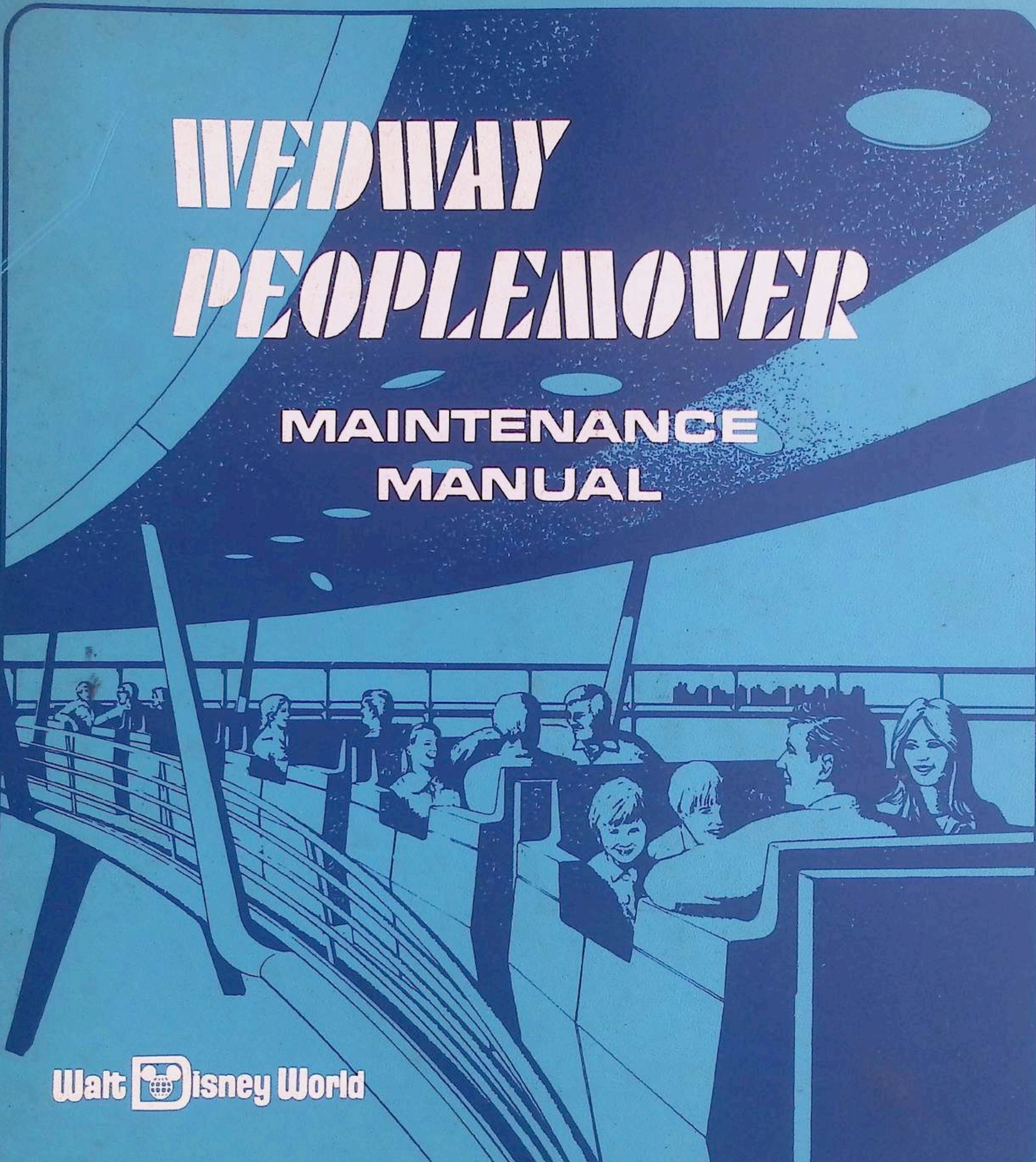
WEDWAY PEOPLEMOVER

MAINTENANCE MANUAL



Walt Disney World

Cwright

WALT DISNEY WORLD
JAN 1 6 1978
MATERIAL CONTROL

WALT DISNEY WORLD
JAN 1 6 1978
MATERIAL CONTROL

WEDWAY PEOPLEMOVER

WALT DISNEY WORLD

MAINTENANCE MANUAL

INTRODUCTION

This document has been prepared to aid in preventive and corrective maintenance of the WEDWAY Peoplemover.

Information contained in this manual represents the latest engineering and vendor data available at the time of publication and will be updated on a periodic or "as required" basis.

Monte Hoult
Monte Hoult
Mapo Technical Publications

Approved: Morris Y. Houser

Approved: [signature]

Approved: R. D. Snyder

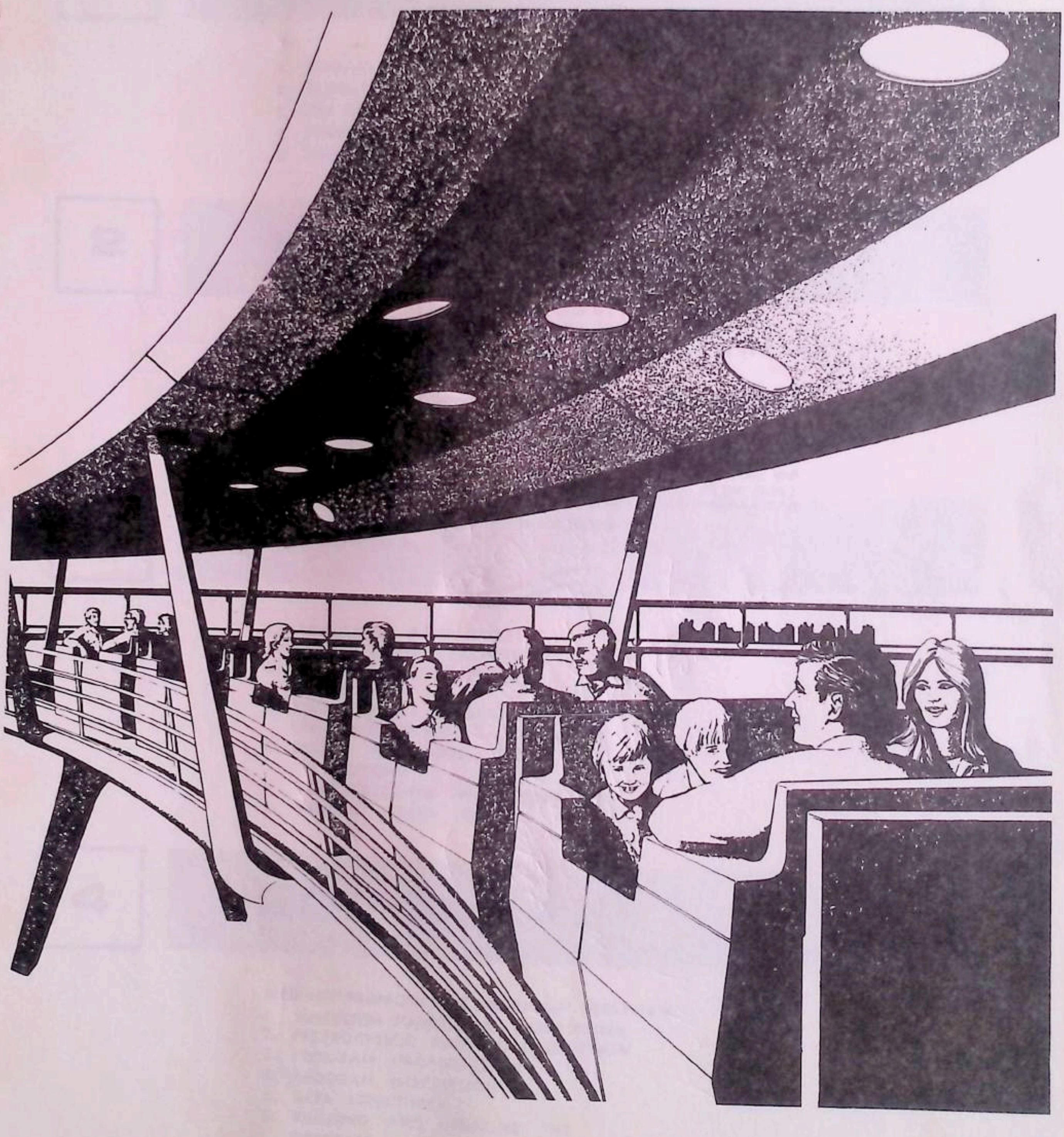
Approved: [signature]

Distribution: November, 1977

WDW -	Mo Bone	1	
	Ted Crowell	1	
	Neil Gallagher	1	
	Tim Kelley	1	
	Vince Lucchese	1	
	Howard Roland	1	
	Jon Sinkinson	10	
	Jim Verity	6	
	Material Control	1	
WED -	Dave Snyder	1	
	Coordination	1	
	Library	1	

MAPO -	Ken Ball	2	
	Mel Black	1	
	Bob Booth	1	
	Jerry Chavalas	1	
	Bob Develle	2	
	Bill Gibson	1	
	Roy Gygi	1	
	Monte Hoult	1	
STUDIO -	Dave Smith	1	

WEDWAY PEOPLEMOVER



PRODUCED by

WED/MAPO TECHNICAL PUBLICATIONS

NOTICE

The data in this document incorporates proprietary rights of

WED ENTERPRISES

1401 FLOWER ST. – GLENDALE, CALIFORNIA 91201

Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others, without the consent of WED Enterprises.

© 1977 WED ENTERPRISES

TABLE of CONTENTS

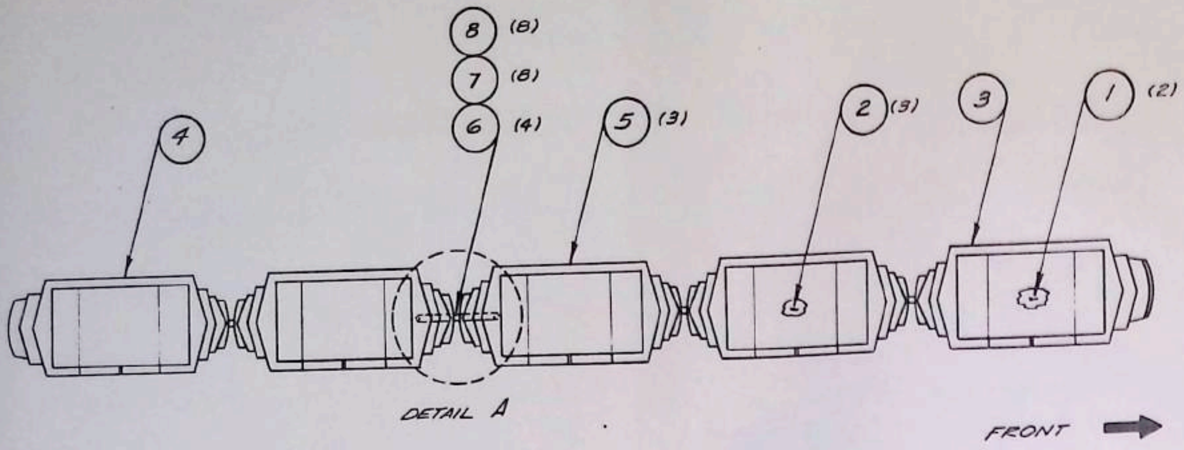
SECTION 1

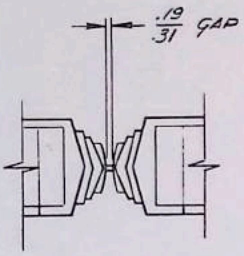
MECHANICAL

SECTION 1

TABLE OF CONTENTS

1. VEHICLES

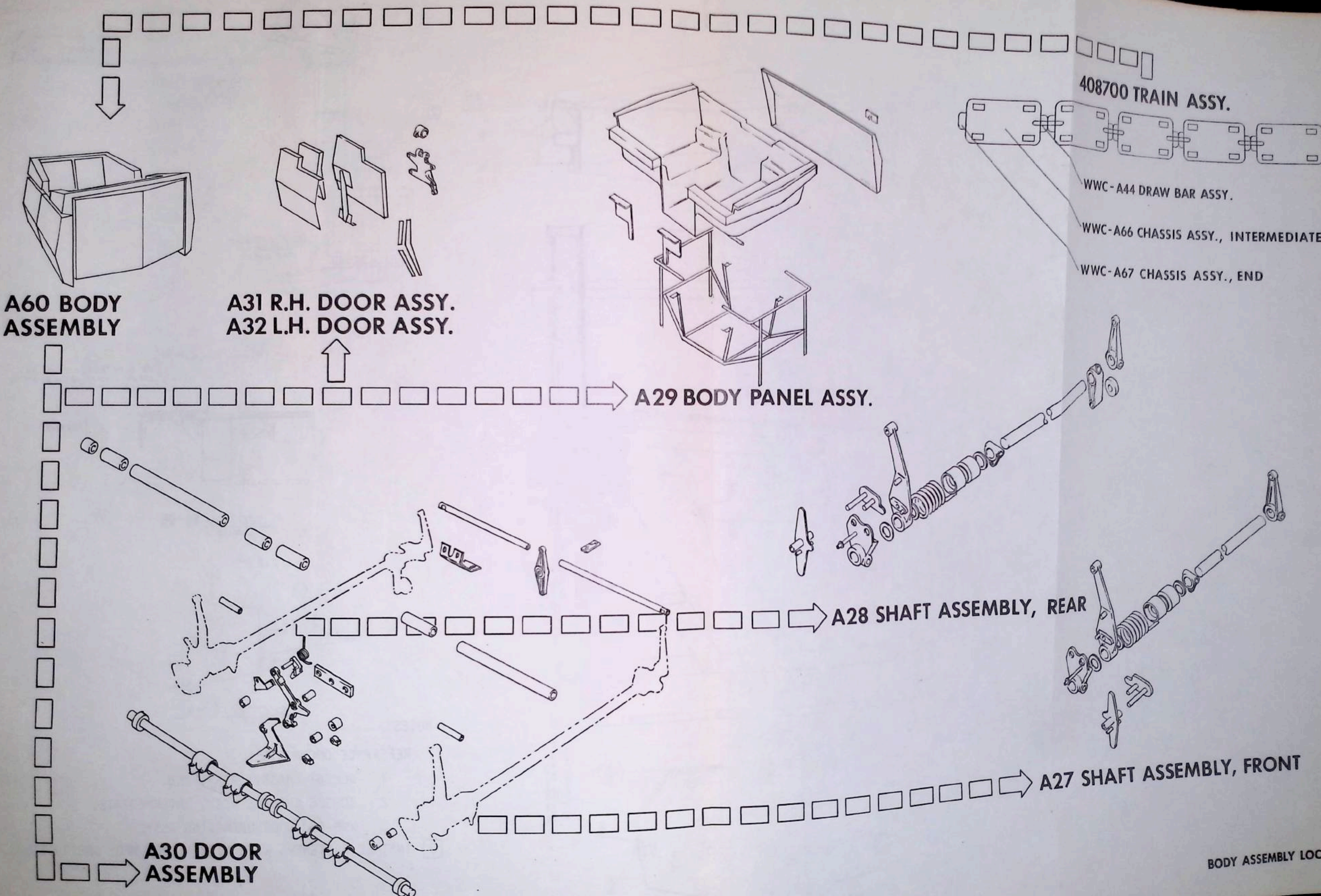




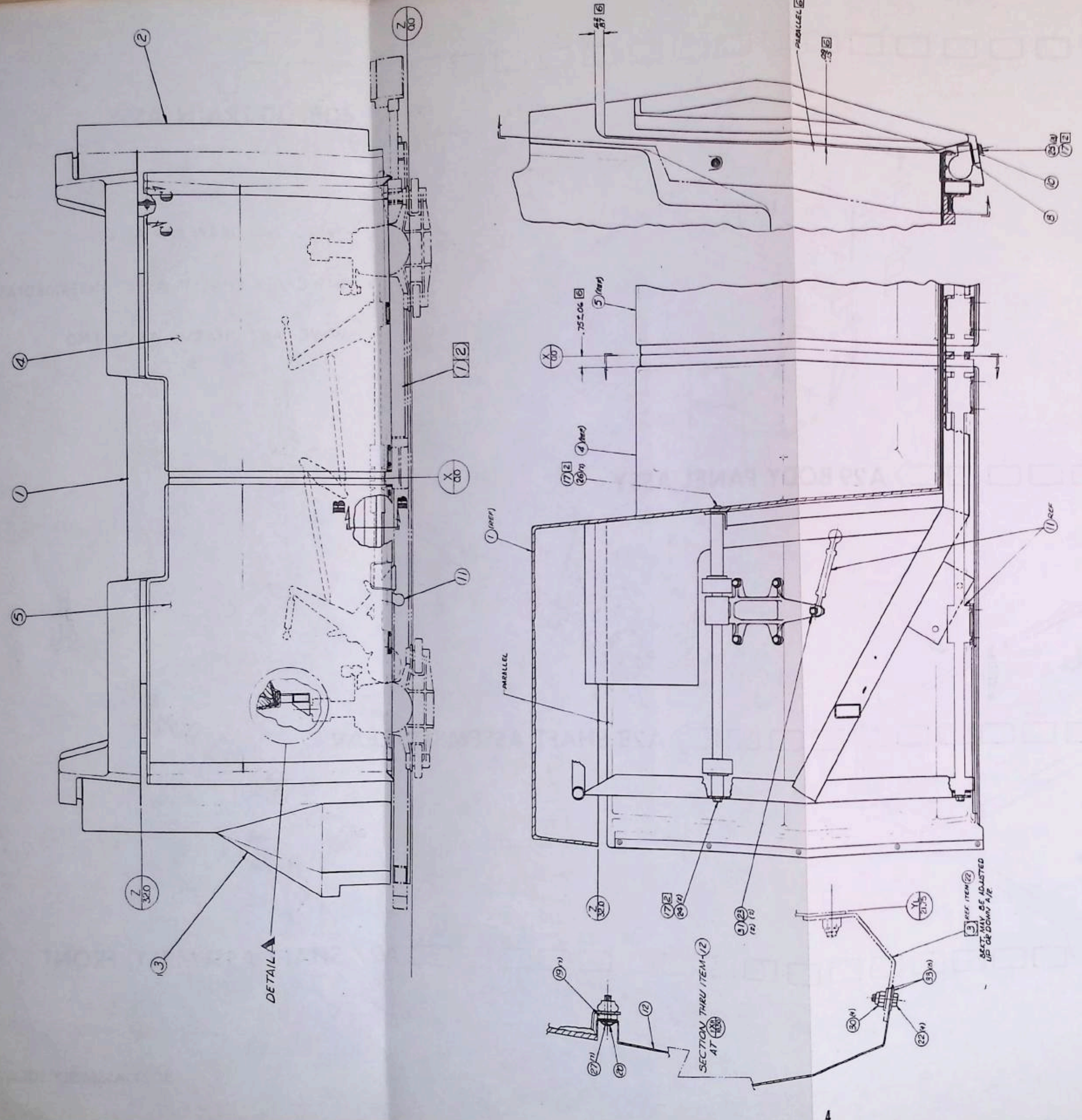
DETAIL A

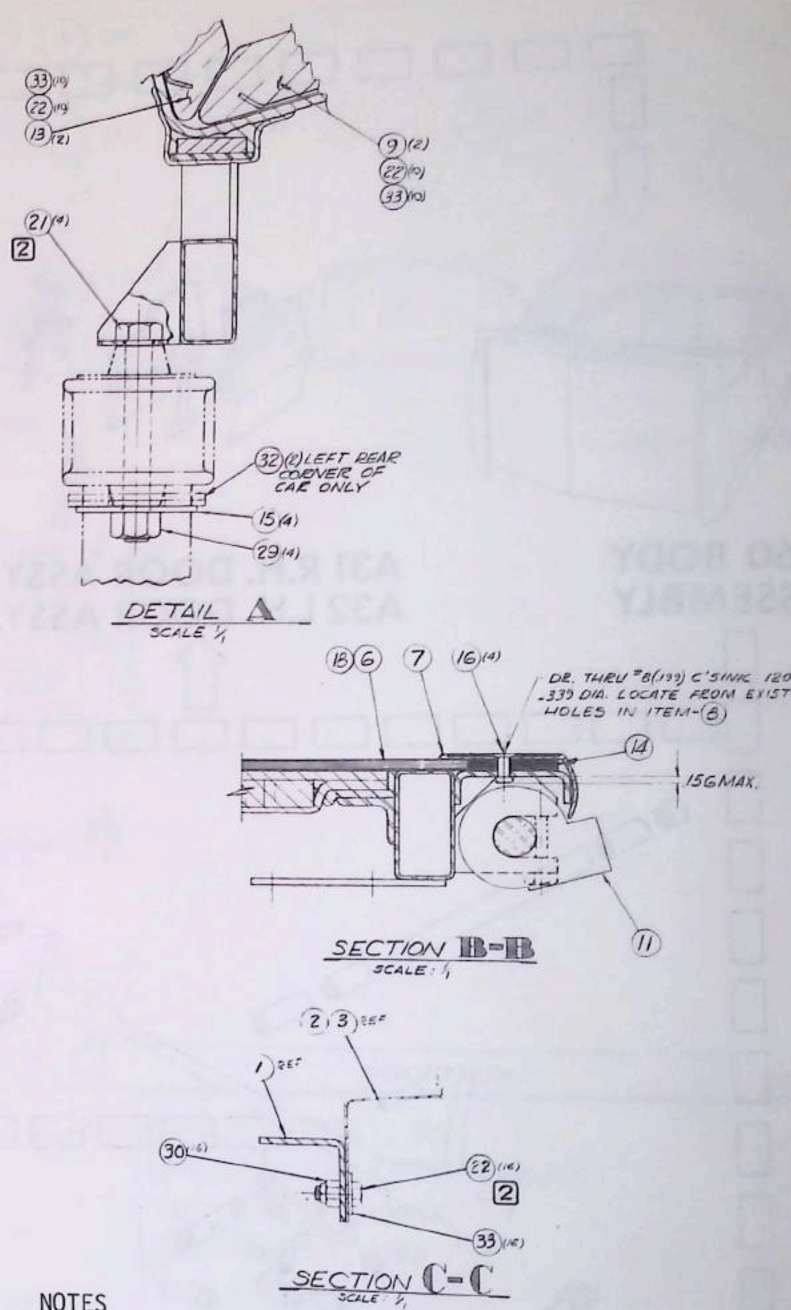
ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY
1.		WWC-A67	CHASSIS ASSEMBLY, END	2
2.		WWC-A66	CHASSIS ASSEMBLY, INTERMEDIATE	3
3.		WWB-A60	BODY ASSEMBLY, FRONT	1
4.		WWB-A60	BODY ASSEMBLY, REAR	1
5.		WWB-A60	BODY ASSEMBLY	3
6.		WWC-A44	DRAWBAR ASSEMBLY	4
7.		AN10-20A	BOLT	8
8.		AN365-1018	NUT	8

408700
TRAIN ASSEMBLY



BODY ASSEMBLY LOC





NOTES

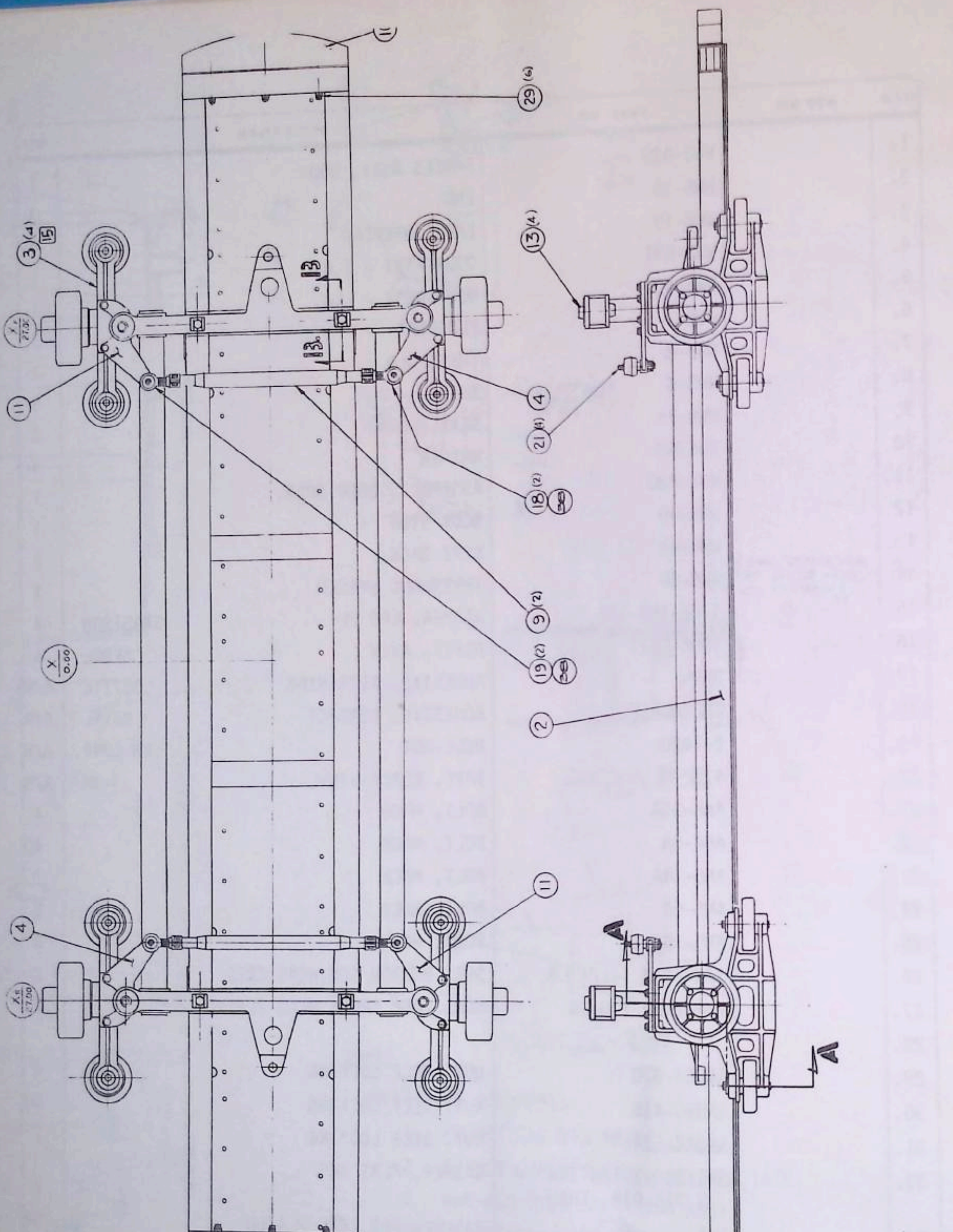
1 REFERENCE DOCUMENTS:

1. 408367 CHASSIS ASSY, END.
2. 408366 CHASSIS ASSY, INTERMEDIATE.
3. WWB-A30 DOOR OPERATING ASSY.

