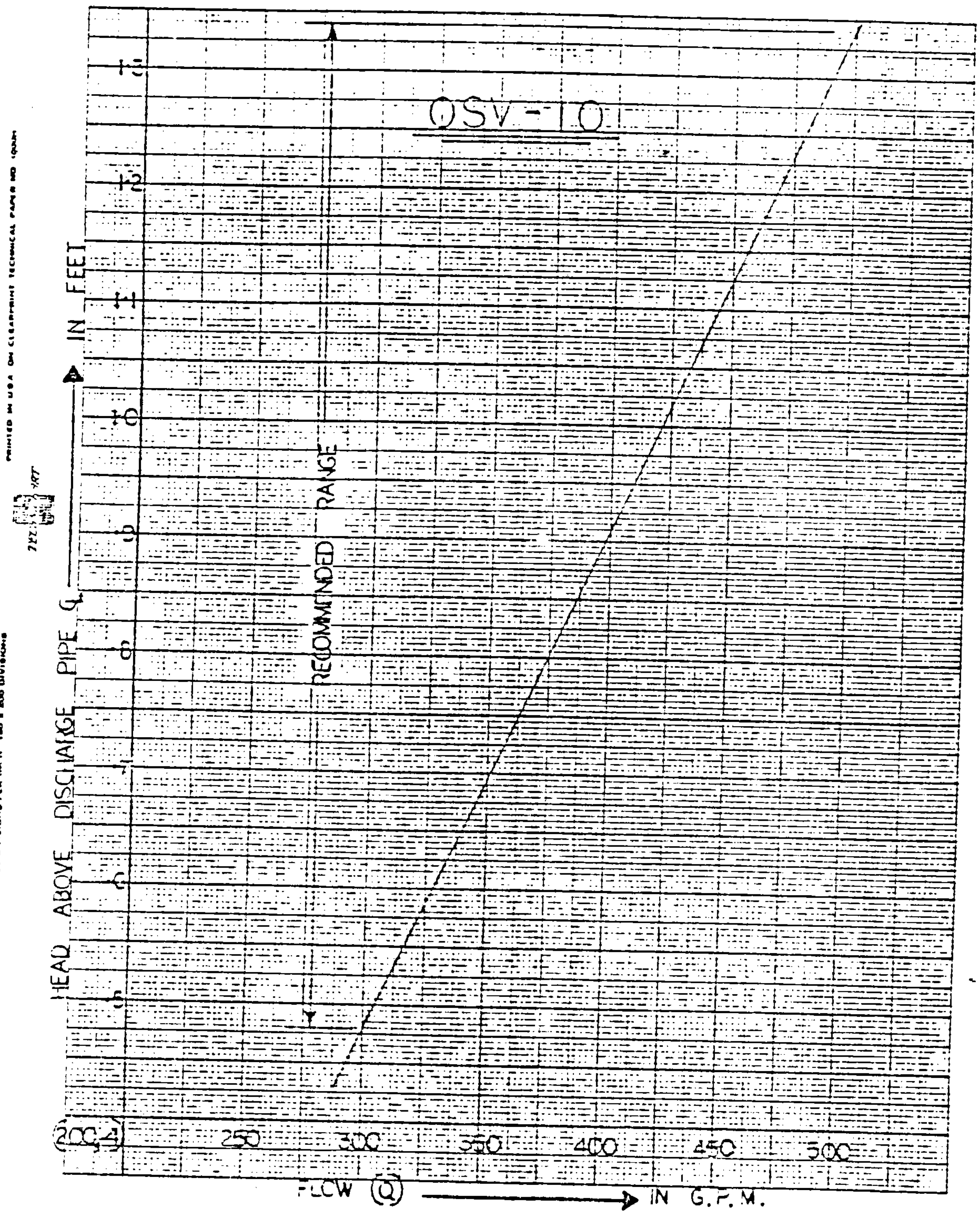


Fig 9.0

2.11.2-42

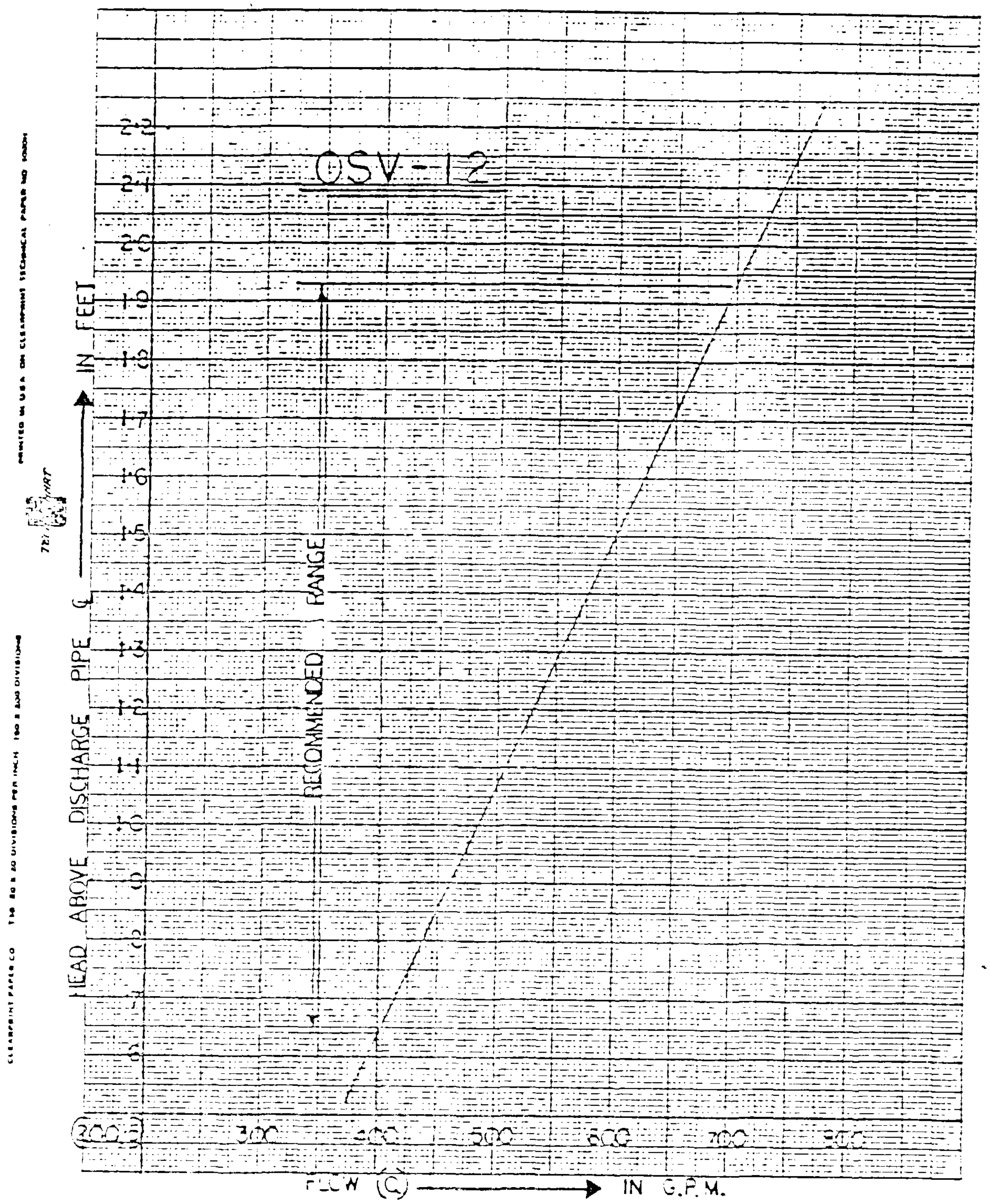


Fig 10.0

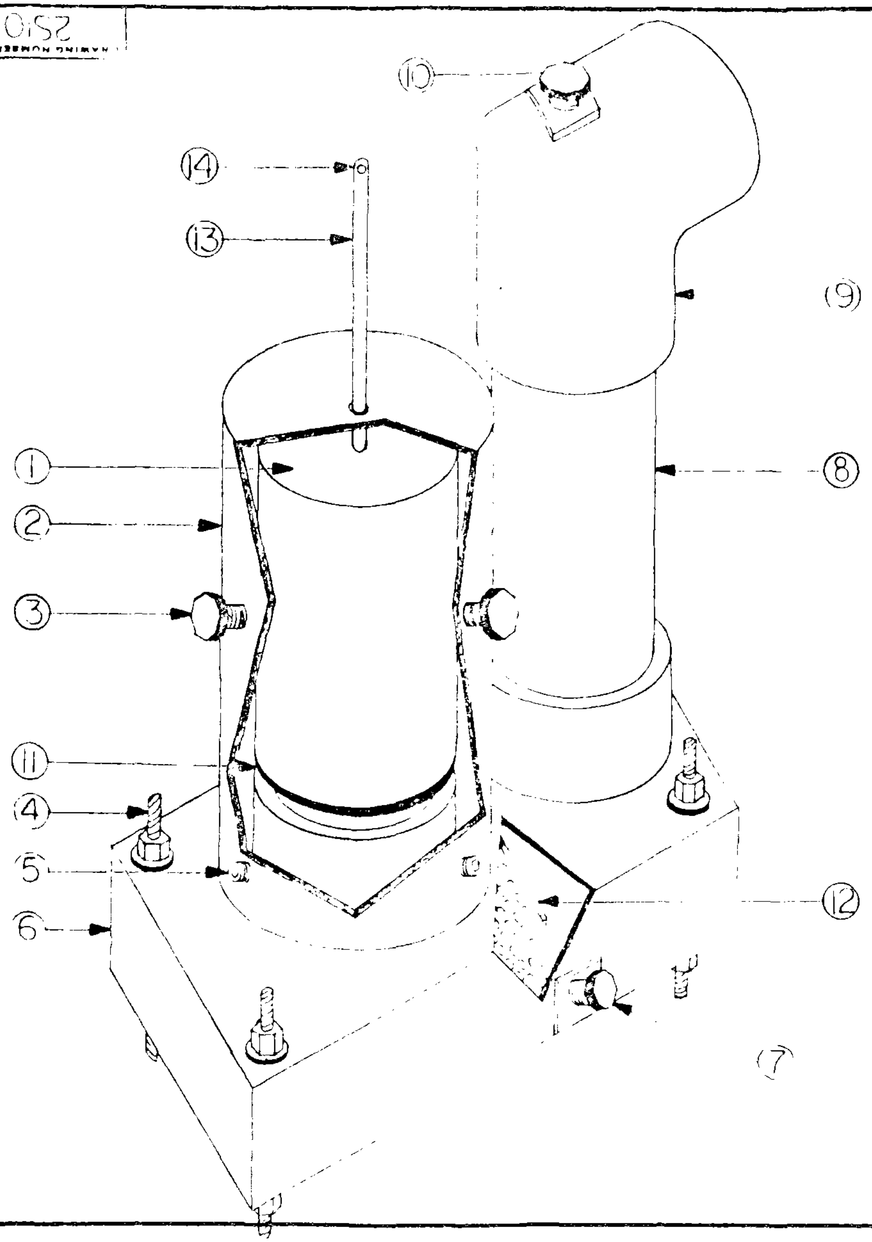
2.11.2-43

MAINTENANCE

Since the oil stop valves are made from corrosion resistant materials and have only one moving part, maintenance requirements are minimal. Unless service requirements are severe, drain tank and visually inspect the OSV annually. Check float orientation and wear on the valve gasket at this time. If the valve shuts off the flow regularly, service requirements are severe and the valve should be inspected more often (two to four times per year).

TROUBLESHOOTING GUIDE

PROBLEM	CAUSE	CURE
1. Flow is less than design	Valve partially plugged	Remove valve float housing, check screen (item 12, dwg 2S10) for debris.
	Discharge pipe plugged	Clean discharge piping
	Float hanging up	Check float alignment bolts and check float guide rod for straightness
	Inadequate discharge pipe submergence	Check design flows and elevations
	Plugged siphon pipe	Clean siphon pipe
2. Water backing up in separator	Valve float down valve plugged	Raise float (see above)
3. Valve shuts off	Flow through valve too high	Decrease flow
	Improper ballast weight	Check float for leaks check float weight
4. Valve will not reopen	Siphon pipe plugged or submerged	Clean siphon pipe, raise siphon pipe above water level
	See problem 3	



ASSEMBLY LIST

1) Float
2) Float housing
3) Float alignment bolts, 3 reqd
4) Valve leveling legs, stainless steel threaded rods maximum 2" adjustment
5) Float housing fastener set screws, 3 reqd
6) Valve base
7) Drain plug
8) Discharge pipe
9) Discharge elbow for hose connection (standard) (flanged connection optional)
10) 1" diameter, NPT siphon breaker connection (NOTE: Siphon breaker pipe - NOT BY AFL)
11) Gasket
12) Base stiffener and trash screen
13) Float guide rod
14) 1/8" Ø manual release cable attachment hole (cable - NOT BY AFL)

AFL industries, inc.
1149 HOWARD DRIVE, WEST CHICAGO, ILLINOIS 60185 (312) 231-7555

SCALE: NONE	THIS DRAWING AND SPECIFICATIONS IS THE PROPERTY OF AFL INDUSTRIES, 1149 HOWARD DR., WEST CHICAGO, ILLINOIS 60185 AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION.	DRAWN BY AMP
DATE: 12-7-79		CHECKED:

MODEL: AFL/CLARK OIL STOP VALVE

JOB: STANDARD ASSEMBLY

DRAWING NUMBER: 2S10

Proctor & Gamble
Fair Oaks, California

AFL/CLARK OIL STOP VALVE SPECIFICATION

Application ---------------------------- To stop oil spill into the effluent

Model Number --------------------------- OSV-8

Number of Units ------------------------ One (1)

Each unit will conform to the following specifications:

Description ---------------------------- Fabricated control valve designed to control oil spills. Valve assembly shall consist of base, housing, inlet housing, float and outlet connection. Valve designed to operate on specific gravity differential principle.

Oil Specific Gravity ------------------- 0.9

Flow ----------------------------------- 181-300 GPM gravity

Inlet Size ----------------------------- 8" diameter

Outlet Connection ---------------------- 8" diamter socket fitting, complete with 1" diameter socket type connection for siphon breaker. Siphon breaker connection - NOT BY AFL.

Materials of Construction:

Base, Float, Housing and Outlet Piping - PVC

Float Guide ---------------------------- Type 304 Stainless Steel

Bolts ---------------------------------- Type 304 Stainless Steel

Design Requirements:

Pressure Rating ------------------------ Ambient

Temperature ---------------------------- Ambient with 130° F maximum

Valve to be shipped completely assembled by AFL Industries for installation by customer.

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
SA-311	Ullage Maintenance Unit	2.12.1	5163147
SA-701	Nitrogen Vaporizer Supply Unit	2.12.2	5163163
(UGFA)	TU Ullage Gas Flame Arrester	2.12.3	5163147
——	O_2 Analyzer - Process Gas Chromatograph	2.12.4	5163147

2.12.4 O_2 Analyzer

2.12.4.1 Identification

Tag Number	Description
None	Process Gas Chromatograph

2.12.4.2 Description

Manufacturer: Beckman Instruments
Fullerton, Ca 92634

Part No: Model 6710

2.12.4.3 Prescribed Service

Oxygen Analyzer

2.12.4.4 Vendor

Beckman

2.12.4.5 Piping Connections

DOE Dwg No. 40P3005132020, 40P7005133249

2.12.4.6 Operation/Maintenance

See Beckman Model 6710 Process Gas Chromatograph System

CP9-134

BECKMAN

ANALYZER AND PROGRAMMER UNITS
For Model 6710 Process Gas Chromatograph Systems

OPERATING AND SERVICE MANUAL

Beckman Instruments, Inc., Fullerton, CA 92634
June 1977 770005 015-555331-A Printed in U.S.A.

CONTENTS

CONTENTS (Continued)

ILLUSTRATIONS

SPECIFICATIONS

ANALYZER

AMBIENT TEMPERATURE LIMITS
-20° to 120°F (-29° to 50°C).

POWER REQUIREMENTS
107 to 127 volts a.c., 50/60 Hz, 750 watts maximum.

SERVICE AIR REQUIREMENTS
3 to 5 scfm (85 to 142 liters/min) at 55 to 60 psig (380 to 414 kPa) required for oven heater and pneumatically actuated slider valve(s).

DETECTORS (ALTERNATE OPTIONS)
Thermal Conductivity;
Hydrogen Flame Ionization (maximum operating temperature 140°C):

CARRIER GAS REQUIREMENTS
50 to 100 cc/min normal, varies with application.

ADDITIONAL GASES REQUIRED FOR FLAME-IONIZATION DETECTOR
40 to 60 cc/min of burner hydrogen; 350 to 450 cc/min of burner air.

SAMPLE FLOW
Approximately 10 cc/min of liquid or 100 cc/min of vapor through analyzer (bypass as required).

OVEN TEMPERATURE
Adjustable from 55° to 225°C with ambient temperature range of -20° to 120°F (-29° to 50°C).
Adjustable from 55° to 200° with ambient temperature range of -30° to 120°F (-34° to 50°C).
Controlled to ±0.05°C.

THERMAL OVERLOAD PROTECTORS
100°C Select as required
150°C for specific
230°C application

NOTE

For Group C applications, temperature will be limited to 150°C.

WEIGHT
175 pounds (79.3 kg) net; 225 pounds (102 kg) shipping.

ELECTRICAL CLASSIFICATION
Designed for use in Class I, Group D, (and Group C, ethylene), Division 1 hazardous locations.

PROGRAMMER

NUMBER OF COMPONENTS
As required by application.

AMBIENT TEMPERATURE LIMITS
32° to 110°F (0° to 43.3°C).

POWER REQUIREMENTS
107 to 127 volts a.c., 50/60 Hz, 250 watts.

LOCATION
Up to 1000 feet (304.8m) from analyzer. Greater distances per special request.

WEIGHT
Approximately 70 pounds (31.7 kg) net; 125 pounds (56.6 kg) shipping.

ELECTRICAL CLASSIFICATION
General Purpose.

1.1 MODEL 6710 PROCESS GAS CHROMATOGRAPH SYSTEMS

A complete Model 6710 Process Gas Chromatograph system, such as the typical example shown in Figure 1-1, consists of four major units: sample conditioner; analyzer; programmer; and, data-acquisition device, such as recorder, recorder/controller, or computer.

The **sample conditioner** receives raw sample from the process stream and prepares it for introduction into the analyzer.

Within the **analyzer,** Figure 1-2, a measured volume of the conditioned sample is injected into a chromatographic column and is swept along by a continuous flow of inert carrier gas.

Individual components emerge from the column, in characteristic sequence, as elution bands diluted with carrier gas. Column effluent is routed through a thermal-conductivity (TC) detector or flame-ionization detector (FID), yielding signals proportional to the concentrations of the eluting components. These signals are amplified and transmitted to the programmer.

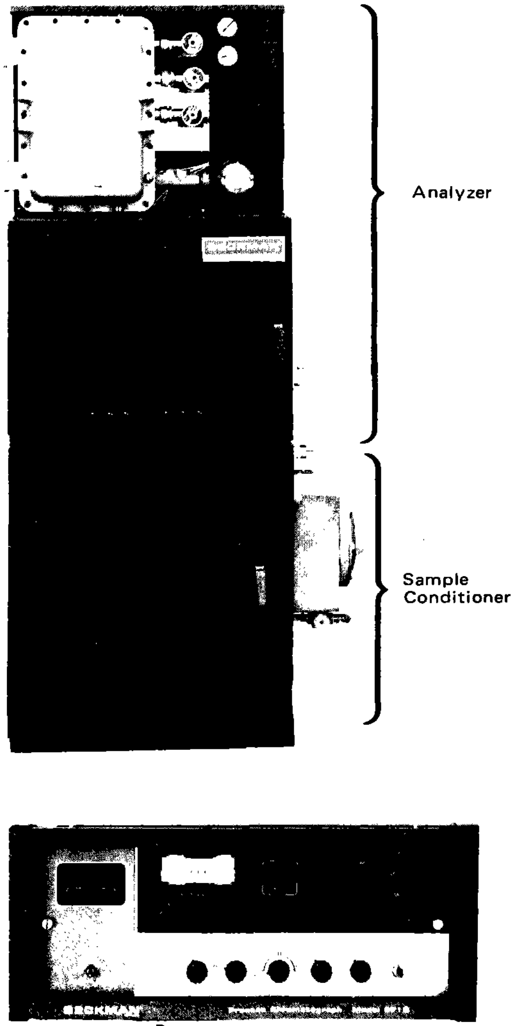
The **programmer** normally provides the control signals required to operate the analyzer, and converts the analyzer-output signal into a form compatible with the data-acquisition device(s). Alternatively, these functions may be provided by another device, such as a computer.

1.2 SCOPE OF THIS INSTRUCTION MANUAL

This instruction manual contains:

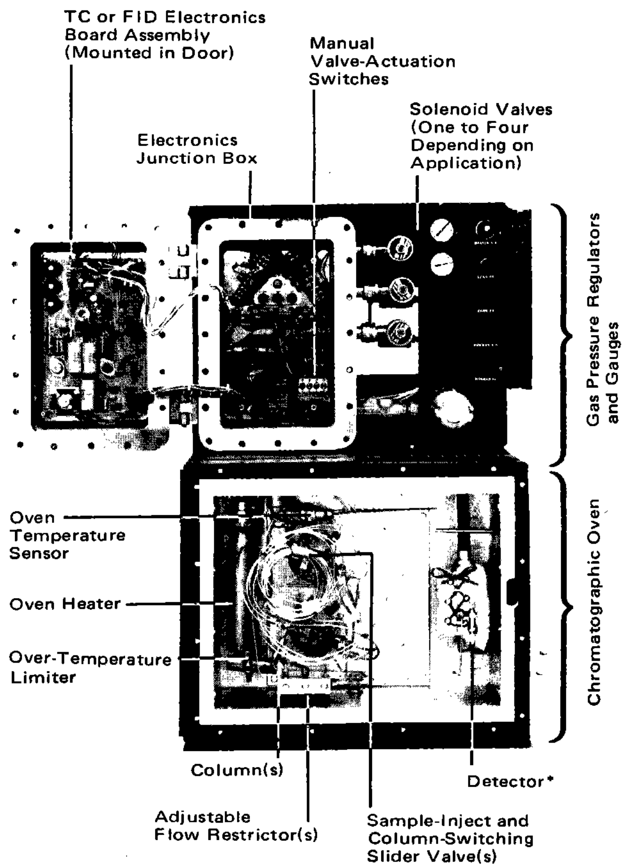
a. Detailed information on the analyzer and programmer units. Areas covered include installation, checkout, startup, service, and maintenance.
b. General operating instructions for typical Model 6710 systems.

In addition, the documentation package supplied with each instrument includes separate instruction manuals for the sample conditioner and recorder, and drawings and data sheets specific to the individual system.



NOTE
Data Acquisition Device Not Shown.

Figure 1-1. Typical Model 6710 Process Gas Chromatograph System



NOTE
Thermal-Conductivity Detector Shown. Flame-Ionization Detector is an Alternate Option.

Figure 1-2. Typical Analyzer—Interior View

SECTION TWO INSTALLATION

2.1 FACILITY PREPARATION

Paragraphs 2.1.1 through 2.1.5 provide information that may be required prior to installation. If desired, certain preparations may be completed prior to delivery of the instrument. Conduits may be installed and cables run. After locations of the individual units are selected, the corresponding panels may be cut as required.

NOTE
Allow proper clearances for servicing.

2.1.1 OUTLINE AND MOUNTING DIMENSIONS

For outline and mounting dimensions of the constituent units of the chromatograph system, refer to appropriate figures listed below.

640900 Programmer .... Figure 2-1
640300 Analyzer .... Figure 2-2
Sample-Conditioner/Combinations *(various optional and interconnection arrangements for sample conditioner and analyzer units)*. Figure 2-3

A dimensional drawing of the separate **sample conditioner** is given in Beckman Instructions 015-082293. For dimensions of the recorder, refer to corresponding separate instruction manual.

2.1.2 LOCATION AND MOUNTING

Sample Conditioner and Analyzer

Preferably, sample conditioner and analyzer units should be mounted near the process stream and adjacent to one another. If so ordered, these two units are factory assembled and interconnected as a sample-conditioner/analyzer combination. If ordered as separate units, they may be combined through use of a tie kit mounting.

Installation of the **sample conditioner** is explained in Beckman Instructions 015-082293.

The analyzer (or sample-conditioner/analyzer combination, if used) should be installed in a weather-protected environment, and should be shaded from direct sunlight.

Programmer

For convenience and/or safety, the programmer can be mounted remotely from the analyzer. (The analyzer contains amplification circuitry for improved transmission of detector-output signal, and an auto-zero circuit to minimize drift.)

Analyzer and programmer are interconnected with a single multi-conductor cable. It transmits the amplified detector-output signal from the analyzer to programmer, and also transmits control signals from programmer to analyzer.

Alternate options for programmer mounting are:

1. **Panel mounting** with Beckman hardware, in 17-3/8" x 7-1/8" (441 mm x 181 mm) cutout. When installing programmer in cutout, remove drawer and chassis to facilitate handling. To disconnect cables, remove cable locks and retain for later use. After programmer is in place, chassis can be installed easily.
2. **Rack-mounting** with customer-supplied hardware. Programmer is designed for mounting in standard 19-inch relay-rack with standard W.E./E.I.A./RETMA spacing.

Recorder

Preferably, the recorder should be near the programmer, and oriented so the operator can readily observe response to adjustment of the controls. Installation of the recorder is covered in the recorder manual.

2.1.3 ELECTRICAL INTERCONNECTION DIAGRAMS

Figure 2-4 is a *general* electrical interconnection diagram for analyzer and programmer units of Model 6710 systems. Also supplied is a *separate* interconnection drawing specific to the *individual* system.

2.1.4 TUBING HOOKUP DIAGRAMS

For locations of gas inlet and outlet connections, refer to appropriate dimensional drawing: Figure 2-2, 640300 Analyzer; or Figure 2-3, Sample-Conditioner/Analyzer Combination. Refer also to schematic flow diagram appropriate to detector type: Figure 2-5, thermal-conductivity detector; or Figure 2-6, flame-ionization detector.

2.1.5 UTILITY SPECIFICATIONS

Analyzer

Electrical Power
107 to 127 volts a.c., 50/60 Hz, 750 watts, maximum.

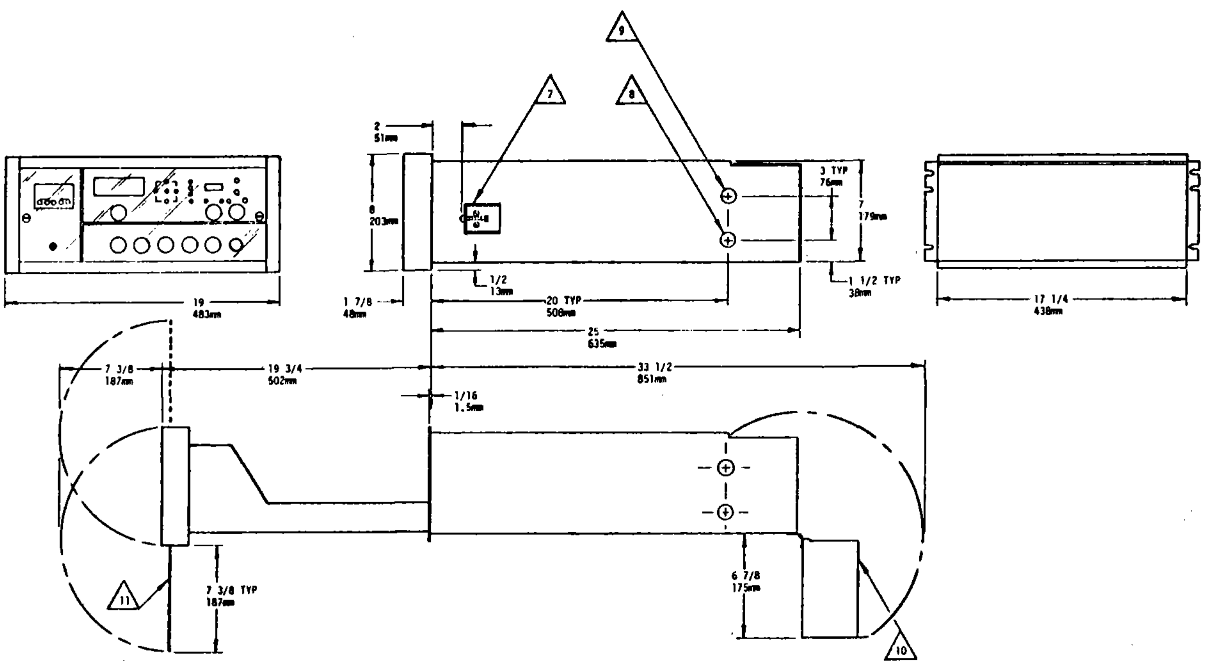
Service Air
Clean, dry, oil-free air; supplied through in-line filters; pressure-regulated to 55 to 60 psig (380 to 414 kPa). Capacity at least 5SCFM (142 liters/minute). Normal consumption 3 to 5 SCFM (85 to 142 liters/minute).
Note: Analyzer also requires cylinder gas(es) appropriate to the detector type and the particular application. Refer to Paragraph 2.2.

Programmer

Electrical Power
107 to 127 volts a.c., 50/60 Hz, 250 watts.

Service Air
Required only for air purge option. Clean, dry, oil-free air; supplied via in-line filters. Flow to be controlled and measured by customer; 0.6 CFM (17 liters/minute) required for exchange of four case volumes in ten minutes.

DWG. 640378



640900 MODEL 6710 PROGRAMMER

1. ALL DIMENSIONS IN INCHES ± 1/16 - MILLIMETERS ± 2mm.
2. WEIGHT APPROX. 70 LBS.
3. 117 VAC 50/60 HZ, 250 WATTS MAX.
4. MOUNT INDOORS.
5. 19" RACK MOUNTABLE.
6. RECOMMENDED PANEL CUTOUT 17 3/8" WIDE x 7 1/8" HIGH (1 1/2" MAX. PANEL THICKNESS).

△7 BRACKET AND HARDWARE FOR PANEL MOUNTING SUPPLIED BY BECKMAN. (QUANTITY TWO).

△8 TWO (2) 1 3/8 DIA HOLES FOR 1 INCH CONDUIT FITTINGS. (ONE ON EACH SIDE BOTTOM).

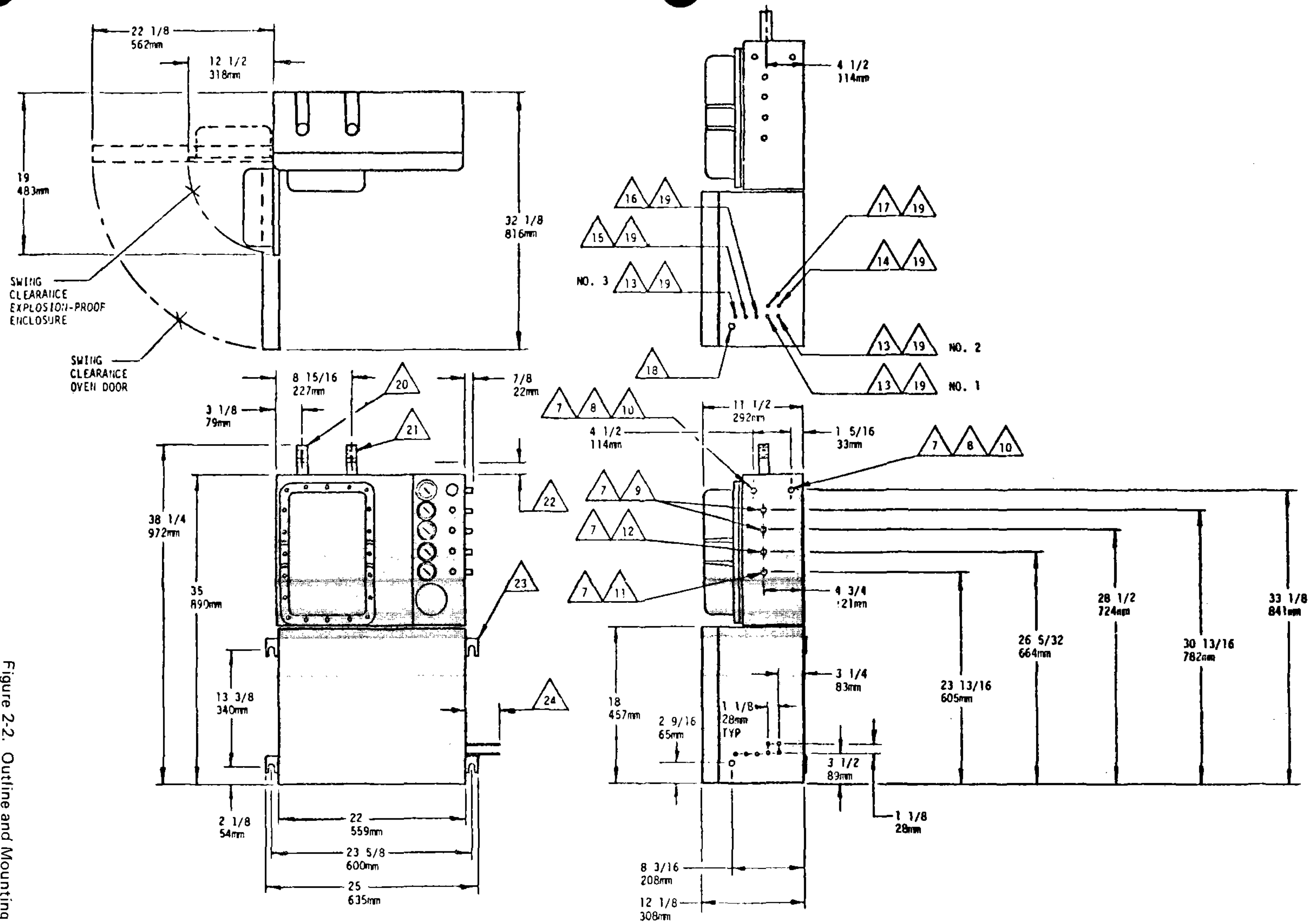
△9 TWO (2) 1 1/8 DIA HOLES FOR 3/4 INCH CONDUIT FITTINGS. (ONE ON EACH SIDE TOP).

△10 POWER SUPPLY SWINGS DOWN FOR INFREQUENT MAINTENANCE AND EASE OF POWER CORD AND INTERCONNECTING CABLE HOOK-UP.

△11 OPTIONAL DOOR (SWINGS UP OR DOWN).

Figure 2-1. Outline and Mounting Dimensions of 640900 Programmer

DWG. 640378, sheet 2 of 4



640300 MODEL 6710 ANALYZER

1. ALL DIMENSIONS IN INCHES ± 1/16 - MILLIMETERS ± 2mm.
2. WEIGHT APPROX 200 LBS.
3. 117 VAC 50/60 HZ 750 WATTS
4. MOUNT IN PROTECTED AREA FROM SUN AND RAIN.
5. RECOMMENDED MOUNTING HARDWARE 3/8 DIA BOLTS AND WASHERS - 4 REQUIRED (SUPPLIED BY CUSTOMER).

△6 LOCATED ON SAMPLE CONDITIONER WHEN SUPPLIED BY *BECKMAN*.

△7 RECOMMENDED INLET PRESSURE 55-60 PSIG. DO NOT EXCEED 60 PSIG.

△8 2-5 SCFM OIL-FREE DRY AIR.

△9 CARRIER GAS. 1/4 O.D. BULKHEAD FITTING.

△10 COMPRESSED AIR. 1/4 O.D. BULKHEAD FITTING.

△11 H_2 FUEL. 1/4 O.D. BULKHEAD FITTING (H_2F DETECTOR ONLY).

△12 BURNER AIR. 1/4 O.D. BULKHEAD FITTING (H_2F DETECTOR ONLY).

△13 AUX. VENT.

△14 COLUMN VENT.

△15 SAMPLE VENT.

△16 SAMPLE IN.

△17 REFERENCE VENT.

△18 DRAIN (H_2F DETECTOR ONLY). 1/2 O.D. TUBE. (12.7mm) DRAIN SHOULD NOT EXCEED ELEVATION OF 1/2 DRAIN TUBE.

△19 1/8 O.D. (3.17mm) TUBE.

△20 3/4 NPT - MALE FOR 115 VAC POWER CABLE

△21 1 NPT - MALE FOR INTERCONNECTING CABLE TO PROGRAMMER

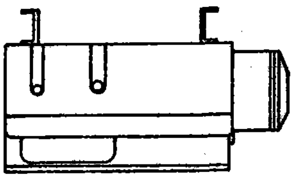
△22 ALLOW 1 1/4 (29mm) FOR COVER REMOVAL FOR INFREQUENT MAINTENANCE.

△23 OPTIONAL WALL MOUNTING STRAP.

△24 ALLOW ROOM FOR CUSTOMER TUBING CONNECTIONS.

Figure 2-2. Outline and Mounting Dimensions of 640300 Analyzer

DWG. 640378, sheet 4 of 4



1. ALL DIMENSIONS IN INCHES ± 1/16 - MILLIMETERS ± 2mm UNLESS OTHERWISE NOTED.
2. WEIGHT - APPROX. 450 LBS.
3. MOUNT-IN PROTECTED AREA FROM SUN AND RAIN.
4. RECOMMENDED MOUNTING HARDWARE 3/8 BOLTS AND WASHERS 4 REQUIRED FOR FLOOR MOUNTING - 8 REQUIRED FOR WALL MOUNTING (CUSTOMER SUPPLIED).
5. 3/4 NPT - FEMALE FOR 115 VAC POWER CABLE (CUSTOMER SUPPLIED).
6. 1 NPT - FEMALE FOR INTERCONNECTING CABLE TO PROGRAMMER.
7. CONDULET NOT PRESENT ON SINGLE STREAM SYSTEM.
8. OPTIONAL FREE STANDING FLOOR MOUNT.
9. OPTIONAL WALL MOUNTING SUPPORT.

NOTE: For piping connections to sample conditioner, refer to Beckman Instructions 015-082293.

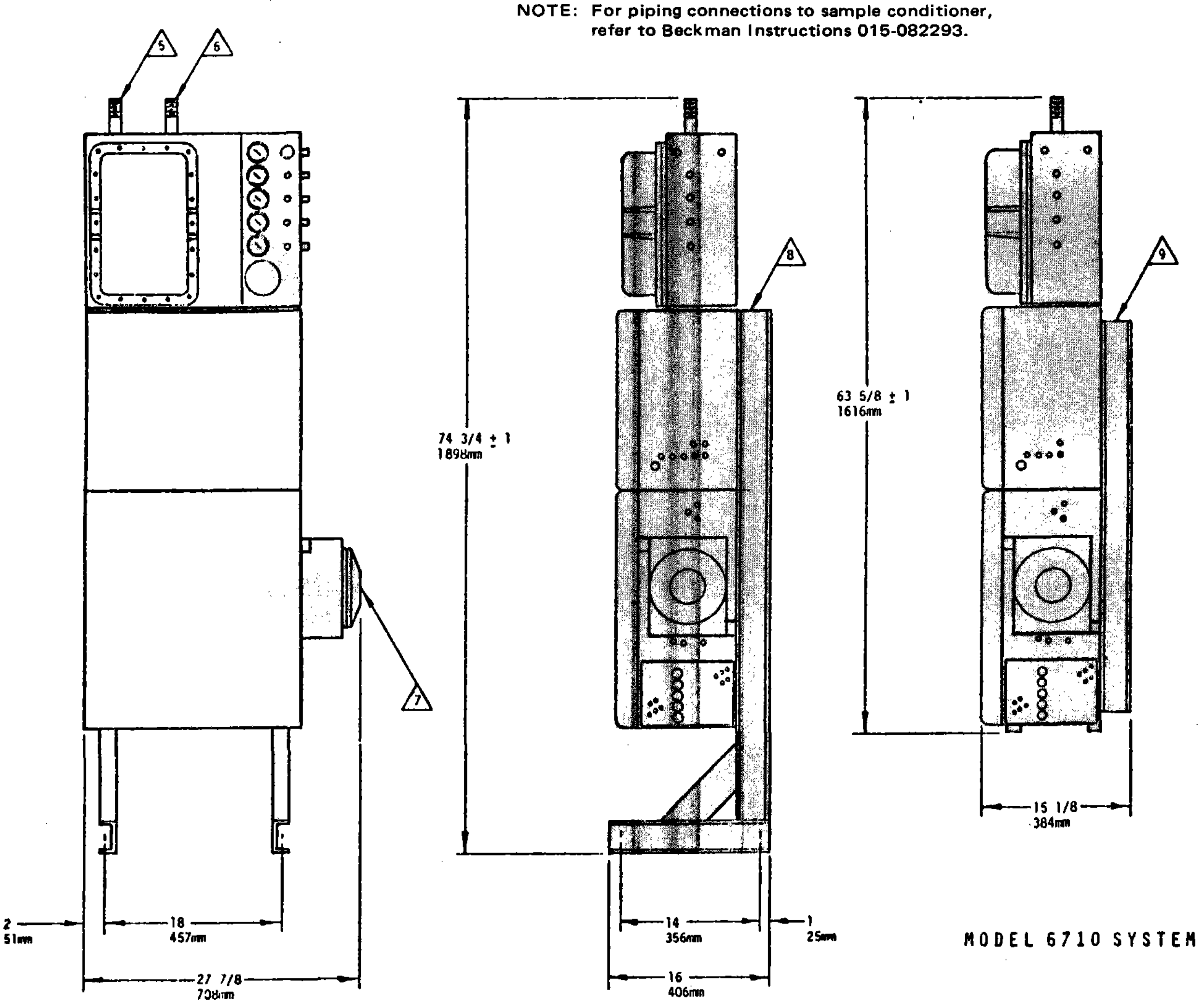
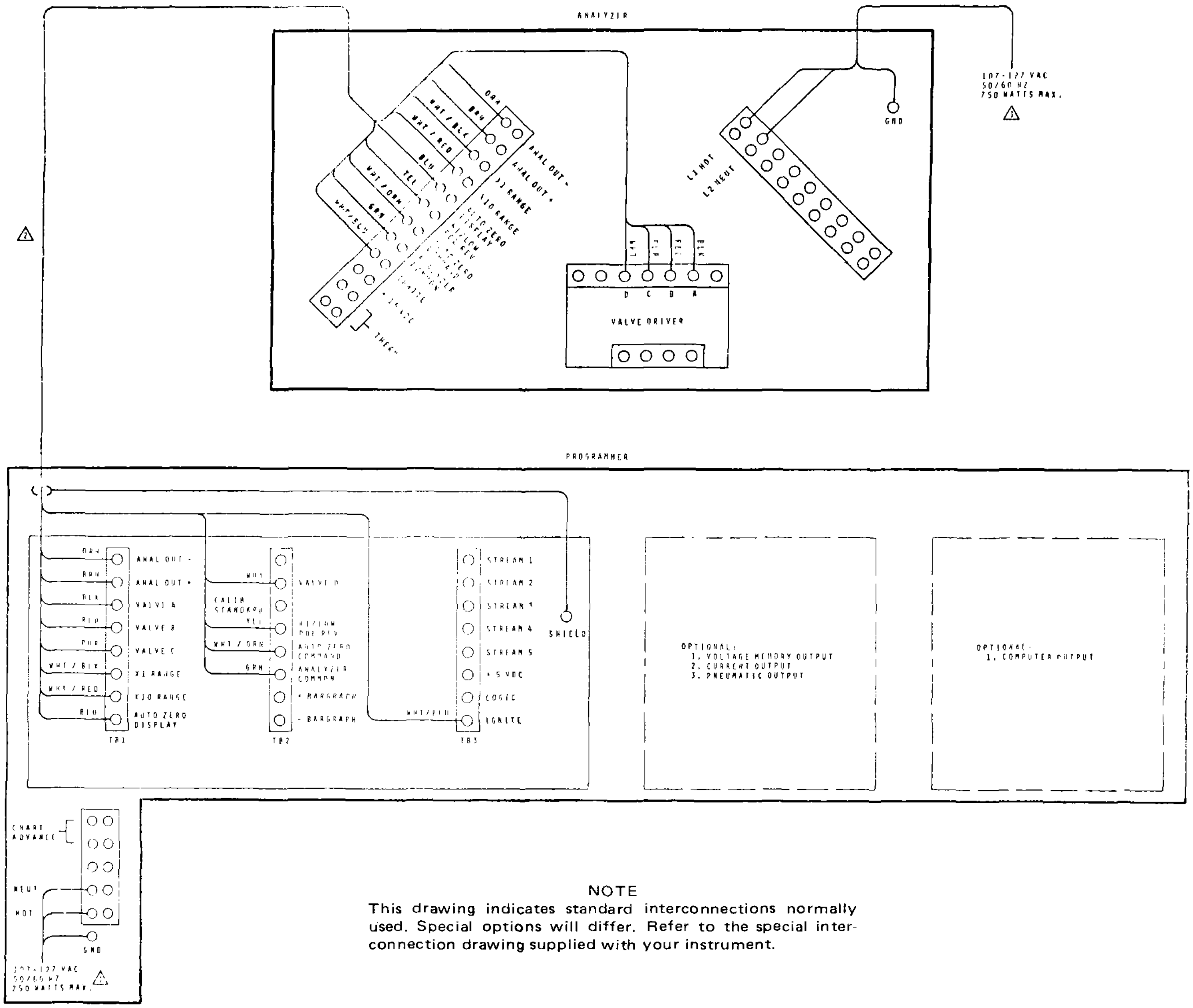


Figure 2-3. Outline and Mounting Dimensions of Sample-Conditioner/Analyzer Combinations

DWG. 640387



NOTE

This drawing indicates standard interconnections normally used. Special options will differ. Refer to the special interconnection drawing supplied with your instrument.

Figure 2-4. General Electrical Interconnection Diagram for Analyzer and Programmer Units of Model 6710 System

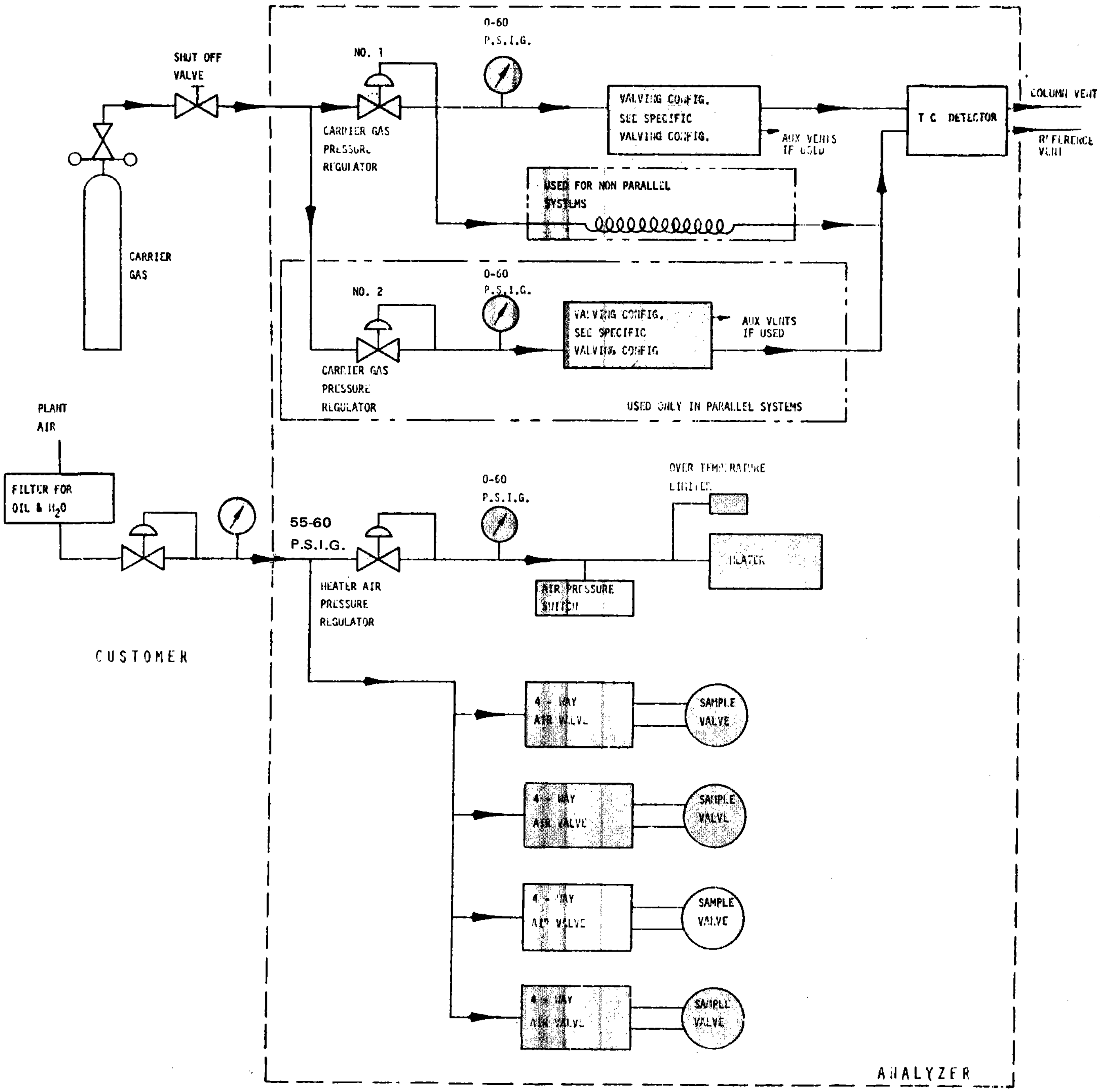


Figure 2-5. Flow Diagram of Analyzer with Thermal-Conductivity Detector

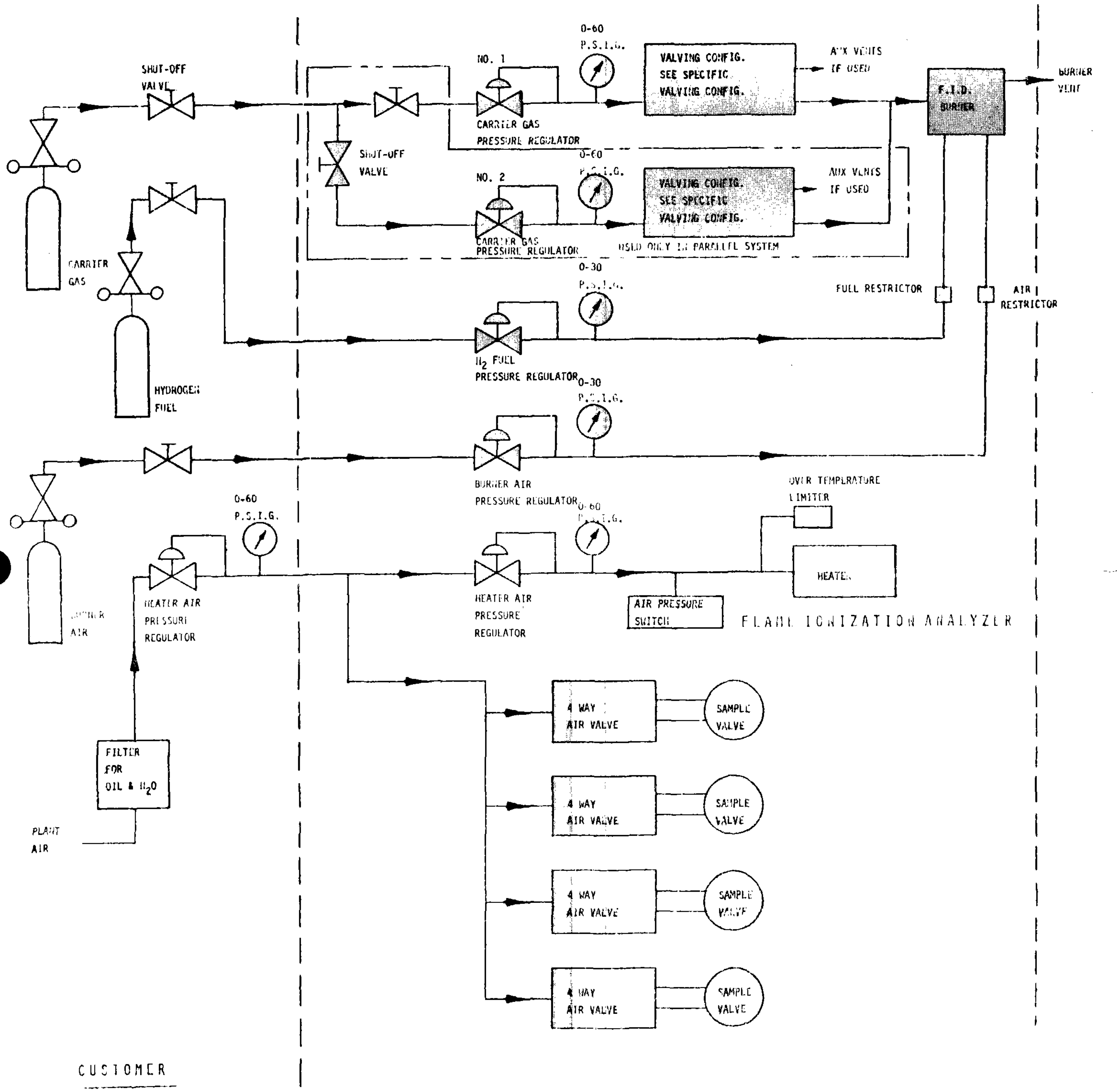


Figure 2-6. Flow Diagram of Analyzer with Flame Ionization Detector

2.2 CYLINDER GAS REQUIREMENTS

The analyzer requires cylinder gas(es) appropriate to the detector type and the particular application. If Applications Engineering Service is purchased, the Applications Data Sheet will specify the specific gas(es) required. If such service is not purchased, use the following information as a guide to selection of gas(es) and associated regulators and other hardware.

2.2.1 CARRIER GAS FOR THERMAL-CONDUCTIVITY (TC) DETECTOR

Helium Carrier (Preferred)

Preferred carrier gas for thermal-conductivity detector is **helium.** Requirements are: purity, 99.999% or better; dew point, −80° to −90°F (−62° to −68°C). Helium of suitable purity is available from several suppliers under their various grade names. Typical examples are: Air Reduction, A-1 Reactor Grade; Linde, Blue Dot Grade; Matheson, Ultra Pure Grade. Other vendors offer helium of comparable purity and price range under their own grade names.

Alternative Carriers for Specific Analysis Requirements

If helium carrier is not readily available, or is not suited to the requirements of the particular analysis, nitrogen, argon, or hydrogen may be used. Purity and dew point should be similar to those specified above for helium.

WARNING

Hydrogen *carrier requires a leak-free system to avoid danger of explosion.*

Carrier Gas Pressure Regulator

The carrier gas cylinder should be equipped with a **clean, hydrocarbon-free,** two-stage regulator with indicating gauges of approximately 0 to 3000 psig (0 to 20.7 MPa) for cylinder pressure and 0 to 100 psig (0 to 689 kPa) for delivery pressure. Regulator should have a metallic, **not elastomeric,** diaphragm, should have a ¼-inch NPT female outlet, and should be LOX clean. A shutoff valve on the regulator is recommended.

2.2.2 GASES FOR FLAME-IONIZATION DETECTOR (FID)

The flame-ionization detector requires three gases normally supplied from cylinders:

1. **Carrier gas,** preferably helium. Purity requirements are same as for helium used with TC detector (Paragraph 2.2.1). Alternatively, chromatograph-grade **hydrogen** or argon may be used.
2. **Burner hydrogen.** Ultra pure grade is recommended. Requirements are: purity, 99.999%; total hydrocarbons content, expressed as methane, less than one part per million; dew point, −90°F (−68°C). Hydrogen may be supplied from a cylinder. Alternatively, a palladium-diffusion hydrogen generator may be used, provided that it is capable of supplying hydrogen at the required flow rate, and within the specified dew point.

NOTE

In some applications **hydrogen** *is used as a* **carrier.** *If so, it is supplied to the CARRIER inlet. In such special applications, gas requirements and connections are covered in the Application Data Sheets.*

3. Burner air, used as support gas for the FID. Use breathing-grade air. Requirements are: total hydrocarbons content, expressed as methane, less than two parts per million; dew point, −90°F (−68°C) or lower.

Pressure Regulators

Each gas cylinder used should be equipped with a **clean, hydrocarbon-free** two-stage regulator with indicating gauges of approximately 0 to 3000 psig (0 to 20.7 MPa) for cylinder pressure and 0 to 100 psig (0 to 689 kPa) for delivery pressure. Regulator should have a metallic, **not elastomeric,** diaphragm, should have a ¼-inch NPT female outlet, and should be LOX clean.

In addition to a regulator, a shutoff valve is desirable, particularly on the hydrogen cylinder.

2.3 GAS CONNECTIONS TO ANALYZER

2.3.1 TUBING RECOMMENDATIONS

For external gas lines, the use of all new tubing throughout is strongly recommended. The preferred type is new, **refrigeration-grade** copper tubing, sealed at the ends. Generally, stainless-steel tubing is less desirable, as it contains hydrocarbon contaminants, necessitating thorough cleaning before installation. Precleaned "chromatograph-grade" stainless steel tubing, available at premium price from various supply houses, is recommended if stainless steel is desired. Stainless steel of other than "chromatograph-grade" may be used, provided that it is properly cleaned before use, as explained in Paragraph 2.3.2.

Pipe Connections

Seal with Teflon® tape ONLY. Start one or two threads back, to prevent shredding and subsequent plugging of lines, filter, etc. DO NOT use pipe-thread compound or other substance with an organic base.

Tubing Connections

Gyrolok® fittings are preferred. Teflon tape is not required on tubing connections.

2.3.2 HOOKUP PROCEDURE

1. Check analyzer to make sure that plugs and caps are removed from all inlet and outlet fittings. See Figure 2-2 or 2-3, or special drawing provided.
2. Connect VENT outlets to suitable disposal system, for venting to **atmospheric pressure.** If vent must be connected to a header, make sure there is no back pressure. To avoid condensation and possible formation of bubbles within the lines, make sure that vent lines slope downward.

3. Unless external gas-supply lines are new, hydrocarbon-free, and sealed, they must now be cleaned. First wash with a hydrocarbon solvent such as acetone or trichlorethylene. Next, wash out lines with distilled or deionized water. Then, **before** connection to the instrument, heat line with a torch to drive out contaminants. Recommended method is to connect the tubing, via a two-stage regulator, to a cylinder of dry nitrogen. Adjust the regulator for a low flow of nitrogen through the tubing. With a propane or natural-gas torch, heat the tubing, working the heat source slowly from the regulator end to the open end. This will remove contaminants from the inner walls of the tubing and expel them from the open end.

CAUTION

Never heat lines while connected to the chromatograph, as the contaminants would then be driven into the instrument.

WARNING

Never apply a torch to a gas line when purging with **hydrogen**.

4. Unless external gas fittings are new, hydrocarbon-free and sealed, they must now be cleaned. First, wash with a hydrocarbon solvent such as acetone or trichloroethylene; then, rinse with distilled or deionized water.
5. Connect external gas-supply lines to corresponding fittings on analyzer, Figure 2-2 or 2-3, or special drawing provided.

NOTE

Some chromatographic columns may be supplied loose (not installed), with ends capped to prevent degradation. Such columns should be uncapped and installed in accordance with Applications Engineering information.

6. Check for leakage of carrier gas in **external** system:
   a. On the analyzer, close pressure regulator(s) associated with carrier gas, to prevent any flow of carrier.
   b. Adjust regulator on carrier-gas cylinder for output pressure of 60 psig (414 kPa). Turn off gas at cylinder. Loosen outlet fitting on cylinder regulator to permit **high-pressure** side of regulator to bleed to zero; then, with the **second stage** of the regulator still showing an up-scale reading, re-tighten the fitting. Carrier gas is now confined within the external supply line and associated fittings between the regulator on the cylinder and the input side of the regulator in the analyzer.

   Observe gauge on second stage of cylinder regulator. Pressure should remain constant; if so, external connections associated with the carrier-gas supply are leak-free. Proceed to Step 7.

   If pressure reading drops, leakage is occurring; locate source with SNOOP (Beckman Part 837801) or other suitable leak-test liquid. Do not use soap or other organic substances; they will contaminate the system, resulting in excessive noise and background current. After correcting leakage, proceed to Step 7.
7. If analyzer incorporates **flame-ionization** detector, test for leakage in the external connections associated with burner hydrogen and air supplies, by the same method that was used for carrier gas in Step 6.

WARNING

If analyzer uses hydrogen, be particularly careful in checking for leaks in **hydrogen** *lines. Hydrogen leakage can cause an explosion.*

8. Adjust regulators on gas clyinders for appropriate supply pressures at analyzer inlets. Do not use pressure greater than 60 psig. (414 kPa).

2.4 ELECTRICAL CONNECTIONS

2.4.1 PROGRAMMER ELECTRICAL CONNECTIONS

The programmer rear panel has terminals for all standard connections. Additionally, all plug-in options have their own connections, with all external tie-points provided. If connections are made according to the interconnection diagram supplied, no difficulty should be encountered.

CAUTION

For any external options other than those provided by Beckman, it is mandatory that command signals be applied indirectly, through relay contacts, **not** *by direct connection. Also, switching must be accomplished through an* **external** *power source. Do not, under any circumstances, connect a switching network to amplifier ground, or to the return terminal associated with the +15.0 volt and −15.0 volt power supplies.*

Programmer AC Power Connections and Grounding

Supply a.c. power to the programmer via a three-conductor cable, minimum wire size 14 gauge. The power leads enter the programmer through the side, and connect to the side of the chassis. Be sure to connect the CHASSIS ground terminal to an earth ground via the third wire of the power cable.

Recorder Output Connections

For bargraph output, the programmer has two potentiometric outputs:

1. Rear-panel terminals marked BARGRAPH (+) and (−) provide a selectable output of 10 millivolts or one volt:
   a. The 10-millivolt output is obtained across a 20-ohm resistor. With this output, the readout device should

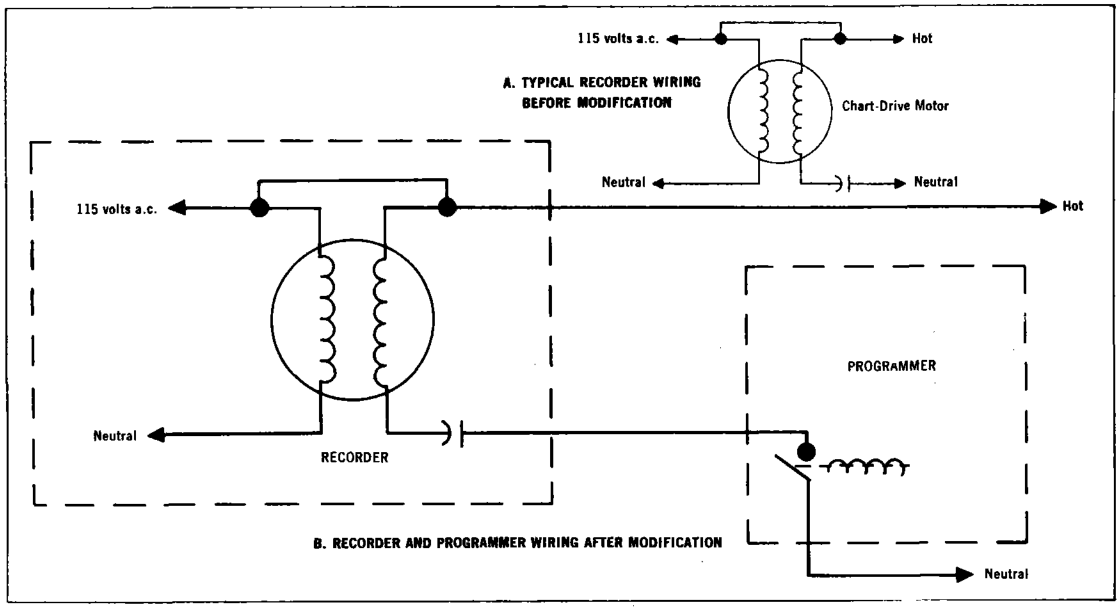


Figure 2-7. Wiring Modifications to Recorder Chart-Drive Circuit for Adaptation to Bargraph Readout

have an input impedance of **at least** 10K (loading effect, 0.2% and constant), and preferably greater than 100K.

b. The one-volt output is obtained across a 2K resistor. With this output the readout device should have an input impedance of **at least** one megohm (loading effect, 0.2% and constand).

2. Front-panel jack marked TEST OUTPUT provides a **fixed** output of 10 millivolts, identical to the 10-millivolt output at the rear-panel terminals. If both 10-millivolt outputs are used, note loading effects cited above.

Recorder Chart-Advance Connections

The recorder chart-advance function is controlled by the programmer through a solid-state relay.

If the recorder **is provided by Beckman,** the chart-drive circuit within the recorder is factory-modified for use with the programmer.

If recorder is **customer-supplied,** the modification must be made by the customer. Figure 2-7 shows a typical example. Recorder chart speed should be one inch (25 mm) per minute.

2.4.2 ANALYZER ELECTRICAL CONNECTIONS

Electrical connections to the analyzer are made through two conduit pipes, shown in Figure 2-8.

Programmer-to-Analyzer Connections

For programmer-to-analyzer interconnection, Beckman will supply, on order, a single multi-conductor cable with color-coded leads. For specific connections, refer to interconnection diagram supplied.

If a **customer-supplied** interconnection cable is used, assign desired colors to leads, then connect leads and shield as shown in appropriate interconnection diagram.

Analyzer AC Power Connections

Leads from a.c. power source enter analyzer through left-hand conduit pipe and are connected as shown in Figures 2-4 and 2-5. Minimum acceptable wire size is 14 gauge; preferred size is 12 gauge. Power requirements are 107 to 127 volts a.c., 50/60 Hz, 750 watts maximum.

Before supplying power to the analyzer, complete the gas connections. If **flame-ionization** detector is used, make sure that all connections for burner hydrogen are leak-free, as explained in Paragraph 2.3.2. Checks for **internal** leakage within the chromatograph flow system will be made during the startup procedure of Paragraph 3.1.

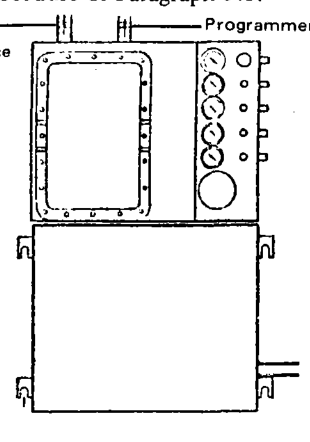


Figure 2-8. Routing of Electrical Leads into Analyzer

If so ordered, the Model 6710 Process Gas Chromatograph is factory-equipped to perform a specific analysis: the analyzer is provided with the appropriate column-and-valving configuration, detector, and associated electronics; the programmer is assembled and approximately adjusted for the required functions.

Instruments Ordered With Applications Engineering Service

If Applications Engineering service is ordered, the instrument is processed through the Beckman Application Engineering Department. Here, columns are selected, and all controls are factory-adjusted for the required analysis. Before changing any control setting on such an instrument, read the Applications Data Sheets provided with the manual. Set all utilities at the values specified; verify that control settings are those listed. If controls have moved during shipment or installation, return them to the correct settings before putting the instrument into operation. After initial start-up and component calibration per Paragraphs 3.1 and 3.2, the instrument should function satisfactorily in either automatic or manual mode. Subsequently, it should normally require no more than minor adjustments of component attenuators, valve-switching times, etc.

More extensive adjustments and possible reprogramming may be required under such circumstances as: (a) user wishes instrument to perform a different analysis than that originally provided, or (b) after a period of operation, columns and/or plug-in circuit boards are replaced. In these cases, the instrument must be readjusted by the user, as explained in Paragraph 3.2.

Instruments Ordered Without Applications Engineering Service

An instrument purchased **without** Applications Engineering service must be programmed **from the beginning** by the user, as explained in Paragraph 3.2.

3.1 STARTUP PROCEDURE

Control Locations and Functions

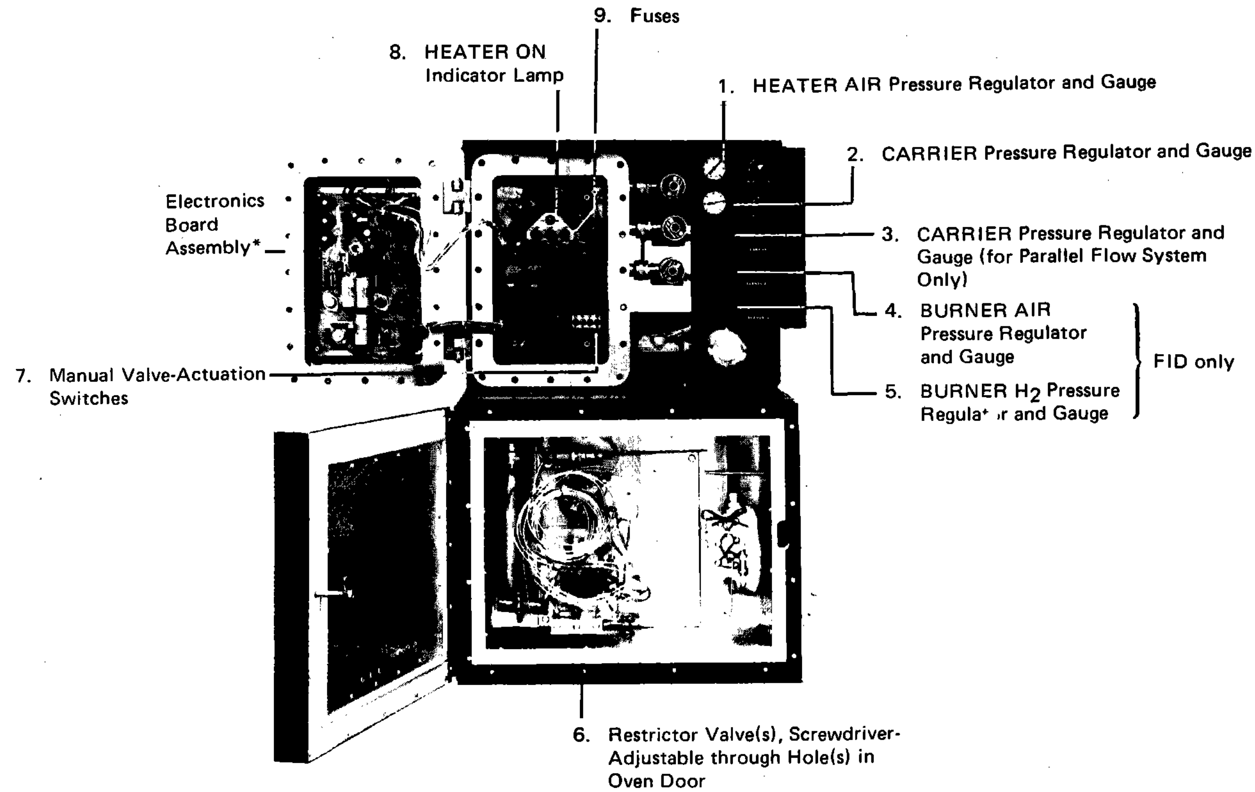
Figures 3-1 through 3-14 give locations and brief descriptions for standard and optional controls of the basic analyzer and programmer units, and of the various plug-in circuit boards. Preparatory to startup and operation, a thorough familiarization with those controls pertinent to the particular instrument is strongly recommended.

Figure	Control Locations
3-1	Analyzer Basic Operating Controls and Indicators
3-2	TC Detector Electronics Board Assembly
3-3	FID Electronics Board Assembly
3-4	Programmer Operating Controls and Indicators
3-5	Programmer Internal Controls and Adjustments
3-6	Programmer Power Supply Board
3-7	Digital Timer Boards, Alternate Options
3-8	Typical Component-Programming Section of Component Board or Component/Valve Board
3-9	Typical Valve-Programming Section of Valve Board or Component/Valve Board
3-10	Peak-Picker Board
3-11	Circuit Boards Associated with Integrator Function
3-12	Typical Long-Term Memory Board
3-13	Computer Driver Board
3-14	High/Low Alarm Board

Refer also to appropriate flow diagrams of Figures 5-3 through 5-12, or specific configuration diagram provided.

Figure	Configuration
5-3	Single-Column Backflush Configuration for Liquid Samples
5-4	Single-Column Backflush Configuration for Gas Samples
5-5	Single-Column Stripper Configuration for Liquid Samples
5-6	Single-Column Stripper Configuration for Gas Samples
5-7	Single-Column Heart-Cut/Stripper Configuration for Liquid Samples
5-8	Single-Column Heart-Cut/Stripper Configuration for Gas Samples
5-9	Dual-Column Backflush Configuration for Liquid Samples
5-10	Dual-Column Backflush Configuration for Gas Samples
5-11	Dual-Column Stripper Configuration for Liquid Samples
5-12	Dual-Column Stripper Configuration for Gas Samples

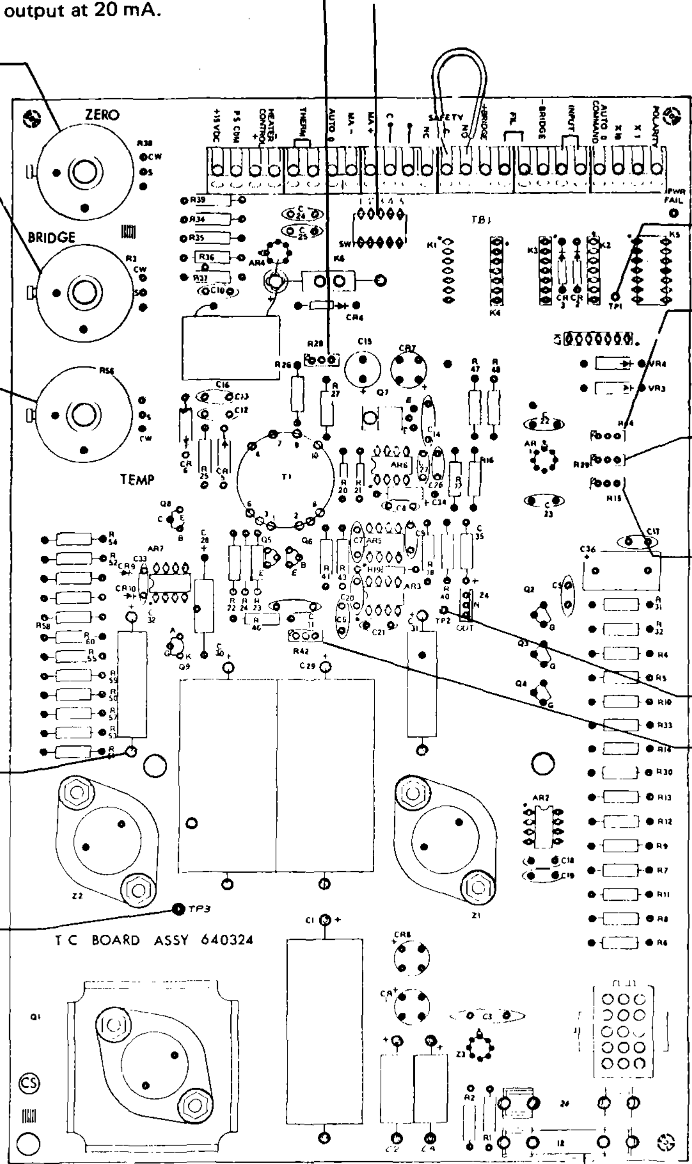
When confident of adequate familiarity with system controls and other characteristics, use startup procedure appropriate to detector type: thermal-conductivity detector, Paragraph 3.1.1; or, flame-ionization detector, Paragraph 3.1.2.



*Electronics Board Assembly depends on detector type. Alternate options are:
TC Detector Electronics Board, Figure 3-2
FID Electronics Board, Figure 3-3

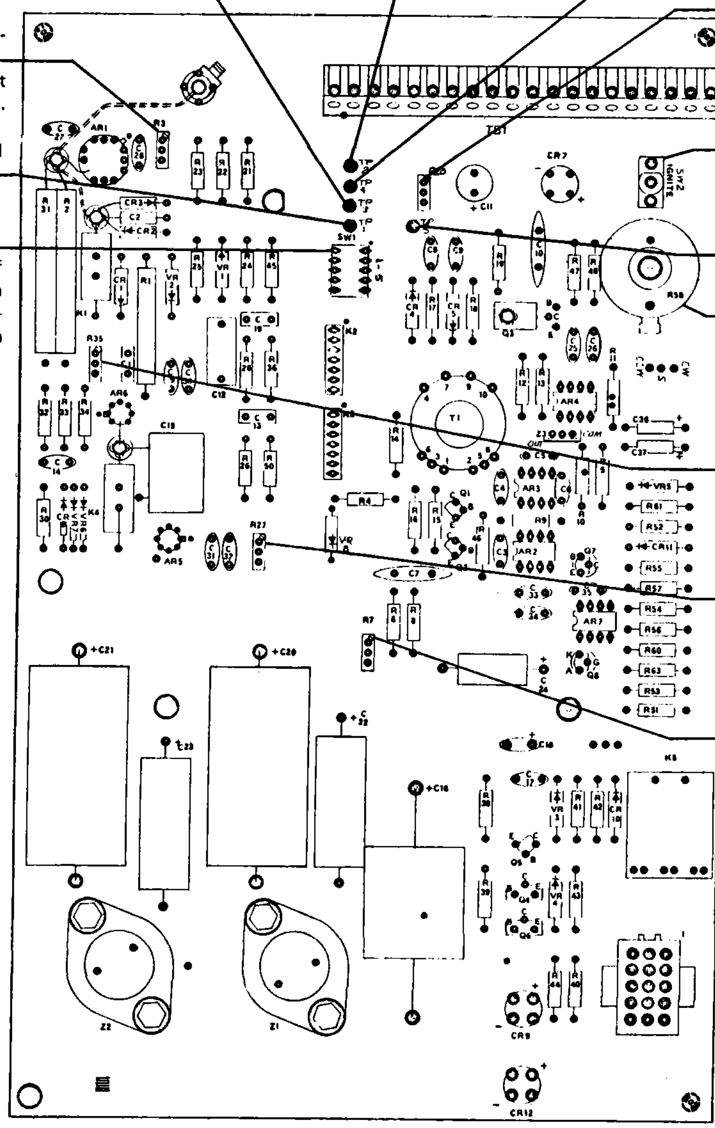
1. HEATER AIR Pressure Regulator and Gauge: Pressure adjustment for service air supplied to air-bath heater. Normal operating setting is 20 to 25 psig (138 to 172 kPa).
2. CARRIER Pressure Regulator and Gauge: Pressure adjustment for carrier gas. Normally, proper setting is between 5 and 55 psig (35 and 380 kPa), depending on flow requirements of the analysis.
3. CARRIER Pressure Regulator and Gauge: Present only if analyzer has parallel flow system. Identical to item 2. Provides independent adjustment of gas supply pressure for reference side of system.
4. BURNER AIR Pressure Regulator and Gauge: Pressure adjustment for air support gas supplied to FID. Normal setting is 15 to 25 psig (104 to 172 kPa).
5. BURNER H_2 Pressure Regulator and Gauge: Pressure adjustment for hydrogen fuel supplied to FID. Normal setting is 10 to 20 psig (69 to 138 kPa).
6. Adjustable Restrictor Valve(s): Functions depend on detector type and column-and-valving configuration.
7. Manual Valve-Actuation Switches: Closure of each toggle switch actuates the corresponding slider valve in the oven. (For automatic operation, manual switches must be turned off. Slider valves are then actuated by preprogrammed commands from programmer).
8. HEATER ON Indicator Lamp: Illuminates during application of power to oven heater element. After stabilization of oven temperature, lamp should pulse on and off.
9. Fuses

Figure 3-1. Analyzer Basic Operating Controls and Indicators



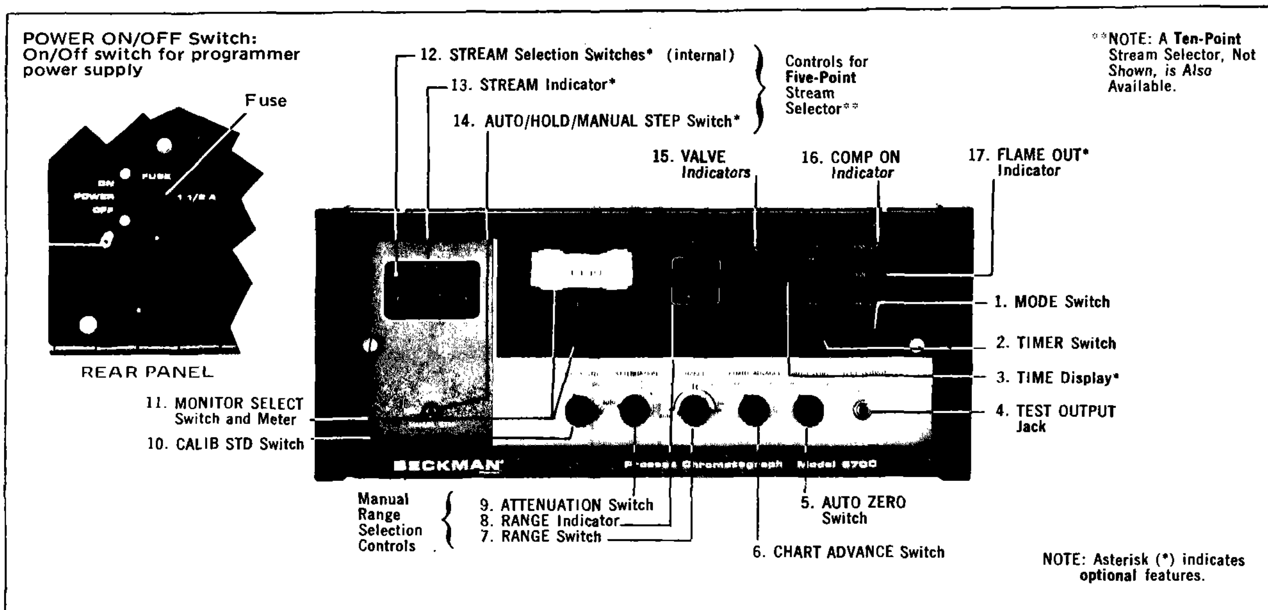
Switch Contact	Function
1	POLARITY REVERSE Command
2	X1 RANGE Command
3	AUTO ZERO Command
4	X10 RANGE Command
5	Grounds signal input to TC amplifier AR1.

Figure 3-2. TC Detector Electronics Board Assembly



Switch Contact	Function
1	High output range for auto zero circuit. (With switch contact *open*, auto zero circuit is on Low range.) Proper setting depends on system cleanliness. Low setting offers greater stability, but narrower range, than high setting. Normally, high setting is used for startup and low setting for operation.
2	X10 RANGE Command
3	X1 RANGE Command
4	AUTO ZERO Command
5	HIGH RANGE Command

Figure 3-3. FID Electronics Board Assembly

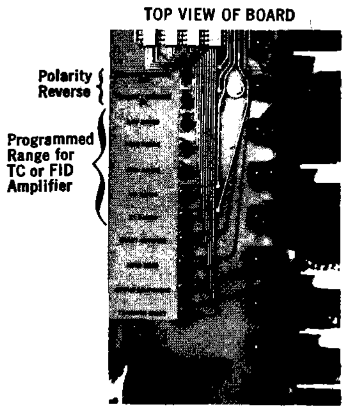


1. **MODE Switch:** Master reset switch for programmer. RESET: All functions stop, and go to reset state. RUN: All functions enabled, ready to run. Both switch positions have associated indicator lights.
2. **TIMER Switch:** ON-OFF switch for digital timer. Both switch positions have associated indicator lights. NOTE: TIMER Switch inoperative when MODE Switch at RESET.
3. **TIME Display***: *Digital display of elapsed time, in seconds, from 000 to 999.*
4. **TEST OUTPUT Jack:** For applications where **local** recorder not provided. Provides 0 to 10 millivolt signal for portable **test recorder,** to permit observation of analog output.
5. **AUTO ZERO Switch:** AUTO: Auto-zero function under preprogrammed control of component boards. ON: Auto-zero function continuously activated.
6. **CHART ADVANCE Switch:** AUTO: Recorder chart-advance function under preprogrammed control of sequencer on control card. ON: Recorder chart advances continuously; all automatic chart-advance commands from sequencer are overridden.
7. **RANGE Switch:** Controls system sensitivity via TC or FID amplifier **(in analyzer).** This switch affects **all** data presentations: chromatogram, bargraph, and trend. Significance of LOW and HIGH designations depends on detector type:
   Thermal-Conductivity Detector—LOW and HIGH ranges are **identical.** Operating range has three sub-ranges: 1, 10, and 100.
   Flame-Ionization Detector—HIGH range, is used to monitor comparatively **high-concentration** components.
   LOW range, used to monitor **low-concentration** components, has sub ranges of 1, 10, and 100.
   With RANGE Switch in any position **except AUTO,** the manually-selected range is applicable, and all automatic range selection controls are overridden. AUTO position places range selection for TC or FID amplifier under preprogrammed control of component boards.
8. **RANGE Indicator:** Illumination of LOW TC/FID or HIGH FID legend plus numeral 1, 10, or 100 indicates that corresponding range of TC or FID amplifier is now in effect, because of either manual or automatic range selection.
9. **ATTENUATION Switch:** Provides attenuation of amplified output signal received from analyzer. Attenuation is applicable to chromatogram or bargraph (but **not** trend) data presentation. Numbered positions provide selectable signal-attenuation factor of 1, 2, 4, 8, or 16. AUTO position places attenuation under preprogrammed control of component boards.
10. ***CALIB STD Switch:*** *Permits actuation, at* programmer, of remote-calibration function (if analyzer so equipped). ON position actuates remote-calibration solenoid **valve,** thus admitting calibration standard gas to analyzer, and overriding all stream commands from multi-stream sample-handling system, if provided. During normal operation, and at all other times when flow of calibration standard gas is **not desired**, switch must be OFF.
11. **MONITOR SELECT Meter and Switch:** A center-zero, direct-reading voltmeter, with associated selector switch, for checkout of individual circuits and isolation of malfunctions in analog circuitry.

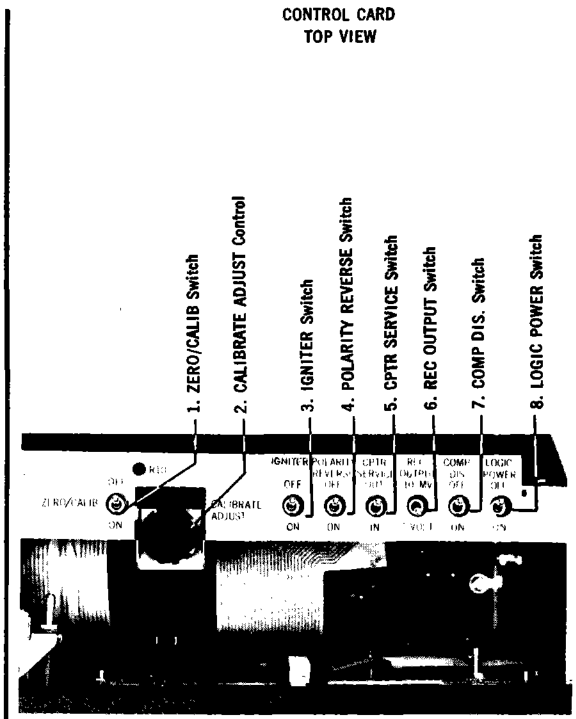
Switch Position	Meter Indication
AMPLIFIER OUT	Output signal from TC or FID amplifier (in **analyzer)**
AUTO ZERO	Output signal from auto-zero amplifier (in **analyzer**). With **TC detector,** meter must read onscale, indicating that bridge balance is attainable within compensating range of auto-zero circuit. Preferably, meter **should** read downscale, indicating that auto-zero circuit is operating near its midrange, with equal compensating capabilities in both directions. With **FID,** meter reading **is an** inverse function of system cleanliness. **An offscale** reading indicates that background signal is beyond compensating range of auto-zero circuit, because of unacceptably high **level** of hydrocarbon contaminants in system.
+5 VOLTS	Output voltage of logic power supply (in programmer).
+15 VOLTS	Output voltages of analog power supply (in programmer). These voltages are applied to the meter via dropping resistors, yielding fullscale readings of +15 and −15 volts.
−15 VOLTS	

12. **STREAM Selector Switches***: Used to place desired streams on ACTIVE status, **for** inclusion in automatic or manual sampling sequence. **Streams not** on ACTIVE status are skipped.
13. **STREAM Indicator***: Numerals illuminated in area marked ACTIVE **correspond** to streams placed on ACTIVE status, by closure of corresponding STREAM Selector *Switches (item 12).* Illumination of STREAM legend plus a numeral indicates that corresponding stream is being analyzed.
14. **AUTO/HOLD/MANUAL STEP Switch***: AUTO: Automatic, repetitive, sequential sampling, with each ACTIVE stream, in turn, sampled for preprogrammed interval. HOLD: Sequence stops at stream corresponding to numeral now on display, and remains there until switch is moved. MANUAL STEP: Selector advances to next stream, and continues to advance until switch is moved from MANUAL STEP position. During stream-switching operation initiated by selection of MANUAL STEP position, stream manifold is off. In changing from AUTO to HOLD sampling mode, use MANUAL STEP position to obtain desired stream.
15. **VALVE ON Indicator:** Illumination of VALVE legend A, B, C, or D indicates actuation of corresponding slider valve in analyzer oven. In **automatic** mode, each slider valve is actuated *automatically at preprogrammed time. In* ***manual*** *mode, each valve* may be actuated either with corresponding valve-control switch in analyzer, or at appropriate valve board or component/valve board in programmer.
16. **COMP ON Indicator:** Illumination of COMP ON legend indicates activation of corresponding component gate and attenuator. In **automatic** mode, each component function is activated automatically at preprogrammed time. In **manual** mode, any component function may be activated by selecting MAN position of MANUAL COMPONENT Switch on component board.
17. **FLAME OUT Legend***: Remains illuminated while flame in FID is extinguished.

Figure 3-4. Programmer Operating Controls and Indicators



MASTER BOARD INDICATORS FOR CHECKING PROGRAMMING OF INDIVIDUAL COMPONENT BOARDS
These indicators permit rapid checking of programming for any desired component board.
While holding MANUAL COMPONENT Switch on **component board** in STATUS position, observe indicators on **master board.** Do not test component status during automatic operation.



1. ZERO/CALIB Switch: ON-OFF switch for CALIBRATE ADJUST Control (item 2, following).
2. CALIBRATE ADJUST Control: Applies adjustable zero-biasing signal to input of summing amplifier.
   In programmer checkout, this control is manipulated for upscale and downscale deflection of recorder pen, to verify proper functioning of summing amplifier and subsequent stages of analog circuitry.
   In component calibration, the control is adjusted to provide a simulated analyzer-output signal corresponding to given concentration of sample component. The appropriate potentiometer on the component board is then adjusted for the desired recorder deflection.
3. IGNITER Switch: Used to ignite flame in FID.
4. POLARITY REVERSE Switch: Permits reversing polarity of amplified detector-output signal within the TC Detector Electronics Board of analyzer, if required for the particular component. OFF position is used with all applications of the FID, and with most applications of TC detector. ON position is used only with TC detector, for those components that give a negative detector-output signal.
5. COMPUTER SERVICE IN/OUT Switch: Controls a relay on the computer output option. Switch inoperative in instruments not equipped with this option.
6. REC OUTPUT Switch: Provides selectable potentiometric output of 10 mv or 1 volt, available at rear-panel terminals marked BARGRAPH (+) and (-). Switch does not affect output available at front-panel TEST OUTPUT Jack.
7. COMP DIS. Switch: ON: This switch position disables all component functions, permitting an automatic run to be made without occurrence of any component-related functions. OFF: Component functions occur as programmed.
8. LOGIC POWER Switch: ON-OFF switch for +5 volts d.c. supplied to master board and front panel of programmer. OFF position is used for removal of digital logic cards, but does not remove +5 volt d.c. supply from stream-selector.

Figure 3-5. Programmer Internal Controls and Adjustments

Clock Adjustment R6: Used to adjust pulse width of 50/60 pulse-per-second generator that drives 632196 Digital Timer, if instrument is so equipped. Potentiometer R6 is adjusted for pulse width of between 1 and 3 milliseconds.

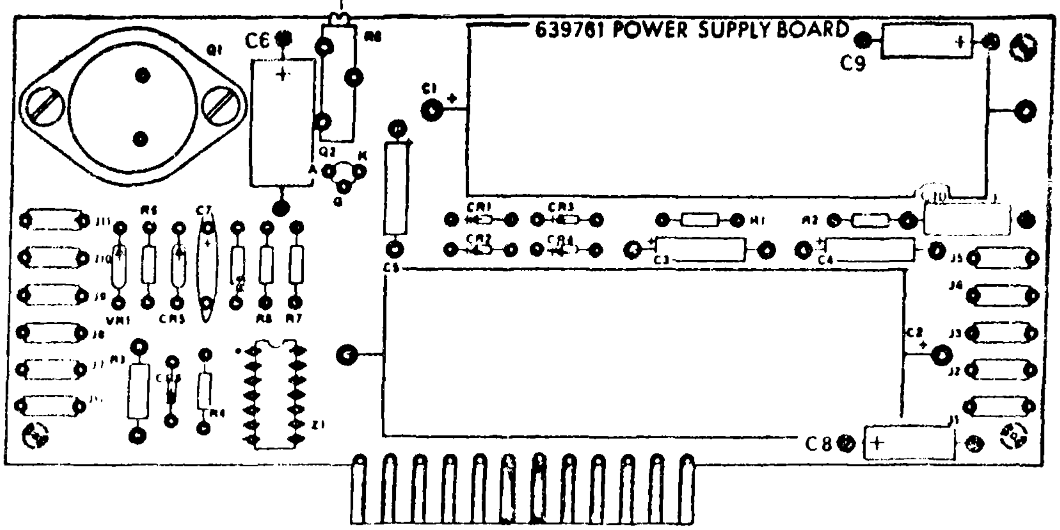
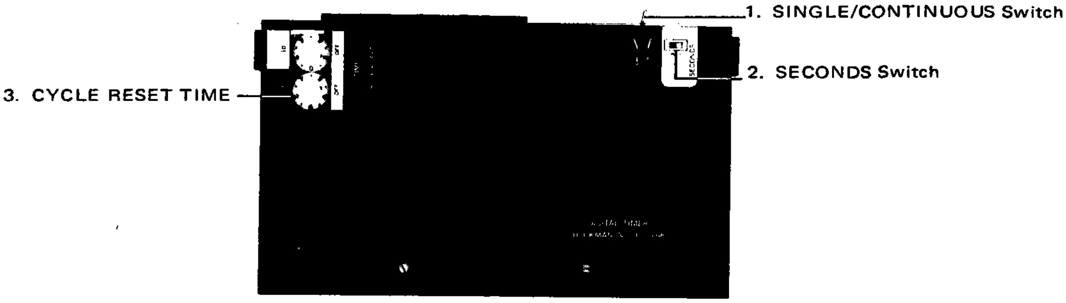


Figure 3-6. Programmer Power Supply Board

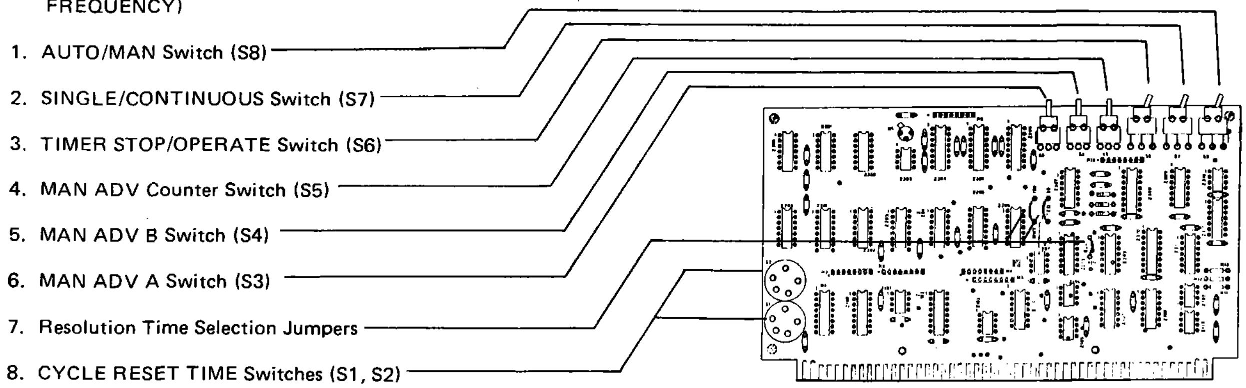
A. 632196 DIGITAL TIME BOARD (OPERATES ON LINE FREQUENCY)



1. SINGLE/CONTINUOUS Switch (S1): SINGLE: System performs a single analysis cycle, then goes into timer-off state and remains in this condition until switch is moved to CONTINUOUS. If another single analysis cycle is desired, switch may be returned immediately to SINGLE position. With switch at CONTINUOUS, system automatically and repetitively performs programmed analysis.
2. SECONDS Switch (S2): With switch in position 1, digital timer advances by one count for each second of elapsed time. With switch in position 2, timer advances by one count for each two seconds of elapsed time.
3. CYCLE RESET TIME Switches (S3, S4): Used to select desired cycle reset time. Reset time is referenced to "time zero"; i.e., the beginning of the analysis cycle. The reset time is the sum of the individual OFF times selected with the two rotary switches designated 100 and 10, signifying seconds; i.e., hundreds and tens, respectively.
   When selected reset time occurs, system recycles to zero and restarts at program time 000.

NOTE: In multiple-stream system, programmer may incorporate a Dual Reset Board. This board provides two independently selectable CYCLE OFF times, designated I and II. STREAM SELECT Switches permit assigning any desired stream(s) to CYCLE OFF TIME I and any other desired stream(s) to CYCLE OFF TIME II.

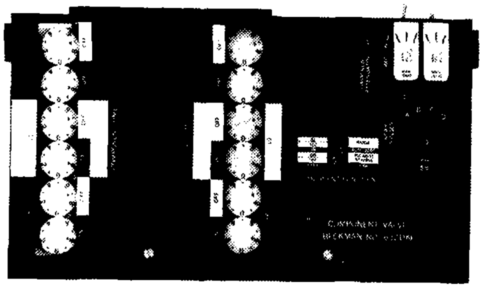
B. 638493 DIGITAL-TIMER/LOGIC-TEST BOARD (OPERATES ON INTERNAL OSCILLATOR, INDEPENDENT OF LINE FREQUENCY)



1. AUTO/MAN Switch (S8): Selection of MAN position stops the automatic counting sequence of the timer, and activates manual switches S3 (MAN ADV A), S4 (MAN ADV B), and S5 (MAN ADV Counter), to permit manual stepping of the corresponding functions. Normal stepping sequence is: counter, Clock A, Clock B.
   AUTO position is used for normal automatic operation.
2. SINGLE/CONTINUOUS Switch (S7): SINGLE: System performs a single analysis cycle, then goes into timer-off state and remains in this condition until switch is moved to CONTINUOUS. If another single analysis cycle is desired, switch may be returned immediately to SINGLE position. With switch at CONTINUOUS, system automatically and repetitively performs programmed analysis.
3. TIMER STOP/OPERATE Switch (S6): STOP position stops the automatic counting sequence of the timer, as with the MAN position of AUTO/MAN Switch S8. Normally, the AUTO/MAN Switch is used for this purpose as it is under clock control.
   OPERATE position of Switch S6 is used for normal automatic operation.
4. MAN ADV CounterSwitch (S5): Momentary depression of this pushbutton generates a single pulse for the counter system.
5. MAN ADV B Switch (S4): Momentary depression of this pushbutton generates a single pulse of Clock B.
6. MAN ADV A Switch (S3): Momentary depression of this pushbutton generates a single pulse of Clock A.
7. Resolution Time Selection Jumpers: For one-second resolution, cut red jumper only; digital timer will then advance by one count for each second of elapsed time. For two-second resolution, cut both blue jumper and white jumpers; digital timer will then advance by one count for each two seconds of elapsed time.
8. CYCLE RESET TIME Switches (S1, S2): Used to select desired cycle reset time. Reset time is referenced to "time zero"; i.e., the beginning of the analysis cycle. The reset time is the sum of the individual OFF times selected with the two rotary switches designated 100 and 10, signifying seconds; i.e., hundreds and tens, respectively.
   When selected reset time occurs, system recycles to zero and restarts at program time 000.

NOTE: In multiple-stream system, programmer may incorporate a Dual Reset Board. This board provides two independently selectable CYCLE OFF times, designated I and II. STREAM SELECT Switches permit assigning any desired stream(s) to CYCLE OFF TIME II.

Figure 3-7. Digital Timer Boards, Alternate Options



1. MANUAL COMPONENT Switch

MAN: Position used for checkout and adjustment of various functions, not for normal operation. MAN position activates COMPONENT ATTENUATOR and COMPONENT ATTENUATOR ON Indicator, also long-term memory amplifier, if provided.

NOTE

At a given time, only one component board may have its MANUAL COMPONENT Switch at MAN. Selection of MAN position on two component boards would cause simultaneous activation (i.e., parallel connection) of two component attenuators, resulting in erroneous readings.

AUTO: Normal setting for routine automatic operation. Component functions under preprogrammed control, as determined by COMPONENT TIME ON/OFF Switches (item 5).

STATUS: A test position, used momentarily, to check programming of component board. While holding switch at STATUS, observe indicators on master board, Figure 3-5.

CAUTION

Never check component status during automatic operation; this will disrupt system logic.

2. COMPONENT FUNCTION Switches

RANGE Switches: Control system sensitivity via TC or FID amplifier in analyzer. Range selected is applicable to all data presentations: chromatogram, bargraph, and trend. Significance of HIGH and LOW designations depends on detector type. TC Detector: LOW and HIGH ranges are identical; operating range has three sub-ranges, X1, X10, and X100 (in effect when neither the X1 nor X10 switch position is selected). FID: HIGH range, used to monitor comparatively high-concentration components, has subranges of X1, X10, and X100 (in effect when neither the X1 nor X10 switch position is selected). LOW range, used to monitor low-concentration components has similar subranges.

AUTO ZERO ON/OFF Switch: ON: During automatic operation, auto-zero function occurs approximately three seconds before activation of COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.

POLARITY REVERSE ON/OFF Switch: Permits reversing polarity of amplified detector-output signal within TC Detector Electronics Board of analyzer, if required for the particular component.

3. COMPONENT ATTENUATOR Adjustment

Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but not trend) data presentation. In normal automatic operation, COMPONENT ATTENUATOR remains activated during time interval programmed with COMPONENT TIME ON/OFF Switches (item 5). In either automatic or manual operation, COMPONENT ATTENUATOR may be activated by placing MANUAL COMPONENT Switch (item 1) at MAN. In automatic operation, principal use of manual activation of COMPONENT ATTENUATOR is in running chromatograms.

4. COMPONENT ATTENUATOR Indicator

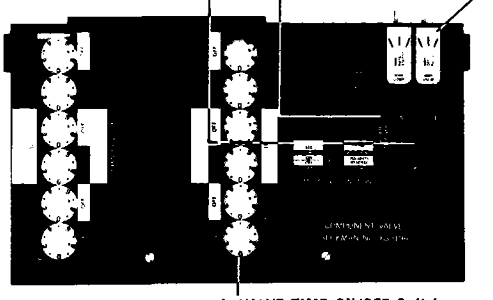
Illuminates during activation of COMPONENT ATTENUATOR (item 3).

5. COMPONENT TIME ON/OFF Switches

Used to program "component on" and "component off" times desired for given component during automatic operation. These times are referenced to "time zero," i.e., beginning of the analysis cycle. "Component on" time is sum of individual "on" times selected with three rotary switches designated 100, 10, and 1, signifying seconds, i.e., hundreds, tens, and units, respectively. Similarly, "component off" time is sum of individual "off" times.