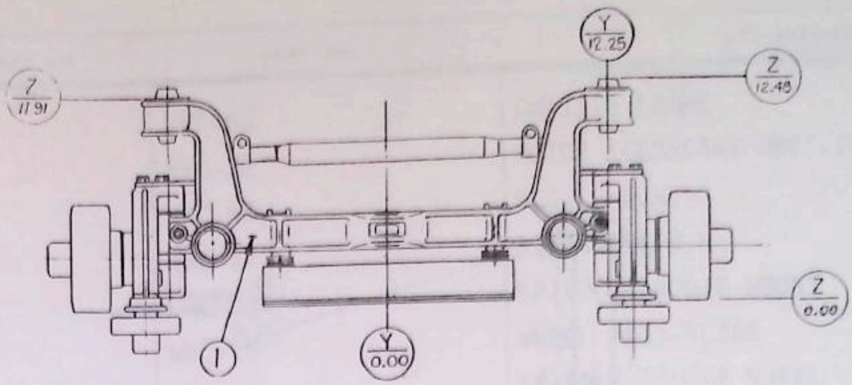
[2] INSTALL FASTENERS WITH ITEM-17 PER MFG. INSTRUCTION

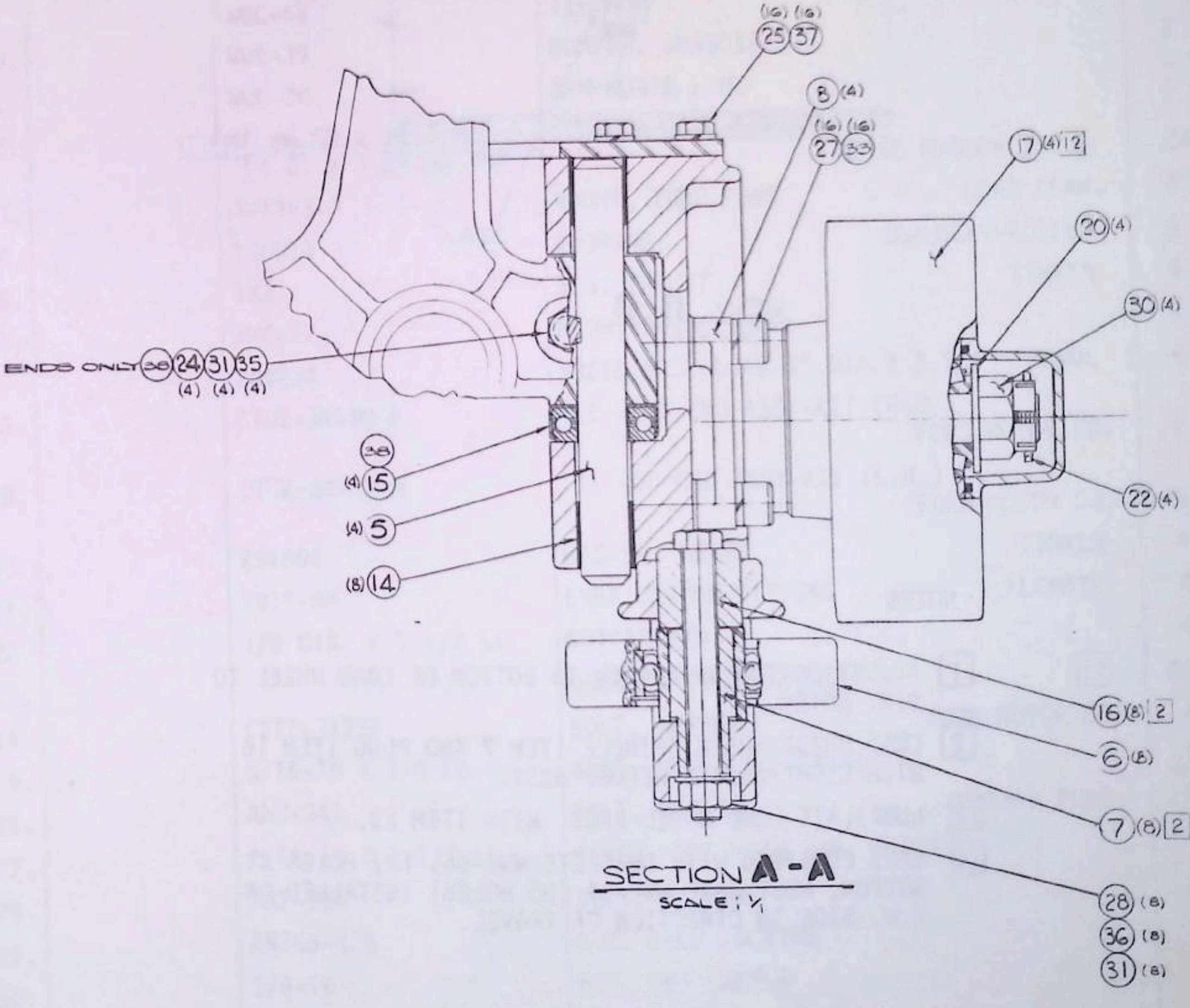
WWB-A60
BODY ASSEMBLY

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWB-A29	PANELS ASSY, BODY		1
2.		WWB-35	END		3
3.		WWB-19	END, INTERCAR		4
4.		WWB-A31	DOOR ASSY - R.H.		1
5.		WWB-A32	DOOR ASSY - L.H.		1
6.		WWB-7	FLOORMAT		1
7.		WWB-8	THRESHOLD		1
8.		WWB-6	SHIM		5
9.		WWB-74	SEAT		2
10.		206348	WASHER		4
11.		WWB-A30	ASSEMBLY, DOOR OPER.		1
12.		WWB-40	BODY SIDE		1
13.		WWB-81	SEAT BACK		2
14.		WWB-89	THRESHOLD SPACER		1
15.		5702-168-125	WASHER, CAD PL	SEASTROM	4
16.		1604-0621	RIVET, AVEX	AVDEL	4
17.		242	ADHESIVE, RETAINING	LOCTITE	A/R
18.		GREENGRIP	ADHESIVE, CONTACT	ROYAL	A/R
19.		D-1420	WELL-NUT	USM CORP.	A/R
20.		471	TAPE, BLACK VINYL	3M	A/R
21.		AN8-35A	BOLT, MACH		4
22.		AN4-6A	BOLT, MACH		40
23.		AN5-14A	BOLT, MACH		2
24.		AN6-5A	BOLT, MACH		2
25.		AN5-10A	BOLT, MACH		8
26.		3/8-24 X 1-1/4 LG	SCR. BUTTON SOC HEAD CRES		2
27.		1/4-20 X 1.0 LG	SCR., REC TRUSS HEAD PLATED		7
28.					
29.		AN364-820	NUT, SELF LOCKING		4
30.		AN365-428	NUT, SELF LOCKING		20
31.		AN365-524	NUT, SELF LOCKING		2
32.		2-1/2SQ X 1/8 THK. X 7/8 DIA. THRU	WASHER, FLAT ABS		2
33.		1/4	WASHER, FLT. CAD PLATED		44

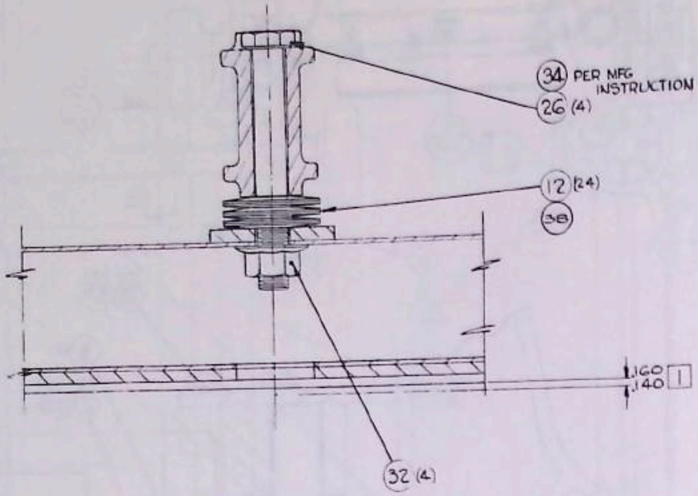


WWC-A66
CHASSIS ASSEMBLY, INTERMEDIATE
SHEET 1 of 3





SECTION A-A
SCALE: 1/1



VIEW B-B
SCALE: 1/1

NOTES

[1] ADJUST BOTTOM OF PLATEN TO BOTTOM OF LOAD WHEEL TO DIM. NOTED.

[2] COAT GUIDE WHEEL SPINDLE ITEM 7 AND PLUG ITEM 16 WITH LIGHT GREASE BEFORE ASSY.

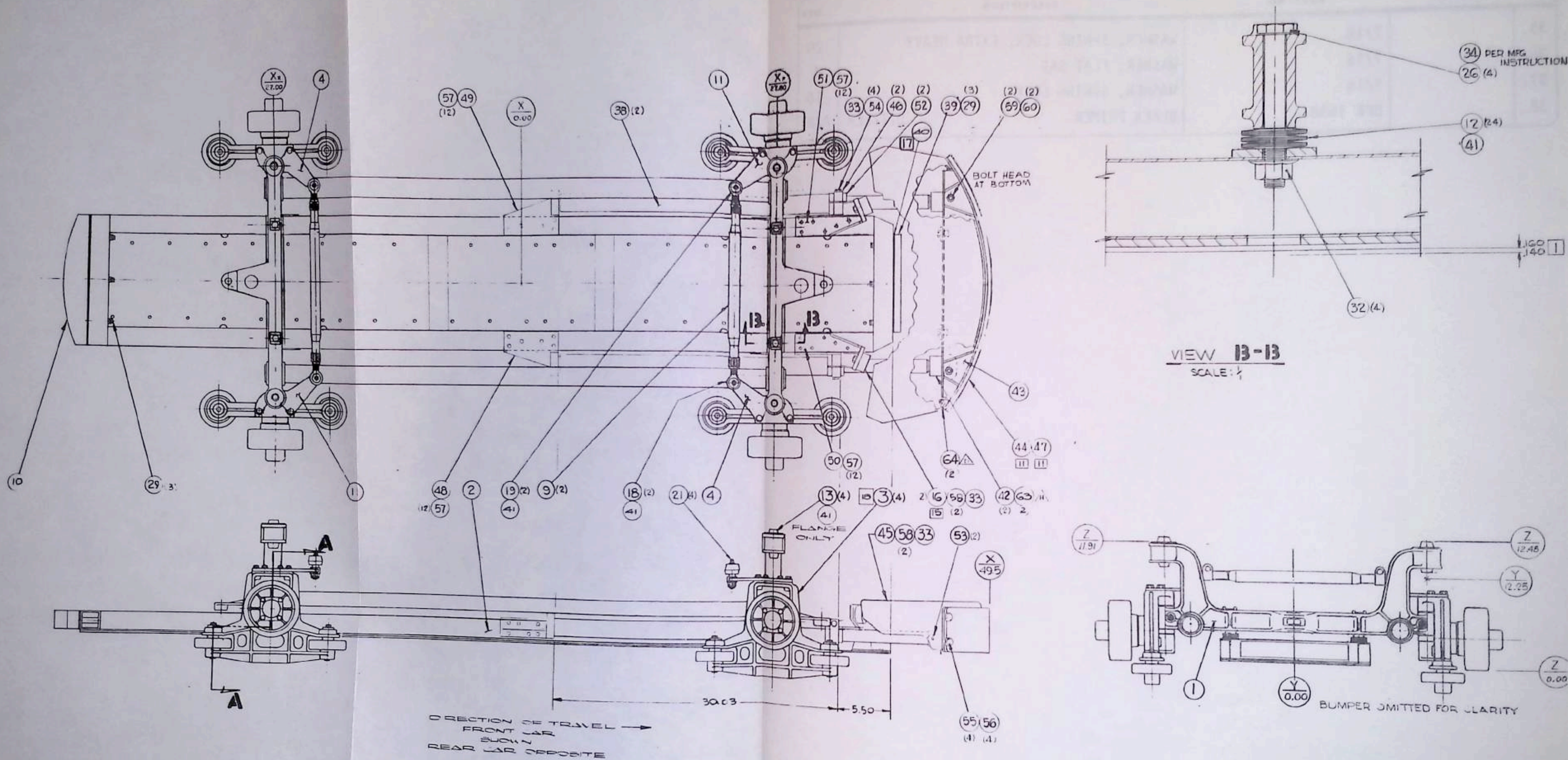
[12] LUBRICATE LOAD WHEEL BRGS. WITH ITEM 23.

[15] CARS EQUIPPED WITH OBSOLETE WWC-56, (2) HOLES AT BOTTOM, MUST HAVE WWC-55 (NO HOLES) INSTALLED ON R.H. SIDE IN DIRECTION OF TRAVEL.

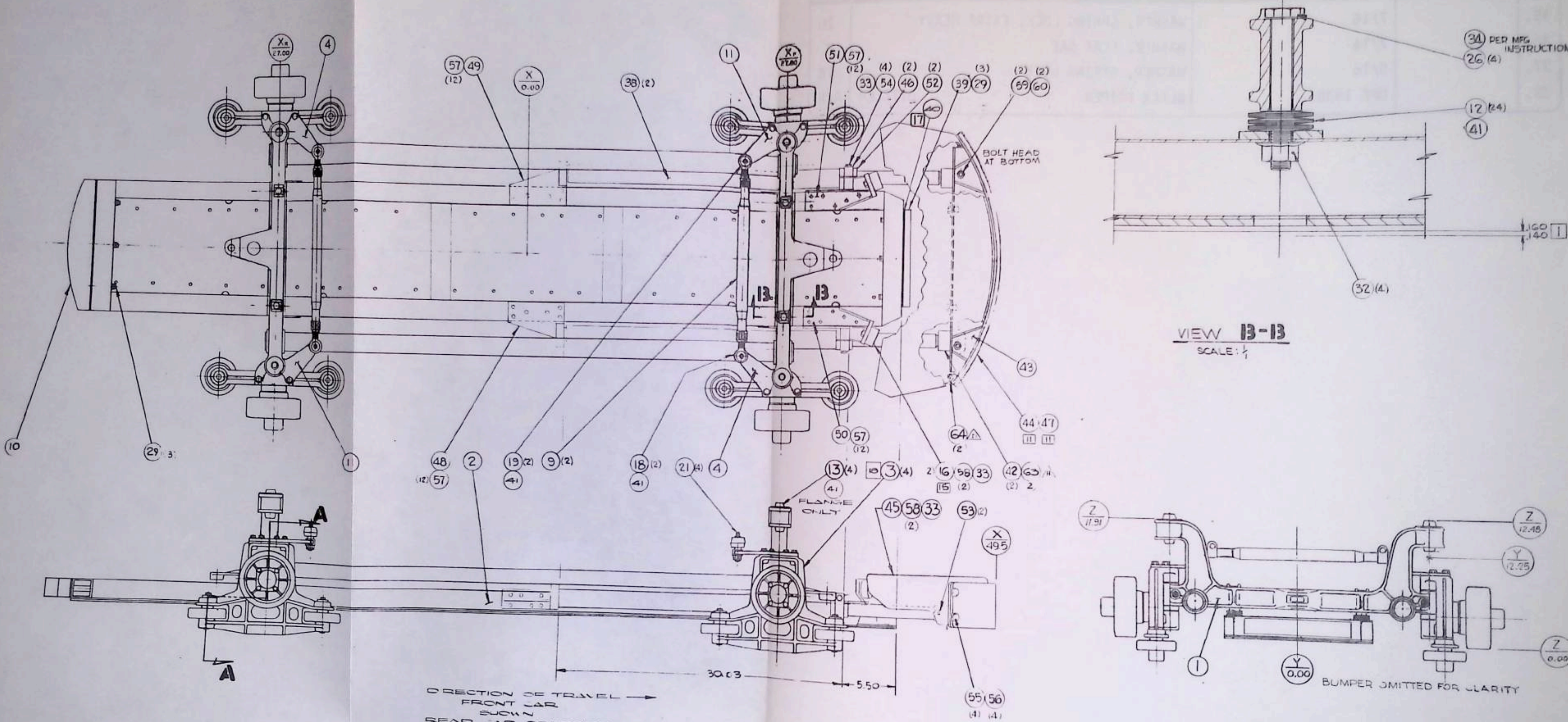
ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		WWC-63	CHASSIS FRAME	1
2.		WWC-32	MOTOR SECONDARY UNIT-INTERMEDIATE	1
3.		WWC-55	BOGIE, L.H.	2
4.		WWC-71	ARM-BOGIE R.H.	2
5.		WWC-60	SPINDLE, BOGIE MOUNT	4
6.		WWC-25	WHEEL ASSY-GUIDE	8
7.		WWC-61	SPINDLE, GUIDE WHEEL	8
8.		1830-207821	SPINDLE, LOAD WHEEL	4
9.		WWC-69	TIE ROD	2
10.		WWC-39	BUMPER, CHASSIS	2
11.		WWC-70	ARM-BOGIE L.H.	2
12.		40 mm OD X 14.3 mm I.D. X 1.25 mm THK	SCHNORR DISC SPRING NEISE MODERN TOOLS	24
13.		J-4363-3	MOUNT, TUBE FORM LORD CORP.	4
14.		12DU16	BUSHING GARLOCK-NADELLA	8
15.		T83	BRG. THRUST TIMKEN	4
16.		WWC-62	PLUG, GUIDE WHEEL	8
17.		204234	WHEEL ASSY-LOAD 6" DIA. X 2-1/4 AEROL	4
18.		C1UZ-3A130-A	TIE ROD END ASSY-KIT (R.H.) FORD MOTOR CO.	2
19.		C1UZ-3A131-A	TIE ROD END ASSY-KIT (L.H.) FORD MOTOR CO.	2
20.		K91504	WASHER, KEYED TIMKEN	4
21.		1911-B1	LUBRICATION FITTING ALEMITE	4
22.		1/8 DIA. X 1-1/2 LG	COTTER PIN	4
23.			GREASE, WHEEL BEARING 12	A/R
24.		C2TZ-3122A	BOLT, KEEPER FORD MOTOR CO.	4
25.		5/16-18 X 7/8 LG	BOLT, HEX HEAD, PLATED	16
26.		AN8-34A	BOLT, MACHINE DORMAN PROD.	4
27.		7/16-14 X 1-1/2 LG	SCREW, SOC HEAD CAP, PLATED	16
28.		AN7-37A	BOLT, MACHINE	8
29.		AN365-428	NUT, SELF LOCKING	6
30.		3/4-16	NUT, HEX CASTLE	4
31.		AN365-720	NUT, SELF LOCKING	12
32.		29 LFT1220	NUT, LARGE FLANGE SELF LKG, 1/2-20 MAC LEAN-FOGG	4
33.		WWC-56	BOGIE, R.H.	2
34.		271	ADHESIVE, RETAINING LOCTITE	A/R

WWC-A66
CHASSIS ASSEMBLY INTERMEDIATE
SHEET 1 of 2

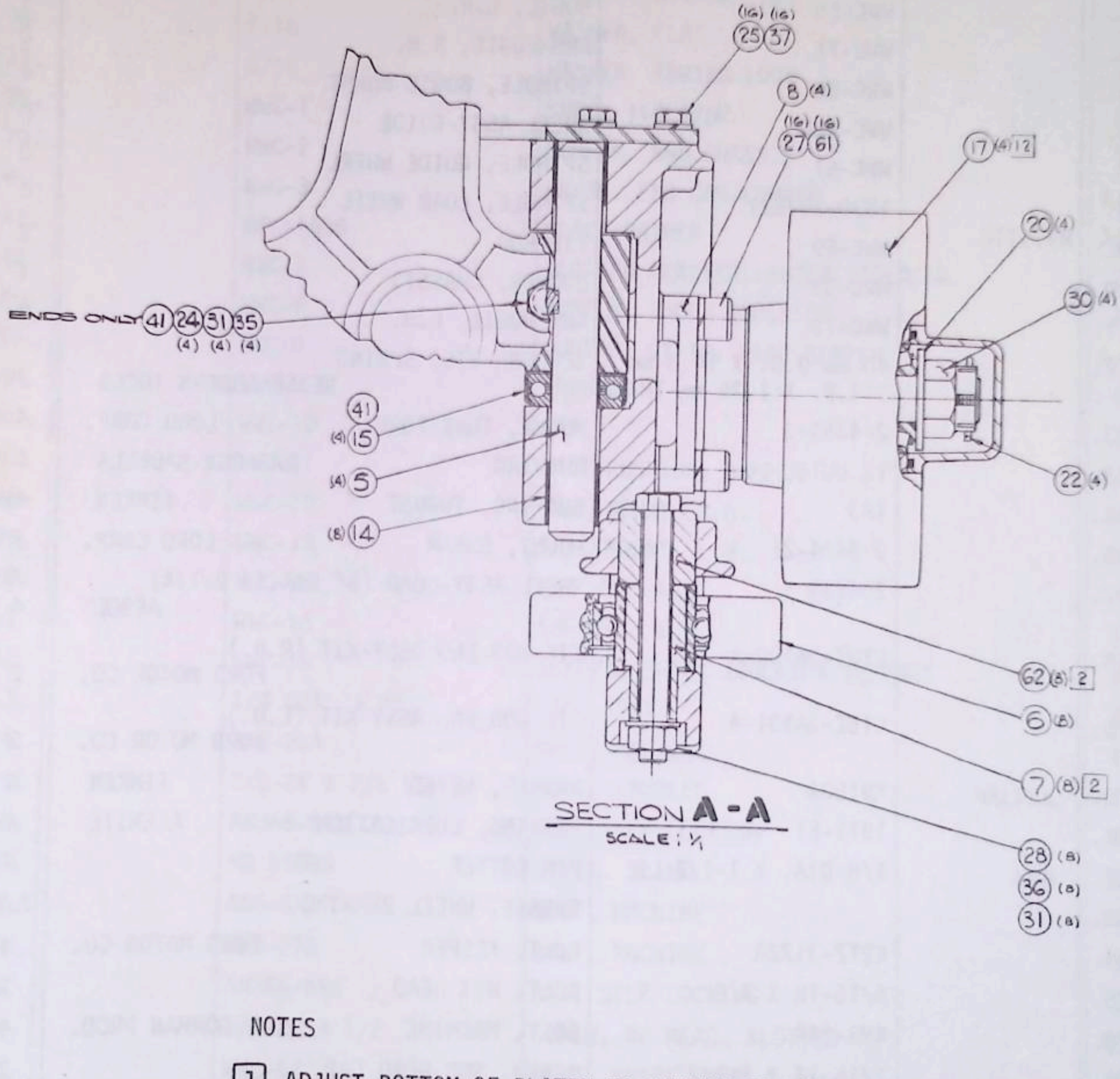
ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
35.		7/16	WASHER, SPRING LOCK, EXTRA HEAVY	20
36.		7/16	WASHER, FLAT SAE	8
37.		5/16	WASHER, SPRING LOCK	16
38.		DPE 1538	BLACK PRIMER DITZLER	A/R



WWC-A67
CHASSIS ASSEMBLY END
SHEET 1 of 2



WWC-A67
HASSIS ASSEMBLY END
SHEET 1 of 2



NOTES

1. ADJUST BOTTOM OF PLATEN TO BOTTOM OF LOAD WHEEL TO DIM. NOTED.
2. COAT GUIDE WHEEL SPINDLE ITEM 7 AND PLUG ITEM 62 WITH LIGHT GREASE BEFORE ASSY.
12. LUBRICATE LOAD WHEEL BRGS. WITH ITEM 23.
15. CUT ITEM 16 INTO (2) EQUAL PIECES.