NOTE: In multiple-stream system, programmer may incorporate a Dual Component Board with function-select capability. The Dual Component Board contains two independent component-programming sections, designated I and II. STREAM SELECT Switches permit assigning any desired stream(s) to Component-Programming Section I, and any other desired stream(s) to Component-Programming Section II.

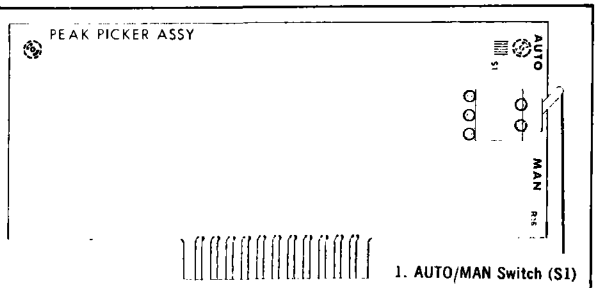
Figure 3-8. Typical Component-Programming Section of Component Board or Component/Valve Board



1. **VALVE SELECT Pin**	Used to assign valve control circuit to desired slider valve in analyzer. Pin is inserted into VALVE SELECT position A, B, C, or D. Letter designations correspond to those of Manual Valve-Actuation Switches in analyzer, Figure 3-1.
2. **STREAM TRIGGER Pin** (Used only if stream trigger function desired.)	If circuit is to advance stream selector in sample conditioner, pin is inserted in STREAM TRIGGER position.
3. **MANUAL VALVE Switch**	**MAN:** Actuates the slider valve previously selected with VALVE SELECT Pin (item 1). **OFF:** Disables selected slider valve. **AUTO:** Normal setting for routine automatic operation. Selected slider valve under preprogrammed control, as determined by VALVE TIME ON/OFF Switches (item 4).
4. **VALVE TIME ON/OFF Switches**	Used to program "valve on" and "valve off" times desired for selected slider valve during automatic operation. These times are referenced to "time zero," i.e., the beginning of the analysis cycle. "Valve on" time is sum of individual "on" times selected with three rotary switches designated 100, 10, and 1, signifying seconds, i.e., hundreds, tens, and units, respectively. Similarly, "valve off" time is sum of individual "off" times.
5. **Valve Mode Selection Jumper**	This hand-wired jumper provides the selected slider valve with the appropriate one of two operating modes: standard (off-on-off), or inverted (on-off-on). The Applications Engineering Data Sheet specifies which is required.

NOTE:
In **multiple-stream** system, programmer may incorporate a Dual Valve Board that accepts two plug-in Function Select Boards. The Dual Valve Board contains **two** independent valve-programming sections, designated I and II. STREAM SELECT Switches permit assigning any desired stream(s) to Valve-Programming Section I, and any other desired stream(s) to Valve-Programming Section II.

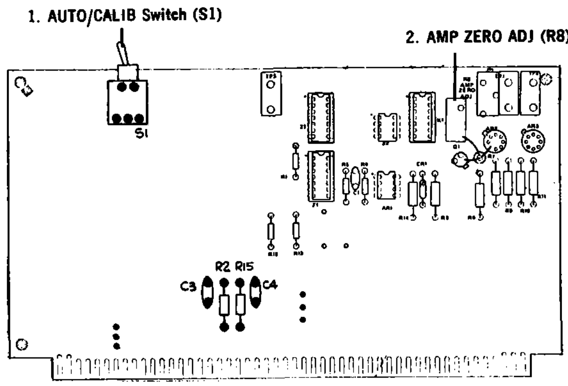
Figure 3-9. Typical Valve-Programming Section of Valve Board or Component/Valve Board.



1. AUTO/MAN Switch (S1). AUTO position enables peak-picking function. MAN position is used to calibrate for trend readout.

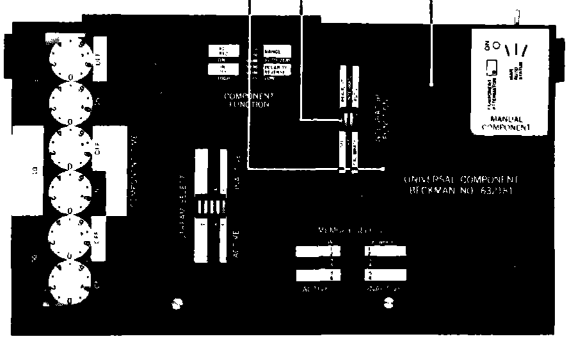
Figure 3-10. Peak-Picker Board

A. INTEGRATOR BOARD



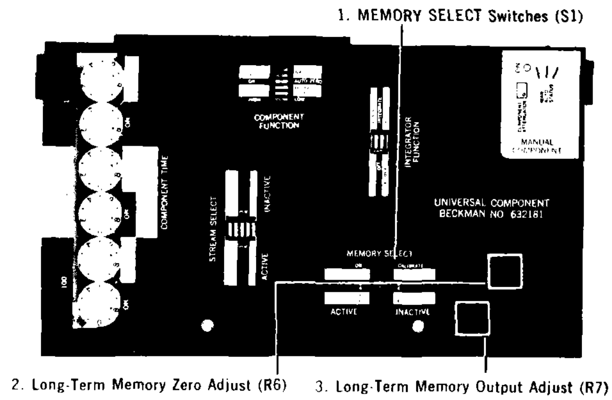
1. **AUTO/CALIB Switch (S1):** Used to set up integrator circuit for calibration or normal automatic operation.
2. **AMP. ZERO ADJ (R8):** Factory-set zero adjustment for integrator circuit.

B. INTEGRATOR CONTROL BOARD (Inserted in Universal Component Board)



1. **NORMAL/INTEGRATE Jumper:** Determines input signal to component attenuator. With jumper in NORMAL position, attenuator input is the conditioned signal from the Master Control Board. With jumper in INTEGRATE position, the attenuator input is the integrated signal from the Integrator Board.
2. **INTEGRATOR FUNCTION Switches (S1):**
RESET YES/NO Switch: RESET position provides reset of the integrator upon completion of the integration function for the particular component. NO position is used to retain the integrated value for summing with later component(s).
COMPUTER TRANSFER YES/NO Switch: For computer output systems. This switch permits the output to be either transferred or inhibited.
3. **RATE ADJUST (R1):** Provides adjustment of input signal strength. For applications involving summation of multiple integrated peaks, the RATE ADJUST on each board determines the weighting factor for the corresponding component.

Figure 3-11. Circuit Boards Associated with Integrator Function

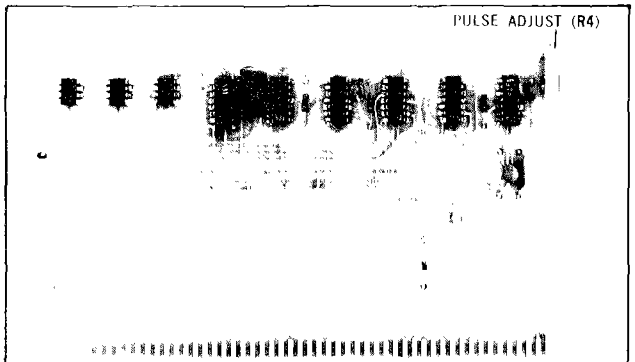


1. **MEMORY SELECT Switches (S1):** Memory output for the given component can be assigned to desired one of six output terminals by placing corresponding switch at ON. The ON position of the seventh switch enables the memory output.

   NOTE

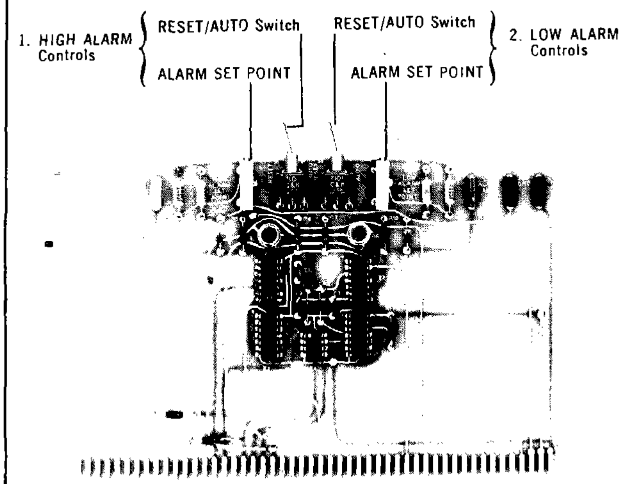
   A given trend output terminal can be selected on **one memory board only.** *Never assign two or more memory boards to the same terminal.*
2. **Memory Zero Adjust (R6):** Sets zero for long-term memory amplifier. Seldom requires readjustment.
3. **Long-Term Memory Output Adjust (R7):** Continuously variable gain adjustment for long-term memory amplifier which provides output for trend data presentation.

Figure 3-12. Typical Long-Term Memory Board



PULSE ADJUST (R4):
With an oscilloscope connected between TP1 and TP2, and a jumper connected to terminals marked SHORT FOR PULSE DURATION ADJUST, R4 is adjusted for pulse duration appropriate to the data-acquisition system.

Figure 3-13. Computer Driver Board



1. HIGH ALARM Controls. HIGH ALARM SET POINT Adjustment: Used to select setpoint for high alarm condition, which will then occur whenever the particular eluting component exceeds the selected height.
HIGH ALARM RESET/AUTO Switch: AUTO position is used for normal automatic operation. RESET position is used to reset circuit after occurrence of high alarm condition. *May be set at Computer Interface terminal.*
2. LOW ALARM Controls. LOW ALARM SET POINT Adjustment: Used to select setpoint for low alarm condition, which will then occur after elution of component which fails to reach selected height.
LOW ALARM RESET/AUTO Switch: AUTO position is used for normal automatic operation. RESET position is used to reset circuit after occurrence of low alarm condition. *May be set at Computer Interface terminal.*

Figure 3-14. High/Low Alarm Board

3.1.1 STARTUP PROCEDURE FOR SYSTEM WITH THERMAL-CONDUCTIVITY DETECTOR

After installing chromatograph system and carrier gas cylinder(s) per Section Two, use following procedure BEFORE SUPPLYING POWER TO EITHER PROGRAMMER OR ANALYZER.

1. In the door of the analyzer electronics junction box, Figure 3-1, disconnect lead from BRIDGE (—) terminal on 634024 TC Board Assembly, Figure 3-2. Detector bridge is now disconnected.

   NOTE

   To safeguard against filament damage, this lead must remain *disconnected until proper gas flows, slider valve operation, and circuit voltages have been established.*

2. Check for internal leakage of carrier gas:

   a. Cap all vents used in the particular column-and-valving configuration. Refer to appropriate diagram of Figures 5-3 through 5-12, or special configuration drawing provided.

   b. Set regulator on carrier-gas cylinder for output pressure of about 20 psig (138 kPa).

   c. With internal carrier loop now pressurized to about 20 psig (138 kPa), turn CARRIER Pressure Regulator (Figure 3-1) fully counterclockwise to close the regulator and prevent any subsequent flow of carrier gas into the loop.

   d. Observe CARRIER Pressure Gauge. Pressure reading may drop initially, but should then stabilize at some value and remain there. If so, loop is leak-free. If reading continues to drop, internal leakage is occuring; locate source with leak-test liquid such as SNOOP (Beckman Part 837801), and correct the condition. (To determine the location of a large leak, it may be necessary to allow carrier to flow into the system.)

NOTE

Do not use SNOOP on slider portion of slider valves.

e. Repeat check of Step 2d, immediately preceding, for both the actuated and the deactuated conditions of each slider valve used in the particular column-and-valving configuration. To permit actuation of slider valve(s), analyzer power must be on and service air must be supplied to the analyzer at the pressure specified in the Applications Engineering Data Sheet. Each slider valve may then be actuated with corresponding Manual Valve Actuation Switch, Figure 3-1. With each change of switch position, the CARRIER Pressure Gauge should respond, then stabilize at a new reading, and remain there. If so, loop is leak-free. If reading continues to drop, internal leakage is occurring; locate and correct it, then repeat test.

f. Remove caps from all vents.

3. If analyzer has parallel flow system utilizing a second CARRIER Pressure Regulator, reference side of system must now be leak-tested by same procedure that was used for measuring side in Step 2.

4. Correct flows of carrier through both sides of detector must now be established. With original factory-installed column(s), flows suitable for initial operation should be obtainable by setting regulator on carrier-gas cylinder, and CARRIER Pressure Regulator in analyzer, for values specified in Applications Data Sheet. (If analyzer has parallel flow system, utilizing a second CARRIER Pressure Regulator, this regulator must also be set as specified.) However, after aging of original column(s) or installation of replacement column(s), different pressure settings may be required to obtain correct flows. To check or adjust flows:

   a. With a flowmeter, verify carrier flow from vents associated with measuring and reference sides of detector. Refer to appropriate diagram of Figures 5-3 through 5-12, or special configuration drawing provided.

   b. If the particular configuration uses column-switching slider valve(s), operate each Manual Valve Actuation Switch and again verify flow from vents. Proper flow rates, and valve positions required for measuring these flows, will depend on the specific column configuration. Refer to Applications Engineering Data Sheets. After measuring flows, actuate slider valve(s) required to place column(s) in purge condition.

NOTE

Carrier must flow continuously through both sides of detector, regardless of status of switching valve(s). Stoppage of carrier flow, because of incorrectly installed column, etc., could cause burned-out filaments upon application of power to detector bridge.

   c. With column(s) in purge condition, verify that flow through measuring side of detector is at least **approximately** equal to value specified in Applications Data Sheet. If actual flow differs **greatly** from given value, adjust appropriate restrictor valve as required. As shown in Figure 3-1, restrictor is mounted in oven, and is adjustable with screwdriver inserted through hole in oven door.

NOTE

Never completely close a restrictor valve as this may damage the fine needle point. Do not connect bridge supply until Step 6 is completed.

Approximate balancing of measuring and reference flows is acceptable at this time. If **exact** balance is desired for maximum detector stability, a final adjustment of the restrictor will be necessary after oven temperature stabilization.

5. In door of analyzer electronics junction box, Figure 3-1, make following checks and adjustments on 640324 TC Electronics Board Assembly, Figure 3-2:

   a. Connect a voltmeter between BRIDGE (+) and (−) terminals to measure regulated bridge voltage. Reading should be equal to the desired value, or to the BRIDGE VOLTAGE value given in the Applications Data Sheet. If not, set BRIDGE Voltage Adjustment R3 as required.

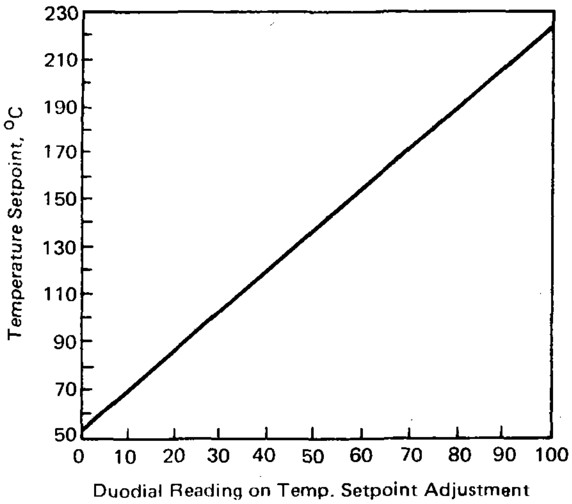
   Adjustment range for R3 is 3 to 11 volts if the 1-ampere fuse is inserted in the holder marked "12", and is 11 to 24 volts if the fuse is inserted in the holder marked "24".

   b. Connect voltmeter from +15 VDC terminal to PS COM terminal; reading should be +15 volts d.c. Move positive lead of voltmeter to negative side of C32; reading should be −15 volts d.c.

6. With bridge voltage now set at correct value, and carrier flowing at proper rates through both sides of detector, reconnect the lead disconnected in Step 1. Filaments will now begin to heat. Verify that carrier is still flowing.

NOTE

At all times when filament power is on, sample loop must be purged continuously with carrier or sample. Never inject **air** *sample when filaments are heated. When heated and exposed to oxygen, filaments oxidize rapidly, and may be destroyed.*



NOTE: TEMP Setpoint Adjustment is designated R56 on TC Electronics Board and R58 on FID Electronics Board.

Figure 3-15. Oven Temperature Setpoint Adjustment

7. Checkout and Adjustment of Oven Temperature Control Circuit:
   a. Verify that HEATER AIR Pressure Gauge indicates adequate pressure. If this pressure drops below the allowable minimum, a safety pressure switch automatically removes power from the oven heater element. Pressure setting differs somewhat from one switch to another, but will be in the range of 16 to 20 psig (110 to 138 kPa).
   b. On TC Detector Electronics Board Assembly, Figure 3-2, turn TEMP Setpoint Adjustment R56 fully clockwise. Check status of HEATER ON indicator Lamp, located within analyzer electronics junction box and connected directly across the oven heater element. At this time, indicator lamp should be on. After about 10 minutes of warmup, turn R56 counterclockwise; the lamp should go out. Now *slowly* rotate R56 clockwise until lamp begins to pulse, indicating that temperature controller is in control. Set R56 for desired oven temperature, using Figure 3-15 to determine the required control setting.

NOTE

Oven heater incorporates a thermal overload protector consisting of a solder plug in the oven. When overheated, the plug melts, causing loss of air pressure, deactuation of safety pressure switch, and removal of power from heater element. Plug material is selected for melting point appropriate to the particular application.

8. Wait for oven temperature to stabilize. Exact balancing of flows through measuring and reference sides of detector can now be obtained by **final** adjustment of the restrictor that was approximately adjusted in Step 4c. Final adjustment should also be made for any other restrictor(s) in the particular column-and-valving configuration. Each such restrictor is the counterpart of an associated column. When this column is placed in bypass condition, by actuation of the corresponding column-switching slider valve, the restrictor receives the flow formerly routed through the column. Criterion for proper adjustment of the restrictor is that flow rate should be the same for the actuated and de-actuated states of the slider valve. Refer to appropriate diagram of Figures 5-3 through 5-12, or special configuration drawing provided.

System is now ready for programming per Paragraph 3.2.

3.1.2 STARTUP PROCEDURE FOR SYSTEM WITH FLAME-IONIZATION DETECTOR

After installing chromatograph and associated gas cylinders per Section Two, proceed as follows:

1. Turn off all gases.
2. Ensure that all power is removed from analyzer.

Steps 3 through 5, following, check for leakage of gases from internal elements. If any test indicates a leak, locate the source with leak-test liquid such as SNOOP (Beckman Part 837801).

NOTE

Do not use SNOOP on slider portion of slider valves.

3. Check for internal leakage of hydrogen:

WARNING

Hydrogen gas is highly explosive.

   a. Disconnect hydrogen line from base of FID, Figure 5-14. Temporarily cap open end of this line.

b. Set regulator on hydrogen cylinder for relatively high output pressure, but not over 60 psig (414 kPa).

c. With internal hydrogen loop now pressurized, turn BURNER H_2 Pressure Regulator (Figure 3-1) fully counterclockwise to close the regulator and prevent any subsequent flow of hydrogen into the loop.

d. Observe BURNER H_2 Pressure Gauge. Pressure reading may drop initially, but should then stabilize at some value and remain there. If so, hydrogen loop is leak-free. If reading continues to drop, internal leakage of hydrogen is occurring; locate and eliminate leakage before proceeding.

e. When hydrogen loop is leak-free, remove cap from hydrogen line; reconnect line to FID.

f. Reset BURNER H_2 Pressure Regulator to value specified in Applications Engineering Data Sheet.

4. Check for **internal** leakage of burner air by procedure similar to that used for hydrogen in Step 3. Then, reset BURNER AIR Pressure Regulator to value specified in Applications Engineering Data Sheet.

5. Check for **internal** leakage of carrier by procedure similar to that used for hydrogen in Step 3. Preparatory to carrier leak test, it is necessary to cap not only the line supplying carrier to the FID, but also all vents associated with the particular column-and-valving configuration. Note also that the carrier leak test must be made for both the actuated and the deactuated conditions of each slider valve used in the particular column-and-valving configuration. To permit actuation of slider valve(s), analyzer power must be on, and service air must be supplied to analyzer at pressure specified in Applications Engineering Data Sheet. Each slider valve may then be actuated with the corresponding Manual Valve Actuation Switch, Figure 3-1. With each change of switch position, the CARRIER Pressure Gauge should respond, then stabilize at a new reading, and remain there.

After leak check, restore gas connections to normal; reset regulator on carrier cylinder for desired output pressure.

6. Correct flows to the FID must be established for burner hydrogen, burner air, and carrier gas. With original factory-installed column(s), flows suitable for initial operation should be obtainable by setting BURNER H_2, BURNER AIR, and CARRIER Pressure Regulators for values specified in Applications Data Sheet. If instrument purchased without Applications service, set BURNER H_2 at 17 psig (118 kPa); BURNER AIR at 20 psig (138 kPa); CARRIER, as required.

   After aging of original column(s) or installation of replacement column(s), different pressure settings may be required to obtain correct flows. If so, each flow, in turn, is established by disconnecting the corresponding line from the FID, Figure 5-14, attaching a soap-bubble or other flowmeter to the open end of this line, and adjusting the appropriate pressure regulator for the flow specified in the Applications Data Sheet.

7. Checkout and Adjustment of Oven Temperature Control Circuit:

   a. Verify that HEATER AIR Pressure Gauge indicates adequate pressure. If this pressure drops below the allowable minimum, a safety pressure switch automatically removes power from the oven heater element. Pressure setting differs somewhat from one switch to another, but will be in the range of 16 to 20 psig (110 to 138 kPa).

   b. On FID Electronics Board Assembly, Figure 3-3, turn TEMP Setpoint Adjustment R58 fully clockwise. Check status of HEATER ON Indicator Lamp, located within the analyzer electronics junction box, and connected directly across oven heater element. At this time, indicator lamp should be on. After about 10 minutes of warmup, turn R58 counterclockwise; the lamp should go out. Now **slowly** rotate R58 clockwise until lamp begins to pulse, indicating that temperature controller is in control. Set R58 for desired oven temperature, using Figure 3-15 to determine the required control setting.

NOTE

Oven heater incorporates a thermal overload protector consisting of a solder plug in the oven. When overheated, the plug melts, causing loss of air pressure, deactuation of safety pressure switch, and removal of power from heater element. Plug material is selected for melting point appropriate to the particular application.

8. If the particular column-and-valving configuration utilizes one or more adjustable restrictor valves, verify that their settings are approximately correct. Each such resistor is the counterpart of an associated column. When this column is placed in bypass condition, by actuation of the corresponding column-switching slider valve, the restrictor receives the flow formerly routed through the column. Criterion for proper adjustment of the restrictor is that flow rate should be the same for the actuated and de-actuated states of the slider valve.

Final adjustment of restrictor valves, if desired, will be made after oven temperature stabilization.

9. Ignite burner flame:

   a. On 640330 FID Electronics Board Assembly, Figure 3-3, connect voltmeter from FID AMPLIFIER OUTPUT terminal to TP4 (circuit ground).

BECKMAN

Addendum To Beckman Instructions 015-555331-A
ANALYZER AND PROGRAMMER UNITS
FOR MODEL 6710 PROCESS GAS CHROMATOGRAPH

3.1.2 STARTUP PROCEDURE FOR SYSTEM WITH FLAME-IONIZATION DETECTOR

On Page 26, insert the following at the end of Step 8:

Before igniting the burner flame in Step 9, following, wait for temperature stabilization of the FID body. If the flame is ignited while the burner is cool, water from the hydrogen flame may condense and plug the flame arrestor.

Beckman Instruments, Inc. Fullerton, CA 92634
March 1979 790618 Printed in U.S.A.

b. To facilitate ignition, set Gas Pressure Regulators as follows:
BURNER H_2, about 30 psig (207 kPa)
BURNER AIR, about 10 psig (69 kPa)
CARRIER, per Applications Data Sheet
c. On FID Electronics Board Assembly, Figure 3-3, depress IGNITE Pushbutton for **not more than 5 seconds**. A muffled explosion should be heard. To verify that flame is burning, note voltmeter response: it should drive upscale. If voltmeter does not drive up-scale, flame is not burning; slightly change setting on BURNER AIR Pressure Regulator and again actuate Igniter Pushbutton. Repeat until flame ignites.
d. Simultaneously reset BURNER H_2 and BURNER AIR Pressure Regulators to normal values. Increase setting on CARRIER Pressure Regulator to normal value.

10. Allow system to stabilize. For maximum stability, system should be allowed to run overnight, with flame burning. After initial startup, or after startup following a prolonged shutdown, the instrument may display baseline drift for a considerable period of time, particularly on the more sensitive ranges. Commonly, small amounts of hydrocarbons are present on inner walls of tubing in both internal flow system and external gas-supply system. Drift results from any factor influencing equilibrium of these adsorbed hydrocarbons, such as temperature or pressure.

NOTE

This type of drift occurs only when flame is burning. If drift occurs when flame is extinguished, electronic circuitry is at fault.

To minimize drift, use clean gases, keep analyzer clean, and locate gas cylinders in an area of relatively constant ambient temperature.

11. Check for correct flow through restrictor valves that were **approximately** adjusted in Step 8. Make final slight adjustment, if necessary.

System is now ready for programming per Paragraph 3.2.

3.2 SYSTEM PROGRAMMING AND COMPONENT CALIBRATION

A chromatograph purchased **without** Applications Engineering service must initially have all functions programmed by the user. For these instruments, the following procedures are essential to proper operation.

A chromatograph processed through the Beckman Applications Engineering Department is fully programmed and is calibrated with a synthetic mixture before shipment. For these instruments, the following procedures serve as checks for proper operation.

NOTE

Preparatory to system programming, a thorough familiarization with the particular column-and-valving configuration is ***strongly*** *recommended. Refer to appropriate diagram of Figures 5-3 through 5-12, or to special print supplied with the system.*

3.2.1 RECORDING MANUAL TEST CHROMATOGRAMS WITH THERMAL-CONDUCTIVITY OR FLAME-IONIZATION DETECTOR

The first step in initial programming of functions, or in checking previously established programming, is to run one or more manual test chromatograms. These will be used to determine component elution times and the corresponding valve-switching times required; also peak heights and the corresponding range and attenuation settings. With system set up as explained in Paragraph 3.1.1 (thermal-conductivity detector) or Paragraph 3.1.2 (flame-ionization detector) proceed as follows:

1. On programmer, place all front-panel switches fully to the left. Momentarily place MODE Switch at RESET to place system in reset condition, then return to RUN position.
2. On circuit board assigned to each component, place MANUAL COMPONENT Switch at AUTO.
3. On circuit board assigned to each slider valve, place MANUAL VALVE Switch at OFF or MAN, as required for the particular column-and-valving configuration.
4. Set programmer controls as follows:
   a. Place MONITOR SELECT Switch at AMPLIFIER OUT and RANGE Switch at 10.
   b. Place AUTO ZERO Switch at ON, note that reading on MONITOR SELECT Meter drops to zero, then return AUTO ZERO Switch to OFF.
   c. If system is equipped with valving for automatic calibration, place CALIB STD Switch at ON, to initiate flow of calibration standard gas to analyzer. If system is not so equipped, use appropriate method to supply calibration standard gas to analyzer.
   d. Select appropriate manual range settings. For initial trial, start with RANGE Switch at 10 and ATTENUATION Switch at 16, resulting in an effective attenuation of 160. With ATTENUATION Switch at 16, system will saturate at approximately 70% of fullscale. If saturation occurs, place RANGE Switch at 100 and ATTENUATION Switch at 8, resulting in an effective attenuation of 800.
5. On recorder, select chart speed of one-inch (25 mm) per minute. Turn on recorder chart drive, either with CHART ADVANCE Switch on programmer front panel, or by external means on recorder.
6. Inject sample by actuation of MANUAL VALVE Switch on circuit board assigned to sample-injection slider valve (Valve A in most configurations). Place

switch in MAN position for time interval specified in Application Data Sheet, then return to OFF position.

7. During component elution, observe recorder trace closely. Whenever necessary, change setting of RANGE and/or ATTENUATION Switch(es) on programmer so recorder pen remains onscale, but elution peaks appear as near-fullscale deflections. Write all control settings on recorder chart for future reference.
8. If analyzer incorporates column-switching slider valve(s), actuate at proper times as components elute. Each valve function is controlled by selection of MAN or OFF position of MANUAL VALVE Switch on circuit board assigned to the particular valve. See Figure 3-9. Proper timing for these valves depends on the column-and-valving configuration used. Paragraphs 5.3.1 through 5.3.5 and the accompanying diagrams cover the standard configurations.
9. Examine resultant test chromatogram. It should closely match the factory test chromatogram (if provided). In high-sensitivity use of the FID, note height of the smallest peak of interest. If too small, an increase in detector response may be obtainable by slight readjustment of BURNER H_2 pressure. In general, the optimum setting for one component may not be optimum for the other components.

Repeat procedure as many times as required to obtain a suitable combination of valve-switching times and range settings (also BURNER H_2 pressure, if required). Then proceed to Paragraph 3.2.2.

3.2.2 PROGRAMMING TIME-RELATED FUNCTIONS

Using test data obtained per Paragraph 3.2.1, program all time-related functions:

1. **Component Functions**, Figure 3-8. For each component of interest, program the following functions:
   a. "Component on" and "component off" times.
   b. Range required for desired peak height. With FID, choice of HIGH or LOW range must be made.
   c. Auto-zero function, if desired to occur before elution of the given component.
   d. Polarity-reverse function, if required for the particular component. This function, if used, must be programmed both on and off; it does *not* go off automatically. The recommended practice is to program *all* components with POLARITY REVERSE OFF command, to ensure against lock-up of the polarity-reverse section in the 640324 TC Detector Electronics Board.
2. **Valve Functions**, Figure 3-9. For each slider valve, program the following functions:
   a. "Valve on" and "valve off" times.
   b. Normal or inverted operation, as required by the particular configuration. Operating mode for the valve is determined by a soldered connection on the valve circuit board. In an application-engineered system, the jumper has been factory-connected as required. If system is purchased **without** applications engineering, jumper is factory-connected for normal mode; if inverted mode is desired, unsolder lead from NORM pin and resolder to INV pin.
3. CYCLE RESET TIME on Digital Timer Board. Set for desired time cycle per Figure 3-7. If **Dual Reset** Board is used, set Digital Timer Board for CYCLE RESET time of 99.

3.2.3 COMPONENT CALIBRATION

Calibrate each component, in turn, as follows:

1. On programmer front panel, Figure 3-4, place TIMER Switch at OFF. Momentarily place MODE Switch at RESET to place system in reset condition. Set RANGE Switch at 100, AUTO ZERO at ON, and ATTENTUATION Switch at the setting used for the particular component on the manual test chromatogram.
2. Within the programmer, Figure 3-5, place ZERO/CALIB Switch at ON. Set CALIBRATE ADJUST Control so that the present recorder reading is equal to the peak height obtained for the particular component in the manual test chromatogram. The CALIBRATE ADJUST Control, which now applies a simulated signal to the input of the amplification circuitry, will remain at the setting thus established throughout the remainder of the calibration procedure for the given component.
3. On the circuit board associated with the given component, place MANUAL COMPONENT Switch at MAN. On all other component boards, place this switch at AUTO.
4. On programmer front panel, place ATTENUATION Switch at AUTO. The simulated signal is now routed through the attenuator on the given component board.
5. Calibration of the given component for chromatogram or bargraph presentation is accomplished with the COMPONENT ATTENUATOR Adjustment on the corresponding circuit board. See Figure 3-8. Set adjustment for appropriate recorder reading, according to the concentration of the component in the calibration standard and the desired fullscale range on the recorder chart.
6. If the given component is to be calibrated for data presentation on a trend recorder, leave CALIBRATE ADJUST Control at setting previously established. On the component board assigned to the given component, Figure 3-8, place MANUAL COMPONENT Switch at ON, thus turning on the long-term memory amplifier. On Peak-Picker Board, Figure 3-10, place AUTO/MAN Switch at MAN. On memory board, Figure 3-12, close the appropriate MEMORY SELECT Switch to route the signal through the desired trend output line, and the corresponding rear-panel terminal, to the recorder channel associated with the component. Now, adjust

R6 on memory board, Figure 3-12, to obtain the desired reading on the recorder channel.

Repeat procedure until all components have been calibrated. System is now ready for routine operation per Section Four.

If subsequently, after a period of satisfactory operation, instrument develops electronic drift, gives inconsistent readings, etc., refer to electronics troubleshooting procedures of Sections Seven and Eight. If trouble proves **not** to be electronic, probable cause is contamination and/or deterioration of the column(s). Refer to Paragraph 6.4.2.

3.2.4 CALIBRATION OF INTEGRATED PEAKS FOR INDIVIDUAL COMPONENTS

Calibrate each individual integrated component, in turn, as follows:

1. On programmer front panel, place RANGE and ATTENUATION Switches at AUTO.
2. On Integrator Board, Figure 3-11, A, place AUTO/CALIB Switch at AUTO.
3. On Universal Component Board, program desired on and off times, auto zero, polarity reverse (if desired), etc., per Paragraph 3.2.2. Also, set COMPONENT ATTENUATOR Potentiometer (R6) at counterclockwise limit and verify that NORMAL/INTEGRATE jumper is connected in INTEGRATE position.
4. On appropriate Integrator Control Board, Figure 3-11, B, place RESET/NO Switch in RESET position.
5. Initiate an analysis of the calibration standard gas. On the readout device, note integrated peak reading for component of interest. Reading should be between 40% and 60% of fullscale. If so, proceed to Step 6. If reading is outside the specified range, make appropriate slight adjustment of RATE ADJUST (R1) on the Integrator Control Board. Turn R1 counterclockwise to increase the signal, or clockwise to decrease it. Repeat the analysis and the adjustment until the desired signal level is attained. If the integrator rate signal is excessively large, it may drive the integrator amplifier on the Integrator Board to saturation during the integration period, resulting in incorrect readout. The output from the integrator amplifier may be measured between TP2 (+) and TP3 (ground), and should be 6 to 8 volts d.c.
6. On Integrator Board, Figure 3-11, A, place AUTO/CALIB Switch at CALIB.
7. On Universal Component Board, place MANUAL/AUTO/STATUS Switch at MANUAL.
8. On Master Control Board, Figure 3-5, place ZERO/CALIB Switch at CALIBRATE. Set CALIB ADJUST Control so that the readout device indicates the same value that was obtained during integration of the peak.
9. On the Universal Component Board, adjust COMPONENT ATTENUATOR (R6) to obtain the appropriate reading, according to the concentration of the particular component in the calibration standard and the desired fullscale range. Component is now properly calibrated. Return CALIB/ZERO Switch on Master Control Board to ZERO; return AUTO/CALIB Switch on Integrator Board to AUTO.

3.2.5 SUMMATION OF INTEGRATED PEAKS FOR MULTIPLE COMPONENTS

For applications involving the summation of multiple integrated peaks, RATE ADJUST (R1) on each Integrator Control Board determines the weighting factor for the corresponding component.

On Integrator Control Boards, set RESET YES/NO Switch as follows:

1. For each component *except the last one,* place RESET YES/NO Switch at NO. Following integration, the corresponding peak will be held in the integrator, for summation with the integrated peak(s) for the subsequent desired component(s).
2. On the Integrator Control Board for the *last* component to be included in the sum, place RESET/NO Switch at RESET. This component will be included in an integrated peak consisting of the summation of all individual integrated peaks.

3.2.6 COMPUTER TRANSFER OF INTEGRATED PEAKS

For use with computer outputs, each Integrator Control Board has a COMPUTER TRANSFER YES/NO Switch that allows the corresponding integrated peak to be either transferrred or inhibited.

4.1 ROUTINE AUTOMATIC OPERATION

After completing component calibration per Paragraph 3.2.3, proceed as follows:

1. On programmer front panel, Figure 3-4, place MODE Switch at RESET.
2. On digital timer board, Figure 3-7, place SINGLE/CONTINUOUS Switch at CONTINUOUS; place SECONDS Switch at position 1 or 2, as desired.
3. On circuit board associated with each component, place MANUAL COMPONENT Switch at AUTO.
4. On circuit board associated with each slider valve, place MANUAL VALVE Switch at AUTO.
5. If system includes peak-picker board, Figure 3-10, place AUTO/MAN Switch at AUTO.
6. If system includes integrator board, Figure 3-11, A, place AUTO/CALIB Switch at AUTO.
7. On programmer front panel, Figure 3-4, place all switches having a position designated "AUTO" in this position. Place TIMER Switch at ON and MODE Switch at RUN. The system will now automatically and repetitively perform the programmed analysis.

4.2 SYSTEM SHUTDOWN

1. Shut off flow of sample only.

NOTE

Do not shut off carrier or other gases until so directed in subsequent steps.

2. If analyzer incorporates **flame-ionization** detector, shut off hydrogen first, then burner air. Leave carrier gas and heater air flowing.

WARNING

For safety in shutdown of FID system, always turn off hydrogen before other gases.

3. Wait for end of cycle, then stop programmer by placing MODE Switch at RESET.
4. If only a **short-term** shutdown is desired, recommended practice is to leave system in present state, with electrical power, heater air, and carrier gas on. With flame-ionization detector, carrier flow may be reduced to 5 to 10 cc/min for economy if desired.

NOTE

If reduced flow of carrier is used with **thermal-conductivity** *detector, TC power supply must be turned off to ensure against filament damage.*

If comparatively **long-term** shutdown is desired, proceed with following steps.

5. Turn off analyzer power.

NOTE

With **thermal-conductivity** *detector, always remove power from* **analyzer** *preparatory to shutting off carrier-gas flow.*

6. Allow carrier gas to purge analyzer for at least 15 to 30 minutes. With samples containing **corrosive components,** such as chlorine or hydrochloric acid, a thorough purging of all tubing in contact with the sample is required before any air is admitted to the system. With these samples, an eight-hour purge is recommended. During subsequent startup, an identical purge period is required before such samples are admitted to the analyzer.
7. Maintain heater air flow until oven cools off.

5.1 PRINCIPLE OF OPERATION

In chromatographic analysis, a measured volume of sample is injected into a column and is swept along by a continuous flow of inert carrier gas. As the sample passes through the column, individual components separate according to their differing affinities for the column substrate. Components emerge from the column, in characteristic sequence, as elution bands diluted with carrier gas.

Column effluent is monitored continuously by a thermal-conductivity (TC) detector or flame-ionization detector (FID). The detector-output signal is processed electronically for compatibility with the recorder or other data-acquisition device.

5.2 PNEUMATICALLY-ACTUATED SLIDER VALVES

All analyzers utilize one or more pneumatically-actuated slider valves, Figure 5-1, to perform sample-injection and column-switching functions. A diagram of a typical slider valve and associated solenoid valve is shown in Figure 5-2. These figures show the Ten-Port (LG10) Valve. The slider valve proper consists of a Teflon slider between two five-port metal blocks. Holes and grooves in the slider form connecting paths between the various ports in the blocks.

Some applications use the Six-Port (LG6) Slider Valve. It is similar to the LG10, but has only three ports, instead of five, in each block. Also, the slider is metal instead of Teflon.

With either valve type, the pneumatic actuator of the slider valve receives pressurized air from an associated solenoid valve mounted on the analyzer electronics junction box, Figure 1-2.

In *manual* mode, the solenoid may be actuated either with the corresponding switch in the analyzer, Figure 3-1, or at the appropriate valve board or component/valve board in the programmer. See Figure 3-9. For operation in *automatic* mode, the manual valve-actuation switch in the analyzer must be left in OFF position, and the MANUAL VALVE Switch on the assigned valve board in the programmer must be at AUTO. The solenoid is then actuated by preprogrammed commands from the programmer.

Depending on the energization status of the solenoid, the actuator drives the slider carriage to one end or the other of its limit of travel. The two slider positions provide appropriate combinations of flow passages through ports in the valve blocks.

5.3 ANALYZER COLUMN-AND-VALVING CONFIGURATIONS

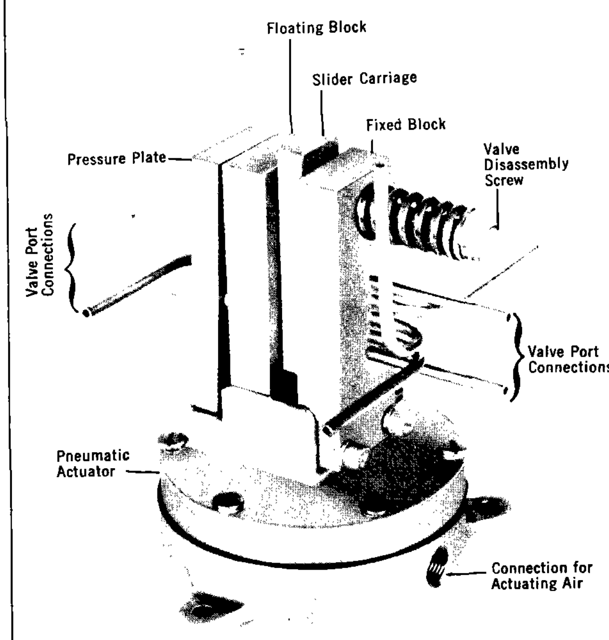
Each analyzer is equipped with a column-and-valving configuration selected to fit the requirements of the particular analysis and application.

Paragraphs 5.3.1 through 5.3.5, following, cover the five **standard** column-and-valving configurations. Each description is accompanied by **two** flow diagrams, one each for liquid and gas samples. Principal difference between the two involves slider-valve connections required for injection of the desired type of sample.

Liquid Sample: In sample-purge condition, sample flows continuously into one valve port, through a hole in the slider, and out the opposite valve port to vent. When slider is actuated to initiate sample injection, liquid sample previously contained within the slider hole is swept into a column. Injected sample volume is comparatively small, and is determined by volume of the hole in the slider.

Gas Sample: In sample-purge condition, sample flows into one port, through connecting passages in the slider, and through an external loop of tubing. When slider is actuated for sample injection, gas sample previously contained within the loop is swept into a column. Sample volume is comparatively large, and is determined by i.d. and length of the loop.

Consider a configuration that utilizes 8 ports of the standard 10-port slider valve when used for **liquid** samples. If used for **gas** samples, the same configuration will use all 10 ports, because of the requirement for equipping the valve with a sample loop.



NOTE: The Ten-Port (LG10) Valve is shown. Some applications use the Six-Port (LG6) Valve. It is similar, but has only three ports, instead of five, in each block.

Figure 5-1. Typical Slider Valve

NOTE: The Ten-Port (LG10) Valve is shown. Some applications use the Six-Port (LG6) Valve. It is similar, but has only three ports, instead of five, in each block.

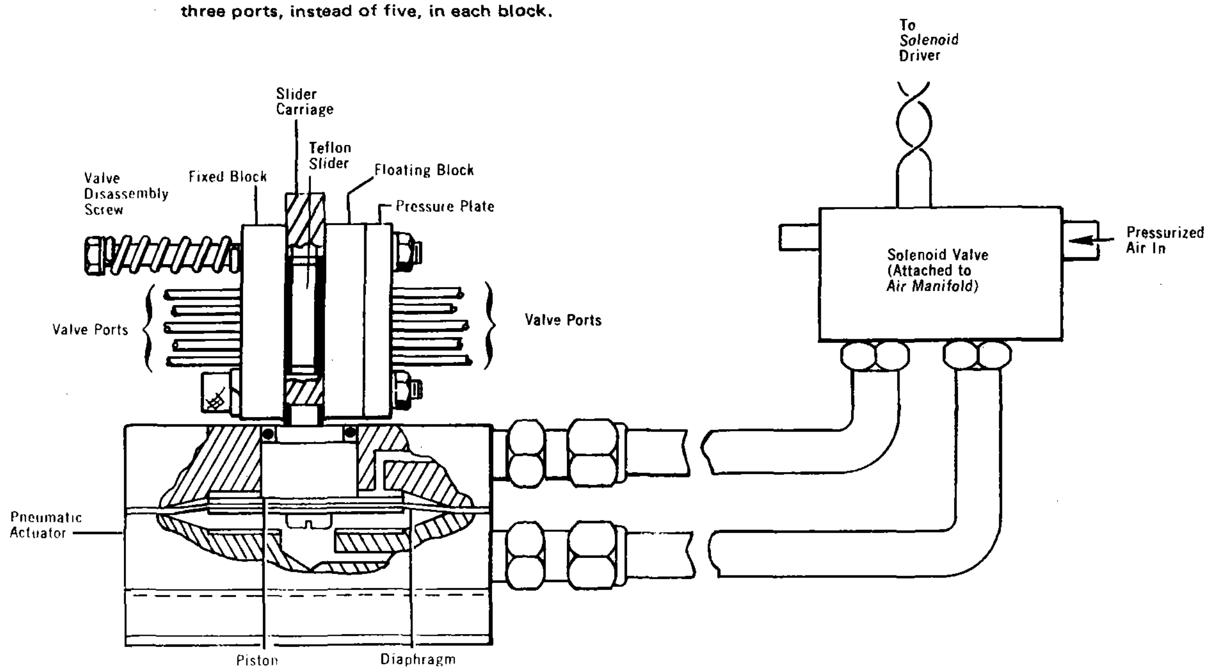


Figure 5-2. Actuation of Typical Slider Valve

5.3.1 SINGLE-COLUMN BACKFLUSH CONFIGURATION

This configuration is used for applications where only the faster-eluting components are of specific interest, and where separation of these desired components is attainable with a single analysis column. The configuration incorporates a backflush function to combine the heavier, less significant, components.

As shown in Figure 5-3 (liquid samples) and Figure 5-4 (gas samples), a single 10-port slider valve is used for both sample-injection and column-switching functions. Operating sequence is:

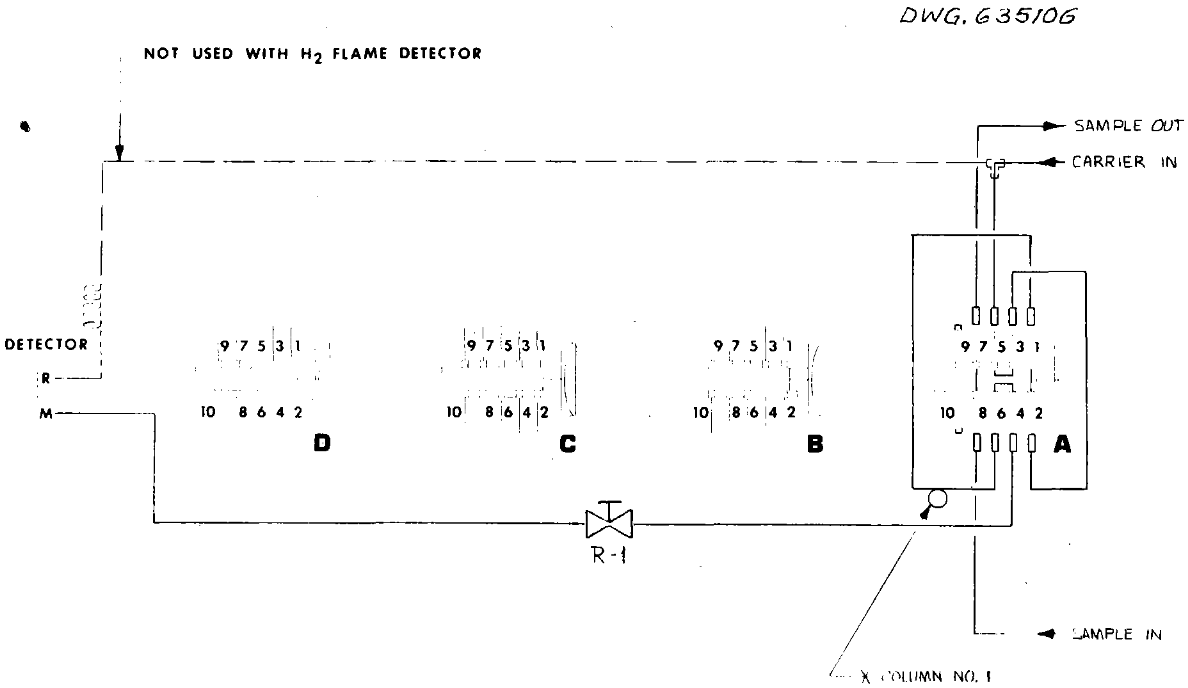
1. Normally, valve A is de-energized, resulting in sample-purge/column-backflush condition.
2. To inject sample, Valve A is energized, resulting in sample-inject/column-foreflush condition. Carrier sweeps sample from the valve, through the column, and to the detector.
3. As soon as the desired, faster-eluting, peaks appear on the recorder chart, but before appearance of the undesired, slower-eluting components, Valve A is de-energized, returning the system to sample-purge/column-backfulsh condition. Slower-eluting components are now flushed, in reverse direction, out of the column and to the detector. Backflushed components appear on the recorder chart as a group measurement, condensed into one peak as required.

5.3.2 SINGLE-COLUMN STRIPPER CONFIGURATION

This configuration is used for applications where only the faster-eluting components are of interest, and where separation of these desired components is attainable with a single **analysis column**. In addition, a **stripper column** is used to separate fast-eluting desired components from slower-eluting undesired components to prevent their entry into the analysis column and/or detector.

As shown in Figure 5-5 (liquid samples) and Figure 5-6 (gas samples) a single 10-port slider valve is used for both sample-injection and column-switching functions. Operating sequence is:

1. Normally, Valve A is de-energized, resulting in sample-purge/stripper-backflush condition.
2. To inject sample, Valve A is energized, resulting in sample-injection/stripper-foreflush condition. Carrier sweeps sample from the valve into stripper column (#1), where the components begin to separate. Components eluting from the stripper column pass into the analysis column (#2).
3. After the last component of interest has eluted from stripper column (#1), Valve A is de-energized, returning it to sample-purge/stripper-backflush condition. At this time, slower-eluting components have not yet emerged from stripper column (#1); these are backflushed to vent via adjustable restrictor R2. Backflushing should continue for sufficient time to clear



* DETERMINED BY CUSTOMER'S APPLICATION
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION		QTY
	*	VALVE ASSY		---
	*	SLIDER		---
	*	FITTING, UNION (SS)		---
	809945	SCREW, PAN HD	(NO. OF VALVES X 3 =)	3
	808268	WASHER, LOCK	(NO. OF VALVES X 3 =)	3
	802137	WASHER, FLAT	(NO. OF VALVES X 3 =)	3
R-	829840	VALVE, NEEDLE (BRASS)		0
R-1	829838	VALVE, NEEDLE (SS)		1
	632251	BRACKET, NEEDLE VALVE	(1 TO 3 = 1) (4 TO 6 = 2)	0
	809942	SCREW, PAN HD	(NO. OF BRACKETS X 2 =)	0
	808268	WASHER, LOCK	(NO. OF BRACKETS X 2 =)	0
	802137	WASHER, FLAT	(NO. OF BRACKETS X 2 =)	0
T-	810056	FITTING, TEE (BRASS)		0
T-	29753	FITTING, TEE (SS)		0
V-1	876009	VALVE, 4 WAY		0
	79686	FITTING, CAP (SS)		2
	8438	FITTING, UNION (SS)		8
	632276	PLATE, VALVE		1
	15-039-46	TUBING		AR

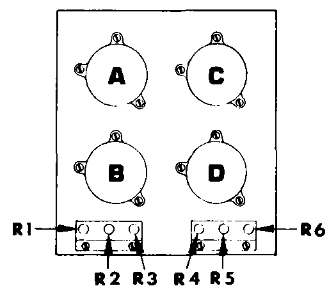


Figure 5-3. Single-Column Backflush Configuration for Liquid Samples

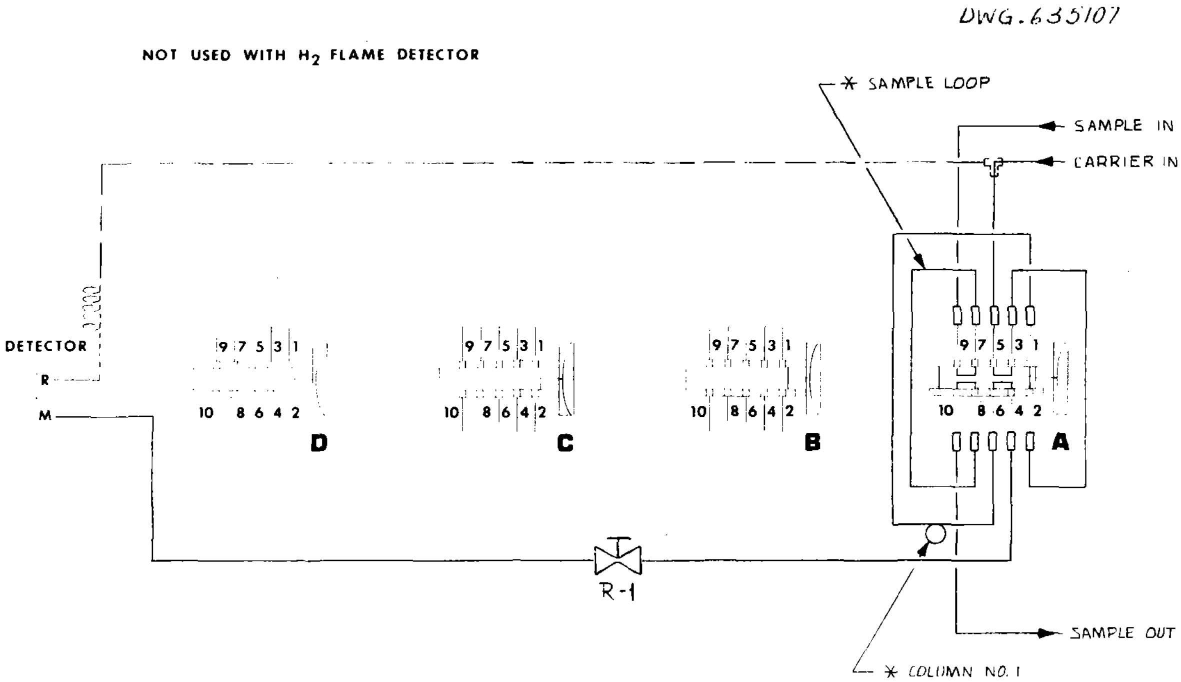
undesired components from the stripper and prevent their interference with the analysis. To ensure adequate flushing, duration of the de-energized period for Valve A must be greater than that of the preceding energized period. During backflushing, flow from the vent is limited by restrictor R2 to prevent excessive consumption of carrier.

5.3.3 SINGLE-COLUMN HEART-CUT/STRIPPER CONFIGURATION

This configuration separates desired components having *intermediate* elution times from undesired components, both faster-eluting and slower-eluting.

Refer to Figure 5-7 (liquid samples) or Figure 5-8 (gas samples). Operating sequence is:

1. Initially, Sample-Injection Valve A and Cutter Valve B are de-energized. Stripper column (#1) flushes to vent via restrictor R2. Primary-separation column (#2) flushes to vent via restrictor R4. Analysis column (#3) foreflushes to detector.
2. To inject sample, Valve A is energized. Carrier sweeps sample into stripper column (#1). Components eluting from this column enter primary-separation column (#2).



* DETERMINED BY CUSTOMER'S APPLICATION
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	3
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	3
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	3
R-	829840	VALVE, NEEDLE (BRASS)	0
R-1	829838	VALVE, NEEDLE (SS)	1
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	0
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	0
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	0
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	0
T-	810056	FITTING, TEE (BRASS)	0
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	0
	79686	FITTING, CAP (SS)	0
	8438	FITTING, UNION (SS)	10
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

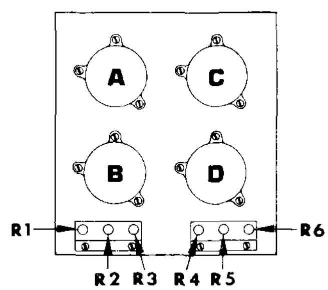


Figure 5-4. Single-Column Backflush Configuration for Gas Samples

Fast-eluting undesired components pass through column #2, and through restrictor R4, to vent.

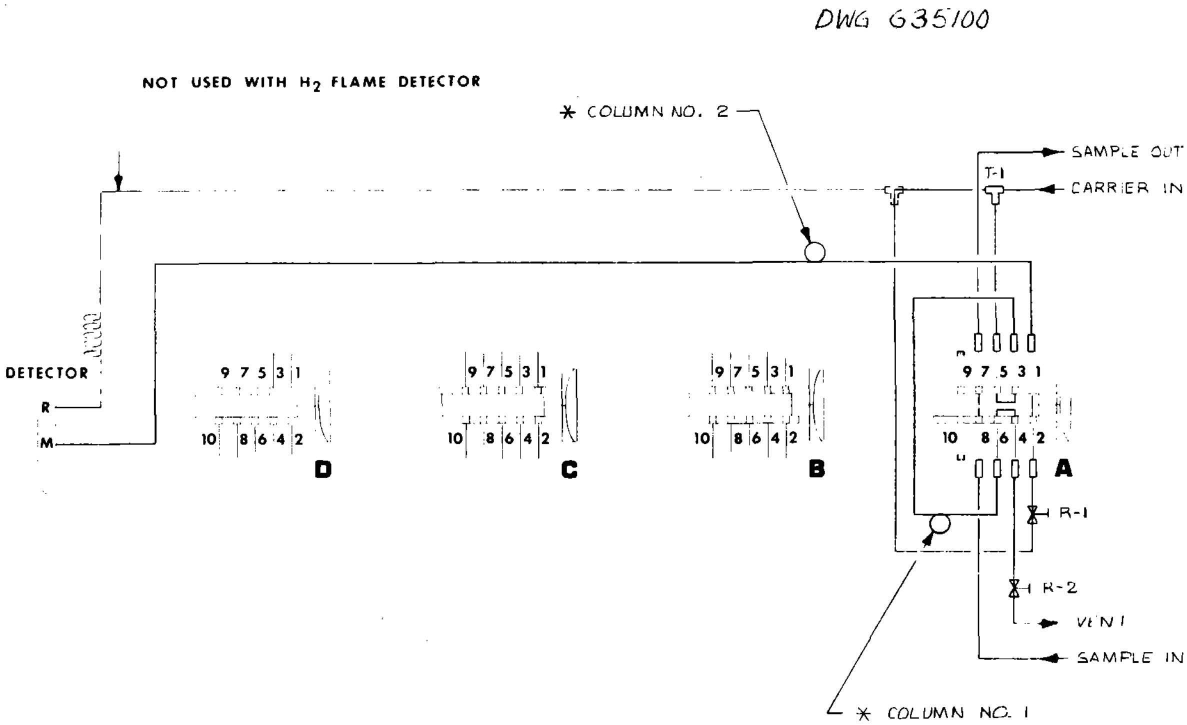
3. Just before the desired components are due to emerge from column #2, and while undesired slow-eluting components are still within column #1, Cutter Valve B is energized. The desired components now enter analysis column (#3).
4. Valves A and B are both returned to de-energized condition. Midcut components are resolved in analysis column (#3). Undesired slower-eluting components within stripper column (#1) are flushed to vent.

The cutter process may be repeated several times during the analysis.

5.3.4 DUAL-COLUMN BACKFLUSH CONFIGURATION

This configuration is used for applications where the desired separation of components is unattainable with a single analysis column.

Refer to Figure 5-9 (liquid samples) or Figure 5-10 (gas samples). Note that the circuit board associated with Valve B is wired to provide valve operation in the **inverted** mode



* DETERMINED BY CUSTOMER'S APPLICATION
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	3
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	3
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	3
R-1	829840	VALVE, NEEDLE (BRASS)	1
R-2	829838	VALVE, NEEDLE (SS)	1
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	1
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	2
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	2
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	2
T-1	810056	FITTING, TEE (BRASS)	1
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	0
	79686	FITTING, CAP (SS)	2
	8438	FITTING, UNION (SS)	8
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

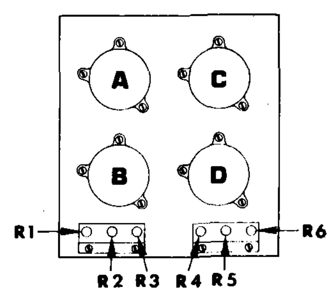
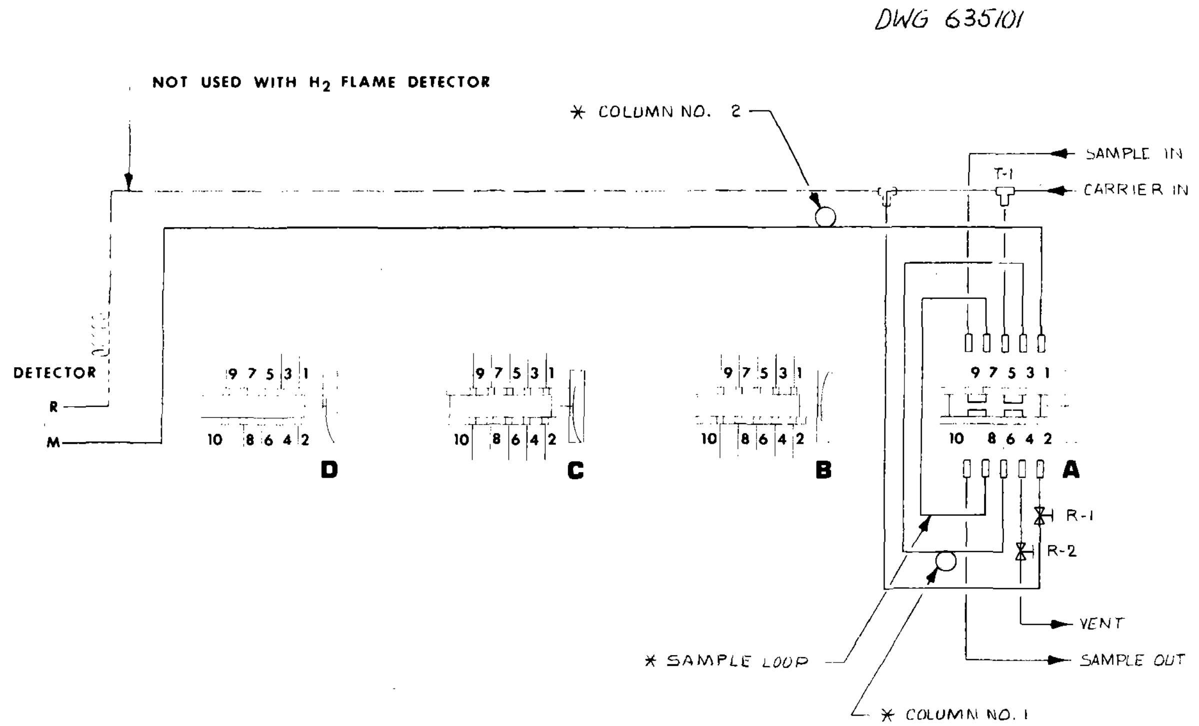


Figure 5-5. Single-Column Stripper Configuration for Liquid Samples

(i.e., on-off-on). Operating sequence for the Dual-Column Backflush configuration is:

1. Initially, Sample-Injection Valve A is de-energized and Dual-Column Valve B is energized. Sample purges Valve A. Column #1 foreflushes to the detector. Column #2 is bypassed.
2. Valve A is energized, thus injecting sample into primary analysis column (#1), and connecting this column in series with secondary analysis column (#2). Sample components begin to separate.
3. When all desired fast-eluting components have entered column #2 or the detector, Dual-Column Valve B is de-energized, placing column #2 in bypass condition. At this time, some slower-eluting components have not yet emerged from column #1; these components bypass column #2, backflush into the detector, and appear on the recorder chart as a single, undifferentiated, elution peak.
4. When all slower-eluting components have been backflushed from column #1, Valve B is energized. Those



*** DETERMINED BY CUSTOMER'S APPLICATION SEE APPLICATION DATA SHEET**

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	3
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	3
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	3
R-1	829840	VALVE, NEEDLE (BRASS)	1
R-2	829838	VALVE, NEEDLE (SS)	1
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	1
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	2
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	2
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	2
T-1	810056	FITTING, TEE (BRASS)	1
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	0
	79686	FITTING, CAP (SS)	0
	8438	FITTING, UNION (SS)	10
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

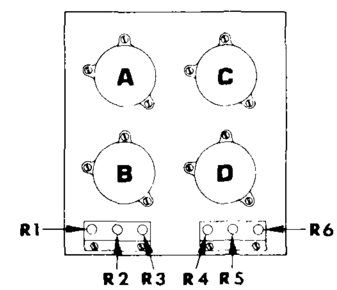


Figure 5-6. Single-Column Stripper Configuration for Gas Samples

lighter components previously held in column #2 now resume elution, undergoing additional separation. On emerging from column #2, they enter the detector.

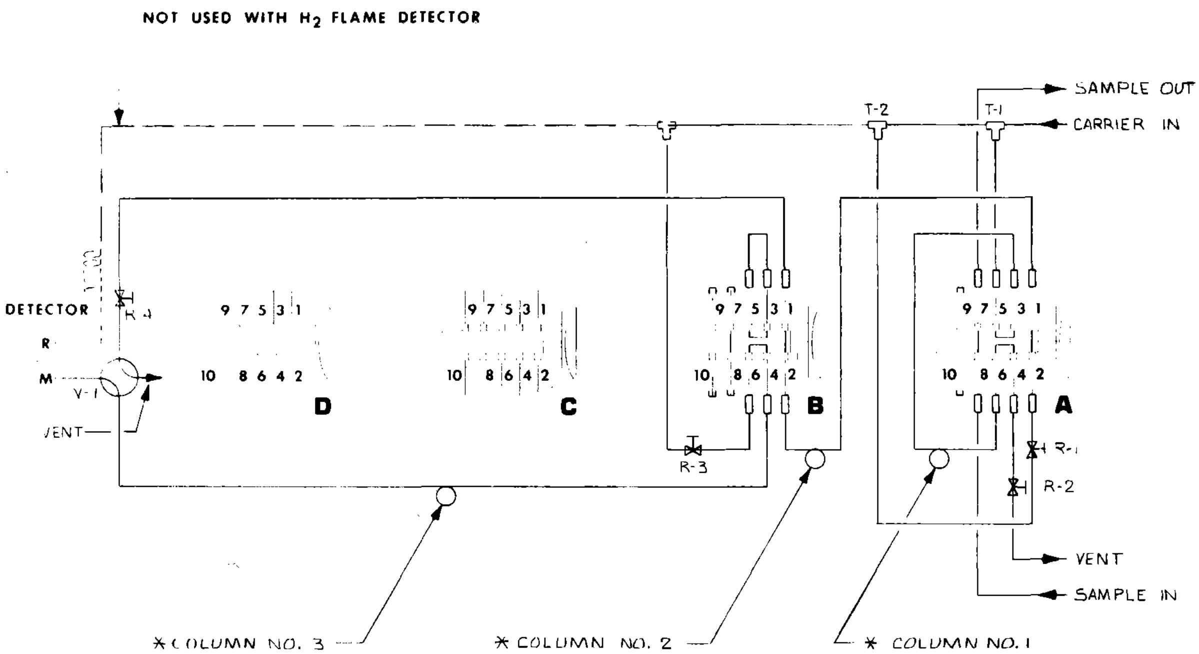
5.3.5 DUAL-COLUMN STRIPPER CONFIGURATION

This configuration is used for applications where only the faster-eluting components are of interest, and where separation of these desired components is unattainable with a single analysis column. The configuration discards the slowest-eluting components and is therefore similar in applicability to the single-column stripper configuration (Paragraph 5.3.2), but provides the additional resolution of a second analysis column.

Refer to Figure 5-11 (liquid samples) or Figure 5-12 (gas samples). Operating sequence is:

1. Initially, Valves A and B are de-energized. Sample purges Valve A. Carrier gas flows through Valve A, flows in reverse direction through stripper column (#1), and passes through restrictor R2 to vent. Another flow of carrier is routed through Valve A and primary analysis column (#2) to detector. Secondary analysis column (#3) is bypassed.

DWG 635102



* DETERMINED BY CUSTOMER'S APPLICATION
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	6
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	6
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	6
R-1,3	829840	VALVE, NEEDLE (BRASS)	2
R-2,4	829838	VALVE, NEEDLE (SS)	2
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	2
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	4
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	4
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	4
T-1,2	810056	FITTING, TEE (BRASS)	2
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	1
	79686	FITTING, CAP (SS)	6
	8438	FITTING, UNION (SS)	14
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

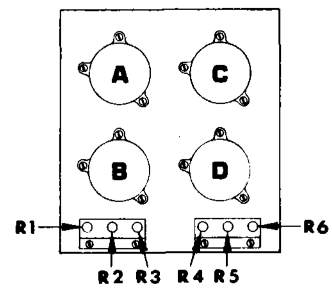
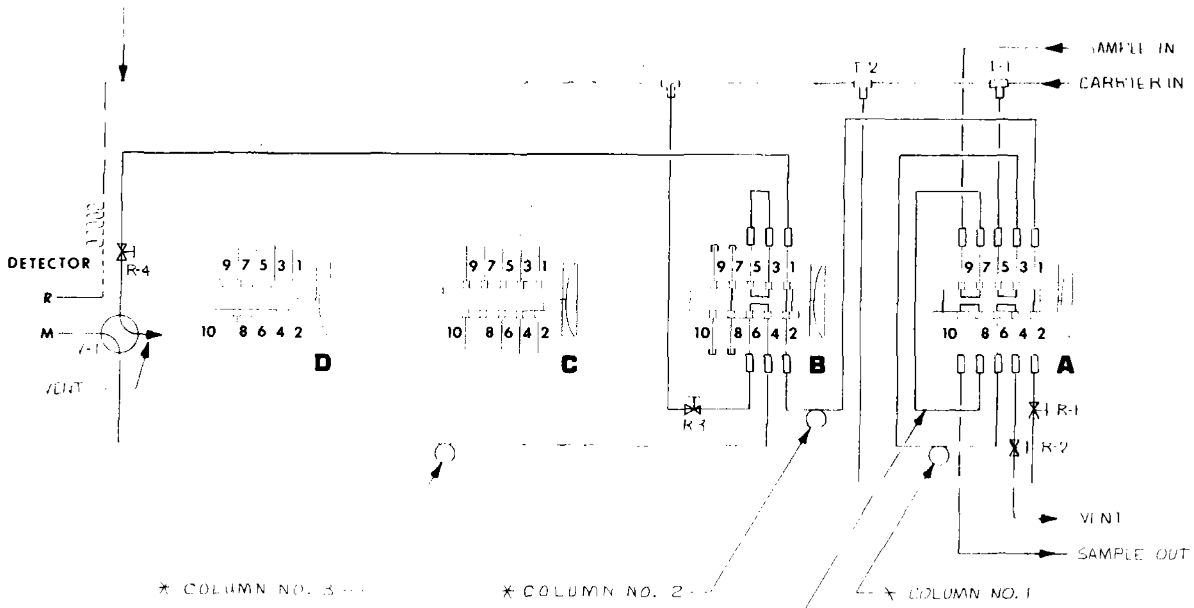


Figure 5-7. Single-Column Heart-Cut/Stripper Configuration for Liquid Samples

2. Valves A and B are energized, thus injecting sample into stripper column (#1), and connecting this column in series with primary analysis column (#2) and secondary analysis column (#3).
3. After the last component of interest has eluted from the stripper column (#1), Valve A is de-energized, returning it to sample-purge/stripper backflush condition. At this time, slower-eluting components that have not yet emerged from stripper column (#1) are backflushed to vent through restrictor R2.
4. After the lightest components have passed rapidly through primary analysis column (#2), Dual-Column Valve B is de-energized, placing column #3 in bypass condition. Components now in column #3 remain there. At this time, slower-eluting components have not yet emerged from column #2. These bypass column #3 and go directly to the detector.
5. At an appropriate time, Valve B is energized for a suitable interval, permitting those components previously held in column #3 to resume elution and undergo additional separation. On emerging from column #3, they enter the detector.

DWG 635103

NOT USED WITH H_2 FLAME DETECTOR



*** DETERMINED BY CUSTOMER'S APPLICATION SEE APPLICATION DATA SHEET**

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	6
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	6
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	6
R-3	829840	VALVE, NEEDLE (BRASS)	2
R-4	829838	VALVE, NEEDLE (SS)	2
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	2
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	4
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	4
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	4
T- 2	810056	FITTING, TEE (BRASS)	2
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	1
	79686	FITTING, CAP (SS)	4
	8438	FITTING, UNION (SS)	16
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

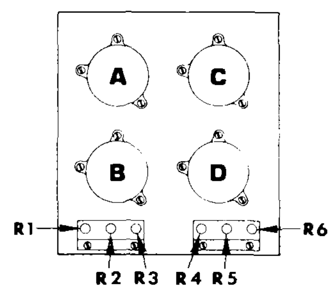
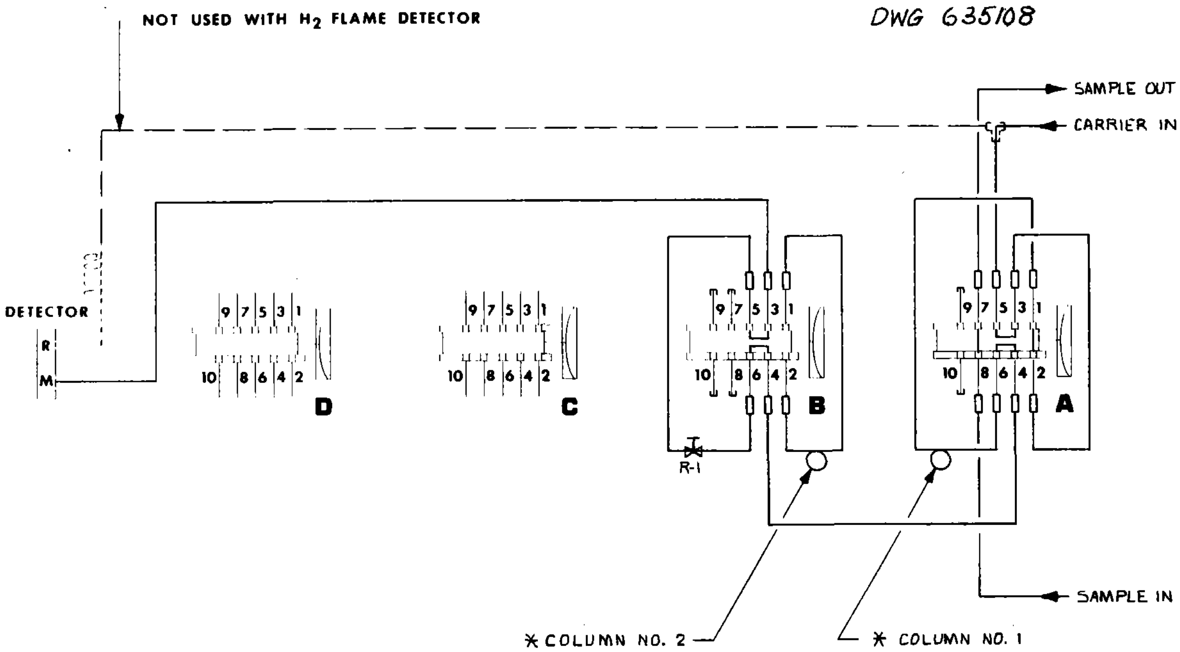


Figure 5-8. Single-Column Heart-Cut/Stripper Configuration for Gas Samples



*** DETERMINED BY CUSTOMER'S APPLICATION SEE APPLICATION DATA SHEET**

REF NO.	BECKMAN PART NO.	DESCRIPTION		QTY
	*	VALVE ASSY		---
	*	SLIDER		---
	*	FITTING, UNION	(SS)	---
	809945	SCREW, PAN HD	(NO. OF VALVES X 3 =)	6
	808268	WASHER, LOCK	(NO. OF VALVES X 3 =)	6
	802137	WASHER, FLAT	(NO. OF VALVES X 3 =)	6
R-	829840	VALVE, NEEDLE	(BRASS)	0
R-1	829838	VALVE, NEEDLE	(SS)	1
	632251	BRACKET, NEEDLE VALVE	(1 TO 3 = 1) (4 TO 6 = 2)	1
	809942	SCREW, PAN HD	(NO. OF BRACKETS X 2 =)	2
	808268	WASHER, LOCK	(NO. OF BRACKETS X 2 =)	2
	802137	WASHER, FLAT	(NO. OF BRACKETS X 2 =)	2
T-	810056	FITTING, TEE	(BRASS)	0
T-	29753	FITTING, TEE	(SS)	0
V-1	876009	VALVE, 4 WAY		0
	79686	FITTING, CAP	(SS)	6
	8438	FITTING, UNION	(SS)	14
	632276	PLATE, VALVE		1
	15-039-46	TUBING		AR

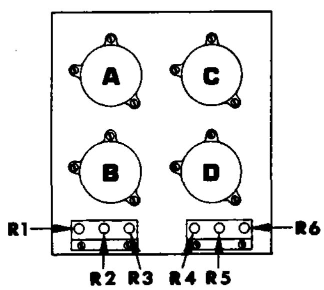
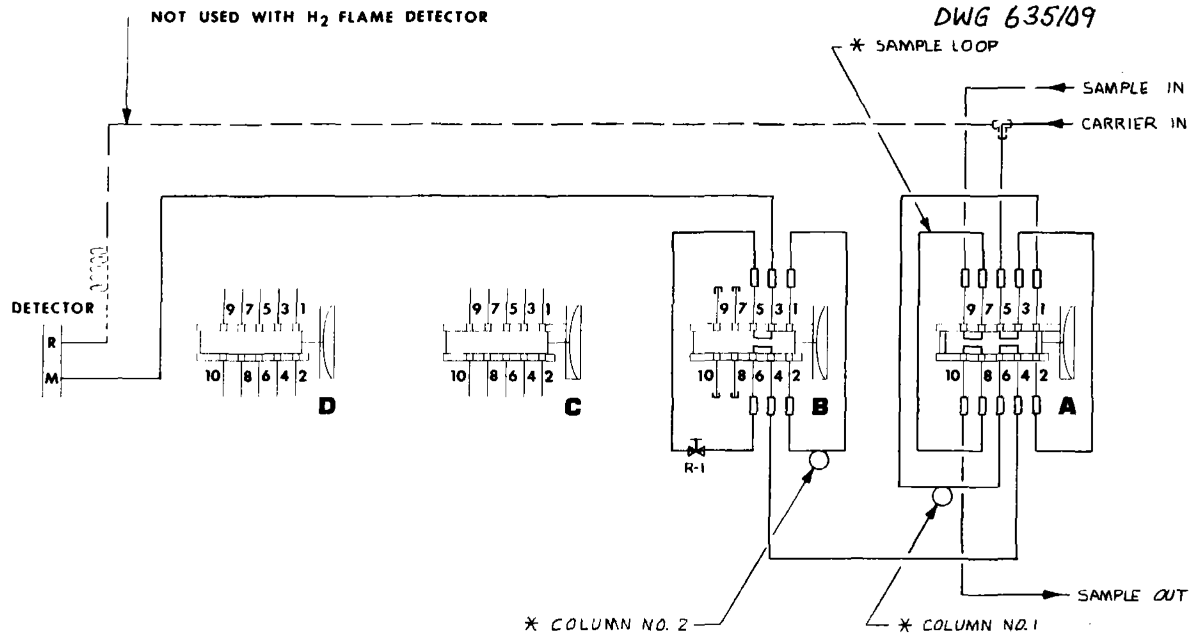


Figure 5-9. Dual-Column Backflush Configuration for Liquid Samples



*** DETERMINED BY CUSTOMER'S APPLICATION**
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	6
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	6
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	6
R-	829840	VALVE, NEEDLE (BRASS)	0
R-1	829838	VALVE, NEEDLE (SS)	1
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	1
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	2
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	2
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	2
T-	810056	FITTING, TEE (BRASS)	0
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	0
	79686	FITTING, CAP (SS)	4
	8438	FITTING, UNION (SS)	16
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

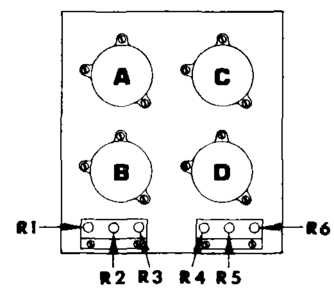
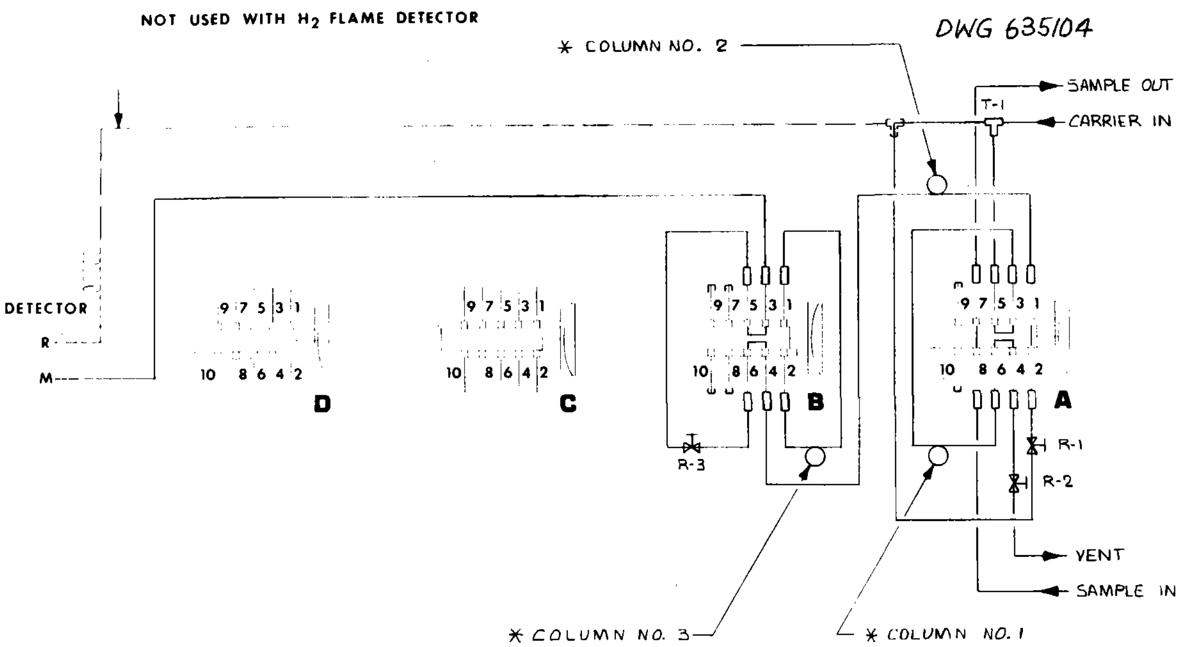


Figure 5-10. Dual-Column Backflush Configuration for Gas Samples



*** DETERMINED BY CUSTOMER'S APPLICATION**
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION	QTY
	*	VALVE ASSY	---
	*	SLIDER	---
	*	FITTING, UNION (SS)	---
	809945	SCREW, PAN HD (NO. OF VALVES X 3 =)	6
	808268	WASHER, LOCK (NO. OF VALVES X 3 =)	6
	802137	WASHER, FLAT (NO. OF VALVES X 3 =)	6
R-1	829840	VALVE, NEEDLE (BRASS)	1
R-2,3	829838	VALVE, NEEDLE (SS)	2
	632251	BRACKET, NEEDLE VALVE (1 TO 3 = 1) (4 TO 6 = 2)	1
	809942	SCREW, PAN HD (NO. OF BRACKETS X 2 =)	2
	808268	WASHER, LOCK (NO. OF BRACKETS X 2 =)	2
	802137	WASHER, FLAT (NO. OF BRACKETS X 2 =)	2
T-1	810056	FITTING, TEE (BRASS)	1
T-	29753	FITTING, TEE (SS)	0
V-1	876009	VALVE, 4 WAY	0
	79686	FITTING, CAP (SS)	6
	8438	FITTING, UNION (SS)	14
	632276	PLATE, VALVE	1
	15-039-46	TUBING	AR

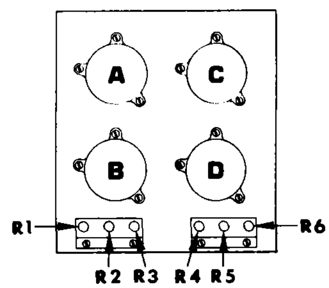
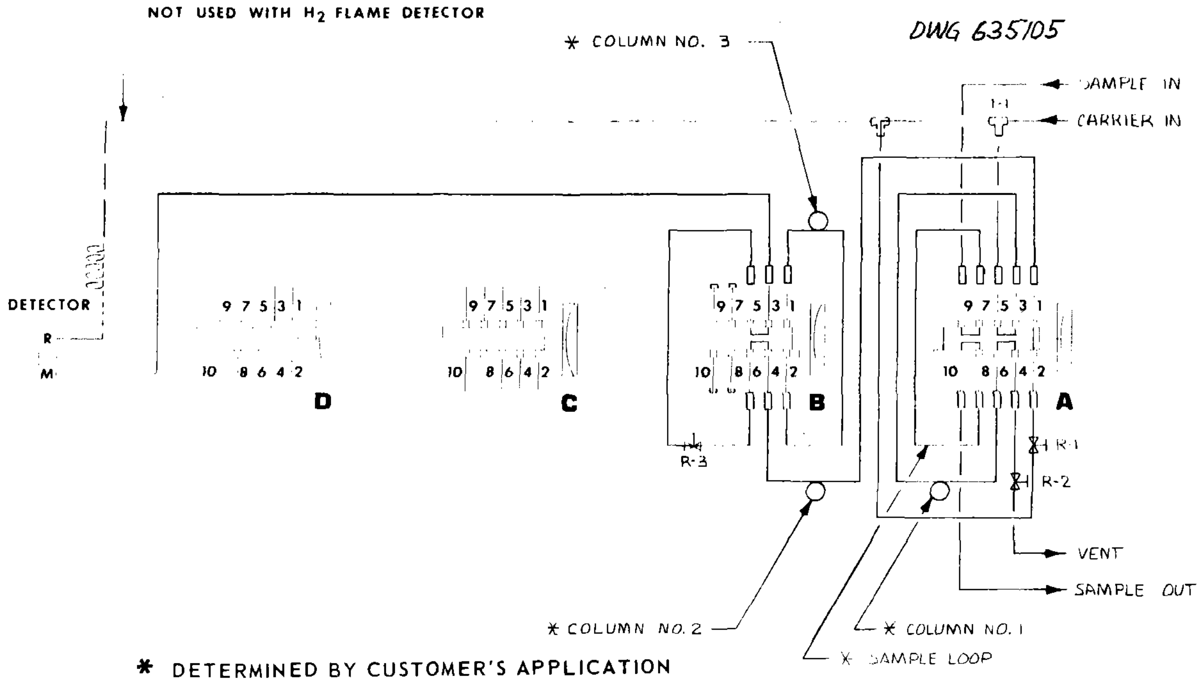


Figure 5-11. Dual-Column Stripper Configuration for Liquid Samples



✱ DETERMINED BY CUSTOMER'S APPLICATION
SEE APPLICATION DATA SHEET

REF NO.	BECKMAN PART NO.	DESCRIPTION		QTY
	✱	VALVE ASSY		---
	✱	SLIDER		---
	✱	FITTING, UNION (SS)		---
	809945	SCREW, PAN HD	(NO. OF VALVES X 3 =)	6
	808268	WASHER, LOCK	(NO. OF VALVES X 3 =)	6
	802137	WASHER, FLAT	(NO. OF VALVES X 3 =)	6
R-1	829840	VALVE, NEEDLE (BRASS)		1
R-2,3	829838	VALVE, NEEDLE (SS)		2
	632251	BRACKET, NEEDLE VALVE	(1 TO 3 = 1) (4 TO 6 = 2)	1
	809942	SCREW, PAN HD	(NO. OF BRACKETS X 2 =)	2
	808268	WASHER, LOCK	(NO. OF BRACKETS X 2 =)	2
	802137	WASHER, FLAT	(NO. OF BRACKETS X 2 =)	2
T-1	810056	FITTING, TEE (BRASS)		1
T-	29753	FITTING, TEE (SS)		0
V-1	876009	VALVE, 4 WAY		0
	79686	FITTING, CAP (SS)		4
	8438	FITTING, UNION (SS)		16
	632276	PLATE, VALVE		1
	15-039-46	TUBING		AR

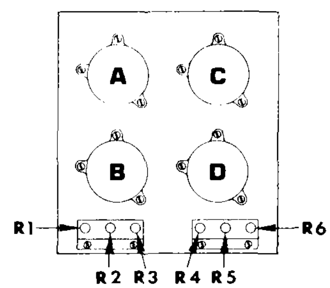


Figure 5-12. Dual-Column Stripper Configuration for Gas Samples

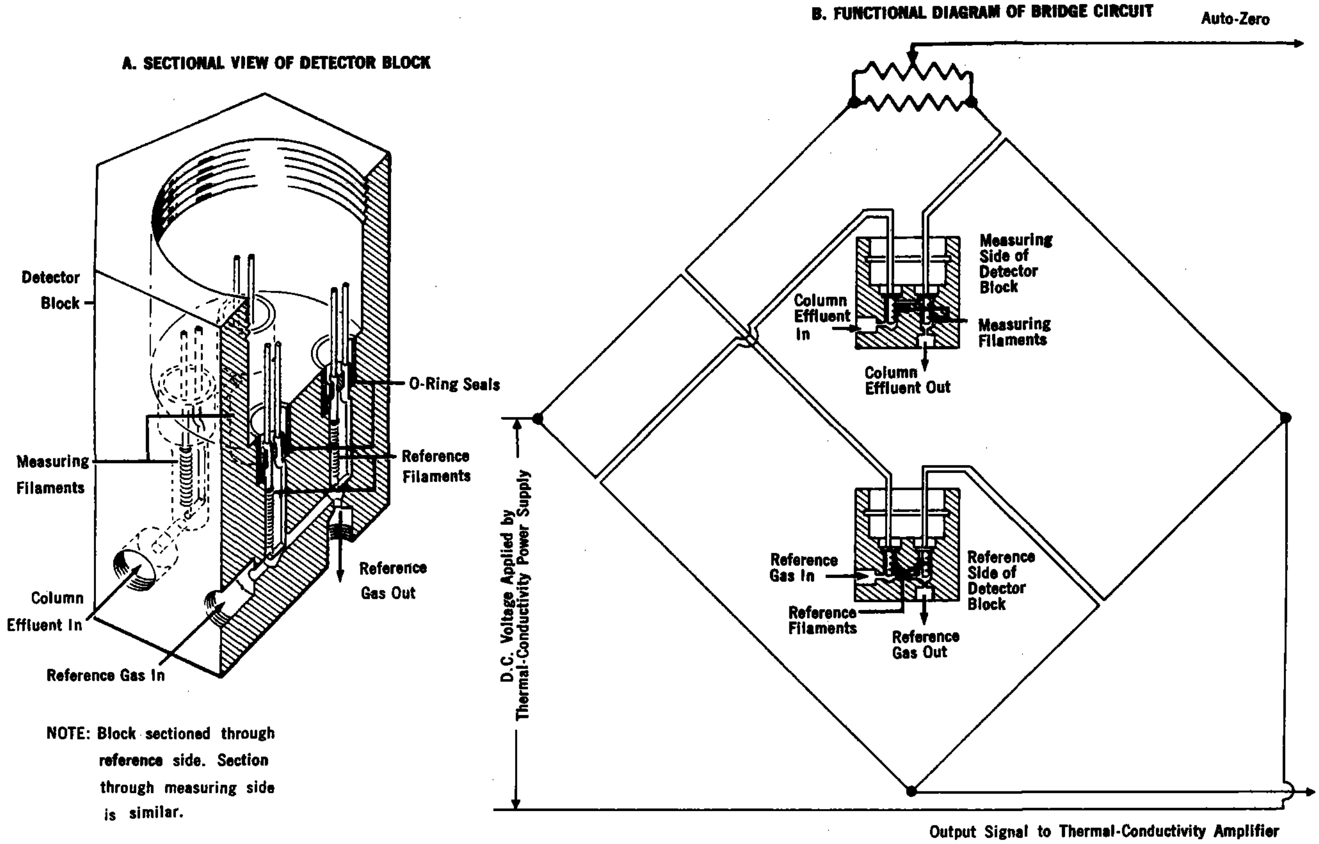


Figure 5-13. Thermal-Conductivity (TC) Detector

5.4 DETECTORS

Depending on the application, the analyzer may incorporate either a thermal-conductivity (TC) detector, Paragraph 5.4.1; or, a flame-ionization detector (FID), Paragraph 5.4.2.

5.4.1 THERMAL-CONDUCTIVITY (TC) DETECTOR

This general-purpose detector is suitable for a wide variety of applications. It has a wide dynamic range; i.e., fullscale sensitivities ranging from several hundred ppm to a 100% concentration of the measured component.

The TC detector consists of four resistive filaments, suspended within individual cavities in a metal block (Figure 5-13, A), and connected electrically as arms of a Wheatstone bridge (Figure 5-13, B). Although *physically* the detector block is one piece, *functionally* it may be considered to have two sides:

1. **Measuring Side.** Here two filaments that constitute opposite arms of the bridge are positioned in an interconnected passage that receives a continuous flow of column effluent, consisting of carrier gas and eluting sample components.
2. **Reference Side.** Here the remaining two filaments, which also constitute opposite arms of the bridge, are positioned in an interconnected passage that receives a continuous flow of pure carrier gas.

Some analyzers use a *parallel* configuration, where the reference side of the system has a column-and-valving arrangement similar to that for the measuring side. The reference side then requires its own carrier gas regulator. The parallel configuration, if used, will be covered in the Applications Data Sheets.

With an appropriately adjusted, constant, voltage applied across the bridge, an electric current flows through the filaments, heating them and thus increasing their electrical resistance. Heat-dissipation rate for each filament depends on thermal conductivity of the surrounding gas. Initially, with pure carrier gas flowing through measuring and reference sides of the detector, the bridge is balanced. Thereafter, the presence of any other substance in the measuring side changes the thermal conductivity of the contained gas, causing a difference in temperature (and therefore in resistance) between measuring and reference filaments. This change in filament resistance unbalances the bridge.

The bridge-imbalance signal is amplified and transmitted to the programmer for processing for application to the recording device.

5.4.2 FLAME-IONIZATION DETECTOR (FID)

The FID is a high-sensitivity detector, particularly suitable for determination of hydrocarbons in trace amounts; i.e., at

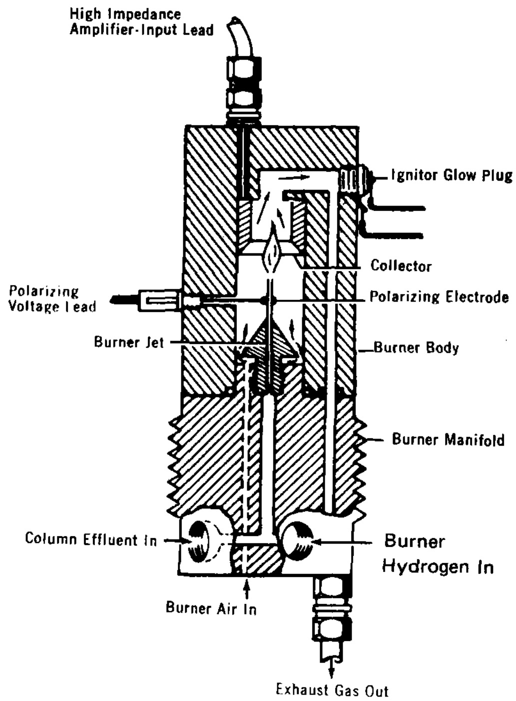


Figure 5-14. Sectional View of Flame-Ionization Detector (FID)

fullscale sensitivities ranging from a few ppm to a few hundred ppm.

Principal components of the FID, Figure 5-14, are the manifold, the burner jet, and the collector. The manifold receives continuous flows of burner hydrogen, burner air, and column effluent (consisting of carrier gas plus eluting sample components). These flows are routed through internal passages in the manifold and into the interior of the FID. Here the hydrogen and column effluent pass through the burner jet and into the flame; the stream of air flows around the periphery of the flame. The jet and the collector function as electrodes. The jet is connected to the +90 volt terminal of the FID power supply (Paragraph 5.5.2). The collector is connected, via the flame amplifier (Paragraph 5.5.2), to the reference. The two polarized electrodes establish an electrostatic field in the vicinity of the flame. The field causes the charged particles formed during combustion to migrate. Electrons go to the burner jet; positive ions go to the collector. Thus a small ionization current flows between the two electrodes. Magnitude of the current depends on the concentration of carbon atoms in the column effluent. The burner current serves as the input signal to the flame amplifier, Paragraph 5.5.2. The output signal from the flame amplifier is further amplified, and is then transmitted to the programmer for processing for compatibility with the data-acquisition device.

Threaded into the burner exhaust passage, near the top of the burner body, is the glow-plug ignitor for the flame-ignition circuit, Paragraph 5.5.2.

5.5 ELECTRONIC CIRCUITRY: ANALYZER UNIT

Most electronic circuitry is contained in the programmer unit. However, with either the thermal-conductivity or flame-ionization detector, certain associated electronic circuitry is mounted in the analyzer unit, for improved signal transmission from a field-located analyzer to a remotely-located programmer. For a description of analyzer circuitry, refer to Paragraph 5.5.1, Thermal-Conductivity Detector; or, 5.5.2, Flame-Ionization Detector (FID).

5.5.1 ANALYZER CIRCUITRY ASSOCIATED WITH THERMAL-CONDUCTIVITY (TC) DETECTOR

If equipped with thermal-conductivity detector, the analyzer utilizes the 640324 TC Detector Electronics Board Assembly. This assembly provides the analog signal circuitry shown in the functional schematic diagram of Figure 5-15. The assembly contains the following:

1. *Bridge Power Supply Section.* It provides a precisely regulated, adjustable voltage for application to the T.C. detector bridge (Paragraph 5.4.1). Adjustment range is 3 to 11 volts d.c. or 11 to 24 volts d.c., depending on the position selected for the 1-ampere fuse.

   As an option, the detector bridge may be connected to the bridge power supply through a pressure switch. Upon loss of carrier gas pressure, the switch removes power from the bridge to prevent filament damage. An additional contact is provided to actuate an alarm if desired. Alarm contacts are rated at 100 mA resistive at 28 volts d.c.

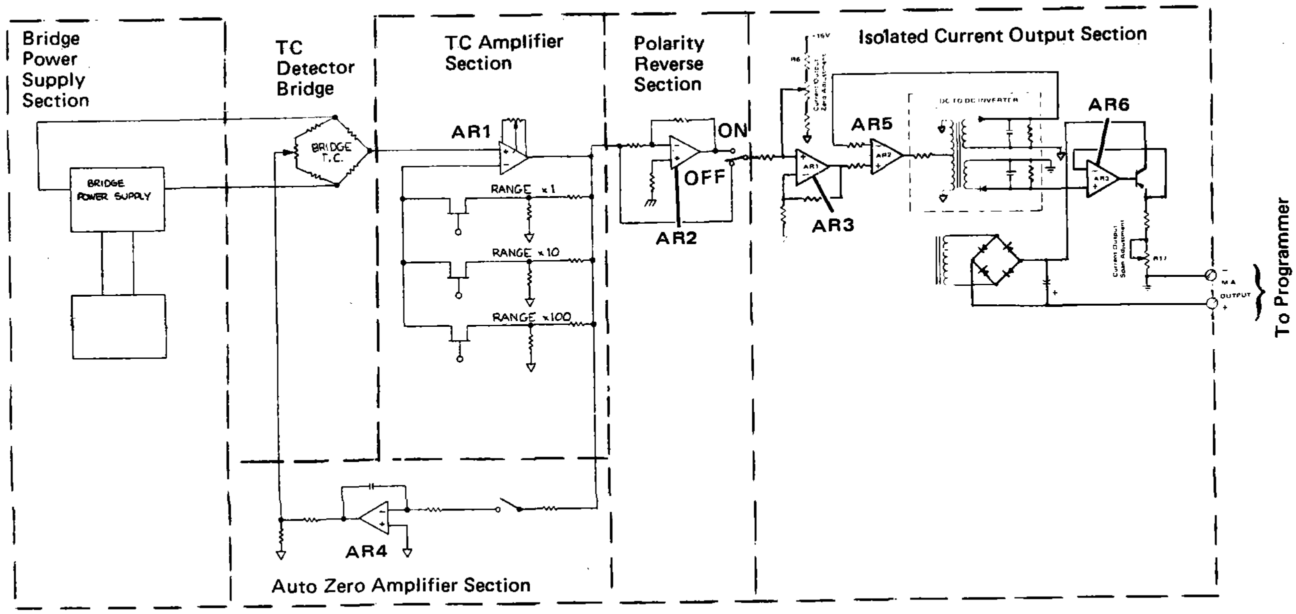
2. *Thermal-Conductivity Amplifier Section.* It amplifies the detector-output signal to an appropriate level. The amplifier may operate at any one of three sensitivity levels, as determined by the feedback resistor used. Connection of each resistor into the feedback loop is controlled by an associated FET switching circuit. In **automatic** operation, the switching circuits are controlled by programming on component boards within the programmer. In **manual** operation, these circuits may be controlled by either Switch SW1 on the TC Detector Electronics Board, or by the RANGE Switch on the programmer front panel.

   The output from the amplifier section is routed through the Polarity-Reverse Section, item 3.

3. *Polarity-Reverse Section.* This circuit provides the capability of reversing the signal polarity, as required with certain sample components, or with parallel systems where samples are run through both sides of the detector.

   With most sample components, the detector-output signal is positive, and thus does **not** require polarity reversal. In this case, the amplifier output signal bypasses the polarity-reverse amplifier and passes through the polarity-reverse section with its polarity unchanged.

   The characteristics of certain sample components may be such that the detector-output signal is **negative.**



640324 TC DETECTOR ELECTRONICS BOARD

Figure 5-15. Analog Signal Flow for Analyzer with Thermal-Conductivity (TC) Detector

Each such component must be programmed for polarity reversal. With the polarity-reverse relay actuated, the signal is routed through an inverting amplifier, and emerges with polarity reversed, i.e., positive.

The polarity-reverse function may be activated **manually** with either Switch SW1 on the TC Detector Electronics Board, or with the POLARITY REVERSE Switch in the programmer.

NOTE

To ensure against lock-up of the polarity-reverse section, it is advisable to program **all** *components with POLARITY REVERSE OFF command.*

4. *Isolated Current Output Section.* It converts the appropriately conditioned voltage signal into a 4 to 20 mA current output, for transmission to the programmer.
5. *Auto-Zero Section.* In **automatic** operation the auto-zero function occurs about 3 seconds before activation of each component function for which auto-zero is desired. At this time, the baseline should be stable. If the bridge is now out of balance, the error signal is amplified by the auto-zero amplifier to provide a voltage of equal magnitude, but opposite polarity, to the bridge offset. With the bridge now nulled to zero, the memory capacitor maintains the output of the auto-zero amplifier at the level thus established until the next auto-zero period.

   The AUTO ZERO command may be initiated **manually** at any time, either with Switch SW1 on the TC Detector Electronics Board, or with the AUTO ZERO Switch on the front panel of the programmer.
6. *±15 Volt Power Supply Section.* (Not shown in Figure 5-15.) This section provides the regulated voltages required for the electronic circuitry of the analyzer unit.
7. *Oven Temperature Control Section.* (Not shown in Figure 5-15.) This section maintains the oven at a controlled, adjustable temperature in the range of 55° to 225°C.