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		WWC-63	CHASSIS FRAME	1
2.		WWC-33	MOTOR SECONDARY UNIT-INTERMEDIATE	1
3.		WWC-55	BOGIE, L.H.	2
4.		WWC-71	ARM-BOGIE, R.H.	2
5.		WWC-60	SPINDLE, BOGIE MOUNT	4
6.		WWC-A25	WHEEL ASSY-GUIDE	8
7.		WWC-61	SPINDLE, GUIDE WHEEL	8
8.		1830-207821	SPINDLE, LOAD WHEEL	4
9.		WWC-69	TIE ROD	2
10.		WWC-39	BUMPER, CHASSIS	1
11.		WWC-70	ARM BOGIE, L.H.	2
12.		40 mm O.D. X 14.3 mm I.D. X 1.25 mm THK	SCHNORR DISC SPRING NEISE MODERN TOOLS	24
13.		J-4363-3	MOUNT, TUBE FORM LORD CORP.	4
14.		12 DU16	BUSHING GARLOCK-NADELLA	8
15.		T83	BEARING, THRUST TIMKEN	4
16.		J-3424-21	MOUNT, SHEAR LORD CORP.	1
17.		204234	WHEEL ASSY-LOAD (6" DIA. X 2-1/4) AEROL	4
18.		C1UZ-3A130-A	TIE ROD END ASSY-KIT (R.H.) FORD MOTOR CO.	2
19.		C1UZ-3A131-A	TIE ROD END ASSY-KIT (L.H.) FORD MOTOR CO.	2
20.		K91504	WASHER, KEYED TIMKEN	4
21.		1911-B1	FITTING, LUBRICATION ALEMITE	4
22.		1/8 DIA. X 1-1/2 LG	PIN COTTER	4
23.			GREASE, WHEEL BEARING	A/R
24.		C2TZ-3122A	BOLT, KEEPER FORD MOTOR CO.	4
25.		5/16-18 X 7/8	BOLT, HEX HEAD	16
26.		AN8-34A	BOLT, MACHINE DORMAN PROD.	4
27.		7/16-14 X 1-1/2"	SCREW, SOC HEAD CAP	16
28.		AN7-37A	BOLT, MACHINE	8
29.		AN365-428	NUT, SELF LOCKING	6
30.		AN310-12	NUT, HEX CASTLE (3/4-16)	4
31.		AN365-720	NUT, SELF LOCKING	12
32.		29 LFT 1220	NUT, LARGE FLANGE SELF LKG (1/2-20) MAC LEAN-FOGG	4
33.		242	ADHESIVE, RETAINING LOCTITE	A/R

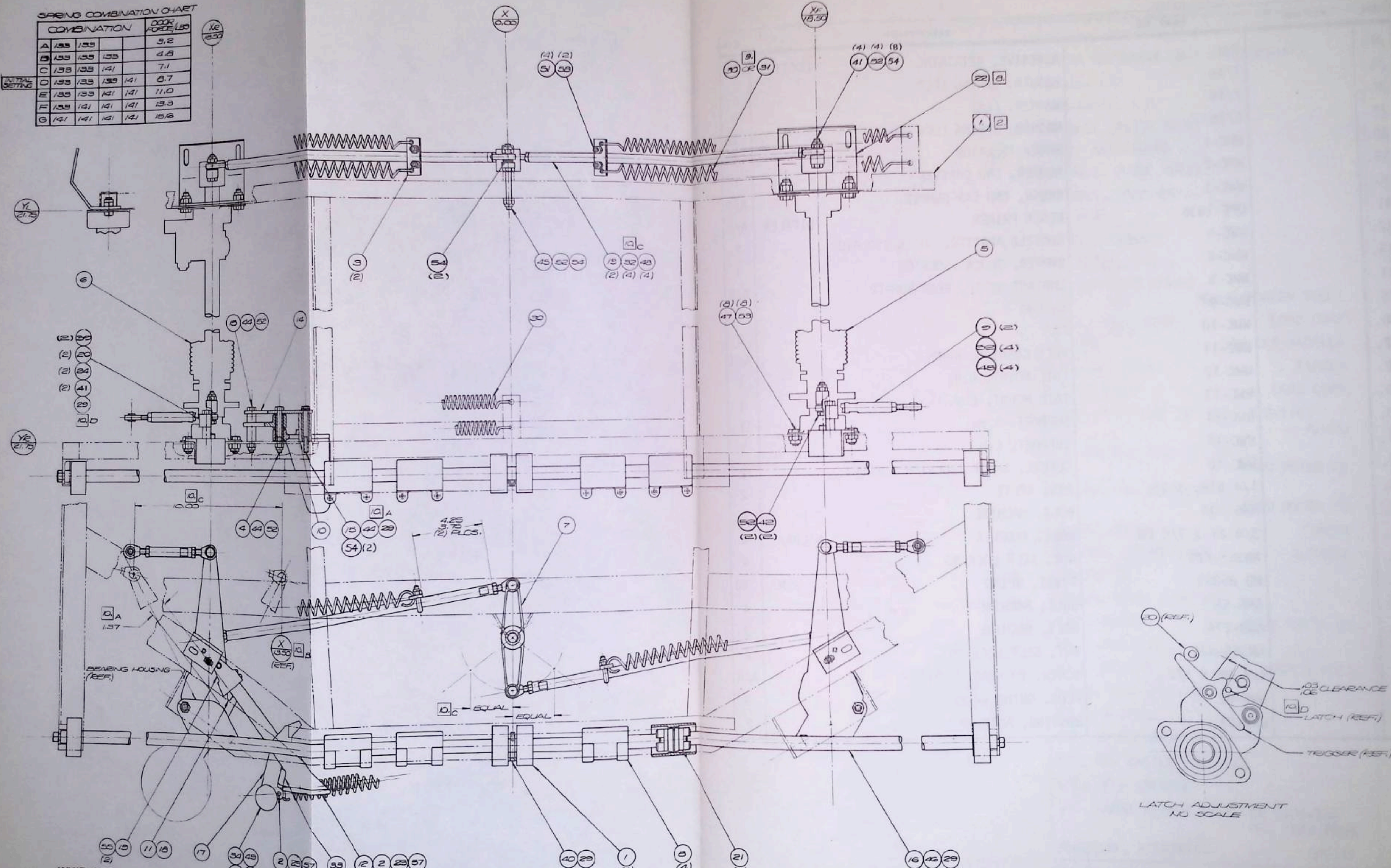
WWC-A67
CHASSIS ASSEMBLY END
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
34.		271	ADHESIVE, RETAINING	LOCTITE	A/R
35.		7/16	WASHER, SPRING LOCK		20
36.		7/16	WASHER, FLAT		8
37.		5/16	WASHER, SPRING LOCK		16
38.		WWC-1	SHOCK ISOLATOR		2
39.		WWC-2	BUMPER, END CHASSIS		1
40.		WWC-3	BRUSH, END CAR-BUMPER		A/R
41.		DPE-1538	BLACK PRIMER	DITZLER	A/R
42.		WWC-5	SLOTTED ADAPTER, SHOCK ISOLATOR		2
43.		WWC-6	BUMPER, SHOCK ISOLATOR		1
44.		WWC-8	CONTACT STRIP, REAR BUMPER		A/R
45.		WWC-9	SHROUD		1
46.		WWC-10	CAP		2
47.		WWC-11	FACE CUSHION, BUMPER		A/R
48.		WWC-12	TAIL MOUNT, R.H.		1
49.		WWC-13	TAIL MOUNT, L.H.		1
50.		WWC-14	SUPPORT, R.H.		1
51.		WWC-15	SUPPORT, L.H.		1
52.		WWC-16	SLEEVE, SHOCK ISOLATOR SUPPORT		2
53.		1/4 DIA. X 2"	PIN, SPLIT		2
54.		AN6-20A	BOLT, MACHINE		4
55.		3/8-24 X 7/8 LG	BOLT, KNURLED	NALPAK	4
56.		AN365-624	NUT, SELF LOCKING		4
57.		MD 850BS	RIVET, BLIND	USM	48
58.		AN6-5A	BOLT, MACHINE		4
59.		AN8-27A	BOLT, MACHINE		2
60.		AN365-820	NUT, SELF LOCKING		2
61.		1/4-28 X 1/2	SCREW, RD HEAD, SLOTTED		A/R
62.		WWC-62	PLUG, GUIDE WHEEL		8
63.		WWC-21	BUSHING, ADAPTER		2

WWC-A67
CHASSIS ASSEMBLY END
SHEET 2 of 2

SPRING COMBINATION CHART

	COMBINATION				DOOR FORCE/LBS
A	133	133			3.2
B	133	133	133		4.8
C	133	133	141		7.1
INITIAL SETTING D	133	133	133	141	8.7
E	133	133	141	141	11.0
F	133	141	141	141	13.3
G	141	141	141	141	15.6



WWB-A30
DOOR OPERATING ASSEMBLY
SHEET 1 of 2

NOTES

[9] REFER TO SPRING COMBINATION CHART. INSTALL AFTER ADJUSTING PER G/N 10.

[10] ADJUSTMENT PROCEDURE:

A. ROTATE ITEM 10 STOP TO OBTAIN 1.37 IN. DIMENSION BETWEEN ITEM 17 LEVER AND BEARING HOUSING ON ITEM 6 ASSY., LOCK SECURELY.

B. MOVE LEVER ON ITEM 6 ASSY. UNTIL CAM FOLLOWER ON ITEM 6 ASSY. DETENTS PAST ITEM 18 PAWL. HOLD LEVER BACK AGAINST PAWL DURING NEXT STEP.

C. ADJUST ITEM 32 ROD ENDS ON ITEM 13 RODS TO POSITION LEVER ON ITEM 5 ASSY. IN THE SAME RELATIVE LOCATION AS LEVER ON ITEM 6 ASSY. AT THE SAME TIME ITEM 7 LEVER MUST MOVE AS SHOWN WHEN ITEM 6 LEVER TRAVELS 10 IN.

D. ROTATE ITEM 20 ADJUSTOR TO OBTAIN CLEARANCE SHOWN BETWEEN TRIGGER AND LATCH ON ITEM 5 AND 6 ASSY., WHEN LEVER ON ITEM 6 ASSY. IS HELD AGAINST ITEM 18 PAWL.

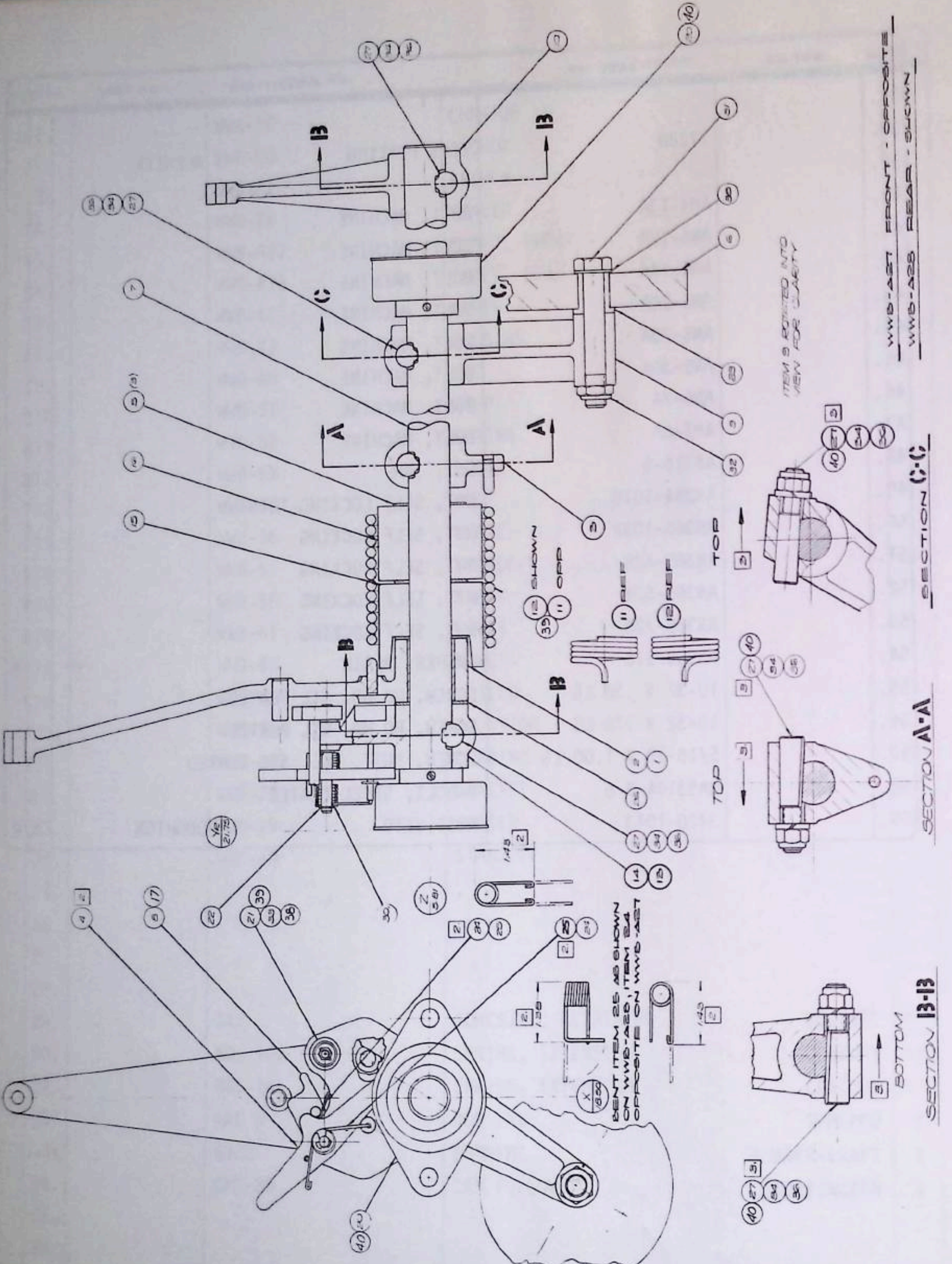
WWB-A30
DOOR OPERATING ASSEMBLY
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWB-16	CUSHION		4
2.		WWB-20	ANCHOR		2
3.		WWB-21	ANCHOR		2
4.		WWB-26	SPACER		1
5.		WWB-A27	SHAFT, FRONT		1
6.		WWB-A28	SHAFT, REAR		1
7.		WWB-42	LEVER		1
8.		WWB-43	HOUSING		4
9.		WWB-48	ROD		2
10.		WWB-51	STOP		1
11.		WWB-52	SPRING		1
12.		WWB-53	PEDAL		1
13.		WWB-55	ROD		2
14.		WWB-56	PLATE		1
15.		WWB-57	STANDOFF		2
16.		WWB-58	SHAFT		1
17.		WWB-61	LEVER		1
18.		WWB-63	PAWL		1
19.		WWB-65	SHIELD		1
20.		WWB-68	ADJUSTOR		2
21.		WWB-A69	BEARING		4
22.		WWB-77	BRACKET		2
23.		WWB-79	SPACER		2
24.		WWB-80	STANDOFF		2
25.					
26.					
27.					
28.					
29.		242	ADHESIVE, RETAINING	LOCTITE	A/R
30.		NO. 133	SPRING, EXTENSION	CENTURY	A/R
31.		NO. 141	SPRING, EXTENSION	CENTURY	A/R
32.		ARE 5	ROD END	SPHERCO	8
33.		4988	BUMPER	RUBBER-CRAFT	1
34.		CRS-26	CAM FOLLOWER	TORRINGTON	1
35.					
36.					

WWB-A30
DOOR OPERATING ASSEMBLY
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
37.					
38.		1728B	ZERK FITTING	ALEMITE	1
39.					
40.		AN4-13A	BOLT, MACHINE		1
41.		AN5-12A	BOLT, MACHINE		4
42.		AN5-14A	BOLT, MACHINE		2
43.		AN5-20A	BOLT, MACHINE		2
44.		AN5-23A	BOLT, MACHINE		3
45.		AN5-30A	BOLT, MACHINE		1
46.		AN6-7A	BOLT, MACHINE		2
47.		AN7-6A	BOLT, MACHINE		8
48.		AN316-5	NUT, JAM		8
49.		AN364-1018	NUT, SELF LOCKING-THIN		1
50.		AN365-1032	NUT, SELF LOCKING		1
51.		AN365-428	NUT, SELF LOCKING		4
52.		AN365-524	NUT, SELF LOCKING		9
53.		AN365-720	NUT, SELF LOCKING		8
54.		AN960-516	WASHER, PLAIN		15
55.		10-32 X .38 LG	SCREW, RD HD, STL PLATED		2
56.		10-32 X .75 LG	SCREW, RD HD, STL PLATED		1
57.		5/16-18 X 1.00 LG	SCREW, BUTT. HD., STL PLATED		2
58.		NAS3104-5-8	U-BOLT, STEEL-PLATED		2
59.		342Q-1043	RUST VETO	HOUGHTON	A/R

WWB-A30
DOOR OPERATING ASSEMBLY
SHEET 2 of 2



WWB-A27/A28
SHAFT ASSY., FRONT—REAR
SHEET 1 of 2

NOTES

[2] ALTER ITEM 24 AND 25 AS SHOWN.

[3] INSTALL ITEM 27 IN DIRECTION AS SHOWN. TORQUE ITEM 34 TO 40 FT-LBS EXCEPT ON ITEM 3, 20-40 FT-LBS.

11 SOLVENT CLEAN AND PAINT ITEM 20 PRIOR TO ASSY, ITEM 27 AFTER ASSY.

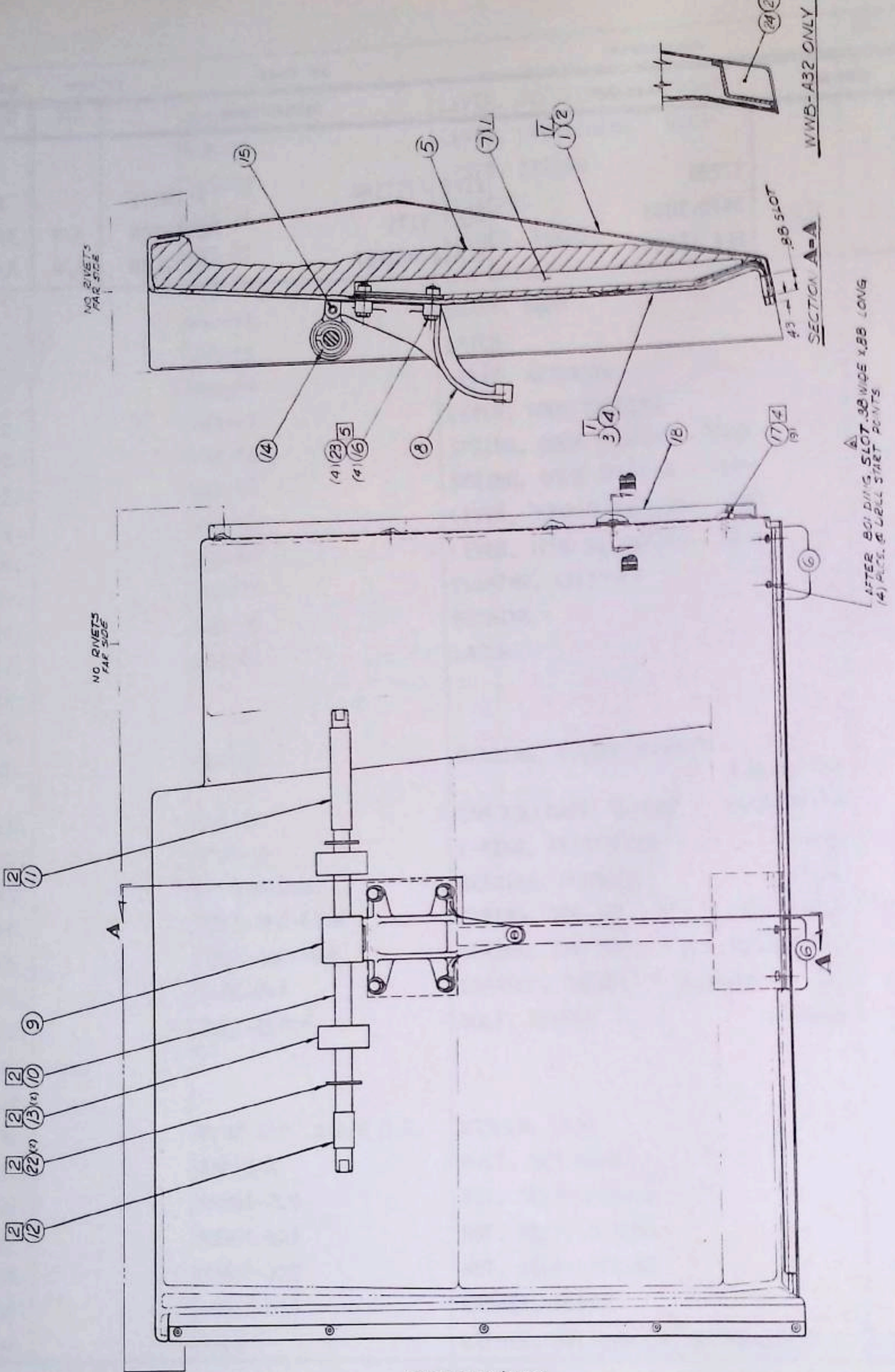
[12] ITEM 5 AND 26 ARE INTERCHANGEABLE.

WWB-A27/A28
SHAFT ASSY., FRONT–REAR
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	A27 QTY	A28 QTY
1.		WWB-10	LEVER, OVERRIDING - FRONT	1	
2.		WWB-11	LEVER, OVERRIDING - REAR		1
3.		WWB-13	LEVER, SPRING	1	1
4.		WWB-14	TRIGGER	1	1
5.		WWB-15	WASHER, THRUST $\boxed{12}$	3	3
6.		WWB-88	CAM WHEEL		1
7.		WWB-45	SHAFT, DOOR	1	1
8.		WWB-66	LATCH	1	
9.		WWB-64	LEVER, ACTUATOR		1
10.		WWB-44	LEVER, DOOR CLOSING	1	1
11.		WWB-46	SPRING, DOOR OPENING - FRNT	1	
12.		WWB-47	SPRING, DOOR OPENING - REAR		1
13.		WWB-49	LEVER, DOOR ACTUATING - FRNT	1	
14.		WWB-50	LEVER, DOOR ACTUATING - REAR		1
15.		WWB-75	BUSHING, RECESSED	1	1
16.		WWB-76	BUSHING	1	1
17.		WWB-67	LATCH		1
18.					
19.					
20.		SRF-16	BEARING, RUBBER MOUNTED SEALMASTER	2	2
21.		CRS-12	CAM FOLLOWER, SEALED TORRINGTON		1
22.		5144-25	E-RING, REINFORCED TRUARC	1	1
23.		CF503D-1000	BEARING, FLANGED ATLAS		1
24.		T048-360-406R	SPRING, TORSION - R.H. ASSOCIATED	1	1
25.		T048-360-406L	SPRING, TORSION - L.H. ASSOCIATED	1	1
26.		T100-7-A	BEARING, THRUST SHAMBAN $\boxed{12}$	1	1
27.		C2TZ-3122A	BOLT, KEEPER FOMOCO	3	4
28.					
29.					
30.		9/32 I.D. X 5/8 O.D.	WASHER, FLAT	1	1
31.		AN8-31A	BOLT, HEX HEAD		1
32.		AN364-820	NUT, SELF-LOCKING		1
33.		AN364-624	NUT, SELF-LOCKING		1
34.		AN365-720	NUT, SELF-LOCKING	3	4
35.		AN960-816	WASHER, PLAIN		1
36.		7/16	WASHER, SPLIT-LOCK, EXTRA HEAVY	3	4

WWB-A27/A28
SHAFT ASSY., FRONT—REAR
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		A28 QTY	A27 QTY
37.						
38.		1728B	ZERK FITTING	ALEMITE		1
39.		342Q-1043	RUST VETO	HOUGHTON	A/R	A/R
40.		DPE 1538	BLACK PRIMER	DITZLER	A/R	A/R



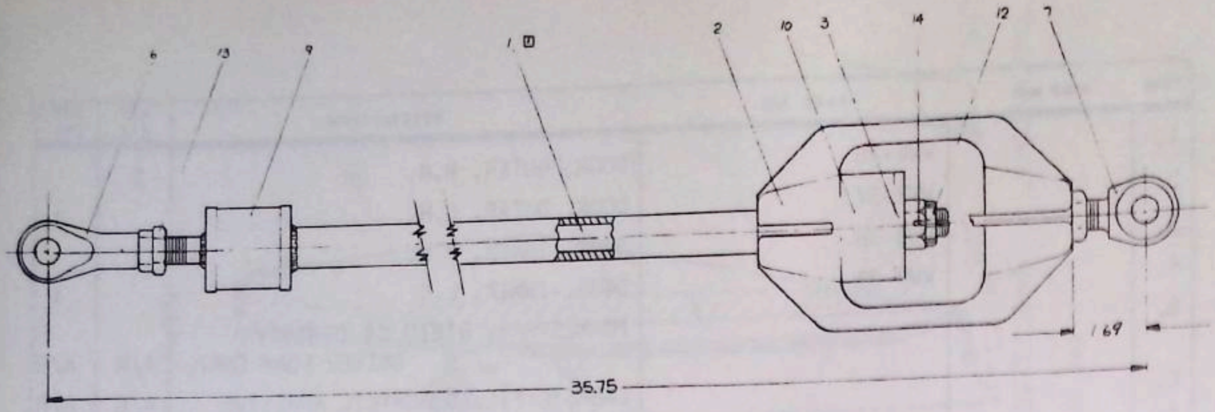
WWB-A31/A32
DOOR ASSEMBLY, R.H.–L.H.
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	A31 QTY	A32 QTY
1.		WWB-36	DOOR, OUTER, R.H.	1	
2.		WWB-37	DOOR, OUTER, L.H.		1
3.		WWB-38	DOOR, INNER, R.H.	1	
4.		WWB-39	DOOR, INNER, L.H.		1
5.			FOAM SPRAY, RIGID 2# DENSITY UNITED FOAM CORP.	A/R	A/R
6.			CABASIC FILLED ACRYLIC ADHESIVE	A/R	A/R
7.		WWB-3	REINFORCEMENT, DOOR	1	1
8.		WWB-4	BRACKET, DOOR	1	1
9.		WWB-17	HOUSING, BEARING, UPPER	1	1
10.		WWB-54	SHAFT, DOOR, UPPER	1	1
11.		WWB-22	SPACER, CLOSE	1	1
12.		WWB-23	SPACER, OPEN	1	1
13.		WWB-16	CUSHION	2	2
14.		WWB-A69	BEARING ASSEMBLY	1	1
15.		3/8 DIA. X 2.0 LG	PIN, SPRING	1	1
16.		AN5-11A	BOLT, MACHINE	4	4
17.		1661-0619	RIVET, AVEX LO-PRO ALUM. AVDEL	7	9
18.		WWB-70	EXTRUSION	1	1
19.		WWB-72	RETAINER	1	1
20.		AD48ABS	RIVET 'POP' USM CORP.	5	5
21.			ADHESIVE, ACRYLIC	A/R	A/R
22.		3/4"	WASHER, FLT, SAE PLATED DORMAN	2	2
23.		242	ADHESIVE LOCTITE	A/R	A/R
24.		WWB-83	CLOSURE		1

NOTES

1. BOND ITEMS 1 THRU 4, 7, 24, WITH ITEM 21.
2. LOOSE ITEMS.
3. PRESS FIT ITEM 14 TO ITEM 9.
5. INSTALL ITEM 16 WITH ITEM 23 PER MFG. DIRECTIONS.

WWB-A31/A32
DOOR ASSEMBLY, R.H.–L.H.
SHEET 2 of 2



NOTES

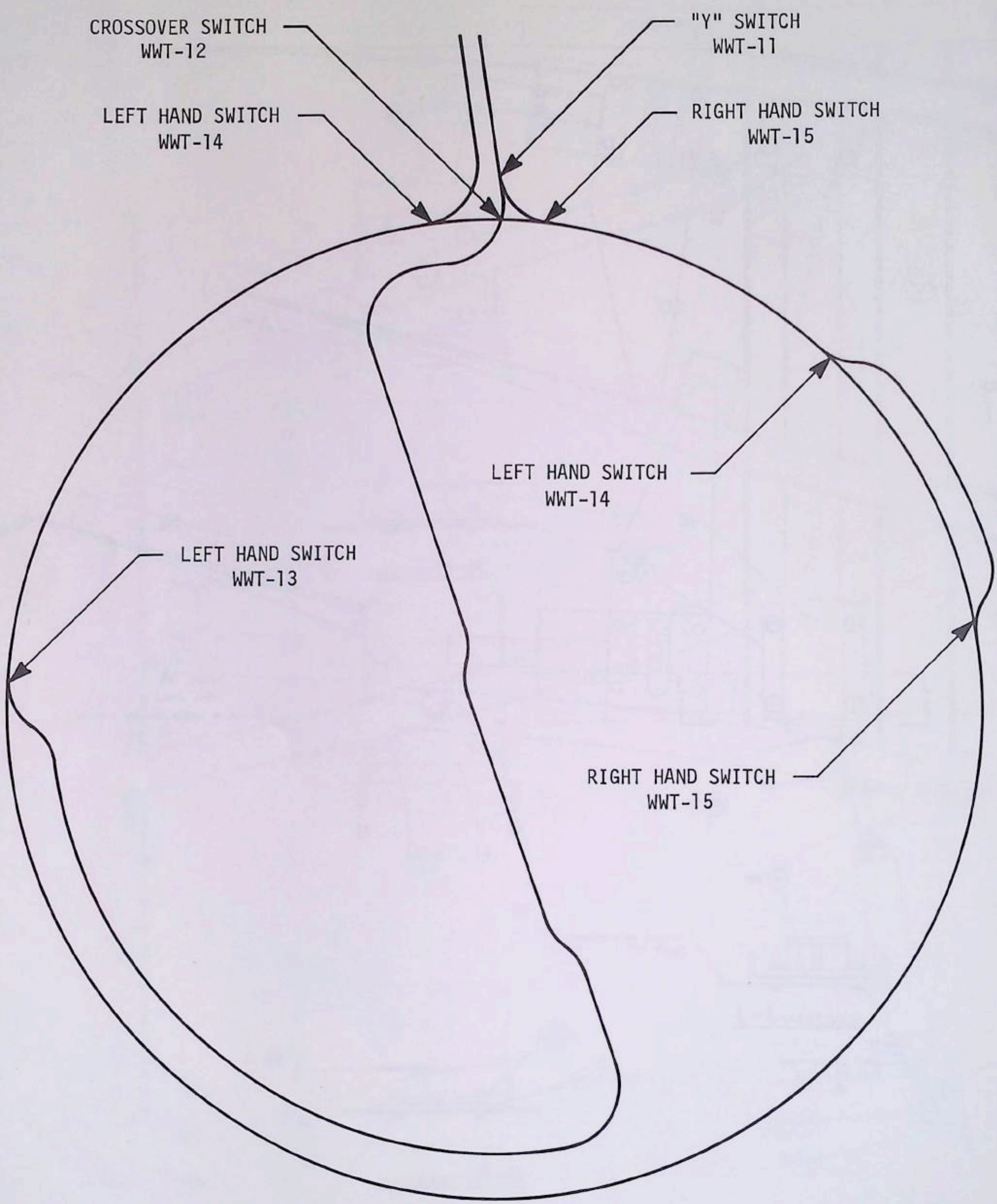
[1] APPLY HEAVY COAT OF MOLYKOTE TYPE G TO O.D. OF ROD ENCLOSED WITHIN TUBE.

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY
1.		WWC-45	ROD [1]	1
2.		WWC-46	BRIDGETUBE	1
3.		WWC-47	WASHER	1
4.				
5.				
6.		TR-10	ROD END, FEMALE SEALMASTER	1
7.		TRE-10	ROD END, MALE SEALMASTER	1
8.				
9.		RS41	RUBBER DIE SPRING VLIER ENGINEERING	1
10.		RS50	RUBBER DIE SPRING VLIER ENGINEERING	1
11.				
12.		AN310-10	CASTELLATED NUT (5/8-18)	1
13.		AN316-10	CHECK NUT (5/8-18)	2
14.		1/8 DIA X 1" LG	COTTER PIN, STEEL	1

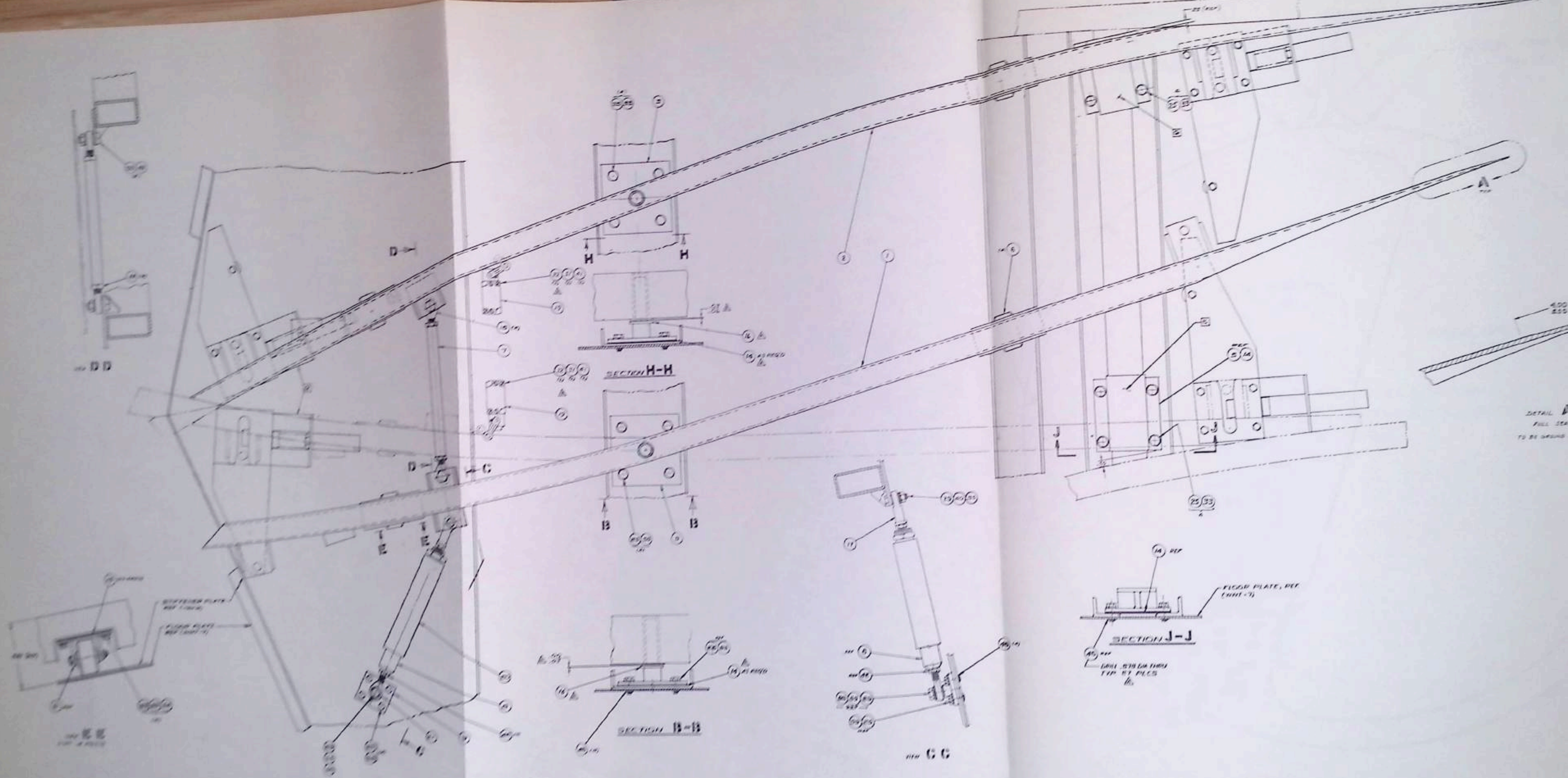
WWC-A44
DRAW BAR ASSEMBLY

2. TRACK SWITCHES

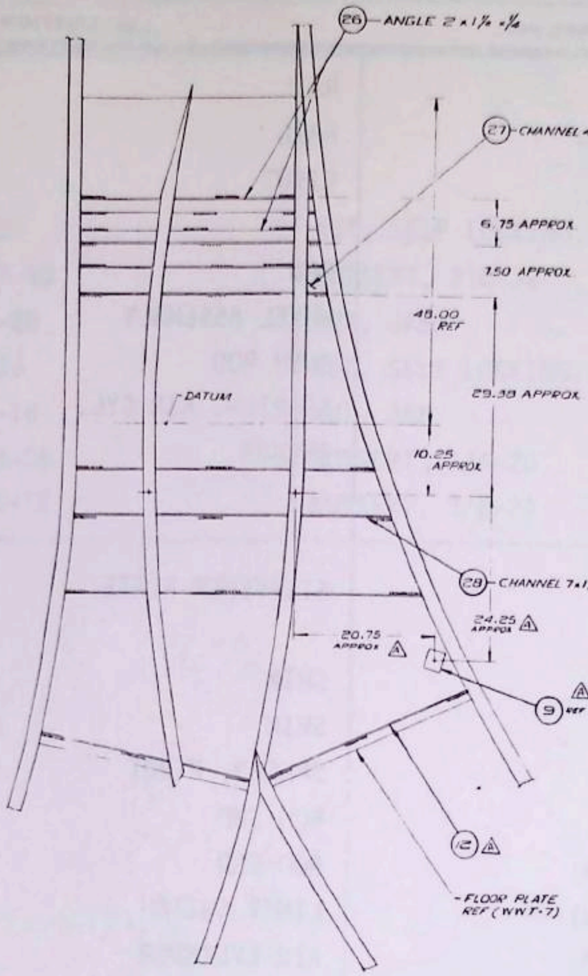
The following six illustrations are assembly drawings of track switch assemblies with accompanying parts lists.



SPACE MOUNTAIN
STORAGE AREA
TRACK SWITCH LOCATOR



WNT-11
SWITCH TRACK ASSEMBLY, INSTALLATION ("Y" SWITCH)
SHEET 1 OF 2



NOTES

6 LUBRICATE PAD SURFACE WITH GULFCROWN EP NO. 1 LUBRICANT.

12 FOR INFORMATION PERTAINING TO LOCKS & PINBAR, SEE DWG WWT-270 SHT 1 & 2.

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWT-16	RAIL		1
2.		WWT-17	RAIL		1
3.		WWT-53	PIVOT		2
4.					
5.		WWT-51	PAD		4
6.		WWT-56	WHEEL ASSEMBLY		4
7.		WWT-36	PUSH ROD		1
8.		WWT-48	ADAPTER, AIR CYL.		1
9.		WWT-47	ANCHOR		1
10.					
11.					
12.		WWT-231	STIFFENER PLATE		1
13.					
14.		WWT-46	SHIM		A/R
15.		WWT-43	SHIM		A/R
16.		WWT-241	SPACER, PIVOT		2
17.		TR-8N	ROD END	SEALMASTER	1
18.		TRE-10N	ROD END	SEALMASTER	2
19.		802T-AW1	LIMIT SWITCH	ALLEN BRADLEY	2
20.		315-DXP	AIR CYLINDER	BIMBA	1
21.		TRE-8N	ROD END	SEALMASTER	1
22.		10-32 X 2"	FILLISTER HD CAP SCREW		4
23.					
24.					
25.		3/8-24 X 1-1/4"	HEX HD CAP SCREW		44
26.		2 X 1-1/2 X 1/4"	ANGLE, 39.00 LG.		2
27.		4 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 40.00 LG.		1
28.		7 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 50.00 LG.		1
29.		1/2-20 X 1-1/2"	HEX HEAD CAP SCREW		2
30.		5/8-18 X 1-5/8"	HEX HEAD CAP SCREW		2
31.		#10	WASHER, SPRING LOCK		4
32.					
33.		3/8	WASHER, SPRING LOCK		44
34.		3/8	WASHER, FLAT		16
35.		1/2	WASHER, FLAT		2
36.		1/2	WASHER, SPRING LOCK		2

WWT-11

SWITCH TRACK ASSY., INSTALLATION ("Y" SWITCH)

SHEET 1 of 2

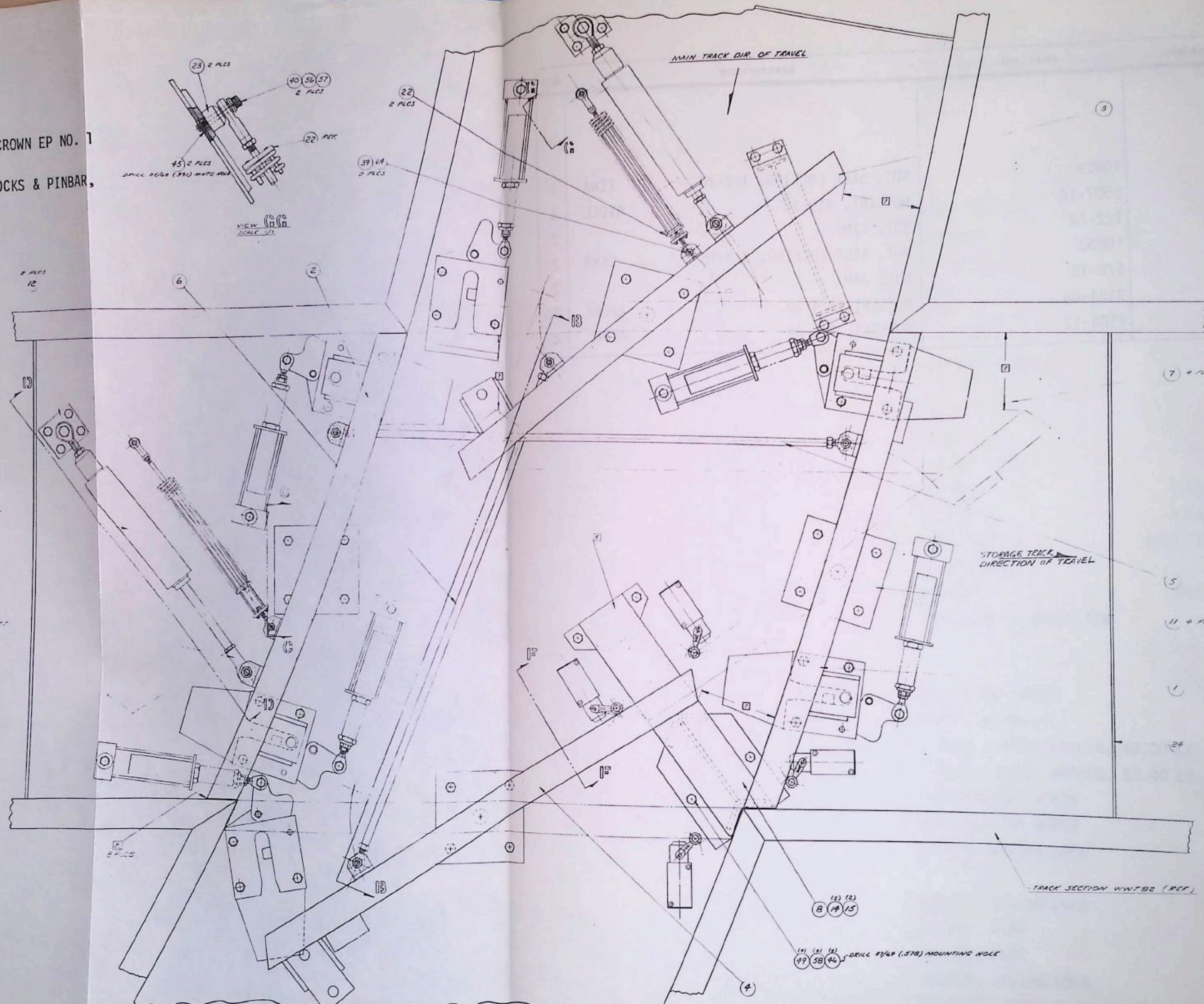
ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
37.				
38.				
39.				
40.		10029	NUT, SELF LOCKING, 1/2-20 ESNA	1
41.		9507-10	NUTSERT, #10-32 AVDEL	4
42.		1/2-20	NUT, JAM	2
43.		10033	NUT, SELF LOCKING, 5/8-18 ESNA	2
44.		5/8-18	NUT, JAM	2
45.		9504-08	NUTSERT, 1/4-20 AVDEL	10
46.		9506-12	NUTSERT, 3/8-24 AVDEL	27

WWT-11
SWITCH TRACK ASSY., INSTALLATION ("Y" SWITCH)
SHEET 2 of 2

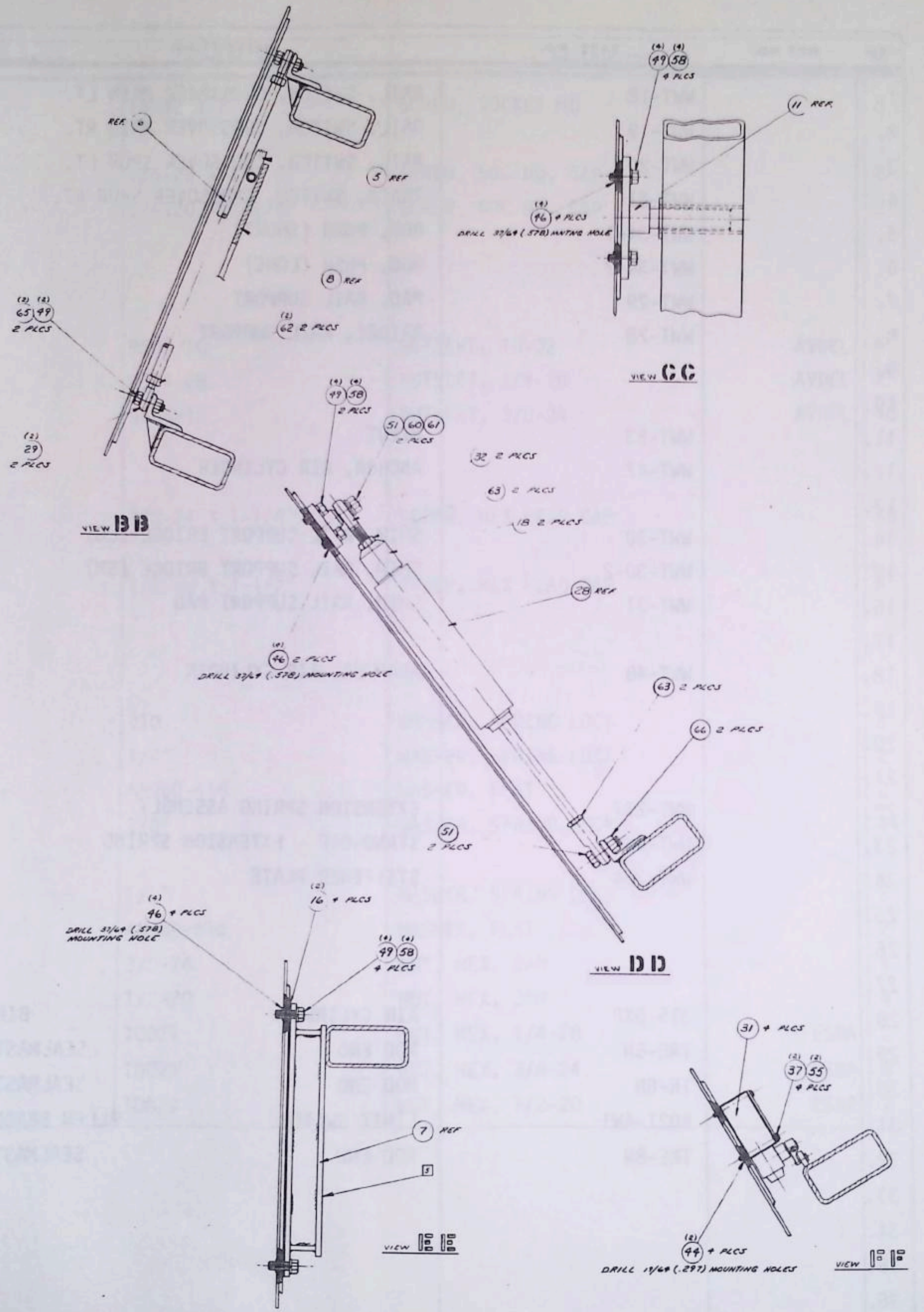
NOTES

[5] LUBRICATE PAD SURFACE WITH GULFCROWN EP NO. 1 LUBRICANT.

10 FOR INFORMATION PERTAINING TO LOCKS & PINBAR, SEE DWG WWT-270 SHT 1 & 2.



WWT–12
SWITCH TRACK ASSEMBLY, INSTALLATION (CROSSOVER)
SHEET 1 of 2



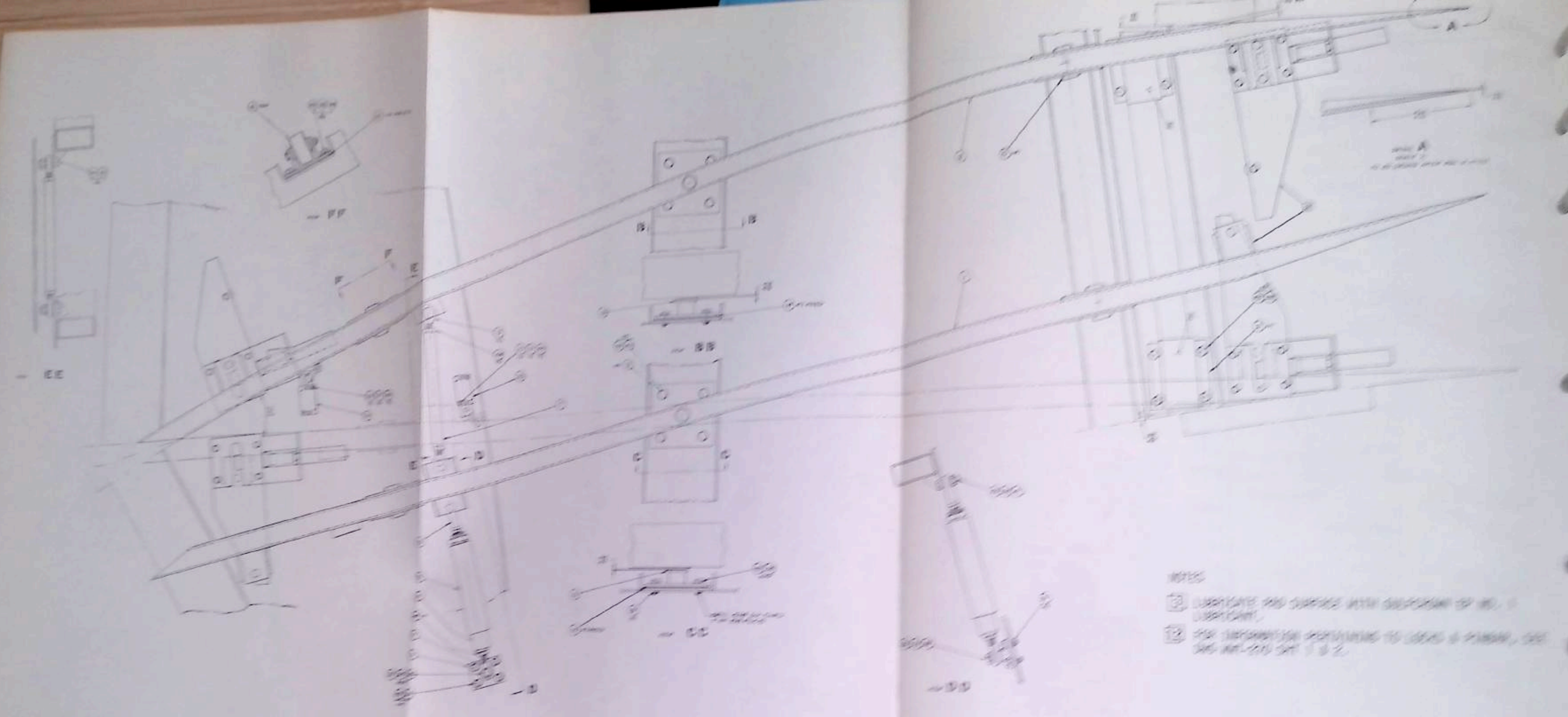
WWT-12
SWITCH TRACK ASSY., INSTALLATION (CROSSOVER)
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWT-18	RAIL, SWITCH, CROSSOVER MAIN LT.		1
2.		WWT-19	RAIL, SWITCH, CROSSOVER MAIN RT.		1
3.		WWT-20	RAIL, SWITCH, CROSSOVER SPUR LT.		1
4.		WWT-21	TRACK, SWITCH, CROSSOVER SPUR RT.		1
5.		WWT-34-1	ROD, PUSH (SHORT)		1
6.		WWT-34-2	ROD, PUSH (LONG)		1
7.		WWT-29	PAD, RAIL SUPPORT		4
8.		WWT-28	BRIDGE, RAIL SUPPORT		1
9.					
10.					
11.		WWT-53	PIVOT		4
12.		WWT-47	ANCHOR, AIR CYLINDER		2
13.					
14.		WWT-30	SHIM, RAIL SUPPORT BRIDGE (LG)		2
15.		WWT-30-2	SHIM, RAIL SUPPORT BRIDGE (SM)		2
16.		WWT-31	SHIM, RAIL SUPPORT PAD		8
17.					
18.		WWT-48	ADAPTER, AIR CYLINDER		2
19.					
20.					
21.					
22.		WWT-237	EXTENSION SPRING ASSEMBLY		2
23.		WWT-242	STAND-OFF - EXTENSION SPRING		2
24.		WWT-234	STIFFENER PLATE		1
25.					
26.					
27.					
28.		315-DXP	AIR CYLINDER	BIMBA	2
29.		TRE-6N	ROD END	SEALMASTER	4
30.		TR-8N	ROD END	SEALMASTER	2
31.		802T-AW1	LIMIT SWITCH	ALLEN BRADLEY	4
32.		TRE-8N	ROD END	SEALMASTER	2
33.					
34.					
35.					
36.					