5.5.2 ANALYZER CIRCUITRY ASSOCIATED WITH FLAME IONIZATION DETECTOR (FID)

If equipped with flame-ionization detector, the analyzer utilizes the 640330 FID Electronics Board Assembly. This assembly provides the analog signal circuitry shown in the functional schematic diagram of Figure 5-16. The assembly contains the following:

1. *Polarizing Voltage Supply Section.* It provides a regulated voltage of approximately 90 volts d.c., for application to the burner tip of the FID (Paragraph 5.4.2). Voltage level is not critical, but should be stable.
2. *Signal-Amplification Circuitry.* It consists of flame amplifier AR1 and range amplifier AR5. Signal current from the FID (Paragraph 5.4.2) is applied to the input of the flame amplifier. This feedback amplifier utilizes

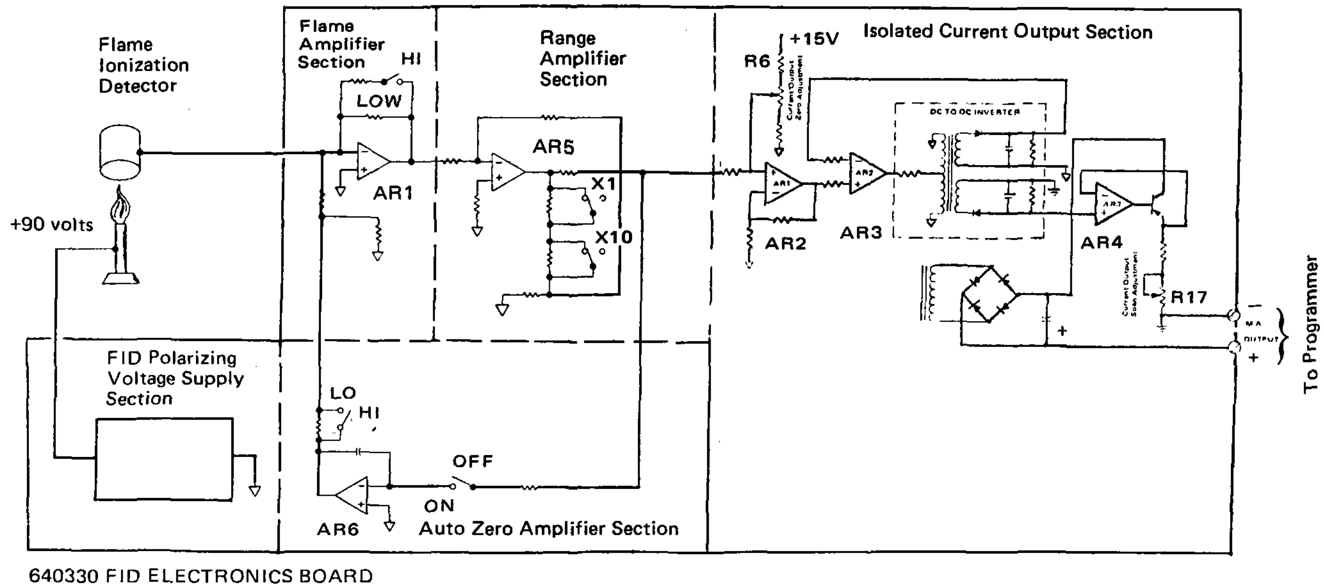


Figure 5-16. Analog Signal Flow for Analyzer with Flame-Ionization Detector (FID)

a diode-protected MOS-FET amplifier to provide an extremely high input impedance, thus minimizing loading effects. Output impedance is comparatively low, to match the following stage.

The flame amplifier may operate on either LOW or HIGH range, as determined by the feedback resistor used. The LOW range may be used on any of three subranges (X1, X10, or X100), obtained by routing the output signal from the flame amplifier through a range-switching amplifier circuit. In automatic operation, the range-switching circuitry is controlled by programming on component boards within the programmer. Refer to Paragraph 5.6. In manual operation, this circuitry may be controlled by either Switch SW1 on the FID Electronics Board, or by the RANGE Switch on the programmer front panel.

3. *Isolated Current Output Section.* It converts the voltage output from the range amplifier into a 4 to 20 mA current output, for transmission to the programmer.
4. *Auto Zero Amplifier Section.* In **automatic** operation, the auto-zero function occurs about 3 seconds before activation of each component function for which auto-zero is desired. At this time, baseline should be stable. During the auto-zero function, the output of range amplifier AR5 is connected to the input of auto-zero amplifier AR6. If any error is now present in the flame amplifier, the auto-zero amplifier supplies the current required to null the system to zero. On completion of the auto-zero function, the output from the auto zero amplifier remains at the level thus established until the next auto-zero period.

   The AUTO ZERO Command may be initiated **manually** at any time, either with Switch SW1 on the FID Electronics Board, or with the AUTO ZERO Switch on the programmer front panel.

   The HIGH/LOW Output Switch provides a choice of two output ranges for the auto-zero circuit. During startup, the system may contain a relatively high level of contaminants, resulting in a high background current, and necessitating use of the HIGH switch position. After startup, with the system now clean, the switch is moved to LOW.
5. *Flame Ignition Circuit.* (Not shown in Figure 5-16.) Upon closure of the IGNITE Switch in either the analyzer or the programmer, current flows through the glow-plug ignitor in the FID (Paragraph 5.4.2).
6. *±15 Volt Power Supply Section.* (Not shown in Figure 5-16.) This section provides the regulated voltages required for the electronic circuitry of the analyzer unit.
7. *Oven Temperature Control Section.* (Not shown in Figure 5-16.) This section maintains the oven at a controlled, adjustable temperature in the range of 55° to 225°C.

5.6 ELECTRONIC CIRCUITRY: PROGRAMMER UNIT

The programmer contains electronic circuitry for the following functions: (1) measurement of the amplified

5.6.2 ZERO/CALIBRATE CIRCUIT

The Zero/Calibrate circuit is a part of the signal conditioning section of the 640908 Master Control Board.

With ZERO/CALIBRATE Switch at ON, the CALIBRATE ADJUST Control provides an adjustable voltage at the output of amplifier AR2-B. This signal is summed with the voltage output signal from the compensating amplifier on the 640922 Basic Terminal Assembly, and the algebraic sum of the two voltages is applied to the input of amplifier AR2-A. When the CALIBRATE ADJUST Control is used, it is recommended that the AUTO ZERO Switch be in ON position.

The CALIBRATE ADJUST Control provides two functions:

1. In **programmer checkout**, the control is manipulated for upscale and downscale deflection of recorder pen, to verify proper functioning of summing amplifier and subsequent stages of analog circuitry.
2. In **component calibration**, the control is used to provide a simulated analyzer-output signal corresponding to a given concentration of sample component. The appropriate sensitivity adjustment on the component board is then set for the desired recorder deflection.

5.6.3 POTENTIOMETRIC OUTPUT CIRCUIT FOR BARGRAPH PRESENTATION

The input signal for this circuit is obtained either directly from the summing amplifier on the Master Control Board, or via the plug-in integrator (for readout of peak areas). The signal is then routed through an attenuating resistor network to provide a selectable output of 10 mv or 1 volt for a potentiometric recorder. Input signal to the Peak-picker, if used, is obtained from the one-volt output terminal of the attenuating network. See Figure 5-17, 5-19, or 5-20.

In **automatic mode**, adjustable attenuation is provided by a built-in or plug-in potentiometer on the individual component board.

In **manual mode**, selectable attenuation is provided by the front-panel ATTENUATION Switch.

During instrument checkout and programming, the **bargraph** readout circuit may be used for **chromatogram** readout, Figure 5-21. Front-panel CHART ADVANCE Switch is placed at ON so that recorder chart advances continuously throughout the analysis cycle. Thus the chart shows a series of discrete peaks, each indicative of the elution of a different component. Elution times are characteristic of the components, and thus serve to identify them. Peak height or area, with attenuator(s) appropriately adjusted, is indicative of the concentration of the corresponding component in the sample.

During normal automatic operation, the readout circuit provides **bargraph** readout, Figure 5-21. Instrument functioning is now essentially the same as for chromatogram readout, except that the recorder chart is stopped during elution of each component of interest and then advanced a

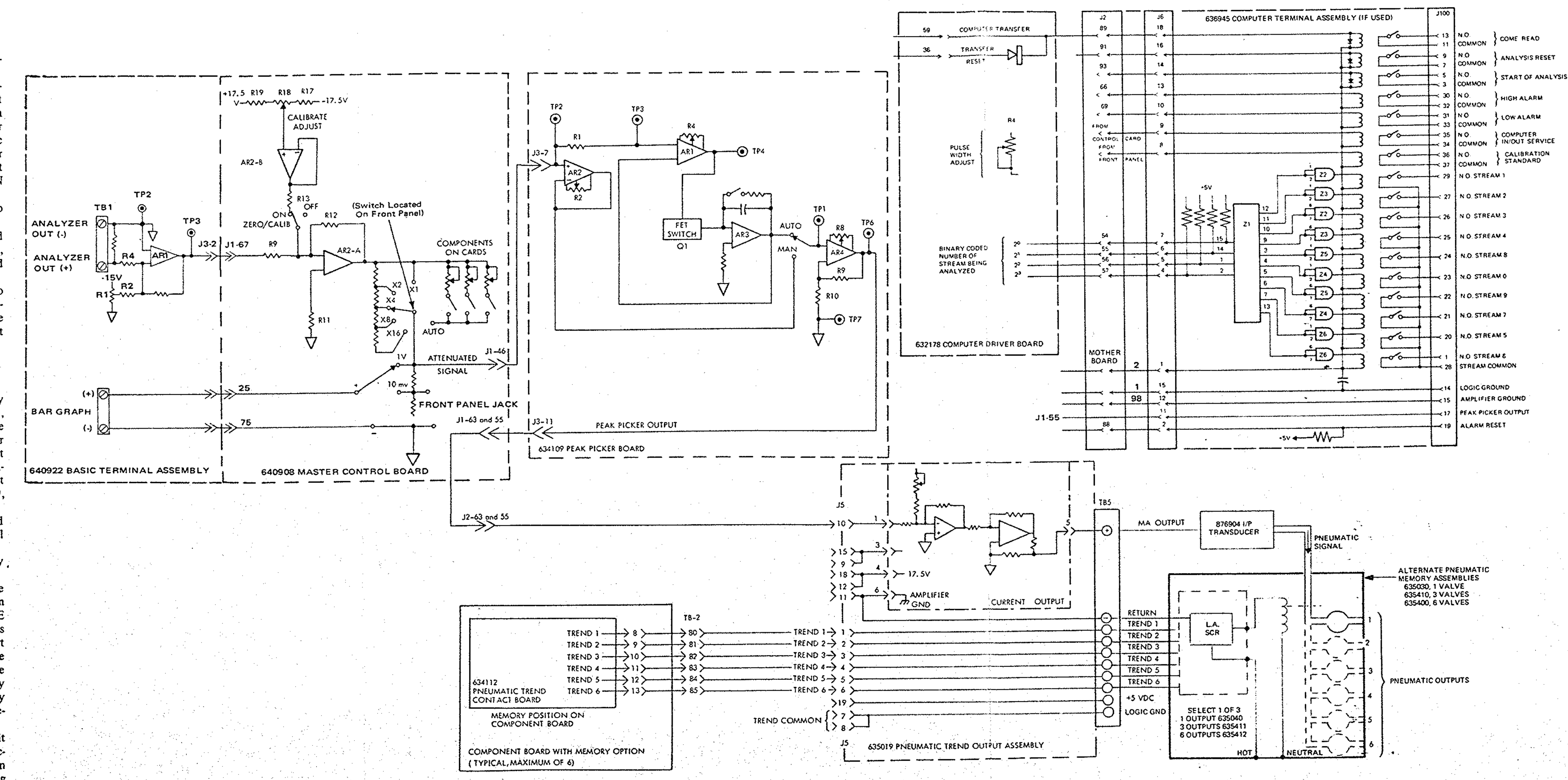


Figure 5-19. Analog Signal Flow for Typical Programmer with Penumatic Trend Output

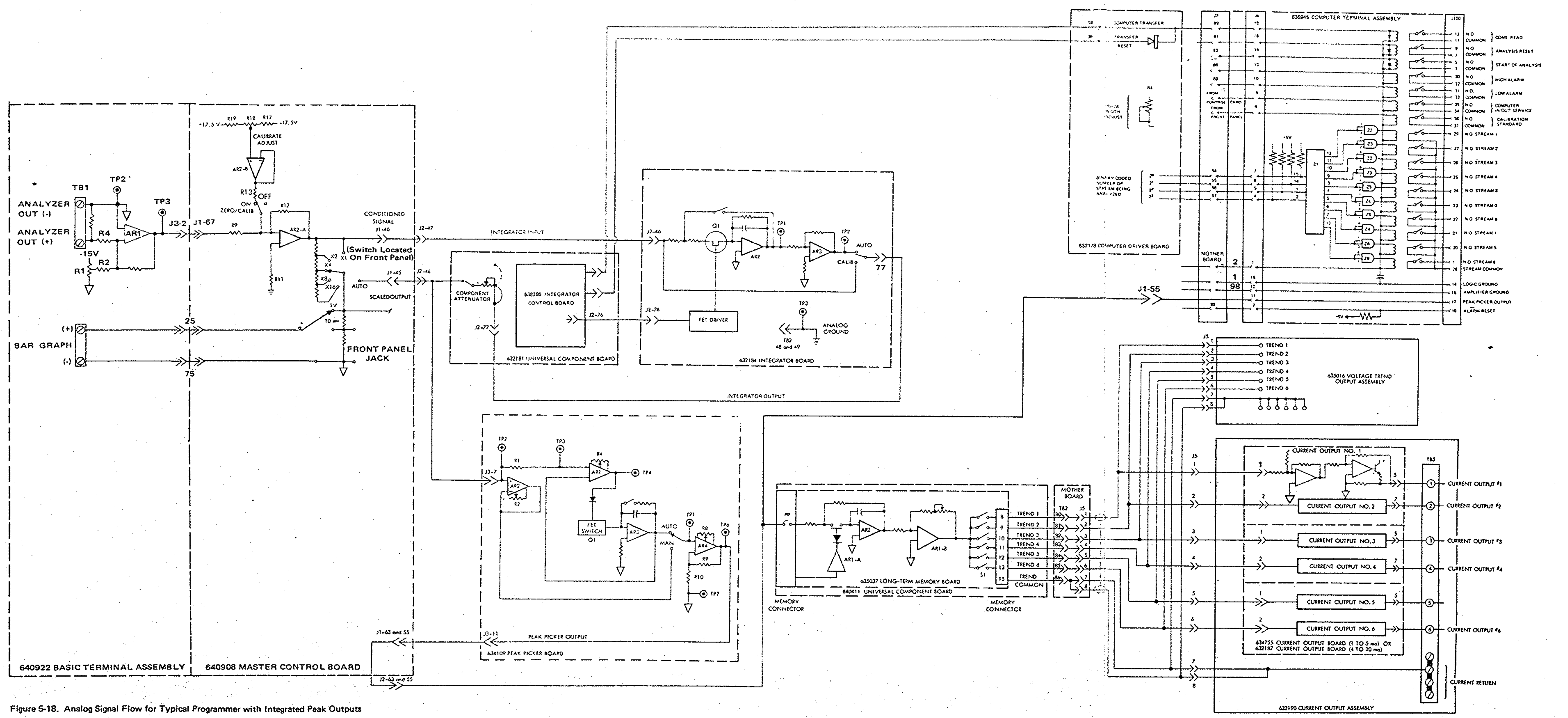
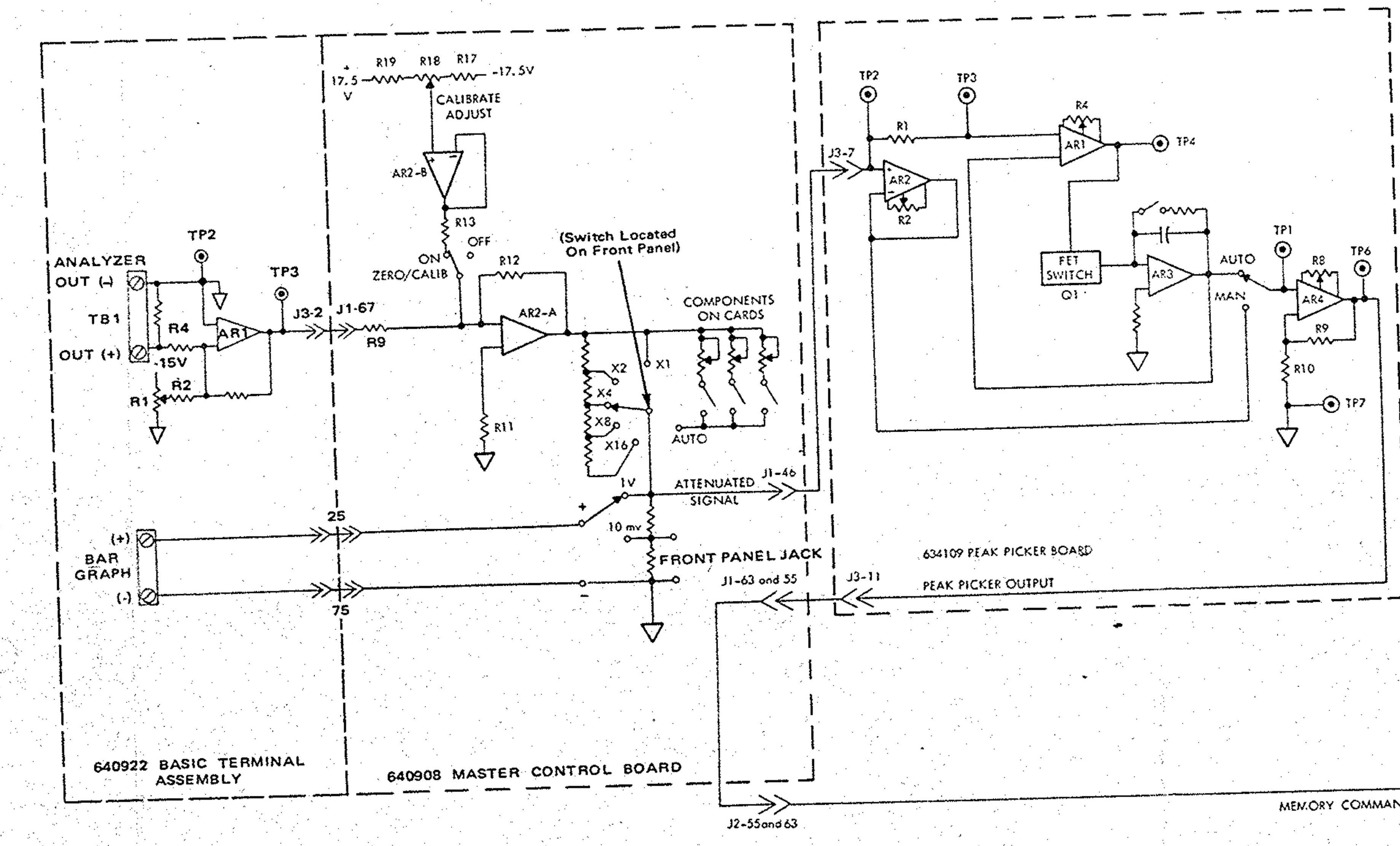


Figure 5-18. Analog Signal Flow for Typical Programmer with Integrated Peak Outputs



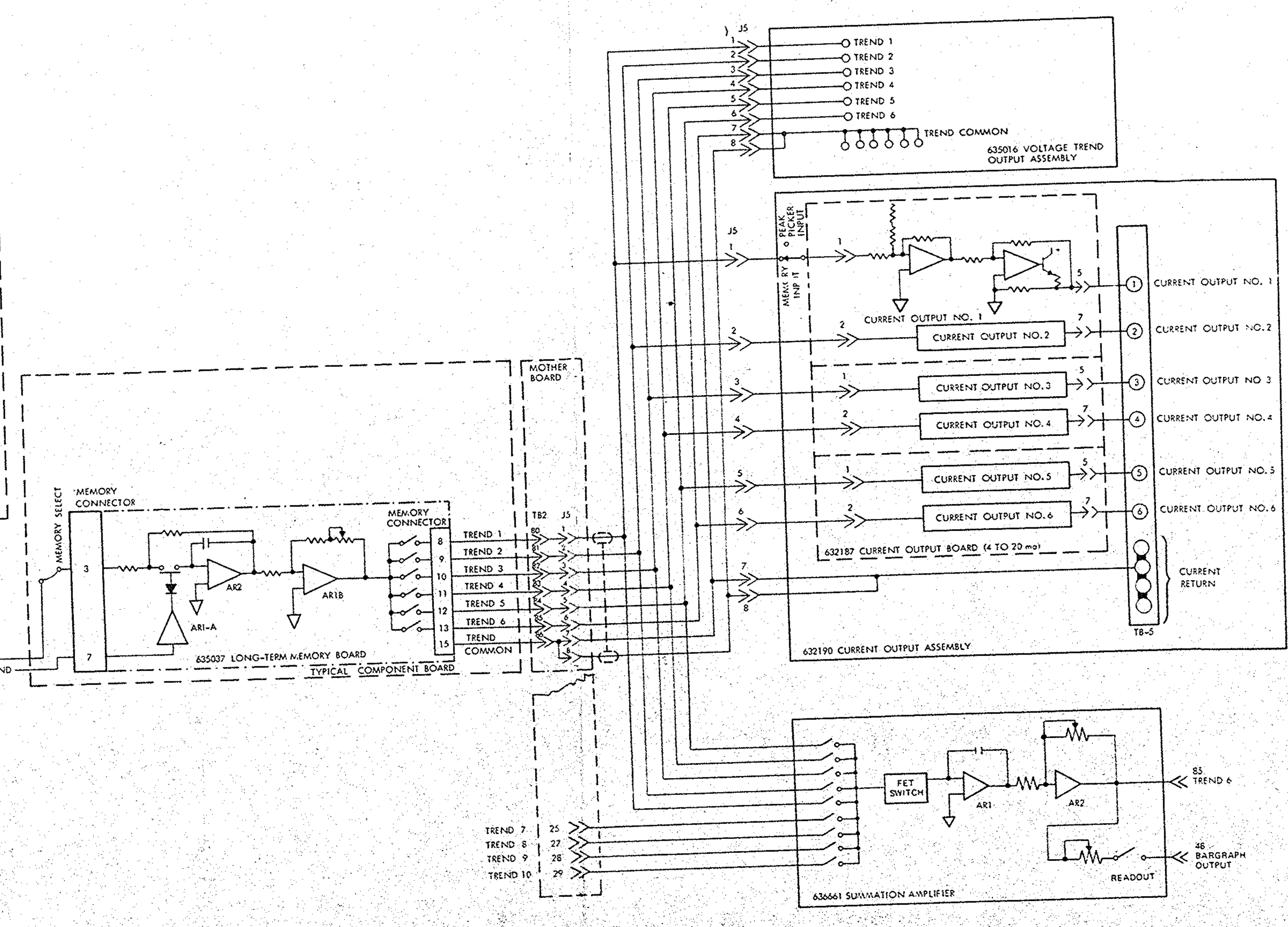


Figure 5-17. Analog Signal Flow for Typical Programmer with Voltage Trend or Voltage/Current Trend Output

detector-output signal received from the analyzer, (2) automatic control of all time-based functions, and (3) data presentation.

5.6.1 ANALOG SIGNAL FLOW THROUGH PROGRAMMER

Figures 5-17 through 5-20 are functional diagrams of *analog signal circuitry* for four typical programmers. These diagrams show signal flow through the Basic Terminal Assembly, and subsequent stages of the electronic circuitry, to the output circuit. Refer to the diagram that most nearly represents your system.

Figure No.	Output Type
5-17	Voltage Trend or Voltage/Current Trend
5-18	Integrated Peaks
5-19	Pneumatic Trend
5-20	Priority Interrupt Computer Output

Within the programmer, the 4 to 20 mA output from the analyzer is routed through an input resistor associated with compensating amplifier AR1 on the 640922 Basic Terminal Assembly. This amplifier allows analyzer zero and programmer zero to be slightly different, and yet properly compensated.

The voltage output signal from the compensating amplifier goes to summing amplifier AR2A in the signal conditioning section of the 640908 Master Control Board.

The voltage output signal from the summing amplifier is then routed through subsequent stage(s) required for the desired type(s) of data presentation. Depending on the options included in the particular instrument, the signal may be routed through any or all of the following: Bargraph Output Circuit, Paragraph 5.6.3; Integrator Plug-In Circuit Board, Paragraph 5.6.4; and/or Peak-Picker Plug-In Circuit Board, Paragraph 5.6.5.

In addition to the routing to the readout circuit, the output from the summing amplifier may be simultaneously directed to the High/Low Alarm Plug-In Board, Paragraph 5.6.10.

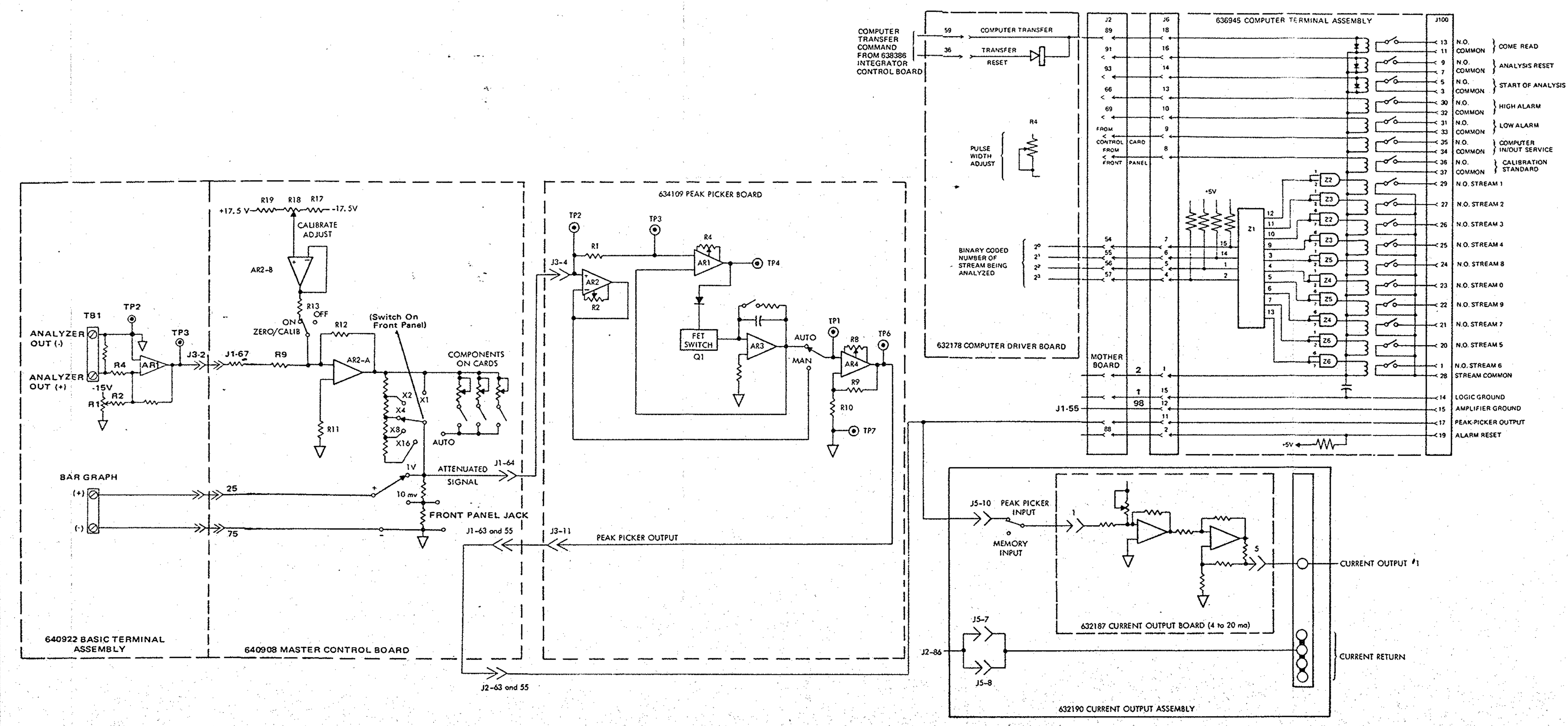


Figure 5-20. Analog Signal Flow for Typical Programmer with Priority Interrupt Computer Output.

discrete interval, causing the corresponding peaks to register as vertical line segments separated by equal spaces. Successive analysis cycles are separated by an extended space for convenience of identification.

5.6.4 632184 INTEGRATOR BOARD AND 638386 INTEGRATOR CONTROL BOARD

If it is desired that readout for certain component(s) be proportional to *areas* rather than height, the programmer must be equipped with a 632184 Integrator Board. This board can integrate output signals for a maximum of nine components. In addition, each component that is to provide an integrated output requires a separate 640411 Universal Component Board equipped with a 638386 Integrator Control Board.

Signal flow for integrated readout is shown in Figure 5-18. The conditioned signal from the 640908 Master Control Board is applied to the input of the 632184 Integrator Board. The output from the Integrator Board enters the Universal Component Board, where the signal is routed, via jumper connection, through the component attenuator. The resultant scaled output is directed to the bargraph readout circuit (Paragraph 5.6.3) and also, if desired, through the peak picker to a 635037 Long-Term Memory Plug-In Board for voltage trend or voltage/current trend output. Refer to Paragraph 5.6.6. If current trend output is desired, the output from the long-term memory board is routed through a 632187 Dual V/I Current-Output Board, Paragraph 5.6.7. Normally, the programmer accommodates a maximum of six long-term memory outputs.

5.6.5 634109 PEAK PICKER BOARD

The 634109 Peak Picker Board provides the capability of monitoring an analog signal to determine its peak value, and of storing the value thus determined for further processing. The board is used where long-term memory is required to provide trend readout on a recorder or computer, current output, or priority-interrupt to a computer.

The signal from the summing amplifier on the Master Control Board is attenuated and then routed through the Peak Picker Board. The peak picker is unidirectional; i.e., it passes only *upscale* signals. During automatic operation, whenever a COMPONENT OFF time occurs, a time interval of 3 seconds is provided for transfer of the signal previously held in the peak-picker. The transferred signal may be directed to:

a. A 635037 Long-Term Memory Board, for voltage trend or voltage/current trend readout of the particular component. Refer to Paragraphs 5.6.6 and 5.6.7.
b. A Voltage-to-Current Board inserted in the 635109 Pneumatic Trend Output Assembly, for pneumatic trend readout of the component. Refer to Paragraph 5.6.8.
c. The 636945 Computer/Alarm Terminal Assembly, for input to a computer on priority-interrupt basis. This peak signal coincides with the COME READ

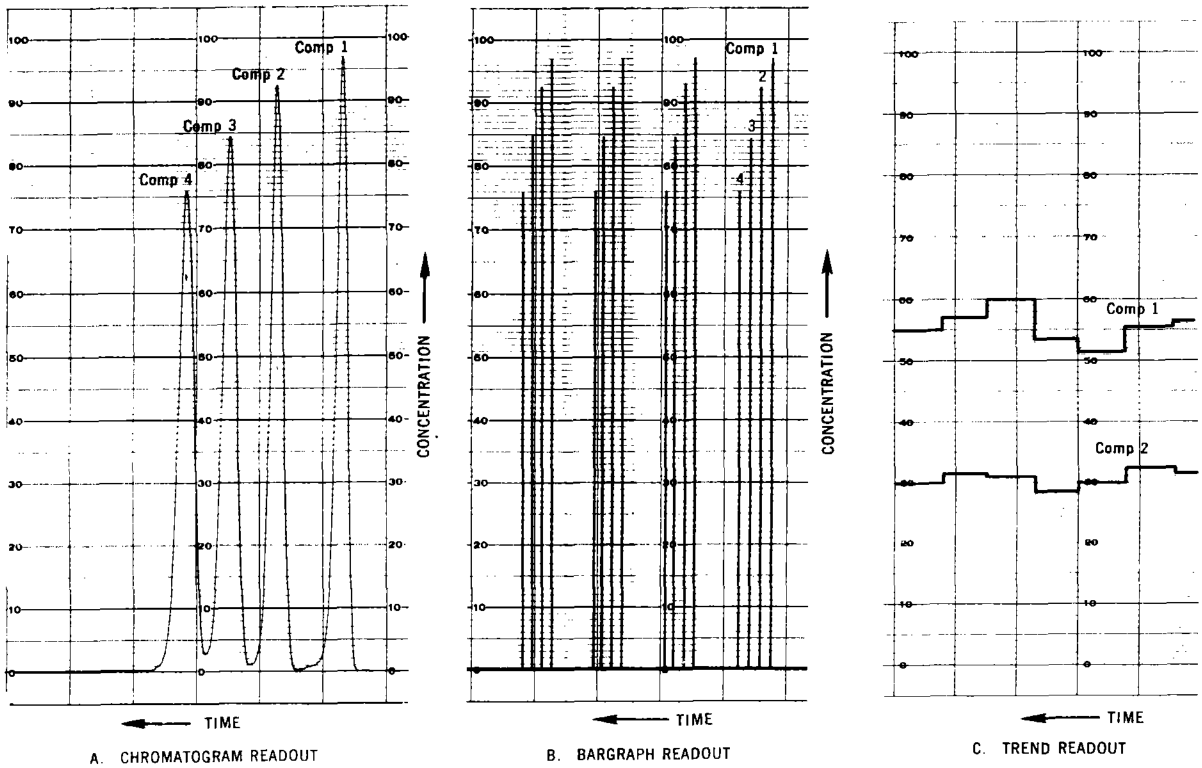


Figure 5-21. Data-Presentation Modes.

command from the computer interface. Refer to Paragraph 5.6.9.

5.6.6 VOLTAGE TREND OUTPUT PROVISIONS

Signal flow for a typical system providing voltage trend output is shown in Figure 5-17.

Individual Trend Outputs

Long-term memory for a given component is obtained by plug-in of a 635037 Memory Board into a 640411 Universal Component Board or other component board with memory option. Normally, the programmer accommodates a maximum of six long-term memories. Depending on the particular readout system, each memory amplifier receives the output from either the integrator (Paragraph 5.6.4) or the peak picker (Paragraph 5.6.5).

Jumper Connections for Signal Routing on Universal Component Board

On the 640411 Universal Component Board, the component attenuator may receive either of two input signals, depending on the jumper connection used. With jumper in NORMAL position, the attenuator input is the conditioned signal from the 640908 Master Control Board. With jumper in INTEGRATOR position, the attenuator input is the integrated signal from the 632184 Integrator Board. After attenuation, the conditioned or integrated signal is routed through the 634109 Peak Picker Board.

The output from the Peak Picker Board is applied to the input of the memory board by connection of a jumper in the position marked PP (for peak picker) on the Universal Component Board.

635037 Memory Board

The 635037 Memory Board accepts a fullscale input signal of +5 volts d.c. from the peak-picker. Fullscale output is adjustable from 1 to 10 volts. Output impedance is approximately zero, and minimum allowable load is 1000 ohms. The Memory Board incorporates selector switches that permit assigning the memory output to the desired one of six numbered trend-output lines, and to associated terminals at the programmer rear panel.

NOTE

A given trend-output line can be selected on one **memory board only**. *Never assign two or more memory boards to the same line.*

Each memory output may be used to drive an associated pen of a multi-pen recorder. See Figure 5-21, C.

If current output is desired, the output from the long-term memory board is routed through a Dual V/I Current-Output Board, Paragraph 5.6.7.

635016 Voltage Trend Output Assembly

Output terminals for trend outputs 1 through 6 are provided by the 635016 Voltage Trend Output Assembly, which mounts at the rear of programmer.

Automatic Operation

During elution of a given component, the peak signal detected by the peak-picker is held for subsequent transfer. When the programmed COMPONENT OFF time occurs, a time interval of 3 seconds is provided for transfer into memory. (Actual transfer time required for zero-to-fullscale response of the memory amplifier is 500 milliseconds.)

Use of Summation Amplifier

Certain applications utilize the 636661 Summation Amplifier Board, Figure 5-17. It accepts a maximum of nine separate trend inputs from long-term memories, and provides an output that is proportional to their sum. The board incorporates adjustments for scaling each input and the output.

The output from the summation amplifier is routed through trend line number 6 to output terminal number 6 on the Voltage Trend Output Assembly. Trend lines 1 through 5, and the corresponding terminals on the Output Assembly, are then used for individual trend outputs from the long-term memory amplifiers associated with components 1 through 5. If *more than five components* are to be summed, one or more Beckman Part 636966 Dual Component/Memory Boards must be used to provide the additional memory inputs to the summation amplifier.

Component Number	Input To Summation Amplifier
6	Trend 7
7	Trend 8
8	Trend 9
9	Trend 10

5.6.7 CURRENT OUTPUT PROVISIONS

Signal flow for typical programmers providing current output is shown in Figures 5-17, 5-18, and 5-20.

For current output, the programmer must be equipped with a 632190 Current-Output Assembly and one or more Dual V/I Current-Output Boards.

632190 Current-Output Assembly

This assembly mounts at the rear of the programmer, and has receptacles for plug-in of three Dual V/I Current-Output Boards, to accommodate a maximum of six components. Note that each component board which is to provide current output must incorporate a memory amplifier to drive the associated V/I converter. Exceptions: A jumper on current output will provide a peak picker/current converter.

632187 Dual V/I Current-Output Board

The 632187 Dual V/I Current-Output Board contains two identical voltage-to-current converters. Each converter accepts an input signal of +5 volts d.c. fullscale, and provides an output of 4 to 20 mA referenced to programmer ground. Maximum permissible load is 750 ohms.

5.6.8 PNEUMATIC TREND OUTPUT PROVISIONS

A functional diagram of a typical system providing pneumatic trend output is shown in Figure 5-19.

For pneumatic trend output, the programmer must be equipped with a 635019 Pneumatic Trend Output Assembly, an 876904 I/P Transducer, and a 635030, 635410, or 635400 Pneumatic Memory Assembly. In addition, each component that is to provide a pneumatic trend output requires a component board with memory option, equipped with a 634112 Pneumatic Trend Contact Board. Instrument design accommodates a maximum of six pneumatic trend outputs.

Signal Flow (Figure 5-19)

Each component that is to provide pneumatic trend output is routed through the 634109 Peak Picker Board to a Voltage-to-Current Board inserted in the 635109 Pneumatic Trend Output Assembly. The resultant current signal is fed to the 876904 I/P Transducer, producing an air-output signal that enters the inlet of the Pneumatic Memory Assembly, and thus into the input manifold of a bank of solenoid valves, all normally-closed.

Memory Transfer Function (Figure 5-19)

While the peak picker is holding the peak value for a particular component, the Pneumatic Trend Contact Board plugged into the corresponding component board generates a transfer command. This command is routed, via the selected jumper connection on the Pneumatic Trend Contact Board, and the corresponding trend line on the Pneumatic Trend Output Board, to the appropriate solenoid driver in the Pneumatic Memory Assembly. The associated solenoid valve now opens, thus applying the air signal to the appropriate channel on the pneumatic recorder.

Brief descriptions of individual circuit boards and other assemblies are given below.

630519 Pneumatic Trend Output Board (Figure 5-19)

This board contains the following:

1. Voltage-to-current transducer that converts the 0 to 5 volts d.c. signal from the peak picker into a 4 to 20

milliampere current loop, to drive the 876904 I/P Transducer.

2. Trend lines 1 through 6. Each line in use provides continuity from a given Pneumatic Trend Contact Board to the associated solenoid driver on the Pneumatic Memory Assembly.

876904 I/P Transducer
The 876904 Current-to-Pressure Transducer receives a 4- to 20-milliampere input signal and converts it into a pneumatic output of 3 to 15 psi (20.6 to 103 kPa).

635030, 635410, and 635400 Pneumatic Memory Assemblies
The Pneumatic Memory Assembly must contain one solenoid valve and associated solenoid driver circuit for each component that is to provide a pneumatic trend output. The assembly is available in three versions, differing only in the number of valves provided.

Number of Solenoid Valves	Part Number of Pneumatic Memory Assembly	Part Number of Solenoid Driver Board in Pneumatic Assembly Memory
1	635030	635040
3	635410	635411
6	635400	635412

634112 Pneumatic Trend Contact Board
This board plugs into the memory slot of a 640411 Universal Component Board or other board with memory option.

5.6.9 COMPUTER INTERFACE PROVISIONS
Signal flow for a typical programmer providing computer interface is shown in Figure 5-20.

To provide computer interface, the programmer must be equipped with a 632178 Computer Driver Board and a 636945 Computer Terminal Assembly.

632178 Computer Driver Board
This board provides the START OF ANALYSIS, COME READ, and ANALYSIS RESET functions, and the Stream Computer Relay Command. The latter transfers the binary-coded number of the stream being analyzed to the Computer Terminal Board for decoding. Note that the information provided indicates the stream being analyzed, **not** the stream being purged.

636945 Computer/Alarm Terminal Assembly
This rear-panel assembly accepts a maximum of 17 plug-in relays to provide all contacts required for computer interfacing. Also available on the board are the output from the peak picker and provision for an external alarm reset.

Relays are available in two types:

1. 867383 Relay, with *mercury-wetted* contacts, generally used where contact bounce cannot be tolerated. This can be used only on Come Read, Start of Analysis, or End of Analysis. Absolute contact ratings; 1 ampere resistive, maximum; 100 volts, maximum.

2. Relay with *dry reed* contacts, generally used for status check, not for interrupt status. Absolute contact ratings: 250 ma, resistive load; 28 volts d.c., resistive load; 3 volt-amperes power limitation on combination voltage and current. Two versions of reed relay are available.

Contact Form	Relay Part Number
1 Form A	636054
1 Form B	636055

5.6.10 ALARM PROVISIONS
If a given component is to be provided with high or low alarm, or both, the signal from this component must be routed through a system containing the following:

1. A 640411 Universal Component Board. This board has provisions for one high and one low alarm function for the assigned component. The desired function is selected by jumper connection on the board.
2. A 632175 High/Low Alarm Board, plugged into the Master Circuit Board. The alarm board contains two independently adjustable comparator circuits, one each for the high and low alarm functions. The high and low alarm circuits may be assigned to the same component, or to different components.

   With the *low alarm* function assigned to a component, an alarm condition will occur immediately after the programmed COMPONENT OFF time, provided that the peak signal for this component has *failed* to reach the selected setpoint.

   After occurrence of an alarm condition in either the high alarm or low alarm circuit, the circuit *remains* in alarm state until reset, either manually by a switch on the alarm board, or automatically through contacts on the Computer Terminal Board.
3. Plug-in relay(s), inserted into the 636945 Computer/Alarm Terminal Assembly. The plug-in relays drive customer-supplied power relays, used to actuate alarm indicator and/or control devices. Relay contacts have a maximum rating of 100 milliamperes at 28 volts d.c., resistive. Manual alarm reset, if desired, is obtainable via the ALARM RESET line in J100 of the 636945 Computer/Alarm Terminal Assembly.

5.6.11 FIVE-POINT STREAM SELECTOR, CONSISTING OF 632084 STREAM SELECT CONTROL BOARD AND 632078 STREAM DISPLAY ASSEMBLY

The Model 6710 system may incorporate either a five-point or ten-point stream selector.

The Ten-Point Stream Selector, covered in Beckman Instructions 015-082458, is an externally-mounted unit, designed for remote use in conjunction with the Programmer and Sample Conditioner modules.

The Five-Point Stream Selector consists of an internal plug-in circuit board and a front-panel assembly, interconnected by a flexible cable. The two units are used in combination to provide the following functions:

1. Commands to the Sample Conditioner Unit to activate one of five sample streams.
2. Identification, on the recorder chart, of the stream being analyzed.
3. Activation/deactivation for any combination of the five streams.
4. Stream memory for functions that are stream-related.
5. Front-panel AUTO/HOLD/MANUAL STEP Switch, *permitting automatic or manual selection of streams*, or retention of a stream for repetitive analyses.
6. Front-panel digital display of the stream being analyzed, when AUTO/HOLD/MANUAL STEP Switch is in AUTO position.

Operation

The Stream Select Control Board has five on-off toggle switches. These are used to place the desired streams on ACTIVE status, for inclusion in the automatic or manual sampling sequence. Closure of a given switch places the associated stream on ACTIVE status, and causes illumination of the corresponding numeral in the area marked ACTIVE on the front-panel STREAM Indicator.

For automatic operation, the front-panel AUTO/HOLD/MANUAL STEP Switch is placed in AUTO position. The number then on display beneath the STREAM legend will *remain* on until after completion of the analysis then in progress. Which stream will next be analyzed depends on whether the switch was moved to AUTO before or after occurrence of the STREAM TRIGGER command. This command originates on one of the programmed valve control boards.

Manual Stepping Sequence

When the front-panel AUTO/HOLD/MANUAL STEP Switch is placed in MANUAL STEP position, the selector will advance sequentially through all stream numbers, including those of streams *not* on ACTIVE status. During this sequence, the solenoid valves for all streams are deenergized.

When the switch is moved to HOLD, the sequence stops at the stream whose number is then on display, and remains there until the switch is moved to another position. If the stream thus selected is on ACTIVE status, it will purge while the switch remains in HOLD position. If the selected stream is inactive, it will not purge although its number will be displayed.

A typical chromatographic system includes a sample conditioner, analyzer, programmer, and recorder or other data-acquisition device. Trouble developing anywhere in the system must be traced to the faulty unit before it can be corrected. This process, described in Sections Seven and Eight, is greatly simplified if the Process Gas Chromatograph system is serviced as a whole, and an accurate record is kept of its operation. The following procedures are recommended:

1. Keep a routine check list. Entries should be made three times a week for the first few weeks of operation. After that, twice a week may be sufficient. In case of malfunction, instrument control settings may be checked against listed values to reveal any obvious deviations. Over a longer period of time, the list will indicate aging of some components and will eventually suggest preventative maintenance measures in addition to those listed. The list also will serve as a valuable record of total downtime for each unit.
2. At least once a week, run a chromatographic analysis of the calibration standard and compare peak heights and elution times with those in the original chromatograph runs. If peak heights and elution times are changed sufficiently to affect accuracy, check temperature, flow rates, etc., then recalibrate the instrument with a calibration standard.

6.1 SAMPLE CONDITIONER MAINTENANCE

Maintenance of the sample conditioner is covered in Beckman Instructions 015-082293.

6.2 RECORDER MAINTENANCE

Maintenance of the recorder or other data-acquisition device is covered in the instructions supplied by its manufacturer.

6.3 PROGRAMMER MAINTENANCE

The programmer requires little service or maintenance. The front-panel MONITOR SELECT Switch and Meter permit isolation of analog malfunctions to analyzer or programmer, readout of applied auto-zero signal, and checkout of power supply voltages. If a malfunction within the **programmer** is indicated, the front-panel indicators may be observed to monitor all automatic functions as they occur.

For programmer checkout, refer to Section Eight.

6.4 ANALYZER MAINTENANCE

Analyzer maintenance consists principally of replacing minor parts that have deteriorated through extensive use. The necessity for such servicing is evidenced by abnormal functioning of the instrument.

NOTE

In ordering replacement parts, give serial number of analyzer as well as Beckman Part Number of desired item.

The following paragraphs describe servicing of various components within the analyzer unit.

6.4.1 SLIDER VALVE(S) AND ASSOCIATED SOLENOID VALVE(S)

All configurations utilize from one to four pneumatically-actuated slider valves to perform sample-injection and column-switching functions.

Solenoid Valve(s)

Each slider valve in the oven is actuated by air from an associated solenoid valve mounted externally on the analyzer electronics junction box, Figure 1-2. Mounting arrangements for the solenoid valves are shown in Figure 6-1.

Slider Valve(s)

Slider valve(s) should be checked if analyzer performance indicates a leaky or sticking valve condition. Refer to Figure 6-2, Ten-Port (LG10) Teflon Slider Valve; or Figure 6-3, Six-Port (LG6) Metal Slider Valve.

1. Remove hex nut from ¼-20 cap screw. Hex nut is item 22 in Figure 6-2, and item 25 in Figure 6-3. Fixed and floating blocks, slider, slider carriage, and associated parts may now be removed. If these are the only parts involved in the leakage, proceed directly to Step 3.

   If the slider valve fails to actuate, even though its pneumatic actuator receives appropriately pressurized air from the associated solenoid valve, first perform Step 2, following.
2. Remove six screws from pneumatic actuator. Remove piston, diaphragm, and two backup plates. Check diaphragm and O-rings; replace if cracked or otherwise damaged.
3. Thoroughly clean all metal parts **except the slider** with appropriate **hydrocarbon-free** solvent or cleaning fluid. Do **not** clean slider.
4. Carefully check surface finish of fixed block and floating block; surfaces must be finished to a smoothness of 4 microns (number 4 finish) for best performance. Also check slider. If surfaces are damaged, pitted or scored, replace with new slider. For Beckman Part Number, refer to Figure 6-2 or 6-3. DO NOT ATTEMPT TO SAND THE SEALING SURFACES OF THE SLIDER.

CAUTION

All parts must be absolutely clean before assembling valve. Traces of dirt, grit, or foreign material cause leakage and excessive wear on the sliding surfaces, and result in early malfunction.

5. If pneumatic actuator was disassembled in Step 2, reassemble as follows:
   a. Apply thin coating of silicone grease to O-rings; install O-rings in piston.

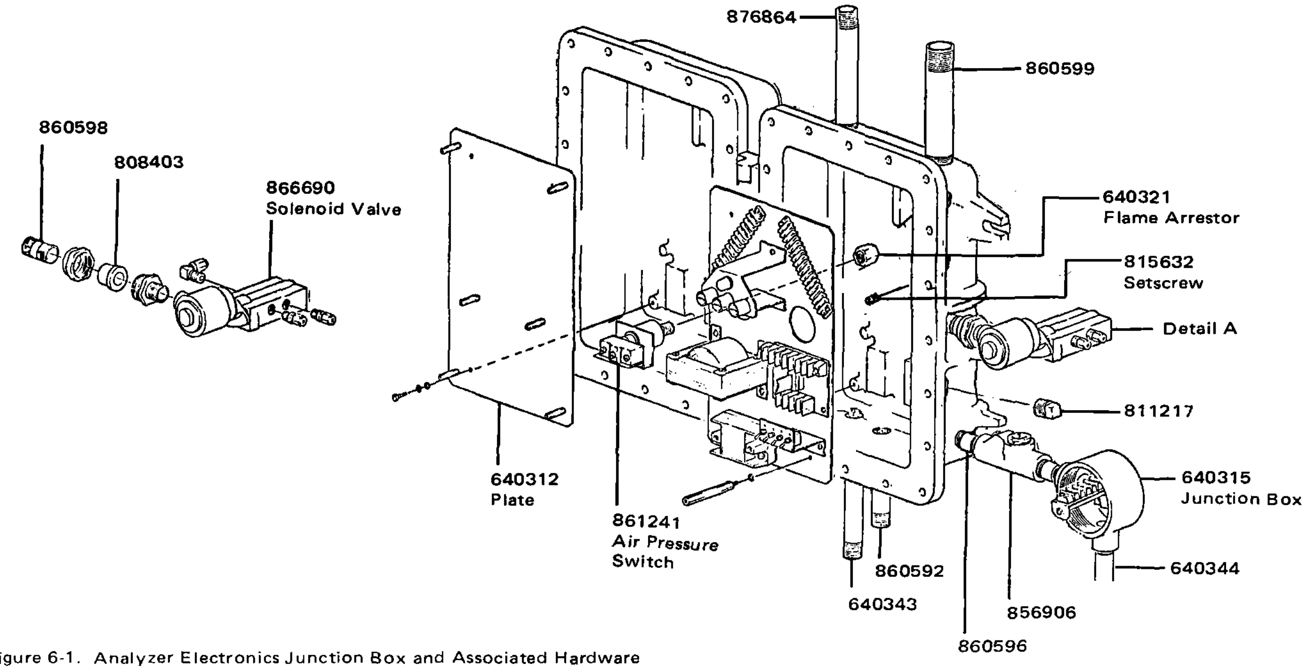


Figure 6-1. Analyzer Electronics Junction Box and Associated Hardware

b. Apply slight amount of silicone grease around edges of diaphragm and two backup plates, to prevent air leakage around diaphragm. Assemble piston, diaphragm and backup plates; tighten attaching screws.
c. Insert piston assembly in cover.
d. Set cover in place. Tighten the six screws evenly until all are secure.

6. Replace fixed block.
7. Replace slider carriage. Insert slider in slider carriage, making sure orientation is correct.
8. Replace floating block.
9. Replace valve disassembly screw and nut, spring, and sleeve. Actuate slider valve several times, then perform checkout and leak test used during startup procedure of Paragraph 3.1.1, thermal-conductivity detector; or 3.1.2, flame-ionization detector. If leakage is noted, **slightly tighten** valve disassembly nut and repeat leak test. If leakage is still apparent, remove slider and check sealing surfaces.

6.4.2 CHROMATOGRAPHIC COLUMN(S)

Factory-Installed Columns

Each **application-engineered** analyzer is shipped with preconditioned column(s) factory-installed in oven, and with vents capped to prevent entry of moisture. If baseline drift occurs on initial startup, probable cause is diffusion of moisture through plastic caps during shipment, necessitating purging with carrier gas until baseline stabilizes.

Replacement Column(s)

Recommended procedure is to precondition replacement columns upon arrival, cap with Swagelok fittings, and store, ready-for-use.

Preconditioning Methods

For convenience, columns may be preconditioned and/or decontaminated in the laboratory. If facilities are not available, column(s) can be purged and preconditioned installed in the analyzer. With **multi-column** systems, however, care is required not to purge contaminants from one column into a subsequent column. Thus, purge first column while bypassing second column; then purge second column with gases routed directly to the detector. When baseline stabilizes, columns are ready for operation.

CAUTION

During initial startup, or startup following installation of replacement column(s), purge analyzer for at least five minutes WITH POWER OFF.

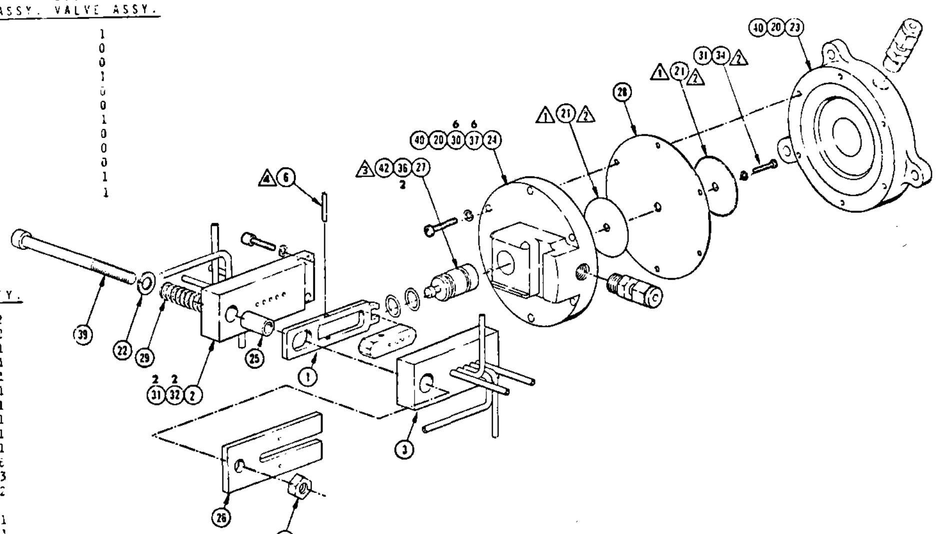
Column Contamination During System Operation

During operation, column contamination may result from such causes as: presence of high-boiling hydrocarbons in sample, introduction of non-volatile material into column(s), and chemical reaction (e.g., reaction between silver nitrate columns and hydrogen carrier gas). None of these is

ITEM NO.	BECKMAN PART NO.	DESCRIPTION	QTY. FOR 633560 VALVE ASSY.	QTY. FOR 635480 VALVE ASSY.
1	[illegible]	CARRIAGE	1	1
	[illegible]	CARRIAGE	0	0
2	632037	BLOCK, FIXED-WELDED	1	0
	[illegible]	BLOCK, [illegible]-WELDED	[illegible]	1
	[illegible]13521	BLOCK, FIXED-WELDED	[illegible]	0
3	632038	BLOCK, FLOATING-WELDED	1	0
	[illegible]	BLOCK, FLOATING-WELDED	0	1
	635520	BLOCK, FLOATING-WELDED	0	0
4	635471	RETAINER	0	0
5	635472	PAD	0	1
	636665	COMMON PARTS GROUP	1	1
6	861158	PIN, MINIATURE	1	1

636665 COMMON PARTS GROUP

ITEM NO.	BECKMAN PART NO.	DESCRIPTION	QTY.
20	29977	CONNECTOR, MALE 1/8 T X 1/8 T	2
21	77076	PLATE, BACK UP	2
22	79185	WASHER, FLAT	1
23	632025	BASE, MACHINED	1
24	632027	COVER, MACHINED	1
25	[illegible]	[illegible]	1
26	[illegible]	[illegible] ASSY	1
27	[illegible]	PISTON	1
28	[illegible]	DIAPHRAGM	1
29	[illegible]	SPRING	1
30	[illegible]	WASHER, SPLIT NO. 6	6
31	[illegible]	WASHER, SPLIT NO. 6	3
32	603993	SCREW CAP, 8-32X1/2	2
33			
34	809969	SCREW, MACH, 6-32X3/8	1
35	812651	NUT, FULL, 1/4-20	1
36	835051	O RING	2
37	835031	SCREW, PAN HD 6-32X7/8	6
38			
39	838965	SCREW, CAP 1/4-20 x 4	1
40	45-045-11	TAPE, TEFLON	A.R
41	55-025-52	SILICON RUBBER RTV	A.R
42	65-043-02	LUBRICANT	A.R



4 861158 PIN IS NOT INSTALLED ON 636669 VALVE ASSY.

3 APPLY ITEM 65-043-02 TO O-RING

2 APPLY ITEM 41 BEFORE ASSY.

1 ASSEMBLE WITH CHAMFER TOWARDS DIAPHRAGM

633560
635480 SLIDER VALVE ASSEMBLY
636669

TEFLON SLIDERS

BECKMAN PART NO.	HOLE A INCH (mm)	HOLE B INCH (mm)	SLOT C INCH (mm)	HOLE D INCH (mm)	HOLE E INCH (mm)	SLOT F INCH (mm)	HOLE G INCH (mm)	HOLE H INCH (mm)	VOLUME $\mu\ell$	CONFIGURATION	BLANK	QUANTITY
632050											632029	1
632051	0.062 (1.58)	0.016 (0.41)							1.07		632029	1
632052	0.062 (1.58)	0.0225 (0.57)							2.12		632029	1
632053	0.062 (1.58)	0.035 (0.89)							5.14		632029	1
632054	0.062 (1.58)	0.052 (1.32)							11.3		632029	1
632055	0.062 (1.58)	0.070 (1.78)							20.6		632029	1
632056	0.062 (1.58)	0.098 (2.49)							40.2		632029	1
632057	0.062 (1.58)		0.062 (1.58)		0.016 (0.41)				1.07		632029	1
632058	0.062 (1.58)		0.062 (1.58)		0.0225 (0.57)				2.12		632029	1
632059	0.062 (1.58)		0.062 (1.58)		0.035 (0.89)				5.14		632029	1
632060	0.062 (1.58)		0.062 (1.58)		0.052 (1.32)				11.3		632029	1
632061	0.062 (1.58)		0.062 (1.58)		0.070 (1.78)				20.6		632029	1
632062	0.062 (1.58)		0.062 (1.58)		0.098 (2.49)				40.2		632029	1
632063	0.062 (1.58)		0.062 (1.58			0.062 (1.58)		0.062 (1.58)			632029	1

ITEM NO.	BECKMAN PART NO.	DESCRIPTION	QUANTITY FOR 635560 VALVE ASSEMBLY 1/8 INCH (3.18 mm) SAMPLE INLET	QUANTITY FOR 635480 VALVE ASSEMBLY 1/16 INCH (1.59 mm) SAMPLE INLET
9	632037	Fixed Block, Welded	1	0
9	635484	Fixed Block, Welded	0	1
10	632038	Floating Block, Welded	1	0
10	635486	Floating Block, Welded	0	1

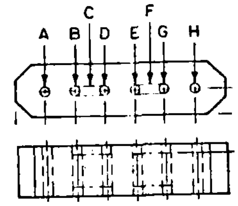


Figure 6-2. Exploded View of 633560 and 635480 Ten-Port (LG10) Teflon Slider Valve Assemblies

likely in an application-engineered system, where sample conditioner and analyzer column-and-valving configuration are factory-assembled to avoid such occurrences. However, other possible causes of contamination are: "bleed" from partition columns, entry of moisture into system, or a malfunction in the system upstream from the column(s).

Typically, column contamination is evidenced by drift, noise, and/or high background. The contaminated column(s) may be regenerated by flushing with carrier gas at oven temperature. Columns in general, and partition columns in particular, are seldom permanently damaged by contamination. Unless damaged by chemical reaction, most columns can be completely purged of moisture or other contaminants in less than 24 hours of continuous flushing with 50 to 100 cc/min of dry carrier gas, at normal operating temperature. Generally, therefore, reconditioning of contaminated column(s) is preferable to replacement. A possible exception involves molecular sieve columns. When

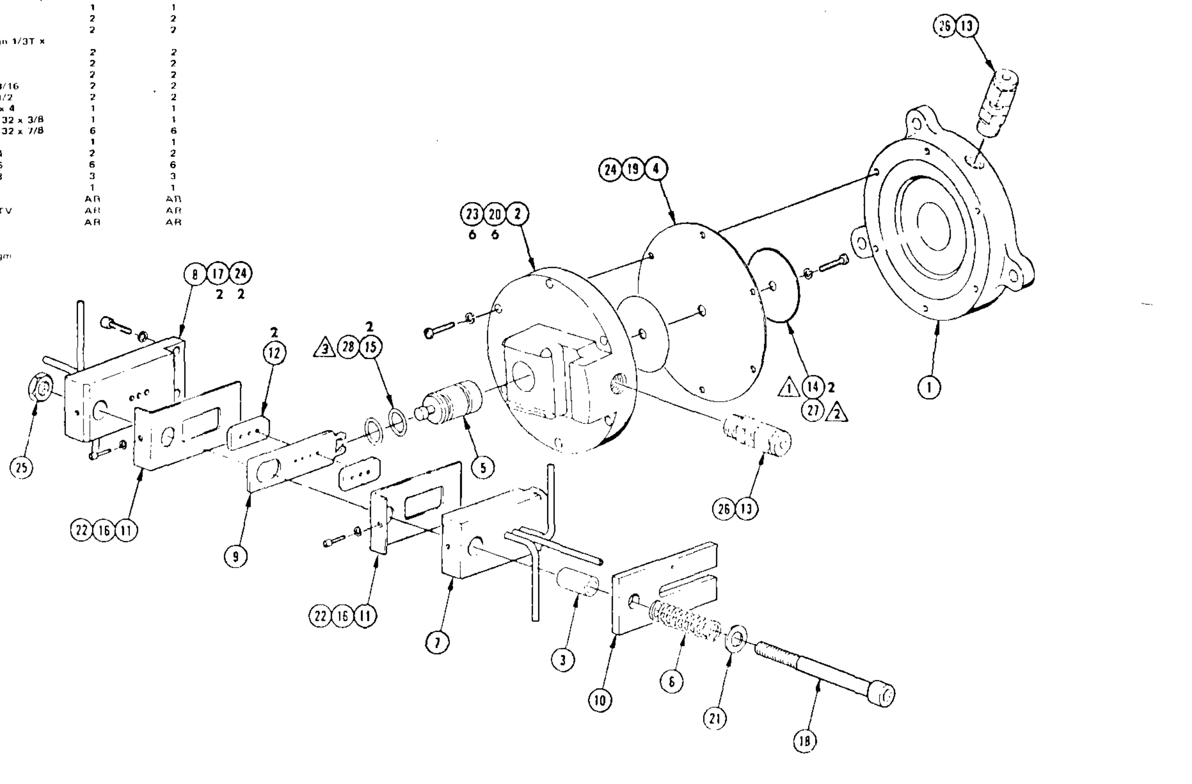
ITEM NO.	BECKMAN PART NO.	DESCRIPTION	640350 QTY	641210 HASTELLOY "C" QTY
1	632025	Base, Machined	1	1
2	632027	Cover, Machined	1	1
3	632028	Sleeve	1	1
4	632047	Diaphragm	1	1
5	632039	Piston	1	1
6	633544	Spring	1	1
7	640351	Floating Block, Welded	1	0
	641060	Floating Block, Welded	0	1
8	640354	Fixed, Block, Welded	1	0
	641053	Fixed, Block, Welded	0	1
9		Carriage, Stainless Steel 316	1	0
		Carriage, Hastalloy "C" 0.5 $\mu\ell$	0	1
10	640359	Plate, Pressure	1	1
11	640360	Retainer	2	2
12	640361	Pad	2	2
13	29977	Fitting, Combination 1/3T x 1/8 NPT	2	2
14	77676	Plate, Backup	2	2
15	835051	O Ring	2	2
16	803934	Screw, Cap 4 40 x 3/16	2	2
17	803993	Screw, Cap 8 32 x 1/2	2	2
18	838985	Screw, Cap 1/4 20 x 4	1	1
19	809969	Screw, Pan Head, 8 32 x 3/8	1	1
20	835631	Screw, Pan Head, 6 32 x 7/8	6	6
21	79185	Washer, Flat 1/4	1	1
22	802161	Washer, Lock, No. 4	2	2
23	802165	Washer, Lock, No. 6	6	6
24	802173	Washer, Lock, No. 8	3	3
25	812651	Nut, Hex, 1/4 20	1	1
26	45 045 11	Tape, Teflon	AR	AR
27	53 025 52	Silicone Rubber, RTV	AR	AR
28	65 043 02	Lubricant	AR	AR

NOTES

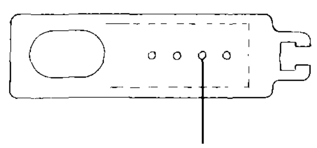
1 Assemble with chamfer towards diaphragm

2 Apply Item 27 before assembly

3 Apply Item 28 to O ring



SLIDER PART NO.	VOLUME	HOLE "A" (Inches/mm)
641291	.5 $\mu\ell$	0.016 (0.41)
641292	1 $\mu\ell$	0.0255 (0.57)
641293	2 $\mu\ell$	0.032 (0.81)
641294	5 $\mu\ell$	0.052 (1.32)



HOLE "A"

Figure 6-3. Exploded View of 640350 and 641210 Six-Port (LG6) Metal Slider Valve Assemblies contaminated by moisture, these may be reconditioned only with difficulty; i.e., by flushing for three hours with dry helium, at 375°C. Note that installation of replacement column(s) will necessitate readjustment of associated restrictor valve(s).

If contamination is suspected, remove analyzer from operation and flush column(s) for a considerable time. With **multi-column** system, be sure not to flush one column into another column. If contamination is due to a malfunction within the system, locate and eliminate the cause; then continue purging until recorder baseline stabilizes. After returning column(s) to operation, check all gating times.

Life Expectancy of Columns

Adsorption columns should last indefinitely in normal operation. Useful life of partition columns ranges from six months to several years, depending on operating condition. Deterioration of the column, through loss of partition liquid, is evidenced by gradual loss of resolution. When resolution is unacceptable, replace column.

6.4.3 THERMAL-CONDUCTIVITY DETECTOR

Depending on the bridge current level, the filaments of the thermal-conductivity detector may become mismatched. Normal progression of symptoms is: baseline drift, requirement for far-off-center settings on zero controls and adjustments and, eventually, complete inability to obtain zero reading on recorder by adjustment of appropriate zero controls. Filaments must then be replaced as a matched set. If filament mismatch is suspected, check per Step 1 of Paragraph 6.4.6.

To replace filaments, refer to Figure 6-4, then proceed as follows:

1. Remove power from analyzer.
2. Turn of all gases.
3. On detector block, unscrew the four tube fittings from the attached sample and reference lines.
4. Unscrew union nut adjacent to detector block and remove detector block from analyzer.
5. Remove filament retainer. Withdraw filaments from detector block. Discard old filaments and O-rings.

MODEL 6710/6700
T.C. DETECTOR ASSEMBLY

Item	P.N.	Description	
1	49702	Washer	
2	49721	Connector	
3	79311	"O" Ring	
4	96395	Union Assembly	
5	634407	Retainer Filament	
6	634408	Pressure Plate	
7	634409	Block Detector	
8	634473	Filaments Hytemco	Refer to Applications Data Sheet for filament type.
	634474	Filaments Tungsten	
9	638180	Insulation Jacket	
15	836208	Screw	
16	829840	Needle Valve	
17	810056	Fitting	
18	125173	Fitting Adaptor	

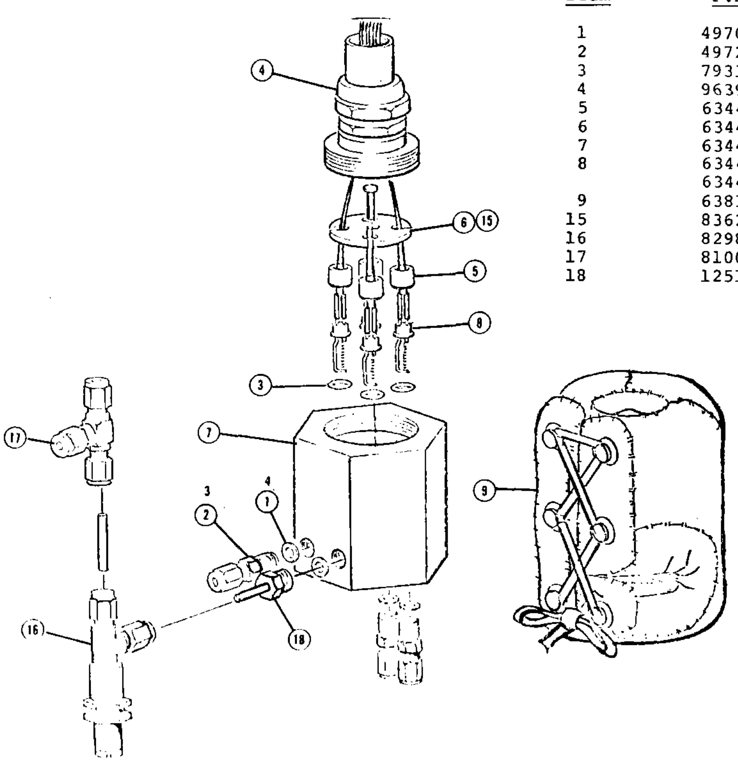


Figure 6-4. Exploded View of Typical Thermal-Conductivity Detector

6. Thoroughly clean detector block. No dirt must enter filament chambers.
7. Install new filaments and O-rings. Filaments are numbered and must be installed in corresponding numbered cavities in detector block.
8. Mount detector in analyzer and reconnect cable leads.

6.4.4 FLAME-IONIZATION DETECTOR

In preventive maintenance of the FID, the most important precautions are: (1) provision for continuous removal of all combustion products, including water vapor, and (2) the use of great care to prevent the contamination of any component with hydrocarbons, even in trace amounts.

Disassembly and Cleaning of the FID

Ordinarily, the FID should be disassembled only if contaminants must be removed.

Combustion products or other contaminants allowed to accumulate inside the FID form electrical leakage paths between collector and burner contact, resulting in noisy readings. If instrument is to be operated at highest sensitivity, mere traces of such contaminants can cause erroneous readings. For best performance, it is absolutely necessary that the FID be kept perfectly free of any kind of contamination.

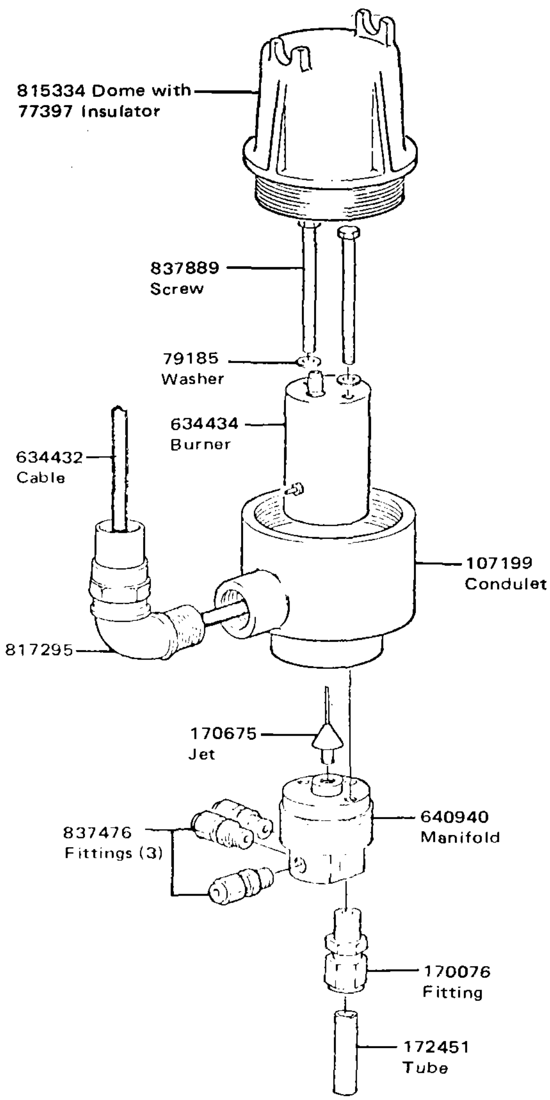
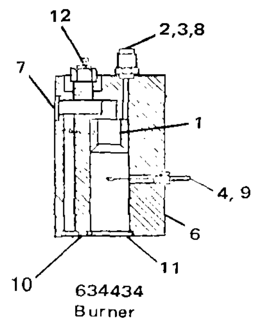


Figure 6-5. Exploded View of Flame-Ionization Detector

MODEL 6710/6700
FID Burner Assembly
P.N.



12	871880	GLOW PLUG
11	837887	'O' RING
10	837886	'O' RING
9	837885	'O' RING
8	837884	'O' RING
7	636361	PLUG
6	170636	BURNER BODY
5		
4	170641	ELECTRODE, POLARIZING
3	170640	RETAINER, COLLECTOR CONNECTOR
2	170639	MODIFICATION, CABLE INPUT
1	170638	COLLECTOR
ITEM	PART NO	DESCRIPTION

NOTES.

1. GLOW PLUG ON BURNER ASSY TO LINE UP WITH EXHAUST HOLE ON MANIFOLD BLOCK.
2. CLEAN 9 WITH METHANOL.
3. FISH PAPER 1 TO COVER INSIDE OF 10 TO PREVENT PLUG FROM SHORTING APPROX. 3.0 WIDE X 7.5 LONG.

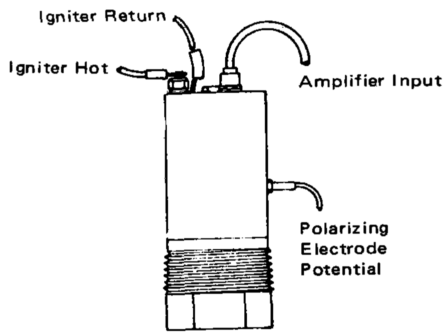


Figure 6-6. Connection of Electrical Leads to Flame-Ionization Detector

When FID requires cleaning, refer to Figure 6-5, and proceed as follows:

CAUTION

Never touch burner tip, Teflon skirt, or burner body with bare hands; always use clean gloves or cloth. If this precaution is not observed, oil from skin will contaminate these items.

1. Remove power from analyzer.
2. Turn off all gases.
3. On FID Electronics Board, Figure 3-3, disconnect high-impedance amplifier-input cable from AR1. Observe precaution tag on cable to prevent damage to field-effect transistor on amplifier circuit board.
4. Unscrew and remove explosion-proof cover from FID, Figure 6-5.
5. Disconnect high-impedance amplifier-input lead from burner body. See Figure 6-6.
6. Remove two hex-head bolts.
7. Lift burner body from manifold.
8. Remove ignitor glow plug from burner body.
9. Unscrew and remove burner tip assembly.

CAUTION

If old burner tip assembly is to be used again, do not touch it with bare hands or any materials likely to contaminate it with hydrocarbons, salt, etc.

10. Clean burner body and burner tip assembly with acetone or methyl ethyl ketone, followed by a distilled water wash.

NOTE

All items used for cleaning (tweezers, swabs, etc.) must be absolutely free of contamination.

Using care not to touch internal parts, reassemble burner in reverse order of disassembly.

NOTE

In replacing burner body, orient it so that ignitor glow plug is above exhaust gas outlet port. This orientation aligns internal passages of burner body with corresponding passages of manifold. See Figure 5-14.

Replacement of Ignitor Glow Plug

To replace a burned-out glow plug, unscrew it from burner body, Figure *5-14*. Discard old glow plug and replace with new one.

6.4.5 CHECKOUT OF OVEN HEATING SYSTEM

Depending on detector type, the oven temperature control section is located on either the TC Detector Electronics Board, Figure 3-2, or the FID Electronics Board, Figure 3-3.

1. Turn TEMP Setpoint Adjustment fully clockwise. The HEATER ON Indicator Lamp, Figure 3-1, should illuminate, provided that HEATER AIR Pressure regulator is set above the pressure setpoint of the safety pressure switch. Pressure setting differs somewhat from one switch to another, but will be in the range of 16 to 20 psig (110 to 138 kPa). Reduce regulator setting below 16 psig (110 kPa); HEATER ON Lamp should go out. If response is as described, air pressure safety switch is functioning properly. Reset regulator to normal operating pressure.
2. After about ten minutes of warmup, turn TEMP Setpoint Adjustment counterclockwise; HEATER ON Lamp should go out. Now **slowly** rotate TEMP Setpoint Adjustment clockwise until lamp begins to pulse, indicating that temperature controller is in control. Set TEMP Setpoint Adjustment for oven temperature specified in Applications Data Sheet. Refer to graph of Figure 3-15.

NOTE

Oven heater incorporates an over-temperature limiter consisting of a solder plug in the oven. When overheated, the plug melts, causing loss of air pressure, deactuation of safety pressure switch, and removal of power from heater element. Plug material is selected for melting point appropriate to the particular application.

Replacement of Oven Heater

The oven heater is removable by unscrewing it from the associated fitting. See Figure 1-2.

6.4.6 ZEROING PROCEDURE FOR ANALYZER SIGNAL CIRCUITRY ASSOCIATED WITH TC DETECTOR

The following adjustments are made in the signal conditioning section of the TC Electronics Board Assembly,

Figure 3-2. With correct voltage applied to detector bridge, carrier flowing at correct rates through measuring and reference sides of detector, and oven temperature-stabilized, proceed as follows:

1. **Checkout of Filament Matching.** If it is suspected that filaments have become mismatched, check as follows:
   a. Connect a voltmeter from one of the two FIL terminals to either terminal marked INPUT. Note polarity of offset.
   b. Connect the voltmeter from the other FIL terminal to the INPUT terminal. Polarity should be the reverse of that noted in "a," above; if not, filaments are damaged and must be replaced. Refer to Paragraph 6.4.3.
2. On Switch SW1, close contact 2 to activate X1 range.
3. **TC Amplifier Zero Adjustment R29 and Polarity Reverse Zero Adjustment R15:**
   a. On Switch SW1, close contact 5 to short-circuit the input to TC amplifier AR1.
   b. Monitor TP1 with respect to TP3. Reading should be 0 volts d.c.; if not, adjust R29 as required.
   c. On Switch SW1, close contact 1 to activate the polarity reverse function.
   d. Monitor TP1 with respect to TP3. Reading should be 0 volts d.c.; if not, adjust R15 as required.
   e. Open contacts 1 and 5 on Switch SW1.
4. **ZERO Bridge Adjustment R38:**
   a. On Switch SW1, close contact 3 to activate AUTO ZERO command.
   b. Monitor AUTO ZERO output terminal with respect to TP3 (circuit ground).
   c. Set ZERO Bridge Adjustment R38 for voltmeter reading of approximately zero.
5. **Auto-Zero Amplifier Zero Adjustment R44:**
   a. Monitor TP1 with respect to TP3. Reading should be 0 volts d.c.; if not, adjust R44 as required.
   b. Open contact 3 on switch SW1.
6. **Current Output Zero Adjustment R42:**
   a. On Switch SW1, close contact 5 to short-circuit the input to TC amplifier AR1.
   b. Connect a milliammeter into the current output loop at the MA (+) and MA (–) terminals. Reading should be 4 mA; if not, adjust R42 as required.
   c. Open contact 5 on SW1.
7. **Current Output Span Adjustment R28:**
   a. Set ZERO Bridge Adjustment R38 for reading of +10 volts d.c., i.e., fullscale signal, at TP1 with respect to TP3.
   b. Milliammeter connected into current output loop should now read 20 mA; if not, adjust R28 as required.
8. Repeat Step 6 to ensure proper zero adjustment.
9. Reset ZERO Bridge Adjustment R38 for reading of 0 volts d.c. at TP1 with respect to TP3.
10. Open all contacts on switch SW1. System is now functional.

6.4.7 ZEROING PROCEDURE FOR ANALYZER SIGNAL CIRCUITRY ASSOCIATED WITH FID

1. At **programmer**, turn power on. Set MODE Switch at RESET. Place RANGE and AUTO ZERO Switches at AUTO.

   The following adjustments are made at the **analyzer**, in *the signal conditioning section of the FID* Electronics Board Assembly, Figure 3-3.
2. Disconnect high-impedance input cable from AR1.
3. Connect a voltmeter from TP2 (AR5 output) to TP4 (circuit ground). Voltmeter will *remain* thus connected throughout remainder of the procedure.
4. On switch SW1, close contact 5 to activate HIGH RANGE; close contact 3 to activate X1 RANGE. Voltmeter is now monitoring the output from range amplifier AR5 on the HIGH, X1 RANGE.
5. **Range Amplifier AR5 Zero Adjustment R27:** Connect jumper from TP3 to TP4 (circuit ground) to provide zero input to AR5. Voltmeter should read zero; if not, adjust R27 as required. Remove jumper from between TP3 and TP4.
6. **Flame Amplifier AR1 Zero Adjust R3:** Connect jumper from TP1 to TP4 to provide zero input to AR1. Voltmeter should read zero; if not, adjust R3 as required. Remove jumper from between TP1 and TP4.
7. **Auto Zero Amplifier AR6 Zero Adjust R35:** On switch SW1, open contact 5 to de-activate HIGH RANGE command; close contact 4 to activate AUTO ZERO command. Voltmeter should read zero; if not, adjust R35 as required. Open contact 4 on SW1.
8. **Current Output Zero Adjustment R7:** Connect a milliammeter into the current output loop at the MA (+) and MA (–) terminals. Reading should be 4 mA; if not adjust R7 as required.
9. **Current Output Span Adjustment R7:** Set Flame Amplifier Zero Adjustment R3 for reading of +10 volts d.c., i.e., fullscale signal, at TP2 with respect to TP4. Milliammeter connected into current output loop should now read 20 mA; if not, adjust R20 as required. Reset R3 for reading of 0 volts at TP2 with respect to TP4.
10. Repeat Step 8 to ensure proper zero adjustment.
11. Open all contacts on Switch SW1. System is now functional.

BECKMAN

Revision to Beckman Instructions 015-555331-A
ANALYZER AND PROGRAMMER UNITS FOR MODEL 6710 PROCESS GAS CHROMATOGRAPH SYSTEMS

In Figure 3-3, Page 16, the correspondence between the numbered switch contacts on SW1 and the various manually activated functions is incorrect. The correct relationship is as follows:

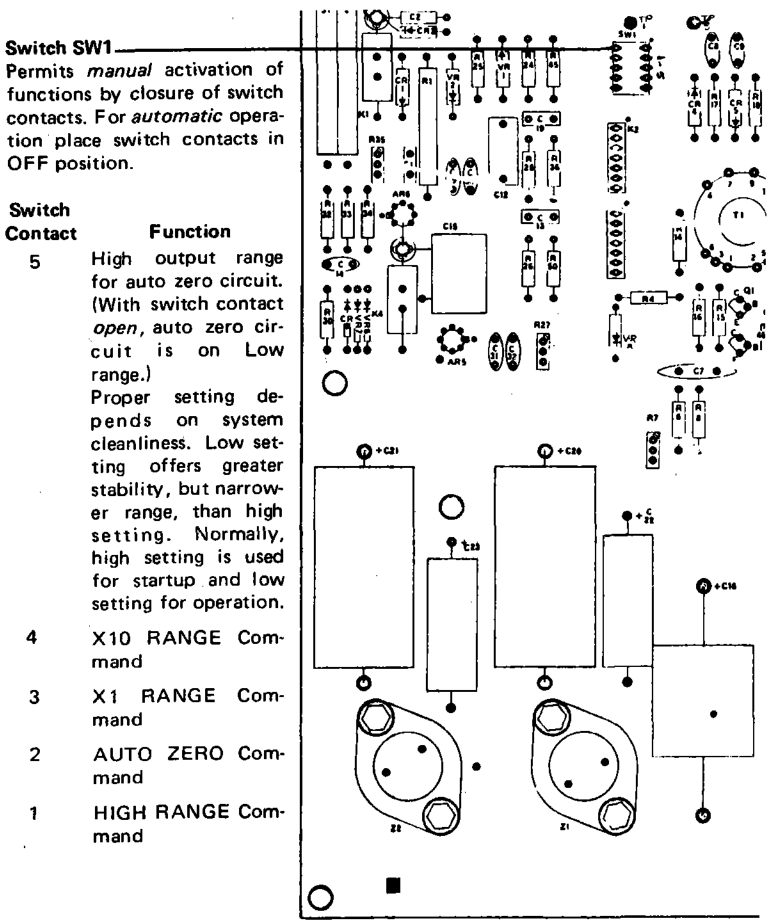


Figure 3-3. FID Electronics Board Assembly

On Page 64, substitute the following for Paragraph 6.4.7, Zeroing Procedure for Analyzer Signal Circuitry Associated with FID.

6.4.7 ZEROING PROCEDURE FOR ANALYZER SIGNAL CIRCUITRY ASSOCIATED WITH FID

1. At programmer, turn power on. Set MODE Switch at RESET. Place RANGE and AUTO ZERO Switches at AUTO.

   The following adjustments are made at the analyzer, in the signal conditioning section of the FID Electronics Board Assembly, Figure 3-3.
2. Disconnect high-impedance input cable from J1.
3. Connect a voltmeter from TP2 (AR5 output) to TP4 (circuit ground). Voltmeter will ***remain*** thus connected throughout remainder of the procedure.
4. On switch SW1, close contact 1 to activate HIGH RANGE; close contact 3 to activate X1 RANGE. Voltmeter is now monitoring the output from range amplifier AR5 on the HIGH, X1 RANGE.
5. **Range Amplifier AR5 Zero Adjustment R27**: Connect jumper from TP3 to TP4 (circuit ground) to provide zero input to AR5. Voltmeter should read zero; if not, adjust R27 as required. Remove jumper from between TP3 and TP4.
6. **Flame Amplifier AR1 Zero Adjust R3**: Connect jumper from TP1 to TP4 to provide zero input to AR1. Voltmeter should read zero; if not, adjust R3 as required. Remove jumper from between TP1 and TP4.
7. **Auto Zero Amplifier AR6 Zero Adjust R35**: On switch SW1, open contact 1 to de-activate HIGH RANGE command; close contact 2 to activate AUTO ZERO command. Voltmeter should read zero; if not, adjust R35 as required. Open contact 2 on SW1.
8. **Current Output Zero Adjustment R7**: Connect a voltmeter between TP5 (AR2 output) and TP4 (circuit ground). Adjust R7 for +2.00 VDC.
9. **Current Output Span Adjustment R20**: Set flame amplifier zero adjustment R3 for reading of +10 VDC, i.e., fullscale signal, at TP2 with respect to TP4.

NOTE

With 640330 FID Board Revision W or later, connect an external 15 megohm resistor between input connector J1 and TP4 (circuit ground) to permit adjustment of R3 for +10 VDC.

Connect DC milliammeter into current output loop and adjust R20 for 20.0 mADC. Remove the 15 megohm resistor, if used, and reset R3 for 0 VDC at TP2 with respect to TP4.

10. Reconnect DC milliammeter into current output loop. Current should be 4.0 mADC.

SECTION SEVEN ANALYZER CIRCUIT BOARDS: SCHEMATIC DIAGRAMS, CIRCUIT DESCRIPTIONS, TEST PROCEDURES, AND COMPONENT PARTS

A pictorial wiring diagram of the analyzer unit is given in Figure 7-1. It is followed by individual sheets covering the various circuit board assemblies, presented in numerical order according to assembly part number. On the front of each sheet are the schematic wiring diagram, circuit descriptions, and test procedures. On the reverse side of the sheet is an assembly drawing with part numbers of individual components.

ANALYZER CIRCUIT BOARDS

640324 TC Detector Electronics Circuit Board Assembly

640330 FID Electronics Board Assembly

640927 Valve Driver Board

For checkout and troubleshooting of the analyzer unit, a Magnehelix flowmeter (Beckman® Part 177932) is recommended. It provides accurate, convenient, flow measurement.

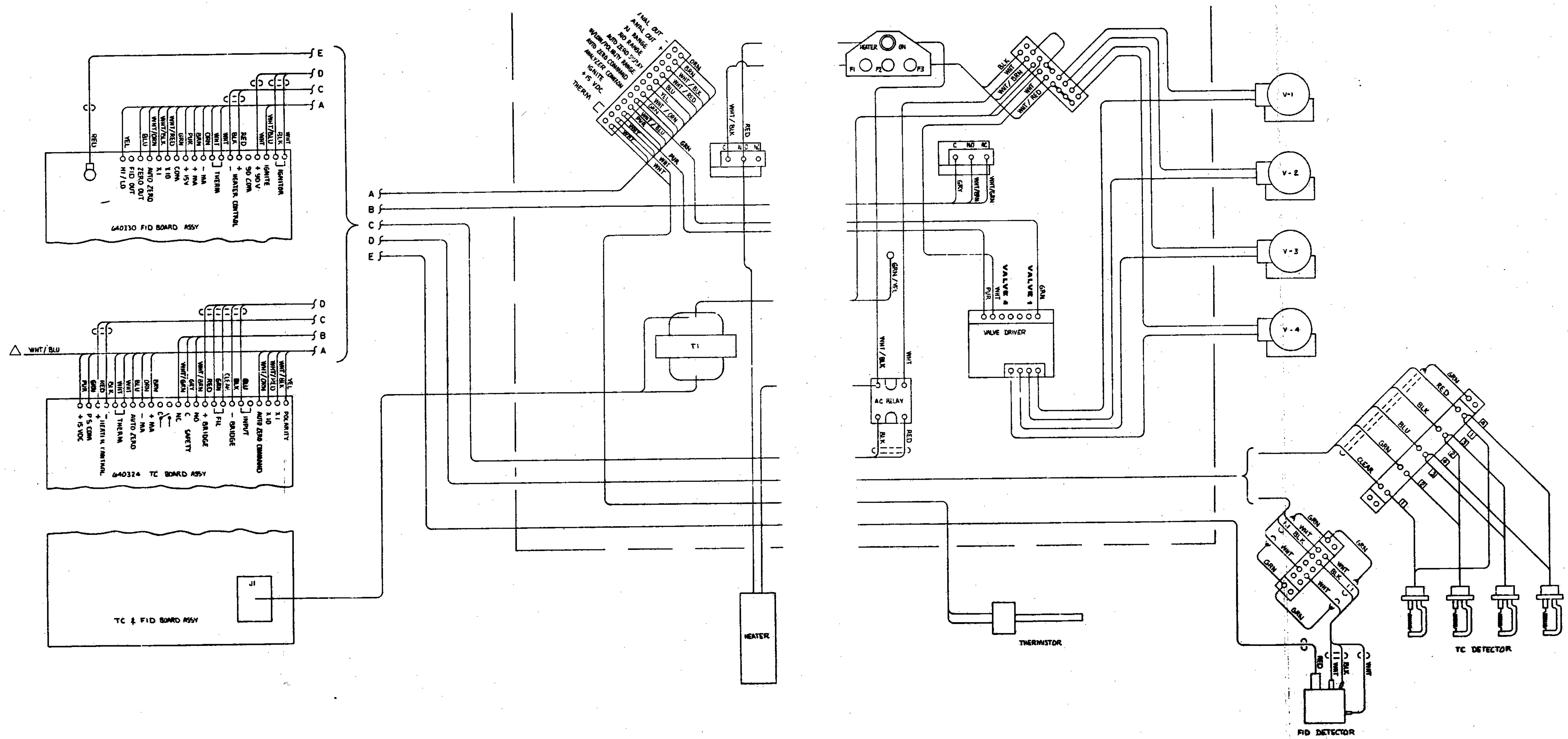
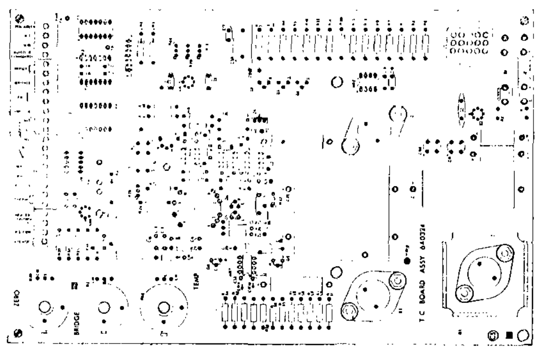


Figure 7-1. Analyzer Pictorial Wiring Diagram

640324 TC DETECTOR ELECTRONICS BOARD ASSEMBLY



The 640324 TC Detector Electronics Board Assembly contains the following:

1. **Bridge Voltage Power Supply Section.** This section provides a precisely regulated, adjustable voltage for application to the TC detector bridge. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR1, regulator Z3, and associated RC filter elements. Power transistor Q1 provides the current-drive capability required for the detector bridge. Potentiometer R3 adjusts the output voltage within a range of 3 to 11 volts d.c. if the 1-ampere fuse is placed in position marked "12," or 11 to 24 volts d.c. if this fuse is placed in position marked "24."

   If equipped with filament safety option, the detector bridge is connected to the bridge power supply through a pressure switch. Upon loss of carrier gas pressure, the switch removes power from the bridge to prevent filament damage; simultaneously, relay K1 provides contact closure to actuate an alarm, if ordered.
2. **TC Amplifier Section.** The detector-output signal is applied to amplifier AR1, a high-gain, low-drift d.c. amplifier with selectable gain of 10, 100, or 1000, obtained by appropriate switching of resistances in the feedback loop. Correspondence between programmer range setting and AR1 gain is as follows: Range 1, gain 1000; Range 10, gain 100; Range 100, gain X10. Range switching is accomplished by FET switching circuits. Switching circuitry is arranged so that if *neither* Range 1 nor Range 10 is commanded, Range 100 is in effect.

   The Range 1 command is applied via relay K2 and the Range 10 command via relay K3. With neither relay energized, Q2 and Q3 are off. Under these conditions, relay K4 is energized and Q4 is on; thus R11 and R12 are inserted into the feedback loop of AR1.

   Assume that the Range 1 command is received. Relay K2 closes, causing Q2 to conduct. Relay K4 is deenergized, turning off Q4. Thus the X1 range command turns off the X100 range command. The X10 range functions similarly in turning off the X100 range command.

   Each range may be activated manually via the appropriate switch. For Range 1, close SW1-2. For Range 10, close SW1-4. For Range 100, open both SW1-2 and SW1-4. For test purposes, the input of AR1 may be grounded by closing SW1-5.
3. **Polarity Reverse Section.** This circuit provides the capability of reversing the signal polarity, as required with certain sample components.

   If the sample component yields a *positive* detector-output signal, it does not require polarity reversal. In this case, the output signal from AR1 bypasses polarity-reverse amplifier AR2 and passes through the polarity reverse section with its polarity unchanged.

   Each sample component that yields a *negative* detector-output signal must be programmed for polarity reversal. The POLARITY REVERSE command actuates relay K5, thus routing the signal through inverting amplifier AR2, so that it emerges with polarity reversed, i.e., positive.

   The polarity-reverse function may be activated *manually* with either Switch SW1-1 on the TC Detector Electronics Board, or with the POLARITY REVERSE Switch in the programmer.
4. **Isolated Current Output Section.** Here the conditioned voltage signal is converted into a 4 to 20 mA current signal, for transmission to the programmer. This section utilizes amplifiers AR3, AR5, and AR6. The correct output is established by adjusting zero-offset potentiometer R42 for 4 mA offset at the current output stage, and adjusting span potentiometer R28 for fullscale span of 16 mA i.e., 20 mA output.
5. **Auto Zero Amplifier Section.** Upon occurrence of the AUTO ZERO command, relay K6 is energized. Amplifier AR4 now integrates the output of AR1. The resultant integrated signal is applied to the TC bridge, balancing it so as to drive the output of AR1 to zero. When the AUTO ZERO command is removed, relay K6 is deenergized, and the auto zero value then stored in capacitor C6 is maintained. The auto zero function may be activated *manually* with Switch SW1-3 on the TC Detector Electronics Board.

   Specifications require that auto zero drift must be less than 1% of fullscale in 15 minutes. The output of the auto zero amplifier is attenuated by a factor of 2000 via a voltage divider consisting of R36 and R37.

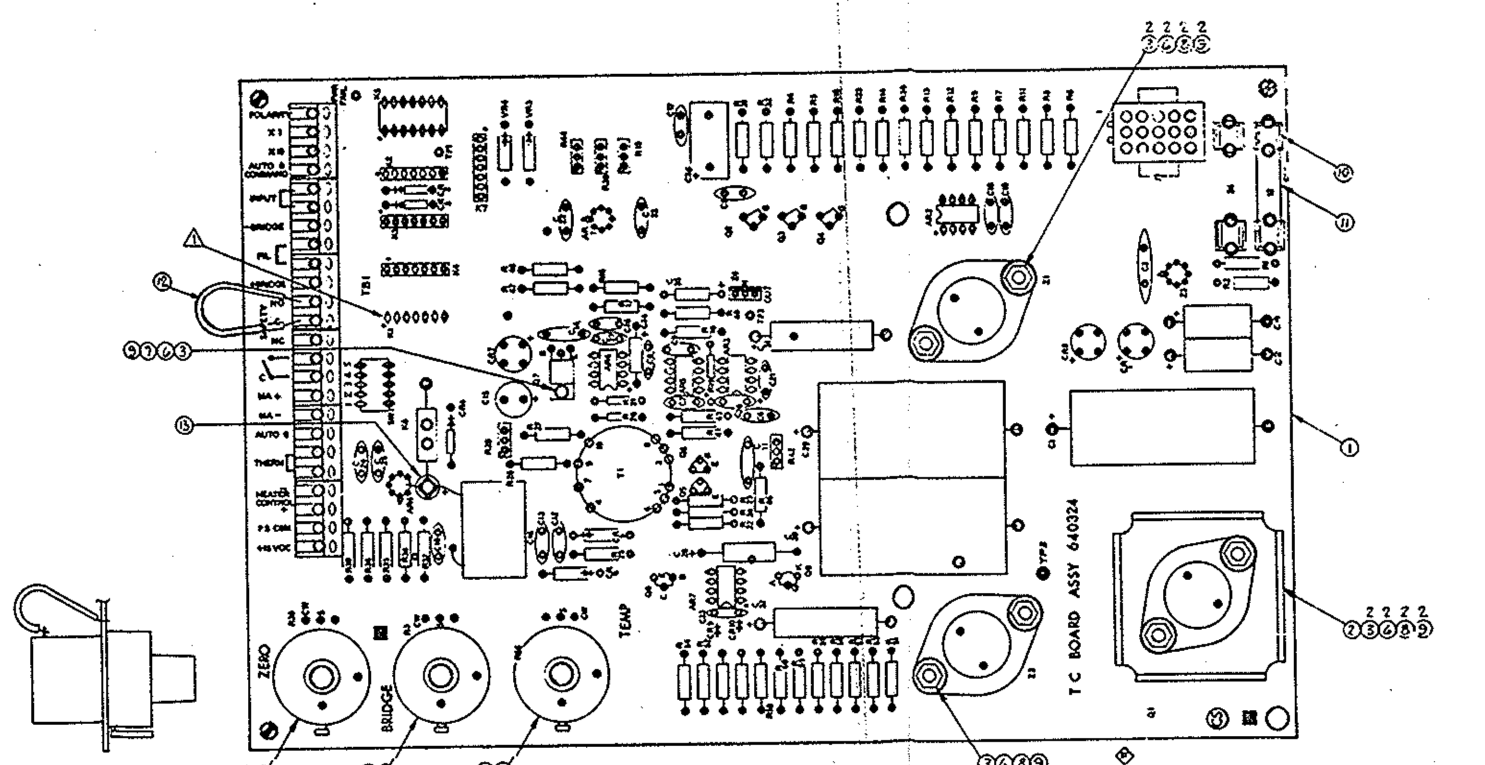
   At maximum sensitivity of the TC system, a fullscale recorder deflection corresponds to a 1 mV bridge offset; thus a 1% deflection is equal to 0.01 mV. This corresponds to a drift rate of 0.01 mV/15 min X 2000 = 1.3 mV/min for the auto zero amplifier. The auto zero circuit has a range of ±6X fullscale, i.e., it can change the bridge by ±6 mV.
6. **±15 Volt Power Supply Section.** This section provides regulated voltages of ±15 volts d.c. for the amplifiers and other elements of the analyzer electronic circuitry, and ±13 volts d.c. for actuation of the various control relays. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR8, regulators Z1 and Z2, and associated RC filter elements.
7. **Oven Temperature Control Section.** This section maintains the oven at a controlled, adjustable temperature in the range of 55°C to 225°C. As shown in the simplified functional diagram, at right the temperature controller circuit utilizes a resistance bridge containing a platinum probe for the temperature sensor and potentiometer R56 for setpoint adjustment. Resistance of the platinum probe is 400 ohms at 25°C, and increases 1.6 ohms for each increase of 1°C.

   If the proportioning current is ignored, the system would function as an on-off controller:
   a. If voltage at point V_p is *lower* than that at V_s, the output of AR7 becomes positive, actuating the solid-state relay and permitting current to flow through the resistive heater element.
   b. If voltage at V_p is *higher* than that at V_s, the output of AR7 approaches zero, deactuating the solid-state relay and removing power from the heater element.

   Because of requirements imposed by response characteristics of the oven system, the above-described on-off operation is not, in itself, an adequate method of temperature control. Therefore, a proportioning current is injected through R58 at intervals of approximately two seconds, causing point V_s to bump. Thus, the amount of heat required to maintain constant temperature can be added without overshoot. The proportioning current circuit includes elements R50, R51, R52, R53, and R57; C28; and Q8 and Q9. Resistors R50 and R51 establish a reference of approximately +9 volts d.c. for the gate of Q9. Capacitor C28 charges through R52 until the voltage across C28 reaches 9 volts d.c. At this time, Q8 becomes conductive, permitting C28 to discharge through Q9. As soon as C28 discharges, Q9 becomes nonconductive, and C28 again begins to charge. The output from emitter-follower Q8 follows the voltage on C28. When Q8 conducts, a small current (i_s) flows into R58, increasing the voltage drop across it. This current causes point V_s to be bumped and go positive with respect to V_p. This causes the output of AR7 to change and shut off the solid-state relay and thus turn off the heater.

TROUBLESHOOTING SIGNAL AND COMMAND CIRCUITRY

1. At the **programmer**, turn power on. Place MODE Switch at RESET. Place RANGE and AUTO ZERO Switches at AUTO.
2. At the **analyzer**, place all contacts of switch S1 in OFF position. Turn on analyzer power. Measure following voltages with respect to PS COM terminal at top of circuit board. Check for +15 volts d.c. at terminal marked +15 VDC. Check for −15 volts d.c. on minus side of C32. Check for + 15 volts d.c. on following terminals: X1 command, X10 command, AUTO ZERO command.
3. Checkout of TC amplifier AR1:
   a. On switch SW1, close contact 2 to activate X1 range; close contact 5 to ground the input to AR1.
   b. Monitor TP1 with respect to TP3. Adjust R29 for readings both above and below zero, then readjust for zero reading.
   c. Open contact 5 on SW1.



⚠ K1 & K7 INSTALLED ON FINAL ASSY IF ORDERED.