WWT-12
SWITCH TRACK ASSY., INSTALLATION (CROSSOVER)
SHEET 1 of 2

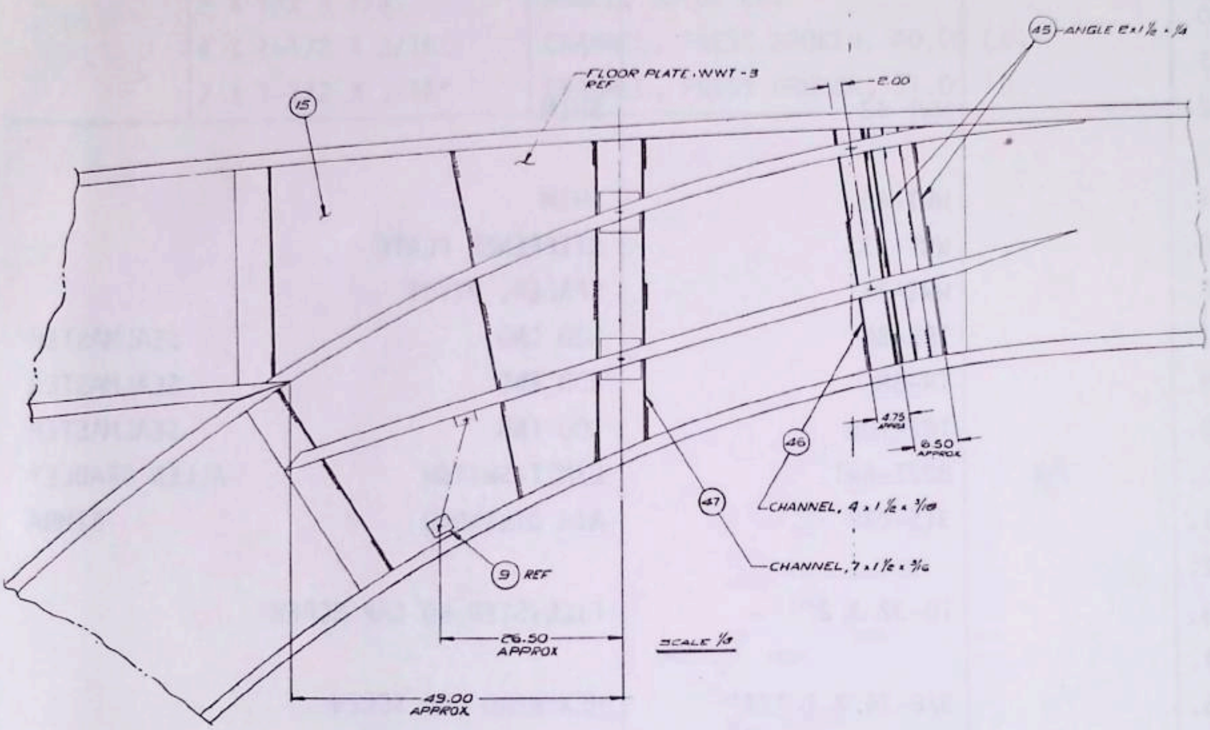
ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
37.		10-32 X 2"	SCREW, SOCKET HD		8
38.					
39.		1/4-28 X 1"	SCREW, SOC HD, CAP		2
40.		1/4-20 X 1-1/2"	SCREW, SOC HD, CAP		2
41.					
42.					
43.					
44.		9507-10	NUTSERT, 10-32	AVDEL	8
45.		9504-08	NUTSERT, 1/4-20	AVDEL	2
46.		9506-12	NUTSERT, 3/8-24	AVDEL	48
47.					
48.					
49.		3/8-24 X 1-1/4"	SCREW, HEX HEAD CAP		48
50.					
51.		1/2-20 X 1-1/2"	SCREW, HEX HEAD CAP		4
52.					
53.					
54.					
55.		#10	WASHER, SPRING LOCK		8
56.		1/4"	WASHER, SPRING LOCK		2
57.		AN960-416	WASHER, FLAT		2
58.		3/8"	WASHER, SPRING LOCK		44
59.					
60.		1/2"	WASHER, SPRING LOCK		2
61.		AN960-816	WASHER, FLAT		2
62.		3/8-24	NUT, HEX, JAM		4
63.		1/2-20	NUT, HEX, JAM		4
64.		10021	NUT, HEX, 1/4-28	ESNA	2
65.		10025	NUT, HEX, 3/8-24	ESNA	4
66.		10029	NUT, HEX, 1/2-20	ESNA	2

WWT-12
SWITCH TRACK ASSY., INSTALLATION (CROSSOVER)
SHEET 2 of 2



NOTES

SWITCH TRACK ASSEMBLY, INSTALLATION (LEFT HAND)



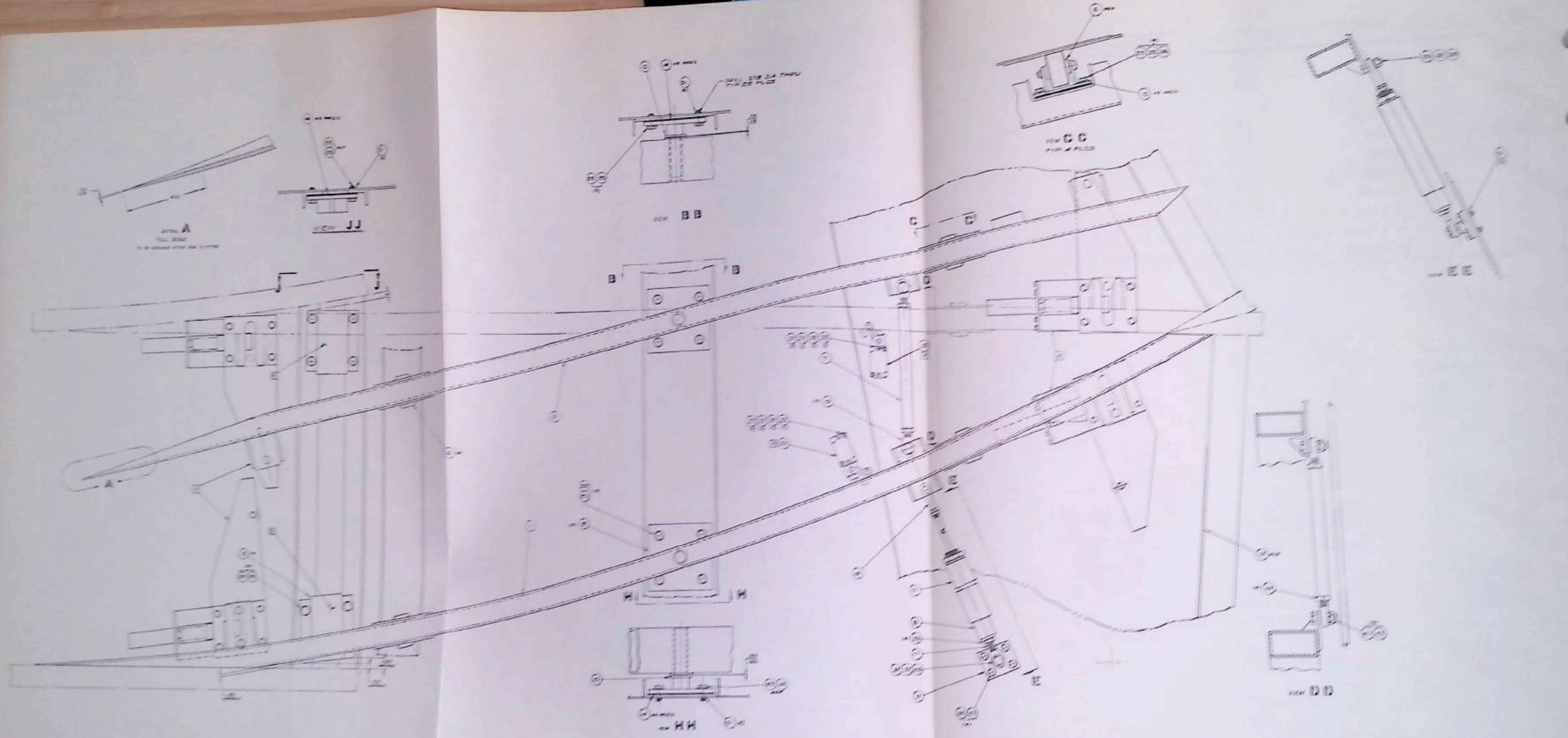
WWT-13
SWITCH TRACK ASSY., INSTALLATION (LEFT HAND)
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWT-23	RAIL		1
2.		WWT-22	RAIL		1
3.		WWT-53	PIVOT		2
4.					
5.		WWT-51	PAD		2
6.		WWT-56	WHEEL ASSEMBLY		4
7.		WWT-36	PUSH ROD		1
8.		WWT-48	ADAPTER, AIR CYL.		1
9.		WWT-47	ANCHOR		1
10.					
11.					
12.		WWT-43	SHIM		A/R
13.					
14.		WWT-46	SHIM		A/R
15.		WWT-233	STIFFENER PLATE		1
16.		WWT-241	SPACER, PIVOT		2
17.		TRE-8N	ROD END	SEALMASTER	1
18.		TR-8N	ROD END	SEALMASTER	1
19.		TRE-10N	ROD END	SEALMASTER	2
20.		802T-AW1	LIMIT SWITCH	ALLEN BRADLEY	2
21.		315-DXP	AIR CYLINDER	BIMBA	1
22.					
23.		10-32 X 2"	FILLISTER HD CAP SCREW		4
24.					
25.		3/8-24 X 1-1/4"	HEX HEAD CAP SCREW		36
26.		1/2-20 X 1-1/2"	HEX HEAD CAP SCREW		2
27.		5/8-18 X 1-5/8"	HEX HEAD CAP SCREW		2
28.					
29.					
30.		9504-08	NUTSERT, 1/4-20	AVDEL	10
31.		9506-12	NUTSERT, 3/8-24	AVDEL	28
32.					
33.		1/2	WASHER, SPRING LOCK		1
34.					
35.		3/8	WASHER, SPRING LOCK		36
36.		3/8	WASHER, FLAT		8

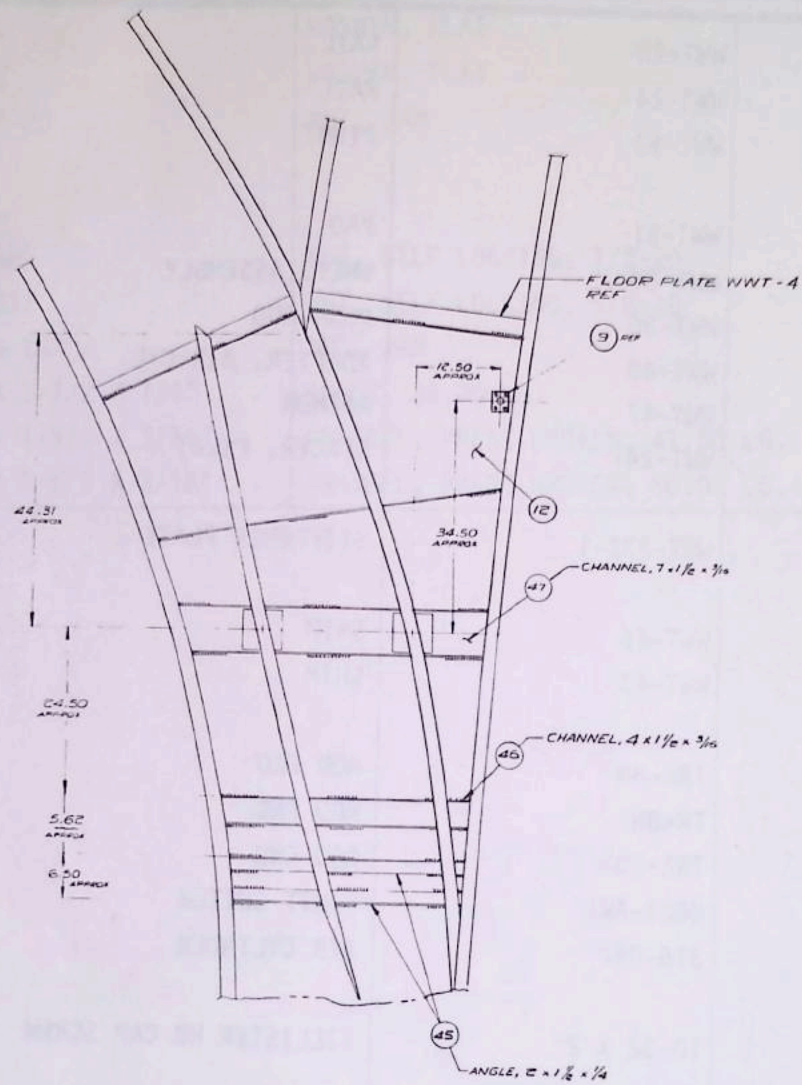
WWT-13
SWITCH TRACK ASSY., INSTALLATION (LEFT HAND)
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
37.		#10	WASHER, SPRING LOCK		4
38.		1/2	WASHER, FLAT		2
39.					
40.		9507-10	NUTSERT, 10-32	AVDEL	4
41.		10029	NUT, SELF LOCKING, 1/2-20	ESNA	1
42.		10033	NUT, SELF LOCKING, 5/8-18	ESNA	2
43.		1/2-20	NUT, JAM		2
44.		5/8-18	NUT, JAM		2
45.		2 X 1/2 X 1/4"	ANGLE, 38.00 LG.		2
46.		4 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 40.00 LG.		1
47.		7 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 51.00 LG.		1

WWT-13
SWITCH TRACK ASSY., INSTALLATION (LEFT HAND)
SHEET 2 of 2



WWT-14
SWITCH TRACK ASSEMBLY, INSTALLATION (LEFT HAND)
SHEET 1 of 2



NOTES

6 LUBRICATE PAD SURFACE WITH GULFCROWN EP NO. 1 LUBRICANT.

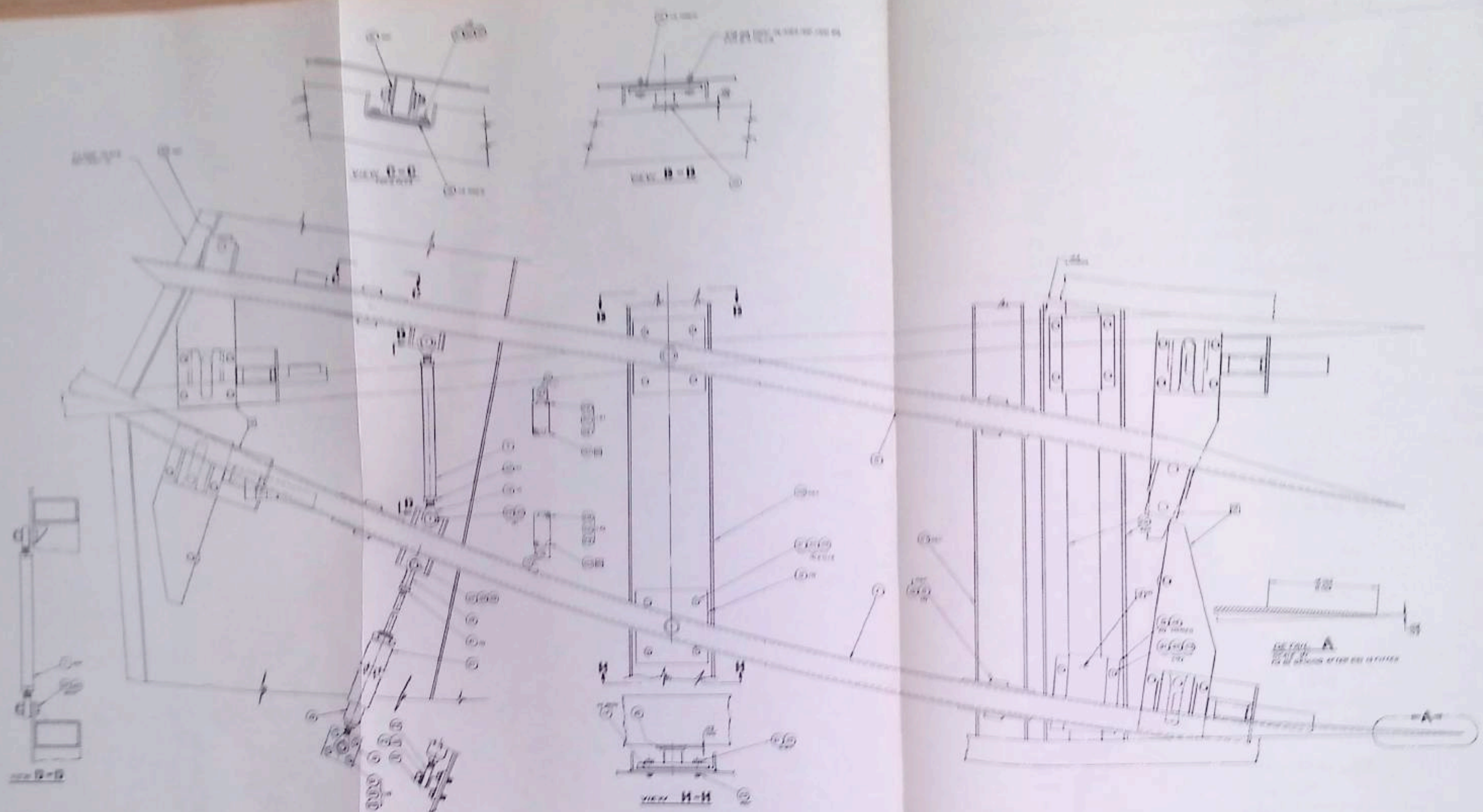
12 FOR INFORMATION PERTAINING TO LOCKS & PINBAR, SEE DWG WWT-270 SHT 1 & 2.

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWT-25	RAIL		1
2.		WWT-24	RAIL		1
3.		WWT-53	PIVOT		2
4.					
5.		WWT-51	PAD		2
6.		WWT-56	WHEEL ASSEMBLY		4
7.		WWT-36	PUSH ROD		1
8.		WWT-48	ADAPTER, AIR CYL.		1
9.		WWT-47	ANCHOR		1
10.		WWT-241	SPACER, PIVOT		2
11.					
12.		WWT-232-1	STIFFENER PLATE		1
13.					
14.		WWT-46	SHIM		A/R
15.		WWT-43	SHIM		A/R
16.					
17.		TRE-8N	ROD END	SEALMASTER	1
18.		TR-8N	ROD END	SEALMASTER	1
19.		TRE-10N	ROD END	SEALMASTER	2
20.		802T-AW1	LIMIT SWITCH	ALLEN BRADLEY	2
21.		315-DXP	AIR CYLINDER	BIMBA	1
22.					
23.		10-32 X 2"	FILLISTER HD CAP SCREW		4
24.					
25.		3/8-24 X 1-1/4"	HEX HEAD CAP SCREW		32
26.		1/2-20 X 1-1/2"	HEX HEAD CAP SCREW		2
27.		5/8-18 X 1-5/8"	HEX HEAD CAP SCREW		2
28.					
29.		9507-10	NUTSERT, 10-32	AVDEL	4
30.					
31.		9506-12	NUTSERT, 3/8-24	AVDEL	20
32.		1/2	WASHER, SPRING LOCK		1
33.		#10	WASHER, SPRING LOCK		4
34.					
35.		3/8	WASHER, SPRING LOCK		32
36.		3/8	WASHER, FLAT		12

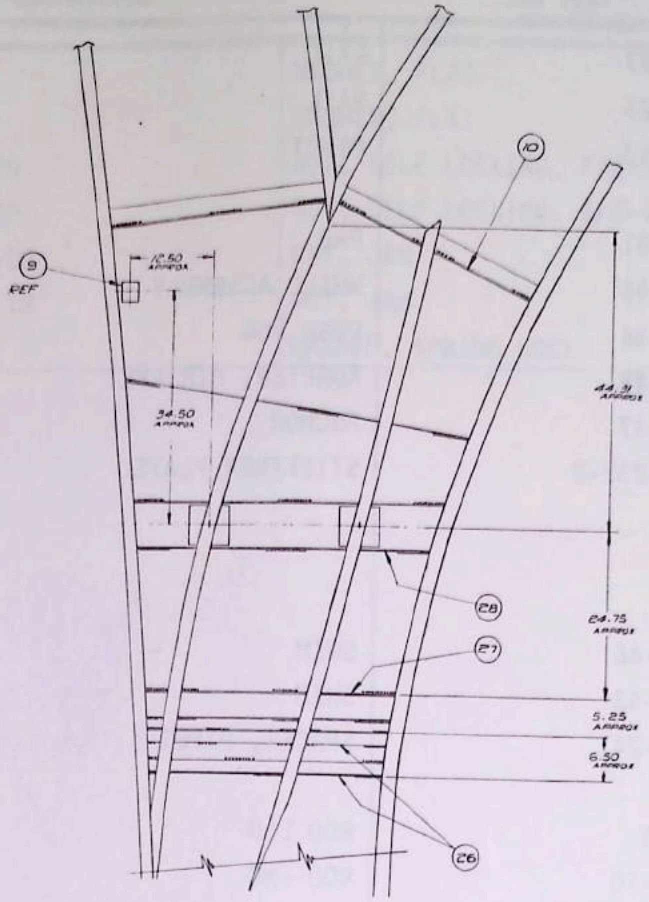
WWT-14
SWITCH TRACK ASSY., INSTALLATION (LEFT HAND)
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
37.		#10	WASHER, FLAT	4
38.		1/2	WASHER, FLAT	2
39.		1/2-20	NUT, JAM	2
40.				
41.				
42.		10029	NUT, SELF LOCKING, 1/2-20 ESNA	1
43.		10033	NUT, SELF LOCKING, 5/8-18 ESNA	2
44.		5/8-18	NUT, JAM	2
45.		2 X 1-1/2 X 1/4"	ANGLE, 39.00 LG.	2
46.		4 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 41.00 LG.	1
47.		7 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 50.00 LG.	1

WWT-14
SWITCH TRACK ASSY., INSTALLATION (LEFT HAND)
SHEET 2 of 2



WWT–15
SWITCH TRACK ASSEMBLY, INSTALLATION (RIGHT HAND)
SHEET 1 of 2



NOTES

4 LUBRICATE PAD SURFACE WITH GULFCROWN EP NO. 1 LUBRICANT.

12 FOR INFORMATION PERTAINING TO LOCKS AND PINBARS SEE DWG. WWT-270 SHT 1 OF 2.

WWT-15
SWITCH TRACK ASSY., INSTALLATION (RIGHT HAND)
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		WWT-27	RAIL		1
2.		WWT-26	RAIL		1
3.		WWT-53	PIVOT		2
4.					
5.		WWT-51	PAD		2
6.		WWT-56	WHEEL ASSEMBLY		4
7.		WWT-36	PUSH ROD		1
8.		WWT-48	ADAPTER, AIR CYL.		1
9.		WWT-47	ANCHOR		1
10.		WWT-232-2	STIFFENER PLATE		1
11.					
12.					
13.					
14.		WWT-46	SHIM		A/R
15.		WWT-43	SHIM		A/R
16.		WWT-241	SPACER, PIVOT		2
17.					
18.		TR-8	ROD END	SEALMASTER	1
19.		TRE-10	ROD END	SEALMASTER	2
20.		802T-AW1	LIMIT SWITCH	ALLEN BRADLEY	2
21.		315-DXP	AIR CYLINDER	BIMBA	1
22.		TRE-8N	ROD END		1
23.		9507-10	NUTSERT, #10-32	AVDEL	4
24.					
25.		9506-12	NUTSERT, 3/8-24	AVDEL	27
26.		2 X 1-1/2 X 1/4"	ANGLE, 39.00 LG.		2
27.		4 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 41.00 LG.		1
28.		7 X 1-1/2 X 3/16"	CHANNEL, PRESS BROKEN, 50.00 LG.		1
29.		10-32 X 2"	FILLISTER HD CAP SCREW		4
30.					
31.		3/8-24 X 1-1/4"	HEX HEAD CAP SCREW		35
32.		1/2-20 X 1-1/2"	HEX HEAD CAP SCREW		2
33.		5/8-18 X 1-5/8"	HEX HEAD CAP SCREW		2
34.					
35.		3/8	WASHER, SPRING LOCK		35
36.		#10	WASHER, SPRING LOCK		4