QTY	ITEM	PART NO.	DESCRIPTION
1	SW1	861250	SWITCH, MINI DIP ROCKER, 8 POS.
1	Z4	861375	REGULATOR, VOLTAGE MC7824CP
1	Z3	871339	CIRCUIT, INTEGRATED LM 305 AH
1	Z2	847369	REGULATOR, VOLTAGE −15V
1	Z1	873697	REGULATOR, VOLTAGE +15V
1	T1	648260	TRANSFORMER
1	K6	861249	RELAY, FORM A (TFE) 12V 142-1A-12
1	K5	861254	RELAY, DIP FORM C 12V, 6835C-4
1	K4	861253	RELAY, SIP FORM B 12V, 6874B-6
◈F 2	K2,3	861252	RELAY, SIP FORM A 12V, 6874 1A-4
1	Q9	871096	TRANSISTOR 2N 6028
1	Q8	838078	2N 3391
1	Q7	846561	2N 4920
2	Q5,6	866486	2N 4946
1	Q1	871449	MJ 3000
3	Q2,3,4	866540	TRANSISTOR, PUT U1897E
1	AR4	861185	CIRCUIT INTEGRATED AD515 J
1	AR3	876934	LM 308 N
3	AR2,5,7	876113	µA741TC
2	AR1,6	847050	CIRCUIT, INTEGRATED µA 725
2	VR3,4	844344	DIODE, ZENER 2.4V, IN 4370
1	CR9	822922	DIODE, ZENER IN 747
6	CR2,3,4, 5,6,10	838731	DIODE IN4448
3	CR1,7,8	873167	DIODE, BRIDGE W04

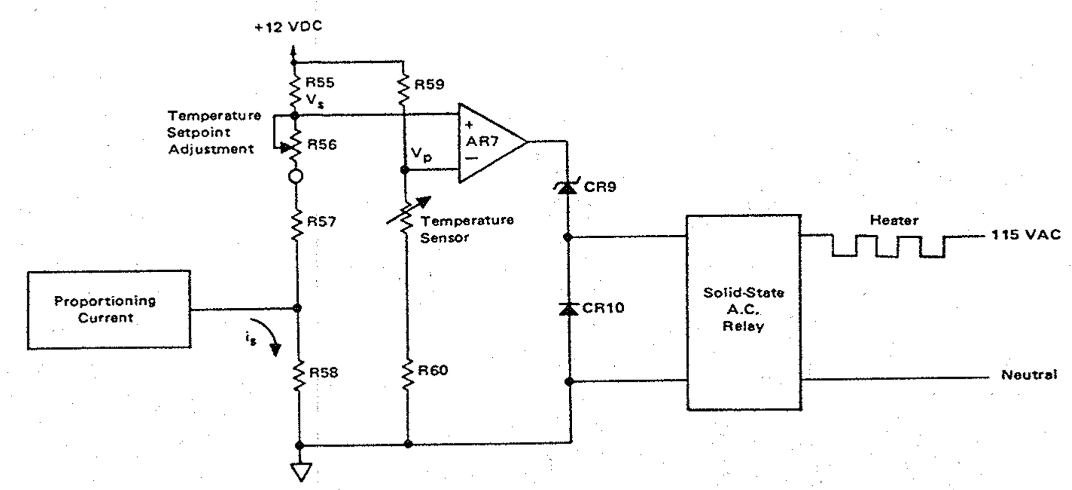
QTY	ITEM	PART NO.	DESCRIPTION
2	C34 35	802939	CAPACITOR 2µF 100V
2	C31,32	863519	250µF 50V
1	C28	802386	5µF 25V
2	C17,27	871635	.02µF 50V
2	C16,36	875441	2µF 50V
1	C15	860413	100µF 50V
2	C12,13	804708	.0015µF 100V
2	C11,14	817629	.1µF 50V
13	C7,8,9,10, 18,19,20, 21,22,23, 24,25,33	836364	.01µF 50V
1	C6	838426	33PF 500V
2	C5,26	871636	.047µF 50V
1	C4	810023	.5µF 35V
1	C3	804721	.02µF 500V
1	C2	24669	10µF 50V
3	C1,29,30	647397	CAPACITOR 1500µF 50V
1	R57	837000	RESISTOR 475±1%, 1/4W
1	R56	869848	VAR 500, ±5% 2W
4	R55,58, 59,60	863988	453±1%, 1/4W
1	R53	823379	10±5%, 1/4W
1	R52	822716	392K±1% 1/4W
1	R51	825857	15K ±1%, 1/4W
◈F 1	R43	825321	1K ±1%, 1/4W
1	R42	871615	RESISTOR, VAR 500Ω ±10% 1/2W

QTY	ITEM	PART NO.	DESCRIPTION
◈F 1	R41	828997	RESISTOR 9.09K ±1%, 1/4W
1	R38	847433	VAR 100Ω ±5% 2W
1	R36	869043	20K ±1% 1/8W
1	R33	863351	49.9K ±1%, 1/8W
1	R32	819667	110±5%, 1/4W
2	R31,47	823386	33±5%, 1/4W
3	R30,34,35	822367	51Ω ±1%, 1/4W
1	R29	847028	VAR 100K ±10%, 1/2W
1	R28	860942	WW VAR 100Ω ±5%, 1W
1	R27	825898	200±1%, 1/4W
2	R25,26	823916	1M26 ±5%, 1/4W
2	R23,24	819669	300±5%, 1/4W
1	R22	822334	22K±5%, 1/8W
1	R21	823395	470±5%, 1/8W
2	R18,40	825358	20K ±1% 1/4W
5	R16,17, 19,20,46	824653	100K ±1% 1/4W
2	R15,44	857624	VAR. 10K ±10% 1/2W
4	R13,14, 50,54	822883	10K ±1%, 1/4W
1	R12	876542	9K ±1% 1/8W
1	R11	876544	1K ±1% 1/8W
1	R9	876541	9.9K ±1% 1/8W
1	R8	876546	100Ω ±1%, 1/8W
1	R7	876540	9.99K ±1% 1/8W
4	R6,37, 39,48	876545	10Ω ±1%, 1/8W
3	R4,5,10	822229	6.8K ±5%, 1/4W
1	R3	876447	VAR. 30K ±5% 2W
1	R2	810533	1.82K ±1% 1/8W
1	R1	813664	RESISTOR 62Ω ±5%, 1/4W
1	11	8395	FUSE 1AMP

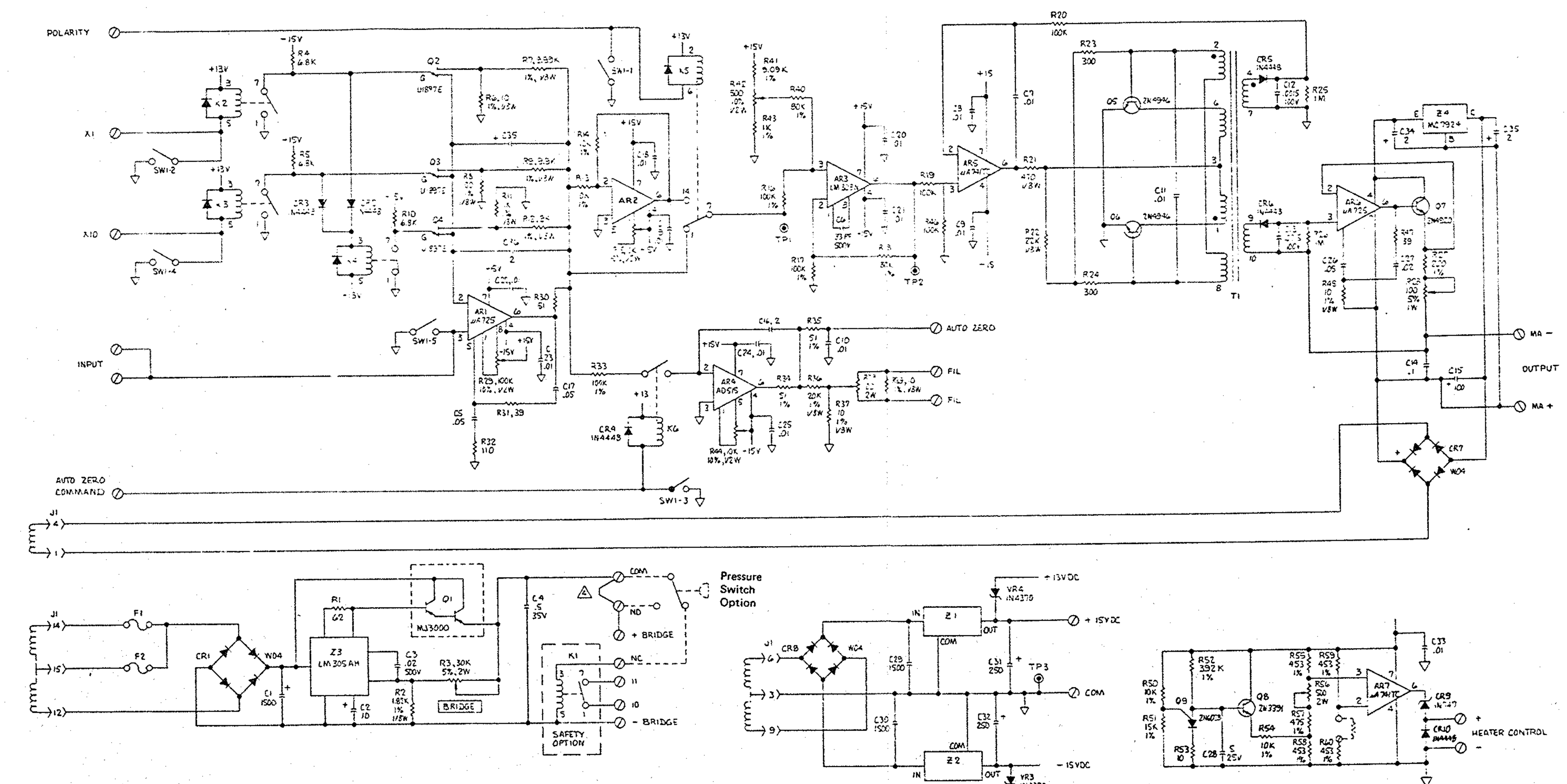
4. Checkout of Auto Zero Amplifier AR4:
   a. Monitor AUTO ZERO output terminal with respect to PS COM terminal. If reading is greater than ±11 volts d.c., momentarily short the two terminals; verify that output drops to zero and remains there. If output *immediately* returns to reading of greater than ±11 volts d.c., AR4 is probably defective.
   b. To check the auto zero relay, ground TP1 to TP3. Momentarily short the AUTO ZERO output terminal to TP3; reading should drop to zero and remain there. If reading returns slowly to ±11 volts d.c., relay K6 is energized. Verify that AUTO ZERO command terminal is at greater than 13 volts with respect to PS COM terminal. If reading is less than 13 volts, check power supply.
   c. If amplifier AR4 and relay K6 are functioning properly, perhaps the TC bridge is unbalanced beyond the compensating range of the auto zero circuit. If so, rebalance bridge per Paragraph 6.4.6.

TROUBLESHOOTING OVEN TEMPERATURE CONTROL SYSTEM

1. Connect voltmeter across HEATER CONTROL terminals and make following two checks:
   a. Disconnect one lead of temperature probe from THERM terminal. Voltmeter should read approximately 0 volts d.c. Reconnect lead.
   b. Connect a shorting jumper across THERM terminals. Voltmeter should be higher than 3 volts d.c.
2. Turn off power. Verify that resistance across HEATER terminals is approximately 24 ohms; if so, heater element is all right.
3. Disconnect probe leads from THERM terminals. Measure probe resistance with an ohmmeter. Nominal resistance of the platinum probe is 400 ohms at 25°C, and increases 1.6 ohms per degree C. If resistance is correct, probe is all right.
4. Turn on power. Verify that setting on HEATER AIR Pressure Regulator is sufficient to ensure closure of air pressure safety switch. Then connect an oscilloscope across HEATER terminals and neutral, and check the following:
   a. Disconnect one lead of probe from THERM terminals; oscilloscope should show zero signal. Reconnect lead.
   b. Short the THERM terminals. Oscilloscope should display a full sine wave. Remove short from THERM terminals.
   c. Turn R56 fully clockwise; oscilloscope should show a full sine wave. Rotate R56 counterclockwise; oscilloscope waveform should drop to zero. Slowly rotate R56 clockwise until there is periodic display of a full sine wave, indicating that the temperature controller is in control.
   d. Reset R56 for desired oven temperature. Refer to Figure 3-15.



Functional Diagram of Temperature Control Circuit

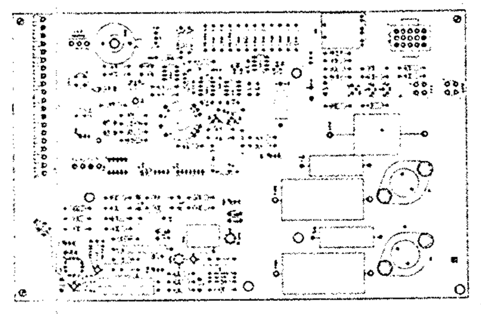


4. JUMPER REMOVED WHEN K1 IS INSTALLED.
3. ALL VOLTAGE READINGS ARE TAKEN IN REFERANCE TO GROUND.
2. ALL CAPACITORS ARE IN MICROFARADS 50V.
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W.

NOTE UNLESS OTHERWISE SPECIFIED

2,12,4-74

640330 FID ELECTRONICS BOARD ASSEMBLY



The 640330 FID Electronic Board Assembly contains the following:

1. **Polarizing Voltage Supply Section.** This section provides a regulated d.c. voltage (approximately 90 volts d.c.) for application to the burner tip of the FID. For further information on the detector, refer to Paragraph 5.4.2. The section utilizes one secondary of power transformer T1, fullwave rectifier CR9, and RC filter elements R38 and C16.

   The resultant filtered d.c. output is applied to a regulator circuit. As the polarizing voltage for the FID requires no current, the regulator is designed for no-load conditions. Transistor pair Q4 and Q5 constitute series-pass transistors which control the difference in voltage between input and output. Transistor Q6 serves as a constant-current source, and is controlled by a divider network consisting of R43 and R44. The voltage drop across Q6 controls the output. When the potential at the junction of R43 and R44 drops, Q6 becomes less conductive, causing the voltage across Q6 to increase, and the output to rise. When the potential at the junction of R43 and R44 rises, Q6 becomes more conductive, causing the voltage across Q6 to decrease and the output to decrease.

2. **Control Relays.** To provide isolation between analyzer and programmer, control relays are used to transmit the IGNITE command, all range commands, and the AUTO ZERO command. Each control relay has an associated switch connected in parallel, to permit manual actuation of the function.

   The control relays are energized by logic commands from the programmer. Each logic command is provided by relay contact closure which causes the control relay to actuate. The relays provide excellent noise immunity because of the actuation time of the relay, in both turn-on and turn-off characteristics, and also allow isolation between analog and digital circuits.

3. **Signal Amplification Circuitry.** This consists of flame amplifier AR1 and range amplifier AR5.

   Flame Amplifier AR1. This hybrid MOS-FET amplifier, with input impedance on the order of 10^{15} ohms, converts the flame current from the FID into a voltage signal. Amplifier AR1 has HIGH and LOW operating ranges. In manual operation, HIGH or LOW range is controlled by SW1-5 on the FID Electronics Board or by the RANGE Switch on the programmer front panel. In automatic operation, this function is controlled by programming on the component boards.

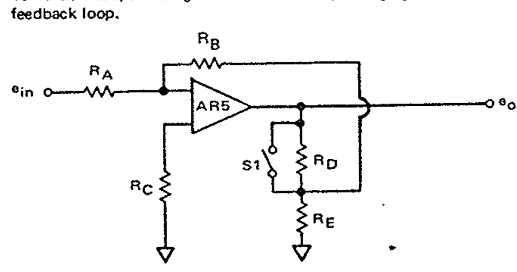
   During normal operation, relay K1 is deenergized, providing AR1 with a measuring capability of 2×10^{-12} amps to 2×10^{-9} amps, with the following outputs.

AR1 Input In Amperes	AR1 Output In Millivolts (TP3 To TP4)
2×10^{-12}	−10
2×10^{-11}	−100
2×10^{-10}	−1000
2×10^{-9}	−10 000

   If a larger input current is to be measured, the HIGH range is selected, i.e., relay K1 is energized, thus shunting a 555-megohm resistor across the $5 \times 10^{+9}$ ohm resistor. With the input of 2×10^{-8} amperes, the output would be −10, 000 millivolts, as measured at TP3 with respect to TP4.

   During operation on HIGH range, range amplifier AR5 remains in unity-gain condition (X100 range). Total measuring capability of the combination of AR1 and AR5 is 2×10^{-12} to 2×10^{-8} amperes.

   Range Amplifier AR5. This is a high-quality, high-gain operational amplifier, operated in an inverting mode, with selectable gain of 1, 10, or 100. In manual operation, gain is selected by switches SW1-2 and SW1-3 on the FID Electronics Board, or by the RANGE Switch on the programmer front panel. Correspondence between programmer range setting and AR5 gain is as follows: Range 1, gain 100; Range 10, gain 10; Range 100, gain 1. AR5 has a basic output of 0- to +1-volt d.c., with an overrange capability of +10 volts. The combination of AR1 output and AR5 gain must be such that AR5 output does not exceed 10 volts. The specified gains are obtained by changing resistances in the feedback loop.



In the general case, the following comments can be made.

With switch S1 closed, R_B is connected to the amplifier output, and R_E serves only as a load resistance. In this case, the transfer function is:

$$e_o = -\left(\frac{R_B}{R_A}\right) e_{in}$$

where

$$\left(\frac{R_B}{R_A}\right) \text{ is the gain term.}$$

If switch S1 were open, the output of the amplifier would be connected to R_E through R_D, changing the transfer function as follows:

$$e_o = -\left(\frac{R_B}{R_A}\right) \times \left(\frac{R_D + R_E}{R_E}\right) e_{in}$$

Here the gain term includes the ratio

$$\left[\frac{R_D + R_E}{R_E}\right]$$

i.e., the total resistance in the output string divided by the resistance below the tie point of the feedback resistor.

On the FID Electronics Board, AR5 gain is determined by the status of resistors R21 and R22, as determined by relays K2 and K3. Note that the input to AR5 (i.e., the output of AR1) is generally negative.

Range 100
R21 and R22 are both shorted out. The transfer function is:

$$e_o = -\left(\frac{R24}{R25}\right) e_{in}$$

Since R24 and R25 are both 100K, the gain is 1.

Range 10
R21 is shorted out; R22 is in circuit. There is 45K (R22)above the feedback point and 5K (R23) below it.

$$e_o = -\left(\frac{R24}{R25}\right)\left[\frac{R22 + R23}{R23}\right] e_{in}$$

$$e_o = -\left(\frac{100K}{100K}\right)\left[\frac{45K + 5K}{5K}\right] e_{in}$$

$$e_o = -\ (10)\ e_{in}$$

thus, gain is 10.

Range 1
R21 is in circuit; R22 is shorted out.

$$e_o = -\left(\frac{R24}{R25}\right)\left[\frac{R21 + R23}{R23}\right] e_{in}$$

$$e_o = -\left(\frac{100K}{100K}\right)\left[\frac{495K + 5K}{5K}\right] e_{in}$$

$$e_o = -\ (100)\ e_{in}$$

Gain is 100.

4. **Isolated Current Output Section.** Here the conditioned voltage signal is converted into a 4 to 20 mA current signal, for transmission to the programmer. This section utilizes amplifiers AR2, AR3, and AR4. The correct output is established by adjusting zero-offset potentiometer R7 for 4 mA offset at the current output stage, and adjusting span potentiometer R20 for fullscale span of 16 mA.

5. **Auto Zero Amplifier Section.** Auto Zero Amplifier AR6 is a J-FET operational amplifier, used in an integrating mode. When the AUTO ZERO ON command occurs, relay K4 is energized, connecting the output of range amplifier AR5 to the input of auto zero amplifier AR6. Amplifier AR6 now integrates the output signal of AR5, and supplies AR1 with the input current required to drive AR5 output to zero. When the AUTO ZERO OFF command occurs, relay K4 is deenergized. The signal stored in capacitor C15 now maintains a constant-current input to AR1 until the next auto zero period.

   The AUTO ZERO command may be initiated manually either with switch SW1-4 on the FID Electronics Board, or with the AUTO ZERO Switch on the programmer front panel.

   Auto Zero HIGH/LOW Output Switch SW1-5 provides a choice of two output ranges for the auto zero circuit. During startup, the system may contain a relatively high level of contaminants, resulting in a high background current. Switch SW1-5 is closed (HIGH position), providing a fullscale zeroing current of 1.2×10^{-10} amperes. After startup, with the system now clean, SW1-5 is opened (LOW position). Fullscale zeroing current is 2.0×10^{-11} amperes. Auto zero drift should not exceed 1% on the most sensitive range; therefore, with SW1-5 in LOW position, amplifier drift rate should not exceed 5 millivolts per minute.

6. **Flame Ignition Circuit.** The IGNITE command is applied manually, either with Switch SW2 on the FID Electronics Board or with the IGNITE Switch in the programmer. Upon occurrence of the command, relay K5 closes, permitting current to flow from one secondary of power transformer T1 through the glow-plug igniter in the FID.

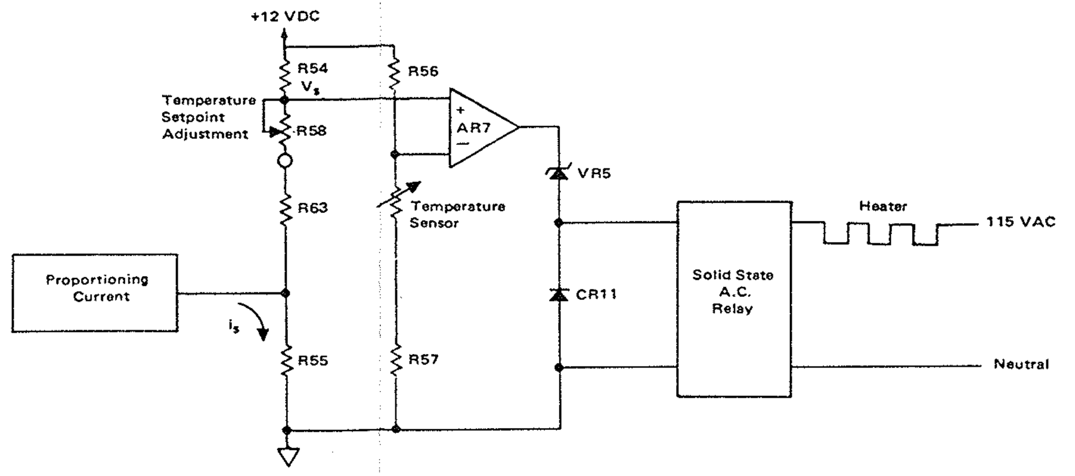
7. **±15 Volt Power Supply Section.** This section provides regulated voltages of ±15 volts d.c. for the amplifiers and other elements of the analyzer electronic circuitry, and ±13 volts d.c. for actuation of the various control relays. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR12, regulators Z1 and Z2, and associated RC filter elements.

8. **Oven Temperature Control Section.** This section maintains the oven at a controlled adjustable temperature in the range of 55°C to 225°C. As shown in simplified function diagram, at right, the temperature controller circuit utilizes a resistance bridge containing a platinum probe for the temperature sensor and potentiometer R58 for setpoint adjustment. Resistance of the platinum probe is 400 ohms at 25°C, and increases 1.6 ohms for each increase of 1°C.

   If the proportioning current is ignored, the system would function as an on-off controller:

   a. If voltage at point V_p is lower than that at V_s, the output of AR7 becomes positive, actuating the solid-state relay and permitting current to flow through the resistive heater element.
   b. If voltage at V_p is higher than that at V_s, the output of AR7 approaches zero, decactuating the solid-state relay and removing power from the heater element.

   Because of requirements imposed by response characteristics of the oven system, the above-described on-off operation is not, in itself, an adequate method of temperature control. Therefore, a proportioning current is injected through R55 at intervals of approximately two seconds, causing point V_s to bump. Thus, the amount of heat required to maintain constant temperature can be added without overshoot. the proportioning current circuit includes elements R60, R51, R52, R53, and R63; C24; and Q7 and Q8. Resistors R60 and R51 establish a reference of approximately +9 volts d.c. for the gate of Q8. Capacitor C24



Functional Diagram of Temperature Control Circuit

charges through R52 until the voltage across C24 reaches 9 volts d.c. At this time, Q7 becomes conductive, permitting C24 to discharge through Q8. As soon as C24 discharges, Q8 becomes nonconductive, and C24 again begins to charge. The output from emitter-follower Q7 follows the voltage on C24. When Q7 conducts, a small current (i_s) flows into R58, increasing the voltage drop across it. This current causes point V_s to be bumped and go positive with respect to V_p. This causes the output of AR7 to change, and shut off the heater.

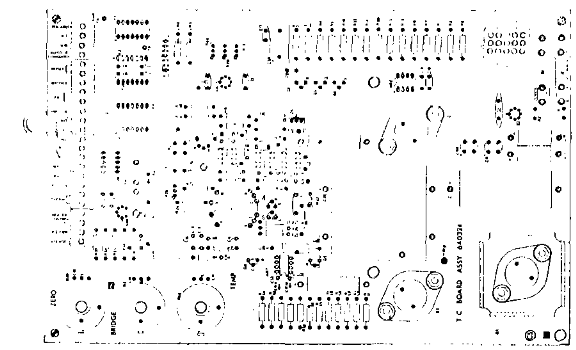
TROUBLESHOOTING SIGNAL AND COMMAND CIRCUITRY

1. At programmer, turn power on and place MODE Switch at RESET. Place RANGE and AUTO ZERO Switches at AUTO.
2. At the analyzer place all contacts of switch SW1 in OFF position. Turn on analyzer power. Measure following voltages with respect to PS COM terminal at top of circuit board. Check for +15 volts d.c. at terminal marked +15 VDC. Check for −15 volts d.c. on minus side of C23. Check for +13 to +15 volts d.c. on following terminals: HIGH/LOW RANGE command, XL RANGE command, X10 RANGE command, and AUTO ZERO command. Check for minus 13 to 15 volts d.c. on IGNITE command.
3. Disconnect high-impedance input cable from AR1.
4. Connect a voltmeter from TP2 (AR5 output) to TP4 (circuit ground). Voltmeter will remain thus connected until Step 8 b.
5. On switch SW1, close contact 5 to activate HIGH RANGE; close contact 3 to activate X1 RANGE. Voltmeter is now monitoring the output from range amplifier AR5 on the HIGH, X1 RANGE.
6. Checkout of Range Amplifier AR5. Connect jumper from TP3 to TP4 (circuit ground) to provide zero input to AR5. Rotate R27 throughout its adjustment range to verify that both positive and negative voltmeter readings are obtainable, then reset R27 for zero volts. Remove jumper from between TP3 and TP4.
7. Checkout of Flame Amplifier AR1. Connect jumper from TP1 to TP4 to provide zero input to AR1. Rotate R3 throughout its adjustment range to verify that both positive and negative voltmeter readings are obtainable, then reset R3 for zero volts. Remove jumper from between TP1 and TP4.
8. Checkout of Auto Zero Amplifier AR6.
   a. On switch SW1, open contact 5 to de-activate HIGH RANGE command; close contact 4 to activate AUTO ZERO command. Voltmeter should read zero; if not, adjust R35 as required. Open contact 4 on SW1.
   b. Make sure that auto zero command is off. Connect voltmeter from AUTO ZERO output terminal to TP4, to measure output of AR6. If reading is greater than ±12 volts, AR6 is probably saturated. Momentarily short the two terminals; reading should drop to zero and remain there. If reading immediately returns to greater than ±11 volts, AR6 or relay K4 is defective.
9. Current Output Zero Adjustment R7: Connect a milliammeter into the current output loop at the MA (+) and MA (−) terminals. Reading should be 4 mA; if not, adjust R7 as required.
10. Current Output Span Adjustment R7: Set Flame Amplifier Zero Adjustment R3 for reading of +10 volts d.c., i.e., fullscale signal, at TP2 with respect to TP4. Milliammeter connected into current output loop should now read 20 mA; if not, adjust R20 as required. Reset R3 for reading of 0 volts at TP2 with respect to TP4.
11. Repeat Step 9 to ensure proper zero adjustment.
12. Open all contacts in switch SW1. System is now functional.

TROUBLESHOOTING OVEN TEMPERATURE CONTROL SYSTEM

1. Connect voltmeter across HEATER CONTROL terminals and make following two checks:
   a. Disconnect one lead of temperature probe from THERM terminal. Voltmeter should read approximately 0 volts d.c. Reconnect lead.
   b. Connect a shorting jumper across THERM terminals. Voltmeter should read higher than 3 volts d.c.
2. Turn off power. Verify that resistance across HEATER terminals is approximately 24 ohms; if so, heater element is all right.
3. Disconnect probe leads from THERM terminals. Measure probe resistance with an ohmmeter. Nominal resistance of the platinum probe is 400 ohms at 25°C, and increases 1.6 ohms per degree Celsius. If resistance is correct, probe is all right.
4. Turn on power. Verify that setting on HEATER AIR Pressure Regulator is sufficient to ensure closure of air pressure safety switch. Then, connect an oscilloscope across HEATER terminals and neutral, and check the following:
   a. Disconnect one lead of probe from THERM terminal; oscilloscope should show zero signal. Reconnect lead.
   b. Short the THERM terminals. Oscilloscope should display a full sine wave. Remove short from THERM terminals.
   c. Turn R58 fully clockwise; oscilloscope should show a full sine wave. Rotate R58 counterclockwise; oscilloscope waveform should drop to zero. Slowly rotate R58 clockwise until there is periodic display of a full sine wave, indicating that the temperature controller is in control.
   d. Reset R58 for desired oven temperature. Refer to Figure 3-15.

640324 TC DETECTOR ELECTRONICS BOARD ASSEMBLY



The 640324 TC Detector Electronics Board Assembly contains the following:

1. **Bridge Voltage Power Supply Section.** This section provides a precisely regulated, adjustable voltage for application to the TC detector bridge. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR1, regulator Z3, and associated RC filter elements. Power transistor Q1 provides the current-drive capability required for the detector bridge. Potentiometer R3 adjusts the output voltage within a range of 3 to 11 volts d.c. if the 1-ampere fuse is placed in position marked "12," or 11 to 24 volts d.c. if this fuse is placed in position marked "24."

   If equipped with filament safety option, the detector bridge is connected to the bridge power supply through a pressure switch. Upon loss of carrier gas pressure, the switch removes power from the bridge to prevent filament damage; simultaneously, relay K1 provides contact closure to actuate an alarm, if ordered.
2. **TC Amplifier Section.** The detector-output signal is applied to amplifier AR1, a high-gain, low-drift d.c. amplifier with selectable gain of 10, 100, or 1000, obtained by appropriate switching of resistances in the feedback loop. Correspondence between programmer range setting and AR1 gain is as follows: Range 1, gain 1000; Range 10, gain 100; Range 100, gain X10. Range switching is accomplished by FET switching circuits. Switching circuitry is arranged so that if *neither* Range 1 nor Range 10 is commanded, Range 100 is in effect.

   The Range 1 command is applied via relay K2 and the Range 10 command via relay K3. With neither relay energized, Q2 and Q3 are off. Under these conditions, relay K4 is energized and Q4 is on; thus R11 and R12 are inserted into the feedback loop of AR1.

   Assume that the Range 1 command is received. Relay K2 closes, causing Q2 to conduct. Relay K4 is deenergized, turning off Q4. Thus the X1 range command turns off the X100 range command. The X10 range functions similarly in turning off the X100 range command.

   Each range may be activated manually via the appropriate switch. For Range 1, close SW1-2. For Range 10, close SW1-4. For Range 100, open both SW1-2 and SW1-4. For test purposes, the input of AR1 may be grounded by closing SW1-5.
3. **Polarity Reverse Section.** This circuit provides the capability of reversing the signal polarity, as required with certain sample components.

   If the sample component yields a *positive* detector-output signal, it does not require polarity reversal. In this case, the output signal from AR1 bypasses polarity-reverse amplifier AR2 and passes through the polarity reverse section with its polarity unchanged.

   Each sample component that yields a *negative* detector-output signal must be programmed for polarity reversal. The POLARITY REVERSE command actuates relay K5, thus routing the signal through inverting amplifier AR2, so that it emerges with polarity reversed, i.e., positive.

   The polarity-reverse function may be activated *manually* with either Switch SW1-1 on the TC Detector Electronics Board, or with the POLARITY REVERSE Switch in the programmer.
4. **Isolated Current Output Section.** Here the conditioned voltage signal is converted into a 4 to 20 mA current signal, for transmission to the programmer. This section utilizes amplifiers AR3, AR5, and AR6. The correct output is established by adjusting zero-offset potentiometer R42 for 4 mA offset at the current output stage, and adjusting span potentiometer R28 for fullscale span of 16 mA i.e., 20 mA output.
5. **Auto Zero Amplifier Section.** Upon occurrence of the AUTO ZERO command, relay K6 is energized. Amplifier AR4 now integrates the output of AR1. The resultant integrated signal is applied to the TC bridge, balancing it so as to drive the output of AR1 to zero. When the AUTO ZERO command is removed, relay K6 is deenergized, and the auto zero value then stored in capacitor C6 is maintained. The auto zero function may be activated *manually* with Switch SW1-3 on the TC Detector Electronics Board.

   Specifications require that auto zero drift must be less than 1% of fullscale in 15 minutes. The output of the auto zero amplifier is attenuated by a factor of 2000 via a voltage divider consisting of R36 and R37.

   At maximum sensitivity of the TC system, a fullscale recorder deflection corresponds to a 1 mV bridge offset; thus a 1% deflection is equal to 0.01 mV. This corresponds to a drift rate of 0.01 mV/15 min X 2000 = 1.3 mV/min for the auto zero amplifier. The auto zero circuit has a range of ±6X fullscale, i.e., it can change the bridge by ±6 mV.
6. **±15 Volt Power Supply Section.** This section provides regulated voltages of ±15 volts d.c. for the amplifiers and other elements of the analyzer electronic circuitry, and ±13 volts d.c. for actuation of the various control relays. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR8, regulators Z1 and Z2, and associated RC filter elements.
7. **Oven Temperature Control Section.** This section maintains the oven at a controlled, adjustable temperature in the range of 55°C to 225°C. As shown in the simplified functional diagram, at right the temperature controller circuit utilizes a resistance bridge containing a platinum probe for the temperature sensor and potentiometer R56 for setpoint adjustment. Resistance of the platinum probe is 400 ohms at 25°C, and increases 1.6 ohms for each increase of 1°C.

   If the proportioning current is ignored, the system would function as an on-off controller:

   a. If voltage at point V_p is *lower* than that at V_s, the output of AR7 becomes positive, actuating the solid-state relay and permitting current to flow through the resistive heater element.

   b. If voltage at V_p is *higher* than that at V_s, the output of AR7 approaches zero, deactuating the solid-state relay and removing power from the heater element.

   Because of requirements imposed by response characteristics of the oven system, the above-described on-off operation is not, in itself, an adequate method of temperature control. Therefore, a proportioning current is injected through R58 at intervals of approximately two seconds, causing point V_s to bump. Thus, the amount of heat required to maintain constant temperature can be added without overshoot. The proportioning current circuit includes elements R50, R51, R52, R53, and R57; C28; and Q8 and Q9. Resistors R50 and R51 establish a reference of approximately +9 volts d.c. for the gate of Q9. Capacitor C28 charges through R52 until the voltage across C28 reaches 9 volts d.c. At this time, Q8 becomes conductive, permitting C28 to discharge through Q9. As soon as C28 discharges, Q9 becomes nonconductive, and C28 again begins to charge. The output from emitter-follower Q8 follows the voltage on C28. When Q8 conducts, a small current (i_s) flows into R58, increasing the voltage drop across it. This current causes point V_s to be bumped and go positive with respect to V_p. This causes the output of AR7 to change and shut off the solid-state relay and thus turn off the heater.

TROUBLESHOOTING SIGNAL AND COMMAND CIRCUITRY

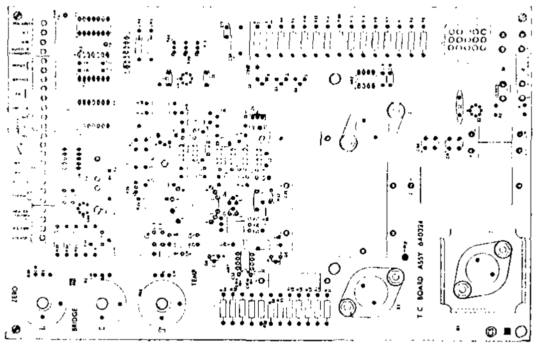
1. At the **programmer**, turn power on. Place MODE Switch at RESET. Place RANGE and AUTO ZERO Switches at AUTO.
2. At the **analyzer**, place all contacts of switch S1 in OFF position. Turn on analyzer power. Measure following voltages with respect to PS COM terminal at top of circuit board. Check for +15 volts d.c. at terminal marked +15 VDC. Check for −15 volts d.c. on minus side of C32. Check for + 15 volts d.c. on following terminals: X1 command, X10 command, AUTO ZERO command.
3. Checkout of TC amplifier AR1:

   a. On switch SW1, close contact 2 to activate X1 range; close contact 5 to ground the input to AR1.

   b. Monitor TP1 with respect to TP3. Adjust R29 for readings both above and below zero, then readjust for zero reading.

   c. Open contact 5 on SW1.

640324 TC DETECTOR ELECTRONICS BOARD ASSEMBLY



The 640324 TC Detector Electronics Board Assembly contains the following:

1. **Bridge Voltage Power Supply Section.** This section provides a precisely regulated, adjustable voltage for application to the TC detector bridge. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR1, regulator Z3, and associated RC filter elements. Power transistor Q1 provides the current-drive capability required for the detector bridge. Potentiometer R3 adjusts the output voltage within a range of 3 to 11 volts d.c. if the 1-ampere fuse is placed in position marked "12," or 11 to 24 volts d.c. if this fuse is placed in position marked "24."

   If equipped with filament safety option, the detector bridge is connected to the bridge power supply through a pressure switch. Upon loss of carrier gas pressure, the switch removes power from the bridge to prevent filament damage; simultaneously, relay K1 provides contact closure to actuate an alarm, if ordered.

2. **TC Amplifier Section.** The detector-output signal is applied to amplifier AR1, a high-gain, low-drift d.c. amplifier with selectable gain of 10, 100, or 1000, obtained by appropriate switching of resistances in the feedback loop. Correspondence between programmer range setting and AR1 gain is as follows: Range 1, gain 1000; Range 10, gain 100; Range 100, gain X10. Range switching is accomplished by FET switching circuits. Switching circuitry is arranged so that if *neither* Range 1 nor Range 10 is commanded, Range 100 is in effect.

   The Range 1 command is applied via relay K2 and the Range 10 command via relay K3. With neither relay energized, Q2 and Q3 are off. Under these conditions, relay K4 is energized and Q4 is on; thus R11 and R12 are inserted into the feedback loop of AR1.

   Assume that the Range 1 command is received. Relay K2 closes, causing Q2 to conduct. Relay K4 is deenergized, turning off Q4. Thus the X1 range command turns off the X100 range command. The X10 range functions similarly in turning off the X100 range command.

   Each range may be activated manually via the appropriate switch. For Range 1, close SW1-2. For Range 10, close SW1-4. For Range 100, open both SW1-2 and SW1-4. For test purposes, the input of AR1 may be grounded by closing SW1-5.

3. **Polarity Reverse Section.** This circuit provides the capability of reversing the signal polarity, as required with certain sample components.

   If the sample component yields a *positive* detector-output signal, it does not require polarity reversal. In this case, the output signal from AR1 bypasses polarity-reverse amplifier AR2 and passes through the polarity reverse section with its polarity unchanged.

   Each sample component that yields a *negative* detector-output signal must be programmed for polarity reversal. The POLARITY REVERSE command actuates relay K5, thus routing the signal through inverting amplifier AR2, so that it emerges with polarity reversed, i.e., positive.

   The polarity-reverse function may be activated *manually* with either Switch SW1-1 on the TC Detector Electronics Board, or with the POLARITY REVERSE Switch in the programmer.

4. **Isolated Current Output Section.** Here the conditioned voltage signal is converted into a 4 to 20 mA current signal, for transmission to the programmer. This section utilizes amplifiers AR3, AR5, and AR6. The correct output is established by adjusting zero-offset potentiometer R42 for 4 mA offset at the current output stage, and adjusting span potentiometer R28 for fullscale span of 16 mA i.e., 20 mA output.

5. **Auto Zero Amplifier Section.** Upon occurrence of the AUTO ZERO command, relay K6 is energized. Amplifier AR4 now integrates the output of AR1. The resultant integrated signal is applied to the TC bridge, balancing it so as to drive the output of AR1 to zero. When the AUTO ZERO command is removed, relay K6 is deenergized, and the auto zero value then stored in capacitor C6 is maintained. The auto zero function may be activated *manually* with Switch SW1-3 on the TC Detector Electronics Board.

   Specifications require that auto zero drift must be less than 1% of fullscale in 15 minutes. The output of the auto zero amplifier is attenuated by a factor of 2000 via a voltage divider consisting of R36 and R37.

   At maximum sensitivity of the TC system, a fullscale recorder deflection corresponds to a 1 mV bridge offset; thus a 1% deflection is equal to 0.01 mV. This corresponds to a drift rate of 0.01 mV/15 min X 2000 = 1.3 mV/min for the auto zero amplifier. The auto zero circuit has a range of ±6X fullscale, i.e., it can change the bridge by ±6 mV.

6. **±15 Volt Power Supply Section.** This section provides regulated voltages of ±15 volts d.c. for the amplifiers and other elements of the analyzer electronic circuitry, and ±13 volts d.c. for actuation of the various control relays. The section utilizes one center-tapped secondary of power transformer T1, fullwave rectifier diode bridge CR8, regulators Z1 and Z2, and associated RC filter elements.

7. **Oven Temperature Control Section.** This section maintains the oven at a controlled, adjustable temperature in the range of 55°C to 225°C. As shown in the simplified functional diagram, at right the temperature controller circuit utilizes a resistance bridge containing a platinum probe for the temperature sensor and potentiometer R56 for setpoint adjustment. Resistance of the platinum probe is 400 ohms at 25°C, and increases 1.6 ohms for each increase of 1°C.

   If the proportioning current is ignored, the system would function as an on-off controller:

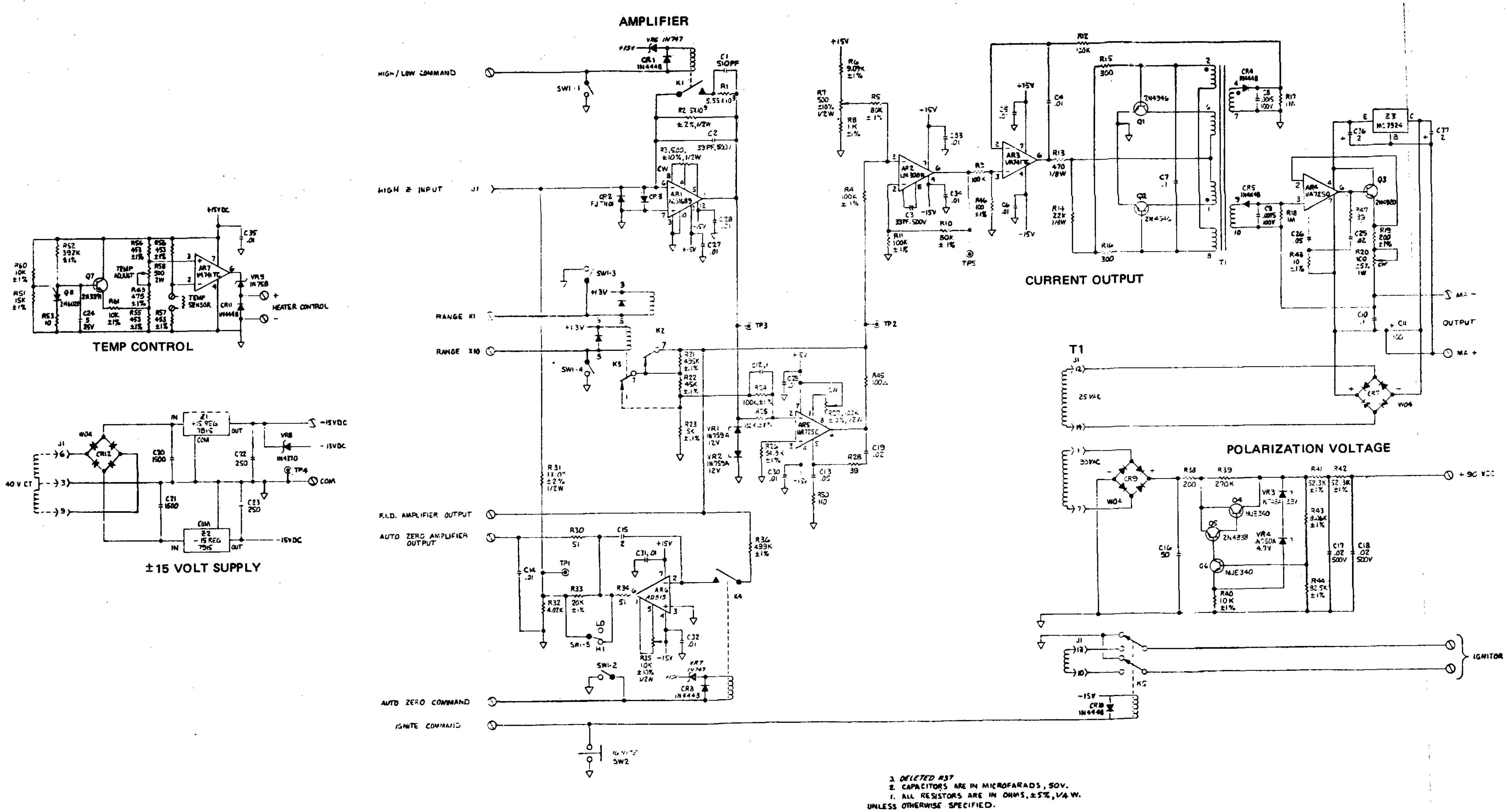
   a. If voltage at point V_p is *lower* than that at V_s, the output of AR7 becomes positive, actuating the solid-state relay and permitting current to flow through the resistive heater element.

   b. If voltage at V_p is *higher* than that at V_s, the output of AR7 approaches zero, deactuating the solid-state relay and removing power from the heater element.

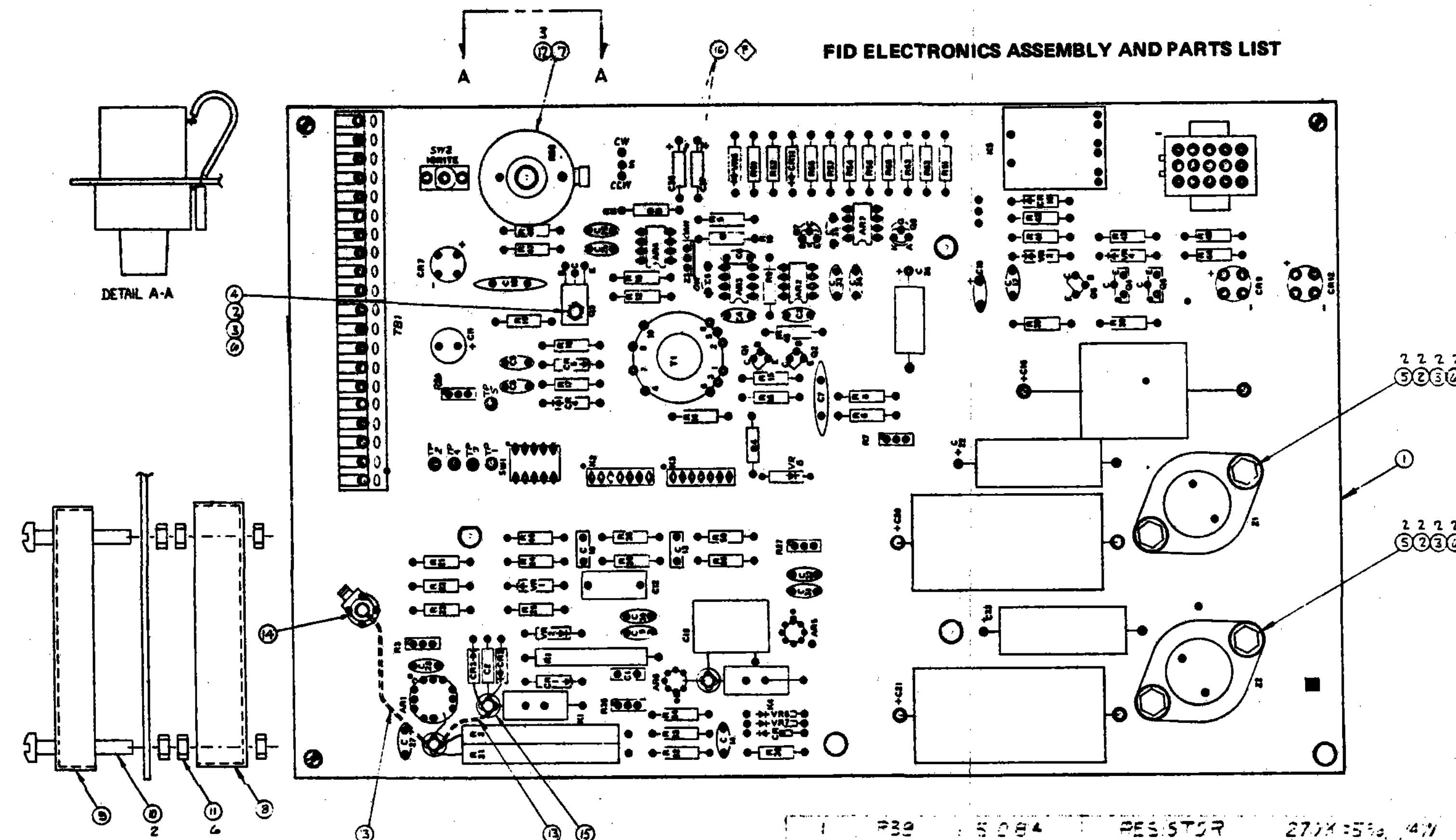
   Because of requirements imposed by response characteristics of the oven system, the above-described on-off operation is not, in itself, an adequate method of temperature control. Therefore, a proportioning current is injected through R58 at intervals of approximately two seconds, causing point V_s to bump. Thus, the amount of heat required to maintain constant temperature can be added without overshoot. The proportioning current circuit includes elements R50, R51, R52, R53, and R57; C28; and Q8 and Q9. Resistors R50 and R51 establish a reference of approximately +9 volts d.c. for the gate of Q9. Capacitor C28 charges through R52 until the voltage across C28 reaches 9 volts d.c. At this time, Q8 becomes conductive, permitting C28 to discharge through Q9. As soon as C28 discharges, Q9 becomes nonconductive, and C28 again begins to charge. The output from emitter-follower Q8 follows the voltage on C28. When Q8 conducts, a small current (i_s) flows into R58, increasing the voltage drop across it. This current causes point V_s to be bumped and go positive with respect to V_p. This causes the output of AR7 to change and shut off the solid-state relay and thus turn off the heater.

TROUBLESHOOTING SIGNAL AND COMMAND CIRCUITRY

1. At the **programmer**, turn power on. Place MODE Switch at RESET. Place RANGE and AUTO ZERO Switches at AUTO.
2. At the **analyzer**, place all contacts of switch S1 in OFF position. Turn on analyzer power. Measure following voltages with respect to PS COM terminal at top of circuit board. Check for +15 volts d.c. at terminal marked +15 VDC. Check for −15 volts d.c. on minus side of C32. Check for + 15 volts d.c. on following terminals: X1 command, X10 command, AUTO ZERO command.
3. Checkout of TC amplifier AR1:
   a. On switch SW1, close contact 2 to activate X1 range; close contact 5 to ground the input to AR1.
   b. Monitor TP1 with respect to TP3. Adjust R29 for readings both above and below zero, then readjust for zero reading.
   c. Open contact 5 on SW1.


AMPLIFIER
CURRENT OUTPUT
TEMP CONTROL
±15 VOLT SUPPLY
POLARIZATION VOLTAGE
T1
HIGH/LOW COMMAND
HIGH Z INPUT
RANGE X1
RANGE X10
F.I.D. AMPLIFIER OUTPUT
AUTO ZERO AMPLIFIER OUTPUT
AUTO ZERO COMMAND
IGNITE COMMAND
HEATER CONTROL
OUTPUT
IGNITOR
3. DELETED R37
2. CAPACITORS ARE IN MICROFARADS, 50V.
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4 W.
UNLESS OTHERWISE SPECIFIED.

FID ELECTRONICS ASSEMBLY AND PARTS LIST

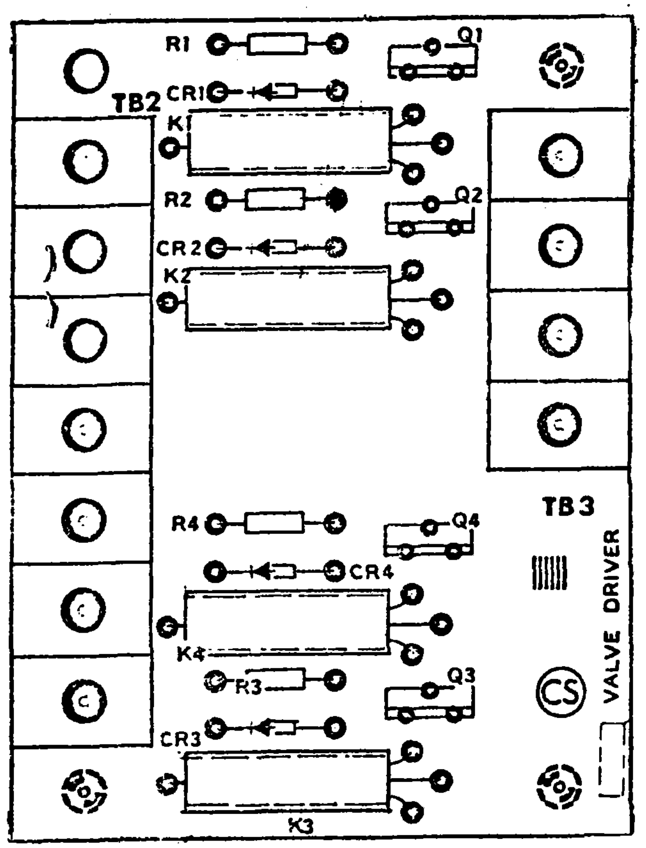


QTY	ITEM	PART NO.	DESCRIPTION
1	T1	646260	TRANSFORMER
1	SW2	876990	SWITCH, PUSH BUTTON
1	SW1	861250	SWITCH, ROCKER
1	Z2	847369	REGULATOR, VOLTAGE -15V 7915
1	Z1	873397	REGULATOR, VOLTAGE +15V 7815
1	Z3	861375	REGULATOR VOLTAGE -24V MC7924CP
1	J1	865514	SOCKET 15 POS.
2	TB1	861256	STRIP, TERMINAL 10 POS.
2	K2,3	861253	RELAY, FORM B SIP
2	K1,4	861249	RELAY, TFE LEAD
1	K5	861457	RELAY, FORM A, SPDT
1	AR6	861185	CIRCUIT, INTEGRATED AD515J
2	AR4,5	847050	µA725C
2	AR3,7	976113	µA741TC
1	AR2	876984	LM 308N
1	AR1	633227	CIRCUIT, INTEGRATED NE5L689
1	Q8	871038	TRANSISTOR 2N 6028
1	Q7	838078	TRANSISTOR 2N 3391
1	Q5	866457	TRANSISTOR 2N 4888
2	Q4,6	866435	TRANSISTOR MJE 340
1	Q3	846561	TRANSISTOR 2N 4920
2	Q1,2	866486	TRANSISTOR 2N 4346
1	VR8	844344	DIODE ZENER 2.4V IN4370
2	VR6,7	822922	DIODE 747
1	VR5	809734	DIODE, ZENER IN756
1	VR4	821972	DIODE, ZENER IN750A
1	VR3	822707	DIODE, ZENER IN742A
2	VR1,2	836043	DIODE, ZENER IN759A
3	CR7,9,12	873157	DIODE, BRIDGE W04
2	CR2,3	873141	DIODE FJT1101
6	CR1,4,5, 8,10,11	838731	DIODE IN4448
2	C36,37	802939	CAPACITOR 2 µF 100V
1	C24	802886	5µF 25V ELECT.
2	C22,23	863516	250µF 50V
2	C20,21	647397	CAPACITOR 1500µF 50V

QTY	ITEM	PART NO.	DESCRIPTION	
2	C 8,25	846735	CAPACITOR	.02µF 50V
2	C17,18	804721		.02µF 500V
1	C16	871036		50µF 250V
1	C15	876441		2µF 50V
13	C4,5,6, 14,27,28, 29,30,31, 32,33,34, 35	835264		.01µF 50V
2	C13,26	804725		.05µF 50V
1	C12	871595		1µF 50V
1	C11	860413		100µF 50V
2	C8,9	804709		.0015µF 100V
2	C7,10	817323		.1µF 50V
1	C3	838426		33pF 500V
1	C2	876713		39pF 500V
1	C1	827474	CAPACITOR	510pF 50V
2	R60,40	822853	RESISTOR	10K ±1%, 1/4W
1	R63	827600		475 ±1%, 1/4W
1	R58	869843		VAR 500, 5% 2W
4	R54,55, 56,57	863858		453±1%, 1/4W
1	R53	823379		10±5%, 1/4W
1	R52	822716		392K±1%, 1/4W
1	R51	825857		15K±1%, 1/4W
1	R50	819667		110Ω±5%, 1/4W
1	R45	817735		100Ω, ±5%, 1/4W
1	R48	823379		10Ω ±5%, 1/4W
1	R44	828912		825K±1%, 1/4W
1	R43	839786		9.76K±1%, 1/4W
2	R41,42	825514	RESISTOR	52.3K±1%, 1/4W

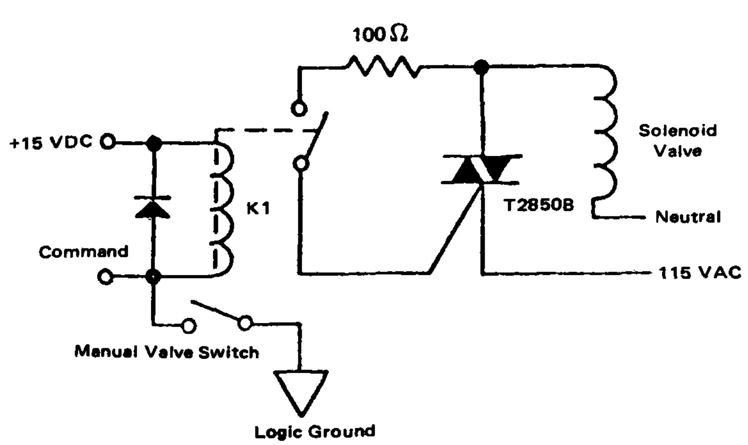
QTY	ITEM	PART NO.	DESCRIPTION	
1	R39	[illegible]5084	RESISTOR	270K ±5%, 1/4W
1	R38	[illegible]22931		200Ω ±5%, 1/4W
1	R36	855053		499K ±1%, 1/4W
1	R35	857609		VAR 10K ±10% 1/2W
1	R33	825324		20K±1%, 1/4W
1	R32	822188		402K ±1%, 1/4W
1	R31	810162		1X 10¹⁰Ω±2%, 1/2W
2	R30,34	822367		51Ω ±5%, 1/4W
2	R28,47	823396		33Ω ±5%, 1/4W
1	R27	847028		VAR 100K ±10% 1/2W
1	R26	863358		54.9K ±1%, 1/4W
1	R23	821325		5K ±1%, 1/4W
1	R22	873367		45K±1%, 1/4W
1	R21	875716		495K ±1%, 1/4W
1	R20	860942		WW VAR 100Ω±5%, 1W
1	R19	825893		200±1%, 1/4W
2	R17,18	823916		1MEG±5%, 1/4W
2	R15,16	819669		300±5%, 1/4W
1	R14	822334		22K±5%, 1/8W
1	R13	823395		470±5%, 1/8W
1	R8	825321		1K, ±1%, 1/4W
1	R7	871615		VAR 500Ω ±10%, 1/2W
1	R6	828897		9.09 K, ±1%, 1/4W
2	R5,10	825858		80K, ±1%, 1/4W
7	R4,11,9, 12,24,25,46	826653		100K, ±1%, 1/4W
1	R3	871615		VAR 500Ω, ±10%, 1/2W
1	R2	818144		5X10⁹Ω ±1%, 1/2W
1	R1	860717	RESISTOR	555X10⁸Ω ±1%, 1/2W
1	14	876718	RECEPTACLE - COAX	

640927 VALVE DRIVER BOARD



The 640927 Valve Driver Board contains four identical valve driver circuits, to operate the slider valves and other switching devices used in the particular analyzer configuration.

A functional diagram of an individual valve driver circuit is shown below.



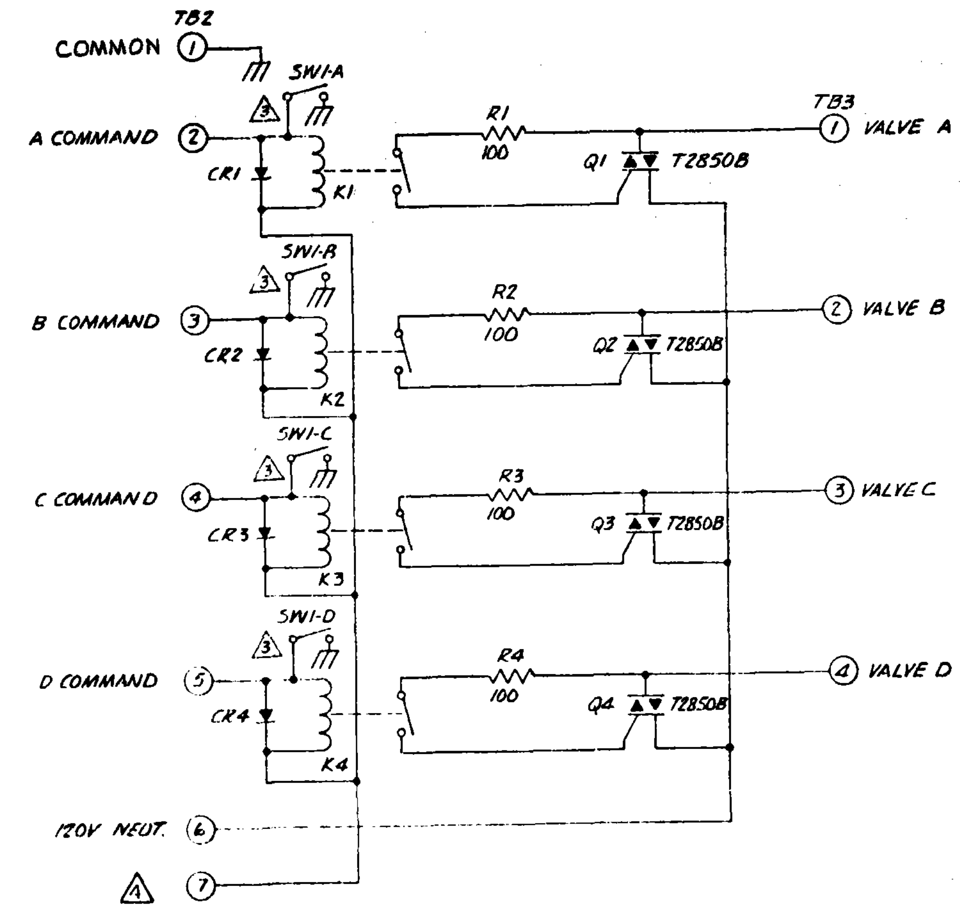
Functional Diagram of Individual Valve Driver Board

Upon receipt of a grounded command from the programmer, or closure of the associated manual valve switch in the analyzer, current flows through relay coil K1, causing relay contacts to close. Current flows through the gate circuit of the TRIAC, causing the TRIAC to conduct and current to flow through the valve solenoid.

In *manual* operation, with the solenoid valves to be actuated by manual valve switches in the *analyzer*, the Mode Switch in the *programmer* should be placed at RESET. Alternatively, the manual vavle switches in the analyzer may be placed at OFF, and each solenoid then actuated by the MANUAL VALVE Switch on the appropriate component board in the programmer.

For *automatic* operation, the manual switches must be placed at OFF. Each solenoid is then actuated by preprogrammed commands from the programmer.

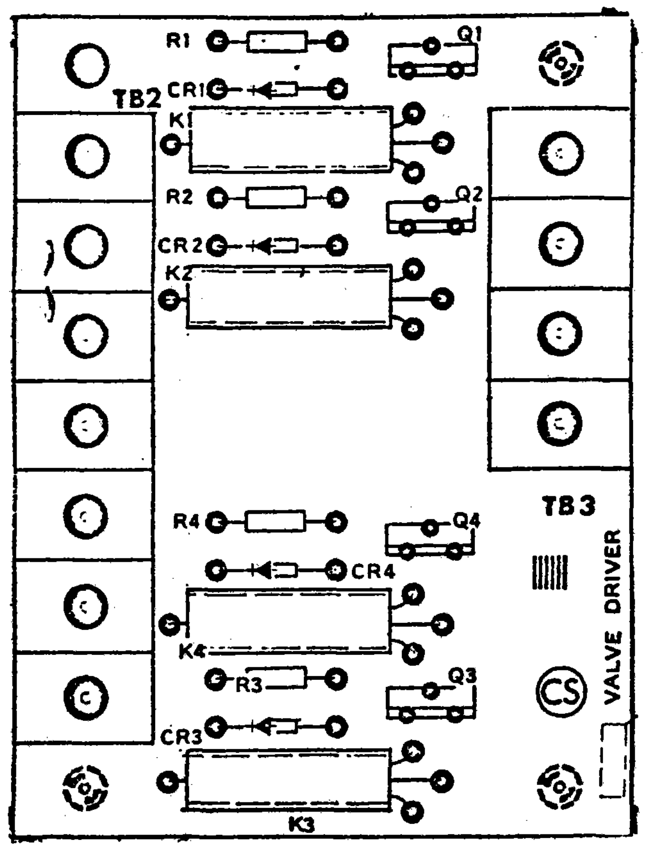
NOTE
Manual valve switch is mounted in lower right-hand corner of analyzer electronics junction box, and is marked with the designation of the associated valve: A, B, C, or D.



4 +15VDC FOR 640927
+5VDC FOR 637195
3 SW1-A - SW1-D NOT USED ON 640927 BOARD ASSY
2 ALL DIODES ARE IN4448
1. ALL RESISTORS ARE IN OHMS 1/4W, ± 10%

TROUBLESHOOTING VALVE DRIVER CIRCUITS

SYMPTOM	PROBABLE CAUSE	TEST
1. Solenoid inoperative.	Defective solenoid.	Check solenoid for continuity.
2. Solenoid chatters when switch is ON.	Failure of TRIAC.	Connect oscilloscope across solenoid. Display of a *half-wave* indicates a defective TRIAC.
3. Solenoid energized when switch is OFF.	Failure of TRIAC or relay.	Turn off power. If resistance of relay contacts is greater than 100 ohms, the TRIAC is defective.



640927	QTY	ITEM	PART NO.	DESCRIPTION
/	1	2	857544	SOCKET 16 PIN I.C.
4	4	Q1,2,3,4	860662	TRIAC, 72850B 1P(?)
4	4	CR1,2,3,4	838731	DIODL, IN4448
4	4	R1,2,3,4	823929	RESISTOR 100 ±10%, 1/4W

SECTION EIGHT PROGRAMMER CIRCUIT BOARDS: SCHEMATIC DIAGRAMS, CIRCUIT DESCRIPTIONS, TEST PROCEDURES, AND COMPONENT PARTS

A pictorial wiring diagram of the programmer unit is given in Figure 8-1. It is followed by individual sheets covering the plug-in circuit boards and other individual circuits, presented in numerical order according to assembly part number. On the front of each sheet are the schematic wiring diagram, circuit descriptions, and test procedures. On the reverse side of the sheet is an assembly drawing with part numbers of individual components.

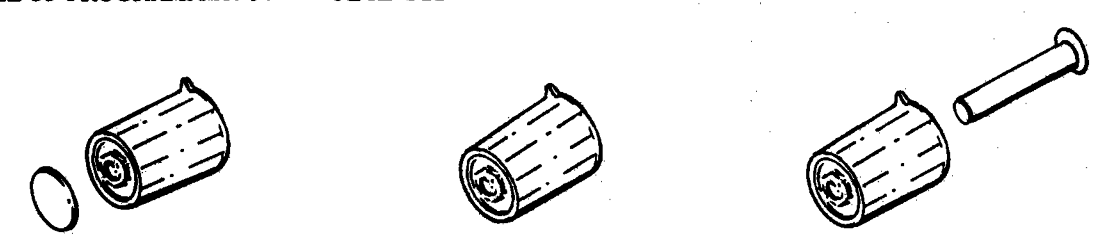
PROGRAMMER CIRCUIT BOARDS

Beckman Part No.	Description
632078	Stream Display Assembly
632084	Stream Select Control Board
632145	Front-Panel Display
632163	Triple Component Board
632172	Dual Reset Board
632175	High/Low Alarm Board
632178	Computer Driver Board
632184	Integrator Board
632187	Dual V/I Current Output Board (4 to 20 mA)
632190	Current Output Assembly
632196	Digital Timer Board
634109	Peak-Picker Board
634112	Pneumatic Trend Contact Board
634115	Dual Component/Memory Board
634121	Power Distribution Board
635016	Memory Voltage Trend Output Assembly
635019	Pneumatic Trend Output Board
635037	Long-Term Memory Board
635040	I/P One Valve-Driver Board
635263	Universal Latch Board
635411	I/P Three Valve-Driver Board
635412	I/P Six Valve-Driver Board
636042	Dual Component/Function-Select Single Timer Board
636567	Switchboard Assembly
636594	Time (Seconds) Display Board
636661	Summation Amplifier Board
636945	Computer Terminal Assembly (Compatible with Ten-Point Stream Selector)
636966	Dual Component/Memory Board (Used with 636661 Summation Amplifier Board, to provide trend lines 7 through 10)
637149	Dual Component/Function-Select Board
637910	Function Select Board
638386	Integrator Control Board
638493	Digital-Timer/Logic-Test Board
639761	Power Supply Board
640411	Universal Component Board
640908	Master Control Board
640915	Dual Valve/Function-Select Board
640916	Single-Component/Single-Valve Board
640922	Basic Terminal Assembly
640932	Master Board (13-Receptacle)
640937	Master Board (7-Receptacle)

USE OF 635498 EXTENDER BOARD

The 635498 Extender Board is recommended for checkout and troubleshooting of the programmer unit. The extender board permits convenient, temporary connection to the pins of a desired plug-in circuit board. The extender board plugs into any receptacle J2 on the master board, and receives the board that is to be tested. All 100 lines on the master board are brought out to test points for monitoring.

REMOVAL OF PROGRAMMER CONTROL KNOBS



1. Pull Cap of Knob Outward Away from Panel
2. Loosen Nut with Driver
3. Pull Knob Off Shaft

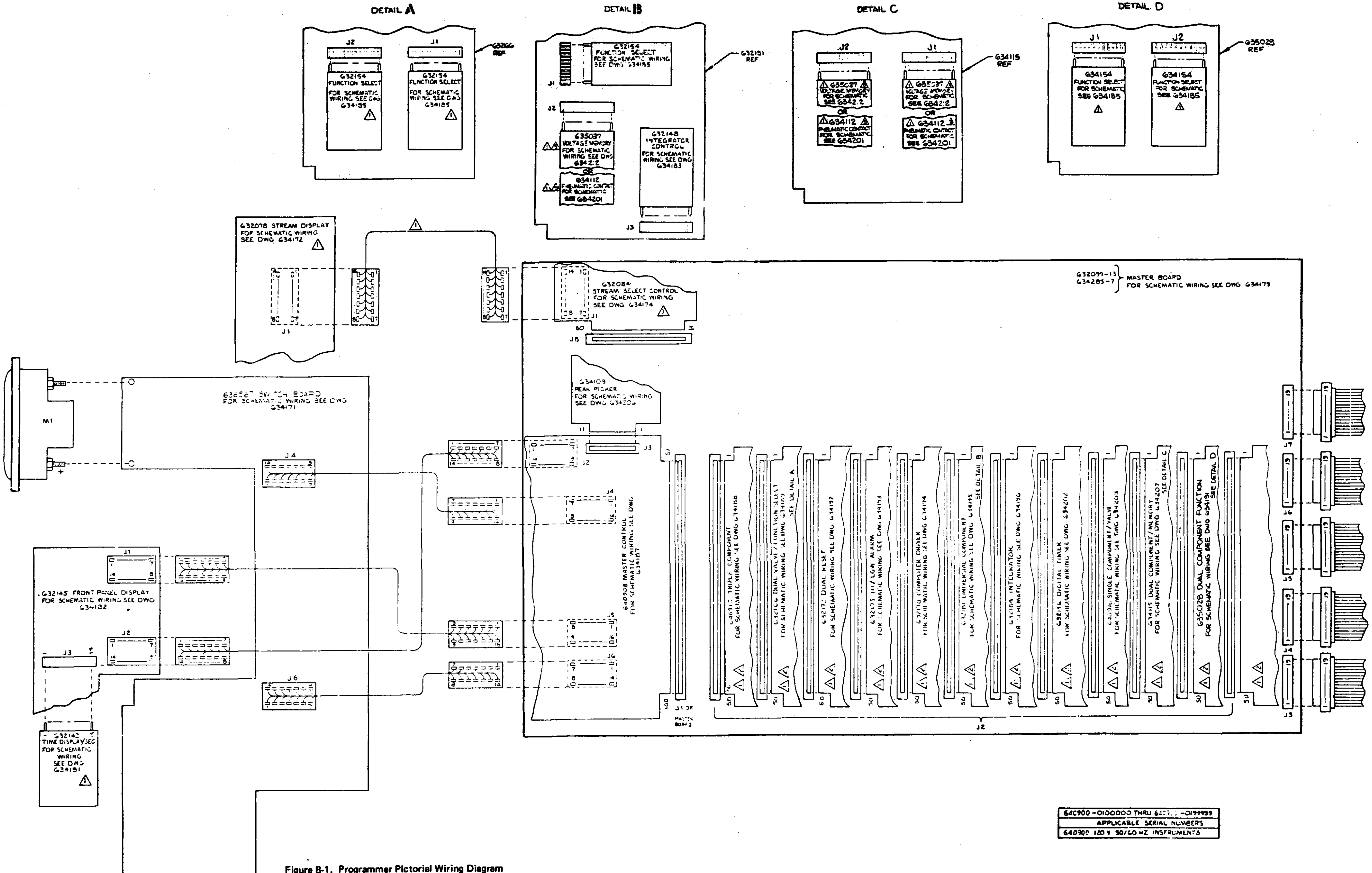
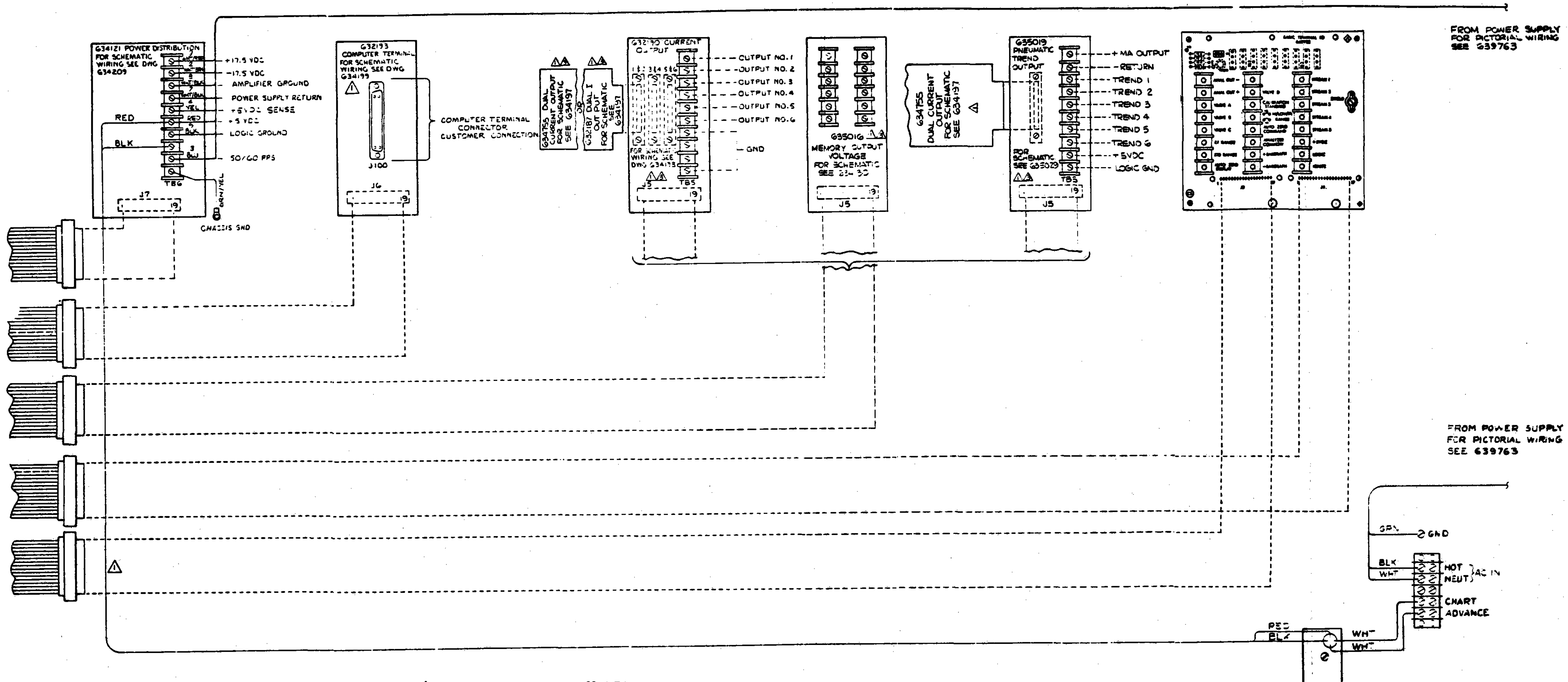


Figure 8-1. Programmer Pictorial Wiring Diagram

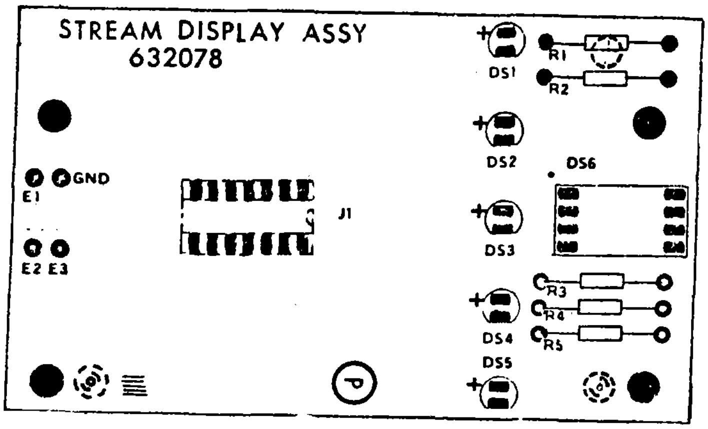


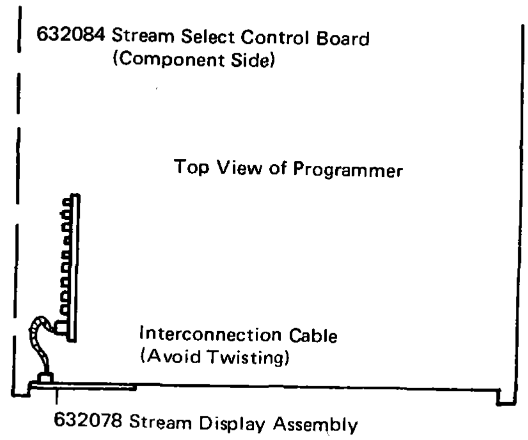
⚠3 SELECTED DEPENDING UPON APPLICATION.

⚠2 ORDER OF BOARD ASSEMBLIES NOT IMPORTANT. BOARD ASSEMBLY MAY BE PLUGGED IN ANY CONNECTOR SLOT.

⚠1 OPTIONAL ITEM AS ORDERED.

632078 STREAM DISPLAY BOARD (Five-Point Stream Selector)





The 632078 Stream Display Board and the 632084 Stream Select Control Assembly, interconnected by a flexible cable, constitute the Five-Point Stream Selector. The two units are used in combination to provide the following functions:

1. Commands to the Sample Conditioner Unit to activate one of five sample streams.
2. Identification, on the recorder chart, of the stream being analyzed.
3. Activation/deactivation for any combination of the five streams.
4. Stream memory for functions that are stream-related.
5. Front-panel AUTO/HOLD/MANUAL STEP Switch, permitting automatic or manual selection of streams, or retention of a stream for repetitive analyses.
6. Front-panel digital display of the stream being analyzed, when AUTO/HOLD/MANUAL STEP Switch is in AUTO position.

OPERATION

The 632084 Stream Select Control Assembly, shown on the following page, has five on-off toggle switches. These are used to place the desired streams on ACTIVE status, for inclusion in the automatic or manual sampling sequence. Closure of a given switch places the associated stream on ACTIVE status, and causes illumination of the corresponding numeral in the area marked ACTIVE on the front-panel STREAM Indicator.

For automatic operation, the front-panel AUTO/HOLD/MANUAL STEP Switch of the 632078 Stream Display Board is placed in AUTO position. The numeral then on display beneath the STREAM legend will *remain* on display until after completion of the anaysis then in progress. Which stream *will next be analyzed depends on* whether the switch was moved to AUTO before or after occurrence of the STREAM TRIGGER command. This command originates on one of the programmed valve control boards.

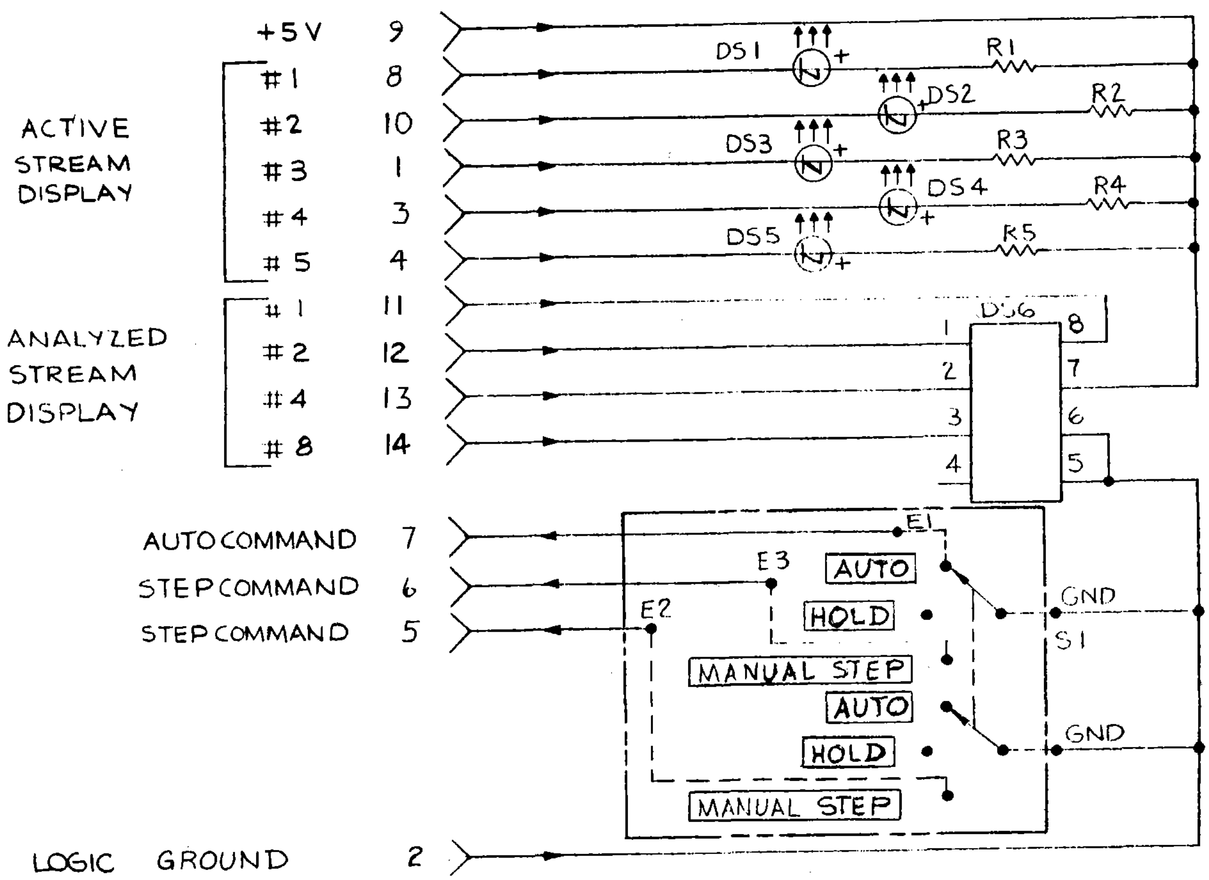
MANUAL STEPPING SEQUENCE

When the front-panel AUTO/HOLD/MANUAL STEP Switch is placed in MANUAL STEP position, the selector will advance sequentially through all stream numbers, including those of streams *not* on ACTIVE status. During this sequence, the solenoid valves for all streams are deenergized.

When the switch is moved to HOLD, the sequence stops at the stream whose number is then on display, and remains there until the switch is moved to another position. If the stream thus selected is on ACTIVE status, it will purge while the switch remains in HOLD position. If the selected stream is inactive, it will not purge although its number will be displayed.

LOGIC CIRCUITRY

For an explanation of logic circuitry of the Five-Point Stream Selector, refer to 632084 Stream Select Control Assembly, on following sheet.

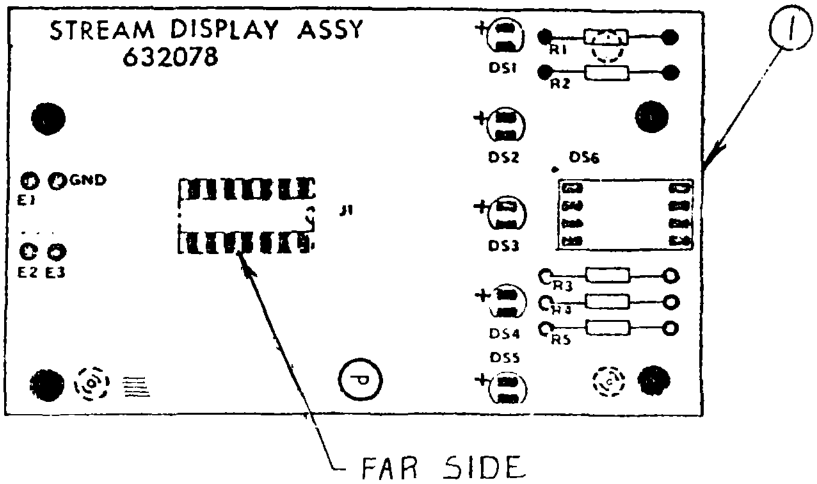


3. DS6 IS LED. DISPLAY HP. #5082-7300

2. DS1-DS5 ARE L.E.D. DIODE # FLU 104.

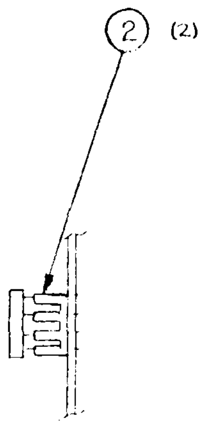
1. ALL RESISTORS ARE 150 OHMS, ± 5%, 1/4 W.

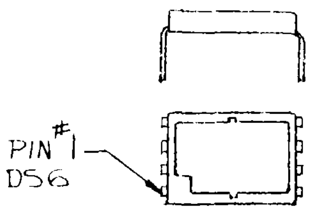
NOTES: UNLESS OTHERWISE SPECIFIED



2. J1 INSTALLED ON WIRING SIDE OF BOARD.

1 POLARITY OF LED DETERMINED BY FLAT SIDE OF DEVICE.

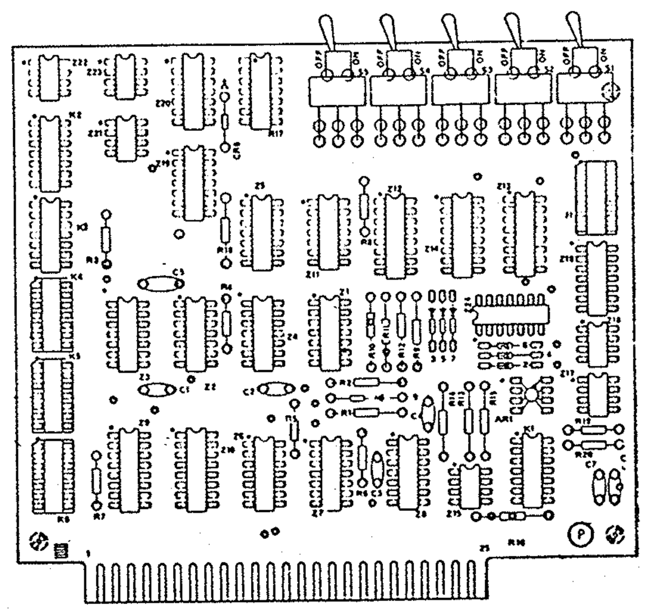




DETAIL A
BOTTOM VIEW

	QTY	ITEM	PART NO.	DESCRIPTION
	2	2	876422	SOCKET, D.I.P. SPRINGS
	1	J1	857545	SOCKET, I.C. 14 PIN
	1	DS6	876110	DISPLAY
E	5	DS12345	860444	DIODE, LIGHT EMITTING
	5	R12345	823391	RESISTOR, 150 Ω, 5%, 1/4W

632084 STREAM SELECT CONTROL ASSEMBLY (Five-Point Stream Selector)



The 632084 Stream Select Control Assembly and the 632078 Stream Display Board, interconnected by a flexible cable, constitute the Five-Point Stream Selector. For a brief functional description of the Five-Point Stream Selector, refer to 632078 Stream Display Board, on preceding page.

LOGIC CIRCUITRY

Timing for the five-Point Stream Selector is included in the Start-of-Analysis Timing Sequence discussed with the 640908 Master Control Board. As shown, the Five-Point Stream Selector functions during the ten-second interval from t = 008 to t = 018.

STREAM MEMORY UPDATE

Stream memory is updated at the first clock AA pulse that occurs after t = 008. Stream memory update is provided by AND-gate Z19A. Its two inputs are clock AA and the STREAM I.D. command. The output of Z19A causes the contents of Z12 to be transferred into Z13, where this new stream information is stored.

CHART ADVANCE, STREAM IDENTIFICATION, AND STREAM ACTIVATION COMMANDS

At the first clock BB pulse after time 008, flip-flops Z7 and Z8 set. Flip-flop Z7 causes chart advance. Flip-flop Z8 activates relay K1, thus routing the stream-identification signal from AR1 to the resistor network associated with the front-panel ATTENUATION Switch. The stream-identification signal will now appear on the recorder chart, provided that the ATTENUATION Switch is at AUTO. The recorder reading should be 10% of fullscale for stream 1, 20% for stream 2, etc. The chart-advance and stream-identification signals will continue until flip-flops Z7 and Z8 are reset by the outputs from Z10. Counter Z9, when enabled by flip-flop Z7, counts clock AA pulses. Z10 is a one-of-ten decoder that converts the BCD information from Z9 into ten outputs, which are used to reset Z7 and Z8.

The STREAM TRIGGER command originates on a valve control board, Paragraph 2.5.1. Normally, this command is provided by the same circuit that is programmed to actuate a slider valve in the analyzer. The STREAM TRIGGER command does not activate stream memory; therefore, a programmed time of greater than 008 must be used for the stream trigger function.

The STREAM TRIGGER command is applied simultaneously to flip-flop Z3. When the command occurs, the input to Z2A goes to logic zero. Z2A inverts this signal, causing Z3A to set. Z3B will now set after the next pulse of clock AA. The combination of Z3B and Z2B functions as a one-shot which provides a one-second pulse at pin 6 of Z2B. This pulse causes Z4A to set, and allows counter Z12 to advance.

Counter Z12 advances until it reaches the count that corresponds to the next *active* stream. This condition is sensed by Z19B, which causes Z4A to reset, thus removing the enable command from counter Z12 and stopping the counting.

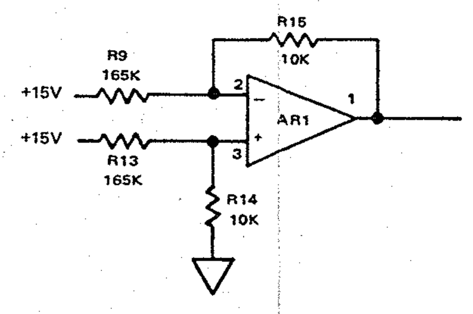
Z12 is a decade (0-to-9) counter. It counts to five, and is then reset to zero by gates Z11, A, B, and C.

Z14 is a 1-of-10 decoder. It converts the BCD output of Z12 into ten discrete outputs, of which only five are utilized in the present application. Each of these five outputs is connected to Z19B through the corresponding stream-activation toggle switch. If a given switch is open, Z19B cannot sense the corresponding output from Z14, and thus cannot cause Z4A to set.

When Z12 has stopped counting, Z14 decodes the counter value and causes the associated stream command to occur. Note that gates Z21, Z22, and Z23 all have one input derived from the STEP COMMAND and STREAM OVERRIDE. This arrangement allows the stream commands to be disabled when the AUTO/HOLD/MANUAL STEP Switch is at MANUAL STEP, or when the CALIB STD Switch is ON.

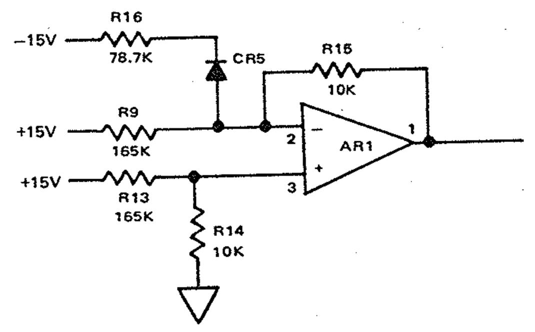
STREAM IDENTIFICATION SECTION

To clarify operation of the stream identification function, consider the following examples. With all streams off, the output at pins 4, 5, and 11 of Z13 are in logic 1 state (i.e., +5 volts d.c.). This causes CR2, CR4, and CR6 to conduct, which causes CR3, CR5, and CR7 to become nonconductive. In effect, the configuration of stream identification amplifier AR1 and associated elements is now as shown below.

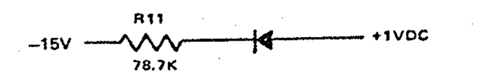


In this configuration, the voltage divider consisting of R13 and R14 applies +1-volt d.c. to the positive input (i.e., pin 3) of AR1. Since the voltages at the positive and negative junctions must be equal, the junction at pin 2 of AR1 must also be at +1-volt d.c. Thus the output must be 0 volts d.c. Current through R9 is 100 microamperes, as is the current through R15.

Now assume that bit 2 is on, i.e., at logic zero. CR5 is now nonconducting, and the configuration is effectively as shown below.



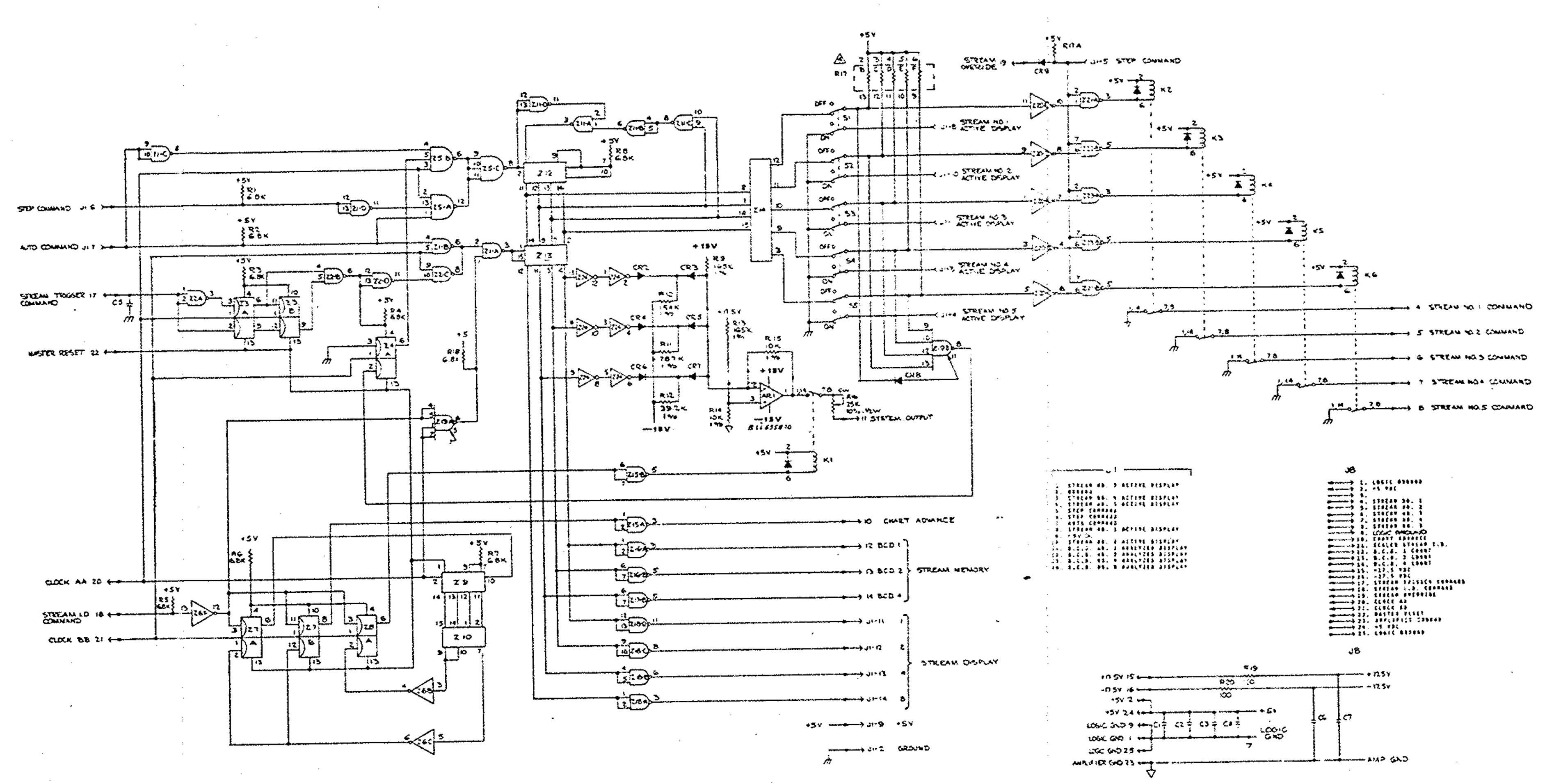
In the first example, current through R9 was 100 microamperes. Since the junction at pin 2 of AR1 must remain at +1-volt d.c., the current through R9 must still be 100 microamperes. The current required through R11 must come from the amplifier output, and may be approximated as shown below.

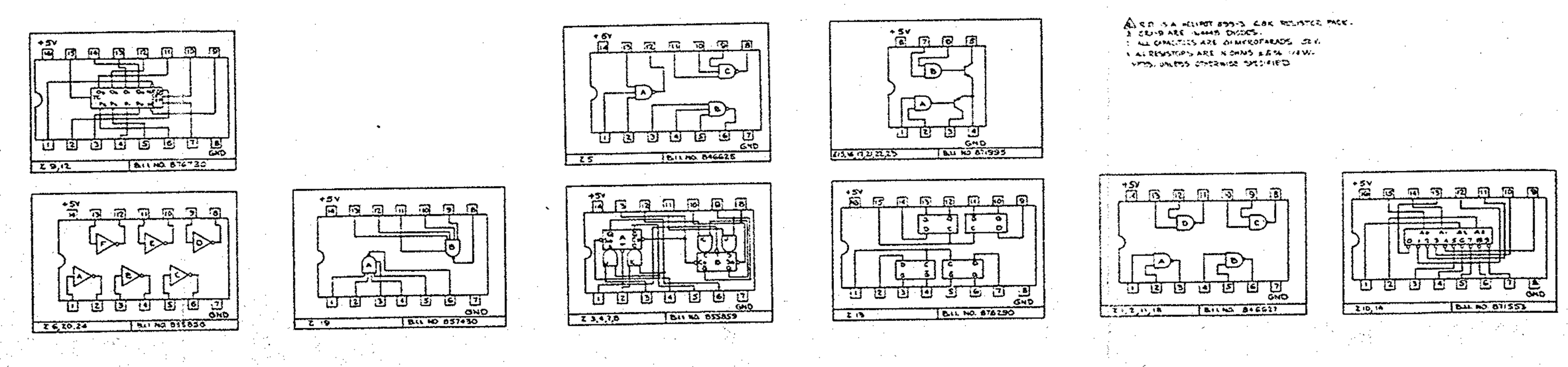


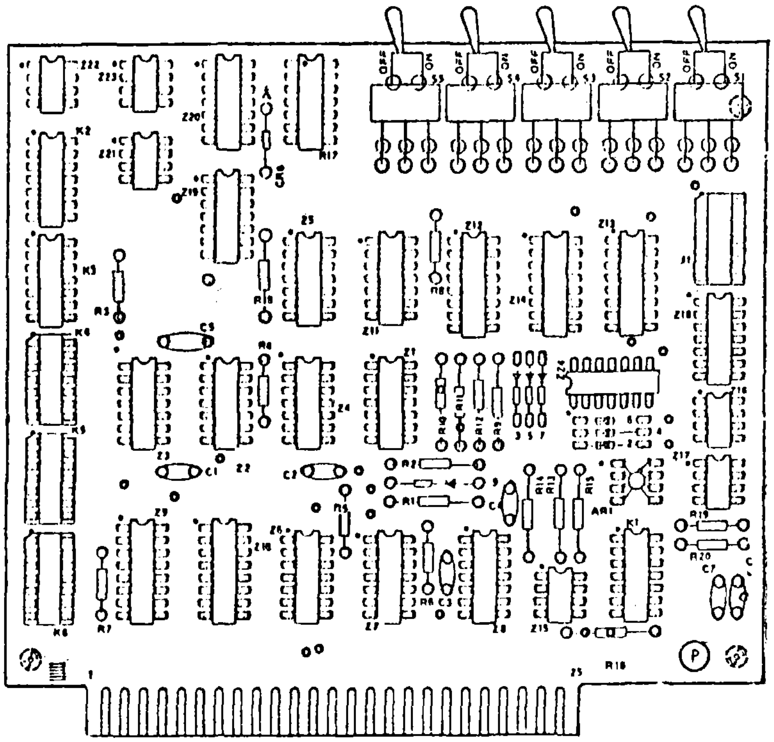
Note that resistances of R10 and R11 differ by a factor of two, as do also R11 and R12. Thus the corresponding outputs obtained from Z13 also differ by the same factor.

The analog output from AR1 is presented to the attenuator bus when relay K1 closes, in response to a stream identification command from flip-flop Z8.

Gates Z15, Z16, A17, and Z18 are drivers that provide commands to other areas of the programmer.

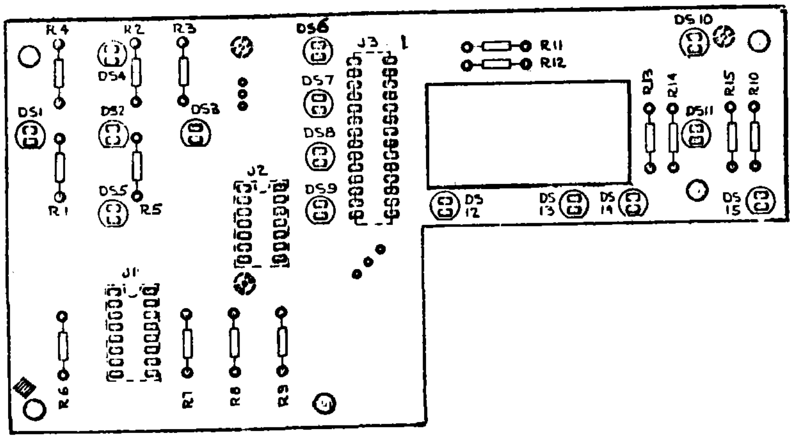




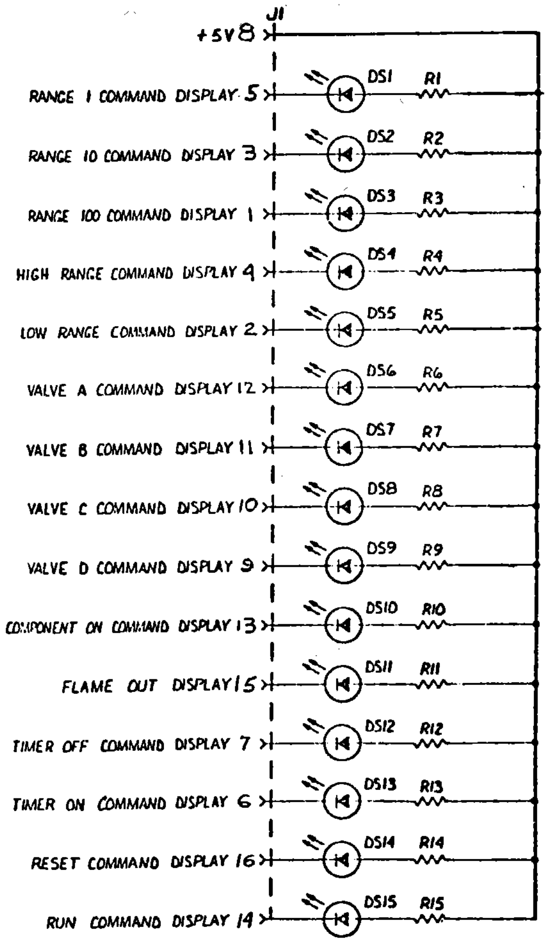


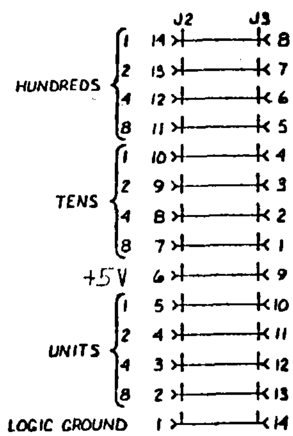
QTY	ITEM	PART NO.	DESCRIPTION
1	Z13	857430	CIRCUIT, INTEGRATED 844P
6	Z15,16,17, 21,22,23	871995	SN75452P
1	Z13	876290	MC1813P
2	Z10,14	847220	9301
2	Z9,12	876730	9310
3	Z6,20,24	855858	836
1	Z5	846625	862
4	Z3,4,7,8	855859	852
4	Z1,2,11,18	846627	CIRCUIT, INTEGRATED 846
8	CR2-9	838731	DIODE - IN4448
1	AR1	635870	AMPLIFIER - SN 72558
5	S1-5	876431	SWITCH, TOGGLE
3	K1-3	633112	RELAY, FORM 1A
7	C1-7	836864	CAPACITOR, 0.01μF, 50V
2	R19,20	825879	RESISTOR, 100Ω, ±1%, 1/4W
1	R17	871949	PACK 899-3, 6.8K
1	R16	828904	21.5K ±1% 1/4W
2	R14,15	822883	10K, ±1%, 1/4W
1	R12	863118	39.2K, ±1%, 1/4W
1	R11	824147	78.7K, ±1%, 1/4W
1	R10	855116	154K, ±1%, 1/4W
2	R9,13	876188	165K, ±1%, 1/4W
9	R1-8,18	822293	RESISTOR, 6.8K, ±5%, 1/4W
4	Z	857545	SOCKET, I.C. 14 PIN

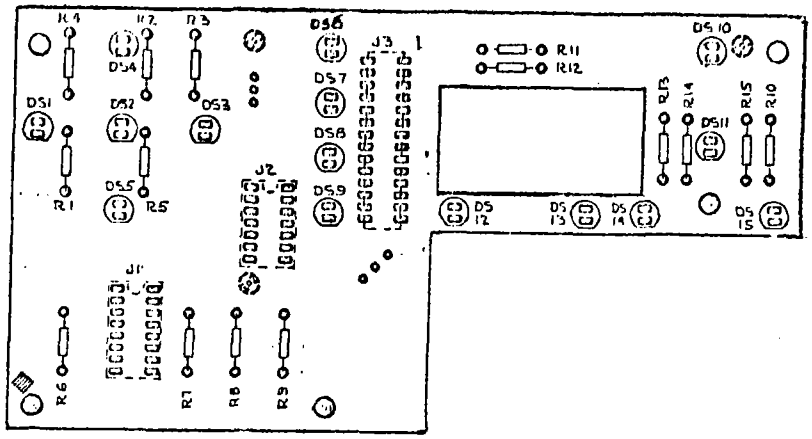
632145 FRONT-PANEL DISPLAY



This circuit board provides the light-emitting diode (LED) indicators for the various functions indicated on the programmer front panel.





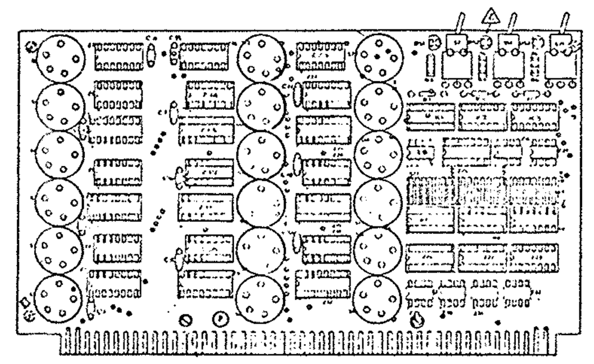


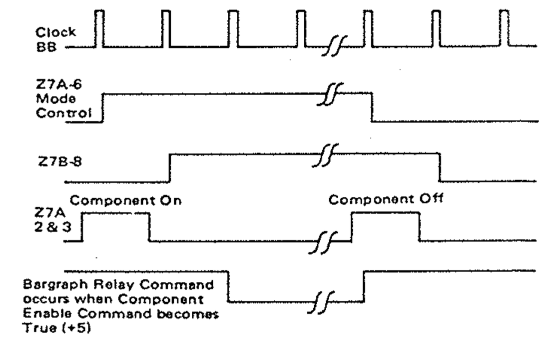
NOMENCLATURE — BACKSIDE
J1 — J2 — J3 ——— BACKSIDE

1. POLARITY OF LED DETERMINED BY FLAT SIDE OF DEVICE.

	QTY	ITEM	PART NO.	DESCRIPTION
	1	J3	816099	CONNECTOR 14 PIN
	1	J2	857545	SOCKET I.C. 14 PIN
	1	J1	857544	SOCKET I.C. 16 PIN
E	15	DS1-15	860403	DIODE, LIGHT EMITTING
	15	R1-15	823391	RESISTOR, 150 Ω, 5%, 1/4W
	1	1	632144	BOARD, PRINTED WIRING

632163 TRIPLE COMPONENT BOARD





Typical ON-OFF Timing Sequence for Component 1

This board contains three identical component-timing sequence sections. The first section is described below. Functioning of the other two sections is identical; however, circuit designations differ.

COMPONENT NO. 1 TIMING SEQUENCE SECTION

This section contains the following selectable functions:

1. **Component ON-OFF Timing.** During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.
2. **MAN/AUTO/STATUS Switch S7.** MAN position activates component attenuator R2 and causes DS1 to illuminate. The amplifier signal will be displayed on the recorder, provided that the ATTENUATION Switch on the programmer front panel is at AUTO.

   AUTO position places the component functions under preprogrammed control.

   STATUS is a test position, used *momentarily*, to check programming of component functions. While holding switch at STATUS, observe indicators on master board. Do not check status during automatic operation.
3. **COMPONENT ATTENUATOR R2.** Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but *not* trend) data presentation.

OUTPUT SELECTOR STAGE

The following functions are selected with switches S22 through S24:

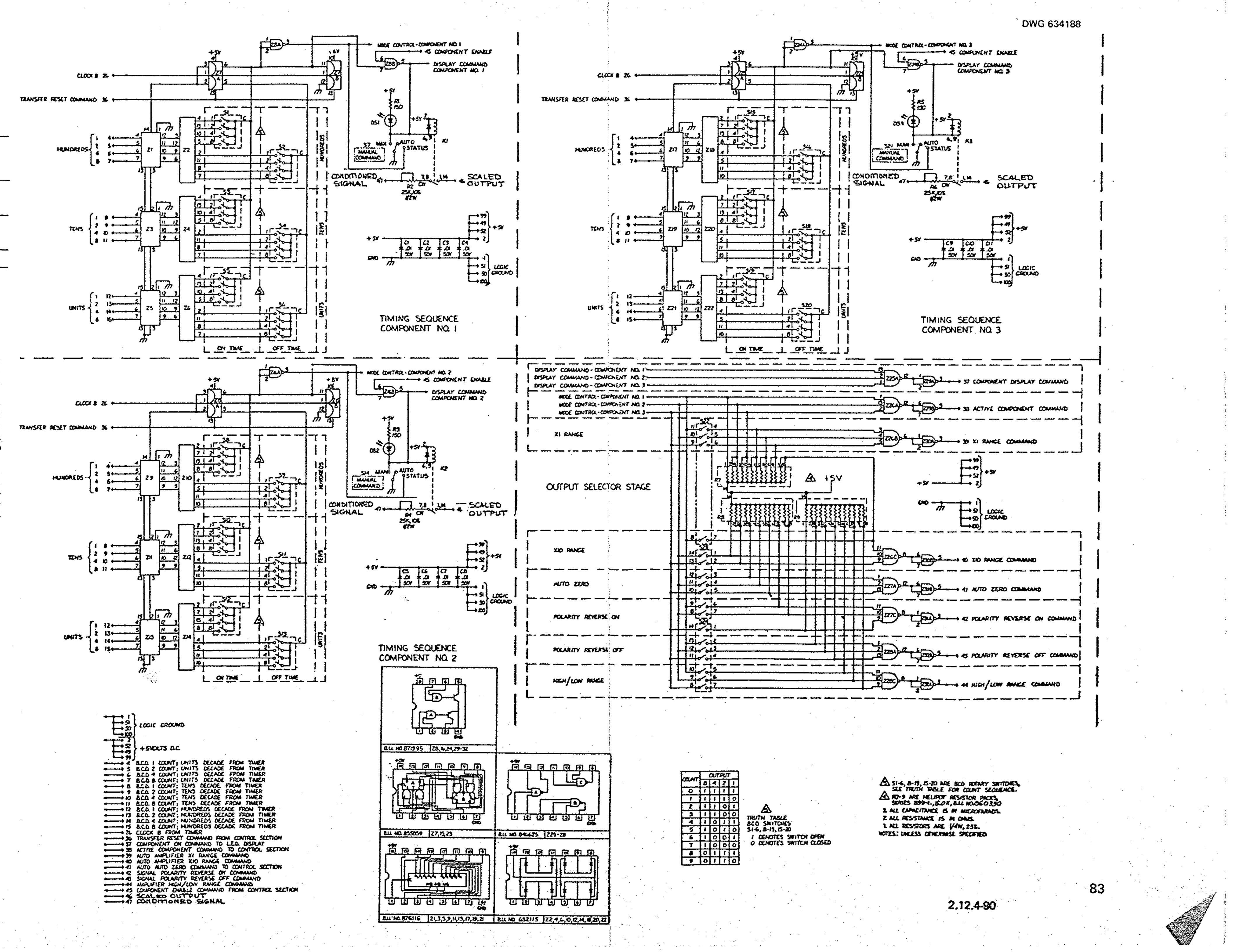
1. **X1 RANGE Switch.** Selects gain of 1000 for TC amplifier or gain of 100 for FID amplifier.
2. **X10 RANGE Switch.** Selects gain of 100 for TC amplifier or gain of 10 for FID amplifier.
3. **AUTO ZERO Switch ON.** During automatic operation, an autozero function will occur approximately three seconds before activation of the COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.
4. **POLARITY REVERSE ON Switch.** Reverses the polarity of the signal in the 640324 TC Detector Electronics Board if analyzer is so equipped.
5. **POLARITY REVERSE OFF Switch.** Turns off the polarity-reverse circuit.
6. **HIGH/LOW Range Switch.** HIGH position provides 1000X attenuation of output signal from FID amplifier. Switch is inoperative with TC amplifier.

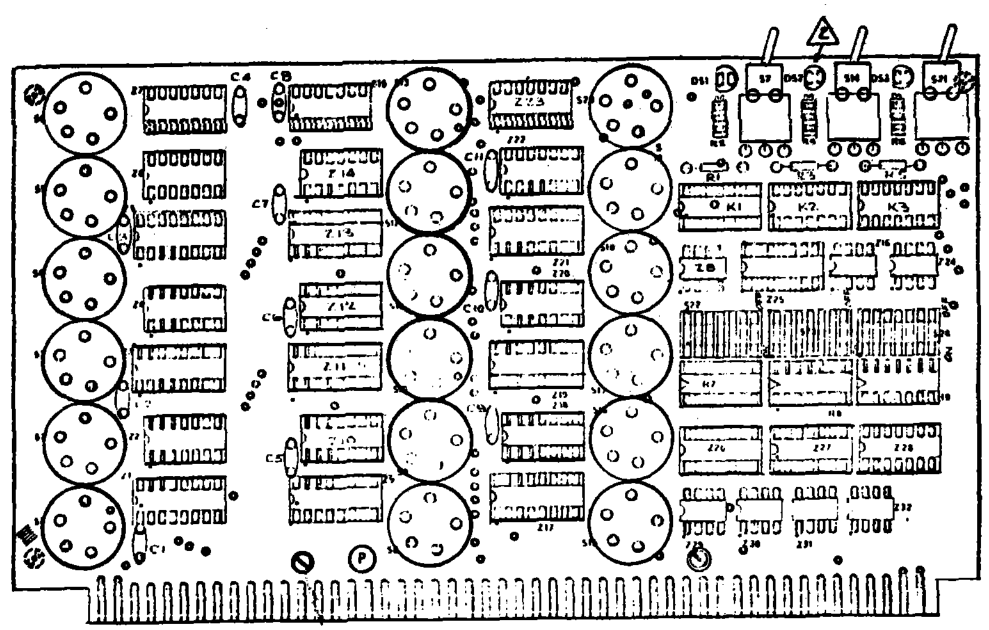
COMPONENT NO. 1 ON-OFF SEQUENCE

At the programmed COMPONENT ON time, pin 6 of Z7A goes to +5 volts d.c., causing all closed functions on Switches S22 through S24 to be energized by Z8A. The next pulse of clock B causes Z7B to go to the set state.

As Z7A is set, the component sequence begins and the COMPONENT. ENABLE command is transmitted from the 640908 Master Control Board. This command causes energization of component relay K1, and routing of the data signal through component attenuator R2. Simultaneously, the COMPONENT ON indicator on the programmer front panel is energized by pin 5 of Z8B.

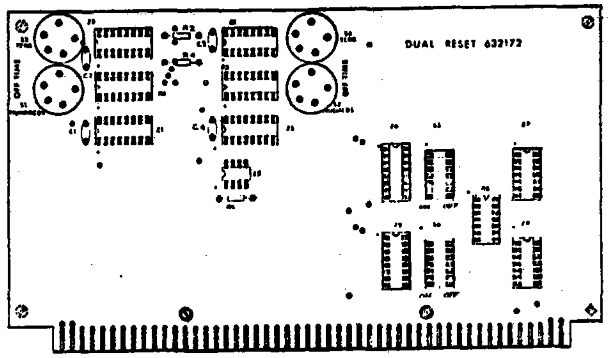
When the programmed COMPONENT OFF time occurs, Z7A goes to the reset state; i.e., pin 6 goes to 0 volts d.c. (Logic Zero). This deactivates component attenuator R2 and the functions selected on Switches S22 through S24. However, Z7B remains in the set state until reset by the TRANSFER RESET COMMAND on pin 36.



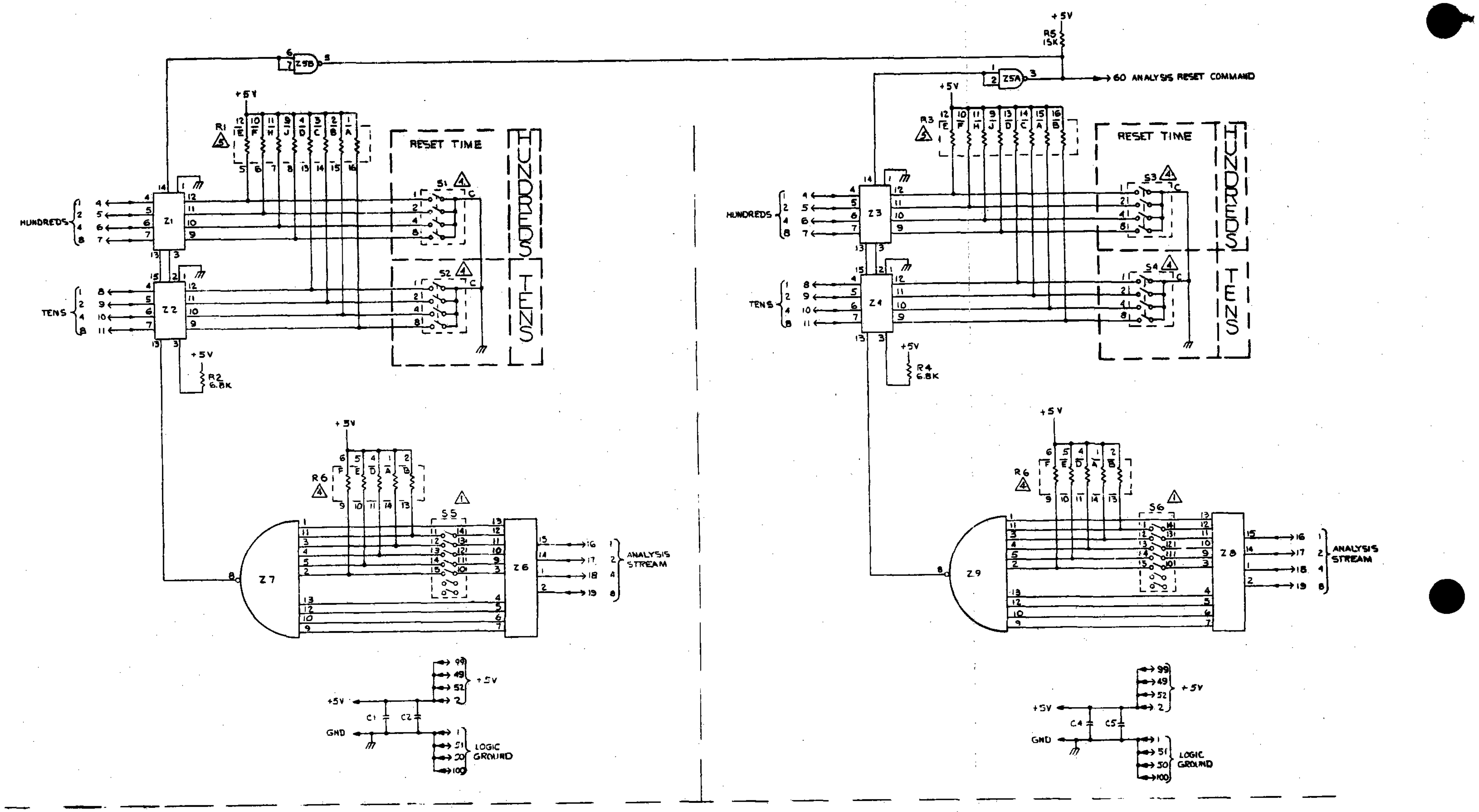


QTY	ITEM	PART NO.	DESCRIPTION
4	Z 25,26 Z 27,28	846625	CIRCUIT, INTEGRATED - 862 P
7	Z 8,16,24 29,30 31,32	871995	CIRCUIT, INTEGRATED SN 75452 P
3	Z 7,15,23	855859	CIRCUIT, INTEGRATED 852 P
9	Z 2,4,6 10,12,14 18,20,22	632115	CIRCUIT, INTEGRATED
9	Z 1,3,5 9,11,13 17,19,21	876116	CIRCUIT, INTEGRATED - 93L 24
3	S22,23,24	876111	SWITCH, DUAL-IN-LINE
3	S7,14,21	876672	SWITCH, TOGGLE
18	S1-6 S8-13 S15-20	876119	SWITCH, ROTARY - B.C.D
3	K1,2,3	633112	RELAY, FORM 1A
11	C1-11	836864	CAPACITOR .01 µF 50 V
3	DS1,2,3	860444	DIODE, LIGHT EMITTING
3	R7,8,9	860330	RESISTOR PACK, 15.0K [illegible]
3	R2,4,6	876534	RESISTOR, VAR 25K 10% [illegible]
3	R1,3,5	823391	RESISTOR 150Ω 5% 1/4 W

632172 DUAL RESET BOARD



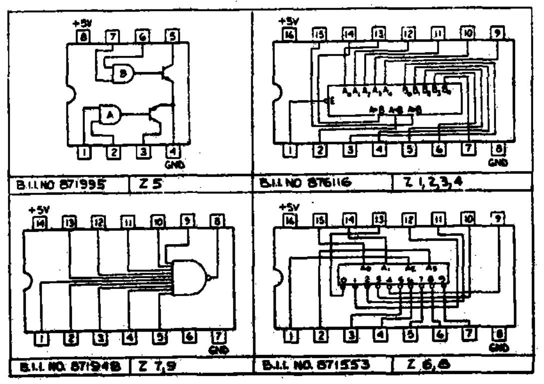
The 632172 Dual Reset Board is used in conjunction with the Five-Point Stream Selector, to provide the capability of two independently selectable ANALYSIS RESET times, designated I and II. STREAM SELECT switches permit assigning any desired stream(s) to RESET TIME I and any other desired stream(s) to RESET TIME II. The cycle reset on timer must be set to a greater number than either of the above reset times.



COUNT	OUTPUT			
	8	4	2	1
0	1	1	1	1
1	1	1	1	0
2	1	1	0	1
3	1	1	0	0
4	1	0	1	1
5	1	0	1	0
6	1	0	0	1
7	1	0	0	0
8	0	1	1	1
9	0	1	1	0

4
TRUTH TABLE
BCD SWITCHS
S1-4

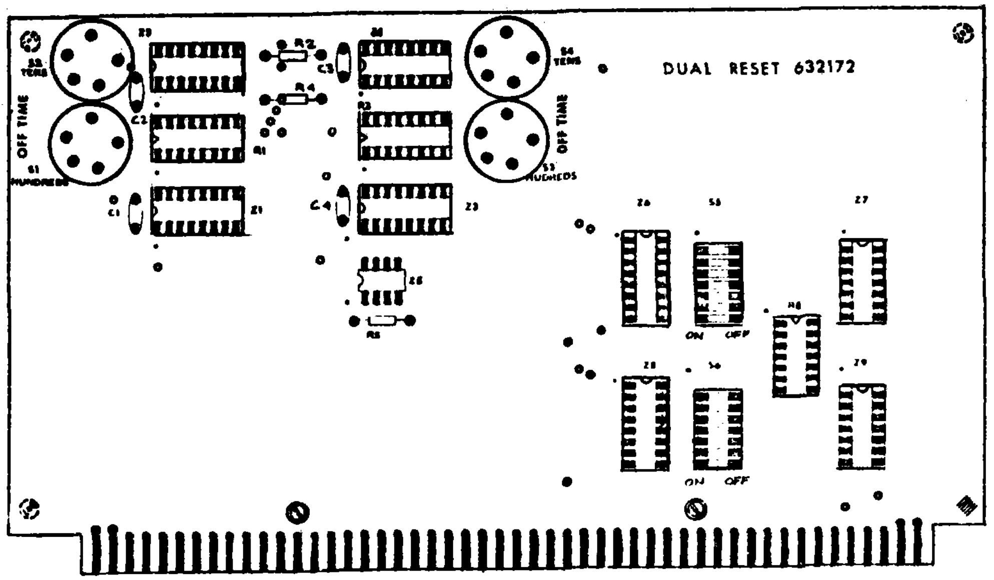
1 DENOTES SWITCH OPEN
0 DENOTES SWITCH CLOSED



1, 51, 50, 100 LOGIC GROUND

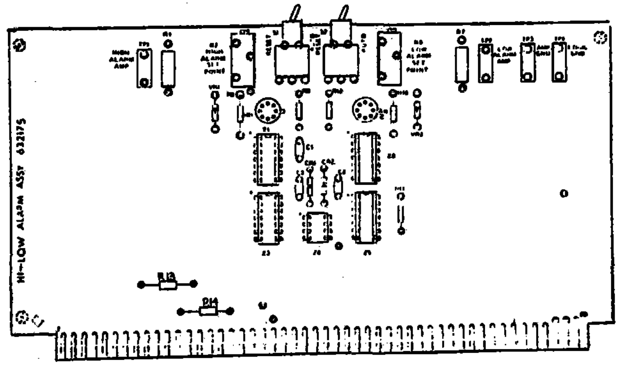
2, 52, 49, 99 +5 VOLTS D.C.

- 4. B.C.D. 1 COUNT HUNDREDS DECADE FROM TIMER
- 5. B.C.D. 2 COUNT HUNDREDS DECADE FROM TIMER
- 6. B.C.D. 4 COUNT HUNDREDS DECADE FROM TIMER
- 7. B.C.D. 8 COUNT HUNDREDS DECADE FROM TIMER
- 8. B.C.D. 1 COUNT TENS DECADE FROM TIMER
- 9. B.C.D. 2 COUNT TENS DECADE FROM TIMER
- 10. B.C.D. 4 COUNT TENS DECADE FROM TIMER
- 11. B.C.D. 8 COUNT TENS DECADE FROM TIMER
- 16. B.C.D. 1 COUNT STREAM BEING ANALYZED FROM STREAM SELECTOR
- 17. B.C.D. 2 COUNT STREAM BEING ANALYZED FROM STREAM SELECTOR
- 18. B.C.D. 4 COUNT STREAM BEING ANALYZED FROM STREAM SELECTOR
- 60. ANALYSIS RESET COMMAND



QTY	ITEM	PART NO.	DESCRIPTION
2	S5,6	876111	SWITCH, DUAL-IN-LINE
4	S1,2,3,4	876119	SWITCH, ROTARY B.C.D
2	Z7,9	857575	CIRCUIT, INTEGRATED SN7430N
2	Z6,8	871553	CIRCUIT, INTEGRATED 93L01
1	Z5	871995	CIRCUIT, INTEGRATED SN75452P
4	Z1,2,3,4	876116	CIRCUIT, INTEGRATED 93L[illegible]
4	C1,2,3,4	836864	CAPACITOR, .01 MFD - 50V
1	R6	876121	RESISTOR PACK, 899-1, 6.8K-2%
1	R5	823107	RESISTOR, 15 K, 5%, 1/4W
2	R2,4	822299	RESISTOR, 6.8K, 5%, 1/4 W
2	R1,3	876315	RESISTOR PACK, 898-3, 6.8K, 2%

632175 HIGH/LOW ALARM BOARD



HIGH ALARM CIRCUIT

Amplifier AR1 compares the signals applied to its two input pins:

1. Pin 3 receives the scale output signal from the assigned Universal Component Board, via pin 46 on the High/Low Alarm Board.
2. Pin 2 receives a voltage that is determined by setpoint adjustment R2.

If the signal on pin 3 exceeds that on pin 2, a high alarm condition occurs, causing flip-flop Z3 to set, and gate Z4A to transmit a HIGH ALARM RELAY command to a relay on the Computer/Alarm Terminal Assembly.

After occurrence of a high alarm condition, the circuit is reset by moving Switch SW1 momentarily to RESET and then back to AUTO. An external reset line is provided on J2-88.

LOW ALARM CIRCUIT

Amplifier AR2 compares the signal applied to its two input pins:

1. Pin 3 receives the scale output signal from the assigned component board, via pin 46 on the High/Low Alarm Board.
2. Pin 2 receives a voltage that is determined by setpoint adjustment R8.

When the *component* function occurs, flip-flop Z5A is set. If the peak value for the component exceeds the setpoint, Z5A is reset, resulting in a nonalarm condition.

If the component peak value fails to exceed the setpoint, Z5A is not reset, and the output from Z5A enables flip-flop Z5B. When the programmed COMPONENT OFF time occurs, it sets Z5B. The output from Z5B and the LOW ALARM COMPONENT COMMAND are applied to the inputs of AND-gate Z4B. Gate Z4B transmits a LOW ALARM RELAY COMMAND to a relay on the 636945 Computer/Alarm Terminal Board. A reset command may be generated externally at the computer output terminal.

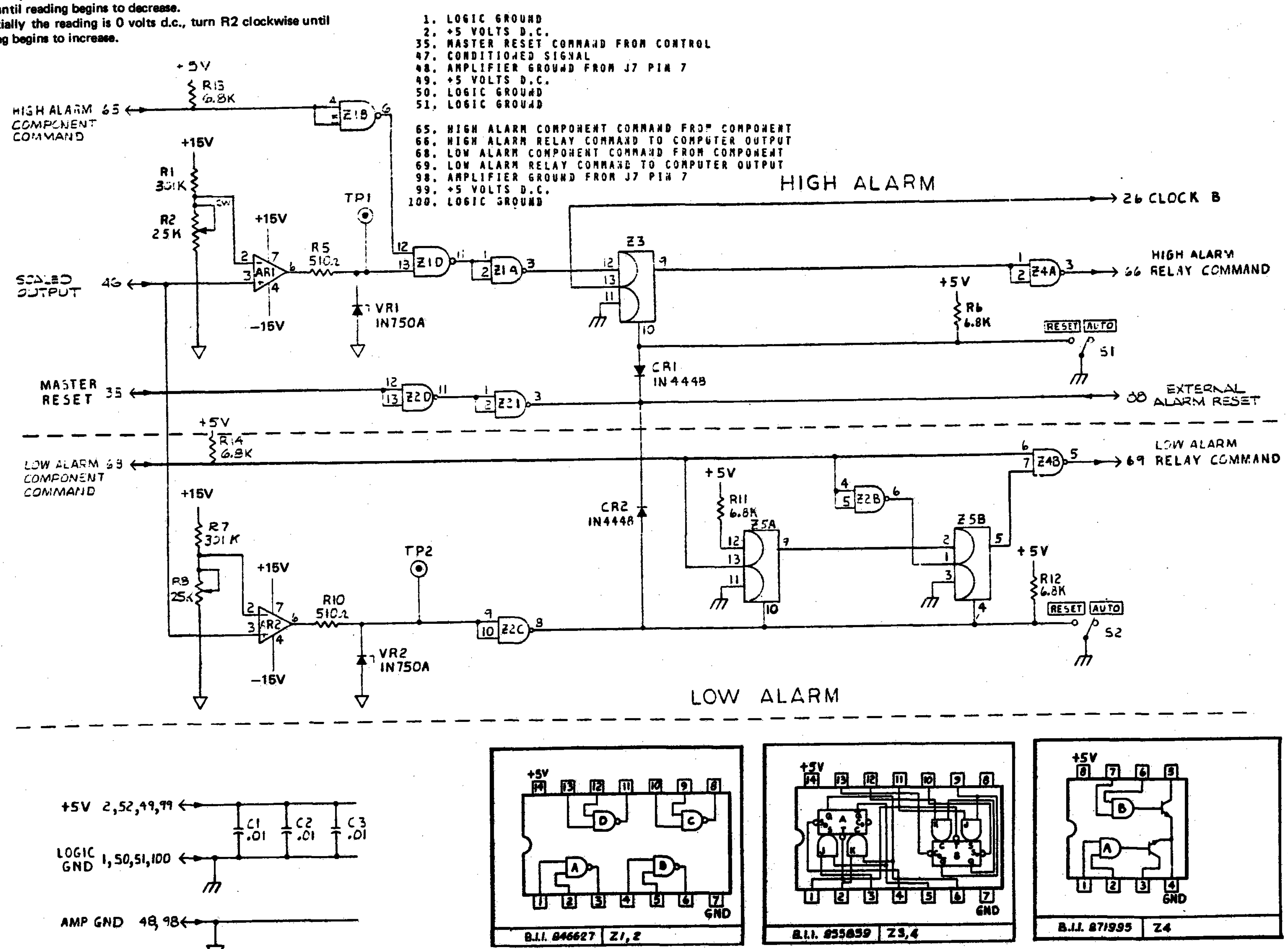
SETUP AND CALIBRATION OF HIGH/LOW ALARM BOARD

HIGH ALARM FUNCTION

1. Within the programmer, place ZERO/CALIB Switch at ON. Set CALIBRATE ADJUST Control so that the recorder reading is equal to the desired high alarm value. Use the attenuator of the component associated with the alarm function.
2. On the High/Low Alarm Board, connect a voltmeter from TP1 to chassis ground. Note voltmeter reading and adjust R1 accordingly:
   a. If initially the reading is +5 volts d.c., turn R1 counterclockwise until reading drops to 0 volts d.c.
   b. If initially the reading is 0 volts d.c., turn R1 clockwise until reading begins to increase.

LOW ALARM FUNCTION

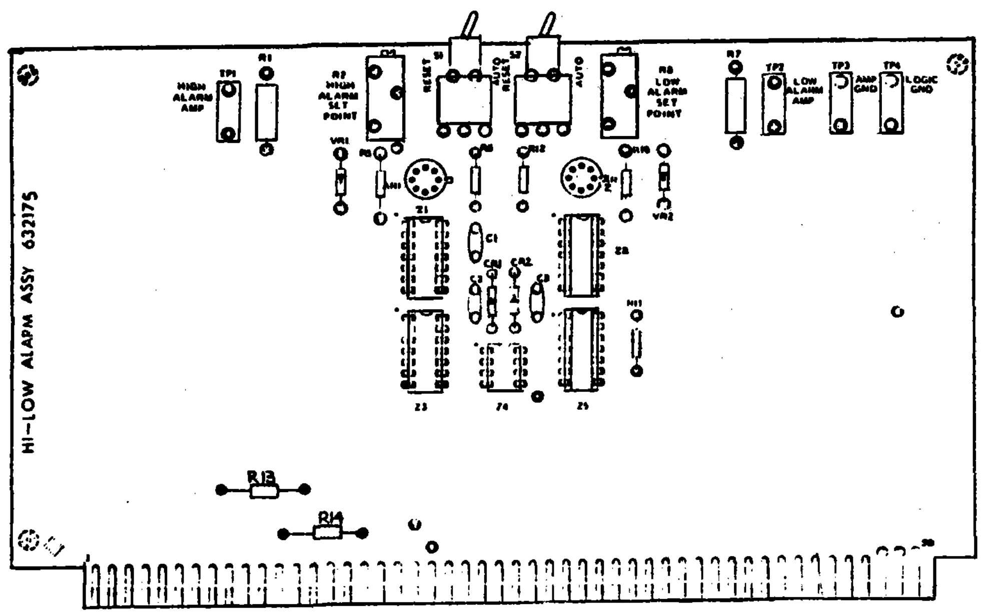
1. Within the programmer, place ZERO/CALIB Switch at ON. Set CALIBRATE ADJUST Control so that the recorder reading is equal to the desired low alarm value.
2. On the High/Low Alarm Board, connect a voltmeter from TP2 to chassis ground. Note voltmeter reading and adjust R2 accordingly:
   a. If initially the reading is +5 volts d.c., turn R2 counterclockwise until reading begins to decrease.
   b. If initially the reading is 0 volts d.c., turn R2 clockwise until reading begins to increase.



2. ALL CAPACITANCE IN MICROFARADS.
1. ALL RESISTORS ARE 1/4W, ±5% AND IN OHMS.
NOTES: UNLESS OTHERWISE SPECIFIED

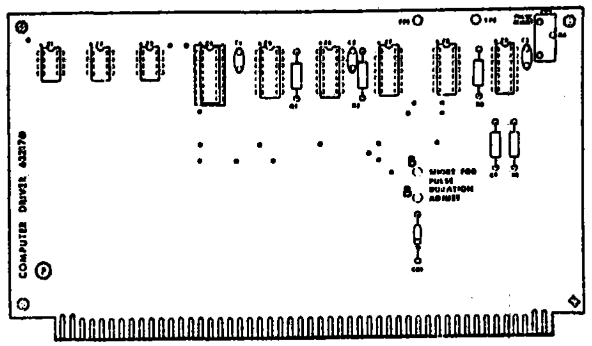
2.12.4-94

+15V +15V



	QTY	ITEM	PART NO.	DESCRIPTION
	1	Z4	871995	CIRCUIT, INTEGRATED-SN75452
	2	Z3,5	855860	CIRCUIT, INTEGRATED - 853P
	2	Z1,2	846627	CIRCUIT, INTEGRATED - 846P
	2	S1,2	876686	SWITCH, TOGGLE
	2	AR1,2	633243	AMPLIFIER, μA 741C
	2	CR1,2	838731	DIODE, 1N4448
	2	VR1,2	821972	DIODE, 1N756A
	3	C1,2,3	836864	CAPACITOR, .01 μF 50V
H	2	R1,7	855120	RESISTOR 301K ±1% 1/4W
	5	R6,11,12 13,14	822299	RESISTOR, 6.8K 5% 1/4 W
H	2	R5,10	822310	RESISTOR, 510 OHMS 5% 1/4W
	2	R2,8	854389	RESISTOR, VAR. 25K 10% 3/4W

632178 COMPUTER DRIVER BOARD



This board provides the following functions.

START OF ANALYSIS, COME READ, AND ANALYSIS RESET COMMANDS

One-shot Z9 provides a pulse of appropriate width for the START OF ANALYSIS, COME READ, and ANALYSIS RESET functions. Pulse width is adjustable via potentiometer R4. Adjustment range, normally 20 to 100 milliseconds, is determined by the values of capacitor C1 and resistors R4 and R5. If pulse width of greater than 100 milliseconds is desired, increase the capacitance of C1.

To check or adjust pulse width, an oscilloscope is connected between TP1 and TP2, and a jumper pin is inserted in the position marked SHORT FOR PULSE DURATION ADJUST. With the pin in place, the one-shot is triggered ten times per second, permitting observation of pulse width, if not greater than 100 milliseconds.

START OF ANALYSIS Command

This command is generated by the 001 COMMAND from the 632196 Digital Timer Board or the 638493 Digital-Timer/Logic-Test Board. The 001 COMMAND triggers one-shot Z9 and also enables gate Z8-D.

COME READ Command

This command is generated by the TRANSFER RESET Command which occurs after the COMPONENT OFF time during the component sequence of Figure 2-13. The COME READ Command occurs while the peak picker is holding the peak value of the component in storage.

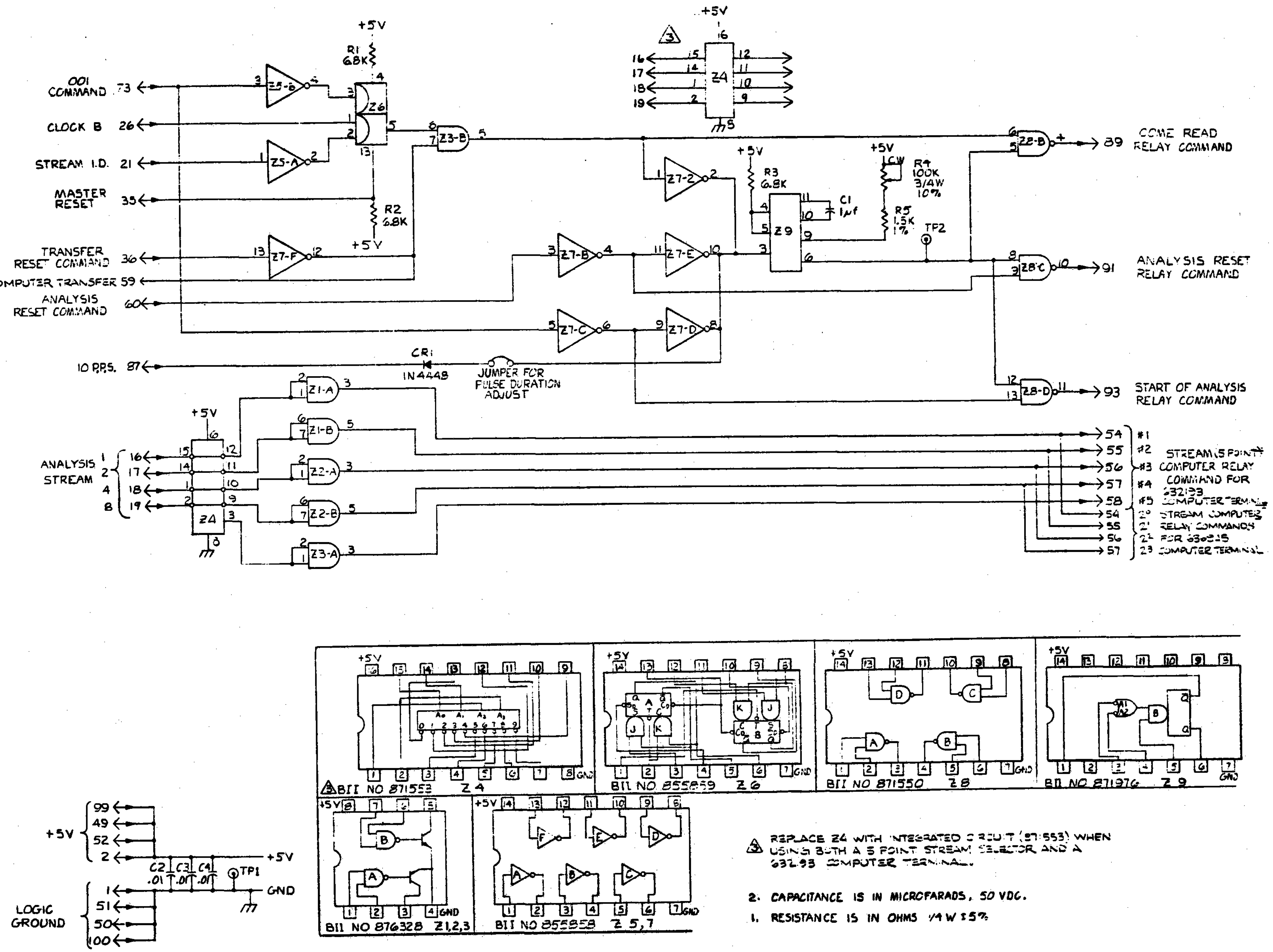
Note that, during the *starting* sequence of Figure 2-12, a TRANSFER RESET Command is generated at 003 seconds. To remove the COME READ pulse during this starting sequence, flip-flop Z6 is set at 001 second by the 001 COMMAND, and is reset at 008 seconds by the STREAM I.D. Command.

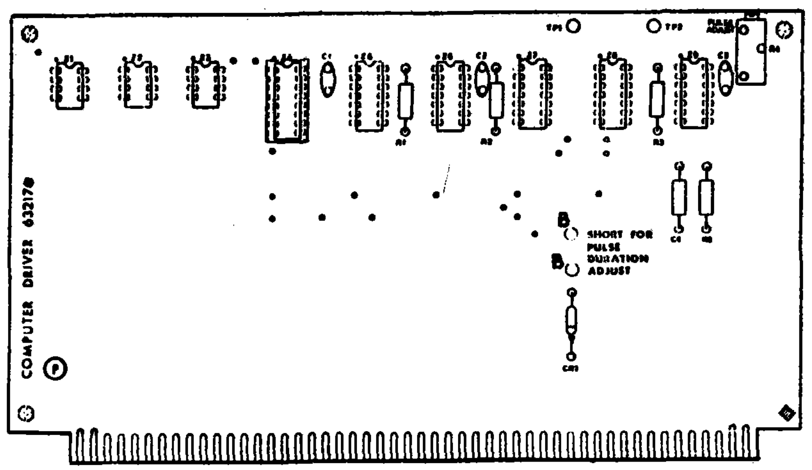
ANALYSIS RESET Command

This command occurs when the digital timer reaches the selected CYCLE RESET time. The command is used to indicate, to an external device, that an analysis has been completed.

STREAM COMPUTER RELAY Command

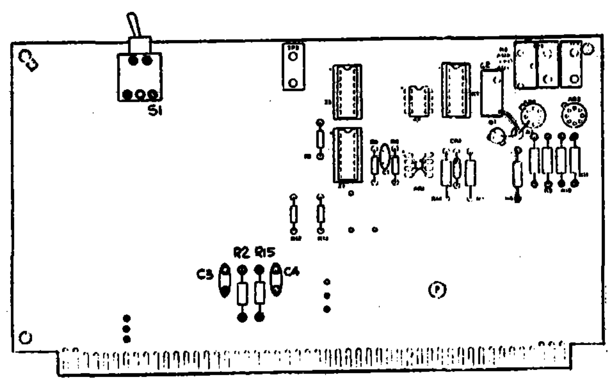
This section transfers the binary-coded number of the stream being analyzed to the 636945 Computer Terminal Board for decoding. Gates Z1 through Z3 serve as relay drivers. Note that the information provided indicates the stream being analyzed, *not* the stream being purged.





QTY	ITEM	PART NO.	DESCRIPTION
1	Z 9	635219	CIRCUIT, INTEGRATED - SN 74121
1	Z 8	871550	858
1	Z 6	855859	852
2	Z 5,7	855858	CIRCUIT, INTEGRATED 836
1	Z 4	637613	PLUG, JUMPER
3	Z 1,2,3	870872	CIRCUIT, INTEGRAILD - SN 7545 IP
1	CR 1	838731	DIODE
3	C 1,2,3	836864	CAPACITOR, .01µf 50 V
1	C 4	871595	CAPACITOR, 1.0µf 50 V
1	R 5	867105	RESISTOR, 1.5 K ±1% 1/4 W
1	R 4	854391	RESISTOR, VARIABLE - 100K ±1% 3/4 W
3	R1,2,3	822299	RESISTOR, 6.8K ±5% 1/4 W
1	2	861509	SOCKET, I.C. 16 PIN

632184 INTEGRATOR BOARD



The integrator provides a peak *area* value instead of the peak *height* value that is used for conventional bargraph readout.

The integral involved is:

$$e_{out} = -\frac{1}{RC}\int_o^t e_{in}(t)\,dt$$

Assume a given value for input (e_{in}). The output (e_{out}) then depends on the values of R, C, and the integration time increment (dt). The integrator circuit utilizes a conventional analog integrator, AR2. Attenuation is obtained by a chopping method. The chopper (FET Q1) is turned on 50 or 60 times per second, depending on line frequency. The rate of integration is controlled by adjustment of pulse width, i.e., dt in the above equation. This adjustment is provided by RATE ADJUST potentiometer R1 on the 638386 Integrator Control Board. If, during operation of the integration function, it is determined that the desired sensitivity is outside the adjustment range provided by the component attenuator on the 640411 Universal Component Board, the appropriate sensitivity may be obtained by changing the value of R6 on the 632184 Integrator Board. If signal is too large, increase R6; if too small, decrease R6.

INTEGRATOR OPERATING MODES

AUTO/CALIB Switch S1 permits selection of either of two modes:

1. **CALIB Mode.** In this mode, the signal bypasses the integrator, to permit calibration.
2. **AUTO Mode.** With the switch at AUTO, the output of the integrator is presented to pins 77 and 78 on the Mother Board.

INTEGRATOR ACTIVATION

When a component that is to be integrated goes on, flip-flop Z1A sets, causing relay K1 to open, and allowing integrator amplifier AR2 to operate.

INTEGRATOR RATE ON-OFF SWITCHING CIRCUIT

Integrator AR2 senses the input signal during the intervals when FET switch Q1 is conducting. The conducting time for Q1 is controlled by switching amplifier AR1. The input to AR1 consists of the INTEGRATOR RATE INPUT signal generated in the particular 638386 Integrator Control Board and routed to the Integrator Board via pin 76 of the Mother Board. Amplifier AR1 converts these digital logic commands into ±15 volts d.c. commands that provide on-off control of Q1. Q1 is conductive when the output at pin 1 of AR1 is positive or 0 volts d.c., and is nonconductive when this output is negative.

INVERTING AMPLIFIER AR3

Amplifier AR3 inverts the output from AR2, so that data presentation is positive.

INTEGRATOR RESET

After integrator readout has been displayed, the INTEGRATOR RESET command causes relay K1 to energize and hold the integrator at zero.

INTEGRATOR ZEROING PROCEDURE

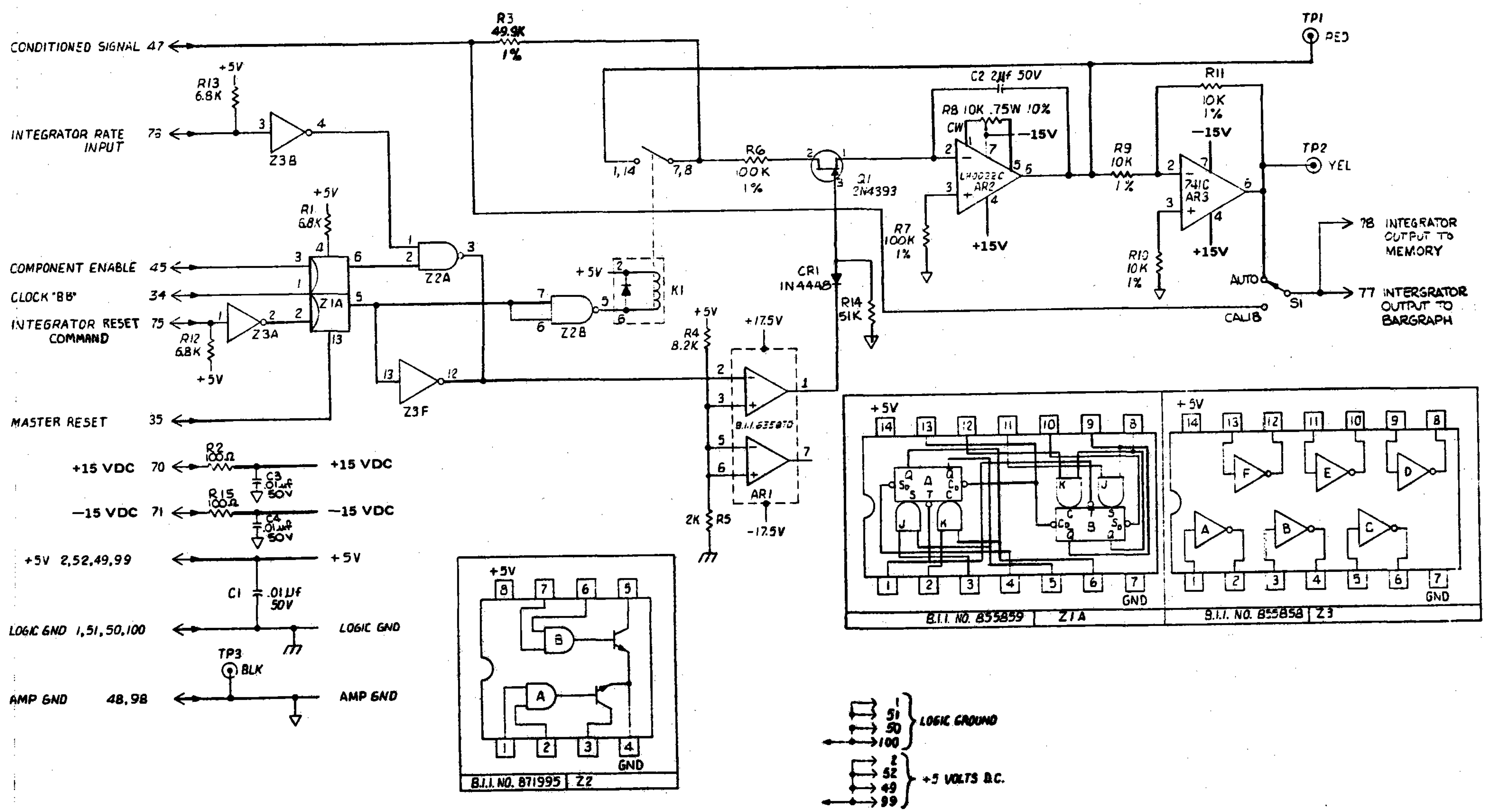
The integrator must be zeroed in a dynamic test:

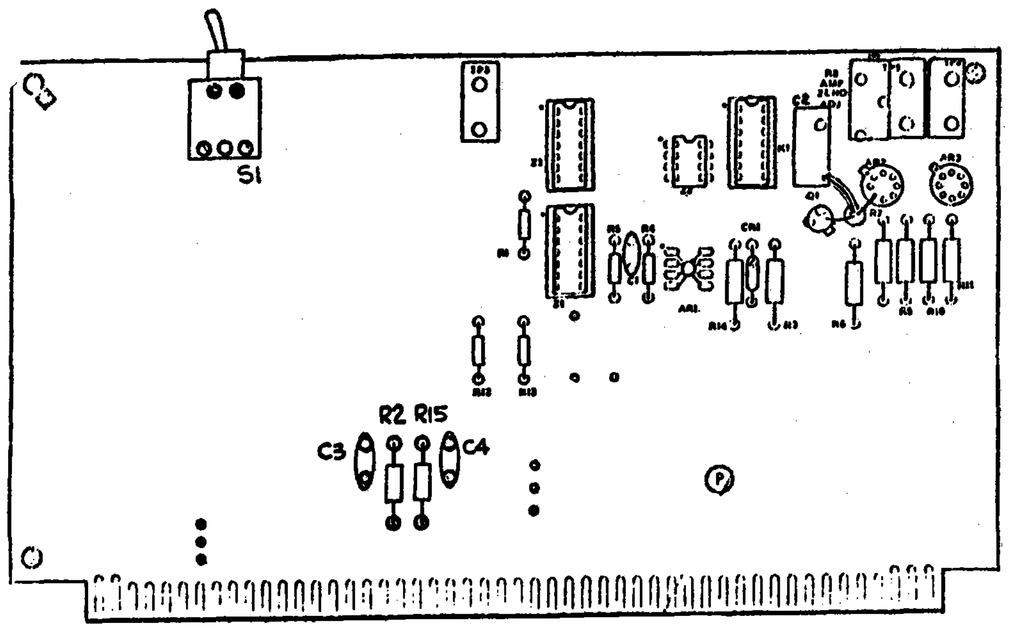
1. Program a Universal Component Board for a COMPONENT ON time of 020 seconds and a COMPONENT OFF time of 300 seconds.
2. Place front-panel MODE Switch at RESET.
3. On Universal Component Board, verify that jumper is connected in INTG position.
4. On Integrator Board, place AUTO/CALIB Switch at CALIB.
5. On Universal Component Board, turn R6 to clockwise limit.
6. Place front-panel ATTENUATION Switch at AUTO.
7. On Master Control Board, adjust R18 for zero reading on recorder.
8. On Integrator Board, place AUTO/CALIB Switch at AUTO.
9. Allow programmer to run and observe until COMPONENT ON light comes on.
10. On Integrator Board, adjust R8 until recorder trace registers as a straight line. Once the integrator is zeroed by the above procedure, it does not normally require readjustment.

5. LOGIC GROUND IS CONNECTED TO Z1 PIN 7.
4. +5V IS CONNECTED TO Z1 PIN 14.
3. ALL CAPACITANCE IS IN MICROFARADS.
2. ALL RESISTANCE IS IN OHMS.
1. ALL RESISTORS ARE 1/4W ±5%

NOTES: UNLESS OTHERWISE SPECIFIED

J2
2. +5 VOLTS D.C.
26. CLOCK B FROM TIMER
35. MASTER RESET COMMAND FROM CONTROL
45. COMPONENT ENABLE COMMAND FROM CONTROL
47. SCALED OUTPUT
48. AMPLIFIER GROUND
70. +17.5 VOLTS D.C.
71. -17.5 VOLTS D.C.
75. INTEGRATOR RESET COMMAND
76. INTEGRATION RATE INPUT TO INTEGRATOR
77. INTEGRATOR OUTPUT TO BARGRAPH
78. INTEGRATOR OUTPUT TO MEMORY
98. AMPLIFIER GROUND

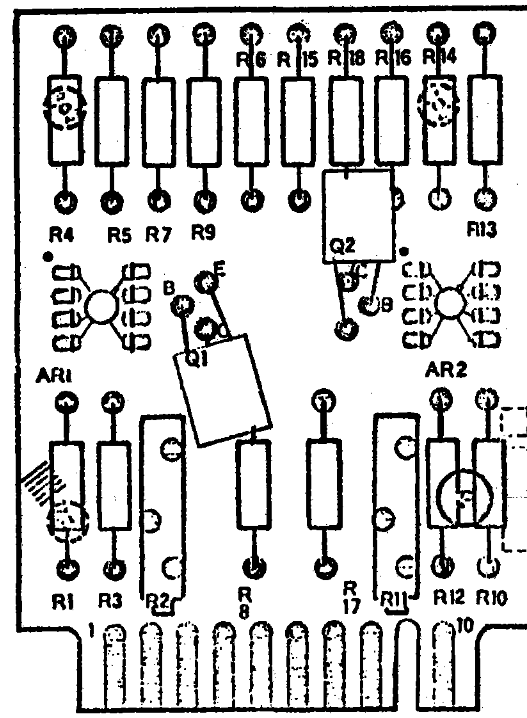




QTY	ITEM	PART NO.	DESCRIPTION
1	K1	633112	RELAY, FORM 1A
1	Q1	866865	TRANSISTOR, FET- 2N4393
1	S1	876686	SWITCH
1	Z3	855858	CIRCUIT INTEGRATED- 836
1	Z2	871995	CIRCUIT INTEGRATED- 75452
1	Z1	855859	CIRCUIT, INTEGRATED- 852
1	CR1	838731	DIODE 1N 4418
2	R2,15	817735	RESISTOR, 100Ω 5% 1/4W
1	AR3	633243	AMPLIFIER, 741C
1	AR2	876311	AMPLIFIER, LH0022C
1	AR1	635810	AMPLIFIER, SN 72558
1	C2	876441	CAPACITOR, 2 uf 50V
3	C1,3,4	836864	CAPACITOR, .01 uf 50V
1	R14	822305	RESISTOR, 51 K 5% 1/4 W
3	R9,10,11	822833	RESISTOR, 10K 1% 1/4 W
1	R8	854387	RESISTOR, VAR 10K-10% 3/4W
1	R5	822293	RESISTOR; 2 K 5% 1/4W
1	R4	822331	RESISTOR, 8.2 K 5% 1/4W
1	R3	863351	RESISTOR, 49.9 K 1% 1/4W
3	R1,12,13	822299	RESISTOR, 6.8 K 5% 1/4W
2	R6,7	826653	RESISTOR, 100 K 1% 1/4 W
1	3	857545	SOCKET, I.C 14 PIN

632184 INTEGRATOR ASSEMBLY

632187 DUAL V/I CURRENT OUTPUT BOARD



A maximum of three 632187 Dual V/I Current Output Boards may be inserted into the 632190 Current Output Assembly.

The 632187 Dual V/I Current Output Board contains two identical voltage-to-current transducers. Each converter accepts an input signal of +5 volts d.c. fullscale, and provides an output of 4 to 20 mA referenced to programmer ground. Maximum permissible load is 750 ohms.

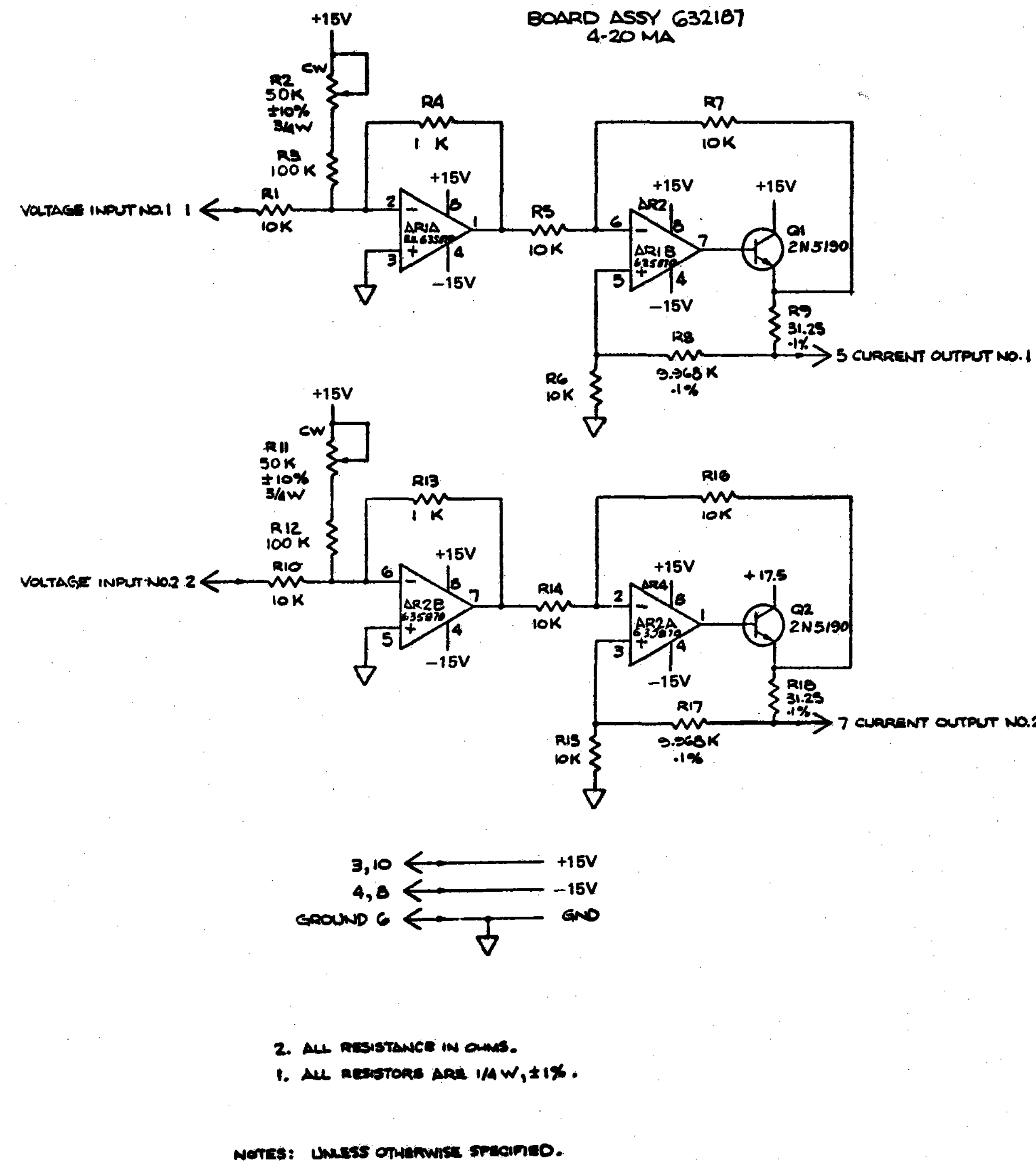
CONVERTER OPERATION

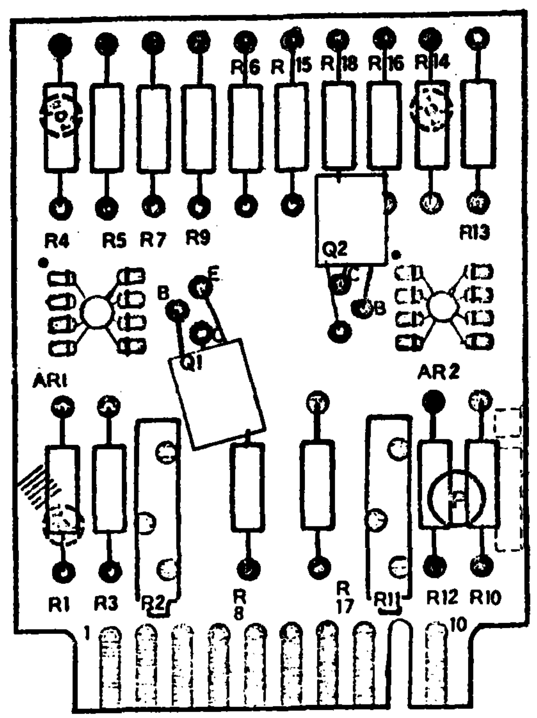
Each converter consists of two stages:

1. **Summing Amplifier.** This inverting amplifier algebraically adds two signals:
   a. Input signal supplied to the converter. Span of this signal is adjustable via the gain control on the preceding driving device, normally a long-term memory amplifier.
   b. Live-zero adjustment, provided by a potentiometer in the converter circuit.
2. **Current Output Stage.** It consists of an amplifier and an associated transistor, connected as an emitter-follower. Output of this stage is equal to its input voltage divided by the value of the output resistor. This resistor is selected to provide a current output of 4 to 20 mA.

OUTPUT ADJUSTMENT

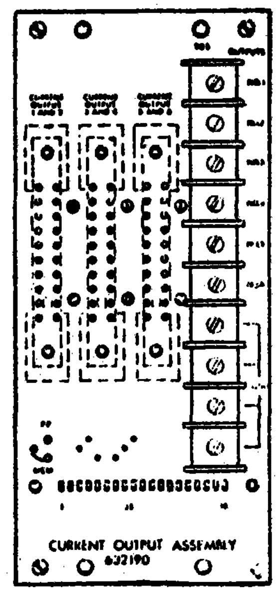
The input signal is adjusted so that fullscale span of the current output stage is 16 mA. The zero-offset potentiometer is then adjusted for 4 mA offset at the current output stage, resulting in an output of 4 to 20 mA.





	QTY	ITEM	PART NO.	DESCRIPTION
	2	Q1,2	862085	TRANSISTOR, 2N5190
3	2	AR1,2	635870	AMPLIFIER,
	2	R4,13	825321	RESISTOR, 1K, ±1%, 1/4W
	2	R9,18	876803	RESISTOR, 31.25 Ω .1%, 1/4W
	2	R6,17	876802	RESISTOR, 9.968K ±.1%, 1/4W
L	2	R2,11	846711	RESISTOR, VARIABLE 50K±10%, 3/4W
	2	R3,12	826653	RESISTOR, 100K ±1% 1/4W
	8	R1,5-7, 10,14-16	822883	RESISTOR, 10 K±1% 1/4W

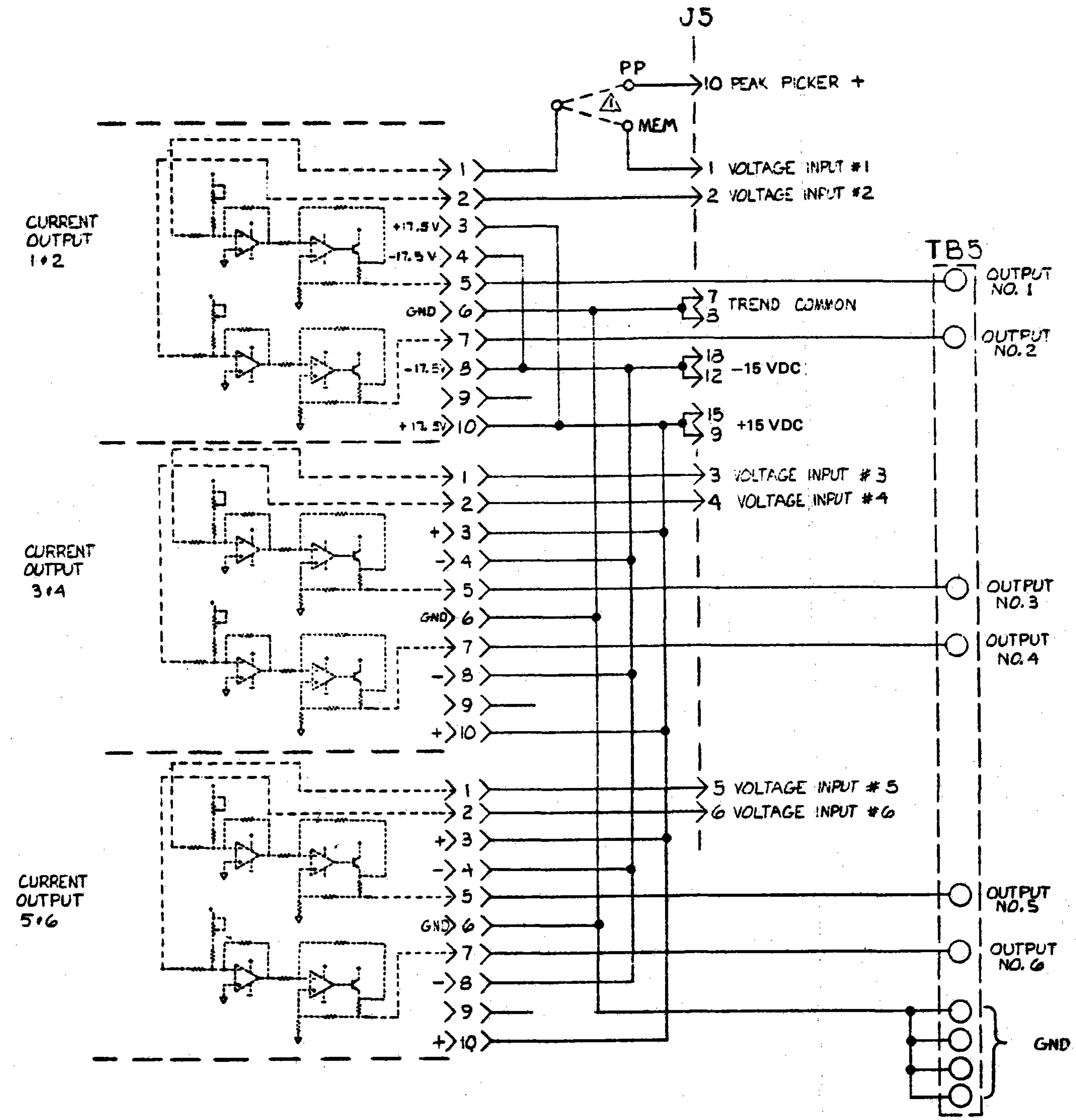
632190 CURRENT-OUTPUT ASSEMBLY



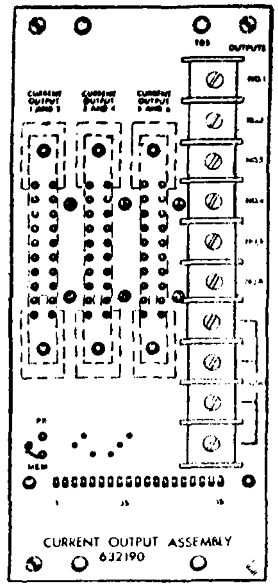
This assembly mounts at the rear of the programmer, and has receptacles for plug-in of three 632187 Dual V/I Current-Output Boards, to accommodate a maximum of six components. Note that each component board which is to provide current outputs must incorporate a memory amplifier to drive the associated V/I converter.

Exceptions: *A jumper on current output will provide a peak picker/current converter.*

Troubleshooting of the Current-Output Assembly consists of continuity checks only.

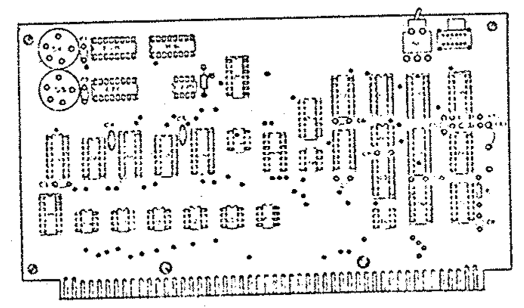


⚠ JUMPER NORMALLY ON MEMORY INPUT.



1	13	[illegible]	PIN, POST
3	12	834153	KEY, POLARIZING
1	6	632066	CABLE ASSY
3	4	859249	CONNECTOR, 10 PIN
QTY	ITEM	PART NO.	DESCRIPTION

632196 DIGITAL TIMER BOARD



The 632196 Digital Timer Board contains the following sections:

THE ÷5 OR ÷6 SECTION

This section receives the 50 or 60 pulse-per-second signal generated in the 639761 Power Supply Board. Preparatory to operation, a two-position jumper on the timer board must be connected in the position appropriate to the line frequency. With the jumper connected in the "50 Hz" position, the 50 pps signal is divided by five, resulting in a 10 pps signal. With the jumper connected in "60 Hz" position, the 60 pps signal is divided by 6, also resulting in a 10 pps signal.

CLOCK AND ANALYSIS TIME SELECTION SECTION

This section converts the 10 pps signal into a 1 pps signal, to provide the basic one-second clock for the system. Normally, Switch S2 is placed in ÷1 position, causing the timer to advance one count per second, up to a maximum of 999 counts, i.e., 999 seconds. If required for the particular application, Switch S2 may be placed in ÷2 position, resulting in a basic count time of one pulse per two seconds. At this setting, the maximum capability of the timer is 999 X 2 = 1998 seconds.

With SINGLE/CONTINUOUS Switch S1 at CONTINUOUS, the timer cycles repetitively. With S1 at SINGLE, flip-flop Z7 is prevented from resetting after occurrence of the preselected CYCLE RESET TIME; therefore, the timer goes into the OFF condition.

BASIC TIMING AND BUFFER SECTION

This section contains basic timing utilized for the various programmable functions. See Section Eleven.

NOTE

For simplicity, the following explanation assumes that Switch S2 on the digital timer board is in "÷1" position, so that the basic timer advances one count per second.

Elements Z14, Z15, and Z16 are decade counters. Each counter counts ten pulses on its input and then provides one pulse at its outputs. These counters are connected in cascade, so that Z14 counts to ten and then advances Z15 one count, etc. Thus Z14 counts by seconds, from 0 to 9; Z15 counts by tens of seconds, from 00 to 90; and Z12 counts by hundreds of seconds, from 000 to 900. Therefore, the timer has a full count capability of 000 to 999 seconds.

NOTE

Time 000 represents the reset state, *and is* not *usable for programming.* No *function can be programmed to occur at time 000.*

Outputs of Counters Z14, Z15, and Z16 are in binary-coded-decimal (BCD) form, i.e., 1–2–4–8. These coded outputs are supplied, via buffering gates Z10 through Z25, to dedicated pins on the Mother Board, for use by all programmable functions on the various plug-in circuit boards. Correspondence between timer BCD outputs and pins on the Mother Board is given in the following table.

Counter Function And Circuit Designation	Counter BCD Outputs	Pin Numbers On Mother Board
Units Counter Z14	1	12
	2	13
	4	14
	8	15
Tens Counter Z15	1	8
	2	9
	4	10
	8	11
Hundreds Counter Z16	1	4
	2	5
	4	6
	8	7

START OF ANALYSIS PULSE SECTION

This section provides two preprogrammed commands:

1. Gate Z19B decodes time 001, to provide the 001 COMMAND. This pulse turns on the control sequencer on the 640908 Master Control Board.
2. Gate Z19A decodes time 008, to provide the STREAM I.D. COMMAND for the 632084 Stream Select Control Board of the optional five-point stream selector.

RESET SECTION

This section is used to select the duration of the analysis cycle.

During *programming*, the desired CYCLE OFF time is selected via two ten-position rotary switches: S3, marked TENS; and S4, marked HUNDREDS. Cycle reset time is the sum of the settings on the two switches. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. The switch converts the selected value into its BCD equivalent.

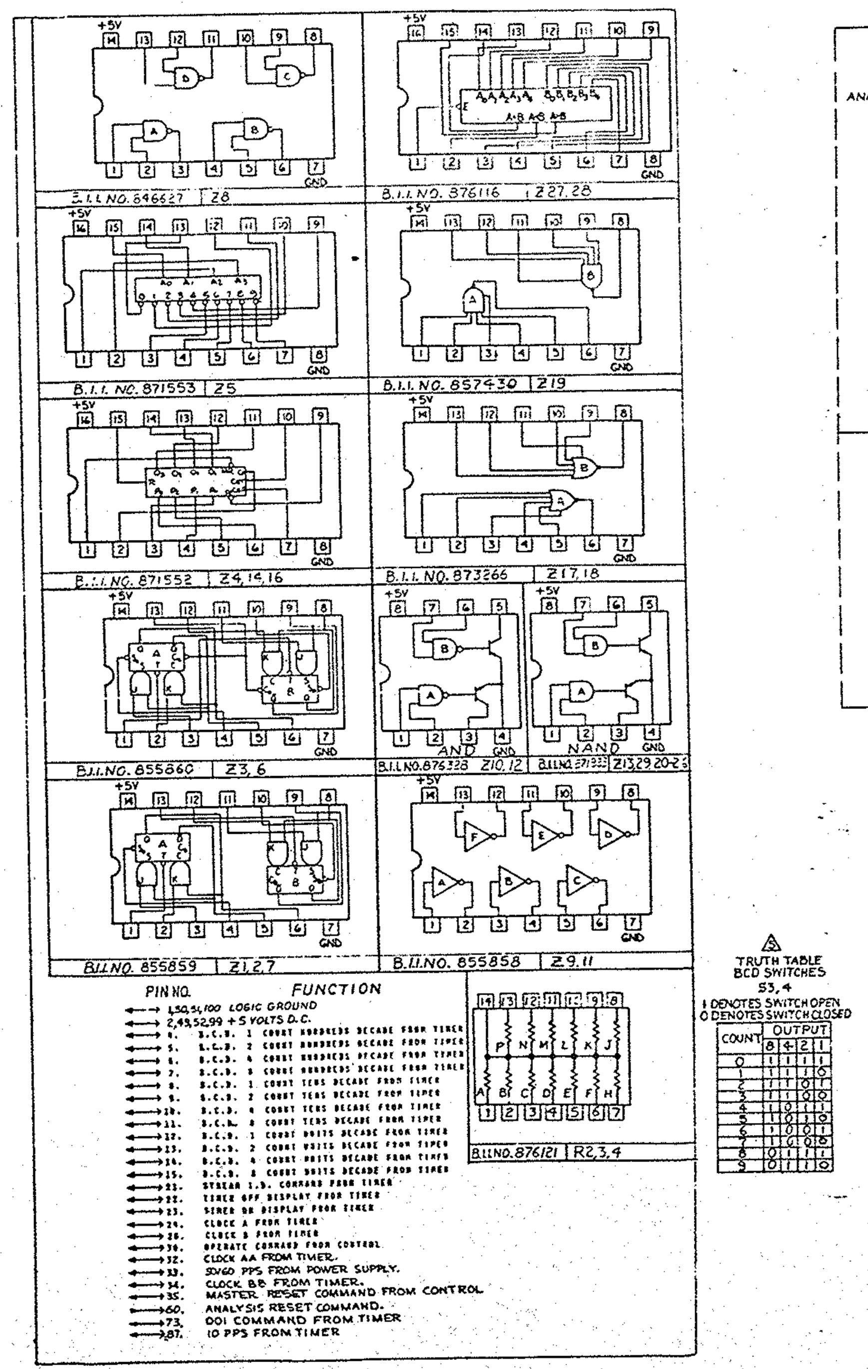
During subsequent *automatic operation*, comparators Z27 and Z28 continuously compare two sets of BCD data:

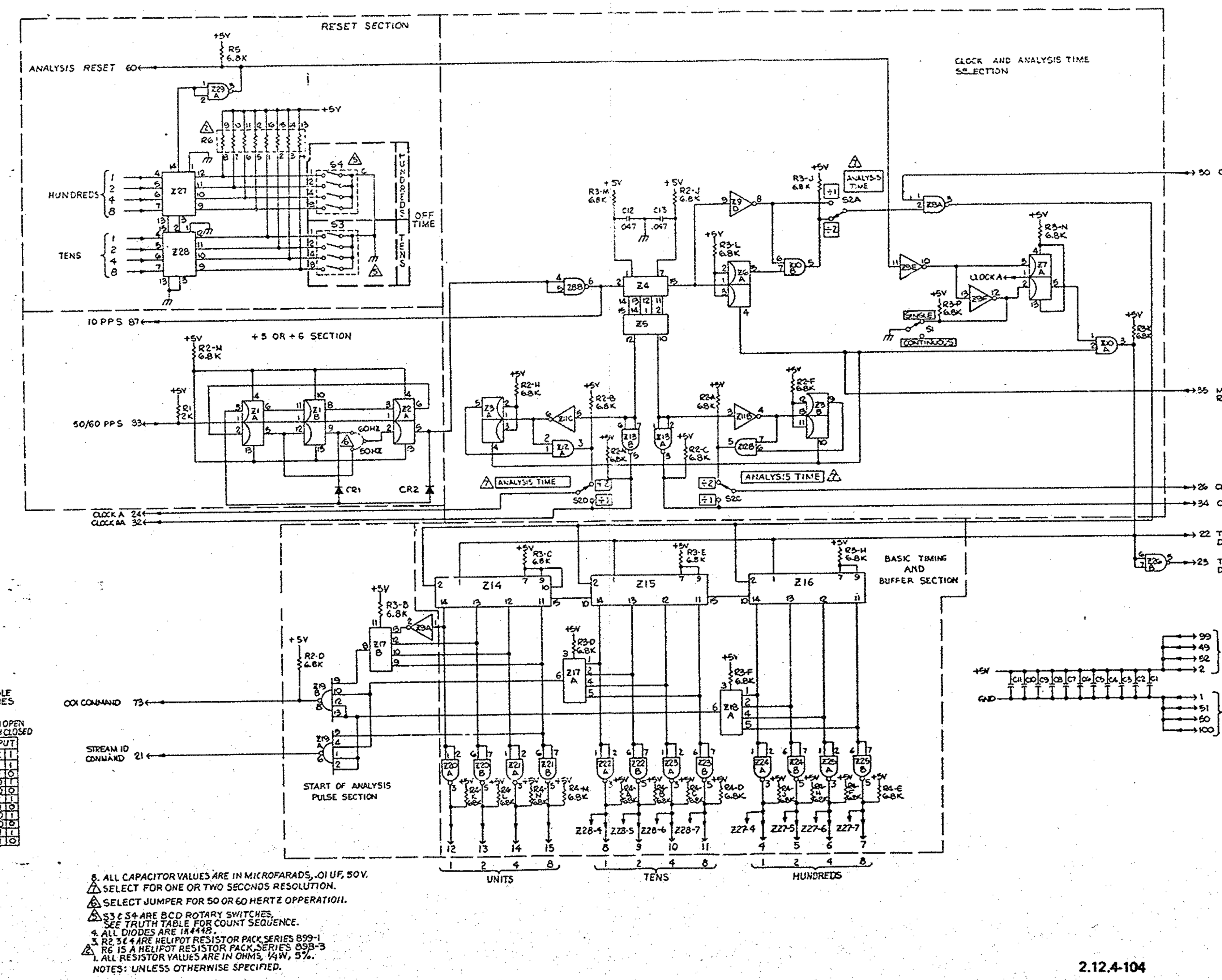
1. The BCD outputs previously set on encoder switches S3 and S4.
2. The continuously-updated BCD outputs from the digital timer.

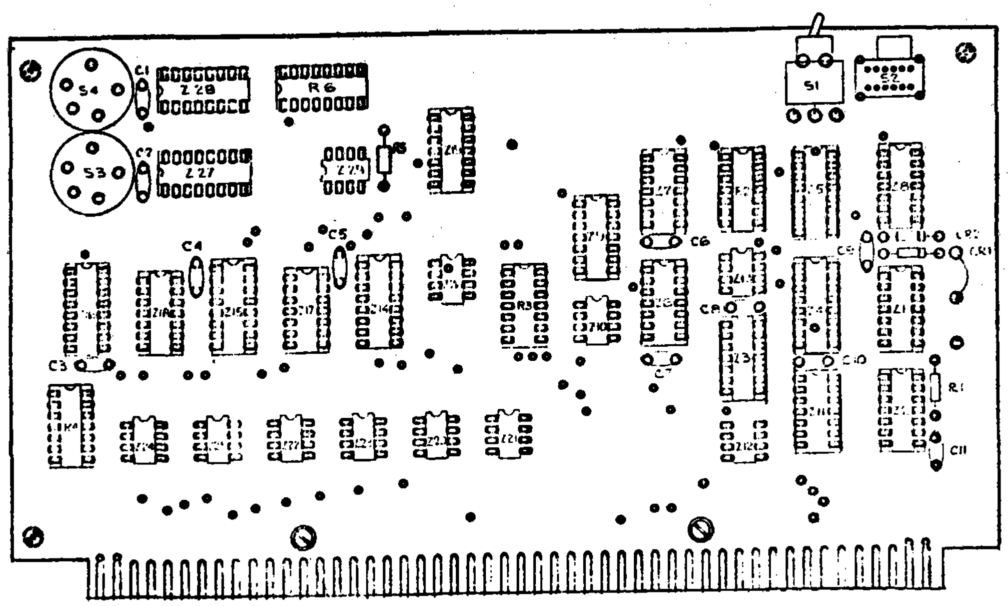
When the two sets of data agree, gate Z29A pulls the ANALYSIS RESET line to ground. This resets the timer to time 000. If SINGLE/CONTINUOUS Switch is at CONTINUOUS, a new cycle will now begin.

NOTE

For more detailed explanation of the rotary encoder switches and the comparators, refer to Section Eleven.



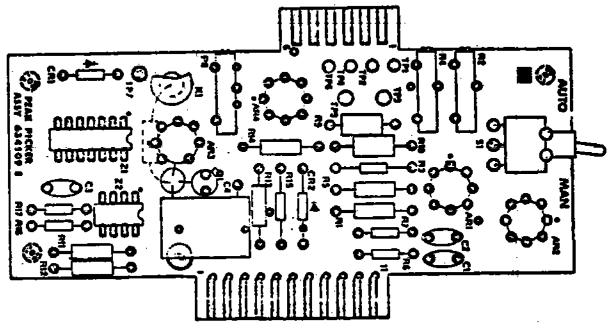




QTY	ITEM	PART NO.	DESCRIPTION
2	Z27,28	876116	CIRCUIT, INTEGRATED- 93L24
1	Z19	857430	CIRCUIT, INTEGRATED- 844
2	Z17,18	873266	CIRCUIT, INTEGRATED-SN7425N
9	Z13,29, 20-26	871995	CIRCUIT, INTEGRATED-SN75452P
2	Z10,12	870872	CIRCUIT, INTEGRATED-SN75457P
2	Z9,11	855858	CIRCUIT, INTEGRATED- 836
1	Z8	846627	CIRCUIT, INTEGRATED- 846
1	Z5	871553	CIRCUIT, INTEGRATED-93L01
4	Z4,14,15,16	871552	CIRCUIT, INTEGRATED-93L10
2	Z3,6	855860	CIRCUIT, INTEGRATED- 853
3	Z1,2,7	855859	CIRCUIT, INTEGRATED- 852
2	S3,4	876119	SWITCH, ROTARY
1	S2	816286	SWITCH, SLIDE
1	S1	876686	SWITCH, TOGGLE
2	CR1,2	838731	DIODE, IN4448
11	C1-11	836864	CAPACITOR, .01 µF 50V
1	R6	816375	RESISTOR PACK, 898-3 6.8K
1	R5	822299	RESISTOR, 6.8K 5% 1/4 W
3	R2-4	876121	RESISTOR PACK, 899-1 6.8K
1	R1	822293	RESISTOR 2K 5% 1/4 W

632196 DIGITAL TIMER ASSEMBLY

634109 PEAK PICKER BOARD



This board provides the capability of monitoring an analog signal to determine its peak value, and of storing the value thus determined for further processing.

Input signal to the peak picker should not exceed +1 volt d.c., corresponding to an output of +5 volts d.c. Output impedance is approximately zero. With 5-volt output, any load applied to the output stage should have an impedance of at least 500 ohms to *ensure* accurate readout; however, the output stage of the peak picker cannot be damaged by a short-circuit, even if continuous. Peak picker response time for a 1-volt square-wave input signal is 40 milliseconds.

The two-position toggle switch marked AUTO/MAN permits selection of either of two modes.

1. **MANUAL Mode.** In this mode, the signal bypasses the peak-picking elements, to permit system calibration. With AUTO/MAN Switch at MAN, the incoming signal received at pin 7 is applied to the input of buffer amplifier AR2, which provides a constant load. AR2 is a noninverting operational amplifier with fixed gain of 1X. The signal from AR2 is routed through Switch S1 to AR4, a fixed-gain (5X) amplifier that constitutes the output stage of the peak picker system.
2. **AUTO Mode.** To select this mode, the AUTO/MAN Switch is placed at AUTO. When a programmed COMPONENT ON time occurs, the component board applies a COMPONENT ENABLE command to pin 3 of flip-flop Z1, causing Z1 to change state and pin 5 of Z1 to become 0 volts d.c. The 0 volts d.c. output signal from Z1 is inverted by Z2A, causing its output to become +5 volts d.c. and relay K1 to be deenergized. With K1 deenergized, and R18 thus removed from the circuit, AR3 constitutes an integrator. Provided that FET Q1 is conductive, AR3 will integrate a −5 volts d.c. signal that is obtained from the junction of R11 and R12, and is routed through R13 and Q1 to AR3. This integrated output signal from AR3 is routed through fixed-gain (5X) amplifier AR4. Note that the output of AR3 compares with the input signal, and therefore should not exceed 1 volt in normal operation.

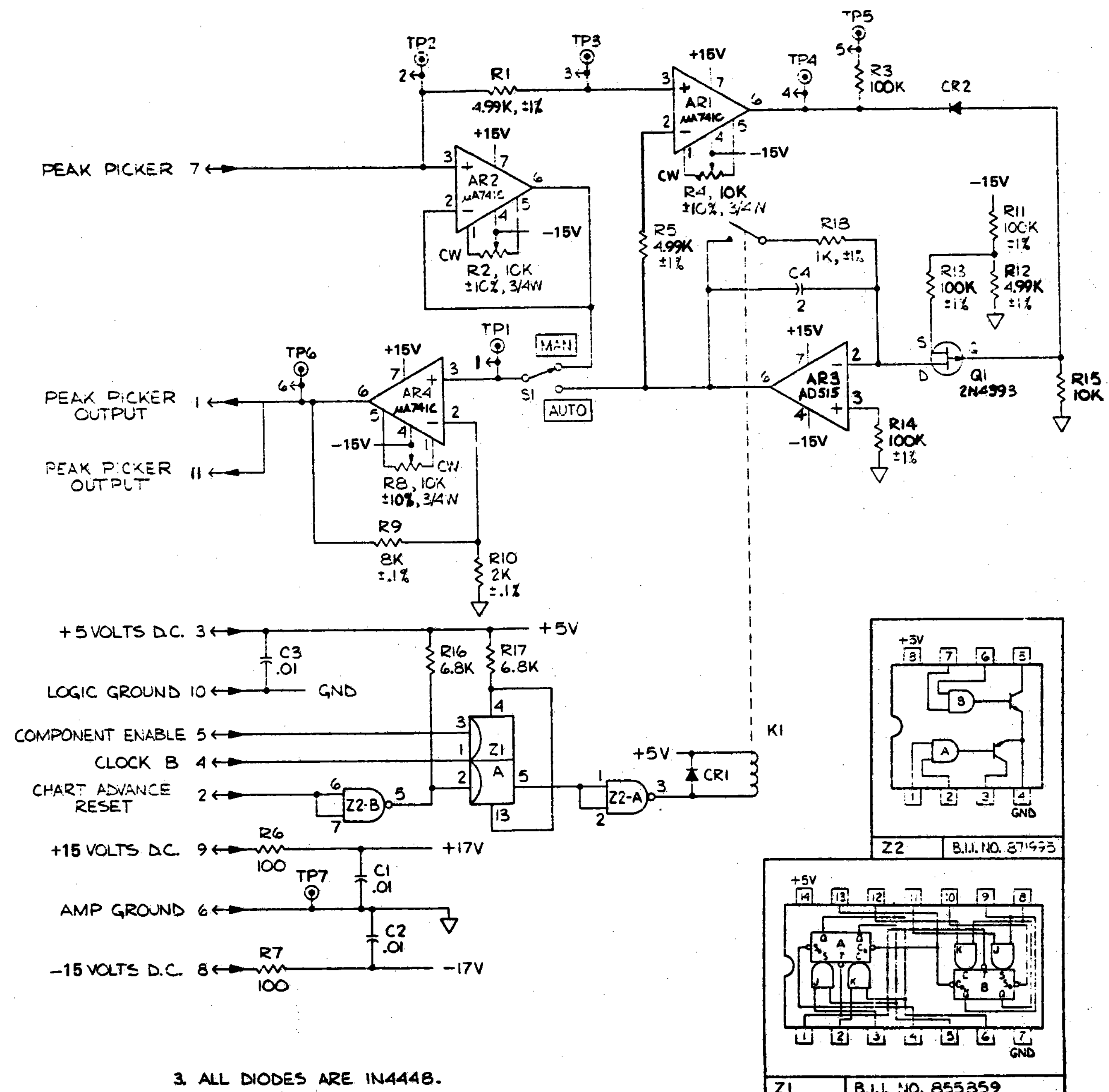
   On-off control of the integration operation, as required for the peak picking function, is provided by comparator amplifier AR1. When the input voltage on pin 2 is *lower* than that on pin 3, the output of AR1 becomes +15 volts d.c. Transistor Q1 now becomes conductive, applying the previously mentioned −15 volts d.c. signal to AR3, and causing the output of AR3 to increase. While the input signal is *increasing*, the output from AR3 will continue to increase. When the input voltage on pin 2 of AR1 becomes *equal* to that on pin 3, the output of AR1 changes to −15 volts d.c., turning off Q1, and stopping the integration. After the peak has passed, and the input voltage on pin 2 of AR1 becomes *more* positive than that on pin 3, the output of AR1 holds Q1 in the off state.

   Six seconds after the programmed COMPONENT OFF time, the CHART ADVANCE RESET command becomes 0 volts d.c. This signal is inverted by Z2B, causing Z1 again to change its state and pin 5 of Z1 to become +5 volts d.c. This signal is inverted by Z2A, causing its output to become 0 volts d.c. and relay K1 to be energized. Capacitor C4 discharges through current-limiting resistor R18, causing the peak picker output to go to zero.

TROUBLESHOOTING PEAK PICKER

1. On programmer front panel, place MONITOR SELECT Switch at +5 VOLTS, +15 VOLTS, and −15 VOLTS; at each setting, verify that meter reading is correct.
2. Provide a +1 volt d.c. input signal for checkout of peak picker amplifiers AR2 and AR4:
   a. On programmer front panel, place MODE Switch at RESET, MONITOR SELECT Switch at AMPLIFIER OUT, ATTENUATION Switch at 1, and RANGE Switch at AUTO.
   b. Within the programmer, place ZERO/CALIB Switch at ON; set CALIB ADJUST Control so front-panel meter indicates an amplifier-output signal of 1 volt.
3. On peak picker board:
   a. Verify that voltage from TP2 to TP7 is +1 volt d.c.
   b. Place AUTO/MAN Switch at MAN.
   c. Verify that voltage from TP1 to TP7 is +1 volt d.c.
   d. Verify that voltage from TP6 to TP7 is +5 volts d.c.

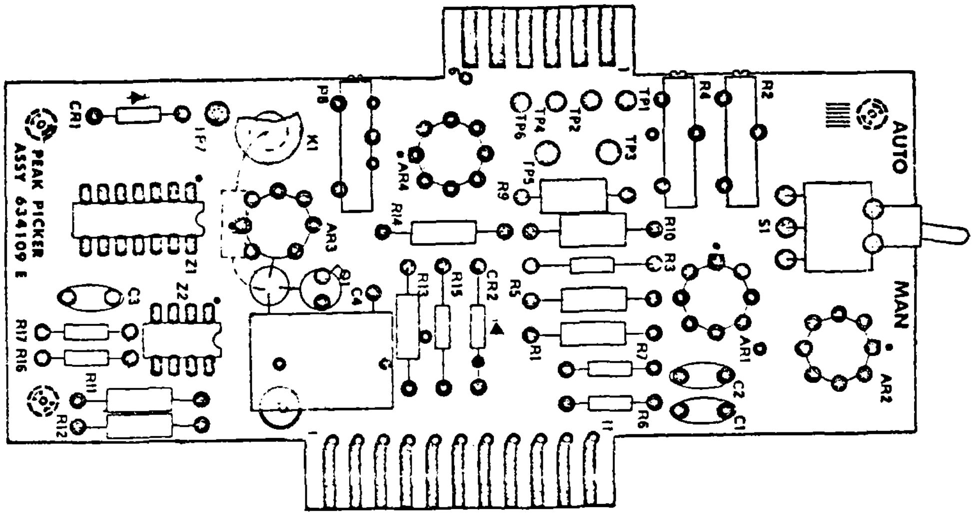
   Satisfactory completion of the above test indicates proper functioning of the peak picker MANUAL mode, involving amplifiers AR2 and AR4. Proceed with following steps to test amplifiers AR1 and AR3.
4. Within the programmer:
   a. Remove all component boards except one. Program it for a COMPONENT ON time of 20 seconds and a COMPONENT OFF time of 60 seconds.
   b. On each valve board, place MANUAL VALVE Switch at OFF.
5. On programmer front panel, place MODE Switch at RESET; MONITOR SELECT Switch at AMPLIFIER OUT; ATTENUATION Switch at 1; RANGE Switch at 100; AUTO ZERO Switch at AUTO.
6. Within the programmer, place ZERO/CALIB Switch at ON; set CALIB ADJUST Control so front-panel meter indicates an AMPLIFIER OUT signal of 1 volt.
7. On peak picker board, connect voltmeter from TP6 to TP7. With AUTO/MAN Switch at MAN, reading should be +5 volts d.c. Move AUTO/MAN Switch to AUTO; reading should be 0 volts d.c. after six seconds of automatic operation.
8. Place TIMER Switch at ON and MODE Switch at RUN. With timer now running, observe voltmeter. Reading should be zero initially, but should change to +5 volts d.c. at some time greater than 24 seconds. If reading *remains* zero, verify proper sequence of peak picker logic, as described in Paragraph 2.9. If reading becomes greater than 10 volts d.c., continue with following steps.
9. Wait until timer has run for more than 70 seconds, to ensure that flip-flop Z1 has been reset by the CHART ADVANCE RESET command, then move MODE Switch to RESET.
10. Connect voltmeter from TP4 to TP7. Reading should be greater than −13 volts d.c.
11. Move MODE Switch to RUN. With timer now running, observe voltmeter. At some time greater than 24 seconds, reading should be greater than +13 volts d.c. If correct reading is now obtained, but test of Step 8 was failed, transistor Q1 is probably defective and should be replaced. If present reading is *incorrect*, amplifier AR1 is probably defective; however, if reading is greater than +3 volts d.c., amplifier AR3 may be at fault.



3. ALL DIODES ARE 1N4448.
2. ALL CAPACITORS ARE IN MICROFARADS, 50V.
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W.

UNLESS OTHERWISE SPECIFIED

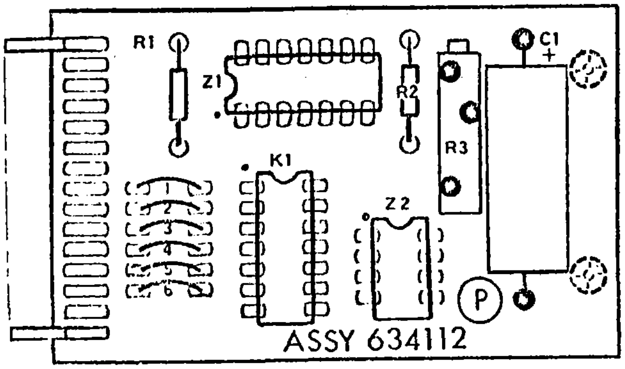
NOTES:

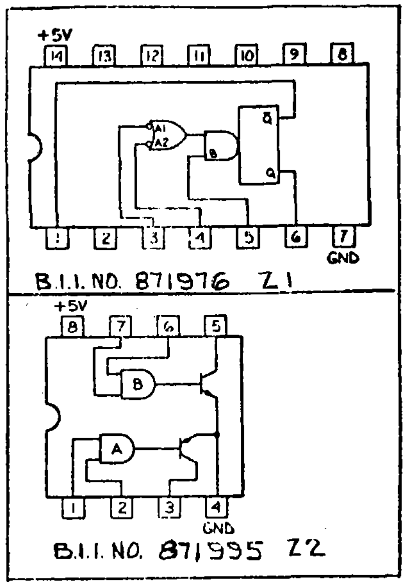


QTY	ITEM	PART NO.	DESCRIPTION
1	S1	876686	SWITCH, TOGGLE - SPDT
1	K1	876313	RELAY
1	Z2	871995	CIRCUIT, INTEGRATED - SN75452P
1	Z1	855859	CIRCUIT, INTEGRATED - 852
1	AR3	861185	AMPLIFIER, AD515
3	AR1,2,4	633243	AMPLIFIER, µA741C
1	Q1	866865	TRANSISTOR, F.E.T. - 2N4393
2	CR1,2	838731	DIODE, 1N4448
1	C4	876441	CAPACITOR, 2 MFD, 50V
3	C1,2,3	836864	CAPACITOR, .01 MFD, 50V
1	R18	825321	RESISTOR, 1K, ± 1%, 1/4W
2	R16,17	822299	RESISTOR, 6.8K, ±5%, 1/4W
1	R15	822324	RESISTOR, 10K, ±5%, 1/4W
3	R11,13,14	826653	RESISTOR, 100K, ±1%, 1/4W
1	R10	876733	RESISTOR, 2K, ±.1%, 1/4W
1	R9	876734	RESISTOR, 8K, ± .1%, 1/4W
2	R6,7	817735	RESISTOR, 100 OHMS, ±5%, 1/4W
1	R3	823904	RESISTOR, 100K, ±5%, 1/4W
3	R2,4,8	854387	RESISTOR, VAR., 10K, ±10%, 3/4W
3	R1,5,12	867141	RESISTOR, 4.99K, ±1%, 1/4W

634109 PEAK-PICKER ASSEMBLY

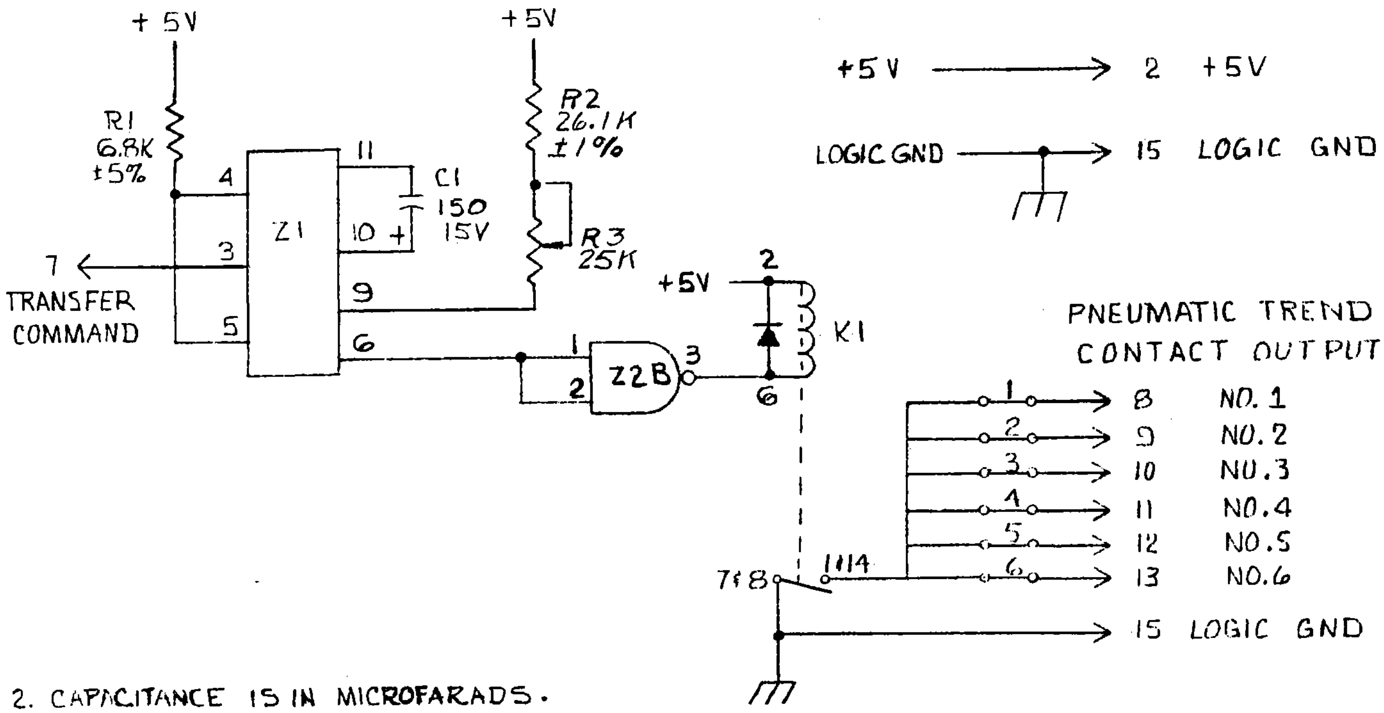
634112 PNEUMATIC TREND CONTACT BOARD





This board plugs into the memory slot of a 640411 Universal Component Board or other component board with memory option.