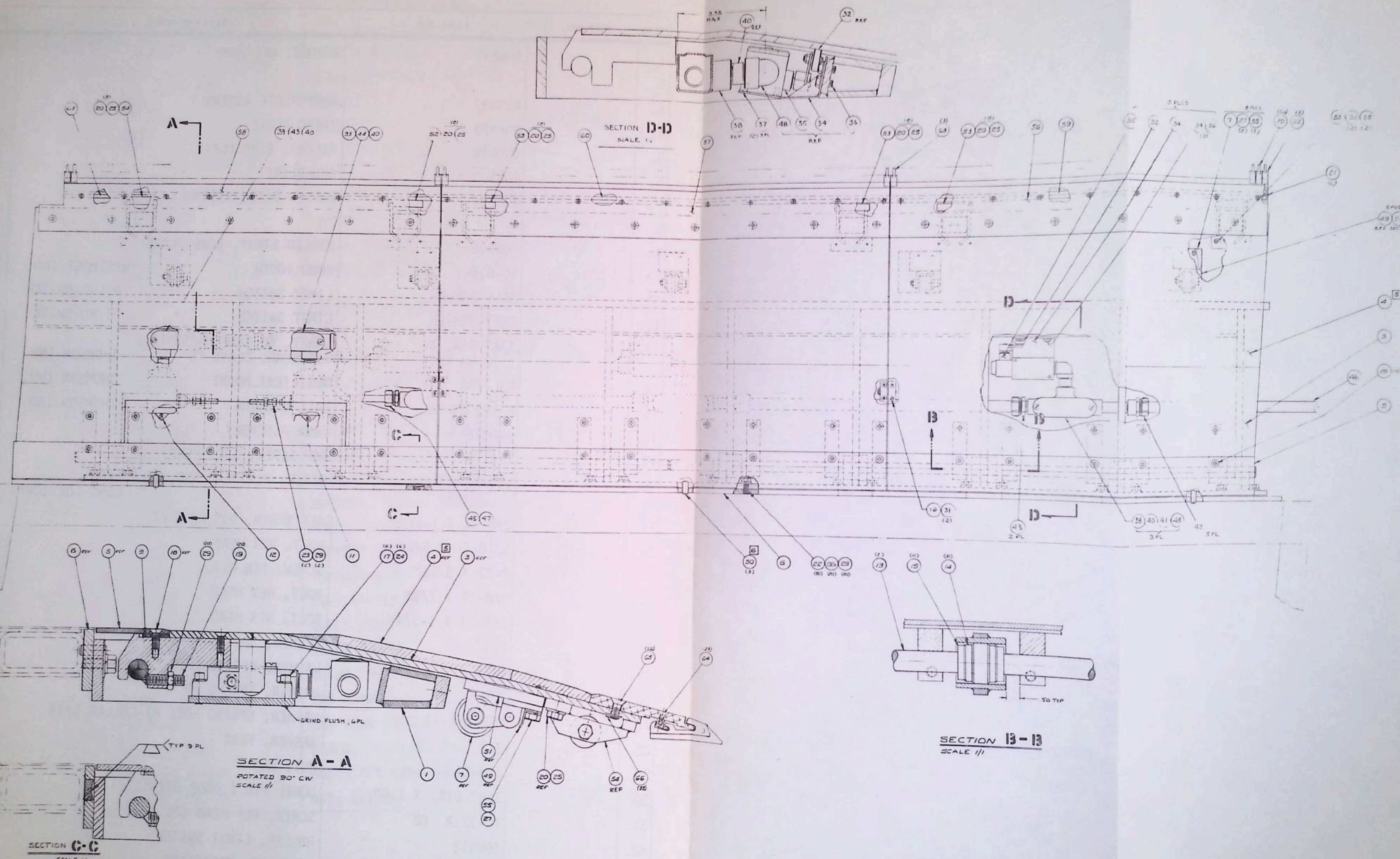
WWT-15
SWITCH TRACK ASSY., INSTALLATION (RIGHT HAND)
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
37.		3/8	WASHER, FLAT		8
38.		1/2	WASHER, FLAT		2
39.		10029	NUT, SELF LOCKING, 1/2-20	ESNA	1
40.		10033	NUT, SELF LOCKING, 5/8-18	ESNA	2
41.		1/2-20	NUT, JAM		2
42.		5/8-18	NUT, JAM		2
43.		1/2	WASHER, SPRING LOCK		1

WWT-15
SWITCH TRACK ASSY., INSTALLATION (RIGHT HAND)
SHEET 2 of 2

3. RAMPS

THE FOLLOWING ILLUSTRATIONS ARE ASSEMBLY DRAWINGS OF THE ON RAMP AND OFF RAMP ASSEMBLIES WITH ACCOMPANYING PARTS LISTS.


SECTION D-D
SCALE 1/1
SECTION A-A
ROTATED 90° CW
SCALE 1/1
GRIND FLUSH, 6PL
TYP 9 PL
SECTION B-B
SCALE 1/1
SECTION C-C
SCALE 1/1
A
B
C
D
REF

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		408895	BRIDGE, OFF RAMP		1
2.					
3.		408897	RAMP PLATE ASSEMBLY		1
4.		408898	TREAD PLATE		1
5.		408899	FILLER, RAMP PLATE		1
6.		408900	END PLATE		1
7.		408934	ROLLER GUIDE ASSEMBLY		5
8.					
9.		408906	FILLER STRIP, RAMP PLATE		1
10.		40-016-1	COMB TOOTH	WESTMONT IND.	200
11.		BAF1-2RN-RH	LIMIT SWITCH	MICRO-SWITCH	1
12.		BAF1-2RN-LH	LIMIT SWITCH	MICRO-SWITCH	1
13.		3/4" DIA. X 30.00 LG.	SHAFT, 60 CASE HARDENED & GROUND, CLASS "S"	THOMSON IND.	3
14.		RSL-750	RESILIENT MOUNT	THOMSON IND.	10
15.		A-122026-SS	BALL BUSHING	THOMSON IND.	10
16.		408916	LINK ASSEMBLY		2
17.		1/4-28 X 1"	CAP SCREW, SOC. HEAD		6
18.		1/4-28 X 3/4"	SCREW, FLT HEAD SOC, SELF LKG	LONG-LOK CORP.	19
19.		3/8-24 X 1-1/2"	SET SCREW, 90° CONE PT		20
20.		5/16-24 X 5/8"	BOLT, HEX HEAD		12
21.		8-32 X 3/16"	SCREW, PAN HEAD		6
22.		3/8-24 X 7/8"	BOLT, HEX HEAD		20
23.		3/8-24 X 1-3/4"	BOLT, HEX HEAD		2
24.		1/4	WASHER, SPRING LOCK		12
25.		5/16	WASHER, SPRING LOCK		22
26.		3/8	WASHER, SPRING LOCK		20
27.		MS51848-11	WASHER, SPRING LOCK HI-COLLAR 5/16		10
28.		3/8	WASHER, FLAT		20
29.		3/8-24	NUT, JAM		22
30.		3/8" DIA. X 1.00	DOWEL PIN (.0002 OVERSIZE)		3
31.		10-32 X .62	SCREW, FLT HEAD SOC.		4
32.		408918	ROLLER, LIMIT SWITCH		3
33.		408919	CONDULET, MODIFIED		1
34.		408917	BRACKET, LIMIT SWITCH		3
35.		802TA	LIMIT SWITCH	ALLEN BRADLEY	3

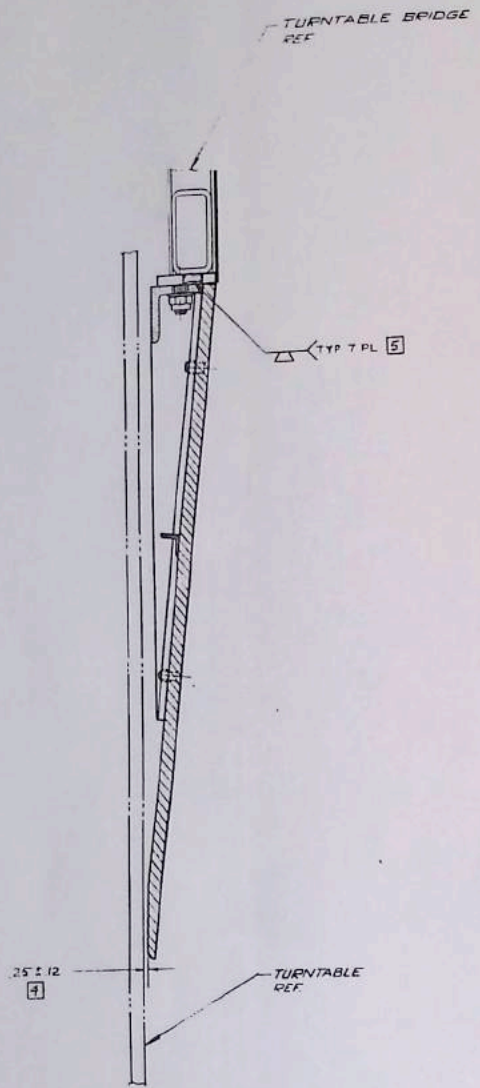
408894
OFF RAMP ASSEMBLY
SHEET 1 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
36.		1/4-28 X 1/2"	BOLT, HEX HEAD	6
37.		10-32 X 3/8"	SCREW, FLAT HEAD SOC.	6
38.		T-19	CONDULETS CROUSE-HINDS	3
39.		LR-19	CONDULETS CROUSE-HINDS	1
40.			NIPPLE, 1/2" CONDUIT, CLOSE	5
41.			NIPPLE, 1/2" CONDUIT, 3" LG	3
42.		5272	ADAPTER, FEM HUB THOMAS & BETTS CO.	3
43.		5332	CONNECTOR, STRAIGHT THOMAS & BETTS CO.	4
44.		2269	ELBOW, STRAIN RELIEF THOMAS & BETTS CO.	1
45.		2522	CONNECTOR, STRAIN RELIEF THOMAS & BETTS CO.	1
46.			CONDUIT, FLEXIBLE 1/2" SEALTITE TYPE EF	A/R
47.			CABLE	A/R
48.		4290	ELBOW 1/2" THOMAS & BETTS CO.	3
49.		408925	STOP, SUPPORT ROLLER	5
50.				
51.		408924	SPACER, SUPPORT ROLLER	5
52.		408921	SUPPORT, ROLLER ASSEMBLY	2
53.		408922	SUPPORT, ROLLER ASSEMBLY	3
54.		408923	SUPPORT, ROLLER ASSEMBLY	1
55.		5/16-24 X 7/8"	BOLT, HEX HEAD	10
56.		408926	SUPPORT PLATE	1
57.		408927	SUPPORT PLATE	1
58.		408928	SUPPORT PLATE	1
59.		408929	GUIDE TOOTH	1
60.		408930	GUIDE TOOTH	1
61.		408931	GUIDE TOOTH	1
62.		408932	END COMB TOOTH - R.H.	3
63.		408933	END COMB TOOTH - L.H.	3
64.		8-32 X 1/2"	SCREW, FLT HEAD SOC.	29
65.		1/4-20 X 3/4"	BOLT, FLT HEAD SOC.	22
66.		C7956-1420-3B	NUT, SPEED TINNERMAN	22

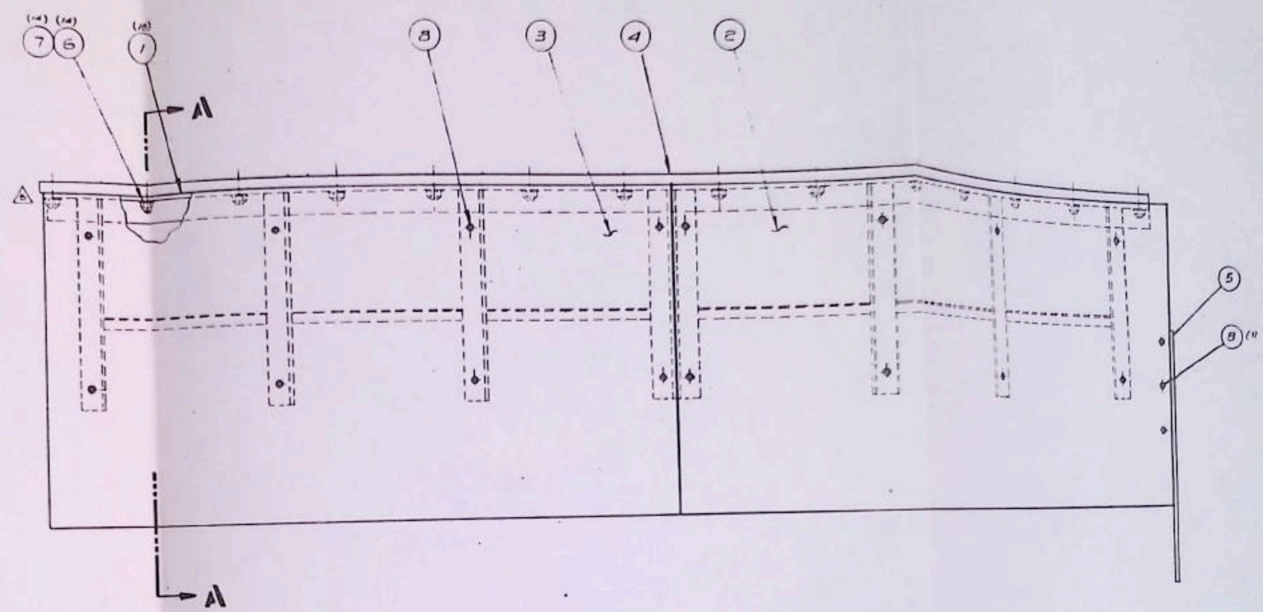
408894
OFF RAMP ASSEMBLY
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY
1.		408888	FRAME, RAMP PLATE	1
2.		408889	RAMP PLATE, OUTER	1
3.		408890	RAMP PLATE, INNER	1
4.		408891	END PLATE	1
5.		408911	STOP, TOE	1
6.			WASHER, FLAT, 1/2", STEEL CAD PLATED	14
7.		79NE-080	LOCKNUT, 1/2-20 UNF	14
8.		16990L-4F-14D	SCREW, FLAT HEAD, SOC, 1/4-28 UNF x 7/8", SELF-LOCKING	19

408887
ON RAMP ASSY



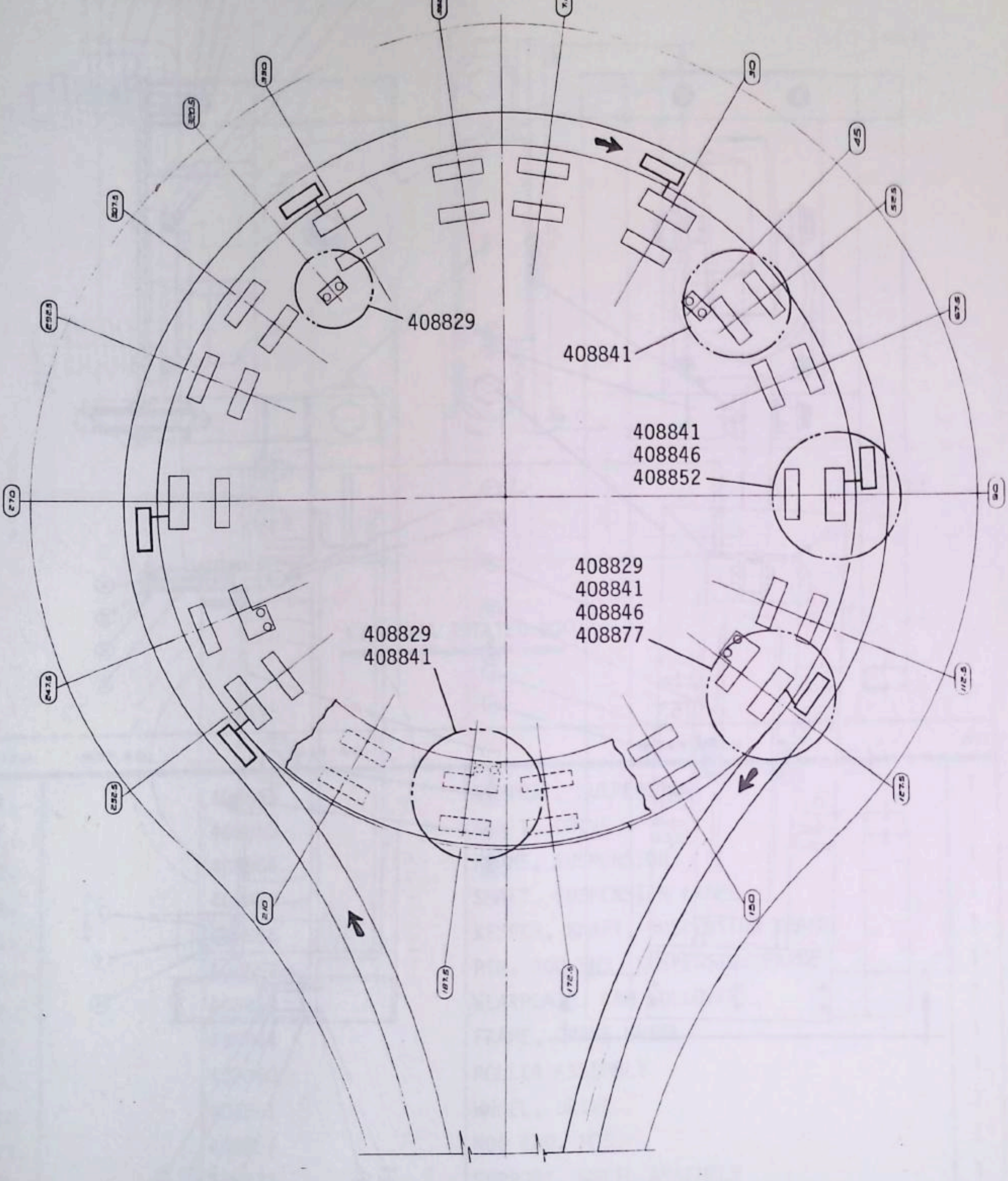
SECTION A – A
SCALE 1/2



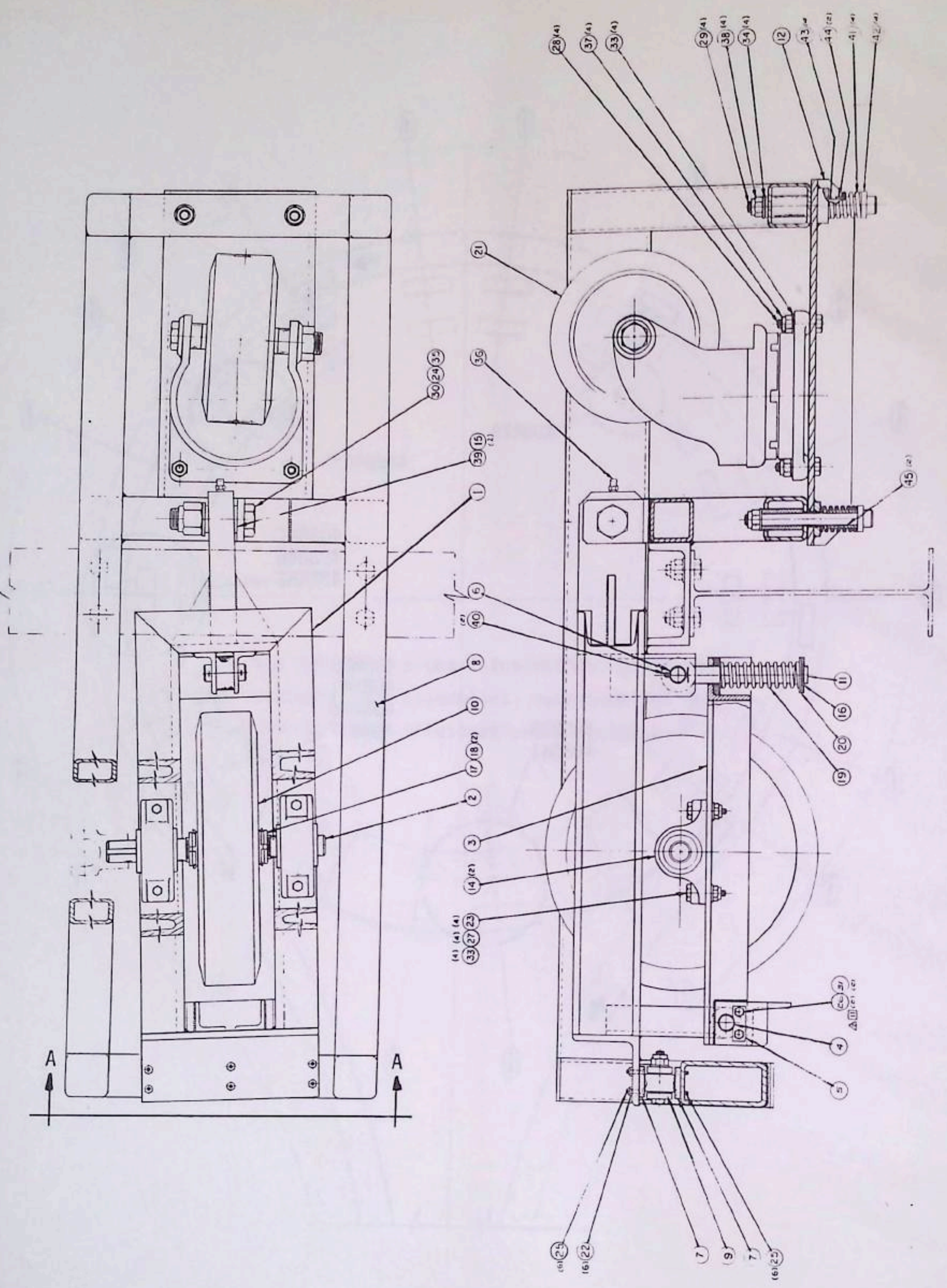
408887
ON RAMP ASSY

4. TURNTABLE

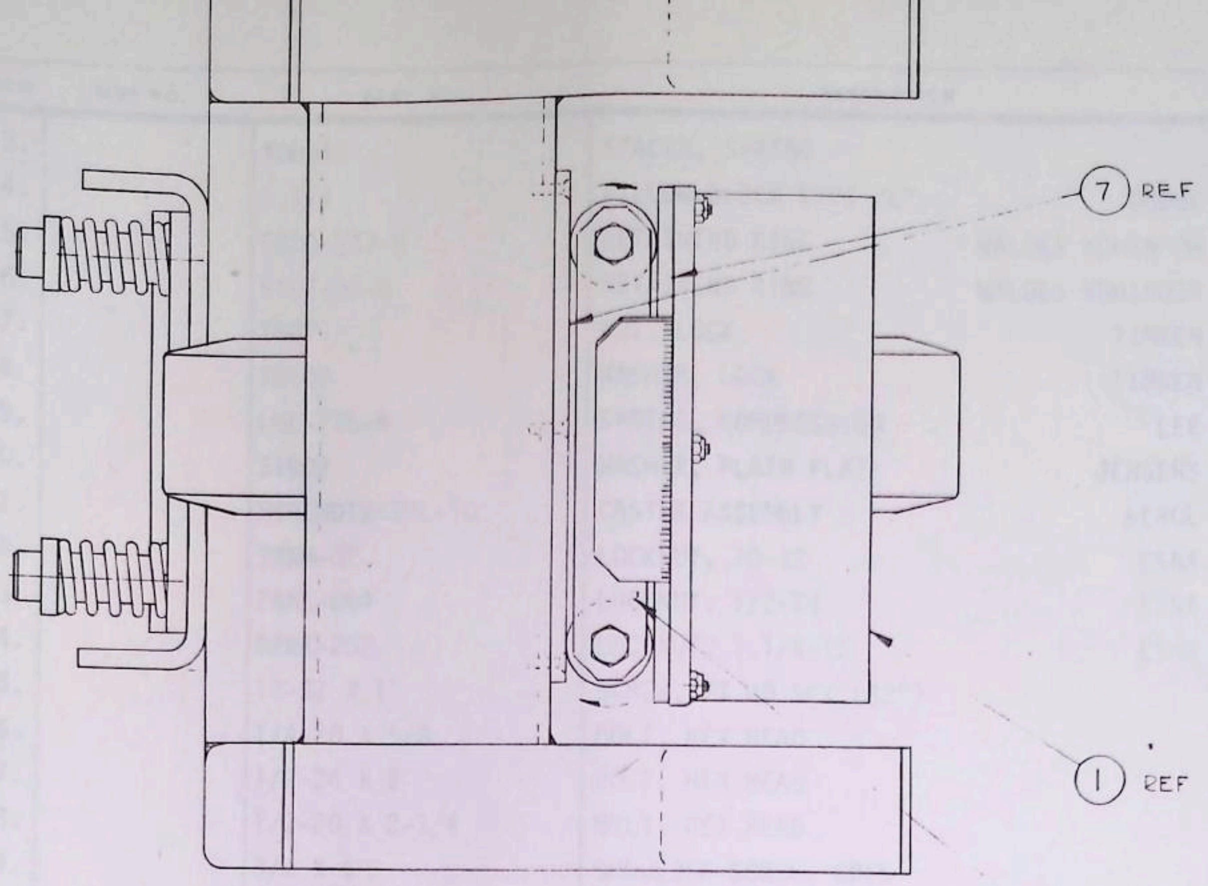
The following eight illustrations break down the turntable into assemblies, subassemblies and piece parts. Each illustration is accompanied by a parts list.



408850
INSTALLATION, SUPPORT WHEELS, &
DRIVE UNITS



408846
DRIVE WHEEL ASSEMBLY
SHEET 1 of 2



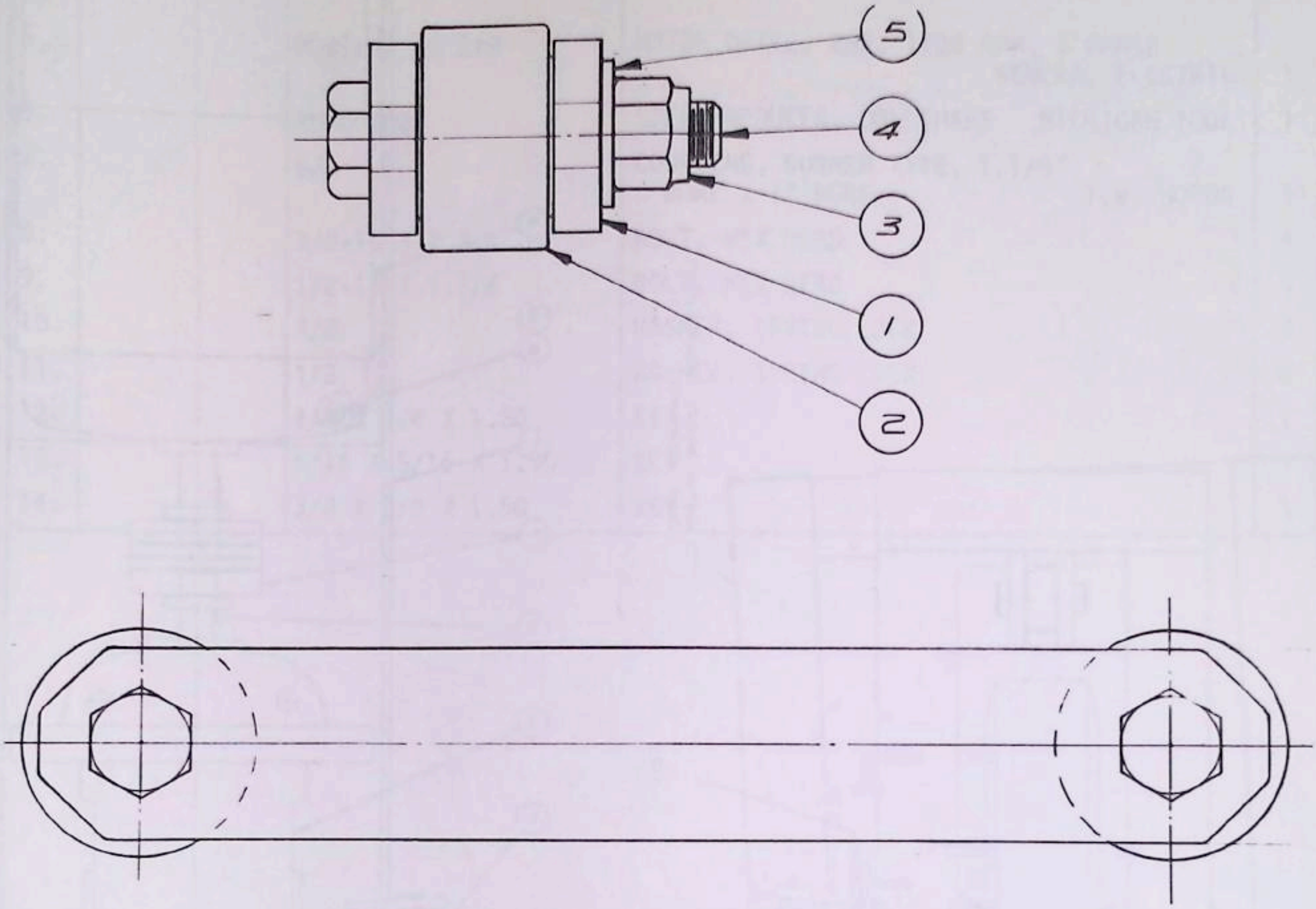
VIEW A-A ROTATED 90°

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		408849	SUPPORT, SUSPENSION	1
2.		408853	SHAFT, DRIVE	1
3.		408854	FRAME, SUSPENSION	1
4.		408855	SHAFT, SUSPENSION FRAME	1
5.		408856	KEEPER, SHAFT, SUSPENSION FRAME	1
6.		408857	PIN, ROD END, SUSPENSION FRAME	1
7.		408858	WEARPLATE, CAM FOLLOWER	2
8.		408864	FRAME, DRIVE WHEEL	1
9.		408860	ROLLER ASSEMBLY	1
10.		408861	WHEEL, DRIVE	1
11.		408881	ROD END, MOD.	1
12.		408873	SUPPORT, WHEEL ASSEMBLY	1

408846
DRIVE WHEEL ASSEMBLY
SHEET 2 of 2

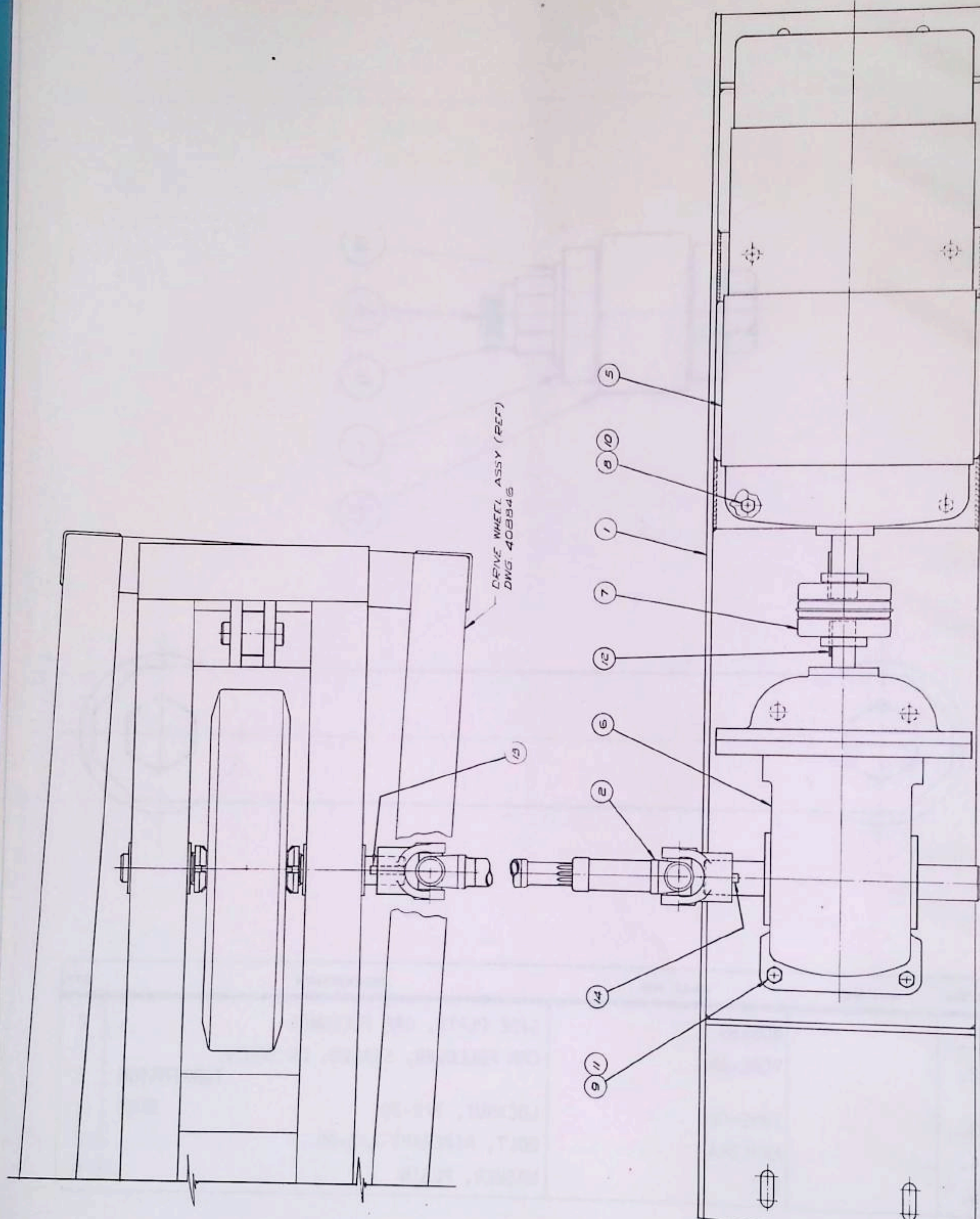
ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
13.		408912	SPACER, SPRING		1
14.		1.1/4	PILLOW BLOCK TYPE "E"	DODGE	2
15.		5000-237-H	RETAINING RING	WALDES KOHINOOR	2
16.		5107-98-H	RETAINING RING	WALDES KOHINOOR	1
17.		TN07	NUT, LOCK	TIMKEN	2
18.		TW107	WASHER, LOCK	TIMKEN	2
19.		LHC-218-4	SPRING, COMPRESSION	LEE	2
20.		31909	WASHER, PLAIN FLAT	JERGENS	1
21.		SCREHD12-EHL-10	CASTER ASSEMBLY	AEROL	1
22.		79NM-02	LOCKNUT, 10-32	ESNA	6
23.		79NE-064	LOCKNUT, 1/2-24	ESNA	4
24.		52NE-202	LOCKNUT, 1.1/4-12	ESNA	1
25.		10-32 X 1	SCREW, FT HD SCK (82°)		12
26.		1/4-20 X 5/8	BOLT, HEX HEAD		2
27.		1/2-24 X 2	BOLT, HEX HEAD		4
28.		1/2-20 X 2-1/4	BOLT, HEX HEAD		4
29.		3/4 X 6	SHOULDER SCREW, CRES		4
30.		AN20-36	BOLT, AIRCRAFT, 1.1/4-12 X 3-15/16		1
31.		1/4	WASHER, SPRING LOCK		2
32.		AN960-2016	WASHER, PLAIN		1
33.		1/2	WASHER, PLAIN		8
34.		5/8	WASHER, PLAIN		4
35.		1.1/4	WASHER, PLAIN		1
36.		1610B	GREASE FITTING,	ALEMITE	1
37.		79NE-080	NUT, HEX LIGHT 1/2-20		4
38.		79NE-101	NUT, HEX LIGHT 5/8-11		4
39.		BTS-20LS	BEARING, SPHERICAL	SEALMASTER	1
40.		3/16 X 1-1/2 LG	COTTER PIN		2
41.		#947	COMPRESSION SPRING	CENTURY	4
42.		31907	WASHER, FLAT	JERGENS	4
43.		408882	BEARING, MODIFIED		4
44.		408883	SPACER, SHORT		2
45.		408884	SPACER, LONG		2

408846
DRIVE WHEEL ASSEMBLY



ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		408859	SIDE PLATE, CAM FOLLOWER	2
2.		YCRS-28	CAM FOLLOWER, SEALED, OR EQUIV. TORRINGTON	2
3.		79NE-080	LOCKNUT, 1/2-20 ESNA	2
4.		AN8C24A	BOLT, AIRCRAFT 1/2-20	2
5.		1/2	WASHER, PLAIN	2

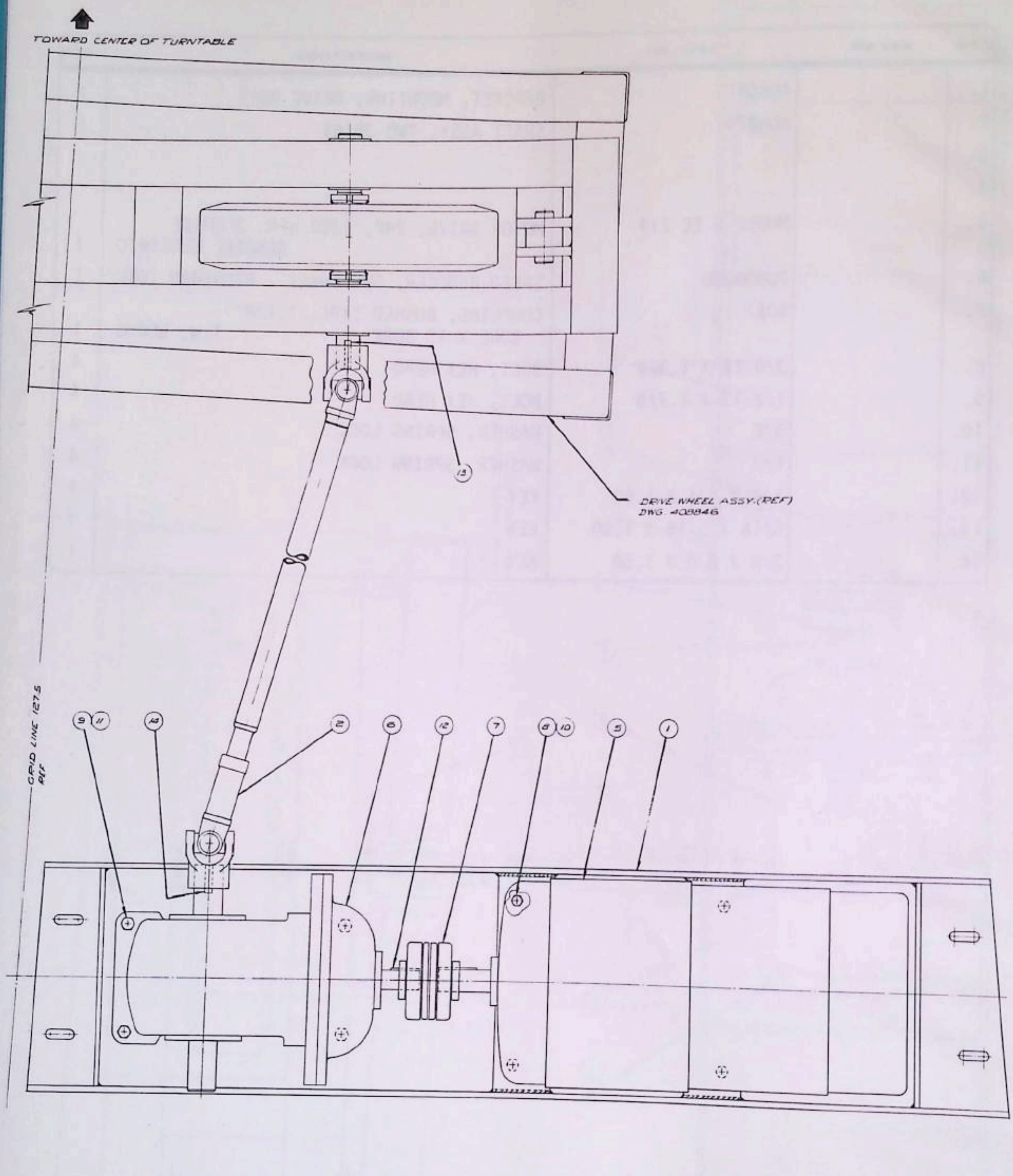
408860
ROLLER ASSEMBLY



408852
DRIVE UNIT ASSEMBLY

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		408851	BRACKET, MOUNTING, DRIVE UNIT	1
2.		408879	SHAFT ASSY, TWO JOINT	1
3.				
4.				
5.		MODEL 5 EC 219	MOTOR DRIVE, 2HP, 1200 RPM, 3 PHASE GENERAL ELECTRIC	1
6.		RU300000	SPEED REDUCER, DBL SHAFT MICHIGAN TOOL	1
7.		6JA	COUPLING, BUSHED TYPE, 1.1/8" BORE X 1" BORE T.W. WOODS	1
8.		3/8-16 X 1.3/4	BOLT, HEX HEAD	4
9.		1/2-13 X 1.7/8	BOLT, HEX HEAD	4
10.		3/8	WASHER, SPRING LOCK	4
11.		1/2	WASHER, SPRING LOCK	4
12.		1/4 X 1/4 X 1.50	KEY	1
13.		5/16 X 5/16 X 1.50	KEY	1
14.		3/8 X 3/8 X 1.50	KEY	1

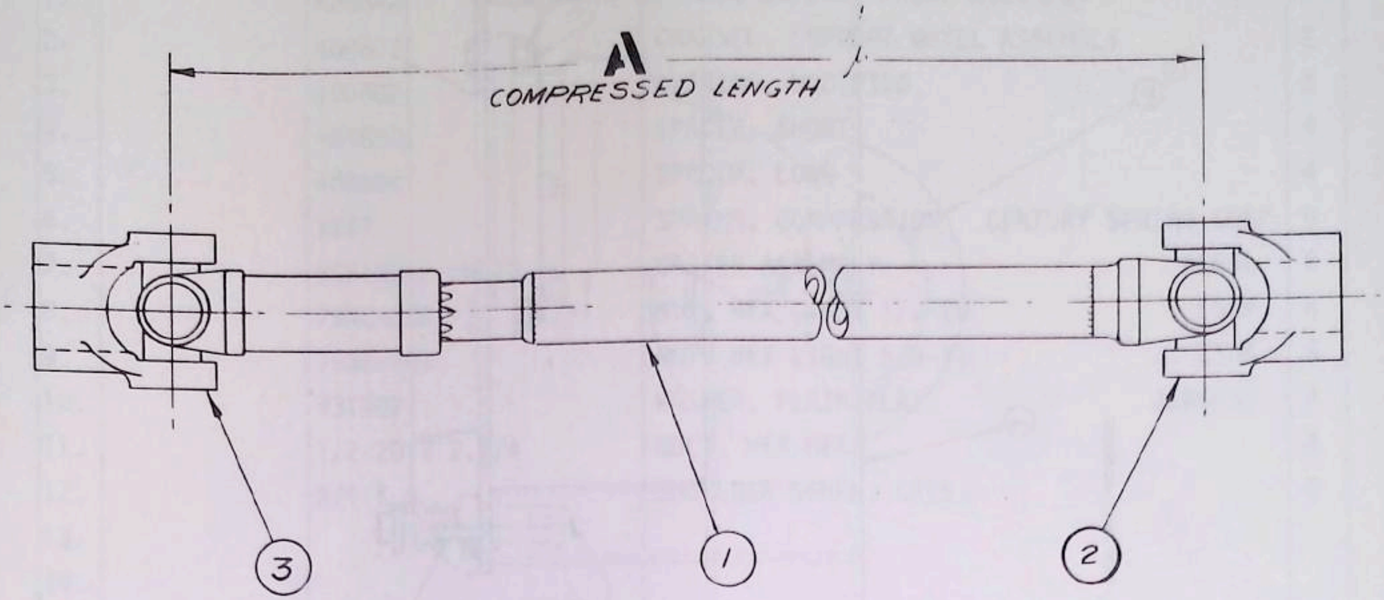
408852
DRIVE UNIT ASSEMBLY



408877
DRIVE UNIT ASSEMBLY
AT 127.5°

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		408878	BRACKET, MOUNTING, DRIVE UNIT AT 127.5°	1
2.		408880	TWO JOINT SHAFT ASSEMBLY	1
3.				
4.				
5.		MODEL 5 EC 219	MOTOR DRIVE, 2 HP, 1200 RPM-3PHASE GE	1
6.		RU300000	SPEED REDUCER, DBL SHAFT MICHIGAN TOOL	1
7.		6JA	COUPLING, BUSHED TYPE, 1.1/8" BORE X 1" BORE T.W. WOODS	1
8.		3/8-16 X 1.3/4	BOLT, HEX HEAD	4
9.		1/2-13 X 1.7/8	BOLT, HEX HEAD	4
10.		3/8	WASHER, SPRING LOCK	4
11.		1/2	WASHER, SPRING LOCK	4
12.		1/4 X 1/4 X 1.50	KEY	1
13.		5/16 X 5/16 X 1.50	KEY	1
14.		3/8 X 3/8 X 1.50	KEY	1

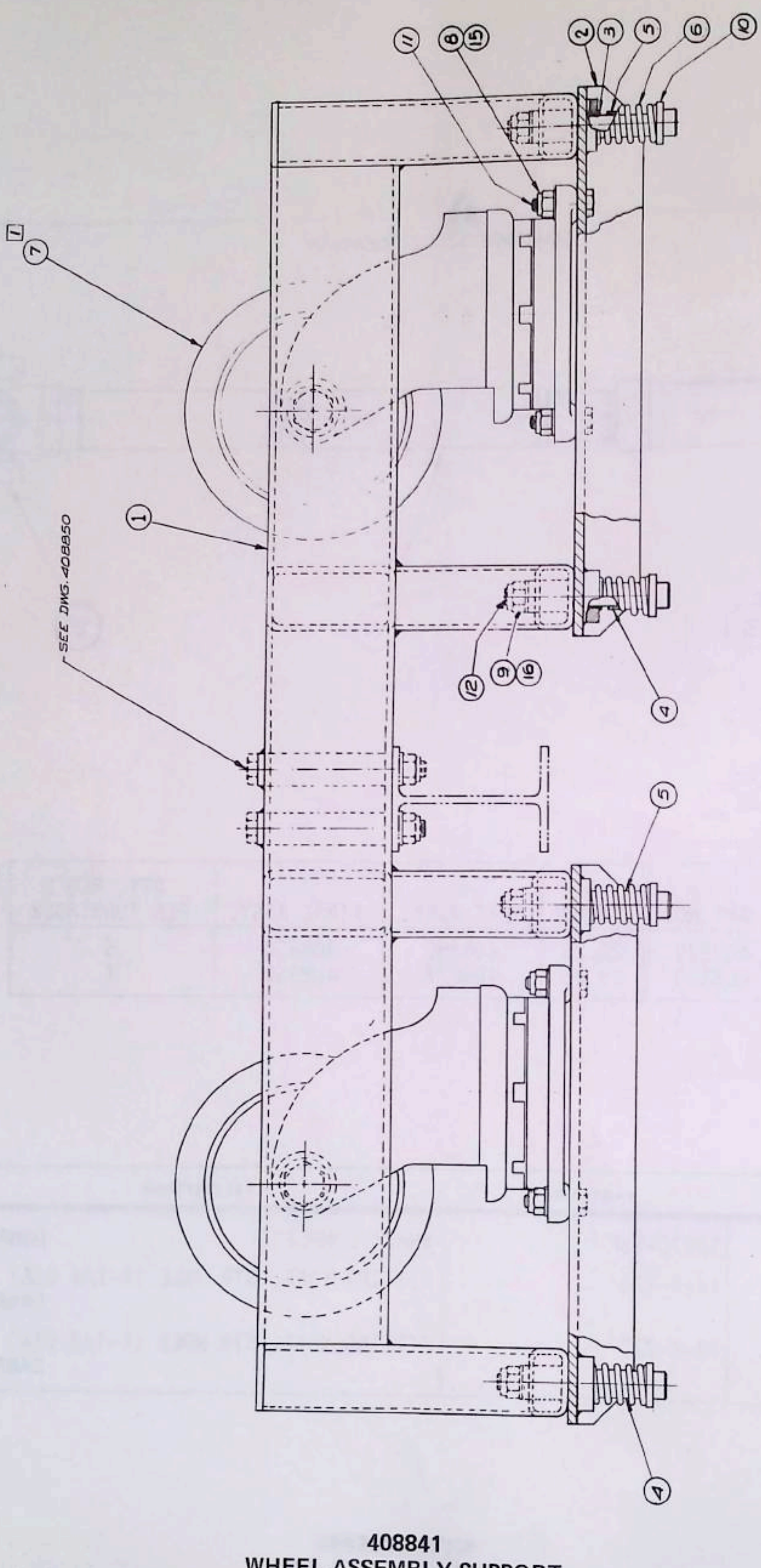
408877
DRIVE UNIT ASSEMBLY
AT 127.5°



PART NO.	A DIM.	NEXT ASSY.	FINAL ASSY.	QTY. REQ'D PER TURNTABLE
408879	22.25	408852	408850	5
408880	23.25	408877	408850	1

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		10270-ISF	SHAFT COMPLETE DANA CORP.	1
2.		10-4-123	FITTING YOKE, STR HOLE (1-1/4 DIA) DANA CORP.	1
3.		10-4-223	FITTING YOKE, STR HOLE (1-1/2 DIA) DANA CORP.	1

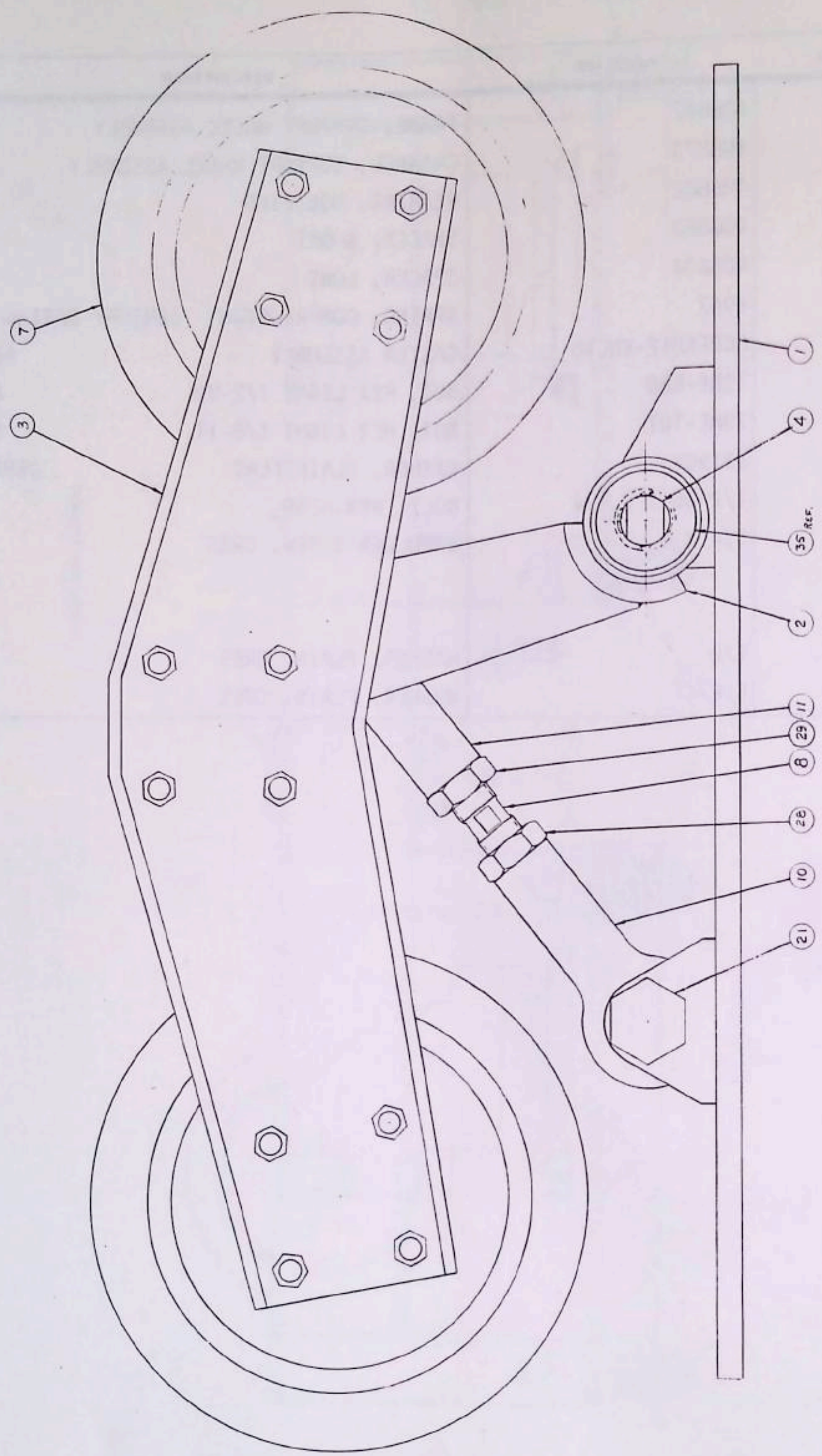
408879/408880
TWO JOINT SHAFT ASSY.