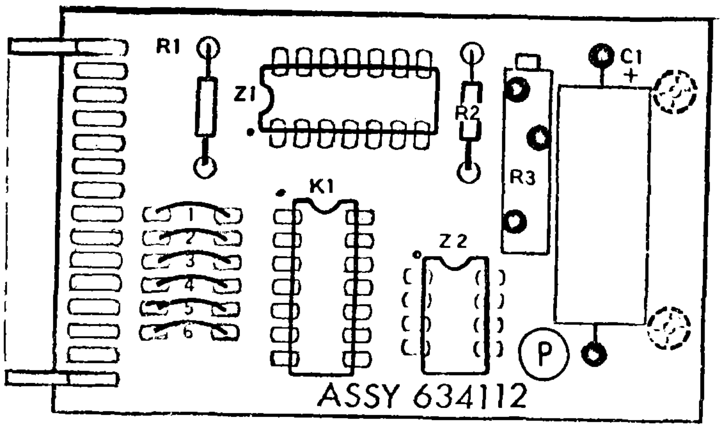
The TRANSFER RESET COMMAND causes one-shot Z1 to generate a pulse of five to six seconds duration that energizes relay K1. With the relay contact closed, logic ground is applied to the desired one of six trend lines, as selected with the appropriate jumper on the 634112 Pneumatic Trend Contact Board. (Remove all jumpers except the one desired.) The logic ground signal is routed, through the corresponding trend line on the 635019 Pneumatic Trend Output Board, to the driver circuit of the appropriate solenoid valve in 635030, 635410, or 635400 Pneumatic Memory Assembly.



2. CAPACITANCE IS IN MICROFARADS.

1. RESISTANCE IS IN OHMS 1/4 W

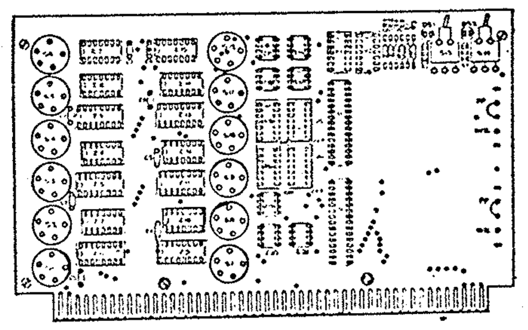
NOTES UNLESS OTHERWISE SPECIFIED.



QTY	ITEM	PART NO.	DESCRIPTION
1	Z2	871995	CIRCUIT, INTEGRATED
1	Z1	635219	CIRCUIT, INTEGRATED
1	K1	633112	RELAY, FORM 1 A
1	C1	802914	CAPACITOR, 150 UF, 15 V
1	R3	864036	RESISTOR, VARIABLE, 25K
1	R2	828905	RESISTOR, [illegible]K, 1%, [illegible]W
1	R1	822299	RESISTOR, 6.8K ±5% 1/4W

634112 PNEUMATIC TREND ASSEMBLY

634115 DUAL COMPONENT/MEMORY BOARD



This board contains two identical component-programming sections. The first section is described below. Functioning of the second section is identical; however, circuit designations differ.

STANDARD SELECTABLE FUNCTIONS

1. **Component ON-OFF Timing.** During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.
2. Programming Functions (Selected with Switch S15):
   a. *X1 RANGE Switch.* Selects gain of 1000 for TC amplifier or 100 for FID amplifier.
   b. *X10 RANGE Switch.* Selects gain of 100 for TC amplifier or 10 for FID amplifier.
   c. *AUTO ZERO Switch ON.* During automatic operation, an auto-zero function will occur approximately three seconds before activation of the COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.
   d. *POLARITY REVERSE ON Switch.* Reverses the polarity of the signal in the 640324 TC Detector Electronics Board if analyzer is so equipped.
   e. *POLARITY REVERSE OFF Switch.* Turns off the polarity-reverse circuit.
   f. *HIGH/LOW Range Switch.* HIGH position provides 1000X attenuation of output signal from FID amplifier. Switch is inoperative with TC amplifier.
3. **ON/AUTO/STATUS Switch S13.** ON position activates component attenuator R2 and causes DS1 to illuminate. The amplifier signal will be displayed on the recorder, provided that the ATTENUATION Switch on the programmer front panel is at AUTO.

   AUTO position places the component functions under preprogrammed control.

   STATUS is a test position, used *momentarily*, to check programming of component functions. While holding switch at STATUS, observe indicators on master board. Do not check status during automatic operation.
4. **COMPONENT ATTENUATOR R2.** Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but not trend) data presentation.

MEMORY OPTION

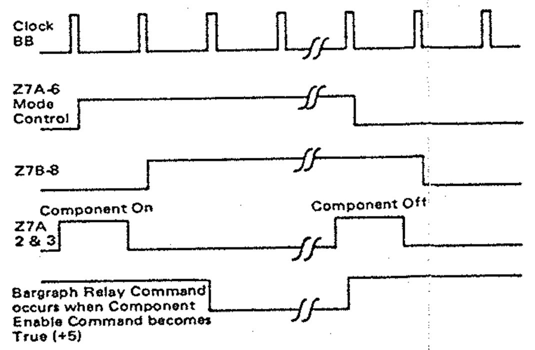
The section may be provided with memory function through plug-in of a 635037 Voltage Memory Board.

COMPONENT ON-OFF SEQUENCE

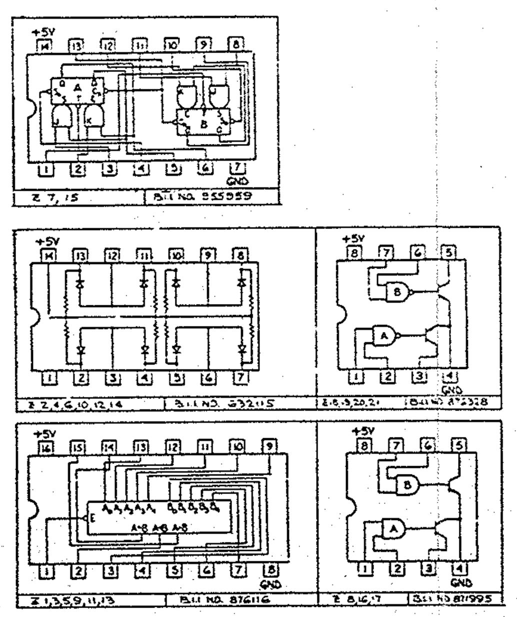
At the programmed COMPONENT ON time, pin 6 of Z7A goes to +5 volts d.c., causing all closed functions on Switch S15 to be energized by Z8A. The next pulse of clock B causes Z7B to go to the set state.

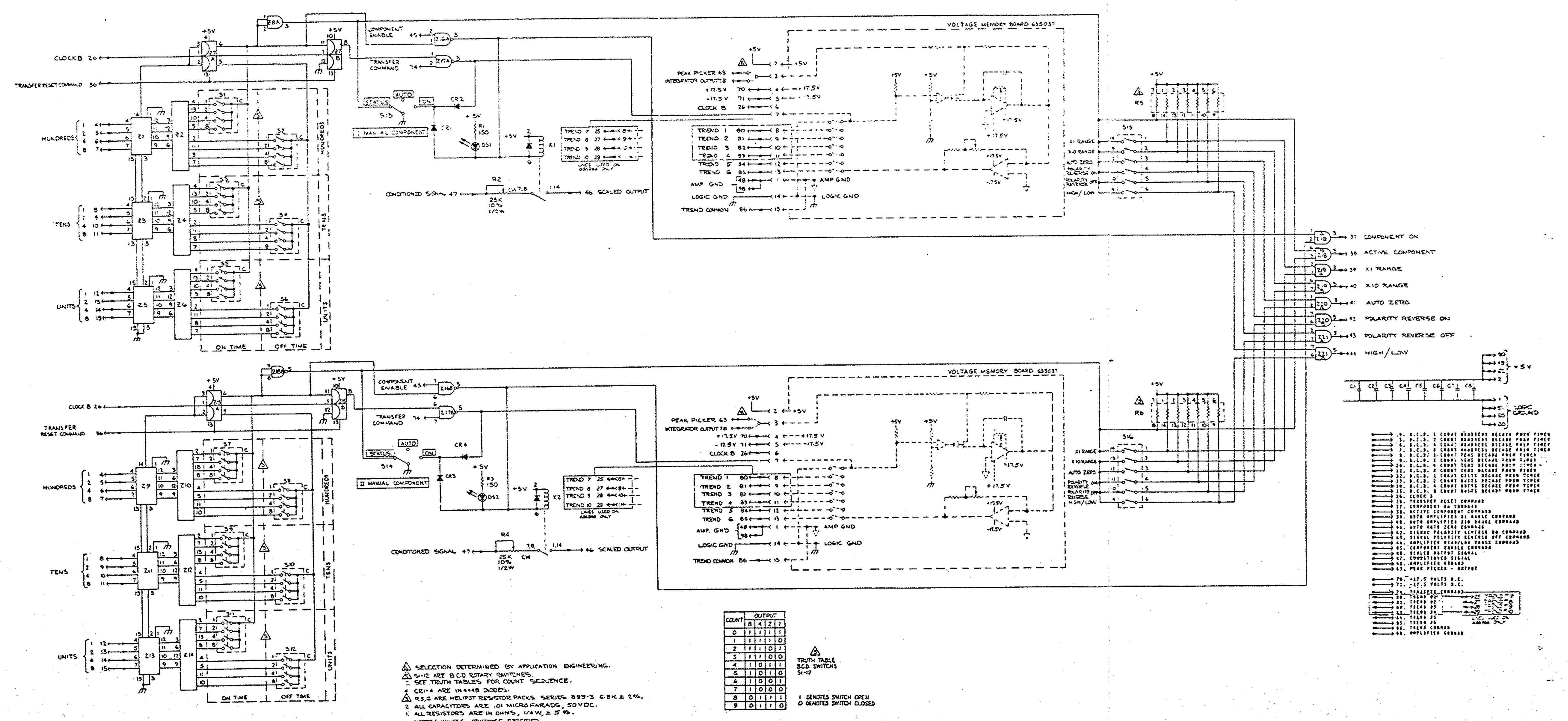
As Z7A is set, the component sequence begins and the COMPONENT ENABLE command is transmitted from the 640908 Master Control Board. This command causes energization of component relay K1, and routing of the data signal through component attenuator R2. Simultaneously, the COMPONENT ON indicator on the programmer front panel is energized by pin 3 of Z16A.

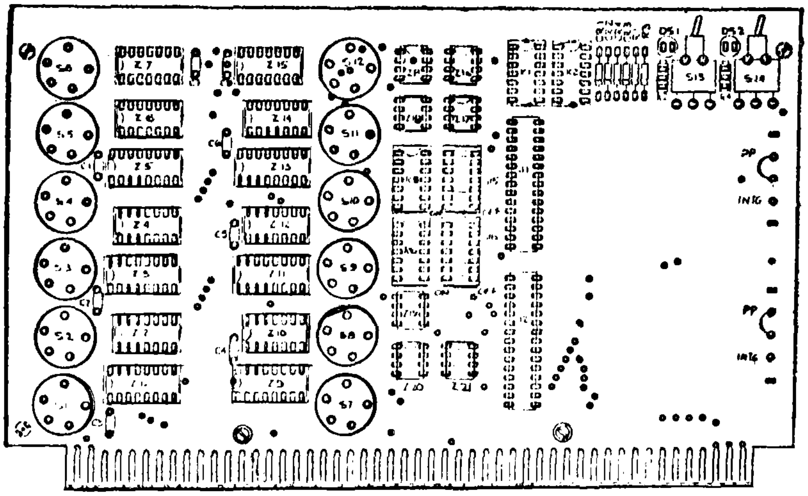
When the programmed COMPONENT OFF time occurs, Z7A goes to the reset state; i.e., pin 6 goes to 0 volts d.c. (Logic Zero). This deactivates the component attenuator and the function selected on Switch S15. However, Z7B remains in the set state, enabling the TRANSFER COMMAND to permit updating of the 635037 Voltage Memory Board, if provided. Z7B is reset by the TRANSFER RESET COMMAND on pin 36.



Typical ON-OFF Timing Sequence for Component 1



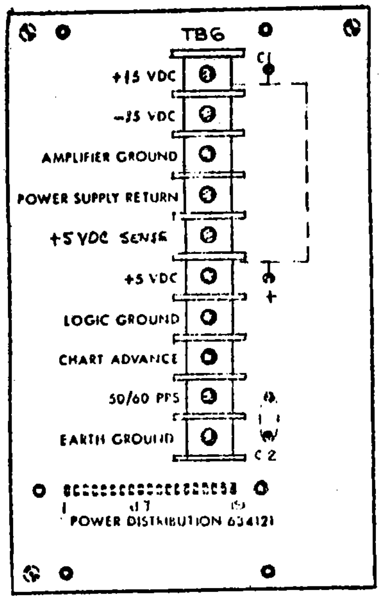




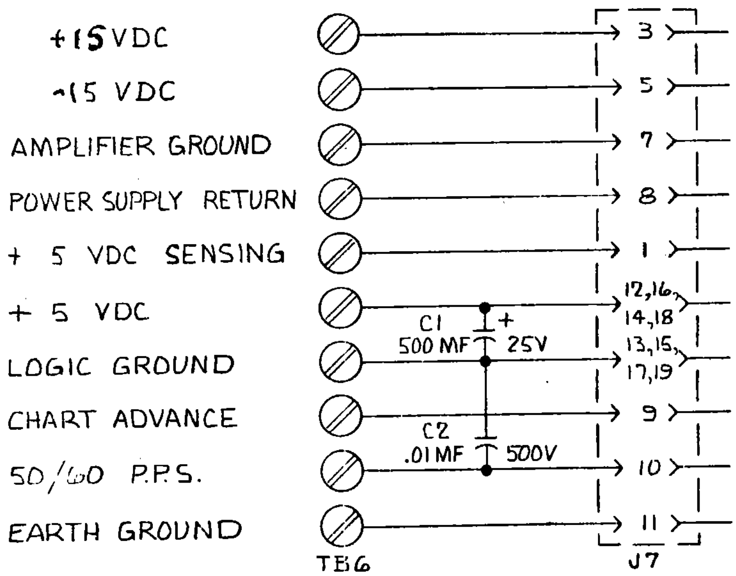
QTY	ITEM	PART NO.	DESCRIPTION
4	Z 18, 19, 20, 21	870872	CIRCUIT, INTEGRATED-SN75451P
3	Z 8, 16, 17	871995	CIRCUIT, INTEGRATED-SN75452P
2	Z 7, 15	855859	CIRCUIT, INTEGRATED -
6	Z 2, 4, 6, 10, 12, 14	632115	CIRCUIT, INTEGRATED
6	Z 1, 3, 5, 9, 11, 13	876116	CIRCUIT, INTEGRATED - 93L24
2	S15, 16	876111	SWITCH, DUAL-IN-LINE
2	S13, 14	876[illegible]	SWITCH, TOGGLE
12	S1-12	876119	SWITCH, ROTARY B.C.D.
2	J1, 2	876283	CONNECTOR, 15 PIN
2	K1, 2	[illegible]3112	RELAY, FORM 1A
2	DS1, 2	[illegible]	DIODE, LIGHT EMITTING
4	CR1-4	[illegible]731	DIODE, 1N4448
8	C1-8	836364	CAPACITOR, .01 μF 50V
2	R5, 6	871949	RESISTOR PACK 6.8K
2	R2, 4	876[illegible]34	RESISTOR, VARIABLE 25K 1/2W 10%
2	R1, 3	87[illegible]391	RESISTOR, 150 Ω 1/4 W 5%

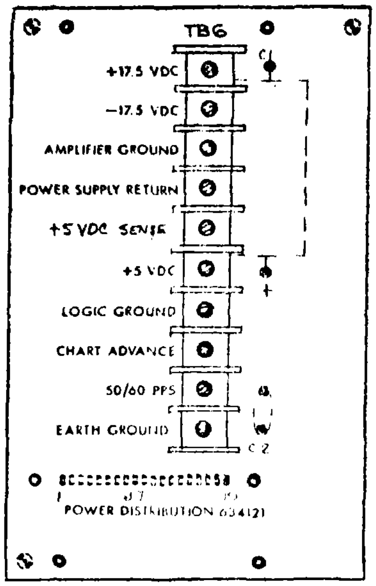
634115 DUAL COMPONENT MEMORY ASSEMBLY

634121 POWER DISTRIBUTION BOARD



The 634121 Power Distribution Board routes the various voltages from the 639761 Power Supply Board to the appropriate circuits. Troubleshooting of the 634121 Power Distribution Board consists of continuity checks only.

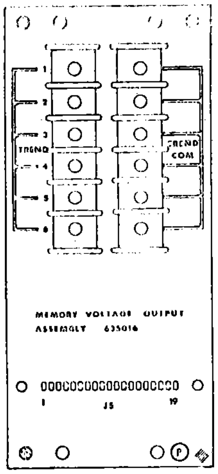




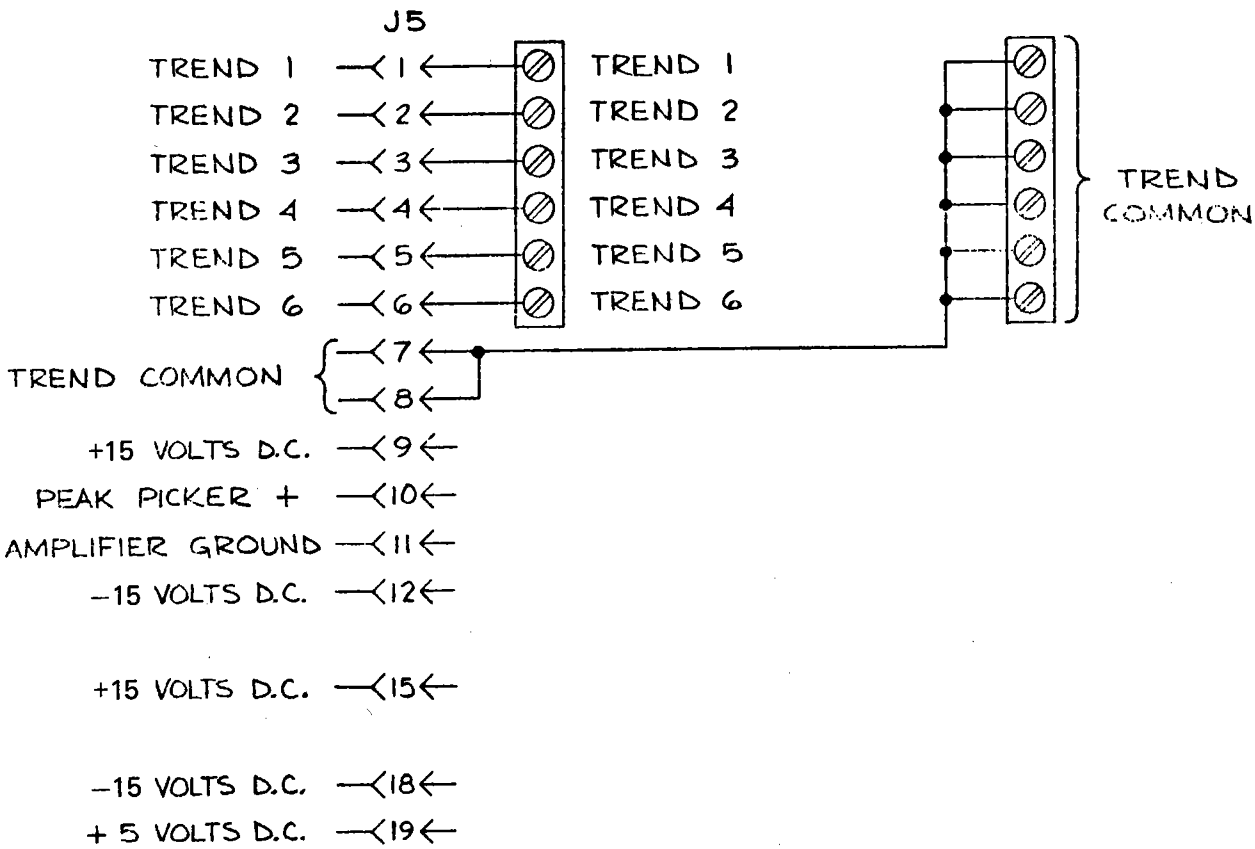
QTY	ITEM	PART NO.	DESCRIPTION
2	9	809890	SCREW PAN HD 4-40 X 1/4
4	8	811756	WASHER, FLAT NO. 4 S.C.
4	7	808264	WASHER, SPLIT NO. 4 SC
2	6	809892	SCREW, MACH 4-40 X 3/8 P.S.C.SL
2	5	861026	SPACER, THREADED
1	4	638066	CABLE ASSY
1	3	860065	PIN, POST
1	2	871264	BLOCK, TERMINAL

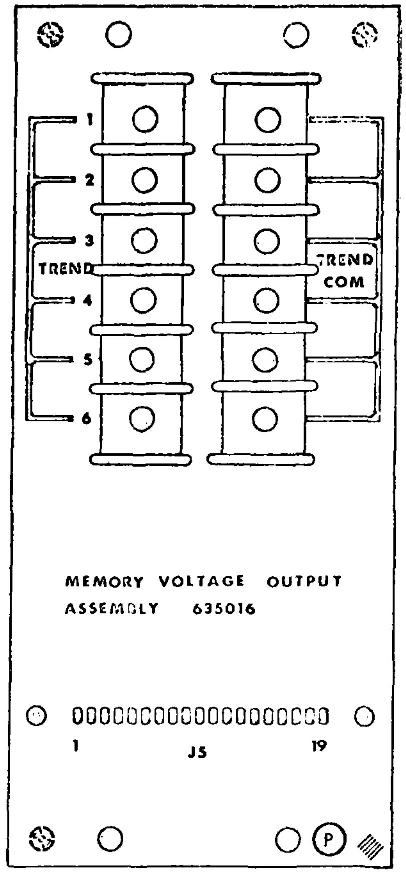
634121 POWER DISTRIBUTION ASSEMBLY

635016 VOLTAGE TREND OUTPUT ASSEMBLY



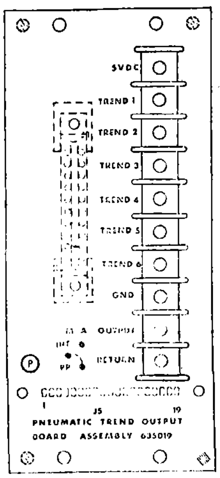
The 635016 Voltage Trend Output Assembly mounts at the rear of the programmer and provides output terminals for trend outputs 1 through 6. Troubleshooting of the output assembly consists of continuity checks only.





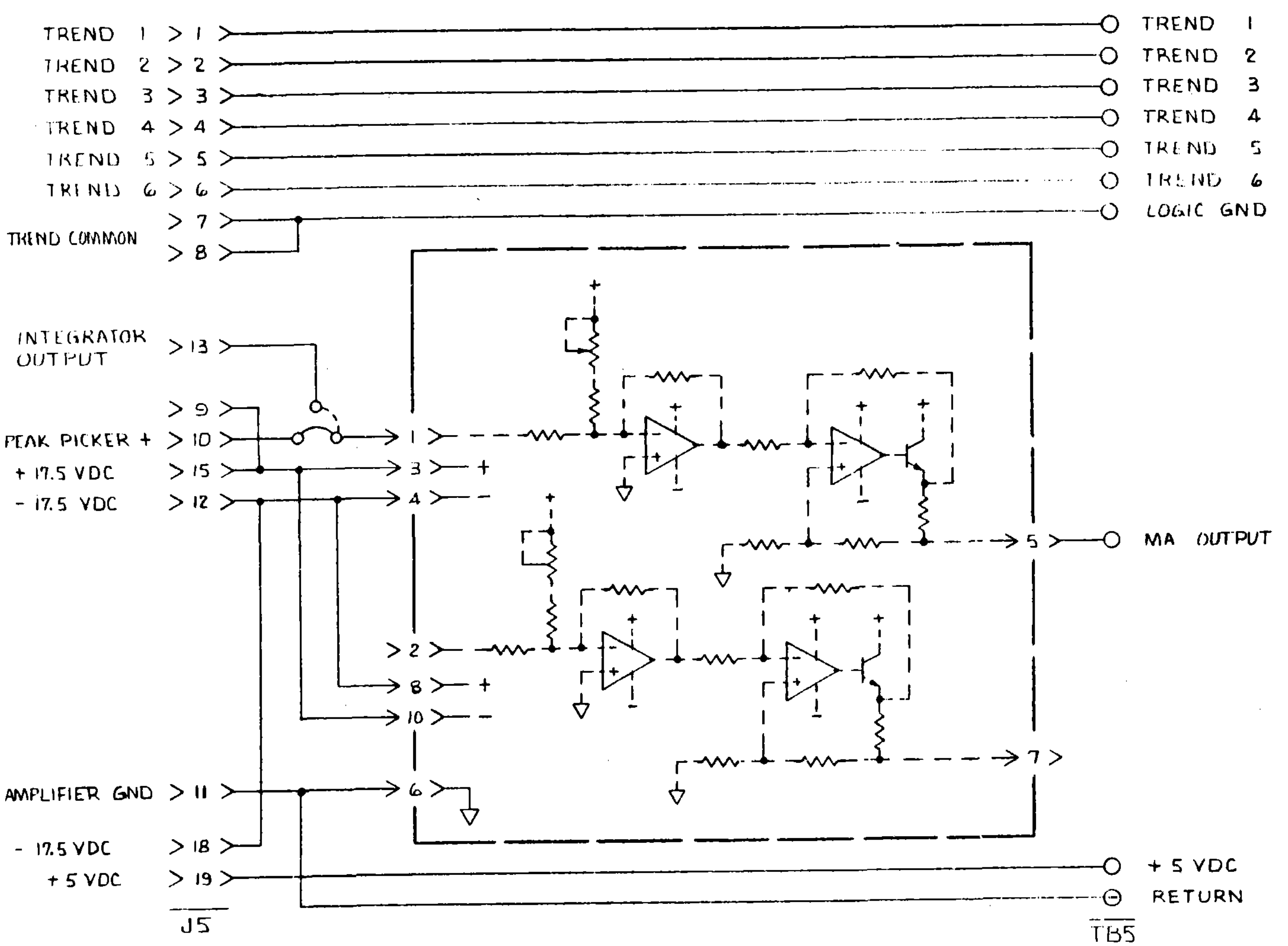
1	3	632066	CABLE, ASSY
QTY	ITEM	PART NO.	DESCRIPTION

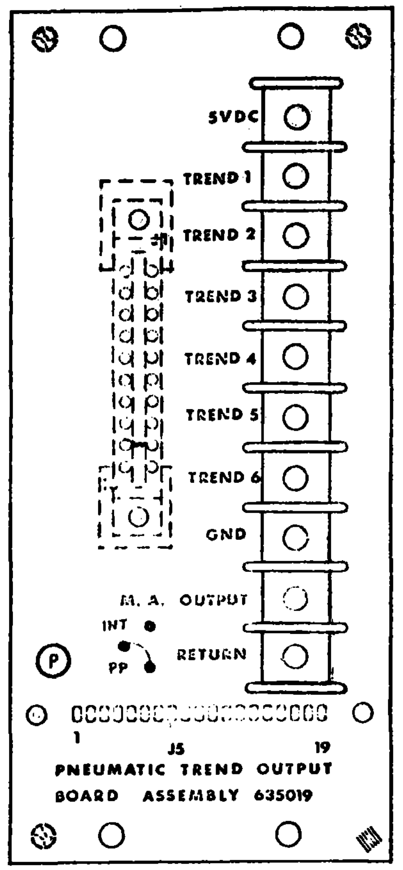
635019 PNEUMATIC TREND OUTPUT BOARD



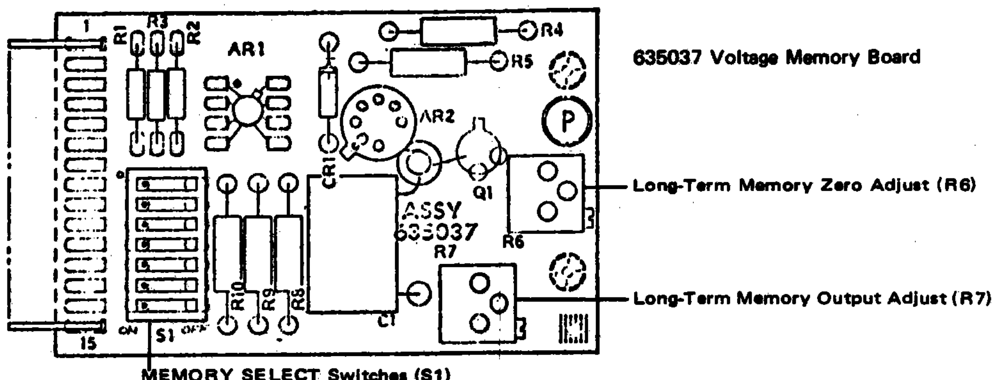
This board contains the following:

1. **Voltage-to-Current Transducer.** Converts the 0 to 5 volts d.c. signal from the 634109 Peak Picker into a 4 to 20-milliampere current loop, to drive the 876904 I/P Transducer. The transducer converts the current output into a pneumatic output of 3 to 15 psi (21 to 103 kPa).
2. **Trend Lines 1 Through 6.** Each line in use provides continuity from a given 634112 Pneumatic Trend Contact Board to the associated solenoid driver on the 635030, 635410, or 635400 Pneumatic Memory Assembly.





QTY	ITEM	PART NO.	DESCRIPTION
1	11	834753	KEY, POLARIZING
1	5	632066	CABLE ASSY



635037 Voltage Memory Board

Long-term memory for a given component is obtained through plug-in of a 635037 Voltage Memory Board into a 640411 Universal Component Board or other component board with memory option. Normally, the programmer accommodates a maximum of six long-term memories.

ELECTRONIC CIRCUITRY

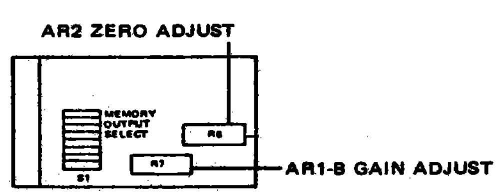
The 635037 Memory Board contains a long-term sample-and-hold circuit. The memory device is AR2, an inverting amplifier with 2X gain. It accepts a fullscale input signal of +5 volts d.c. from the peak picker, and provides a fullscale output signal of −10 volts d.c. Capacitor C1 stores the charge and thus maintains the signal in memory.

The 10-volt fullscale output from AR2 is applied to amplifier stage AR1-B. Gain of AR1-B is adjustable from 0.1X to 1X via R7. Thus R7 provides an adjustment range of 1 volt to 10 volts for the fullscale output of the memory board. Output impedance is approximately zero, and minimum allowable load 1000 ohms.

Switch S2 permits assigning the memory output to the desired one of six numbered trend-output lines, and to associated terminals at the programmed rear panel.

NOTE

A given trend-output line can be selected on one memory board only. Never assign two or more memory boards to the same line.



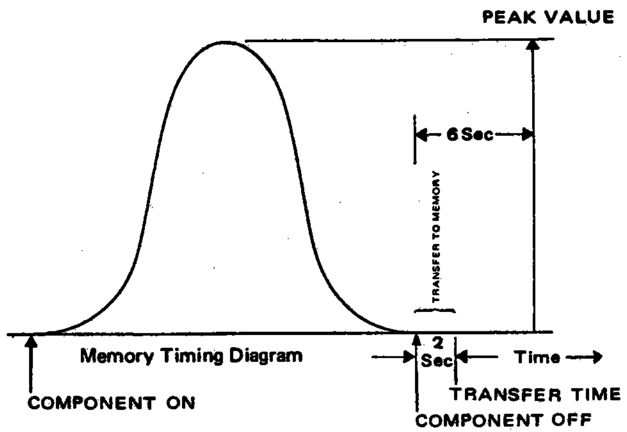
Memory Board Adjustments

MEMORY DRIFT RATE

To minimize drift, the memory function utilizes the two stages of amplification described above, with the memory gain adjustment incorporated into the second stage. Drift rate for the memory output from AR2 depends on the leakage current that is characteristic of capacitor C1, not the voltage impressed across C1. Fullscale output of AR2 is 10 volts.

AUTOMATIC OPERATION

After the peak has been attained, the output of the peak picker is present on pin 3 of the memory board. Three seconds after the programmed COMPONENT OFF time, a MEMORY COMMAND pulse is sent through the component board to pin 7 of the memory board. This pulse causes the output of AR1-A to change from −15 volts d.c. to +15 volts d.c., and Q1 to conduct. With Q1 conductive,

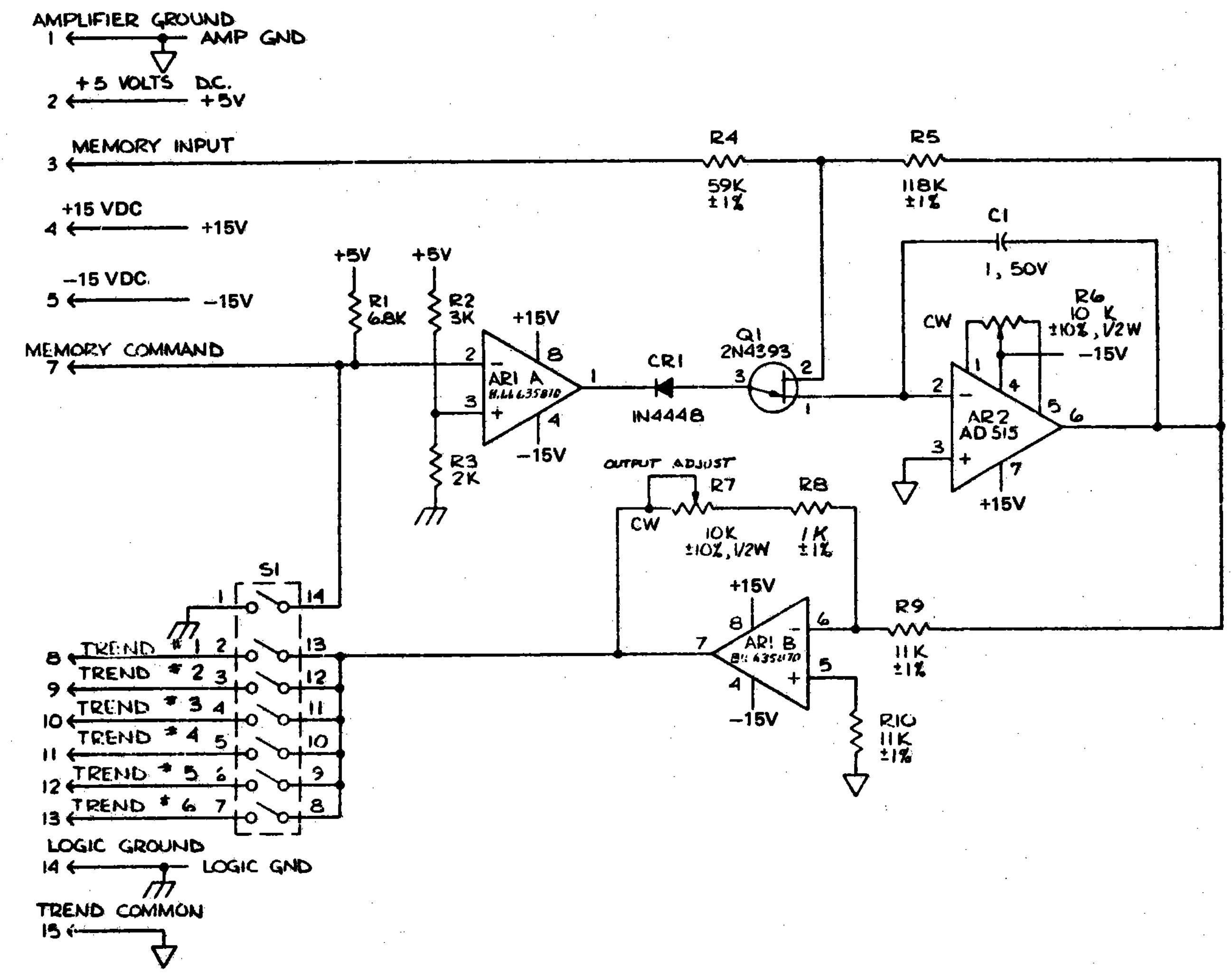


the signal on pin 3 is applied to the input of AR2, the memory amplifier previously described. The charge on capacitor C1 increases until it attains a value twice as great as the signal then present on pin 3 of the memory board. The memory command is then removed from pin 7; the output of AR1-A reverts to −15 volts d.c.; and FET Q1 becomes nonconductive. With R4 and R5 now removed from the feedback loop, AR2 maintains the value stored on C1.

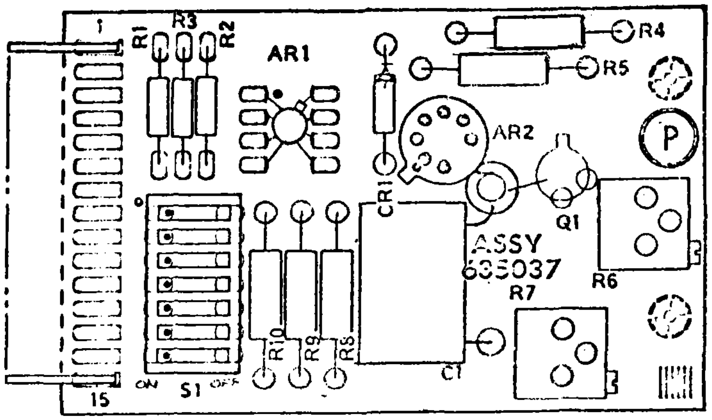
In troubleshooting, a memory output is most conveniently monitored on the associated channel of a trend recorder. If trend recorder is not available, partially withdraw memory board from its connector to permit connection of jumpers to appropriate pins.

CHECKOUT OF MEMORY BOARD FOR COMPONENT FAILURE

1. On programmer front panel, place MONITOR SELECT Switch at +5 VOLTS, +15 VOLTS, and −15 VOLTS; at each setting, verify correct reading on front-panel meter.
2. On programmer front panel, place MODE Switch at RESET, MONITOR SELECT Switch at AMPLIFIER OUT, ATTENUATION Switch at 2, RANGE Switch at AUTO, AUTO ZERO Switch at AUTO.
3. Within the programmer, place ZERO/CALIB Switch at ON: set CALIB ADJUST Control so front-panel meter indicates an amplifier-output signal of 1 volt.
4. On peak picker board, place AUTO/MAN Switch at MAN.
5. On the component board associated with the given memory function, place MANUAL COMPONENT Switch at MAN.
6. Verify that the appropriate MEMORY SELECT Switch on the memory board is at ON.
7. Monitoring device should now show an upscale reading, which will depend on the gain of AR1-B, as determined by the setting of R7 on the memory board.
8. Within the programmer, set CALIB ADJUST Control so front-panel meter indicates an amplifier-output signal of 2 volts. Reading on monitoring device should increase to twice its previous value.
9. Checkout of Amplifier Stage AR1-A:
   a. On memory board, verify that voltage on pin 1 of AR1-A is greater than +13 volts d.c.
   b. Make sure that rocker 1 on MEMORY SELECT Switch S1 is at OFF.
      Place MANUAL COMPONENT Switch on component board at MAN.
      Voltage on pin 1 of AR1-A should be greater than −13 volts d.c.
   c. If either voltage is not as specified, replace amplifier AR1.
10. Checkout of Amplifier AR2:
    Connect monitoring device to pin 6 of AR2. Both upscale and downscale readings should be obtainable by adjustment of R6; if not, either Q1 or AR2 is at fault. To localize the trouble, connect a jumper from junction of R4 and R5 to input of AR2 (on Teflon pad). Again note response of monitoring device to adjustment of R6. If correct response is now obtained, Q1 is defective. If response is still incorrect, AR2 is defective.
11. Checkout of Amplifier Output Stage AR1-B:
    If all preceding tests yield correct results, Q1 is defective or Switch S1 has an open contact.



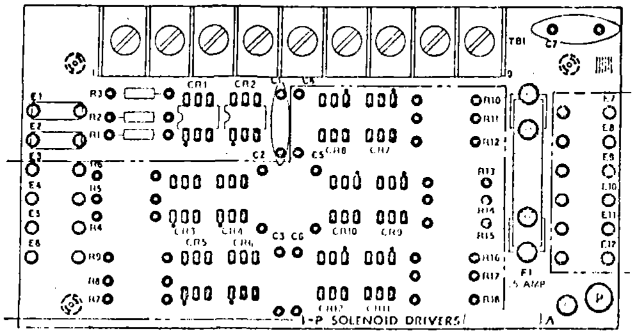
NOTES:
Unless Otherwise Specified
1. All resistors are in ohms ±5%, ¼ W.
2. All capacitance is in microfarads.



1	S1	876111	SWITCH PACK
1	AR2	861185	CIRCUIT, INTEGRATED-[illegible]
1	AR1	635870	CIRCUIT, INTEGRATED-SN[illegible]
1	Q1	866865	TRANSISTOR, F.E.T - 2N4393
1	CR1	838731	DIODE - 1N4448
1	C1	871595	CAPACITOR, 1 MFD, 50V
2	R9,10	825901	RESISTOR, 11K, ±1%, 1/4W
1	R8	825[illegible]	RESISTOR, [illegible] K, ±1%, 1/4W
2	R6,7	876503	RESISTOR, VARI., 10K, ±10%, 1/2W
1	R5	863367	RESISTOR, 118K, ±1%, 1/4W
1	R4	844543	RESISTOR, 59K, ±1%, 1/4W
1	R3	822293	RESISTOR, 2K, ±5%, 1/4W
1	R2	822368	RESISTOR, 3K, ±5%, 1/4W
1	R1	822299	RESISTOR, 6.8K, ±5%, 1/4W
QTY	ITEM	PART NO.	DESCRIPTION

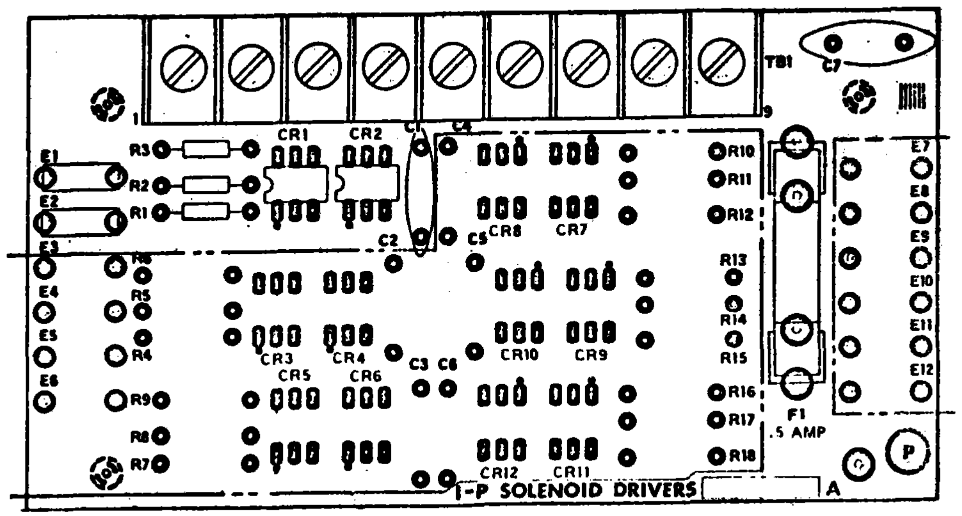
635037 VOLTAGE MEMORY ASSEMBLY

635040 I/P ONE VALVE-DRIVER BOARD



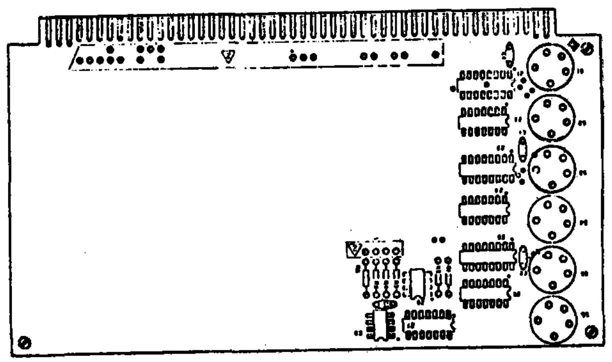
The 635040 I/P Solenoid Valve Driver Board contains one valve driver circuit to drive the solenoid valve in the 635030 Pneumatic Memory Assembly.

For circuit schematic diagram, refer to 635412 I/P Six Valve-Driver Board.



QTY	ITEM	PART NO.	DESCRIPTION
1	TB1	876309	BLOCK, TERMINAL
1	F1	8779	FUSE, .5 AMP
2	CR1,2	876825	RECTIFIER, [illegible]
1	E2	810281	JACK, TEST - WHT
1	E1	810280	JACK, TEST - BLK
1	C7	862282	CAPACITOR, .01 MFD, 2000V
1	C1	841225	CAPACITOR, .05 MFD, 500V
2	R2,3	822324	RESISTOR, 10K, ±5%, 1/4W
1	R1	819666	RESISTOR, 91 OHMS, ±5%, 1/4W
2	2	869341	CLIP, FUSE

635263 UNIVERSAL LATCH BOARD



This plug-in board of various uses provides an on-off switching interval of selectable duration, programmable to occur at any desired time during the analysis cycle. The circuit provides *two* sequential on-off switching functions. The second function lags the first by one second, thus permitting a sequencing action to be attained. The suggested usage of the board is to pull control lines to ground and hold them at ground during the programmed time interval.

PROGRAMMING
In programming, the desired ON and OFF times are selected via ten-position rotary switches on the board, as described in Paragraph 11.1. The on-off switching action must be completed prior to the CYCLE RESET TIME selected on the 632196 Digital Timer Board or 638493 Digital-Timer/Logic-Test Board.

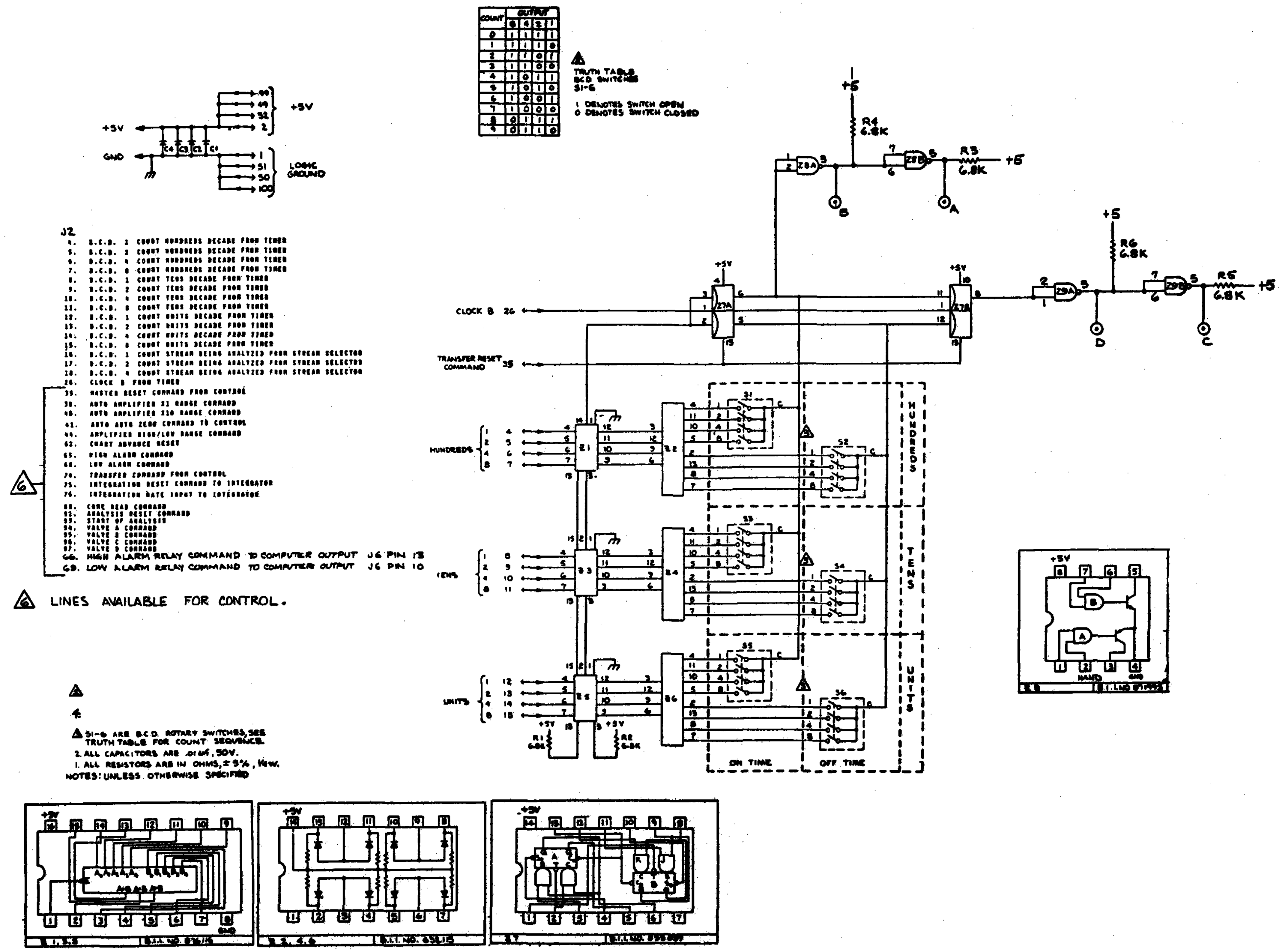
OPERATION
During automatic operation:

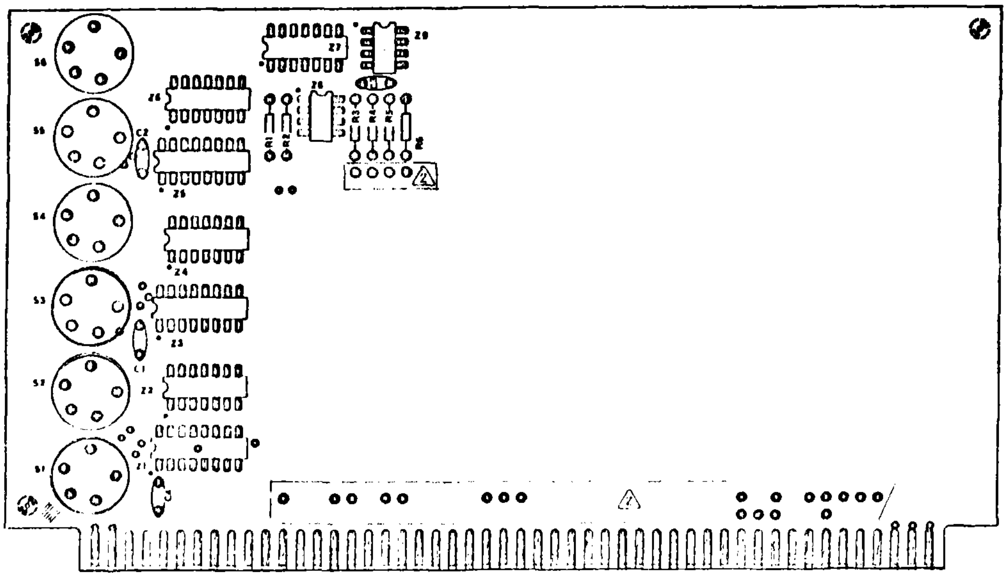
1. At the programmed ON time, flip-flop Z7A sets. *One second* later, Z7B sets.
2. At the programmed OFF time, Z7A resets. One second later, Z7B resets.

OUTPUTS
The output from Z7A is available at gates Z8A and Z8B, which are always the inverse of one another.

Similarly, the output from Z7B is available at gates Z9A and Z9B, which are always the inverse of one another.

Gates Z8 and Z9 provide a current sink of up to 300 milliamperes each.

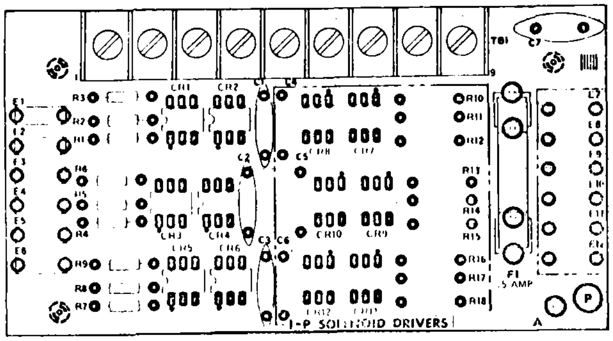




QTY	ITEM	PART NO.	DESCRIPTION
2	Z8,9	871995	CIRCUIT INTERGRATED - SN[illegible]
1	Z7	855869	CIRCUIT, INTERGRATED - [illegible]
3	Z2,4,6	632115	CIRCUIT, INTERGRATED
3	Z1,3,5	876116	CIRCUIT, INTERGRATED - [illegible]
6	S1 - 6	876119	SWITCH, BCD
6	R1 - 6	822299	RESISTOR 6.8K ±5% [illegible]
4	C1 - 4	836864	CAPACITOR .01 MFD 50V

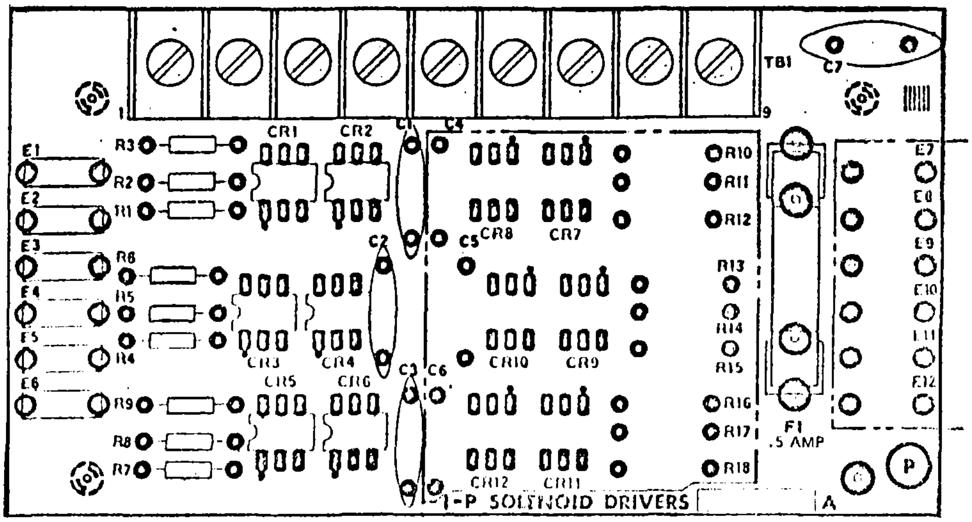
635263 UNIVERSAL LATCH BOARD

635411 I/P THREE VALVE-DRIVER BOARD



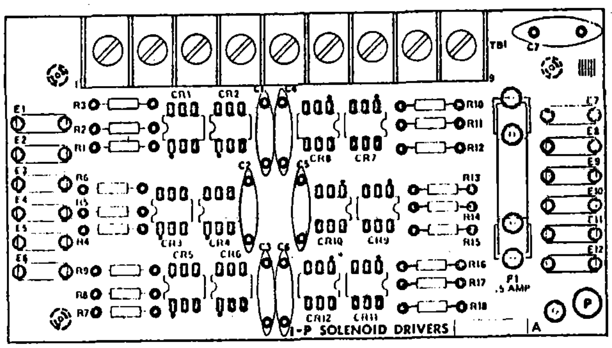
The 635411 I/P Solenoid Valve Driver Board contains three valve driver circuits, one for each solenoid valve in the 635410 Pneumatic Memory Assembly.

For circuit schematic diagram, refer to 635412 I/P Six Valve-Driver Board.

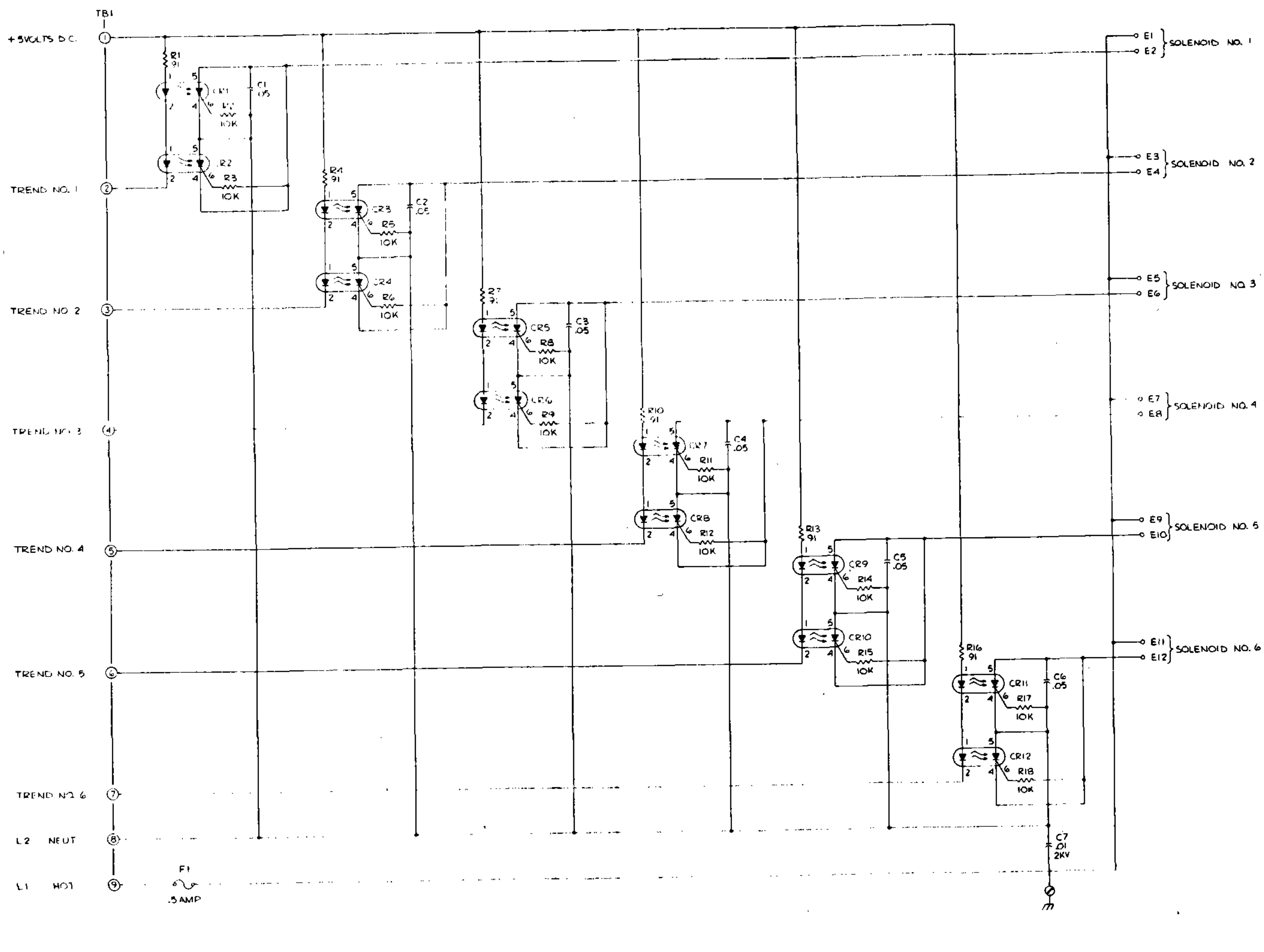


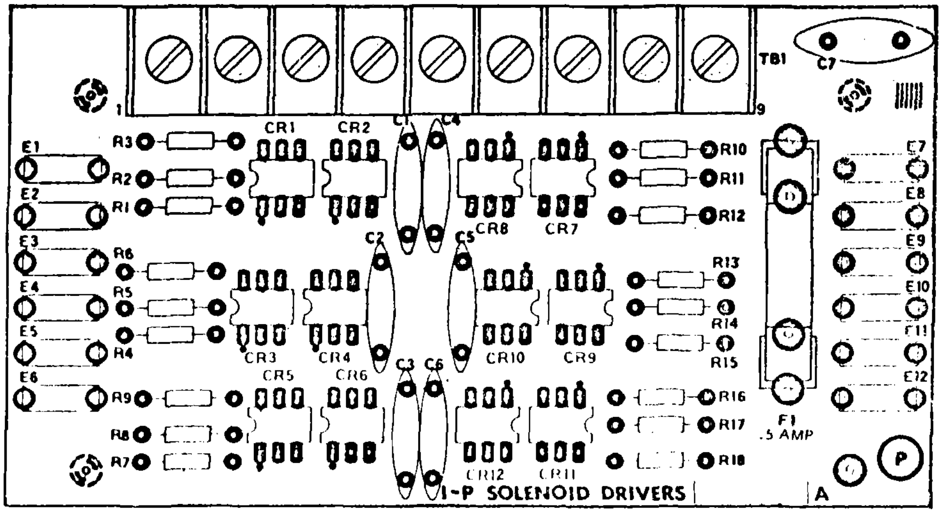
QTY	ITEM	PART NO.	DESCRIPTION
1	TB1	876309	BLOCK, TERMINAL
1	F1	8779	FUSE, .5 AMP
6	CR1-6	876825	RECTIFIER, SCR
3	E2,4,6	810281	JACK, TEST - WHT
3	E1,3,5	810280	JACK, TEST - BLK
1	C7	862282	CAPACITOR, .01 MFD, 2000V
3	C1-3	841225	CAPACITOR, .05 MFD, 500V
6	[illegible]	822324	RESISTOR, 10K, ± 5%, 1/4W
3	R1,4,7	819666	RESISTOR, 91 OHMS, ±5%, 1/4W
2	2	869341	CLIP, FUSE
1	1	635039	BOARD, PRINTED WIRING

635412 I/P SIX VALVE-DRIVER BOARD

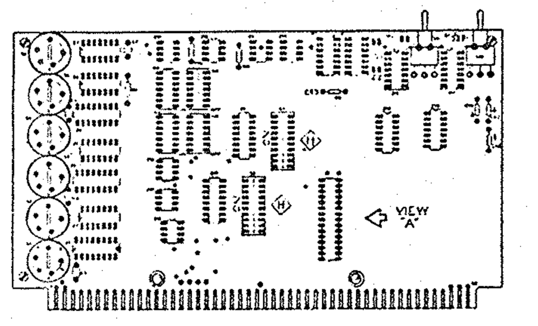


The 635412 I/P Valve-Driver Board contains six valve-driver circuits, one for each solenoid valve in the 635400 Pneumatic Memory Assembly.





QTY	ITEM	PART NO.	DESCRIPTION
1	TB1	876309	BLOCK, TERMINAL
1	F1	8779	FUSE, .5 AMP
12	CR1-12	87[illegible]825	RECTIFIER [illegible]
6	E2,4,6,8,10,12	810281	JACK, TEST - WHT
6	E1,3,5,7,9,11	810280	JACK, TEST - BLK
1	C7	862282	CAPACITOR, .01 MFD, 2000V
6	C1-6	841225	CAPACITOR, .05 MFD, 500V
12	[illegible]	822324	RESISTOR, 10K, ±5%, 1/4W
6	[illegible]	819666	RESISTOR, 91 OHMS, ±5%, 1/4W



In this board, a single ON-OFF timing section controls two component sections, both with function-select capability. Memory output is obtainable through plug-in of a 635037 Voltage Memory Board.

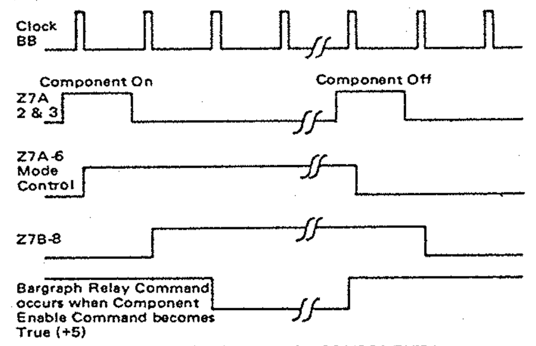
COMPONENT ON-OFF TIMING SECTION
During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.

COMPONENT I SECTION
This section consists of :

1. **Function Select Switch S7.** By closure of the appropriate contacts on this switch, any desired streams may be assigned to the section.
2. **Programming Functions** (Selected with Switch S11):
   a. *X1 RANGE Switch.* Selects gain of 1000 for TC amplifier or 100 for FID amplifier.
   b. *X10 RANGE Switch.* Selects gain of 100 for TC amplifier or 10 for FID amplifier.
   c. *AUTO ZERO Switch ON.* During automatic operation, an auto-zero function will occur approximately three seconds before activation of the COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.
   d. *POLARITY REVERSE ON Switch.* Reverses the polarity of the signal in the 640324 TC Detector Electronics Board, if analyzer is so equipped.
   e. *POLARITY REVERSE OFF Switch.* Turns off the polarity-reverse circuit.
   f. *HIGH/LOW Range Switch.* HIGH position provides 1000X attenuation of output signal from FID amplifier. Switch is inoperative with TC amplifier.
3. **ON/AUTO/STATUS Switch S9.** On position activates component attenuator R5 and causes DS1 to illuminate. The amplifier signal will be displayed on the recorder, provided that the ATTENUATION Switch on the programmer front panel is at AUTO.
   AUTO position places the component functions under pre-programmed control.
   STATUS is a test position, used *momentarily*, to check programming of component functions. While holding switch at STATUS, observe indicators on master board. Do not check status during automatic operation.
4. **COMPONENT ATTENUATOR R5.** Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but not trend) data presentation.

COMPONENT I ON-OFF SEQUENCE
At the programmed COMPONENT ON time, pin 6 of Z7A goes to +5 volts d.c., causing all closed functions on Switch S11 to be energized by Z8A. The next pulse of clock B causes Z7B to go to the set state.

As Z7A is set, the component sequence begins and the COMPONENT ENABLE command is transmitted from the 640908 Master Control Board. This command causes energization of component relay K1, and routing of the data signal through component attenuator R5. Simultaneously, the COMPONENT ON indicator on the programmer front panel is energized by pin 3 of Z14A.

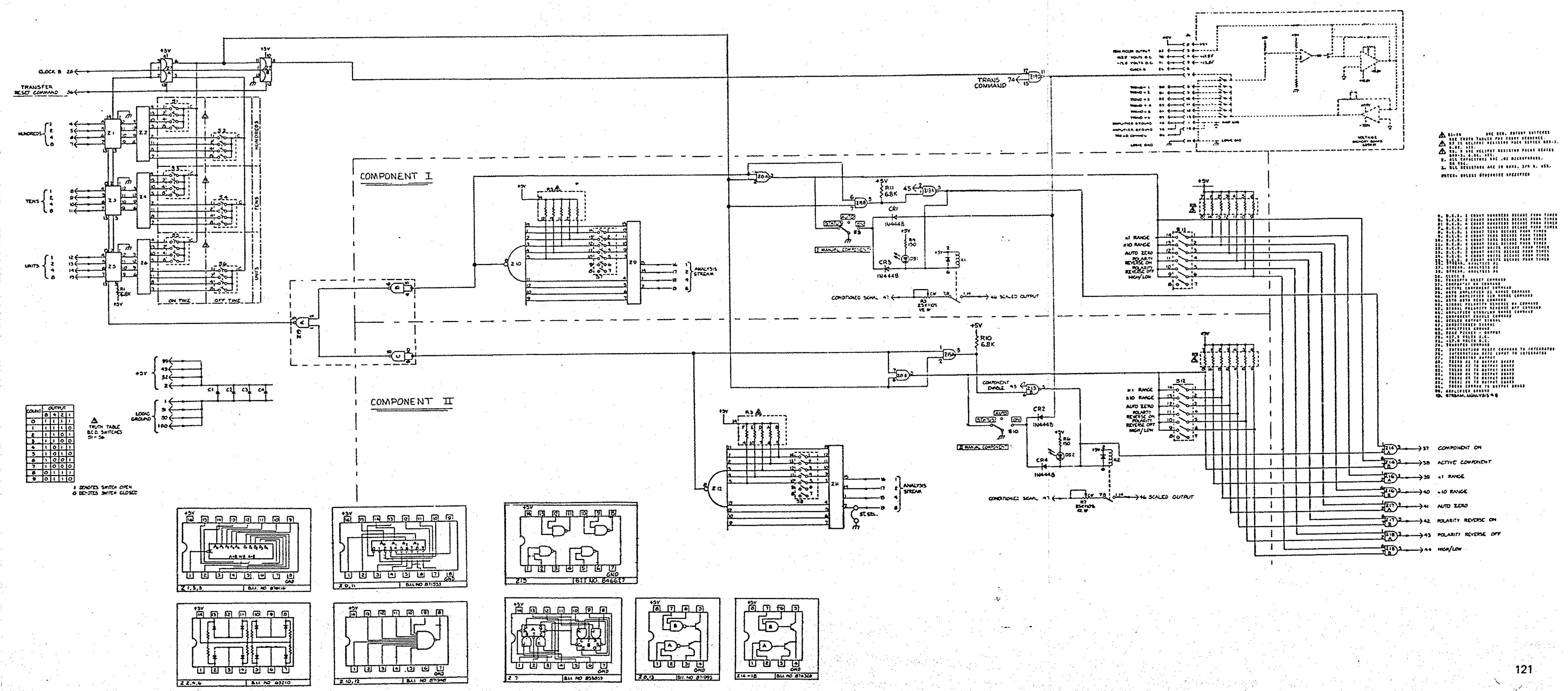


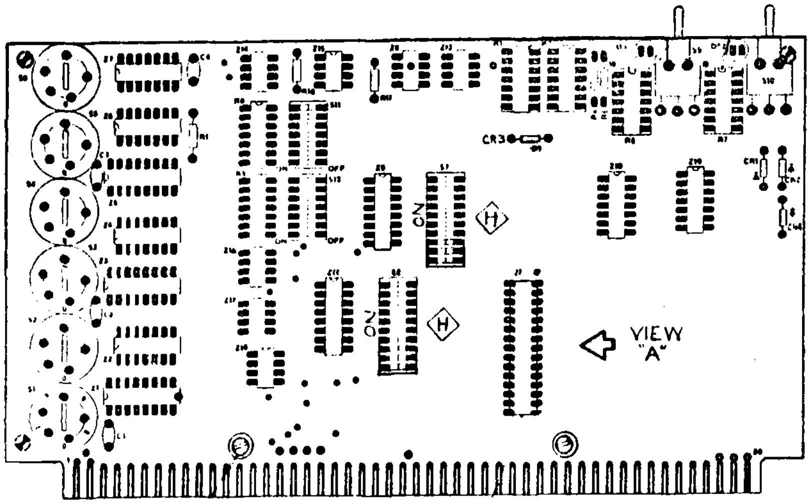
Typical On-Off Timing Sequence for COMPONENT I

When the programmed COMPONENT OFF time occurs, Z7A goes to the reset state; i.e., pin 6 goes to 0 volts d.c., (Logic Zero). This deactivates component attenuator R5 and the functions selected on Switch S11. However, Z7B remains in the set state, enabling the TRANSFER COMMAND to permit updating of the 635037 Voltage Memory Board, if provided. Z7B is reset by the TRANSFER RESET COMMAND on pin 36.

COMPONENT II SECTION
Functionally, this section is identical to the COMPONENT I Section, described above; however, circuit designations differ.

MEMORY OUTPUT
Memory output is obtainable through plug-in of a 635037 Voltage Memory Board.

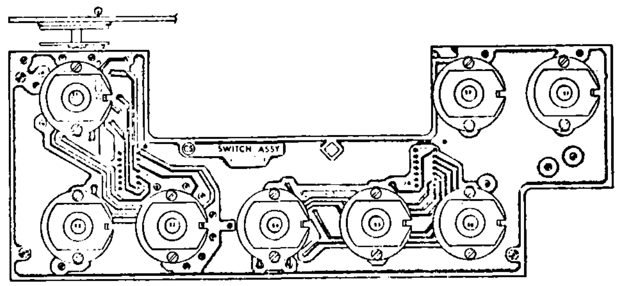




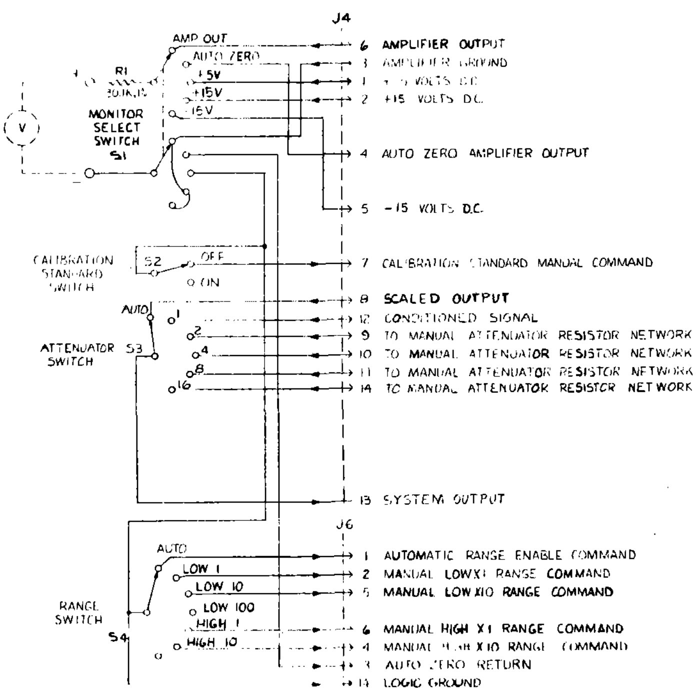
QTY	ITEM	PART NO.	DESCRIPTION
1	Z19	846627	CIRCUIT INTEGRATED , 846
5	Z14-18	870872	, SN75451P
1	Z10	855858	, SN15836N
2	Z9,11	869386	, SN74145N
2	Z8,13	871995	, SN75452P
1	Z7	855859	, 852
3	Z2,4,6	632115	
3	Z1,3,5	876116	CIRCUIT, INTEGRATED , 93L24
2	S7,8	860660	SWITCH, DUAL-IN-LINE 10 POS.
2	S9,10	876327	SWITCH, TOGGLE
2	S11,12	876111	SWITCH, DUAL-IN-LINE 7 POS.
6	S1-6	876119	SWITCH, ROTARY - BCD
2	K1,2	633112	RELAY, FORM 1A
2	DS1,2	860444	DIODE, LIGHT EMITTING
4	CR1-4	838731	DIODE, 1N4448
4	C1-4	836864	CAPACITOR, .01MFD, 50V
2	R8,9	871949	RESISTOR PACK 899-3, 68K
2	R5,7	876396	RESISTOR, VARIABLE, 25K±10%, 1/2W
2	R4,6	823391	RESISTOR, 150 OHMS, ±5%, 1/4W
3	R1,10,11	822299	RESISTOR, 6.8K, ±5%, 1/4W

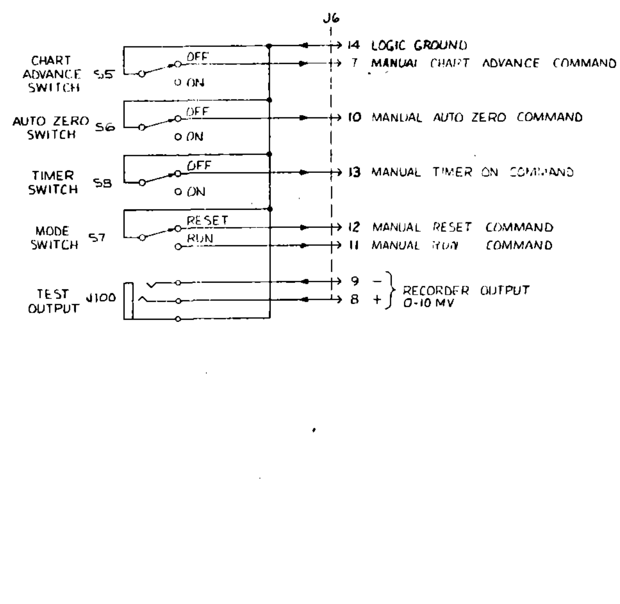
636042 DUAL COMPONENT F.S./SINGLE TIMER BOARD ASSEMBLY

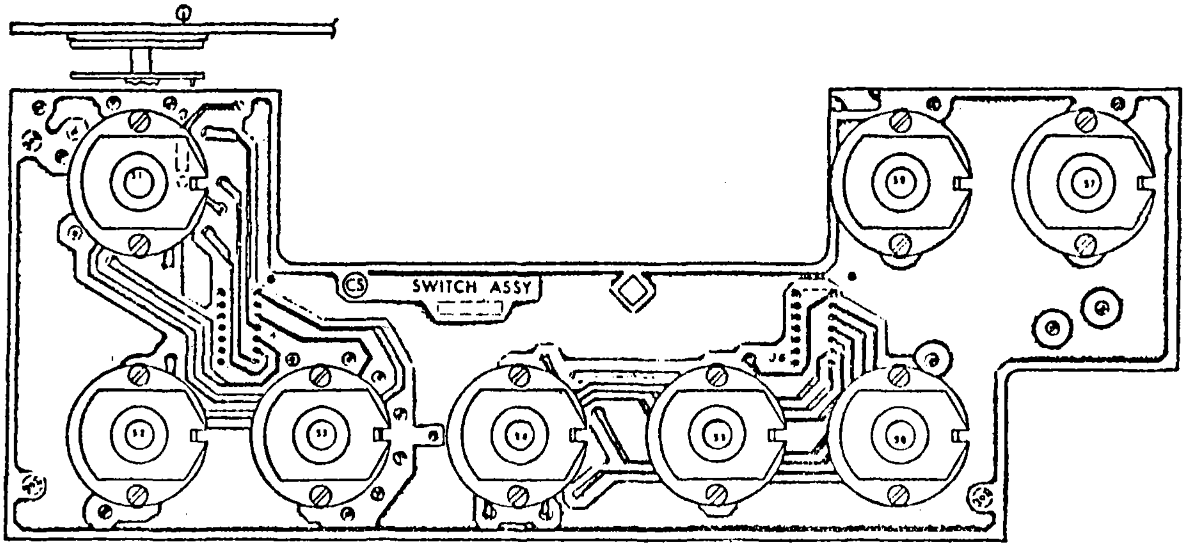
636567 SWITCHBOARD ASSEMBLY



This assembly provides the various switches utilized on the programmer front panel.



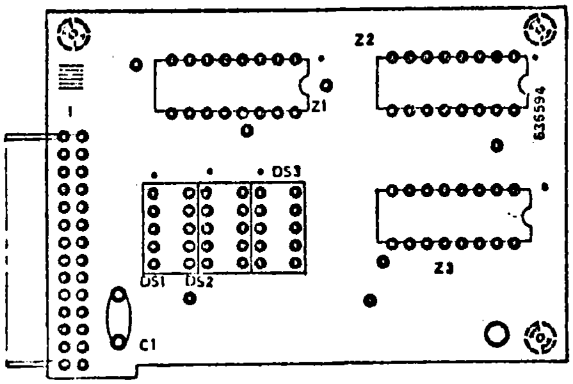


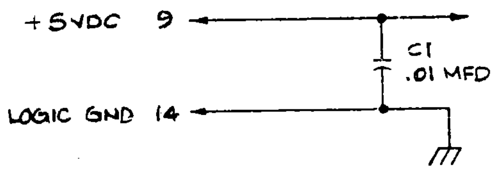


QTY	ITEM	PART NO.	DESCRIPTION
1	R1	826513	RESISTOR 30.1K, ±1%, 1/4W
1	S7	632119	SWITCH (MODE)
1	S4	632118	SWITCH (RANGE)
1	S3	634774	SWITCH (ATTENUATOR)
4	S2, 5, 6, 8	632120	SWITCH (FUNCTION)
1	S1	632121	SWITCH (MONITOR)

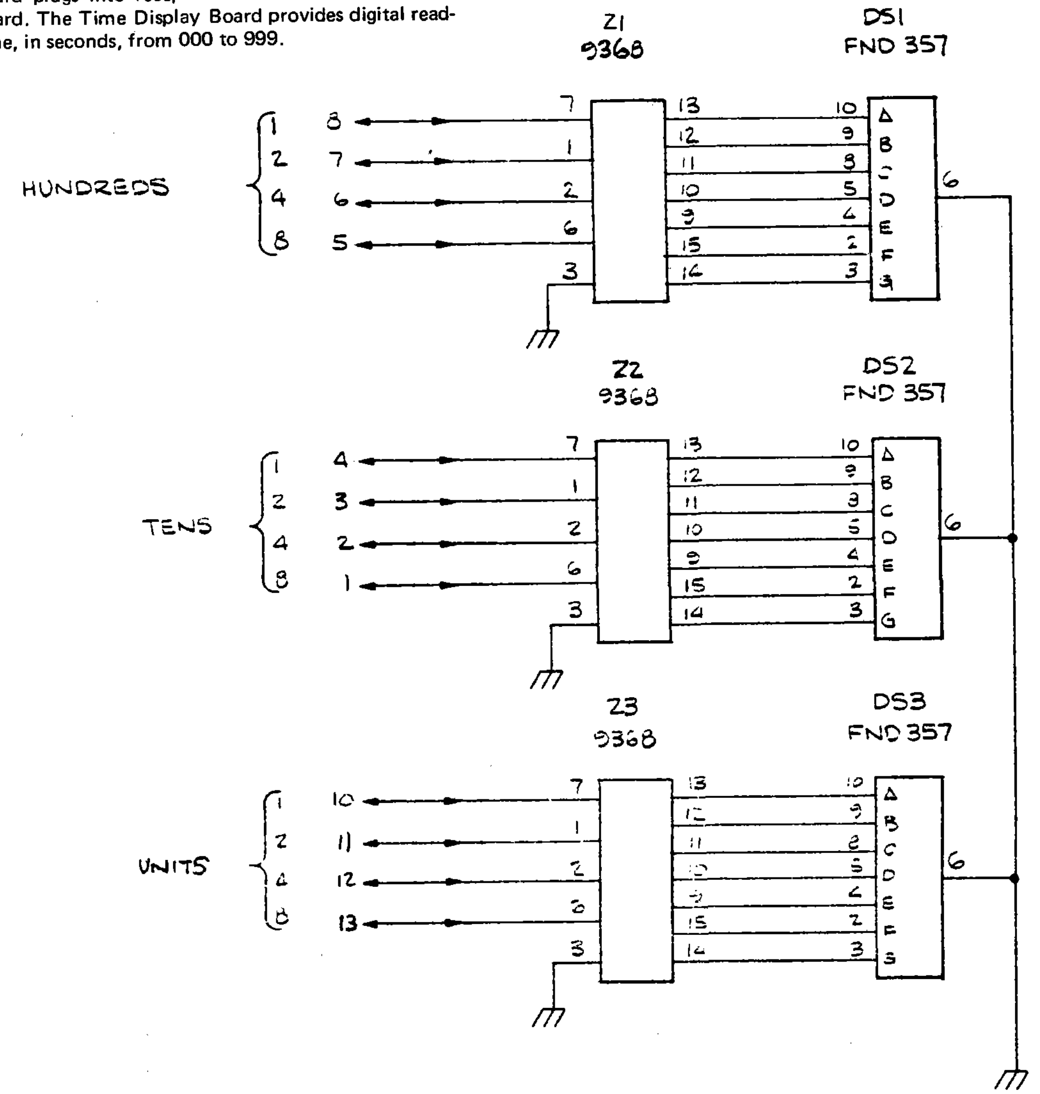
636567 FRONT PANEL SWITCH ASSEMBLY

636594 TIME DISPLAY BOARD

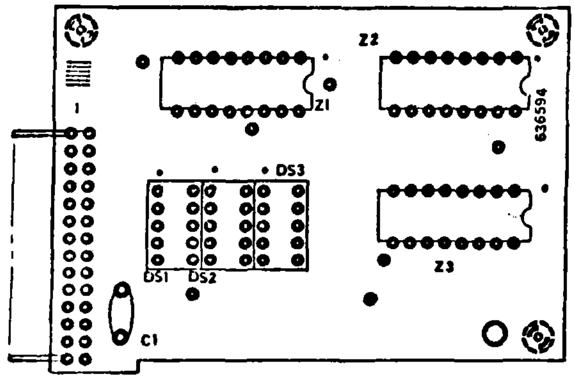




This optional board plugs into receptacle J3 of the 632145 Front Panel Display Board. The Time Display Board provides digital readout of elapsed time, in seconds, from 000 to 999.



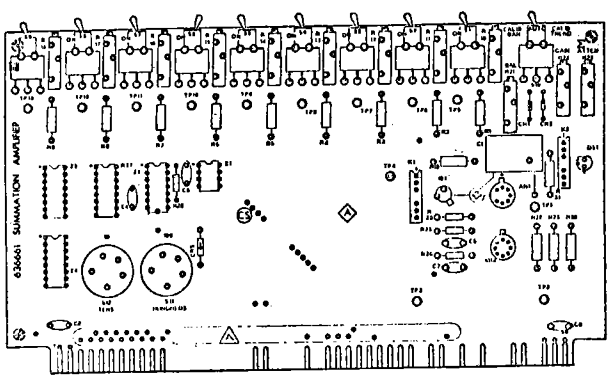
NOTES:
1. DS1-3 Fairchild FND 357, Beckman Part No. 860749.
2. Z1-3, Beckman Part No. 874757.



QTY	ITEM	PART NO.	DESCRIPTION
3	Z1-3	874757	CIRCUIT, INTEGRATED 9368
3	DS1-3	560745	LED DISPLAY
1	C1	836364	CAPACITOR, .01 MFD
3	3	560743	SOCKET
14	2	871973	PIN, CONTACT

636594 TIME DISPLAY BOARD ASSEMBLY

636661 SUMMATION AMPLIFIER BOARD



The 636661 Summation Amplifier Board accepts a maximum of nine separate trend inputs from long-term memories, and provides an output that is proportional to their sum. The board incorporates adjustments for scaling each input and the output.

The board utilizes two amplifier stages:

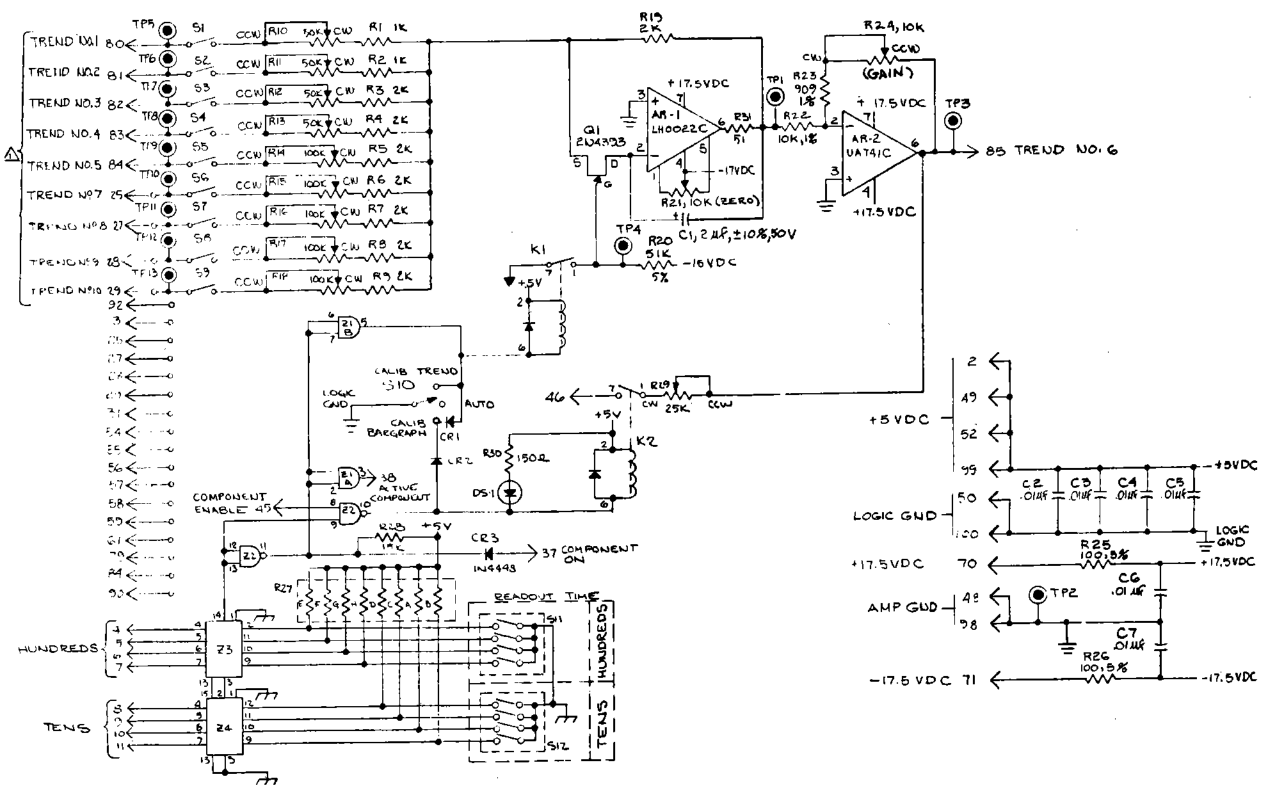
1. **Summing Amplifier AR1.** It receives the individual trend inputs, via adjustable input resistors, and provides an output that is proportional to their sum. This output, observable at TP1, is *negative.*
2. **Follower Amplifier AR2.** It inverts the output signal from AR1, thus providing a *positive* output, observable at TP3, and adjustable via SPAN potentiometer R24. This output provides trend readout, and also is routed through ATTENUATOR R29 to provide bargraph readout.

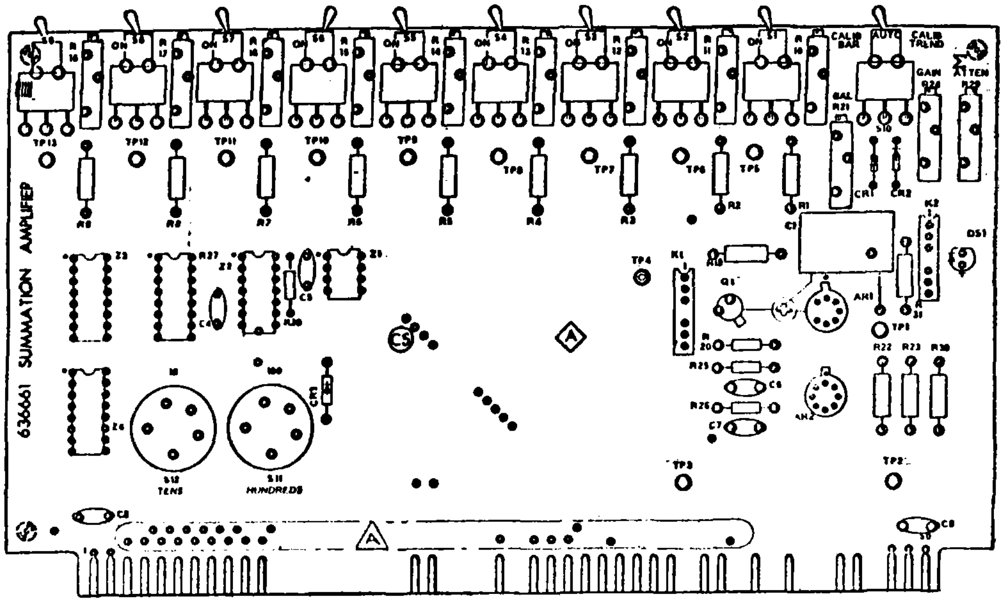
LOGIC CIRCUITRY

Integrated circuits Z3 and Z4 decode the counter. When Z3 and Z4 concur, the output at Z3, pin 14 becomes true (+5 volts) and causes occurrence of the COMPONENT ON command at pin 37. The COMPONENT ON command causes the programmed component sequence to occur on the 636570 Master Control Board, where a command is generated on pin 45 that allows relay K2 to energize. With K2 energized, the attenuated output of the follower amplifier AR2 is presented on pin 46 (the readout bus for all component attenuators), provided that the front-panel ATTENUATOR Switch is at AUTO.

The time desired for bargraph readout of the summed, attenuated, output is selected via rotary encoder switches. S11 (HUNDREDS) and S12 (TENS). The designations signify time, in seconds. The timing sequence thus programmed causes occurrence of a component sequence so that the summed attenuated, output can be fed through the 634109 Peak Picker Board for readout through the 636945 Computer/Alarm Terminal Assembly.

With S10 in AUTO position, gate Z1B causes energization of relay K1, and therefore updating of summation amplifier AR2. Span control R24 adjusts the output of AR2.

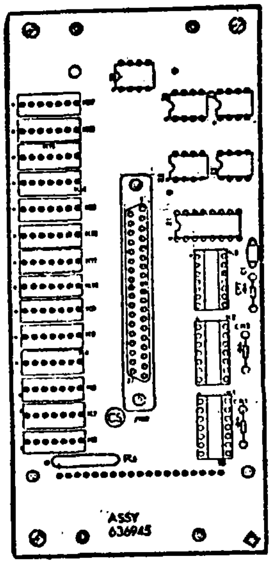




QTY	ITEM	PART NO.	DESCRIPTION
2	K1, K2	861415	RELAY 1 FORM A
2	S11, 12	876119	SWITCH BCD
1	S10	862596	SWITCH TOGGLE
9	S1-9	876686	SWITCH TOGGLE, SPDT
1	Q1	868801	TRANSISTOR 2N4393
2	Z3,4	876116	INTEGRATED CIRCUIT 93L24
1	Z2	871550	INTEGRATED CIRCUIT MC858
1	Z1	870872	INTEGRATED CIRCUIT 75451
1	AR2	633243	AMPLIFIER UA741HC
1	AR1	876311	AMPLIFIER LH0022C
1	DS1	860403	DIODE LIGHT EMITTING
3	CR1-3	838731	DIODE 1N4448
6	C2-7	836864	CAPACITOR .01μf 50V DISC
1	C1	876441	CAPACITOR [illegible] ±10% [illegible]V [illegible]
1	R31	822367	RESISTOR 51Ω ±5% ¼W CAR
1	R30	823391	RESISTOR 150Ω ±5% ¼W CAR
1	R29	863036	RESISTOR VARIABLE 25K
1	R28	822301	RESISTOR 15K ±5% ¼W
1	R27	876375	RESISTOR NETWORK
2	R25,26	817735	RESISTOR 100Ω ±5% ¼W CAR
2	R21,24	860365	RESISTOR VARIABLE 10K CERMET
1	R23	826045	RESISTOR 909Ω ±1% ¼W MF
1	R22	867439	RESISTOR 10K ±1% ¼W MF
1	R20	822305	RESISTOR 51K ±5% ¼W CAR
5	R14-18	846691	RESISTOR VARIABLE 100K
4	R10-13	846711	RESISTOR VARIABLE 50K
8	R3-9,19	871829	RESISTOR 2K ±1% ¼W MF
2	R1,2	825321	RESISTOR 1K ±1% ¼W MF

636661 SUMMATION AMPLIFIER BOARD ASSEMBLY

636945 COMPUTER/ALARM TERMINAL ASSEMBLY (Compatible With Ten-Point Stream Selector)



This rear-panel assembly accepts a maximum of 17 plug-in relays to provide all contacts required for computer interfacing. Z1 decodes the binary input of the stream being analyzed, and converts it into a decimal output. Gates Z2 through Z6 serve as relay drivers. Also available on the board are the output from the peak picker and provision for an external alarm reset.

Relays are available in two types:

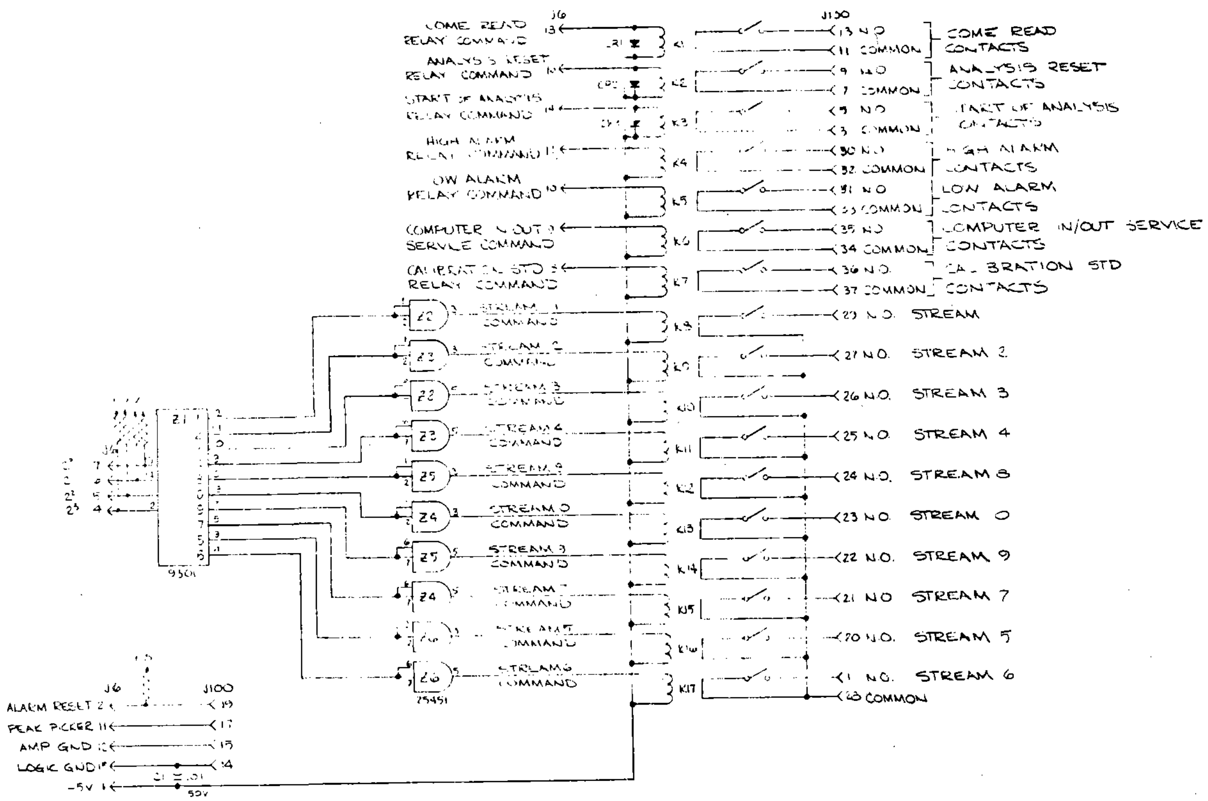
1. Relay with *mercury-wetted* contacts (Beckman Part 867383), generally used where contact bounce cannot be tolerated. Although this type of relay will plug into any socket on the assembly, it is not suitable for certain functions as it does not provide a normally-closed contact position. Absolute contact ratings: 1 ampere resistive, maximum; 100 volts, maximum; 28 volt-amperes, resistive, power limitation.
2. Relay with *dry reed* contacts, generally used for status check, not for interrupt status. Absolute contact ratings: 250 mA, resistive load; 28 volts d.c., resistive load; 3 volt-amperes power limitation on combination voltage and current. Two versions of reed relay are available.

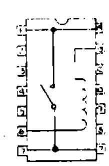
Contact Form	Relay Part Numbers
1 Form A	636054
1 Form B	636055

TROUBLESHOOTING

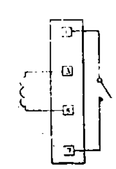
To check for proper operation of a relay, first verify that the pin connected to the positive side of the coil is at 5 volts d.c. with respect to ground. If so, the relay can be energized by connecting this pin to ground.

If the pin is at 0 volts with respect to ground, either the function that drives the relay is now energized, or the relay coil is open. To check, remove the relay from its socket and measure the coil resistance. In a *reed* relay, there is a diode connected across the coil; therefore, proper polarity must be observed. The *mercury* relay does not contain a diode.



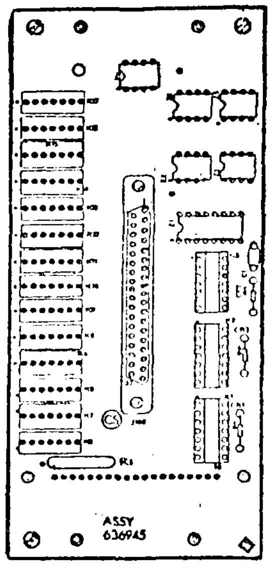


K1 - K3



K4 - K17

2 RELAYS K4 THRU K17 HAVE INTERNAL DIODE PROTECTION.
1 ALL DIODES ARE N4448.
NOTES

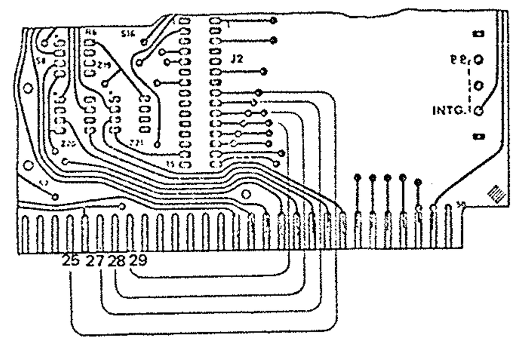


QTY	CIR REF	ITEM	PART NO.	DESCRIPTION
1	R1		860906	RESISTOR, NETWORK 6.8K
1	C1		836864	CAPACITOR, .01MFD, 50V
5	Z2-6		876328	INTEGRATED CIRCUIT 75451
1	Z1		847220	DECODER 9301
3	CR1-3		838731	DIODE 1N4448
1		10	876535	HOOD, CONNECTOR
1		9	806816	CONNECTOR
1		8	638103	COVER, RELAY
1	—	6	876042	CONNECTOR
1	—	2	632066	CABLE ASSY

130

636966 DUAL COMPONENT/MEMORY BOARD

Front of Board

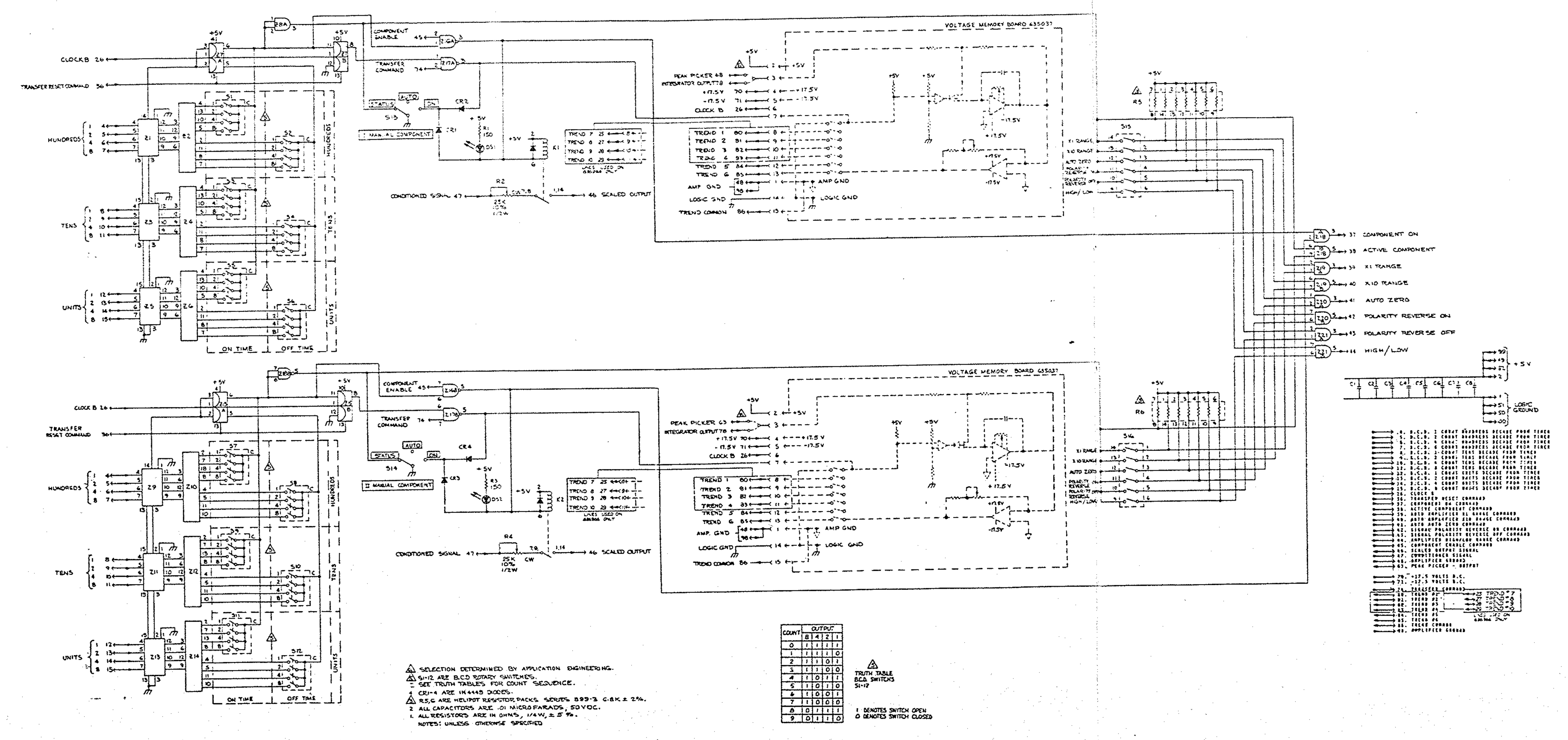


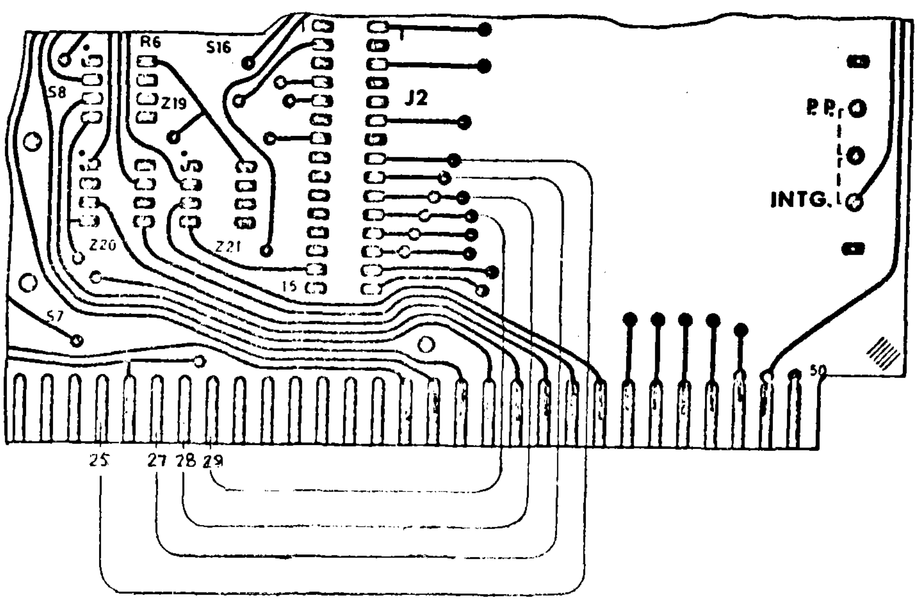
This is a special-purpose board, used only with the 636661 Summation Amplifier Board, and only in applications where *more than five components are to be summed.*

The summation amplifier accepts a maximum of nine separate trend inputs from 635037 Voltage Memory Boards, and provides an output that is proportional to the sum of these inputs. The output from the summation amplifier is routed through trend line number 6 on the 635016 Memory Voltage Trend Output Assembly. Trend lines 1 through 5, and the corresponding terminals on the trend output assembly, are then used for individual trend outputs from the long-term memory amplifiers associated with components 1 through 5. If more than five components are to be summed, one or more 636966 Dual Component/Memory Boards must be used to provide the additional memory inputs to the summation amplifier.

Component No.	Input to Summation Amplifier
6	Trend 7
7	Trend 8
8	Trend 9
9	Trend 10

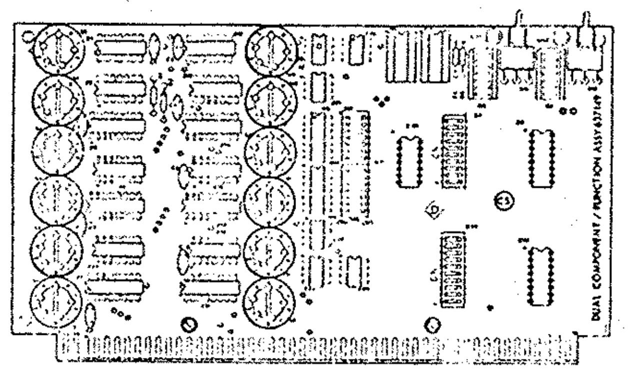
The 636966 Board is a 634115 Dual Component/Memory Board that has been modified to utilize trends 7 through 10. For circuit descriptions, refer to 634115 Dual Component/Memory Board.





1		634115	BOARD ASSY, DUAL COMP/MEM
INF		634207	SCHEMATIC
QTY	ITEM	PART NO.	DESCRIPTION

2.12.4-141



This section contains two component-programming sections. The first section is described below. Functioning of the second section is identical; however, circuit designations differ.

SELECTABLE FUNCTIONS

1. **Component ON-OFF Timing.** During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.
2. **Function Select Switch S7.** By closure of the appropriate contacts on this switch, any desired streams may be assigned to the component-programming section.
3. **Programming Functions (Selected With Switch S17):**
   a. *X1 RANGE Switch.* Selects gain of 1000 for TC amplifier or 100 for FID amplifier.
   b. *X10 RANGE Switch.* Selects gain of 100 for TC amplifier or 10 for FID amplifier.
   c. *AUTO ZERO Switch ON.* During automatic operation, an auto-zero function will occur approximately three seconds before activation of the COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.
   d. *POLARITY REVERSE ON Switch.* Reverses the polarity of the signal in the 640324 TC Detector Electronics Board if analyzer is so equipped.
   e. *POLARITY REVERSE OFF Switch.* Turns off the polarity-reverse circuit.
   f. *HIGH/LOW Range Switch.* HIGH position provides 1000X attenuation of output signal from FID amplifier. Switch is inoperative with TC amplifier.
3. **ON/AUTO/STATUS Switch S15.** On position activates component attenuator R5 and causes DS1 to illuminate. The amplifier signal will be displayed on the recorder, provided that the ATTENUATION Switch on the programmer front panel is at AUTO.

   AUTO position places the component functions under preprogrammed control.

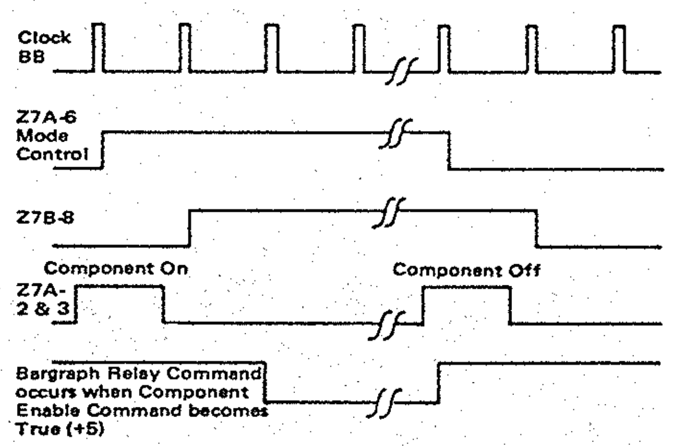
   STATUS is a test position, used *momentarily*, to check programming of component functions. While holding switch at STATUS, observe indicators on master board. Do not check status during automatic operation.
4. **COMPONENT ATTENUATOR R5.** Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but not trend) data presentation.

COMPONENT ON-OFF SEQUENCE

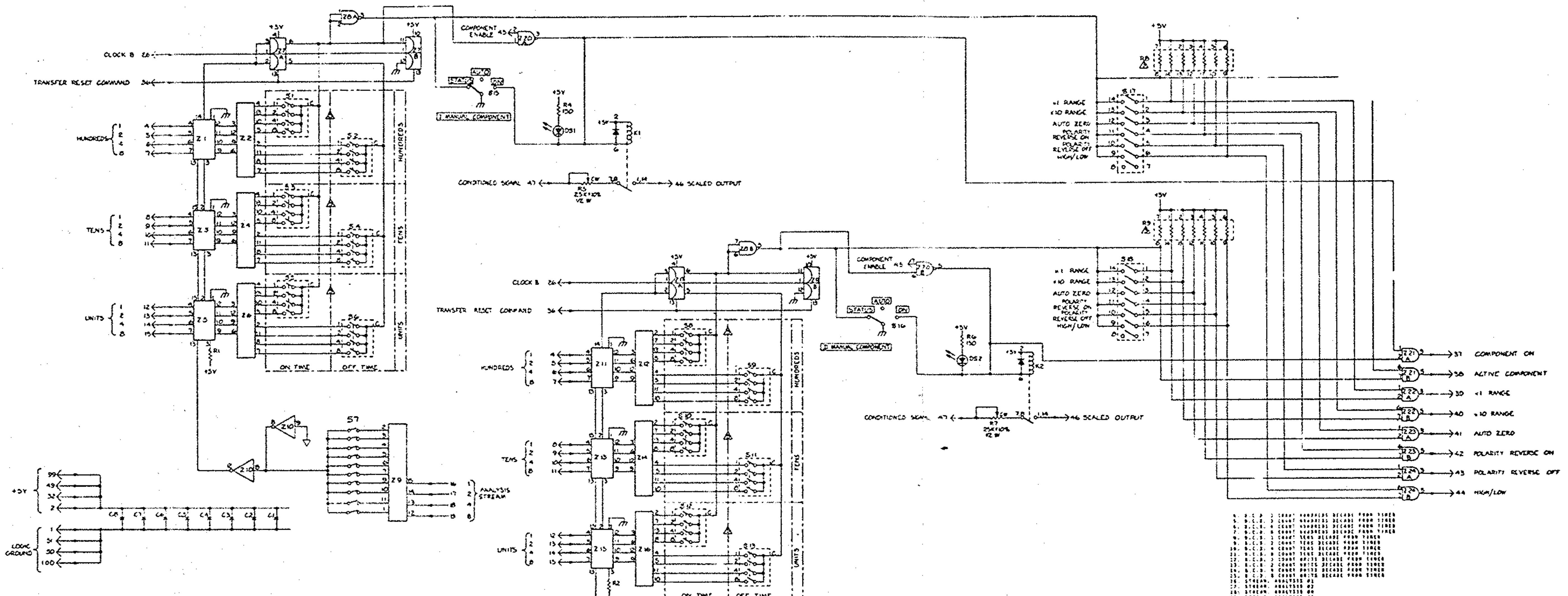
At the programmed COMPONENT ON time, pin 6 of Z7A goes to +5 volts d.c., causing all closed functions on Switch S17 to be energized by Z8A. The next pulse of clock B causes Z7B to go to the set state.

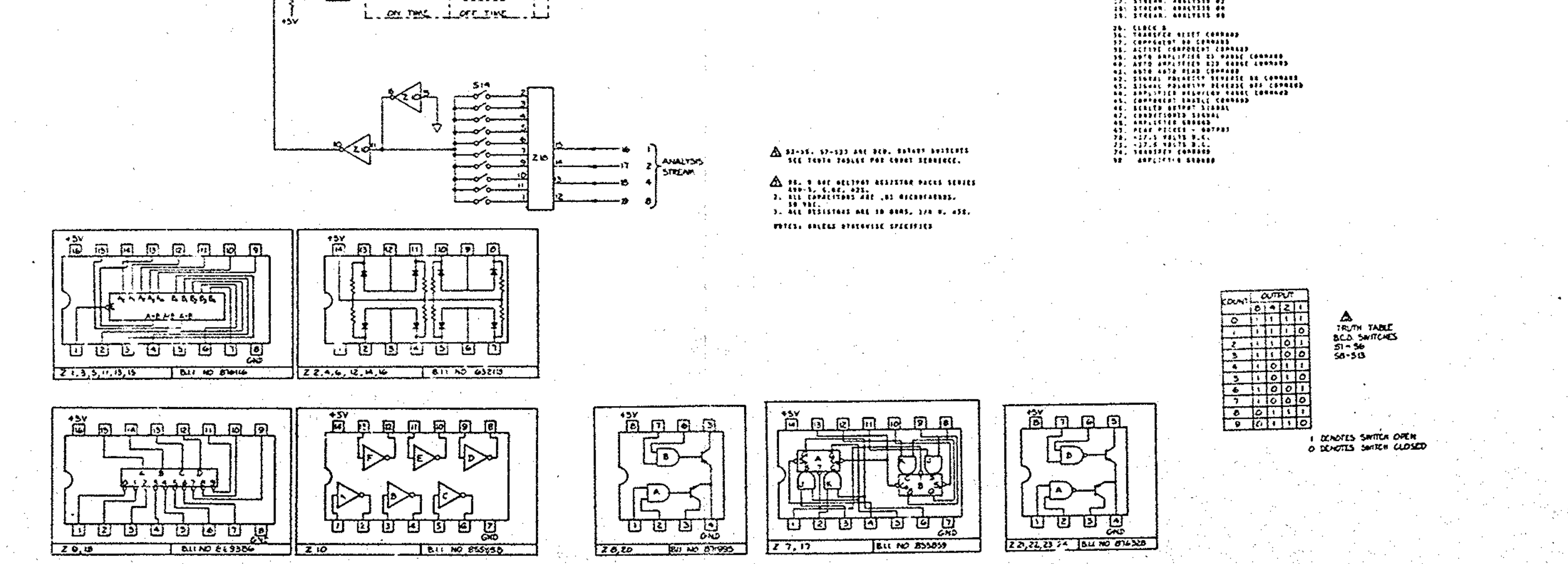
As Z7A is set, the component sequence begins and the COMPONENT ENABLE command is transmitted from the 640908 Master Control Board. This command causes energization of component relay K1, and routing of the data signal through component attenuator R5. Simultaneously, the COMPONENT ON indicator on the programmer front panel is energized by pin 3 of Z21A.

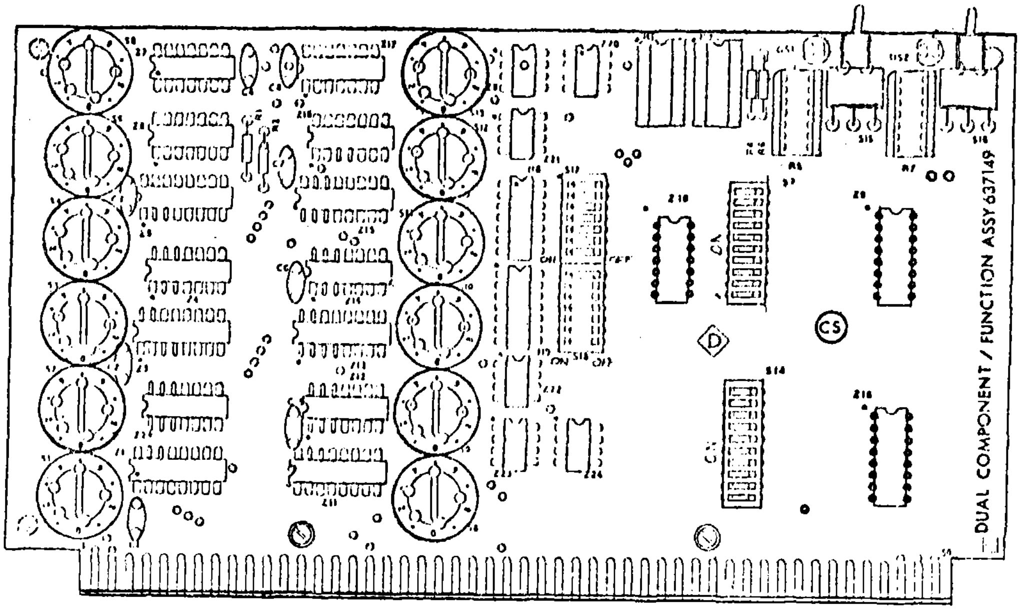
When the programmed COMPONENT OFF time occurs, Z7A goes to the reset state; i.e., pin 6 goes to 0 volts d.c. (Logic Zero). This deactivates component attenuator R5 and the functions selected on Switch S17. However, Z7B remains in the set state until reset by the TRANSFER RESET COMMAND on pin 36.



Typical Component ON-OFF Timing Sequence







4	Z21-24	870872	CIRCUIT, INTEGRATED - SN75-151P
1	Z10,	[illegible]	CIRCUIT, INTEGRATED, SN15836N
2	Z9,18	809386	CIRCUIT, INTEGRATED-SN74145N
2	Z8,20	871995	CIRCUIT, INTEGRATED-SN75452P
2	Z7,17	856859	CIRCUIT, INTEGRATED - 852
6	Z 2,4,6, 12,14,16	632115	CIRCUIT, INTEGRATED
6	Z 1,3,5, 11,13,15	876116	CIRCUIT, INTEGRATED - 93L24
2	S7,14	800600	SWITCH, DUAL-IN-LINE
2	S15,16	876327	SWITCH, TOGGLE
2	S17,18	876111	SWITCH, DUAL-IN-LINE
12	S1-6,8-13	876119	SWITCH, ROTARY - B.C.D.
2	K1, 2	633112	RELAY, FORM 1A
2	DS1,2	[illegible]	DIODE, LIGHT EMITTING
2	5	632064	PAD
8	C1-8	[illegible]	CAPACITOR, .01MFD, 50 V
4	4	870583	SCREW, PAN HD 4-40 x 5/16
2	R8,9	871949	RESISTOR PACK, 899-3, 6.8K
2	R5,7	876396	RESISTOR, VARIABLE, 25K, ±10%, 1/2W
2	R4,6	[illegible]	RESISTOR, 150 OHMS, ±5%, 1/4W
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	SOCKET, I.C. - 14 PIN
1	1	[illegible]	BOARD, PRINTED WIRING
QTY	[illegible]	PART NO.	DESCRIPTION

637149 DUAL COMPONENT/FUNCTION BOARD ASSEMBLY

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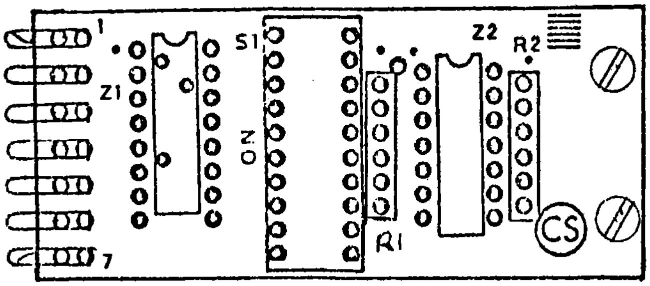
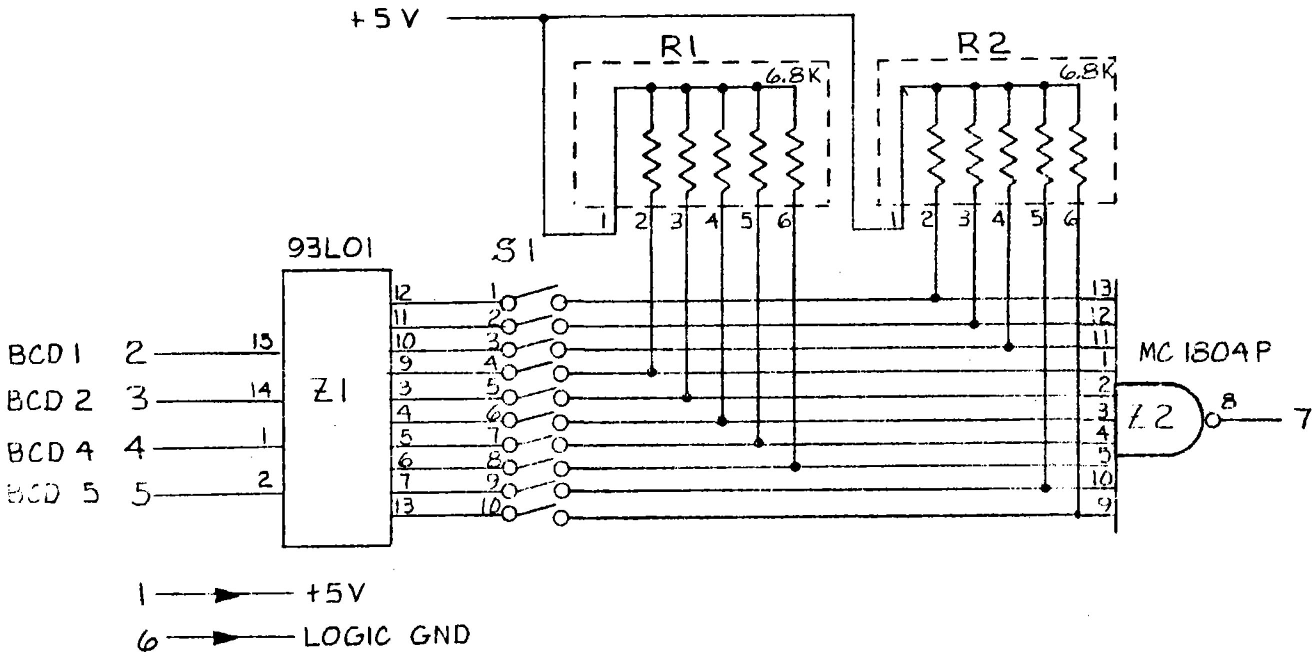
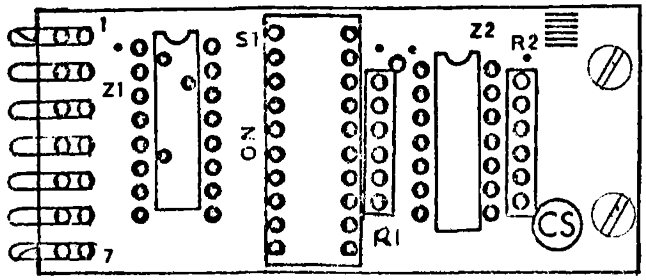
637910 FUNCTION SELECT BOARD



The 637910 Function Select Board is used with multiple-stream systems. Typically, it is plugged into a 640911 Universal Component Board. The appropriate contacts on Switch S1 are then closed to assign the desired streams to the component programming.

The 640915 Dual Valve/Function-Select Board accommodates two 637910 Function Select Boards, one for each valve-programming section. The switch contacts on the Function Select Boards permit assigning any desired stream(s) to VALVE TIMING NO. 1 section and any other desired stream(s) to VALVE TIMING NO. 2 section.

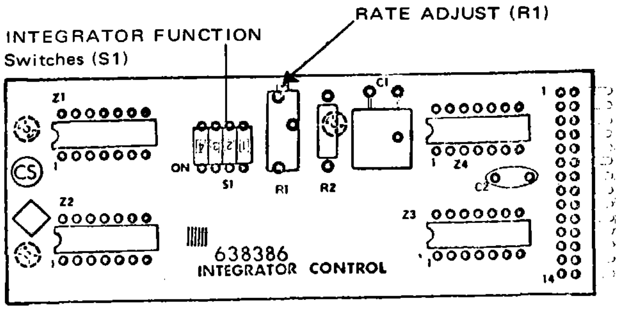




QTY.	ITEM	PART NO.	DESCRIPTION
1	SW1	[illegible]	SWITCH, [illegible]
1	Z2	[illegible]	CIRCUIT, INTEGRATED [illegible]
1	Z1	[illegible]	CIRCUIT, [illegible]
2	R1,R2	[illegible]	RESISTOR NETWORK [illegible]
7	6	[illegible]	PIN, CONTACT

637910 FUNCTION SELECT BOARD

638386 INTEGRATOR CONTROL BOARD



This board provides various controls necessary for operation and readout of an integrated component. Note that a separate Integrator Control Board is required for each component that is to be integrated.

RATE ADJUST Potentiometer R1 determines the rate of integration for the 632184 Integrator Board. Clockwise rotation of R1 increases the rate; counterclockwise rotation decreases it. On each control board, pin 4 (i.e., the integration rate signal) is connected to pin 76 of the Mother Board. Thus, during any integration, the integration rate is determined by the setting of R1 on the particular control board which is then active.

The Integrator Control Board contains two switch-selectable options: RESET YES/NO and COMPUTER TRANSFER YES/NO. With both switches in YES position, the signal is integrated, the integrator is reset, and a COME READ command is sent through the 632178 Computer Driver Board to the 636945 Computer/Alarm Terminal Assembly.

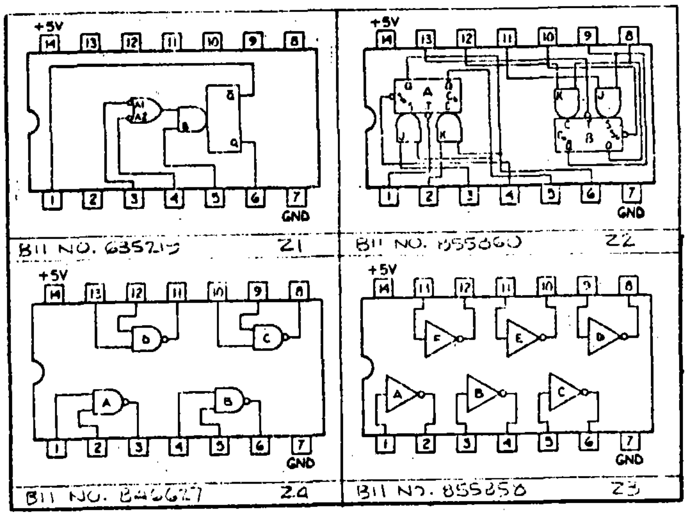
With the RESET Switch in NO position, the TRANSFER RESET pulse is inhibited, allowing the integrated value to be retained and summed with a later integrated signal.

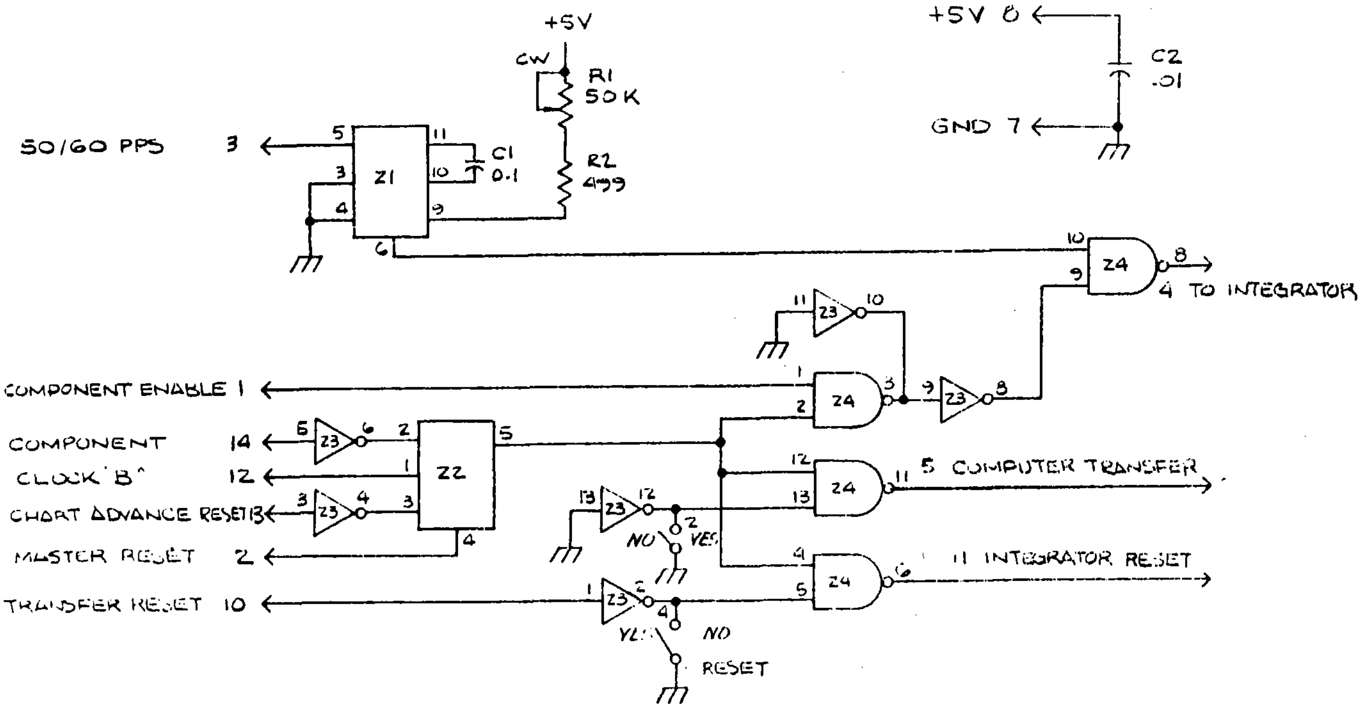
With the COMPUTER TRANSFER Switch in NO position, an inhibit signal is sent, via pin 59 of J2, to Z7-12 on the 632178 Computer Driver Board. The COME READ relay is inhibited during its normal operating time, between the COMPONENT ON command and the CHART ADVANCE RESET.

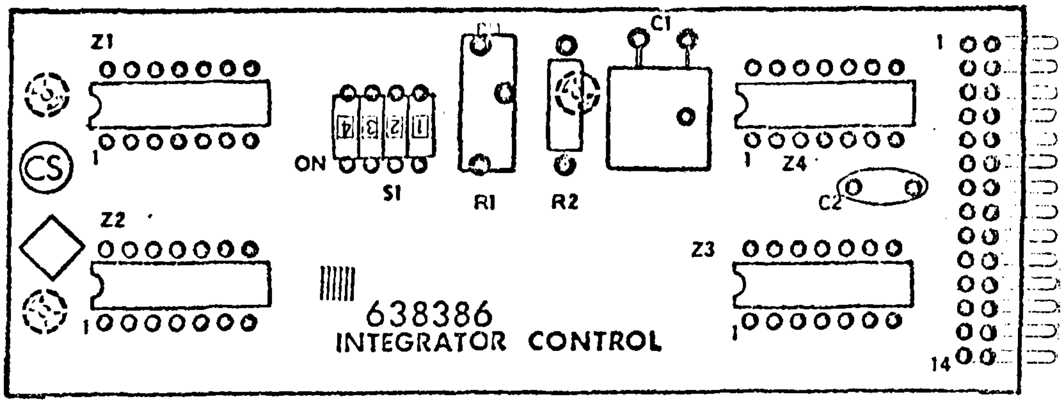
OPERATION OF INTEGRATION RATE FUNCTION

When the component command occurs, flip-flop Z2-A sets and is ANDed with the COMPONENT ENABLE command. The resultant output, in turn, is ANDed with the 50 or 60 pps signal from Z1. The output from Z4-B is the integration rate signal. It is routed through pin 4, and pin 76 of the Mother Board, to the 632184 Integrator Board.

Sequencing of the integrator readout is shown in the Component Sequence Diagram for the 640411 Universal Component Board.

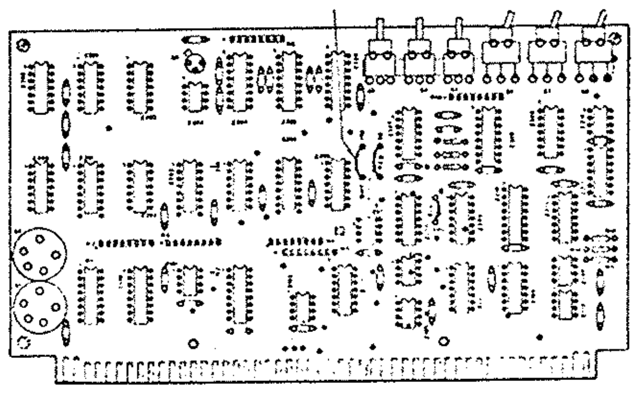






QTY	ITEM	PART NO.	DESCRIPTION
1	C2	836864	CAPACITOR .01 MFD 50V
1	Z4	846627	I.C. 846
1	Z3	[illegible]	I.C. 836
1	Z2	[illegible]	I.C. 853
1	Z1	[illegible]	I.C. SN 74121
1	S1	816[illegible]	SWITCH PACK 4 POS
1	C1	871[illegible]	CAPACITOR .1µf 50V
1	R2	[illegible]	RESISTOR 4990Ω 1% 1/4W
1	R1	846711	RESISTOR VARIABLE [illegible]
14	2	871913	PIN CONTACT

638493 DIGITAL-TIMER/LOGIC-TEST BOARD



The 638493 Digital-Timer/Logic-Test Board is an alternate to the 632196 Digital Timer Board normally supplied with the 6710 System.

In the standard 632196 Digital Timer Board, clock frequency is based on line frequency and is thus subject to line frequency variations, minimal in most areas but significant in some localities.

In the 638493 Circuit Board, clock frequency is based on an internal 10 KHz crystal oscillator, operated from the regulated +5 volts d.c. supply in the programmer, and is thus independent of line frequency. In addition to the timing functions, the 638493 Board incorporates several test functions.

Oscillator U1 operates at 10 KHz. The buffered output of the oscillator is fed to decade counters Z304 and Z305, giving a 100 Hz output at Z305 pin 15. Output of Z305 is passed through flip-flops Z208, giving 50 Hz output at pin 33.

NORMAL AND SLOW CLOCKS

The clear and red jumpers select either a NORMAL or a SLOW clock. For normal operation, the red jumper is cut. For extended analysis time, the clear jumper is cut, giving a basic count time of one pulse every two seconds.

With the clear jumper installed, 100 Hz is fed to Z306, giving 10 Hz to Z308, and 10 Hz also to pin 87.

With the red jumper installed, the 100 Hz is ANDed with the 50 Hz output of Z208. Z306 divides its input by 10, giving 10 or 5 Hz to pin 87 and counter Z308.

OPERATION IN AUTOMATIC MODE

Set switches as follows:

AUTO/MAN Switch (S8):	AUTO
SINGLE/CONTINUOUS Switch (S7):	CONTINUOUS
TIMER STOP/OPERATE Switch (S6):	OPERATE
MAN ADV Counter Switch (S5):	Inoperative
MAN ADV B Switch (S4):	Inoperative
MAN ADV A Switch (S3):	Inoperative
S1 and S2	Set for desired analysis time

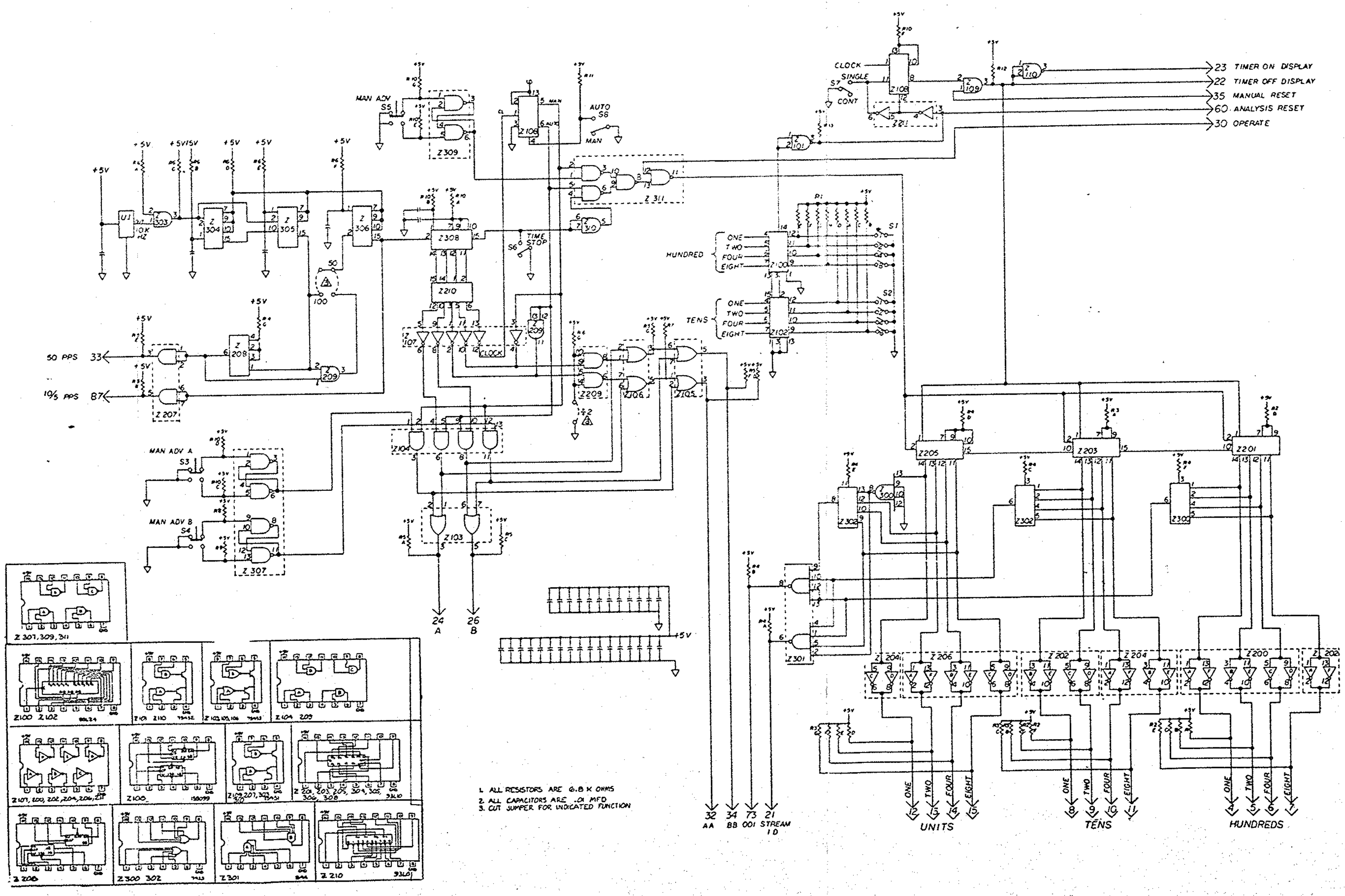
OPERATION IN MANUAL MODE

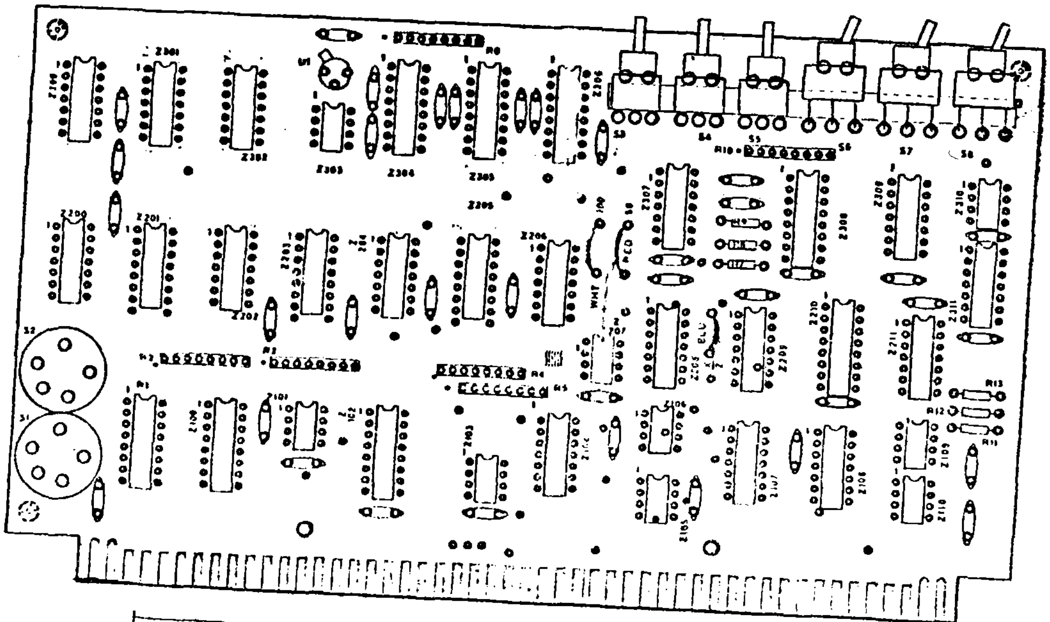
Set AUTO/MAN Switch (S8) at MAN; Clock A and Clock B will stop. Switches S3, S4, and S5 are now operative.

TROUBLESHOOTING

When troubleshooting the system, stop the clock near the desired time value by moving AUTO/MAN Switch (S8) to MAN position. With either one-second or two-second resolution, advance the counter by depressing MAN ADV Counter Switch (S5) once for each count on the clock.

When the desired time is reached, use the manual advance sequence appropriate to the resolution time. With *one-second* resolution, proper sequence is: MAN ADV A, MAN ADV B. With *two-second* resolution, proper sequence is: MAN ADV A, MAN ADV B, MAN ADV A, MAN ADV B.

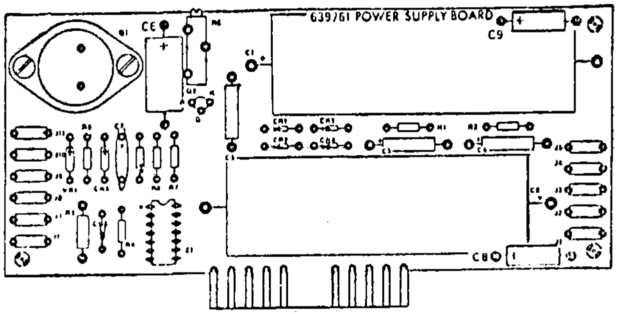




QTY	ITEM	PART NO.	DESCRIPTION
3	S3,4,5	816720	SWITCH, PUSH BUTTON RT 4 MOUNT
3	S6,7,8	876144	SWITCH, TOGGLE RT 4 MOUNT
2	S1,S2	876119	SWITCH, B.C.D. ROTARY
1	U1	861182	CRYSTAL OSCILLATOR, 10 KHz
37	2	836864	CAPACITOR, .01uf DISC
6	R7-9 R11-13	822299	RESISTOR, CARBON 6.8K
6	R2-6 R10	860906	RESISTOR, NETWORK 6.8K
1	R1	876375	RESISTOR, NETWORK 6.8K
2	Z104,209	869776	INTEGRATED CIRCUIT SN 7408
1	Z208	855860	SN 158093
1	Z108	855859	SN158099
1	Z210	871553	93L01
2	Z100,102	876116	DM 93L24
2	Z107,211	855858	DM 936
3	Z301,303 311	846627	MC 846P
7	Z201,203 205,304 305,306 308	871552	DM 93L10
4	Z200,202 204,206	847361	SN 7416N
3	Z103,105 106	861183	
2	Z101,110	871995	SN 75453
4	Z109,207 Z303,310	876328	SN 75452
			SN 75451
1	Z301	857430	MC 844
2	Z300,302	873266	INTEGRATED CKT DM 7425

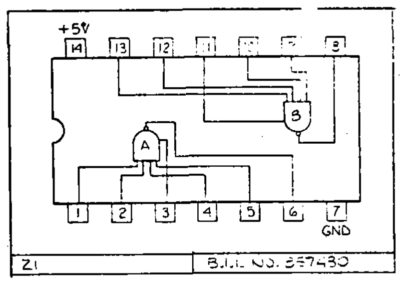
638493 DIGITAL-TIMER/LOGIC-TEST BOARD

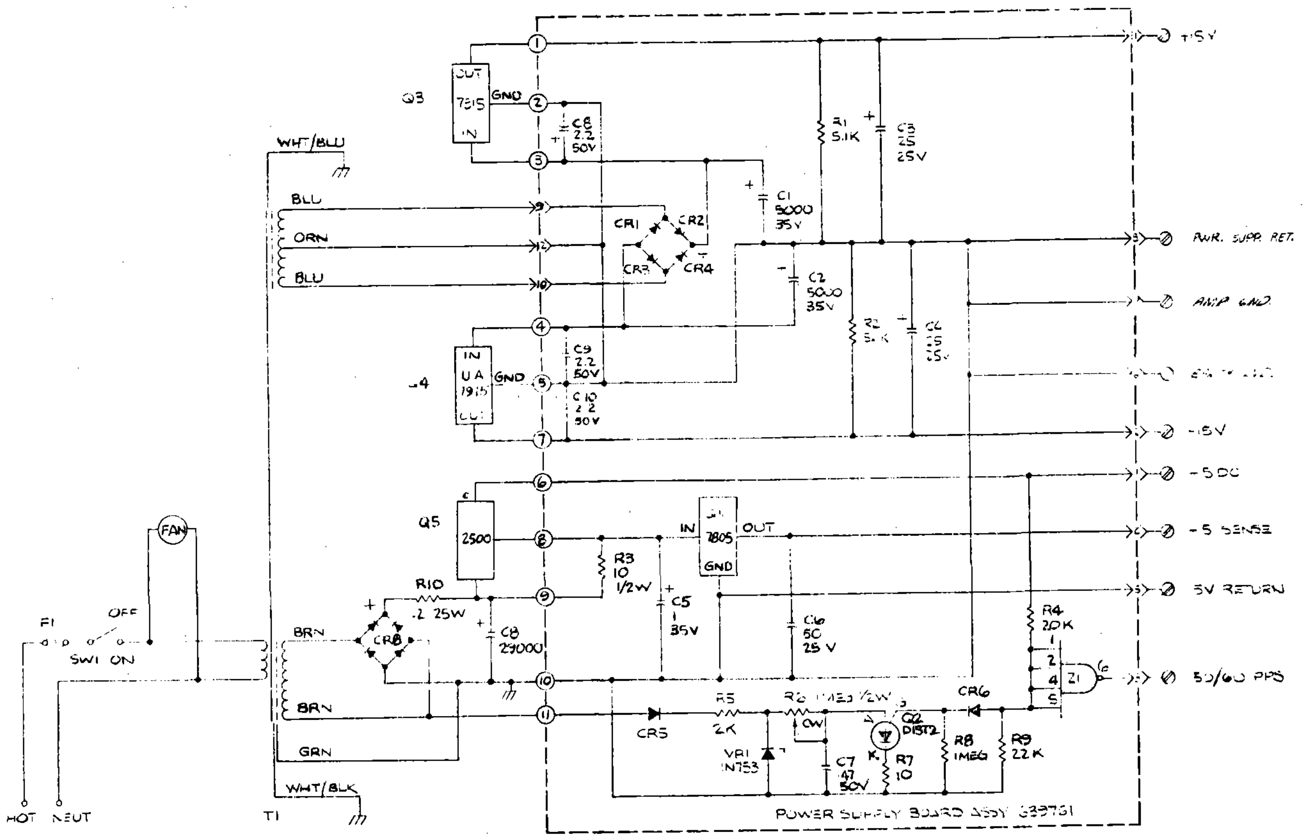
639761 POWER SUPPLY BOARD



This power supply provides the following outputs:

1. +15 and −15 volts d.c.
2. +5 volts d.c.
3. Pulsed signal of 50 or 60 pps, depending on line frequency, to drive the 632196 Digital Timer Board, if programmer is so equipped. Clock Adjustment Potentiometer R6 is set for pulse width of 1 to 3 milliseconds.

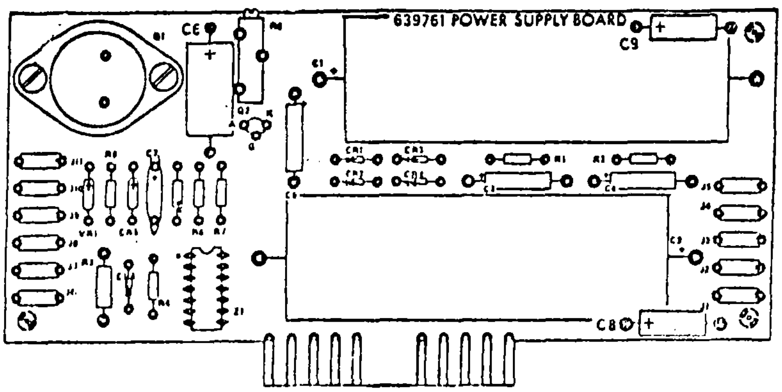




2. ALL CAPACITORS ARE IN MICROFARADS.
1. ALL RESISTORS ARE IN OHMS, ± 5%, 1/4 W,
UNLESS OTHERWISE SPECIFIED
NOTES:

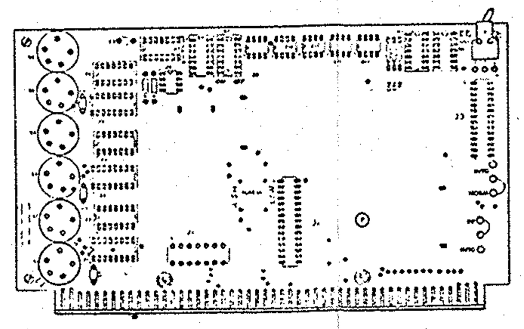
VR1	859934	Diode IN753
CR5-6	416842	Diode
CR1-4	817927	Diode
C8,9	842322	Capacitor 2.2 MF 50V
C7	876680	Capacitor 47MF 50V
C6	802904	Capacitor 50MF 25V
C5	814053	Capacitor 1MF 35V
C3,4	802899	Capacitor 25MF 25V
C1,2	876827	Capacitor 5000MF 35V
R9	822334	Resistor 22K 5% 1/4W
R8	823916	Resistor 1MEG 5% 1/4W
R7	823379	Resistor 10OHM 5% 1/4W
R6	854395	Pot. 1MEG 10% 1/2W
R5	822293	Resistor 2K 5% 1/4W
R4	822366	Resistor 20K 5% 1/4W
R3	22946	Resistor 10OHM 5% 1/2W
R1,2	822298	Resistor 5.1K 5% 1/4W

C8	876495	Capacitor 29000MF
	869330	Fan
T1	639769	Transformer
F1	801566	Fuse
	860197	Fuse Holder
SW1	861119	Switch Slide
	40890	Grommet
CR8	876453	Rectifier Bridge
R10	860703	Resistor .2 OHM 25W
Q3	873697	Regulator MC7815
Q4	847369	Regulator LM32015
Q5	876457	Transistor MJ2500
Q3-4-5	810245	Kit Mounting
Z1	857430	I.C. MC844
Q2	871098	Transistor D13T2
Q1	876094	Regulator 7805



1	Z1	857430	CIRCUIT, INTEGRATED, MC844
1	Q2	871098	TRANSISTOR, D13T2
1	Q1	876094	VOLTAGE REGULATOR 7805
1	VR1	859934	DIODE, IN753
2	CR5,6	416842	DIODE
4	CR1-4	817927	DIODE
2	C8,9	242322	CAPACITOR, 2.2 MFD, 50V
1	C7	876680	CAPACITOR, .47 MFD, 50V
1	C6	802904	CAPACITOR, 50 MFD, 25V
1	C5	814053	CAPACITOR, 1 MFD. 35V
2	C3,4	802899	CAPACITOR, 25 MFD. 25V
2	C1,2	978827	CAPACITOR, 5000 MFD, 35V
1	R9	822334	RESISTOR. 22K, ±5%, 1/4 W
1	R8	823916	RESISTOR, 1MEG, ±5%, 1/4W
1	R7	823379	RESISTOR, 10Ω. ±5%, 1/4 W
1	R6	854395	RESISTOR, VARI. 1MEG, ±10%, 1/2W
1	R5	822293	RESISTOR, 2K, ±5%, 1/4 W
1	R4	822366	RESISTOR. 20K, ±5%, 1/4 W
1	R3	22946	RESISTOR, 10Ω, ±5%, 1/2W
2	R1,2	822298	RESISTOR, 5.1K, ±5%, 1/4W
QTY	ITEM	PART NO.	DESCRIPTION

640411 UNIVERSAL COMPONENT BOARD



STANDARD SELECTABLE FUNCTIONS

1. **Component ON-OFF Timing.** During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.
2. **Programming Functions** (Selected with Switch S7):
   a. *X1 RANGE Switch.* Selects gain of 1000 for TC amplifier or 100 for FID amplifier.
   b. *X10 RANGE Switch.* Selects gain of 100 for TC amplifier or 10 for FID amplifier.
   c. *AUTO ZERO Switch ON.* During automatic operation, an auto-zero function will occur approximately three seconds before activation of the COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.
   d. *POLARITY REVERSE ON Switch.* Reverses the polarity of the signal in the 640324 TC Detector Electronics Board if analyzer is so equipped.
   e. *POLARITY REVERSE OFF Switch.* Turns off the polarity-reverse circuit.
   f. *HIGH/LOW Range Switch.* HIGH position provides 1000X attenuation of output signal from FID amplifier. Switch is inoperative with TC amplifier.
3. **ON/AUTO/STATUS Switch S8.** ON position activates component attenuator R6 and causes DS1 to illuminate. The amplifier signal will be displayed on the recorder, provided that the ATTENUATION Switch on the programmer front panel is at AUTO.

   AUTO position places the component functions under pre-programmed control.

   STATUS is a test position, used *momentarily*, to check programming of component functions. While holding switch at STATUS, observe indicators on master board. Do not check status during automatic operation.
4. **COMPONENT ATTENUATOR R6.** Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but not trend) data presentation. Attenuator R6 may receive either of two input signals, depending on the jumper connection used. With jumper in NORMAL position, the attenuator input is the conditioned signal from the 640908 Master Control Board. With jumper in INTEGRATOR position, the attenuator input is the integrated signal from the 632184 Integrator Board.

OPTIONAL FUNCTIONS

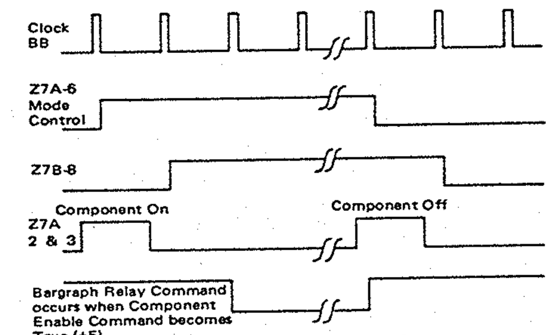
Optionally, the Universal Component Board may be provided with additional functions through plug-in of 635037 Voltage Memory Board, 637910 Function Select Board, and/or 638386 Integrator Control Board.

COMPONENT ON-OFF SEQUENCE

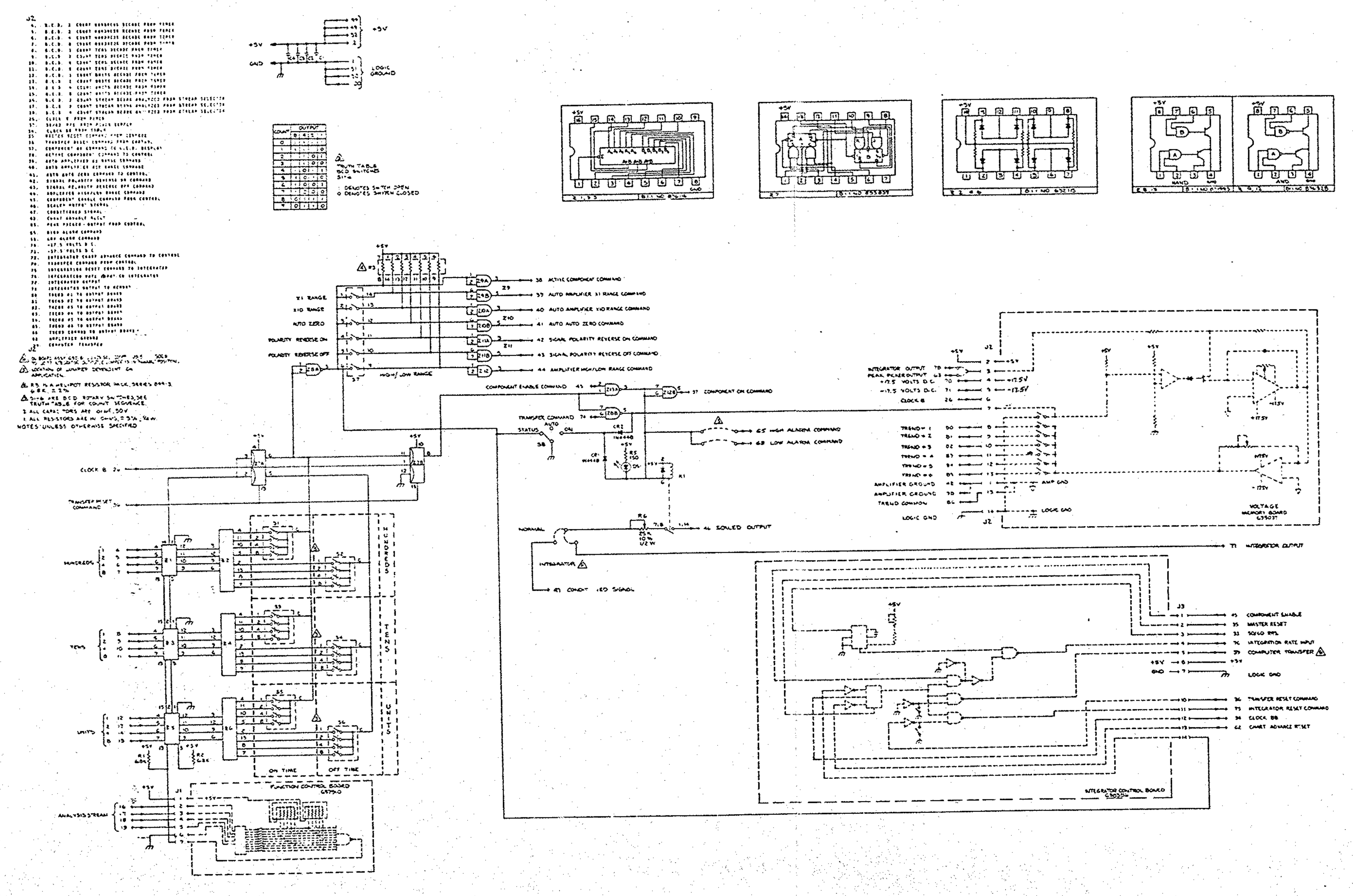
At the programmed COMPONENT ON time, pin 6 of Z7A goes to +5 volts d.c., causing all closed functions on Switch S7 to be energized by Z8A. The next pulse of clock B causes Z7B to go to the set state.

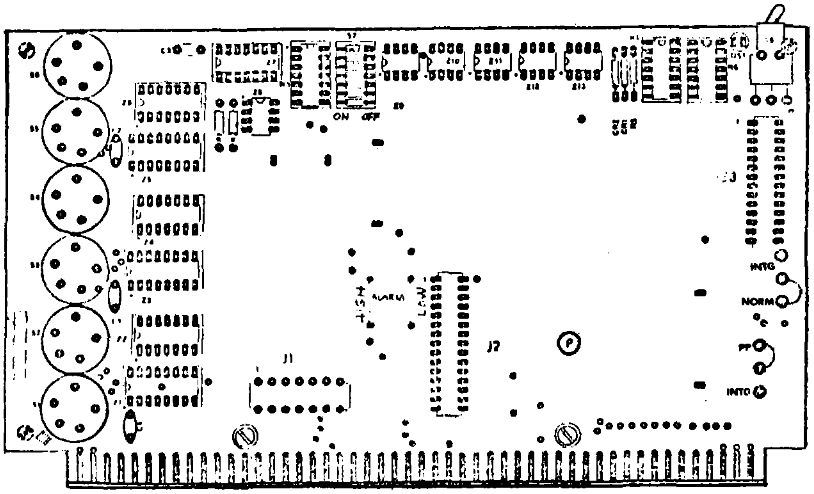
As Z7A is set, the component sequence begins and the COMPONENT ENABLE command is transmitted from the 640908 Master Control Board. This command causes energization of component relay K1, and routing of the data signal through component attenuator R6. Simultaneously, the COMPONENT ON indicator on the programmer front panel is energized by pin 5 of Z12B.

When the programmed COMPONENT OFF time occurs, Z7A goes to the reset state; i.e., pin 6 goes to 0 volts d.c. (Logic Zero). This deactivates the component attenuator and the functions selected on Switch S7. However Z7B remains in the set state, enabling the TRANSFER COMMAND to permit updating of the 635037 Voltage Memory Board, if provided. Z7B is reset by the TRANSFER COMMAND on pin 36.



Typical Component ON-OFF Timing Sequence

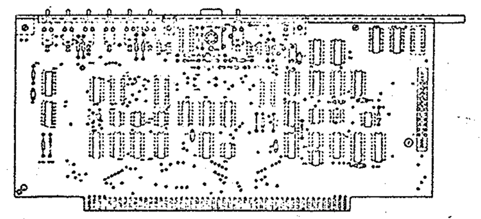




QTY	ITEM	PART NO.	DESCRIPTION
4	Z9-12	870872	CKT, INTERGRATED-SN75451
2	Z8,13	871995	CKT, INTERGRATED-SN75452
1	Z7	855859	CKT, INTERGRATED-852
3	Z2,4,6	632115	CKT, INTERGRATED-
3	Z1,3,5	876116	CKT, INTERGRATED-93L24
1	S8	876692	SWITCH, TOGGLE
1	S7	876111	SWITCH PACK
6	S1-6	876119	SWITCH, BCD
1	K1	633112	RELAY
1	DS1	860444	DIODE, LIGHT EMITTING
2	CR1,2	838731	DIODE, IN4448
4	C1-4	836864	CAPACITOR, .01 MFD 50V
1	R6	876396	RESISTOR, VAR 25K ±10% ½W
1	R5	823391	RESISTOR, 150Ω ±5% ¼ W
1	R3	871949	RESISTOR PACK, 6.8K
2	R1,2	822299	RESISTOR, 6.8K ±5% ¼W

640411 UNIVERSAL COMPONENT BOARD

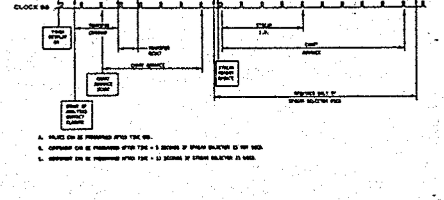
640908 MASTER CONTROL BOARD



The 640908 Master Control Board contains most of the sequencing circuitry, as well as various other circuits, used in the Model 6710. The board consists of the following sections.

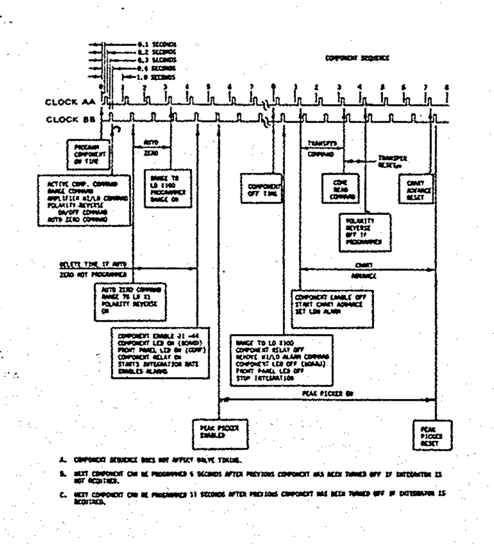
A. CONTROL SEQUENCER SECTION

1. **MANUAL START, MANUAL RESET, and MASTER RESET Commands**
   The MANUAL START command is generated by the RUN position of the front-panel MODE Switch. The MANUAL RESET command, and also the MASTER RESET command, are generated by the RESET position of the MODE Switch. Since the MANUAL START and MANUAL RESET commands are provided by opposite sides of the same two-position switch, one or the other of these commands is always in effect. Selection of either switch position places the corresponding function under control of clock AA.
2. **CALIBRATION STANDARD Manual Command**
   This command is generated by selection of the ON position on the front-panel CALIB STD Switch, thus activating the CALIB STANDARD RELAY command, and also activating the STREAM OVERRIDE command to shut off all streams in the stream selector.
   The remaining functions of the Control Sequencer Section are best understood by considering how they are involved in the basic timing sequence of the programmer, as explained below.



3. **START-OF-ANALYSIS Timing Sequence (See Diagram Below)**
   At the beginning of the timing cycle, the 632196 Digital Timer Board or 638493 Digital-Timer/Logic-Test Board generates the 001 command. This command is sensed by Z4B, causing flip-flop Z14A to set and to initiate the CHART ADVANCE command; and flip-flop Z14B to set and to initiate the TRANSFER COMMAND.

   Flip-flop Z14A also enables counter Z15, which then advances one count for each pulse to clock AA. When the count reaches 2, Z16 decodes the time, and pin 11 of Z16 goes to a low state. This causes Z14B to reset and terminate the TRANSFER COMMAND. When Z14A senses a count of 2, it generates a TRANSFER RESET COMMAND. This command is used to reset the second flip-flop on each component function, if activated.
   Counter Z15 continues to count pulses of clock AA until the count reaches 6.
   Z16 then decodes this value, generates a CHART ADVANCE RESET signal, and also resets Z14A to terminate the CHART ADVANCE signal. If the computer output option is used, the 001 command also causes a START OF ANALYSIS contact closure. This also terminates the starting sequence if the system does not incorporate a stream selector.
   If a stream selector *is* used, another CHART ADVANCE command is generated by the 632084 Stream Selector Control Board. This command, routed to the Control Sequencer Section via pin 72 on the Master Control Board, causes the cycle to occur again.
4. **COMPONENT CONTROL Timing Sequence.**



After a programmed COMPONENT ON time occurs, an ACTIVE COMPONENT command is applied to pin 37 on the Master Control Board. If AUTO ZERO function is programmed on the component board:

a. The ENABLE COMPONENT command is delayed for three seconds, to permit operation of the auto zero function. The auto zero function lasts for two seconds, during which time the LOW X1 range is in effect regardless of the range programmed on the component board. After completion of the auto zero function, the programmed range goes into effect.
b. At the first pulse of clock BB that occurs after component time 004, an ENABLE COMPONENT command is routed to all component boards.

The ENABLE COMPONENT command is ANDed with the particular component that is then activated, causing the following to occur:

a. Illumination of COMPONENT ATTENUATOR ON indicator on component board.
b. Illumination of COMPONENT ON indicator on programmer front panel.
c. Energization of component relay.
d. Initiation of integration function, if used.
e. Enabling of alarm function, if used.
f. Enabling the peak picker, if used.

At the first pulse of clock BB that occurs after the programmed COMPONENT OFF time, the following occur:

a. Range goes to LOW, X100.
b. Component relay is deenergized.
c. Alarm function is disabled.
d. COMPONENT ATTENUATOR ON indicator on component board goes out.
e. COMPONENT ON indicator on programmer front panel goes out.
f. Integration stops.
g. ACTIVE COMPONENT command is disabled.

Two clock AA pulses after the programmed COMPONENT OFF time, the Component Enable function is disabled, and the Chart Advance sequence starts. On the 636570 Master Control Board, the output of Z7D causes flip-flops Z14A and Z14B to set. Flip-flop Z14A initiates the CHART ADVANCE function, and enables counter Z15. Flip-flop Z14B causes generation of the TRANSFER COMMAND. Counter Z15 advances to count 2, then resets Z14B and terminates the TRANSFER COMMAND. When Z15 is in count state 2, the TRANSFER RESET COMMAND occurs. The TRANSFER RESET COMMAND provides three functions:

a. Initiation of the COME READ command.
b. Removal of the polarity-reverse function, if previously activated and if programmed to turn off.
c. Reset of the second flip-flop in the COMPONENT ON section of the component board.

Chart advance continues until Z15 reaches the count of 6, thus generating the CHART ADVANCE RESET command, and resetting Z14A, which resets Z15 to the zero-count state, and also resets the 634109 Peak Picker (if used).

B. SIGNAL CONDITIONING SECTION

Pin 67 receives the voltage output signal from the compensating amplifier on the 640922 Basic Terminal Assembly. The signal is then routed, via a plug connector that bypasses polarity reverse amplifier AR1, to the Zero/Calibrate Circuit. The *Model 6710* system utilizes a polarity reverse amplifier and associated switching relay in the 640324 TC Detector Board Assembly in the *analyzer*. (Polarity reverse amplifier AR1 on the master control board is functional only if the board is used with a *Model 6700* system. Polarity reverse switching is then provided by plug-in relay K1 on the master control board, not by a relay in the analyzer.)

1. **ZERO/CALIBRATE Circuit**
   With ZERO/CALIBRATE Switch S7 in CALIBRATE position, CALIBRATE ADJUST Control R19 applies a zero-offset voltage, via amplifier AR2B, to the input of amplifier AR2A. The CALIBRATE ADJUST Control provides two functions:
   a. In *programmer checkout*, the control is manipulated for upscale and downscale deflection of recorder pen to verify proper functioning of summing amplifier and subsequent stages of analog circuitry.
   b. In *component calibration*, the control is used to provide a *simulated* analyzer-output signal corresponding to a given concentration of sample component. The appropriate sensitivity adjustment on the component board is then set for the desired recorder deflection.

C. RANGE SELECTION SECTION

This section controls the gain of the TC or FID amplifier in the analyzer.

When front-panel RANGE Switch is at AUTO, range selection for the TC or FID amplifier is under preprogrammed control of the component boards. With RANGE Switch at AUTO, an AUTO RANGE ENABLE command is applied to gate Z23D, which enables gates Z24A, Z25A, and Z25B. Range selection is now controlled via programmed signals received by gates Z23A, Z23B, and Z23C.

When front-panel RANGE Switch is set for any *manually-selected* range, gates Z26A, Z26B, and Z27A are active and functional.

The automatic and manual range commands are OR-connected, so that they operate in parallel.

D. METER CONDITIONING SECTION

This section contains resistors required for display of various functions on the front-panel MONITOR SELECT Meter. Fullscale meter span is 1 volt, so resistors are used to scale the inputs.

E. FLAME OUT SECTION

This section is used only with the FID, *not* with the TC detector. During operation, AR3 continuously compares the output of the auto zero amplifier with a fixed reference voltage. If the auto zero output falls *below* the 1-volt reference level on the meter, the flame-out indicator is activated. Ignore this indicator if the TC detector is used.

IGNITE Switch S6 is used during startup, to actuate the flame-ignition circuit in the 640330 FID Electronics Board.

F. MANUAL ATTENUATOR RESISTOR NETWORK SECTION

Resistors R14, R15, R16, and R32 form the resistance network that is associated with the front-panel ATTENUATION Switch. The circuit provides selectable attenuation of 1, 2, 4, 8, or 16.

G. OUTPUT SELECT CIRCUIT SECTION

OUTPUT SELECT Switch S3 provides a selectable potentiometric output of 10 millivolts or 1 volt, available at the rear-panel terminals marked BARGRAPH (+) and (–).

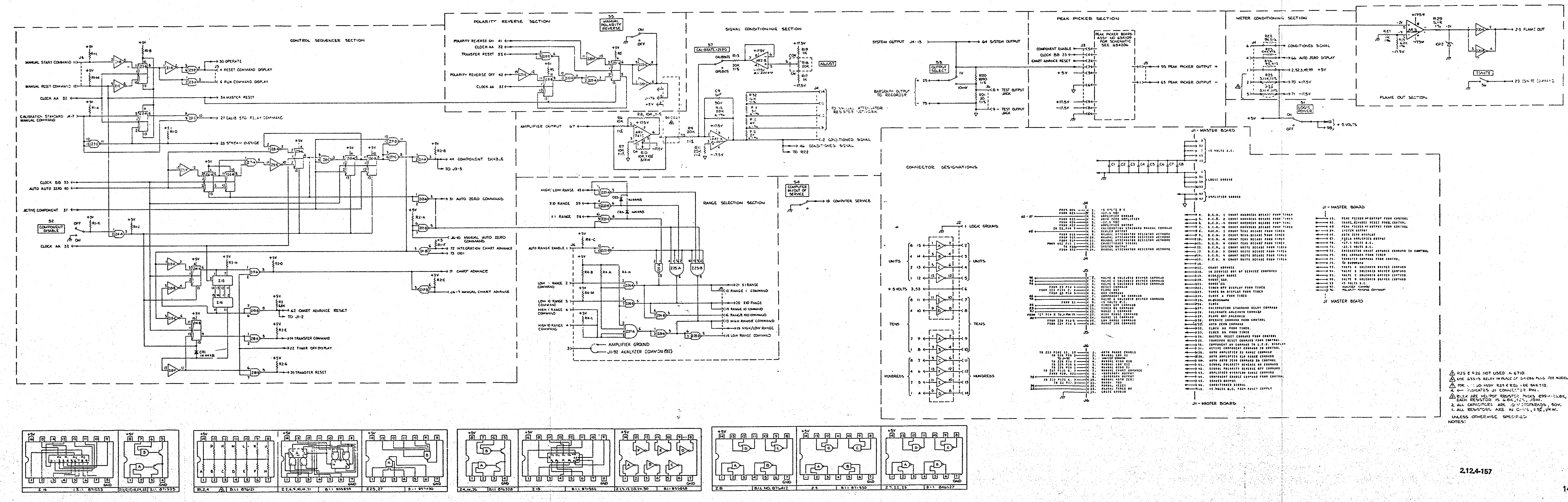
NOTE

The front-panel phone jack marked TEST OUTPUT provides an output of 10 millivolts only, identical to the 10-millivolt output at the rear-panel terminals.

H. POLARITY REVERSE SECTION

This section controls actuation of polarity reverse relay K5 in the 640324 TC Detector Board Assembly. The polarity reverse function can be actuated manually with Switch S5, or can be programmed to occur with each component that requires polarity reversal. Polarity reverse must be programmed both on and off; it does not go off automatically.

Assume that POLARITY REVERSE ON is programmed for a particular component. When this component occurs, flip-flop Z21A sets. It then remains set until the POLARITY REVERSE OFF command occurs, or until the front-panel MODE Switch is placed at RESET. The POLARITY REVERSE OFF command sets Z21B and enables AND-gate Z22D. When the other input of Z22D receives the TRANSFER RESET command, the output of Z22D resets Z21A, causing deactuation of the polarity reverse relay.



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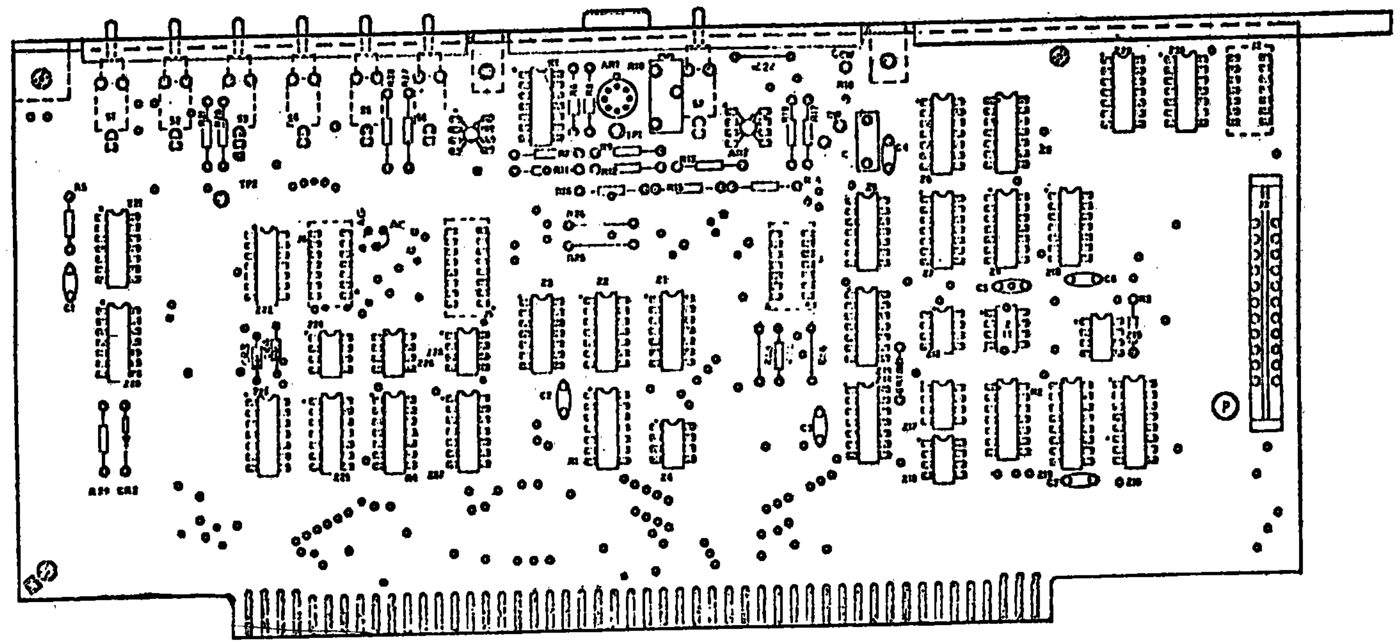

QTY	ITEM	PART NO.	DESCRIPTION
2	Z25,27	857430	CIRCUIT, INTEGRATED- 844
3	Z4,19,26	870872	-SN75451P
1	Z16	871553	-93L01P
1	Z15	871552	-93L10P
1	Z8	876412	-MC1810P
3	Z7,22,23	846627	-846
6	Z11,12,17, 18,21,29	871995	-SN75452P
1	Z3	871550	-MC858P
6	Z2,6,9, 10,14,[illegible]	855859	-852
6	Z1,5,13, 20,[illegible]	855858	CIRCUIT, INTEGRATED - 836
2	AR2,3	635870	AMPLIFIER, SN72558
1	AR1	633243	AMPLIFIER, 741C
1	S6	876732	SWITCH, TOGGLE
6	S1-5,7	876409	SWITCH, TOGGLE
1	K1.	641286	PLUG, JUMPER
1	J5	857544	SOCKET, I.C. -16PIN
1	J3	876410	CONNECTOR, 11 PIN
4	J2,4,6,K1	857545	SOCKET, I.C. - 14-PIN

QTY	ITEM	PART NO.	DESCRIPTION
1	CR2	821972	DIODE, IN750A
3	CR1,3,4	838731	DIODE, IN4448
1	R29	823396	RESISTOR. 560 Ω
1	C9	871595	CAPACITOR, 1.0MFD, 50V
7	C1-7	836864	CAPACITOR, .01MFD, 50V
1	R32	876555	RESISTOR 16 K ±1% 1/4W
1	R28	828901	162K, ±1% 1/4W
1	R21	825356	20Ω.
1	R20	876489	1.98K, ±1% 1/4W
1	R18	869779	VAR., 20K
3	R17,19,27	825321	1K, ±1% 1/4W
1	R16	822879	2K, ±5% 1/4W
1	R15	864858	4.0K ±1% 1/4W
1	R14	876483	8K
4	R9,11-13	825324	20K
3	R6,7,8	822883	10K
2	R3,5	822299	6.8K ±1% 1/4W
3	R1,2,4	876121	RESISTOR PACK, 899-1-R6.8K
1	R10	854387	RESISTOR, VARIABLE

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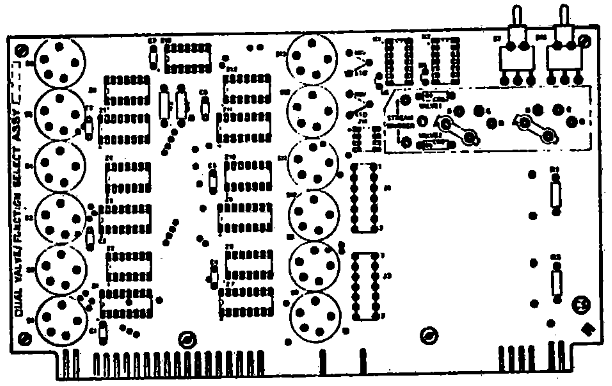
640915 DUAL VALVE/FUNCTION-SELECT BOARD



This board contains two identical valve-programming sections, each for use by an associated slider valve in the analyzer.

VALVE TIMING NO. 1 PROGRAMMING SECTION

This section consists of:

1. **Valve ON-OFF Timing.** During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD decimal equivalent.
2. **Valve Control Circuit** (containing three selectable functions):
   a. ***VALVE SELECT Pin.*** This pin permits routing the output of the valve-control circuit to the desired one of four terminals at the programmer rear panel, then through the interconnection cable to the associated valve driver circuit in the analyzer. Valve designations A, B, C, and D correspond to those assigned to the slider valves in the analyzer.
   b. ***STREAM TRIGGER Pin.*** If desired, the valve-control circuit may be used to advance the stream selector in addition to actuating a slider valve in the analyzer. If so, a pin is inserted in the STREAM TRIGGER position.
   c. ***STANDARD/INVERTED Jumper.*** This jumper provides the selected slider valve with the appropriate one of two operating modes: STANDARD (off-on-off) or INVERTED (on-off-on). The Applications Engineering Data Sheet specifies which is required for the particular column-and-valving configuration.
3. **Optional 637910 Function Select Board.** Used with multi-stream systems, this board permits assigning any desired stream(s) to the VALVE TIMING NO. 1 section.

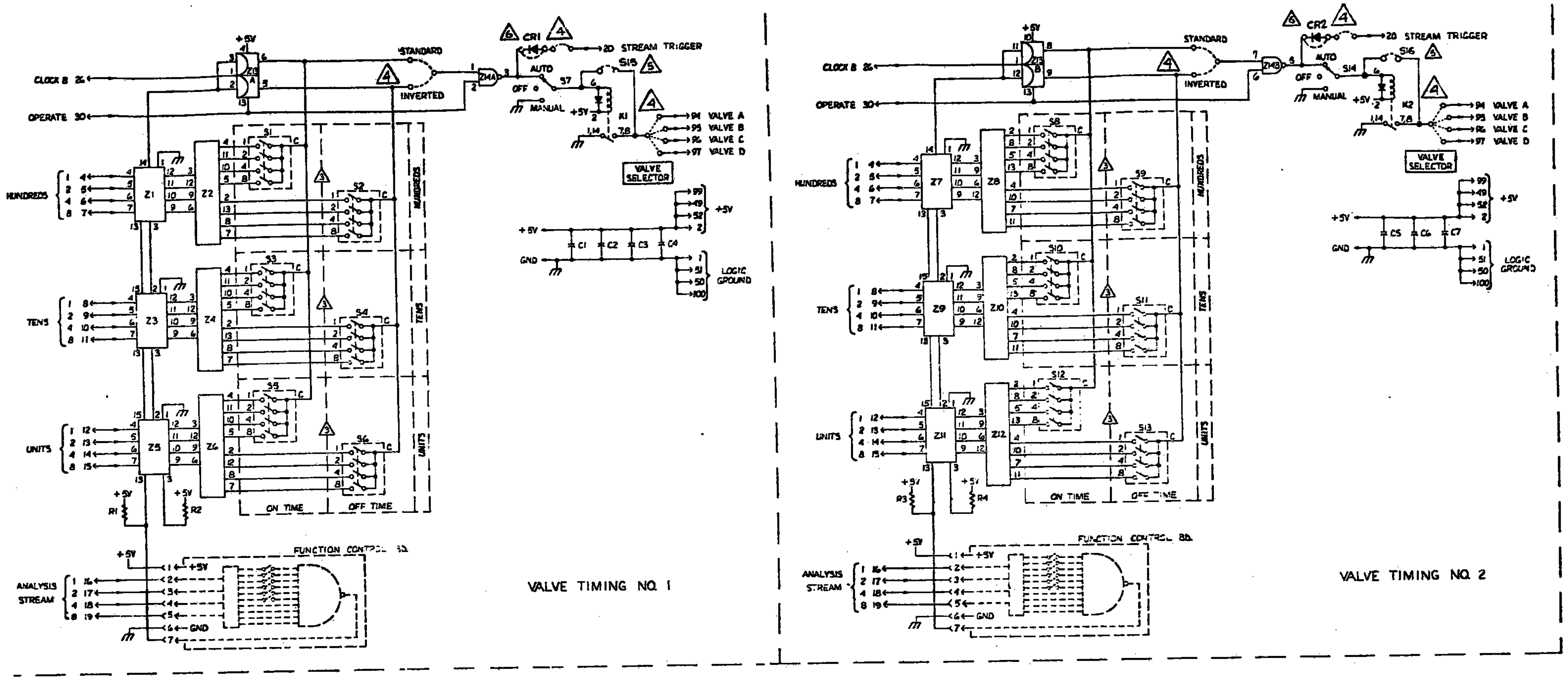
Circuit Operation (As Determined by MANUAL VALVE Switch S7)
With valve control circuit wired for standard (i.e., off-on-off) operation, the occurrence of the VALVE ON command will cause pin 1 of Z14A to become TRUE. With the OPERATE command applied to pin 2 of Z14A, pin 3 of Z14A goes to zero output (current sink condition). Provided that S7 is at AUTO, relay K1 (located on the basic terminal assembly) now energizes and transmits the valve-actuation signal to the selected valve driver circuit in the analyzer. (Pin 2 of Z14A is connected to the OPERATE command to allow the valve to be placed in fail-safe condition when the programmer is in RESET state.)

With S7 at OFF, K1 is disabled, preventing actuation of the valve by commands from the *programmer*. The valve can now be actuated only by the manual switch in the *analyzer*.

With S7 at MAN, K1 is actuated continuously, maintaining the slider valve in actuated condition even if the programmer is in RESET state.

VALVE TIMING NO. 2 PROGRAMMING SECTION

Functionally, this section is identical to the VALVE TIMING No. 1 Section, described above; however, circuit designations differ.



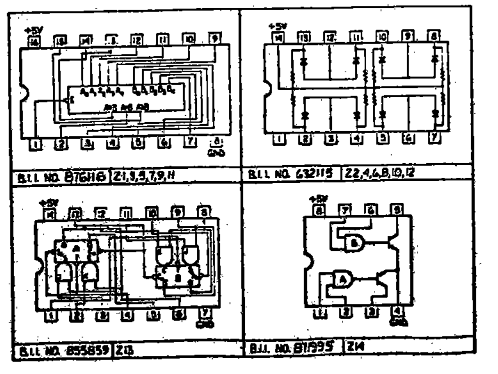
COUNT	OUTPUT			
	8	4	2	1
0	1	1	1	1
1	1	1	1	0
2	1	1	0	1
3	1	1	0	0
4	1	0	1	1
5	1	0	1	0
6	1	0	0	1
7	1	0	0	0
8	0	1	1	1
9	0	1	1	0

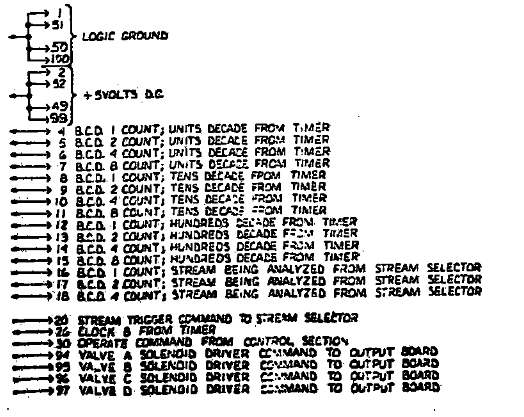
3 TRUTH TABLE BCD SWITCHES S1-6, 8-13

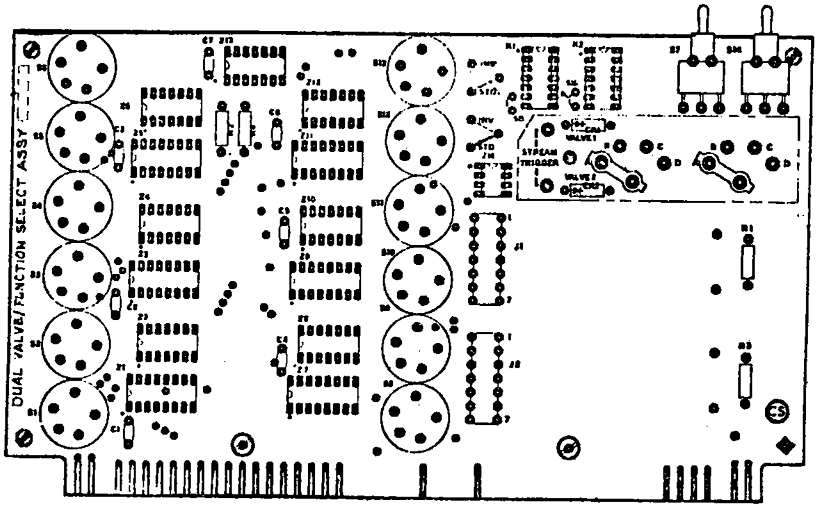
1 DENOTES SWITCH OPEN
0 DENOTES SWITCH CLOSED

6 ADD STRAP IN P_ACE OF CR1 & 2 ON 682766 BD. ASSY.
5 STRAP USED ON 640915 BOARD WHEN RELAY NOT REQ'D
4 SELECTION DETERMINED BY APPLICATION

3 S1-6, 8-13 ARE BCD ROTARY SWITCHES, SEE TRUTH TABLE FOR COUNT SEQUENCE
2. ALL CAPACITORS ARE .01μF, 50V.
1. ALL RESISTORS ARE 6.8K, ±5%, 1/4W.
NOTES: UNLESS OTHERWISE SPECIFIED.

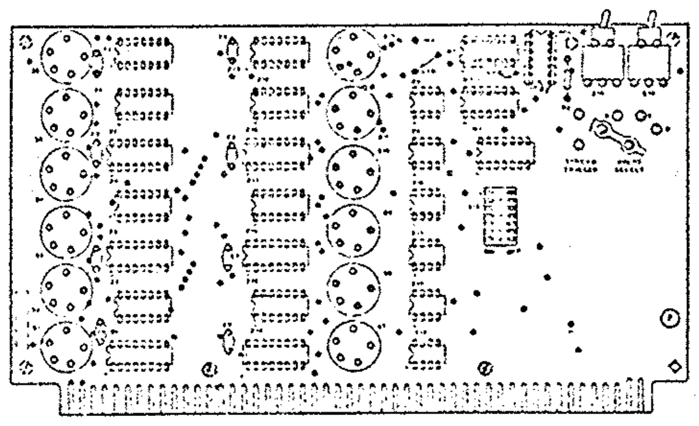






QTY	ITEM	PART NO.	DESCRIPTION
2	CR1,2	838731	DIODE, IN4448
1	Z14	871995	CIRCUIT, INTEGRATED-SN75152
1	Z13	855859	CIRCUIT, INTEGRATED-8S2
6	Z2,4,6, 8,10,12	632115	CIRCUIT, INTEGRATED
6	Z1,3,5, 7,9,11	876116	CIRCUIT, INTEGRATED-93L24
2	S7,14	862596	SWITCH, TOGGLE
12	S1-6, S8-13	876119	SWITCH, ROTARY - BCD
2	J1,2	876098	CONNECTOR, 7 PIN
7	C1-7	836864	CAPACITOR, .01 μF, 50 V
4	R1,2,3,4	822299	RESISTOR, 6.8K, ±5%, 1/4 W

640916 SINGLE-COMPONENT/SINGLE-VALVE BOARD



COMPONENT-PROGRAMMING SECTION

The component-programming section of the board contains the following selectable functions:

1. Component ON-OFF Timing. During programming, the desired ON and OFF times are selected via ten-position rotary switches S1 through S6. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.
2. Programming Functions (Selected with Switch S13):
   a. *X1 RANGE Switch.* Selects gain of 1000 for TC amplifier or 100 for FID amplifier.
   b. *X10 RANGE Switch.* Selects gain of 100 for TC amplifier or 10 for FID amplifier.
   c. *AUTO ZERO Switch ON.* During automatic operation, an auto-zero function will occur approximately three seconds before activation of the COMPONENT ATTENUATOR. The OFF position disables the auto-zero function for the particular component.
   d. *POLARITY REVERSE ON Switch.* Reverses the polarity of the signal in the 640324 TC Detector Electronics Board, if analyzer is so equipped.
   e. *POLARITY REVERSE OFF Switch.* Turns off the polarity-reverse circuit.
   f. *HIGH/LOW Range Switch.* HIGH position provides 1000X attenuation of output signal from FID amplifier. Switch is inoperative with TC amplifier.
3. ON/AUTO/STATUS Switch S14. ON position activates component attenuator R3 and causes DS1 to illuminate. The amplifier signal will be displayed on the recorder, provided that the ATTENUATION Switch on the programmer front panel is at AUTO.

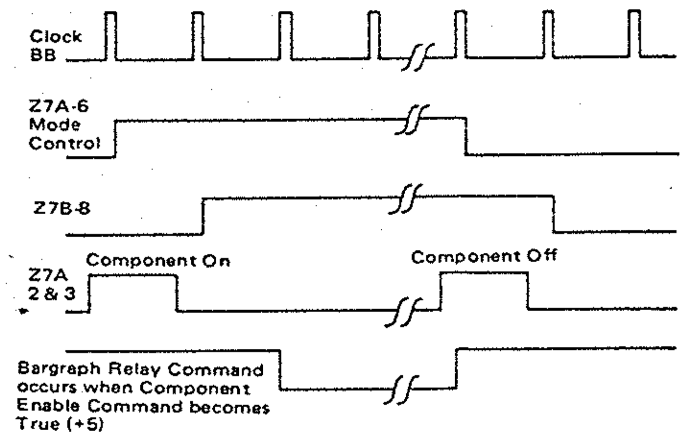
   AUTO position places the component functions under preprogrammed control.

   STATUS is a test position, used *momentarily*, to check programming of component functions. While holding switch at STATUS, observe indicators on master board. Do not check status during automatic operation.
4. Component Attenuator R3. Provides adjustable attenuation (X1 to X13.5) of signal output for chromatogram or bargraph (but not trend) data presentation.

COMPONENT ON-OFF SEQUENCE SECTION

At the programmed COMPONENT ON time, pin 6 of Z7A goes to +5 volts d.c., causing all closed functions on Switch S13 to be energized by Z8A. The next pulse of clock B causes Z7B to go to the set state.

As Z7A is set, the component sequence begins and the COMPONENT ENABLE command is transmitted from the 640908 Master Control Board. This command causes energization of component relay K2, and routing of the data signal through component attenuator R3. Simultaneously, the COMPONENT ON indicator on the programmer front panel is energized by pin 5 of Z12B.



Typical Component ON-OFF Timing Sequence

When the programmed COMPONENT OFF time occurs, Z7A goes to the reset state; i.e., pin 6 goes to 0 volts d.c. (Logic Zero). This deactivates component attenuator R3 and the function selected on Switch S13. However, Z7B remains in the set state until reset by the TRANSFER RESET COMMAND on pin 36.

VALVE-PROGRAMMING SECTION

This section controls an associated slider valve in the analyzer. The section consists of the following:

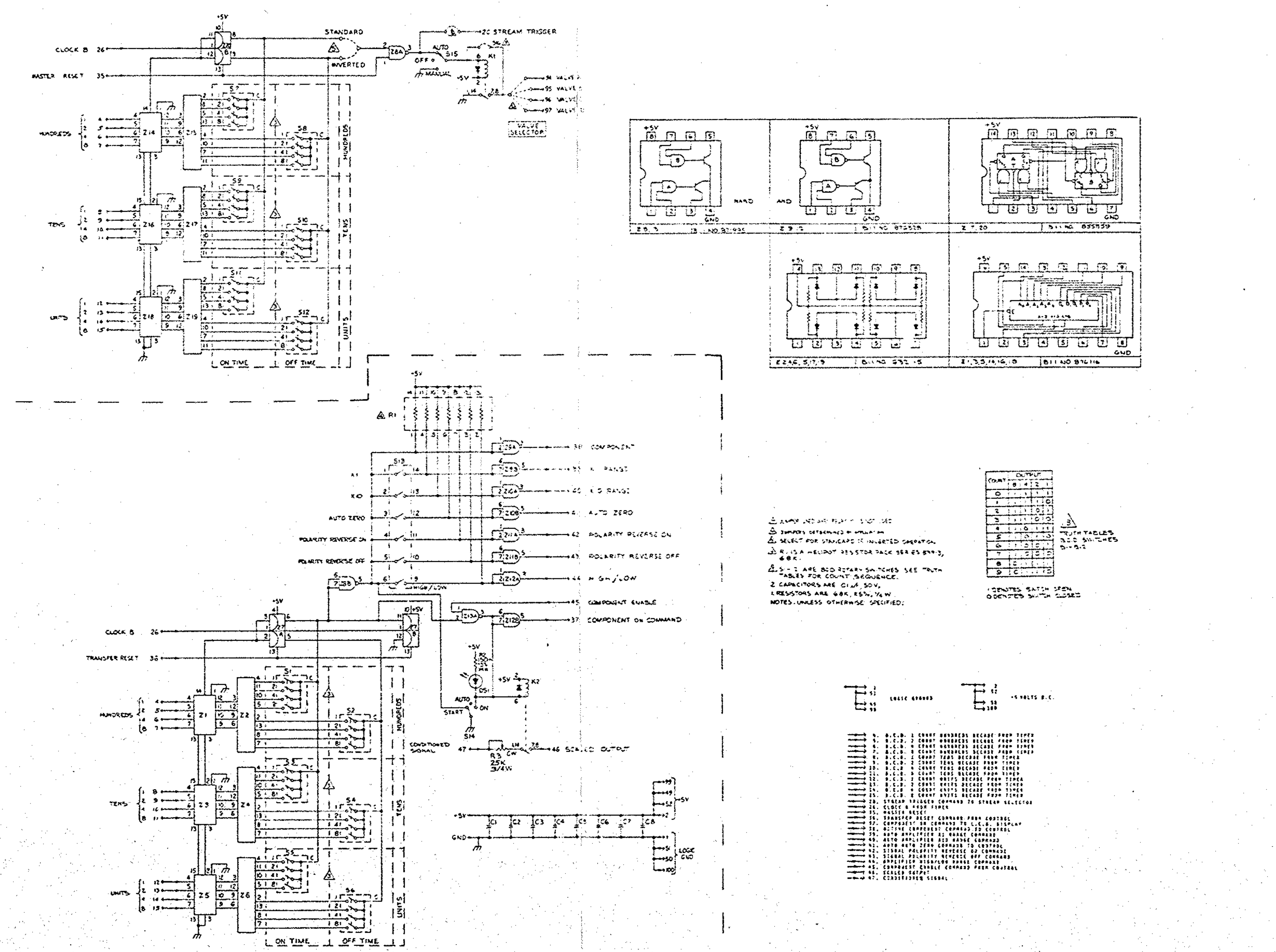
1. Valve ON-OFF Timing. During programming, the desired ON and OFF times are selected via ten-position rotary switches S7 through S12. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. Each switch converts the selected value into its BCD equivalent.
2. Valve Control Circuit (containing three selectable functions):
   a. *VALVE SELECT Pin.* This pin permits routing the output of the valve-control circuit to the desired one of four terminals at the programmer rear panel, then through the interconnection cable to the associated valve driver circuit in the analyzer. Valve designations A, B, C, and D correspond to those assigned to the slider valve in the analyzer.
   b. *STREAM TRIGGER Pin.* If desired, the valve-control circuit may be used to advance the stream selector in addition to actuating a slider valve in the analyzer. If so, a pin is inserted in the STREAM TRIGGER position.
   c. *STANDARD/INVERTED Jumper.* This jumper provides the selected slider valve with the appropriate one of two operating modes: STANDARD (off-on-off) or INVERTED (on-off-on). The Applications Engineering Data Sheet specifies which is required for the particular column-and-valving configuration.

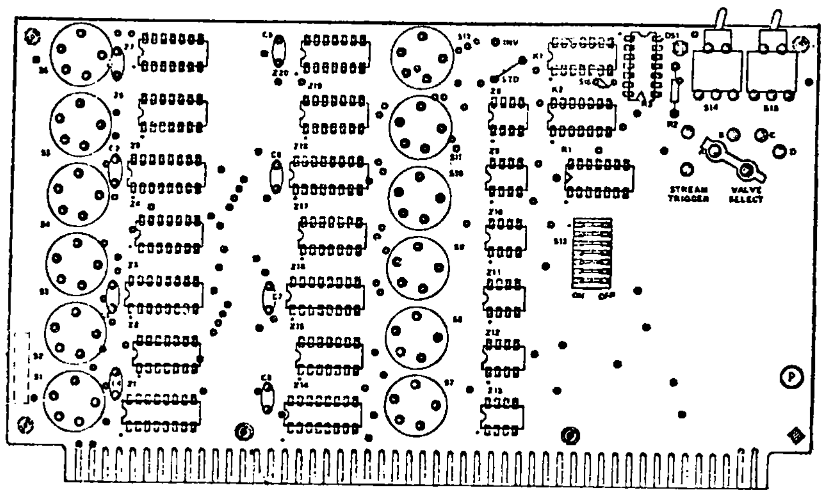
Circuit Operation as Determined by MANUAL VALVE Switch S15

With valve control circuit wired for standard (i.e., off-on-off) operation, occurrence of the VALVE ON command will cause pin 2 of Z8A to become TRUE. With the MASTER RESET command applied to pin 1 of Z8A, pin 3 of Z8A goes to zero output (current sink condition). Provided that S15 is at AUTO, relay K1 now energizes and transmits the valve-actuation signal to the selected valve driver circuit in the analyzer. (Pin 1 of Z8A is connected to the MASTER RESET command to allow the valve to be placed in fail-safe condition when the programmer is in RESET state).

With S15 at OFF, K1 is disabled, preventing actuation of the valve by commands from the *programmer*. The valve can now be actuated only by the manual switch in the *analyzer*.

With S15 at MAN, K1 is actuated continuously, maintaining the slider valve in actuated condition even if the programmer is in RESET state.

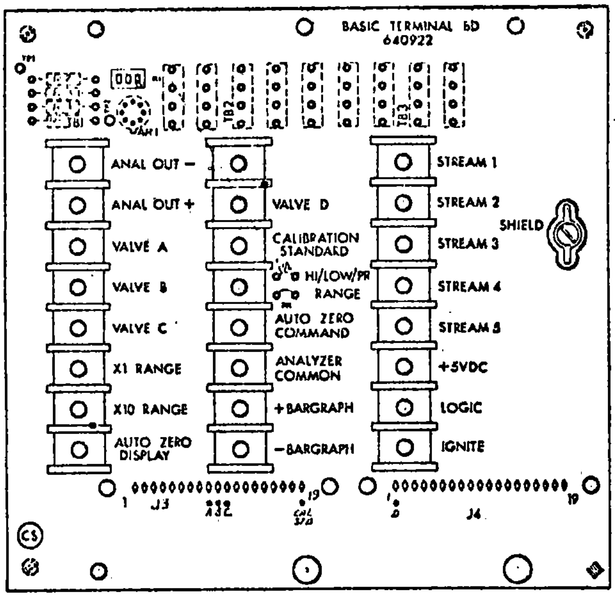




QTY	ITEM	PART NO.	DESCRIPTION
4	Z9-12	870572	CIRCUIT, INTEGRATED SN75451P
2	Z8,13	871995	CIRCUIT, INTEGRATED SN75452P
2	Z7,20	855859	CIRCUIT, INTEGRATED 852
6	Z2,4,6, 15,17,19	632115	CIRCUIT, INTEGRATED
6	Z1,3,5, 14,16,18	876116	CIRCUIT, INTEGRATED 93L24
1	S15	862596	SWITCH, TOGGLE
12	S1-12	876119	SWITCH, ROTARY B.C.D.
1	K2	633112	RELAY FORM 1A
1	DS1	860444	DIODE, LIGHT EMITTING
8	C1-8	836864	CAPACITOR .01 μf 50V.
1	R3	876396	RESISTOR, VAR. 25K 6% P
1	R2	823391	RESISTOR, 150Ω 5% 1/4 W
1	R1	871049	RESISTOR PACK, 1.5K 899-3

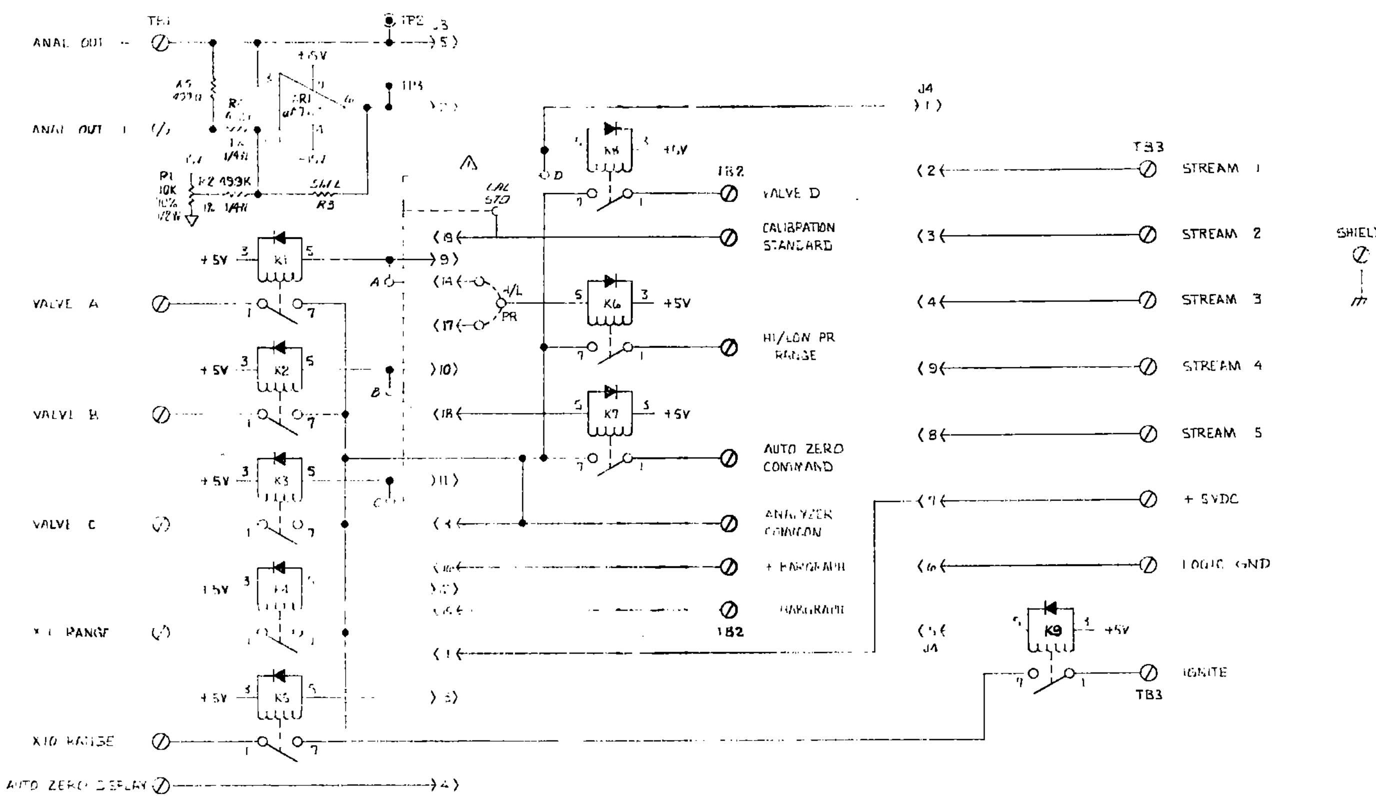
640916 SINGLE-COMPONENT/SINGLE-VALVE BOARD

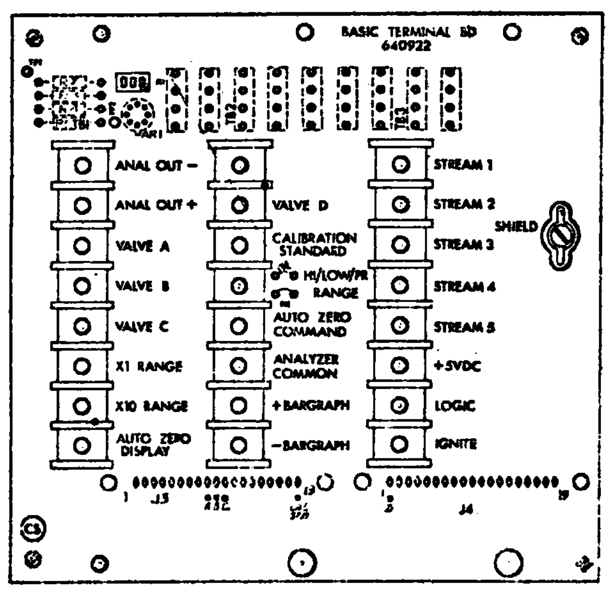
640922 BASIC TERMINAL ASSEMBLY



This assembly provides terminals to connect the programmer to the analyzer and other units of the chromatographic system. The assembly contains the following:

1. **Compensating Amplifier AR1.** It converts the 4 to 20 mA output from the analyzer into a voltage output signal which is routed to summing amplifier AR2A in the signal conditioning section of the 640908 Master Control Board. Amplifier AR1 allows analyzer zero and programmer zero to be slightly different, and yet properly compensated.
2. **Control Relays.** That transmit commands to the analyzer, and thus provide isolation between analyzer and programmer units.

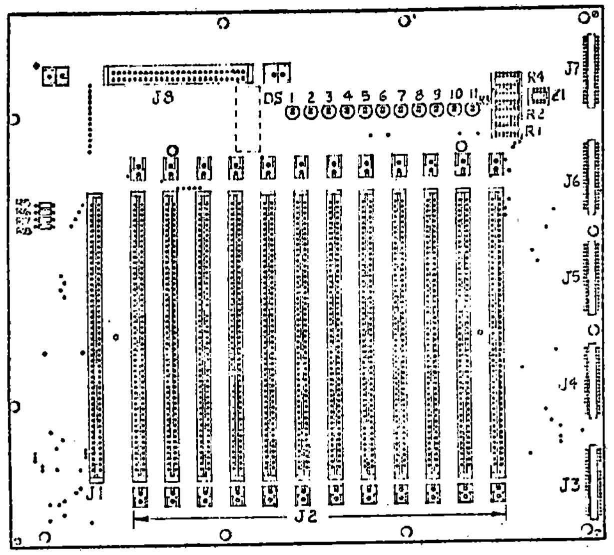




	QTY	ITEM	PART NO.	DESCRIPTION
C	1	R3	828910	RESISTOR 51.1K ±1% 1/4 W
	1	AR1	633243	AMPLIFIER, μA741C
	1	R5	822881	RESISTOR, 499Ω ±1%, 1/4W
	1	R4	843264	RESISTOR, 40.2K ±1%, 1/4 W
C	1	R2	863351	RESISTOR, 49.9K ±1%, 1/4 W
	1	R1	857624	RESISTOR, VAR 10K, ±10%, 1/2 W
	1	4	632066	CABLE ASSY

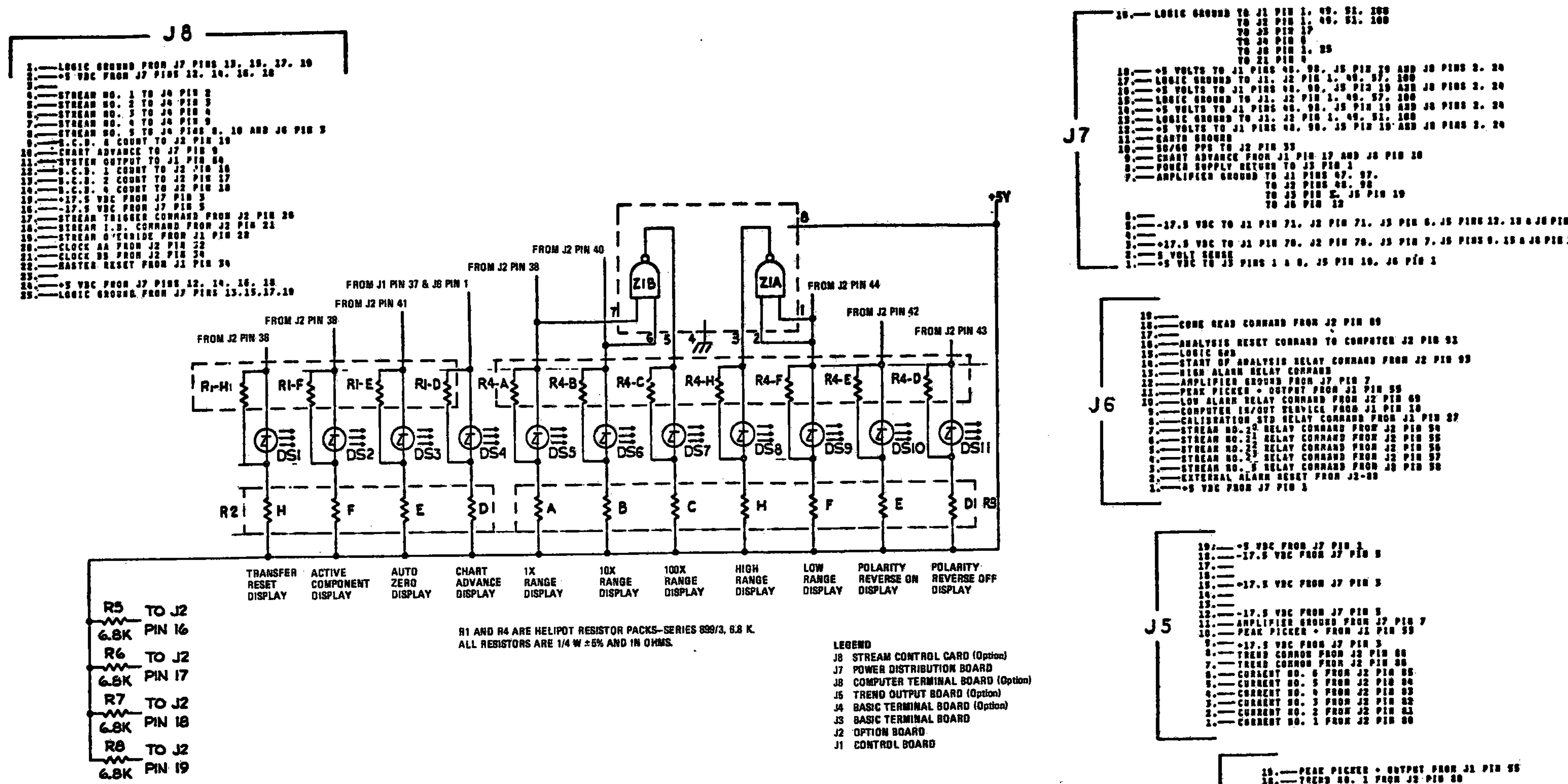
640922 BASIC TERMINAL ASSEMBLY

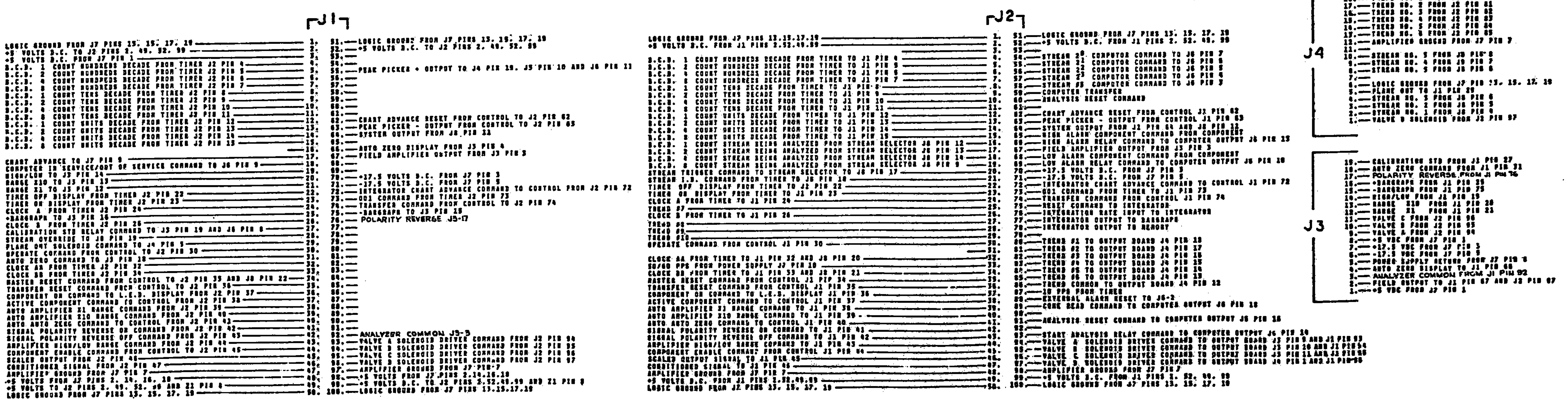
640932 MASTER BOARD (13-RECEPTACLE)

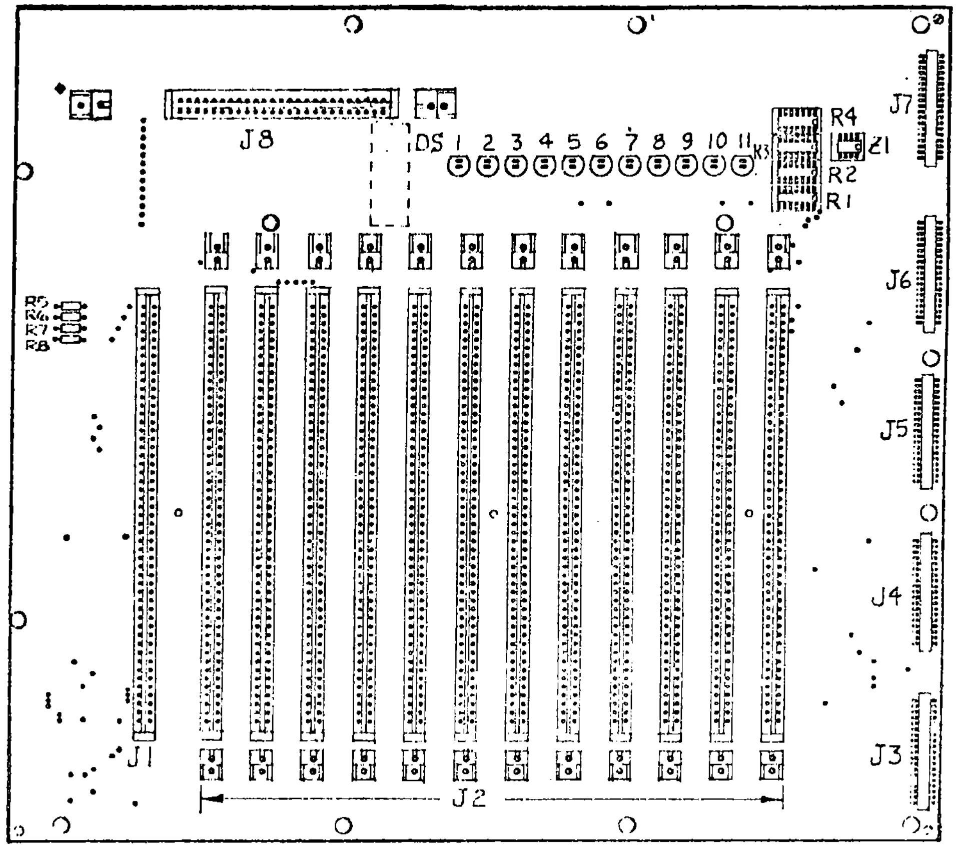


Depending on the number of plug-in circuit boards to be used in the individual programmer, it is factory-assembled to incorporate either the 640932 Master Board (13-Receptacle) or the 640937 Master Board (7-Receptacle).

The Master Board has light-emitting diode (LED) indicators to permit rapid checking of programming for any desired component board. While holding MANUAL COMPONENT Switch on *component board* in STATUS position, observe indicators on *master board*. Do not test component status during automatic operation.



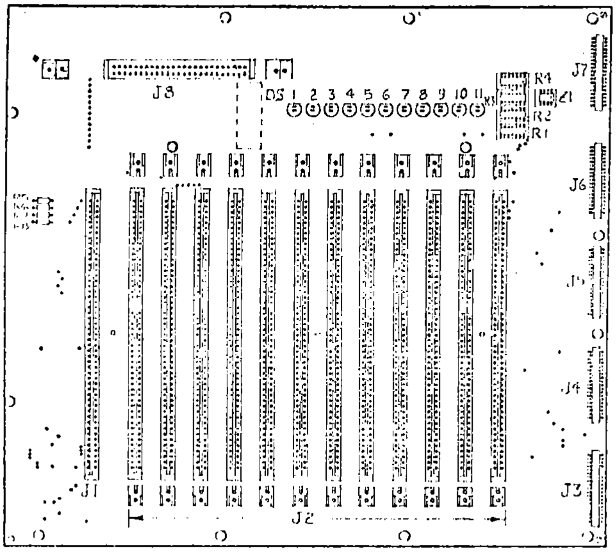




QTY	ITEM	PART NO.	DESCRIPTION
2	R2,3	876401	RESISTOR PACK 899-3, 150Ω
2	R1,4	871949	RESISTOR PACK 899-3, 6.8K
1	Z1	871995	CIRCUIT, INTEGRATED-SN75452
11	DS1-11	860414	DIODE, LIGHT EMITTING
4	R5-8	822299	RESISTOR 6.8K, ±5% 1/4W

640932 MASTER BOARD (13-RECEPTACLE)

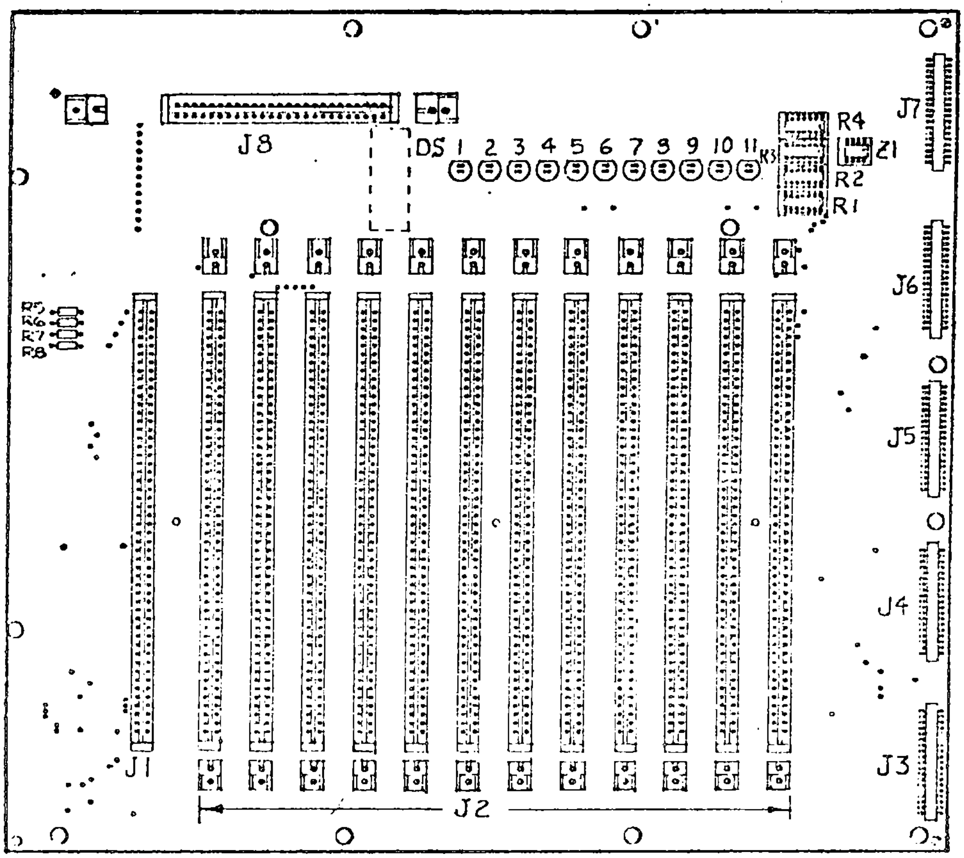
640937 MASTER BOARD (7-RECEPTACLE)



Depending on the number of plug-in circuit boards to be used in the individual programmer, it is factory-assembled to incorporate either the 640937 Master Board (7-Receptacle) or the 640932 Master Board (13-Receptacle).

The Master Board has light-emitting diode (LED) indicators to permit rapid checking of programming for any desired component board. While holding MANUAL COMPONENT Switch on *component board* in STATUS position, observe indicators on *master board*. Do **not** test component status during automatic operation.

For schematic circuit diagram, refer to 640932 Master Board (13-Receptacle).



QTY	ITEM	PART NO.	DESCRIPTION
2	R2,3	876401	RESISTOR PACK 899-3, 150Ω
2	R1,4	871949	RESISTOR PACK 899-3, 6.8K
1	Z1	871995	CIRCUIT, INTEGRATED - SN75452E
11	DS1-11	860444	DIODE, LIGHT EMITTING
4	R5-8	822299	RESISTOR 6.8K, ±5% 1/4W

640937 MASTER BOARD (7 RECEPTACLE)

SECTION NINE SELECTED REPLACEMENT PARTS

Listings for most replacement parts are included in the appropriate service and maintenance instructions, as tabulated below.

ASSEMBLY	PARTS LISTING REFERENCE
Solenoid Valves	Figure 6-1
Ten-Port (LG10) Teflon Slider Valve Assemblies	Figure 6-2
Six-Port (LG6) Metal Slider Valve Assemblies	Figure 6-3
TC Detector	Figure 6-4
Flame Ionization Detector	Figure 6-5
Analyzer Circuit Boards and Individual Components	Section Seven
Programmer Circuit Boards and Individual Components	Section Eight

For miscellaneous replacement parts not covered in the service and maintenance instructions, refer to Paragraph 9.1 and Figures 9-1 and 9-2, Analyzer Unit; or Paragraph 9.2, Programmer Unit.

9.1 ANALYZER UNIT

RECOMMENDED SPARE PARTS

BECKMAN PART NO.	DESCRIPTION
817120	Thermometer
634144	Temperature Sensor, platinum (400 ohms at 25°C)
632229	Heater, Dual-Pass
634255	Air Pressure Switch
	NEEDLE VALVES
829840	Brass (used in carrier line)
929838	Stainless-Steel (used in sample line)
810056	Brass Tee (used with Brass Needle Valve)
29753	Stainless-Steel Tee (with Stainless-Steel Needle Valve)
	SOLDER PLUG (Over-Temperature Protection)
634436	Plug, 146°C
634437	Plug, 232°C
634449	Plug, 96°C

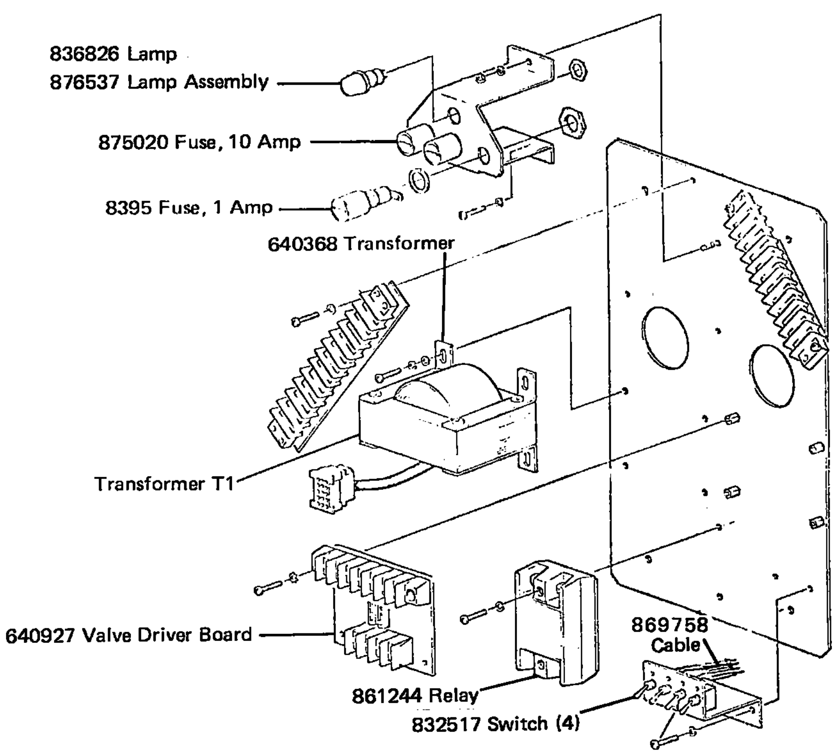


Figure 9-1. Analyzer Basic Electrical Components

9.2 PROGRAMMER UNIT

BECKMAN PART NO.	DESCRIPTION
634220	Front Door Assembly (Swing-Down)
637846	Front Panel Meter
	Knob Assembly, Front Panel *(Order following three items)*:
876419	Knob
876420	Pointer
876421	Cap
	LED Replacement Package *(Good for all LED's in 6710)*:
876110	Time Display, Dotted Numbers
636594	Time Display, Solid Bar Numbers
876255	Spring Clip (Holds roll-up cable in place)
632066	Roll-Up Cable
636054	Relays, Component, Form A
861255	Relays, Valve Driver, Form A
636056 or	
633113	Relays on Master Control Card, Form C
869330	Fan
777059	Fuse Power
866609	Power Switch
876583	Relay Chart Advance

Ten-Point Stream Selector, includes Instructions 015-082458.

BECKMAN PART NO.	DESCRIPTION
635490	Extender Board
637980	Clean Air Accessory (Includes Beckman Instructions 015-555301)
637980	Clean Air Accessory with Methanator (Includes Beckman Instructions 015-555301)

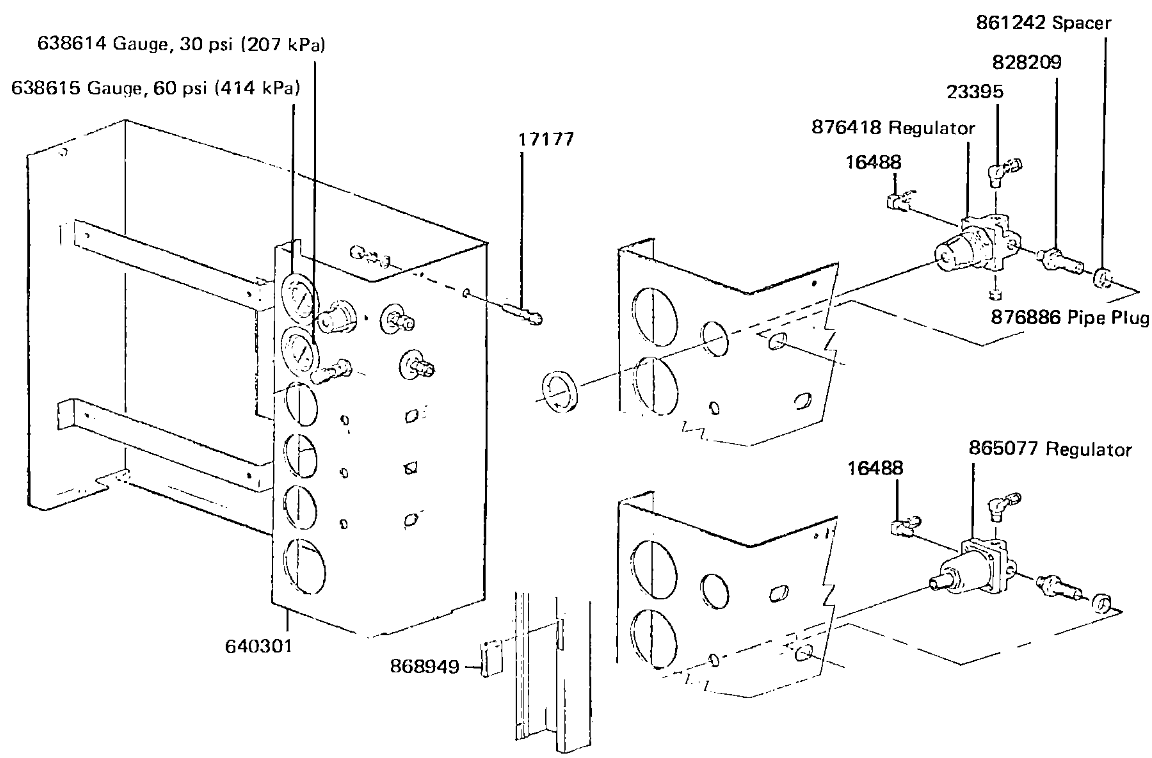


Figure 9-2. Analyzer Basic Gas Regulation Components

11.1 PROGRAMMABLE ON-OFF TIMES FOR INDIVIDUAL FUNCTIONS

Various plug-in circuit boards provide programmable ON and OFF times for one or more individual functions. (See Figure 11-1.)

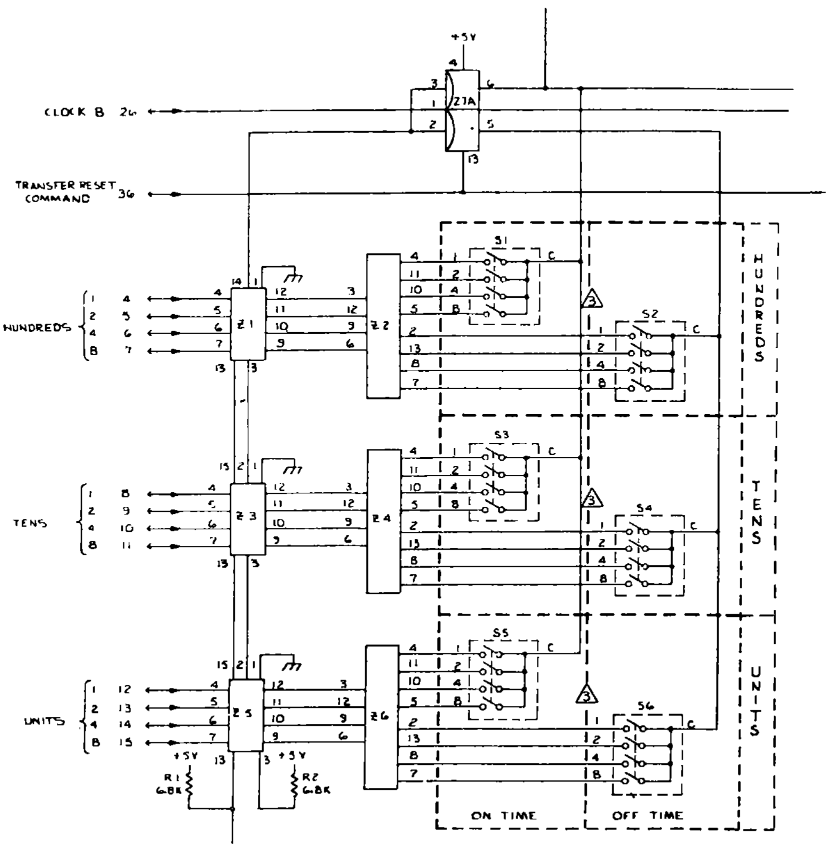


Figure 11-1. Typical ON-OFF Programming Section

During *programming*, the desired ON and OFF times are selected via ten-position rotary switches on the boards. Each switch constitutes a decimal-to-BCD encoder. Switch positions are marked in units, from 0 to 9. The switch converts the selected value into its BCD equivalent.

During subsequent *automatic operation*, the system continuously compares the two sets of BCD data: (a) BCD outputs previously set on the encoder switches associated with the programmed function, and (b) the BCD outputs from the continuously updated digital timer. When the two sets of data agree, a pulse is generated with duration of one period (normally, one second).

For each decade of timing, the individual programmed function utilizes a comparator and a circuit for presenting program data to the comparator. The data-presentation circuit consists of two rotary encoder switches (one each for ON and OFF times) and an associated resistor-diode network.

11.1.1 COMPARATOR

The Fairchild 93L24 Comparator, Beckman Part 876116, has five-bit capability. In the present application, four bits are used for the comparison function, while the fifth bit receives information from the preceding comparator.

Each comparator has three outputs. Assume that the inputs from the rotary switches constitute word "A" and the inputs from the digital timer constitute word "B." Comparator outputs are then:

Output	Pin Number On Comparator
A greater than B	15
A less than B	2
A equal to B	14

The truth table for these relationships is given below:

TRUTH TABLE

Enable	Ay	By	Pin 15 A > B	Pin 2 A < B	Pin 14 A = B
L	Word A =	Word B	L	L	H
L	Word A >	Word B	H	L	L
L	Word A <	Word B	L	H	L

L = Logic Zero (Zero Volts)
H = Logic One (+5 Volts)

Note that the A > B and A < B outputs are both low only when A = B. At all other times, one of the other of the two is high.

As shown in Figure 11-2, the A > B and A < B signals are fed forward, to become part of the word for the following comparator. Thus the output of the last comparator applies to all comparators. The A = B output of the last comparator is true only when agreement is reached between the "A" inputs (i.e., switch-selected data) and the corresponding "B" inputs (i.e., timer output data) for all three comparators.

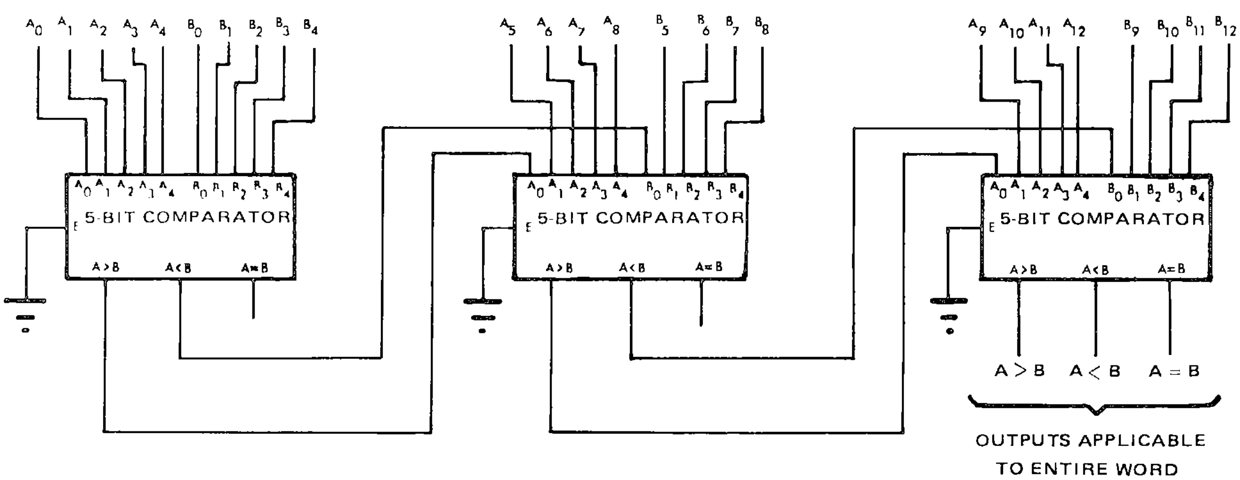


Figure 11-2. Serial Expansion of Comparators for Longer Word Lengths

11.1.2 ROTARY ENCODER SWITCHES AND ASSOCIATED RESISTOR-DIODE NETWORK

Each comparator has an associated resistor-diode network that provides pull-up resistors for the decimal-to-BCD encoder switches, and also routes the signal from the ON or OFF switch to the comparator. Figure 11-3 shows a signal comparator with its associated switches and resistor-diode network.

The four BCD inputs designated A_1, A_2, A_3 and A_4 are from the rotary encoder switches. The four BCD inputs designated B_1, B_2, B_3 and B_4 are from the digital timer. The inputs designated A_0 and B_0 are from the preceding comparators.

Each one of inputs A_1, A_2, A_3, and A_4 is connected, through diodes, to both an ON switch pole and an OFF switch pole. The ON switch is functional only when its common connection is at ground potential. Similarly, the OFF switch is functional only when its common connection is grounded. Since ON and OFF functions are driven by opposite sides of the same flip-flop, they are always of opposite status.

Each four-pole switch constitutes a decimal-to-BCD encoder with 1–2–4–8 output. Assume that the ON switch constitutes a decimal-to-BCD encoder, with 1–2–4–8 output. Assume that the ON switch receives a grounded command from the driving flip-flop. If all four poles of the ON switch are closed, inputs A_1, A_2, A_3 and A_4 would all be at ground potential (zero volts).

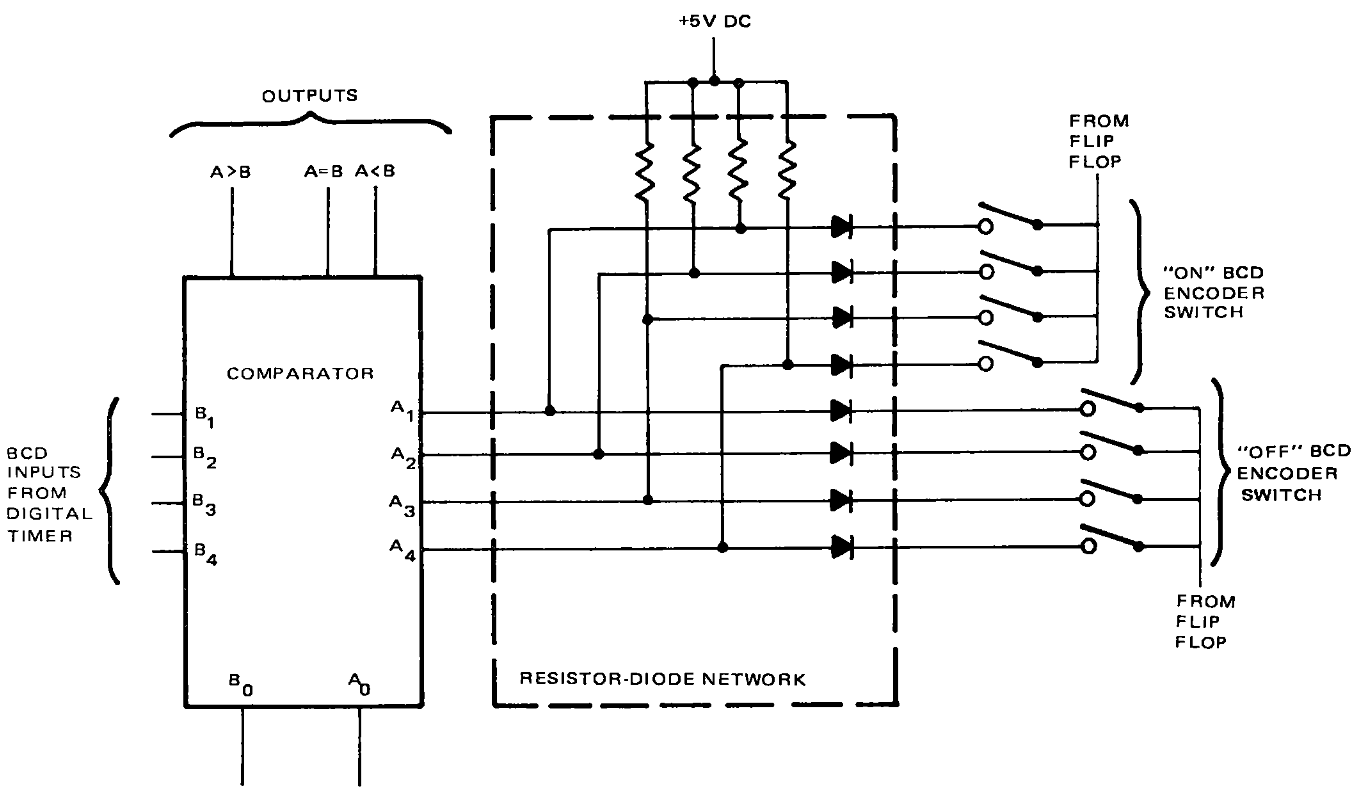


Figure 11-3. Typical Comparator Circuit

For a simplified view of how switch data are presented to a comparator, consider a single "A" input and its associated elements, Figure 11-4. Assume that the flip-flop output connected to the ON switch pole is at ground potential. With the ON pole open, the input to the comparator will be +5 volts d.c. If the ON pole is now closed, current will flow through D1 from both R1 and R2, causing the input to the comparator to go to zero. The OFF pole functions similarly.

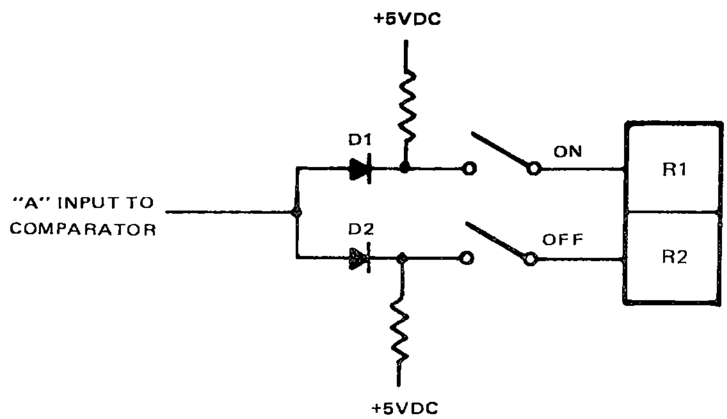


Figure 11-4. Typical "A" Input to Comparator

WARRANTY

Subject to the exceptions and upon the conditions specified below, Beckman agrees to correct, either by repair, or, at its election, by replacement, any defects of material or workmanship which develop within one (1) year after delivery of the products to the original Buyer by Beckman or by an authorized representative, provided that investigation and factory inspection by Beckman discloses that such defect developed under normal and proper use.

Some components and accessories by their nature are not intended to and will not function for one (1) year. A complete list of such components or accessories is maintained at the factory and at each Beckman District Sales Office. The lists applicable to the products sold hereunder shall be deemed to be part of this warranty. If any such component or accessory fails to give reasonable service for a reasonable period of time, Beckman will repair, or at its election, replace such component or accessory. What constitutes either reasonable service and a reasonable period of time shall be determined solely by Beckman.

Any product claimed to be defective must, if requested by Beckman, be returned to the factory, transportation charges prepaid, and will be returned to Buyer with the transportation charges collect unless the product is found to be defective in which case Beckman will pay all transportation charges.

Beckman makes no warranty concerning products or accessories not manufactured by it. In the event of failure of any such product or accessory, Beckman will give reasonable assistance to the Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

Beckman shall be released from all obligations under all warranties, either expressed or implied, if any product covered hereby is repaired or modified by persons other than its own authorized service personnel, unless such repair by others is made with the written consent of Beckman, or unless such repair in the sole opinion of Beckman is minor, or unless such modification is merely the installation of a new Beckman plug-in component for such product.

BECKMAN MAKES NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF WITH RESPECT TO THE PRODUCTS COVERED HEREBY OTHER THAN AS EXPRESSLY STATED HEREIN. BECKMAN EXPRESSLY AND SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTY OF, AND MAKES NO WARRANTY WITH RESPECT TO, THE FITNESS OF ANY PRODUCT COVERED HEREBY FOR ANY PARTICULAR PURPOSE OR USE UNLESS SUCH A WARRANTY IS EXPRESSLY SET FORTH ON THE FACE HEREOF.

THE BUYER OR ANYONE CLAIMING UNDER ANY WARRANTY RELATING TO PRODUCTS SOLD HEREUNDER AGREES THAT IF BECKMAN BREACHES ANY SUCH WARRANTY, OR ANY WARRANTY IMPLIED EITHER IN FACT OR BY OPERATION OF LAW, OR IF ANY PRODUCT WARRANTED HEREUNDER PROVES DEFECTIVE IN ANY MANNER WHATSOEVER, BECKMAN'S SOLE LIABILITY HEREUNDER IS LIMITED TO EITHER REPLACEMENT OF ANY DEFECTIVE PRODUCT OR AT THE OPTION OF BECKMAN, REFUNDING TO THE BUYER THE PURCHASE PRICE AND TRANSPORTATION COSTS PAID FOR SUCH DEFECTIVE PRODUCT. IF A PRODUCT WHICH IS OR HAS BEEN WARRANTED HEREUNDER CAUSES, AT ANY TIME, ANY PROPERTY DAMAGE, PERSONAL INJURY, OR ECONOMIC LOSS, FOR ANY CAUSE WHATSOEVER, THE BUYER AND ANYONE ELSE CLAIMING UNDER ANY WARRANTY RELATING TO SUCH PRODUCT SOLD HEREUNDER EXPRESSLY AND SPECIFICALLY AGREE THAT BECKMAN IS NOT RESPONSIBLE FOR, AND THAT BUYER AND ANY OTHER CLAIMANT OR CLAIMANTS SHALL ASSUME ALL LIABILITY FOR, ANY SUCH PROPERTY DAMAGE, PERSONAL INJURY OR ECONOMIC LOSS AND ANY CLAIM OR CLAIMS FOR SUCH PROPERTY DAMAGE, PERSONAL INJURY, OR ECONOMIC LOSS.

If a Beckman Special Warranty (covering a designated item or items) is attached hereto, the terms and conditions specified therein are incorporated herein by reference and shall supplement this warranty. In the event of a conflict between the terms and/or conditions specified herein, and those specified in such Special Warranty, the terms and or conditions of the Special Warranty shall control.

Representations and warranties made by any person, including dealers and representatives of Beckman, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitations of the liability of Beckman as set forth above), shall not be binding upon Beckman unless reduced to writing and approved by an expressly authorized representative of Beckman.

Beckman Instruments, Inc.,
Fullerton, CA 92634

[redacted]

RECEIVED JUN 15 1981

BECKMAN

BECKMAN INSTRUMENTS, INC.
PROCESS INSTRUMENTS DIVISION
2500 Harbor Boulevard, Fullerton, California 92634 · Telephone: (714) 871-4848 · TWX: 910-592-1260 · Telex: 06-78413

June 10, 1981

Stearns-Roger
P.O. Box 5888
Denver, Colorado 80217

Attention: Jerry May

Reference: Beckman Proposal 4902-818955

Gentlemen:

In response to your request, we are pleased to present our proposal for a Beckman Model 6710 Process Gas Chromatograph System to measure oxygen and hydrogen in the TSS Storage Tank.

The Model 6710 Programmer includes all circuits necessary for measuring the detector signal, automatic control of all time related functions, and data reduction and presentation. The programmer features such items as direct digital timing for precise analysis, auto zero capability before each component for maximum stability, future field expansion by addition of plug-in circuit boards, test switch and LED display for malfunction isolation, integrated circuits, solid-state switches and LED indicators for reliability.

The Model 6710 Analyzer consists of an oven with a precise temperature control system, air and carrier gas regulators, and a four element thermal conductivity detector. A single column stripper valving configuration will be employed to resolve the components of interest. The analyzer will operate at a temperature of 100°C, employ helium carrier gas, and have an analysis cycle time of 3-5 minutes.

BECKMAN

The Model 6710 Analyzer features field located power supplies for precise control and stability, field amplification of detector signal with isolated current transmission for reduction of noise and signal loss, manual valve control switches for field set-up and maintenance testing without communications to control room, a single low-cost cable for interconnection to the programmer, thus reducing installation costs considerably, and field proven sliding plate valve utilizing single bolt assembly for simple maintenance.

We will provide a sample handling system per drawing B/CE 16639 with the following changes:

1. Sample handling cubicle will be electrically heated and not steam heated as shown.

2. Steam and N_2 purge will be deleted.

3. Jet pump can be operated with 35 psig N_2 or water.

We hope the attached proposal is self-explanatory. Should you have any questions, please contact us directly or through our Field Sales Representative, Mr. Rob Bowman. Mr. Bowman is located at 4890 Ironton Avenue, Unit C, Denver, Colorado 80239; telephone (303) 371-0950, and he will be pleased to offer assistance.

Should you prefer to discuss the contents of this proposal directly with someone at our Fullerton facility, please contact Mr. Craig Mathews. Mr. Mathews is located at 2500 Harbor Boulevard, Fullerton, California 92634; telephone (714) 773-8202.

Sincerely,

BECKMAN INSTRUMENTS, INC.

Don W. Stevens

Don W. Stevens
Division Manager
Process Instruments Division

DWS:mfs
enclosure
cc: Mr. W. J. Manning - Lord Electric
Mr. R. Bowman
Mr. W. Dell
Mr. W. Bierbaum

BECKMAN®

BECKMAN INSTRUMENTS, INC.
PROCESS INSTRUMENTS DIVISION
2500 Harbor Boulevard, Fullerton, California 92634 · Telephone: (714) 871-4848 · TWX: 910-592-1260 · Telex: 06-78413

PROPOSAL SPECIFICATIONS

CUSTOMER Lord Electric Company, Inc. QUOTE NO. 4901-818955 DATE

ITEM

APPLICATION ENGINEERING

Application Engineering adapts the chromatograph specifically to the analysis required. Analytical columns are engineered to provide adequate separation of components. These columns are installed in the analyzer of the chromatograh and used in actual operation on a synthetic sample representative of the process stream. All operating data of pressures, temperatures and flow rates required to do the analysis are recorded and supplied with the instrument.

Final calibration of the instrument is to be performed by your firm or a Beckman Service Engineer. If the instrument is placed upon an installation in which the stream conditions are other than as stated below, the ranges, analysis time, etc., cannot be guaranteed without re-evaluation of the stream conditions. Any charges incurred after the placement of an order for such re-evaluation will be assumed by the customer.

Application:
Time of Analysis: 3-5 minutes
Carrier Gas: Helium
Sample Inject Valve: Vapor
Detector: Thermal Conductivity
Repeatability: ±1/2%
Minimum Detectability: 2% of full scale

Measured Components	Range
Oxygen	0-5%
Hydrogen	0-20%

We assume above conditions apply for TSS Storage Tank

BECKMAN

BECKMAN INSTRUMENTS, INC.
2500 Harbor Boulevard, Box 3100
Fullerton, California 92634

(714) 871-4848, TWX 910-592-1260; TELEX 06-78413

DIVISION OPERATION Process Instruments

ISSUE POINT Fullerton, California

Date June 10, 1981

Customer Inquiry

Quotation No. 4902-818955

Please refer to this Quote No. in Future Correspondence

Stearns-Roger
P.O. Box 5888
Denver, Colorado 80217

Attention: Jerry May

ITEM	QTY.	DESCRIPTION	UNIT PRICE	NET PRICE
01	1	BECKMAN MODEL 6710 PROCESS CHROMATOGRAPH SYSTEM to consist of the following:	$11,100.00	$11,10

A. Model 6710 Programmer to include:

* Electronic Auto Zero Configuration
* 7 Receptacle Master Circuit Board with required plug-in option boards
* Digital Timer Board
* Rear Terminal Outputs of 0-1 V and 0-10 mv
* Front Panel Test Switch and Meter
* Two Long Term Memories with 4-20 ma Output
* Front Panel Time Display Board
* Front Door Assembly

B. Model 6710 Analyzer to include:

* Stand Alone Capability
* Field Amplification of Detector Signal
* Isolated Current Transmission of Detector Signal
* Ten Port Sample Inject Valve Sliding Plate Design
* Single Column Stripper Valving Configuration
* Four Element Hot Wire Thermal Conductivity Detector
* Purge Safety - Turns off power to analyzer when instrument air fails
* Carrier Gas Safety Kit

C. Application Engineering and Factory Checkout

APPLICATION ENG. DATA SHT.

PROPOSAL FOR ACCEPTANCE WITHIN DAYS OF ABOVE DATE.
SHIPMENT:
FROM RECEIPT OF ORDER AND APPROVAL OF CREDIT.
TERMS . F.O.B.
SHIPPING POINT:
This proposal is subject to Buyer's acceptance of the terms and conditions of sale appearing on the reverse side hereof.
MINIMUM ORDER $50.00

BECKMAN INSTRUMENTS, INC.

Signed

Title

This proposal is made contingent upon the acceptance by Buyer without change or modification of the provisions of this proposal including all insertions on the face hereof and of the terms and conditions on reverse side hereof. Unless specifically accepted by Beckman in writing, contrary or additional terms, conditions or changes in specifications imposed by Buyer's Purchase Order (if any) or otherwise shall not bind Beckman. Issuance of Buyer's Purchase Order against this quotation (or the acceptance of the products or any part thereof offered hereby) shall be deemed an unqualified acceptance of the provisions of this quotation including the terms and conditions of sale on the reverse side hereof. Upon any acceptance of this quotation it shall contain the entire agreement between Buyer and Beckman and shall supersede all prior representations, promises or conditions written or oral in connection herewith not expressly included herein.

BECKMAN

BECKMAN INSTRUMENTS, INC.
2500 Harbor Boulevard, Box 3100
Fullerton, California 92634

(714) 871-4848, TWX 910 592-1260, TELEX 06-78413

DIVISION/OPERATION

ISSUE POINT

Date June 10, 1981

Stearns-Roger

Customer Inquiry

Quotation No. 4902-818955

Attention: Jerry May

Please refer to this Quote No. in Future Correspondence

ITEM	QTY.	DESCRIPTION	UNIT PRICE	NET PRICE
02	~~1~~	~~THREE SIDED SHELTER - Steel and fiberglass will be painted with corrosion resistant paint and suitable for pad mounting. Outside dimensions are 72" x 72" x 72" HWD per drawing 818955. A bulkhead panel will be mounted in the shelter, to facilitate hook-up of analyzer to support gases.~~ DO NOT ORDER S-R TO ADVISE Ko	~~$11,542.00~~	~~$11,542.~~
03	1	SAMPLE CONDITIONING SYSTEM PER DRAWING B/CE 16639 With remote calibration with electrically heated cubicle	3,360.00	3,360.
4	1	LEEDS AND NORTHRUP MODEL "H" STRIP CHART RECORDER FOR BRAGRAPH PRESENTATION	2,200.00	2,200.
05	A/R	INTERCONNECTING CABLE - PROGRAMMER TO ANALYZER, P/N 640912	0.95/ft.	
06	2	MATHISON 1A HELIUM CARRIER GAS CYLINDER (99.999% purity req'd)	650.00	1,300.
07	1	MATHISON 1A CALIBRATION GAS CYLINDER Blend to consist of: Argon 4%, Hydrogen 16%, Ethane 20%, Methane 60%	718.00	718.

DO NOT BUY YET. POSSIBLY HAVE SCE PROCURE
MOAC TO ADVISE
Ko

PROPOSAL FOR ACCEPTANCE WITHIN DAYS OF ABOVE DATE.
SHIPMENT:
FROM RECEIPT OF ORDER AND APPROVAL OF CREDIT.
TERMS: F.O.B.
SHIPPING POINT:
This proposal is subject to Buyer's acceptance of the terms and conditions of sale appearing on the reverse side hereof.
MINIMUM ORDER $50.00

BECKMAN INSTRUMENTS, INC.

Signed

Title

This proposal is made contingent upon the acceptance by Buyer without change or modification of the provisions of this proposal including all insertions on the face hereof and of the terms and conditions of sale on the reverse side hereof. Unless specifically accepted by Beckman in writing, contrary or additional terms or conditions or changes in specifications imposed by Buyer's Purchase Order (if any) or otherwise shall not bind Beckman. Issuance of Buyer's Purchase Order against this quotation (or the acceptance of the products or any part thereof offered hereby) shall be deemed an unqualified acceptance of the provisions of this quotation including the terms and conditions of sale on the reverse side hereof. Upon any acceptance of this quotation it shall contain the entire agreement between Buyer and Beckman and shall supersede all prior representations, promises or conditions written or oral, in connection herewith not expressly included herein.

Form No. 23-32.68.6 PRINTED IN U.S.A.

2,124-181

BECKMAN

BECKMAN INSTRUMENTS, INC.
2500 Harbor Boulevard, Box 3100
Fullerton, California 92634

(714) [illegible]-4848; TWX 910-592-1260; TELEX 06-78413

DIVISION/OPERATION

ISSUE POINT

Stearns-Roger

Date June 10, 1981

Customer Inquiry

Quotation No. 4902-818955

Please refer to this Quote No. in Future Correspondence

Attention: Jerry May

ITEM	QTY.	DESCRIPTION	UNIT PRICE	NET PRICE
		Start-up service is available at a rate of $416.00 per day portal-to-portal, plus $60.00 per diem plus travel expenses.		
		The above rates are based upon an eight-hour working day. Overtime is charged at one and one-half times standard rate. Saturday work is charged at one and one-half times standard rate. Sunday work is charged at two times standard rate.		
		3 - 5 DAYS START-UP POSSIBLY SEPERATE CONTRACT IF REQUIRED		
		120		

NOTE DATE!

PROPOSAL FOR ACCEPTANCE WITHIN 60 DAYS OF ABOVE DATE.
SHIPMENT: 16-20 WEEKS
FROM RECEIPT OF ORDER AND APPROVAL OF CREDIT.
TERMS: F.O.B. Fullerton, California
SHIPPING POINT: Fullerton, California

This proposal is subject to Buyer's acceptance of the terms and conditions of sale appearing on the reverse side hereof.

MINIMUM ORDER $50.00

BECKMAN INSTRUMENTS, INC.

Signed Don W. Stevens/ Don W Stevens

Title Division Manager/Process Instruments Division

This proposal is made contingent upon the acceptance by Buyer without change or modification of the provisions of this proposal including all insertions on the face hereof and of the terms and conditions of sale on the reverse side hereof. Unless specifically accepted by Beckman in writing, contrary or additional terms or conditions or changes in specifications imposed by Buyer's Purchase Order (if any) or otherwise shall not bind Beckman. Issuance of Buyer's Purchase Order against this quotation (or the acceptance of the products or any part thereof offered hereby) shall be deemed an unqualified acceptance of the provisions of this quotation including the terms and conditions of sale on the reverse side hereof. Upon any acceptance of this quotation it shall contain the entire agreement between Buyer and Beckman, and shall supersede all prior representations, promises or conditions written or oral, in connection herewith not expressly included herein.

Form No. 23-32.68.6

PRINTED IN U.S.A.

MODEL 6710 PROGRAMMER - PLUG-IN CIRCUIT BOARD SETTINGS

CUSTOMER Lord Electric P.O. 26715 PI/IP 26715-01

CITY/STATE Paramount, CA TAG NO. ______ DATE 11/27/81

BOARD NO. ______ **DUAL COMPONENT MEMORY** **P/N 634115**

I

COMPONENT NAME Hydrogen RANGE 0-20%

PIANO SELECTOR SWITCH

COMPONENT GATE

TIME ON 66 SEC.

TIME OFF 93 SEC.

	RANGE X1	RANGE X10	AUTO ZERO	POLARITY REV ON	POLARITY REV OFF		RANGE
ON	X		X		X	(HI)	
OFF		X		X		(LO)	X

MEMORY OUTPUT P/N 635037 YES X NO ______

OUTPUT TO MEMORY NO. 1 X 2 ____ 3 ____ 4 ____ 5 ____ 6 ____

II

COMPONENT NAME Oxygen RANGE 0-5%

PIANO SELECTOR SWITCH

COMPONENT GATE

TIME ON 100 SEC.

TIME OFF 115 SEC.

	RANGE X1	RANGE X10	AUTO ZERO	POLARITY REV ON	POLARITY REV OFF		RANGE
ON		X			X	(HI)	
OFF	X		X	X		(LO)	X

MEMORY OUTPUT P/N 635037 YES X NO ______

OUTPUT TO MEMORY NO. 1 ____ 2 X 3 ____ 4 ____ 5 ____ 6 ____

BOARD NO. ______ **DUAL COMPONENT MEMORY** **P/N 634115**

I

COMPONENT NAME ______ RANGE ______

PIANO SELECTOR SWITCH

COMPONENT GATE

TIME ON ____ SEC.

TIME OFF ____ SEC.

	RANGE X1	RANGE X10	AUTO ZERO	POLARITY REV ON	POLARITY REV OFF		RANGE
ON						(HI)	
OFF						(LO)	

MEMORY OUTPUT P/N 635037 YES ______ NO ______

OUTPUT TO MEMORY NO. 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____

II

COMPONENT NAME ______ RANGE ______

PIANO SELECTOR SWITCH

COMPONENT GATE

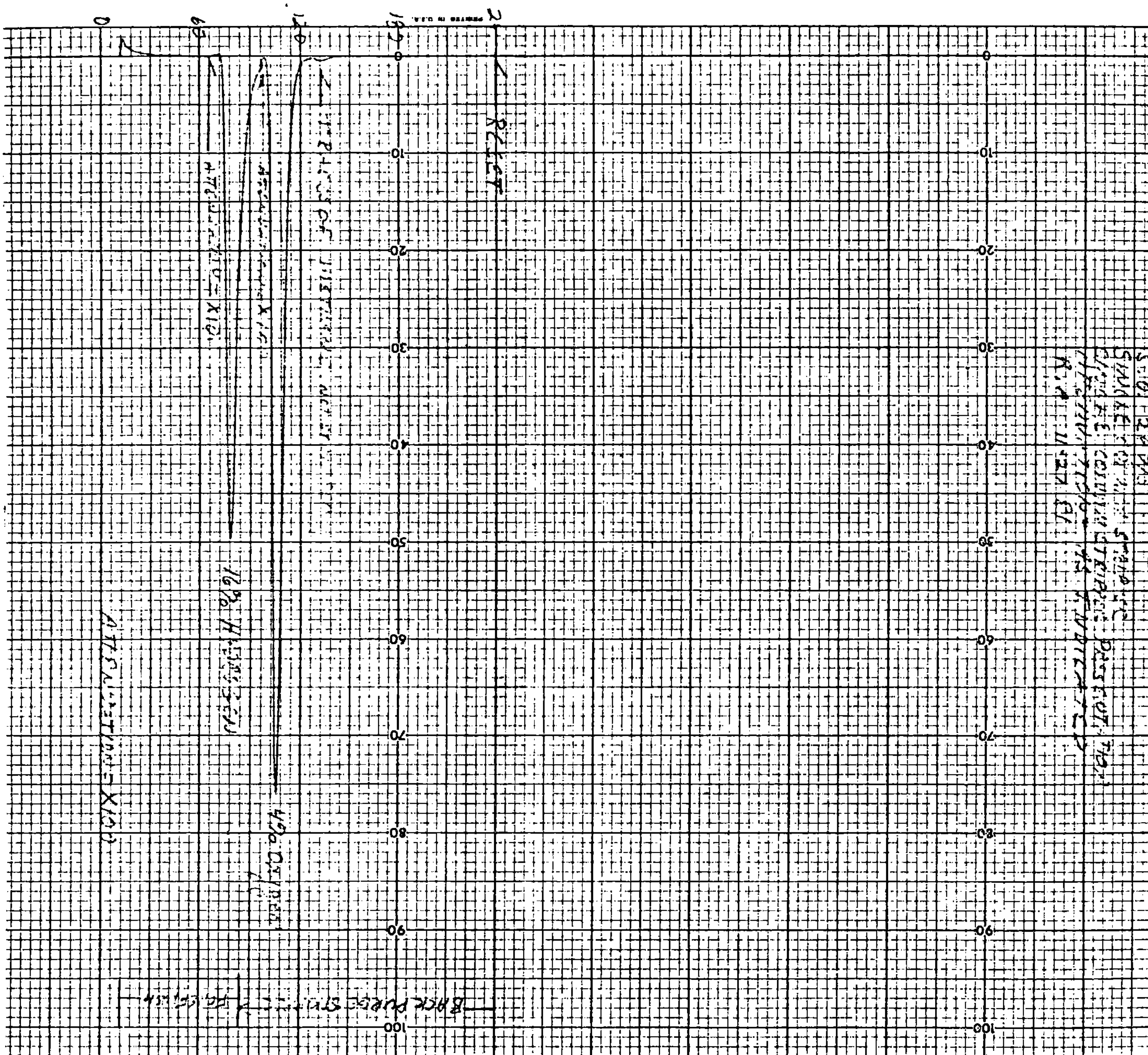
TIME ON ____ SEC.

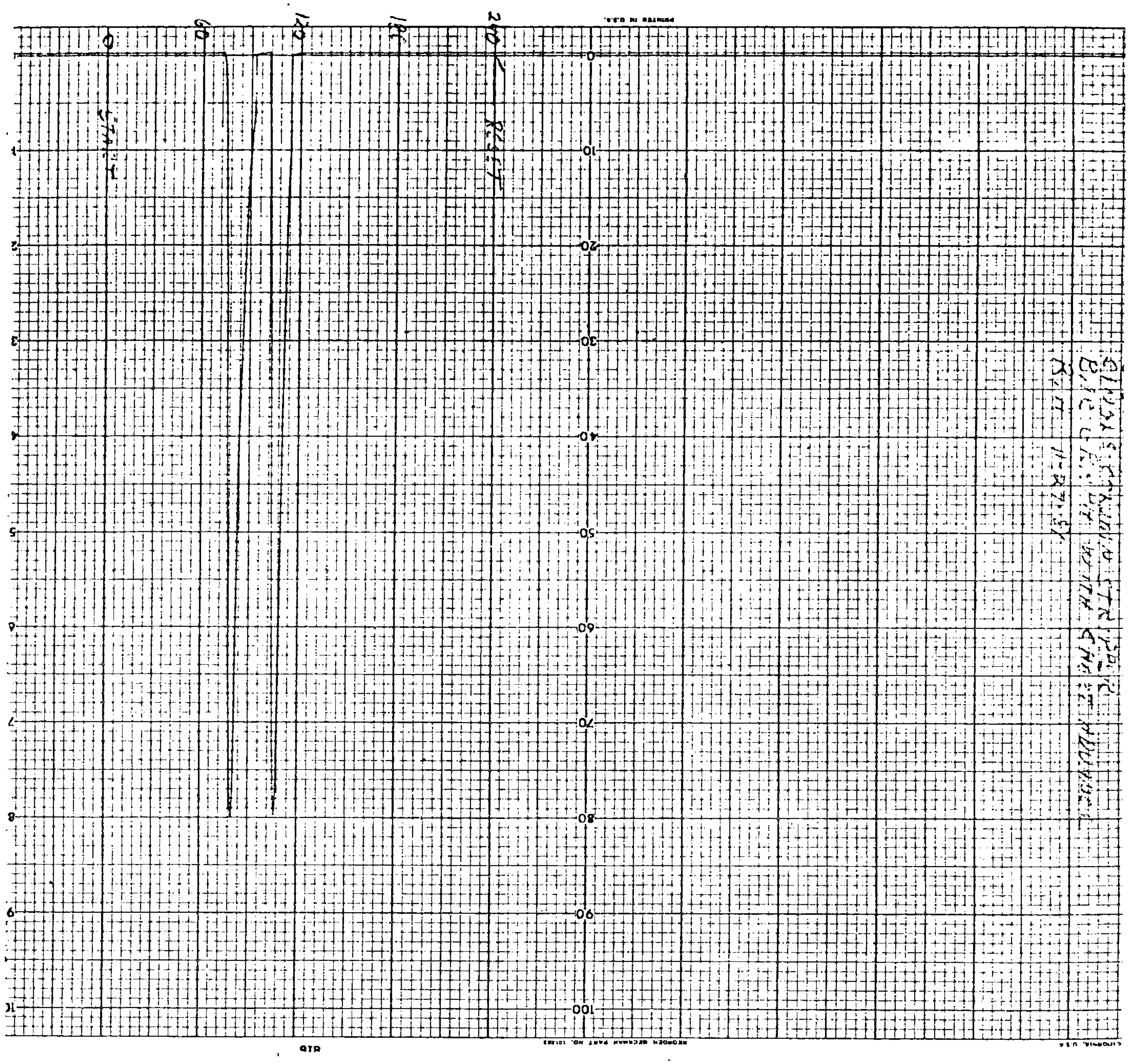
TIME OFF ____ SEC.

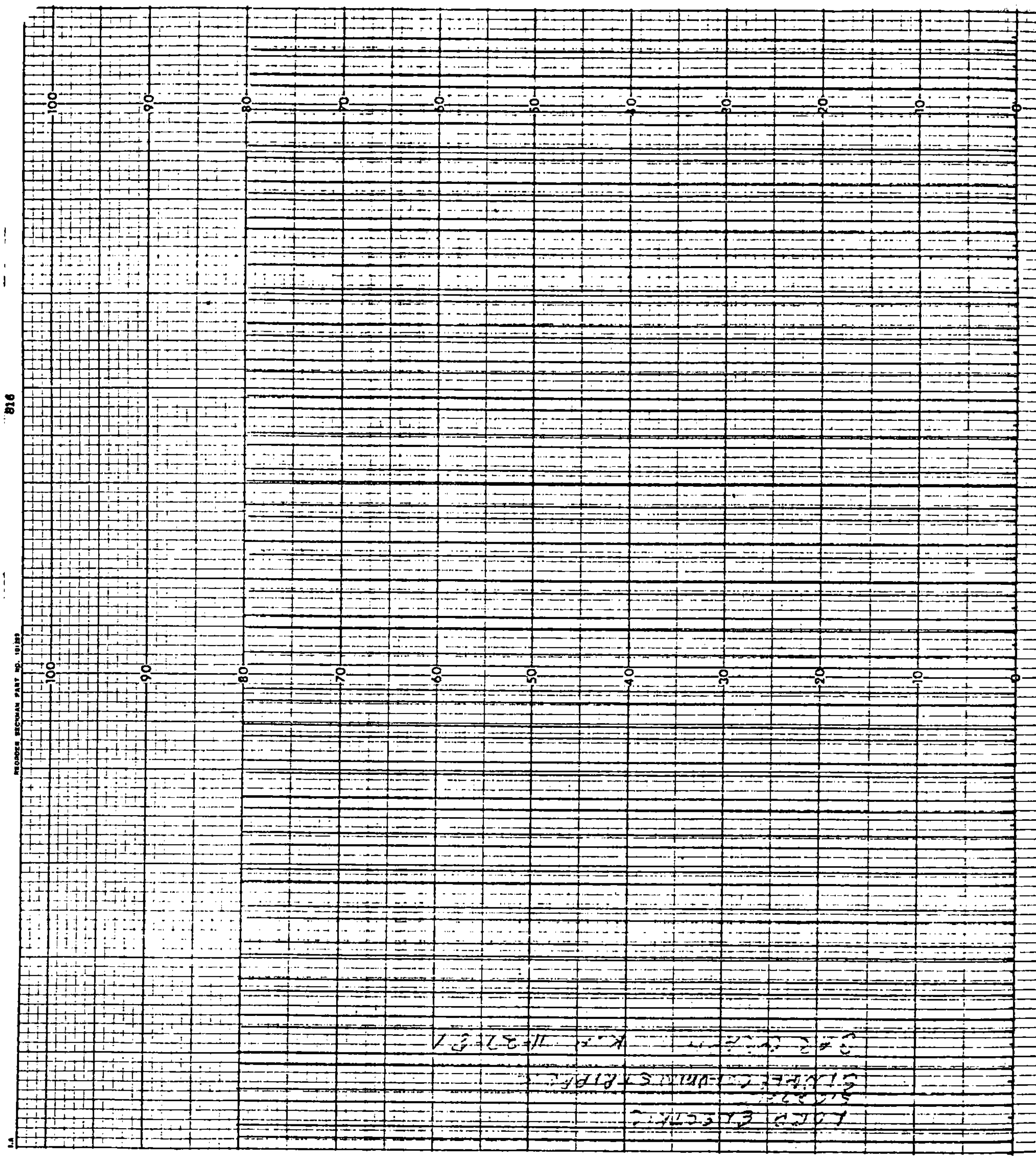
	RANGE X1	RANGE X10	AUTO ZERO	POLARITY REV ON	POLARITY REV OFF		RANGE
ON						(HI)	
OFF						(LO)	

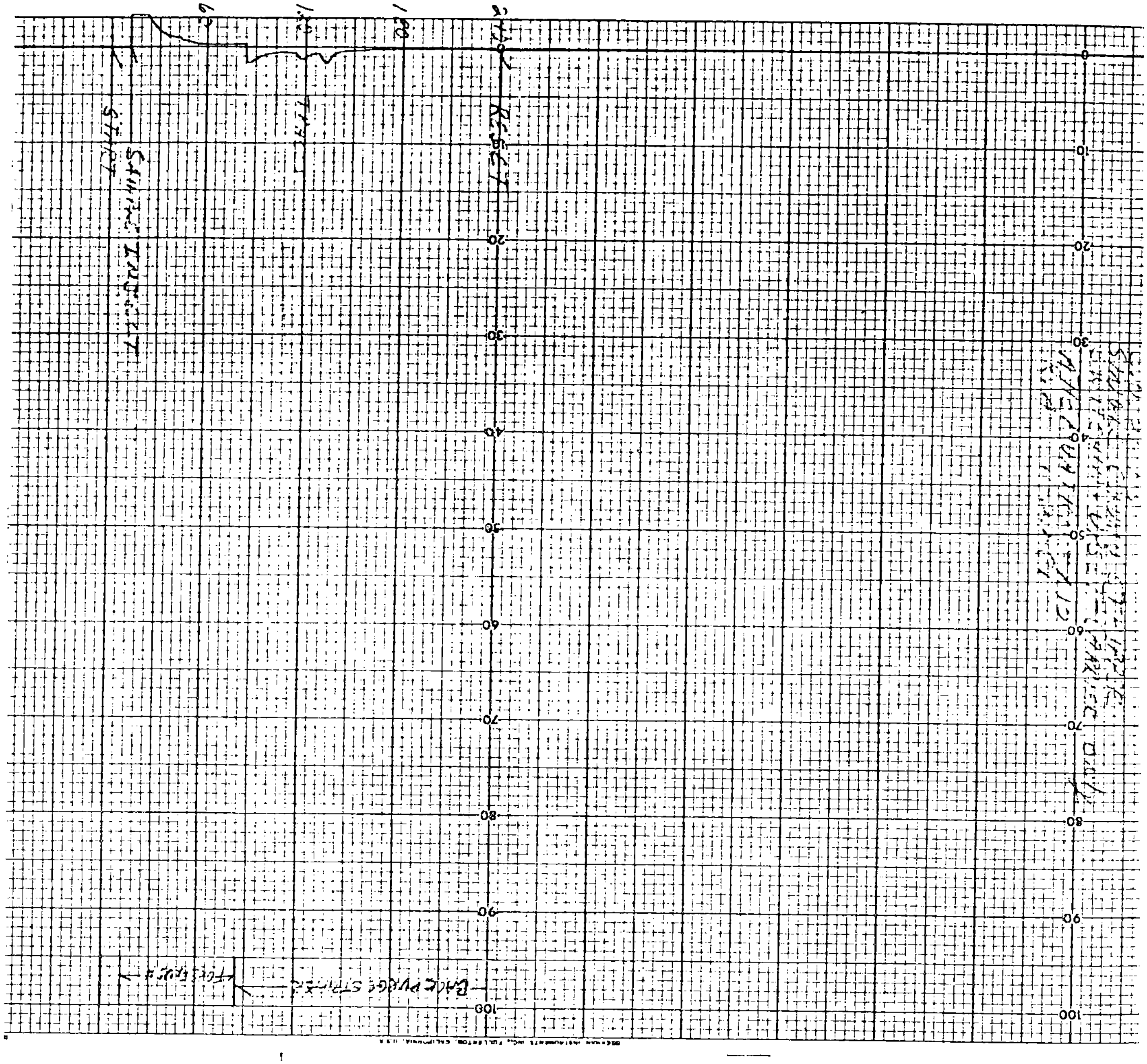
MEMORY OUTPUT P/N 635037 YES ______ NO ______

OUTPUT TO MEMORY NO. 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____




0
60
120
180
240
0
10
20
30
40
50
60
70
80
90
100


100 90 80 70 60 50 40 30 20 10 0
100 90 80 70 60 50 40 30 20 10 0



INITIAL START UP ON JUNE 29 1982
CALIBRATION GAS CYL. WAS 16.16 % H^2
AND 4.04 OXYGEN

ELUTION TIMES ON 240 SEC. CYCLE
HYDRGEN - START - 66
STOP - 94

OXYGEN START - 106
STOP - 120

MODEL 6710 PROCESS GAS CHROMATOGRAPH APPLICATION ENGINEERING DATA SHEET COLUMNS AND OPERATING CONDITIONS

CUSTOMER Lord Electric
CITY/STATE Paramount, CA
COLUMN CONFIG. Single column stripper

P.O. 26715
TAG NO.
PI/IP 26715-01
DATE 11/27/81
DWG. NO. 635101

SYSTEM 1 Single column stripper
COLUMN Stripper (Upstream)
LENGTH 6' O.D. 1/8" MAT'L S.S.
PACKING C-102 80/100 Mesh
(220-4) (Code 4-10)

PLUS
COLUMN Stripper (Downstream)
LENGTH 2' O.D. 1/8" MAT'L S.S.
PACKING Molesieve 5A
45/60 Mesh (220-4)
No Code

COLUMN Analytical
LENGTH 3' O.D. 1/8" MAT'L S.S.
PACKING Mole Sieve 5A
45/60 Mesh (220-4)
No Code

COLUMN
LENGTH O.D. MAT'L
PACKING

SYSTEM 2
COLUMN
LENGTH O.D. MAT'L
PACKING

COLUMN
LENGTH O.D. MAT'L
PACKING

COLUMN
LENGTH O.D. MAT'L
PACKING

COLUMN
LENGTH O.D. MAT'L
PACKING

TEMPERATURE 100 °C
DETECTOR TC X FID HID

	SYSTEM 1 (LEFT)	SYSTEM 2 (RIGHT)
Pressure, psig	22 24	
Column Flow, ml/m	9	
Stripper Flow, ml/m	13	
Cutter Flow, ml/m		
Carrier (O_2 Free)	Helium	
Discharge Chamber Flow, ml/m (HID Only)		

Reference Flow ml/m 10
Heater Pressure, psig 25
50 Hertz 60 Hertz X

HYDROGEN FLAME IONIZATION DETECTOR
Fuel (or diluent) Pressure, psig
Combustion Air Pressure, psig

SAMPLE	SIZE	VAPOR	LIQUID
System 1	200ul	X	
System 2			

THERMAL CONDUCTIVITY DETECTOR
Filaments Hytemco X Tungsten Other
Current 130.4 ma Bridge Voltage 20.5
Column Connection System 1; Flow X Diff System 2; Flow Diff

Cycle Time 240 Sec.

ALL COLUMNS MUST BE CAPPED WHEN NOT IN USE.

MODEL 6710 PROCESS GAS CHROMATOGRAPH
APPLICATION ENGINEERING DATA SHEET
STREAM COMPOSITION AND RANGES

CUSTOMER Lord Electric Co. P.O. 26715 PI/IP 26715-01
CITY/STATE Paramount, CA TAG NO. DATE 11/27/81

COMPOSITION AND RANGES IN MOL % ______ LIQUID VOL % X WT. % ______

COMPONENT NAME	CONCENTRATION, %					RANGE AND REPEATABILITY(1)				
	1	2	3	4	5	1	2	3	4	5
Water	1.0									
Nitrogen	2.0									
Carton Monoxide	2.4									
Carbon Dioxide	2.0									
Hydrogen	20.8					0-20%				
Oxygen	.2					0-5%				
Methane	20.5									
Ethane	19.3									
Ethylene	.5									
Propane	12.3									
Propylene	2.0									
i Butane	2.4									
n Butane	8.1									
i Pentane	0.4									
n Pentane	6.0									

CONTINUED

Instrument design is based upon this stream information as supplied by Purchaser. Concentrations or conditions other than those listed will cause analyzer failure. Charges for corrective service or parts will be directed to the user.

(1)Repeatability is $\pm 1/2\%$ of range unless otherwise indicated.

Special Features and Limits of Responsibility

X22-28.82

MODEL 6710 PROCESS GAS CHROMATOGRAPH
APPLICATION ENGINEERING DATA SHEET
STREAM COMPOSITION AND RANGES

CUSTOMER Lord Electric P.O. 26715 PI/IP 26715-01

CITY/STATE Paramount, CA TAG NO. DATE 11/27/81

COMPOSITION AND RANGES IN MOL % ______ LIQUID VOL % ______ WT. % ______

COMPONENT NAME	CONCENTRATION, %					RANGE AND REPEATABILITY[1]				
	1	2	3	4	5	1	2	3	4	5
Heptane	BAL									
Phase	Vapor									
Temperature (^oF)	320-575									
Pressure (Inches H_2o)	7-11									

nstrument design is based upon this stream information as supplied by Purchaser. Concentra-ions or conditions other than those listed will cause analyzer failure. Charges for orrective service or parts will be directed to the user.

1) Repeatability is ±1/2% of range unless otherwise indicated.

ecial Features and Limits of Responsibility

X22-28.82

BECKMAN

6710 DATA SHEET
MODEL 6710 PROGRAMMER OPTIONS

CUSTOMER / ADDRESS: Lord Electric Co.
Paramount, CA

P.O. NO. 26715
TAG NO.
P/P 26715
DATE 11/27/81

BECKMAN PART NO.	DESCRIPTION	QUANTITY*
640900	PROGRAMMER	1
640937	Master Board, 7 Receptacle	1
640932	Master Board, 13 Receptacle	
	FRONT PANEL OPTIONS	
640902	Front Door Assembly	1
632134	Blank Panel, Stream Selector Locator	1
632084	5-Point Stream Selector	
635566	5-Point Stream Selector Display	
633112	5-Point Relays (2 Streams Included)	
635268	10-Point Stream Selector Control	
636049	10-Point Stream Selector Display	
636594	Time Display, Seconds	1
	INTERNAL CIRCUIT BOARD OPTIONS	
640916	*Single Component, Valve (640941 Cover)	
632163	*Triple Component (635097 Cover)	
638493	Logic Test, Digital Timer	
632196	Digital Timer	1
634115	*Dual Component, Memory (635091 Cover)	1
640411	*Universal Component (635096 Cover)	
636661	Summation Amplifier	
635037	Memory (Peak Picker Required)	2
634109	Peak Picker	1
638386	Integrator Control	
634112	PSIG Select	
632184	*Integrator	
632175	*Hi/Low Alarm	
632172	*Dual Reset, (635093 Cover)	
640915	*Dual Valve, Function Select (640942 Cover)	1
632178	*Computer Driver (Peak Picker Required)	
635263	*Universal Latch	
636042	*Dual Component, Single Memory (636047 Cover)	
637149	*Dual Component, Function Select, 10-Point (639768 Cover)	
637910	Function Select, 10-Point	
	REAR PANEL OPTIONS	
632066	Cable Assembly, Stream Select/FID/Valve D	
635016	E Output Terminal Assembly (Peak Picker Required)	
632190	I Output Terminal Assembly	1
632187	Dual 4 To 20 Milliamperes Board	1
634755	Dual 1 To 5 Milliamperes Board	

BECKMAN PART NO.	DESCRIPTION	QUANTITY*
	REAR PANEL OPTIONS (Continued)	
635019	PSIG Output Terminal Assembly	
635030	PSIG Memory Accessory, 1 Point	
635410	PSIG Memory Accessory, 3-Point	
635400	PSIG Memory Accessory, 6-Point	
876904	I/P Transducer	
636945	Computer/Alarm Terminal Assembly, 10-Point	
636054	Relay NO (Form A)	
636055	Relay NC (Form B)	
876383	Mercury Relay (Wetted)	
634455	Air Purge Accessory	
	Jumper Strap-Valve B To: Stream , Cal	1
	10-POINT STREAM SELECTOR	
635200	Stream Selector	
639807	24V Power Supply ____ DC or ____ AC	
639808	120 VAC Power Supply	
637480	24 VDC Solenoid Driver	
635297	VAC Solenoid Driver	

COMMENTS

FUNCTION		LOCATION	
Come Read (Hg)	K1		
RESET (Hg)	K2		
START (Hg)	K3		
		NO	NC
Hi Alarm	K4		
Low Alarm	K5		
In Service	K6		
Calibration Standard	K7		
Stream 1	K8		
Stream 2	K9		
Stream 3	K10		
Stream 4	K11		
Stream 5	K16		
Stream 6	K17		
Stream 7	K15		
Stream 8	K12		
Stream 9	K14		
Stream 10	K13		

*Blank Space Indicates None Supplied

FORM A22-28.81.1 PRINTED IN U.S.A.

6710 DATA SHEET

MODEL 6710 ANALYZER OPTIONS

CUSTOMER Lord Electric P.O. 26715 PI/IP 26715-01
CITY/STATE Paramount, CA TAG NO. DATE 11/27/81

Part No.	Description	Quantity (1)
634423	TC Detector, Hytempco	1
634424	TC Detector, Tungsten	
640324	TC Electronics	1
640330	HF Electronics	
640362	HF Detector	
635449	Solder Plugs 96°C	
634436	Solder Plug, 146° C	1
634437	Solder Plug, 232° C	
640366	Regulator Assembly	
640364	Gauge Kit	
640380	Solenoid Kit, one	
640381	Solenoid Kit, two	1
640382	Solenoid Kit, three	
640383	Solenoid Kit, four	
Mounting		
635477	Mounting Straps	
640386	Carrier Gas Safety Kit	1
634737	Free Standing Rack	1
635430	External Wiring, Analyzer	
635420	External Wiring, Sample System	
635478	Tie Kit	
23627	S.S. Tags	

COLUMN CONFIGURATION P/N 635101
COLUMN PACKAGE NO. CUSTOM APPLICATION ENGINEERING Yes

	Valve P/N					Sample		
	633560 Teflon	635032 Metal 10 Port	635480 Special	640350 Metal 6 Port	Insert P/N	Vapor	Liquid	Size
Valve A			X		632063	X		200 ul
Valve B								
Valve C								
Valve D								

(1) Blank Space Indicates None Supplied

MODEL 6710 PROGRAMMER - PLUG-IN CIRCUIT BOARD SETTINGS

CUSTOMER Lord Electric P.O. 26715 PI/IP 26715-01
CITY/STATE Paramount, CA TAG NO. ______ DATE 11/27/81

BOARD NO. DUAL VALVE/FUNCTION SELECT P/N 640915

I VALVE SAMPLE INJECT
TIME ON 012 SEC.
TIME OFF 084 SEC.

VALVE NO.			
A	B	C	D
X			

STREAM TRIGGER
YES ______
NO X

II VALVE NOT USED
TIME ON 900 SEC.
TIME OFF 990 SEC.

VALVE NO.			
A	B	C	D
	X		

STREAM TRIGGER
YES ______
NO X

I FUNCTION SELECT P/N 637910 YES ______ NO X
STREAM NO. 1 ___ 2 ___ 3 ___ 4 ___ 5 ___
6 ___ 7 ___ 8 ___ 9 ___ 10 ___

II FUNCTION SELECT P/N 637910 YES ______ NO X
STREAM NO. 1 ___ 2 ___ 3 ___ 4 ___ 5 ___
6 ___ 7 ___ 8 ___ 9 ___ 10 ___

BOARD NO. DUAL VALVE/FUNCTION SELECT P/N 640915

I VALVE
TIME ON ______ SEC.
TIME OFF ______ SEC.

VALVE NO.			
A	B	C	D

STREAM TRIGGER
YES ______
NO ______

II VALVE
TIME ON ______ SEC.
TIME OFF ______ SEC.

VALVE NO.			
A	B	C	D

STREAM TRIGGER
YES ______
NO ______

I FUNCTION SELECT P/N 637910 YES ______ NO ______
STREAM NO. 1 ___ 2 ___ 3 ___ 4 ___ 5 ___
6 ___ 7 ___ 8 ___ 9 ___ 10 ___

II FUNCTION SELECT P/N 637910 YES ______ NO ______
STREAM NO. 1 ___ 2 ___ 3 ___ 4 ___ 5 ___
6 ___ 7 ___ 8 ___ 9 ___ 10 ___

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
EJ-TO-4-301	TFCP-1 Outlet Line E.J.	2.15.1	40P3005132192
EJ-TO-5-302	TFCP-2 Outlet Line E.J.	2.15.1	40P3005132192
EJ-TO-25-305	Boiler Inlet Line E.J.	2.15.1	5132194
EJ-TO-303-307	Boiler Inlet Line E.J.	2.15.1	5132194
EJ-TO-26-306	Boiler Inlet Line E.J.	2.15.1	5132194
EJ-TO-304-308	Boiler Inlet Line E.J.	2.15.1	5132194
EJ-TO-12-303	TFEP-1 Outlet Line E.J.	2.15.1	5132194
EJ-TO-13-304	TFEP-2 Outlet Line E.J.	2.15.1	5132194
EJ-TO-4-314	Subcooler Inlet Line E.J.	2.15.1	5132192
EJ-TO-5-315	Subcooler Inlet Line E.J.	2.15.1	5132192
EJ-TO-4-316	Subcooler Inlet Line E.J.	2.15.1	5132192
EJ-TO-4-317	Subcooler Inlet Line E.J.	2.15.1	5132192
EJ-TO-4-318	Condenser & Subcooler E.J.	2.15.2	5132192
EJ-TO-5-319	Condenser & Subcooler E.J.	2.15.2	5132192
EJ-FP-22-1	Fire Protection	2.15.3	40P7005133247
EJ-FP-22-2	Fire Protection	2.15.3	40P7005133247

2.15 EXPANSION JOINTS

2.15.3 Expansion Joints (Stearns Roger)

2.15.3.1

Identification Tag Number	Description
EJ-CO-15-1	Stearns-Roger Expansion Joints
EJ-FP-22-1	
EJ-FP-22-2	

2.15.3.2 Maintenance Instructions

See following data sheets

Stearns-Roger

EXPANSION JOINTS

P26-6

DOE NO. 40P70010I

ORDER NO. C-21700

CUSTOMER

DEPARTMENT OF ENERGY
10MWe SOLAR PILOT PLANT
DAGGETT CALIFORNIA

REVISION NO.	A	0										
ISSUE DATE	2/7/80	6/20/80										
FOR												
MDAC												
ROCKETDYNE												
SCE												
STMPO												

SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES	SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES
AC	ACID CLEANING			HW	HOT WATER DOMESTIC		
AS	AUXILIARY STEAM			HY	HYDROGEN		
BD	BLOW DOWN			LO	LUBE OIL		
BO	BLOW OUT			MM	MISCELLANEOUS		
BW	BEARING COOLING WATER			MS	MAIN STEAM		
CD	CO2			N	NITROGEN		
CF	CONDENSATE CYCLE FLUSH			NA	INSTRUMENT AIR		
CH	CHEMICAL			OW	OILY WATER DRAINS		
CO	CONDENSATE	0	1	RD	ROOF DRAINS		
CW	CIRCULATING WATER			RW	RAW WATER		
DL	DRAINS TO DAYLIGHT			SA	SERVICE AIR		
DM	DOMESTIC WATER			SP	SPECIAL		
DO	DIESEL OIL			SS	SANITARY SEWER		
DR	PLANT DRAINS			ST	STEAM (INCL TRAPS)		
DW	DEMINERALIZED WATER			SW	SERVICE WATER		
ED	EQUIPMENT DRAINS			TO	THERMAL OIL		
EW	EQUIPMENT COOLING WATER			TW	TREATED WATER		
FP	FIRE PROTECTION	0	1	VT	VENTS (INCL RELIEF VALVES)		
FW	FEEDWATER			WD	WASTE DRAINS		
HC	HEATING CONDENSATE			XW	CHILLED WATER		
HS	HEATING STEAM						

2.15.3-3

REV.	DATE	
0	6-20-80	**Stearns-Roger**
		EXPANSION JOINTS P.6-6 LIST INDEX
		DEPARTMENT OF ENERGY 10MWe SOLAR PILOT PLANT DAGGET, CALIFORNIA
		ORDER NO. C-21700

TAG NO.	INLET SIZE & TYPE	OUTLET SIZE & TYPE	PRESS	TEMP	MAT'L	MISALIGN	EXP	END TO END	REMARKS
EJ-CO-15-1									DELETED

2.15.3-4

Stearns-Roger

EXPANSION JOINT LIST

CUSTOMER DEPARTMENT OF ENERGY

PROJECT 10MWe SOLAR PILOT PLANT

LOCATION DAGGETT, CALIFORNIA

ORDER NO. C-21700 PAGE 1 OF 1

REV	DATE
5	
4	
3	
2	
1	
0	6-20-80

E0.71 1-68

TAG NO.	INLET SIZE & TYPE	OUTLET SIZE & TYPE	PRESS	TEMP.	MAT'L	MISALIGN	EXP	END TO END	REMARKS
EJ-FP-22-1	8" *	8" *	125 PSIG	60°F	CS	**	**	9 5/8"	REF 3150, C.P. #9
EJ-FP-22-2	8" *	8" *	125 PSIG	60°F	CS	**	**	9 5/8"	REF 3150, C.P. #9

* DRESSER COUPLING W/ STYLE 128 FLG ADAPTER
** PIPE OFFSET 7/16", AXIAL PIPE MOVEMENT 3/16" PIPE DEFLECTION

REV	DATE	
5		Stearns-Roger
4		EXPANSION JOINT LIST
3		CUSTOMER DEPARTMENT OF ENERGY
2		PROJECT 10MWe SOLAR PILOT PLANT
1		LOCATION DAGGETT, CALIFORNIA
0	6-20-80	ORDER NO. C-21700 PAGE 1 OF 1

2.15.3-5

E0.71 1-68

Equipment Number	Description	Maintenance Section	P&ID Dwg. Number
FO-CO-201-201	Moisture Accumulator Water P.O.	2.16.1	
FO-ST-1-305	Condenser Steam Bleed O.P.	2.16.2	
FO-ST-1-306	Condenser Steam Bleed O.P.	2.16.2	
FO-ST-203-201	Flash tank Steam O.P. Inlet	2.16.3	
FO-ST-301-301	Condenser Steam Bleed O.P.	2.16.2	
FO-ST-302-302	Condenser Steam Bleed O.P.	2.16.2	
FO-ST-306-304	Condenser Steam Bleed O.P.	2.16.2	
FO-ST-305-303	Condenser Steam Bleed O.P.	2.16.2	
FO-VT-201-201	Flash Tank Steam O.P. Outlet	2.16.2	
FO-VT-301-301	Steam Trap Vent O.P.	2.16.4	
FO-VT-302-302	Steam Trap Vent O.P.	2.16.4	
FO-BD-1-1	Blowdown	2.16.5	40P3005132195
FO-BD-2-2	Blowdown	2.16.5	40P3005132195
FO-DW-4-1	Water Treatment	2.16.5	40P7005133145
FO-FP-31-1	Fire Protection	2.16.5	40P3005133148
FO-FP-31-2	Fire Protection	2.16.5	40P3005133148
FO-FP-33-5	Fire Protection	2.16.5	40P3005133148
FO-FP-33-6	Fire Protection	2.16.5	40P3005133148
FO-SW-8-1	Service Water	2.16.5	40P7005133150

2.16 FLOW ORIFICES

2.16.5 Flow Orifices (Stearns-Roger)

2.16.5.1

Identification Tag Number	Description
FO-BD-1-1	Stearns-Roger Flow Orifices
FO-BD-2-2	
FO-DW-4-1	
FO-FP-31-1	
FO-FP-31-2	
FO-FP-33-5	
FO-FP-33-6	
FO-SW-8-1	

2.16.5.2 Maintenance Instructions

See following data sheets

Stearns-Roger

FLOW ORIFICES
(RESTRICTION)
P26-9

DOE NO. 40P700131

ORDER NO. C-21700

CUSTOMER

DEPARTMENT OF ENERGY
10MWe SOLAR PILOT PLANT
DAGGETT CALIFORNIA

REVISION NO.	A	O	1	2								
ISSUE DATE	5/7/80	6/20/80	9/12/80	12/5/80								
FOR												
MDAC												
ROCKETDYNE												
SCE												
STMPO												

SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES	SYSTEM ABBR.	SYSTEM	SYSTEM REVISION LEVEL	NO OF PAGES
AC	ACID CLEANING			HW	HOT WATER DOMESTIC		
AS	AUXILIARY STEAM			HY	HYDROGEN		
BD	BLOW DOWN	0	1	LO	LUBE OIL		
BO	BLOW OUT			MM	MISCELLANEOUS		
BW	BEARING COOLING WATER			MS	MAIN STEAM	1	1
CD	CO_2			N	NITROGEN		
CF	CONDENSATE CYCLE FLUSH			NA	INSTRUMENT AIR		
CH	CHEMICAL			OW	OILY WATER DRAINS		
CO	CONDENSATE	0	1	RD	ROOF DRAINS		
CW	CIRCULATING WATER			RW	RAW WATER		
DL	DRAINS TO DAYLIGHT			SA	SERVICE AIR		
DM	DOMESTIC WATER			SP	SPECIAL		
DO	DIESEL OIL			SS	SANITARY SEWER		
DR	PLANT DRAINS			ST	STEAM	0	1
DW	DEMINERALIZED WATER	0	1	SW	SERVICE WATER	0	1
ED	EQUIPMENT DRAINS			TO	THERMAL OIL	0	1
EW	EQUIPMENT COOLING WATER			TW	TREATED WATER		
FP	FIRE PROTECTION	0	2	VT	VENTS		
FW	FEEDWATER			WD	WASTE DRAINS		
HC	HEATING CONDENSATE			XW	CHILLED WATER		
HS	HEATING STEAM						

REV.	DATE
△	
△	
△	
△	
1	9-12-80
0	6-20-80

Stearns-Roger

FLOW ORIFICES P26-9
LIST INDEX

DEPARTMENT OF ENERGY
10MWe SOLAR PILOT PLANT
DAGGET. CALIFORNIA

ORDER NO. C-21700

DIVISION USAGE					
MM	P	PI	ME	EL	SP
	X				

Stearns-Roger Corporation

Engineering Standard

Project C-21700

FLOW ORIFICE (RESTRICTION) INSTRUMENT DATA SHEET

ISSUED

REVISED

Tag No	FO-BD-1-1	F[illegible]-BD-2-2
Service	BLOWDOWN	BLOWDOWN
Location	1"-BD-1-FBA	1"-BD-2-FBA
Type	PLATE 304SS	PLATE 304SS
Fluid	CONDENSATE	CONDENSATE
Flow	550 lb/hr	550 lb/hr
Temp	445°F	445°F
Inlet Press	385 PSIG	385 PSIG
Diff Press	2[illegible]2 PSI	262 PSI
Orifice Size	BY SUPPLIER	BY SUPPLIER
System Des. Press	450 PSIG	450 PSIG
End Conn-Size/Type	1" SCH80 RF SW FLANGE	1" SCH80 RF SW FLANGE
Pipe Schedule	ASTM A106 Gr B SCH80	ASTM A106 Gr B SCH80
PLATE THICKNESS	1/4"	1/4"
Remarks		
Supplied By	MECH. CONTRACTOR	MECH. CONTRACTOR
Manufacturer		
Model No		
[illegible] Dwg.	40F[illegible]5132195	[illegible]195
[illegible] Spec.	CONST PKG #9	CONST PKG #9

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
[illegible] Dwg.		
[illegible] Spec.		

DIVISION USAGE						Stearns-Roger Corporation Engineering Standard	Page 1 of 1
	X						
Project C-21700						FLOW ORIFICE (RESTRICTION) INSTRUMENT DATA SHEET	ISSUED REVISED

Tag No	FO-CO-17-1	
Service		
Location	DELETED	
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.	2.16.5-5	

Stearns-Roger Corporation

Engineering Standard

	X				

Page 1 OF 1

Project C-21700

FLOW ORIFICE (RESTRICTION) INSTRUMENT DATA SHEET

ISSUED

REVISED

Tag No	FO-DW-4-1	
Service	WATER TREATMENT	
Location	2" DW-4-BSA	
Type	PLATE-304SS	
Fluid	DEMINERALIZED WATER	
Flow	BY MECH. CONTRACTOR	
Temp	60°F	
Inlet Press	BY MECH. CONTRACTOR	
Diff Press	BY MECH. CONTRACTOR	
Orifice Size	BY MECH. CONTRACTOR	
System Des. Press	[illegible]	
End Conn-Size/Type	2" SCH 40S RF WN FLANGE	
Pipe Schedule	ASTM A312 TP304 SCH 40S	
PLATE THICKNESS	1/4"	
Remarks		
Supplied By	MECH. CONTRACTOR	
Manufacturer		
Model No		
S-R Dwg.	43P7005133145	
S-R Spec.	CONST PKG 9	

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.	2.16.5-6	

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Tag No	FO-FP-31-1	FO-FP-31-2
Service	FIRE PROTECTION	FIRE PROTECTION
Location	½"-FP-31-ACB	[illegible]-FP-31-[illegible]
Type		
Fluid	WATER	WATER
Flow	0 GPM	0
Temp	60°F	60°F
Inlet Press	125 PSIG	125 PSIG
Diff Press		
Orifice Size	3/32"	3/32"
System Des. Press	175 PSIG	175 PSIG
End Conn-Size/Type	½" WROUGHT CU SOLDER JOINT	½" WROUGHT CU SOLDER JOINT
Pipe Schedule	ASTM B88 TYPE K CU	ASTM B88 TYPE K CU
Remarks		
Supplied By	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR
Manufacturer		
Model No		
Dwg.	40P3005133145	40P3005133148
Spec.	CONST PKG #9	CONST PKG #9

Tag No	FO-FP-32-3	FO-FP-32-4
Service	FIRE PROTECTION	FIRE PROTECTION
Location	½"-FP-32-ACB	[illegible]
Type		
Fluid	WATER	WATER
Flow	0 GPM	0 GPM
Temp	60°F	60°F
Inlet Press	125 PSIG	125 PSIG
Diff Press		
Orifice Size	[illegible]	[illegible]
System Des. Press	175 PSIG	[illegible]
End Conn-Size/Type	[illegible]	[illegible]
Pipe Schedule		
Remarks		
Supplied By	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR
Manufacturer		
Model No		
Dwg.	40P3005133148	40P3005133145
Spec.	CONST PKG #9	CONST PKG #9

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Tag No	FO-FP-33-5	FO-FP-33-6
Service	FIRE PROTECTION	FIRE PROTECTION
Location	1/2"-FP-33-ACB	1/2"-FP-33-ACB
Type		
Fluid	WATER	WATER
Flow	0 GPM	0 GPM
Temp	60°F	60°F
Inlet Press	125 PSIG	125 PSIG
Diff Press		
Orifice Size	3/32"	3/32"
System Des. Press	175 PSIG	175 PSIG
End Conn-Size/Type	1/2" WROUGHT CU SOLDER JOINT	1/2" WROUGHT CU SOLDER JOINT
Pipe Schedule	ASTM B88 TYPE K CU	ASTM B88 TYPE K CU
Remarks		
Supplied By	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR
Manufacturer		
Model No		
S-R Dwg.	[illegible]	40P2005123148
S-R Spec.	CONST PKG #9	CONST PKG #9

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		

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Tag No	FO-MS-11-1	
Service		
	DELETED	
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
PLATE THICKNESS		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.	2.16.5-9	

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Tag No	FO-ST-13-1	FO-ST-14-2
Service		
	DELETED	DELETED
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
PLATE THICKNESS		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		

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Tag No	FO-SW-8-1	
Service	SERVICE WATER	
Location	3" SW-8-48A	
Type	PLATE - 304 SS	
Fluid	RAW WATER	
Flow	700 GPM	
Temp	100°F	
Inlet Press	40 PSIG	
Diff Press		
Orifice Size		
System Des. Press	100 PSIG	
End Conn-Size/Type	3" SCH80 FFSW FLANGE	
Pipe Schedule	ASTM A106 GrB SCH 80	
PLATE THICKNESS	1/4"	
Remarks		
Supplied By	MECHANICAL CONTRACTOR	
Manufacturer		
Model No		
[redacted] Dwg.	40P7025133150	
[redacted] Spec.	CONST PKG 9	

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.	2.16.5-11	

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Tag No	FO-TO-27-1	
Service		
	DELETED	
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
PLATE THICKNESS		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		

Tag No		
Service		
Location		
Type		
Fluid		
Flow		
Temp		
Inlet Press		
Diff Press		
Orifice Size		
System Des. Press		
End Conn-Size/Type		
Pipe Schedule		
Remarks		
Supplied By		
Manufacturer		
Model No		
S-R Dwg.		
S-R Spec.		