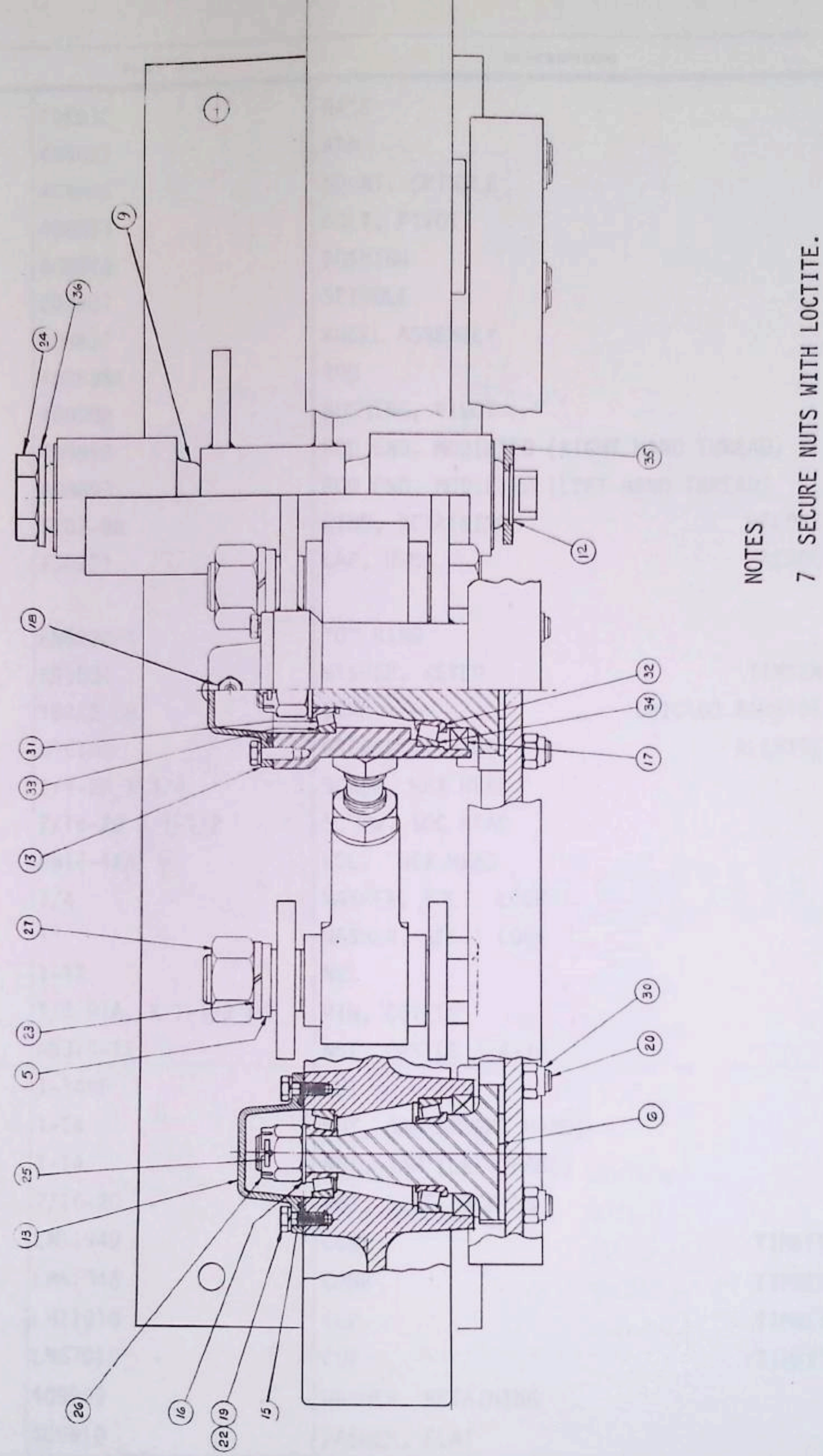
408841
WHEEL ASSEMBLY SUPPORT

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		408842	FRAME, SUPPORT WHEEL ASSEMBLY		1
2.		408873	CHANNEL, SUPPORT WHEEL ASSEMBLY		2
3.		408882	BEARING, MODIFIED		8
4.		408883	SPACER, SHORT		4
5.		408884	SPACER, LONG		4
6.		#947	SPRING, COMPRESSION	CENTURY SPRING CORP.	8
7.		SCREND12-EHL10	CASTER ASSEMBLY	AEROL	2
8.		79NE-080	NUT, HEX LIGHT 1/2-20	ESNA	8
9.		79NE-101	NUT, HEX LIGHT 5/8-11	ESNA	8
10.		#31907	WASHER, PLAIN FLAT	JERGENS	8
11.		1/2-20 X 2.1/4	BOLT, HEX HEAD		8
12.		3/4 X 5	SHOULDER SCREW, CRES		8
13.					
14.					
15.		1/2	WASHER, PLAIN, CRES		8
16.		5/8	WASHER, PLAIN, CRES		8

408841
WHEEL ASSEMBLY SUPPORT



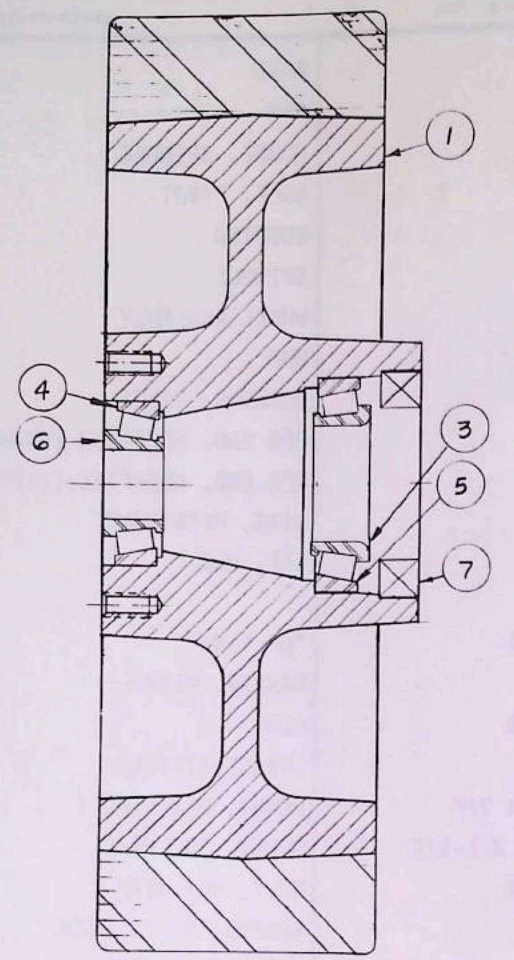
408829
SIDE GUIDE ROLLER ASSY.
SHEET 1 of 2



408829
SIDE GUIDE ROLLER ASSY.
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		408830	BASE		1
2.		408832	ARM		1
3.		408834	MOUNT, SPINDLE		1
4.		408833	BOLT, PIVOT		1
5.		408840	BUSHING		2
6.		207821	SPINDLE		3
7.		408837	WHEEL ASSEMBLY		2
8.		408835A	ROD		1
9.		408908	BUSHING, PIVOT		2
10.		408892	ROD END, MODIFIED (RIGHT HAND THREAD)		1
11.		408893	ROD END, MODIFIED (LEFT HAND THREAD)		1
12.		5107-98	RING, RETAINING	WALDES	1
13.		#50221	CAP, HUB	AEROL	3
14.					
15.		AN6230-4	"O" RING		3
16.		K91504	WASHER, KEYED	TIMKEN	3
17.		16223 CR	SEAL	CHICAGO RAWHIDE	1
18.		#1610B	GREASE FITTING	ALEMITE	3
19.		1/4-20 X 3/4	SCREW, HEX HEAD		12
20.		7/16-20 X 1-1/2	SCREW, SOC HEAD		12
21.		AN16-46A	BOLT, HEX HEAD		2
22.		1/4	WASHER, SPLIT LOCK		12
23.		1"	WASHER, SPLIT LOCK		2
24.		1-12	NUT		2
25.		1/8 DIA. X 1-1/2 LG	PIN, COTTER		3
26.		AN310-12	NUT, CASTLE 3/4-16		3
27.		1-14UF	NUT		2
28.		1-14	NUT, JAM (RIGHT HAND)		1
29.		1-14	NUT, JAM (LEFT HAND)		1
30.		7/16-20	NUT, SELF LOCKING		12
31.		LM11949	CONE	TIMKEN	1
32		LM67048	CONE	TIMKEN	1
33.		LM11910	CUP	TIMKEN	1
34.		LM67010	CUP	TIMKEN	1
35.		409909	WASHER, RETAINING		1
36.		409910	WASHER, FLAT		1

408829
SIDE GUIDE ROLLER ASSY.

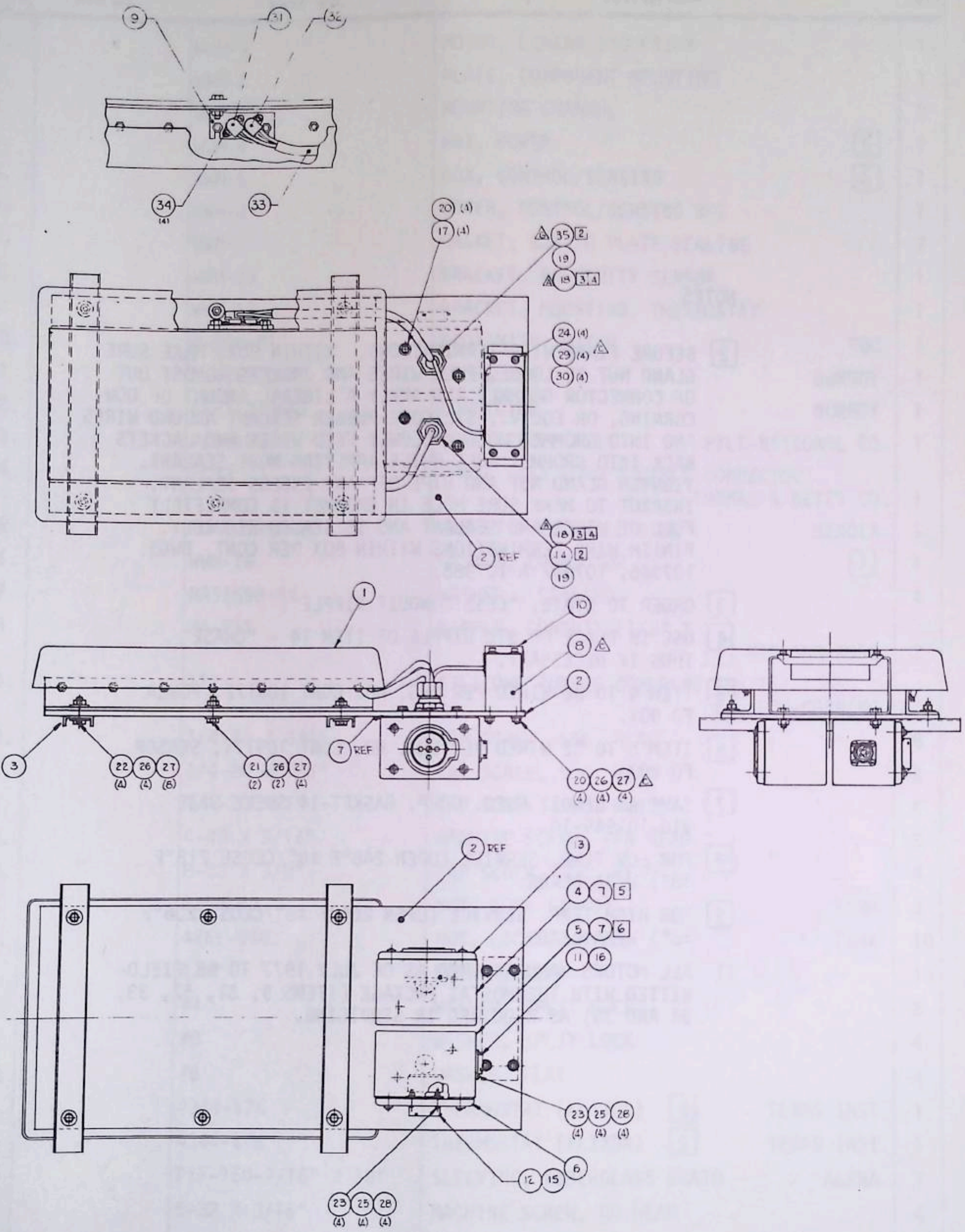


ITEM	WDP NO.	PART NO.	DESCRIPTION		QTY.
1.		408831	WHEEL		1
2.					
3.		LM67048	CONE	TIMKEN	1
4.		LM11910	CUP	TIMKEN	1
5.		LM67010	CUP	TIMKEN	1
6.		LM11949	CONE	TIMKEN	1
7.		16223CR	SEAL	CHICAGO RAWHIDE	1

408837
WHEEL ASSY., SIDE GUIDE ROLLER

5. DRIVE MODULES

The following illustrations are assembly drawings of a linear drive module and a linear motor, respectively. The linear motor is the main subassembly of the drive module.



WWM-1
LINEAR DRIVE MODULE (STANDARD)
SHEET 1 of 2

NOTES

[2] BEFORE FINAL WIRE TERMINATIONS. WITHIN BOX, MAKE SURE GLAND NUT IS LOOSE, PULL WIRES AND JACKETS ALMOST OUT OF CONNECTOR GROMMET AND APPLY A LIBERAL AMOUNT OF DOW-CORNING, OR EQUIV., SILICONE RUBBER SEALANT AROUND WIRES AND INTO GROMMET HOLE. SLOWLY FEED WIRES AND JACKETS BACK INTO GROMMET HOLE WHILE APPLYING MORE SEALANT. TIGHTEN GLAND NUT AND WIPE OFF ANY EXCESS SEALANT. INSPECT TO MAKE SURE HOLE IN GROMMET IS COMPLETELY FULL OF WIRES AND SEALANT AND IS SEALED SECURELY. FINISH WIRE TERMINATIONS WITHIN BOX PER CONT. DWGS: 107986, 107987 & 107988.

[3] ORDER TO STATE, "LESS CONDUIT NIPPLE".

[4] USE IN PLACE OF STD NIPPLE OF ITEM 14 - "CHASE" THDS IF NECESSARY.

[5] ITEM 4 TO BE WIRED PER DWG. NO. CONT 109172, POWER FD BOX.

[6] ITEM 5 TO BE WIRED PER DWG. NO. CONT 109171, SENSOR FD BOX.

[7] SAME AS BENDIX ELEC. CORP. GASKET-14 SHELL SIZE #10-101949-14.

[8] FOR LOW TEMP. SERVICE (OPEN 248°F ±8°/CLOSE 218°F ±8°) W/2A LEADS.

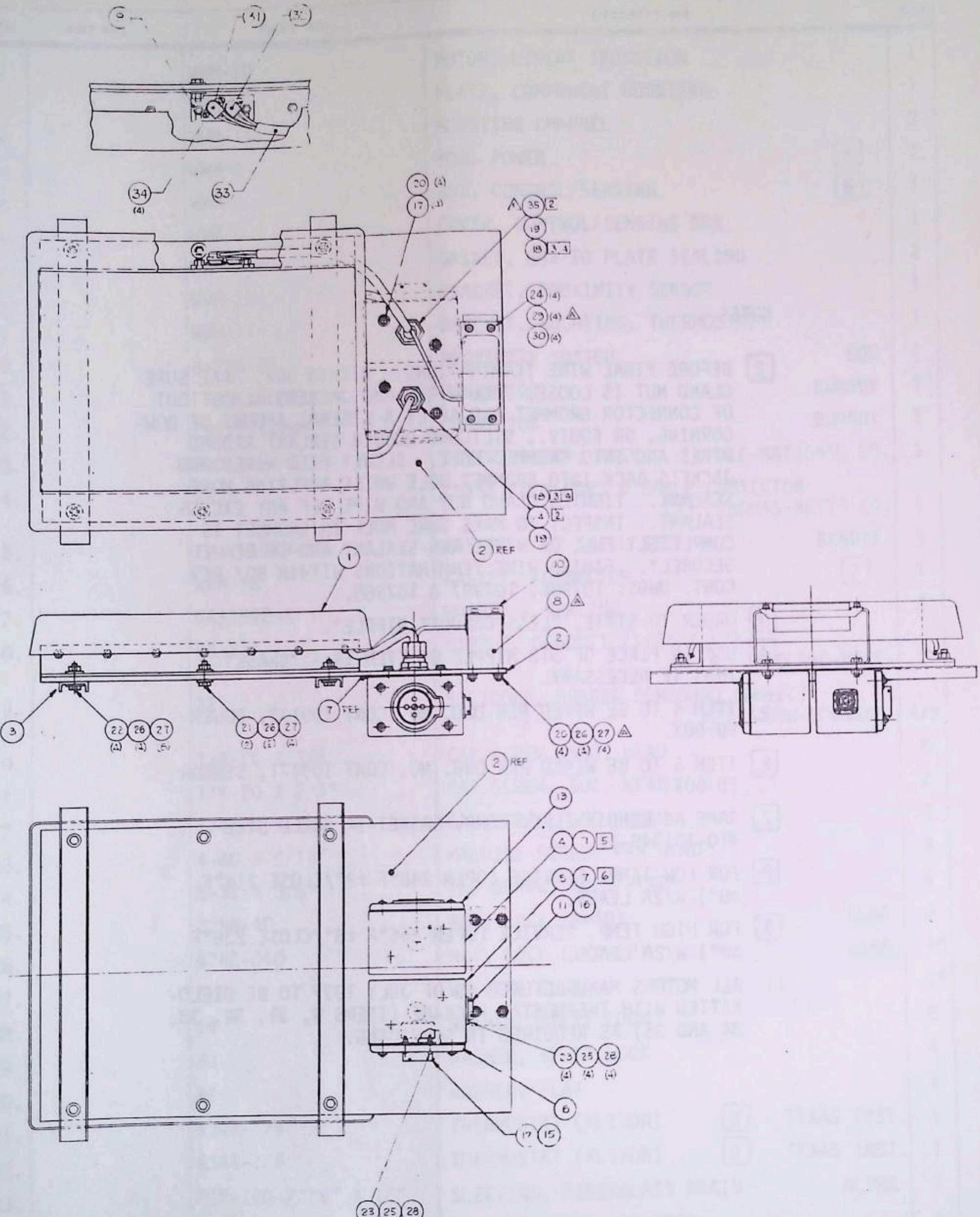
[9] FOR HIGH TEMP. SERVICE (OPEN 266°F ±8°/CLOSE 236°F ±8°) W/2A LEADS.

11 ALL MOTORS MANUFACTURED AS OF JULY 1977 TO BE FIELD-KITTED WITH THERMOSTAT PACKAGE (ITEMS 9, 31, 32, 33, 34 AND 35) AS REQUIRED IN SERVICING.

WWM-1
LINEAR DRIVE MODULE (STANDARD)
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		WWM-9	MOTOR, LINEAR INDUCTION	1
2.		WWM-2	PLATE, COMPONENT MOUNTING	1
3.		WWM-3	MOUNTING CHANNEL	2
4.		WWM-4	BOX, POWER 5	1
5.		WWM-5	BOX, CONTROL/SENSING 6	1
6.		WWM-6	COVER, CONTROL/SENSING BOX	1
7.		WWM-7	GASKET, BOX TO PLATE SEALING	2
8.		WWM-15	BRACKET, PROXIMITY SENSOR	1
9.		WWM-17	BRACKET, MOUNTING, THERMOSTAT	1
10.		8-205-01	PROXIMITY SWITCH EDC	1
11.		L14TE5SON1	CONNECTOR BURNDY	1
12.		L22TE21PON1	CONNECTOR BURNDY	1
13.		P206183	COVER/RECEP ASSY PYLE-NATIONAL CO.	1
14.		2632	CHASE FLEX CORD & CABLE CONNECTOR 3 THOMAS & BETTS CO.	1
15.		10-101949-22	GASKET - 22 SHELL SIZE BENDIX	1
16.		WWM-16	GASKET, CONNECTOR 7	1
17.		NAS1598-AY	WASHER - SEALING	4
18.		HA-211	NIPPLE, CONDUIT (1/2" X 1") 4 MIDLAND-ROSE	2
19.		111	SILICONE RUBBER COMPOUND (WHITE) 2 DOW-CORNING	A/R
20.		1/4-20 X 3/4"	CAP SCREW, SOC. HEAD	8
21.		1/4-20 X 7/8"	CAP SCREW, SOC. HEAD	2
22.		1/4-20 X 1"	CAP SCREW, SOC. HEAD	4
23.		4-40 X 9/16"	MACHINE SCREW, PAN HEAD	8
24.		8-32 X 3/8"	CAP SCREW, SOC. HEAD	4
25.		22NM-40	NUT, LOCK (4-40) ESNA	8
26.		42NE-040	NUT, LOCK (1/4-20) ESNA	10
27.		1/4"	WASHER, FLAT	16
28.		#4	WASHER, SPLIT LOCK	8
29.		#8	WASHER, SPLIT LOCK	4
30.		#8	WASHER, FLAT	4
31.		4344-176	THERMOSTAT (KLIXON) 8 TEXAS INST.	1
32.		4344-176	THERMOSTAT (KLIXON) 9 TEXAS INST.	1
33.		PIF-150-7/16" X 18"	SLEEVING, FIBERGLASS BRAID ALPHA	1
34.		6-32 X 3/16"	MACHINE SCREW, RD HEAD	4
35.		2633	CHASE FLEX CORD & CABLE CONNECTOR THOMAS & BETTS CO.	1

WWM-1
LINEAR DRIVE MODULE (STANDARD)



WWM-13
LINEAR DRIVE MODULE (WIDE)
SHEET 1 of 2

NOTES

2 BEFORE FINAL WIRE TERMINATIONS. WITHIN BOX, MAKE SURE GLAND NUT IS LOOSE, PULL WIRES AND JACKETS ALMOST OUT OF CONNECTOR GROMMET AND APPLY A LIBERAL AMOUNT OF DOW-CORNING, OR EQUIV., SILICONE RUBBER SEALANT AROUND WIRES AND INTO GROMMET HOLE. SLOWLY FEED WIRES AND JACKETS BACK INTO GROMMET HOLE WHILE APPLYING MORE SEALANT. TIGHTEN GLAND NUT AND WIPE OFF ANY EXCESS SEALANT. INSPECT TO MAKE SURE HOLE IN GROMMET IS COMPLETELY FULL OF WIRES AND SEALANT AND IS SEALED SECURELY. FINISH WIRE TERMINATIONS WITHIN BOX PER CONT. DWGS: 107986, 107987 & 107988.

3 ORDER TO STATE, "LESS CONDUIT NIPPLE".

4 USE IN PLACE OF STD NIPPLE OF ITEM 14 - "CHASE" THDS IF NECESSARY.

5 ITEM 4 TO BE WIRED PER DWG. NO. CONT 109172, POWER FD BOX.

6 ITEM 5 TO BE WIRED PER DWG. NO. CONT 109171, SENSOR FD BOX.

7 SAME AS BENDIX ELEC. CORP. GASKET-14 SHELL SIZE #10-101949-14.

8 FOR LOW TEMP. SERVICE (OPEN 248°F ±8°/CLOSE 218°F ±8°) W/2A LEADS.

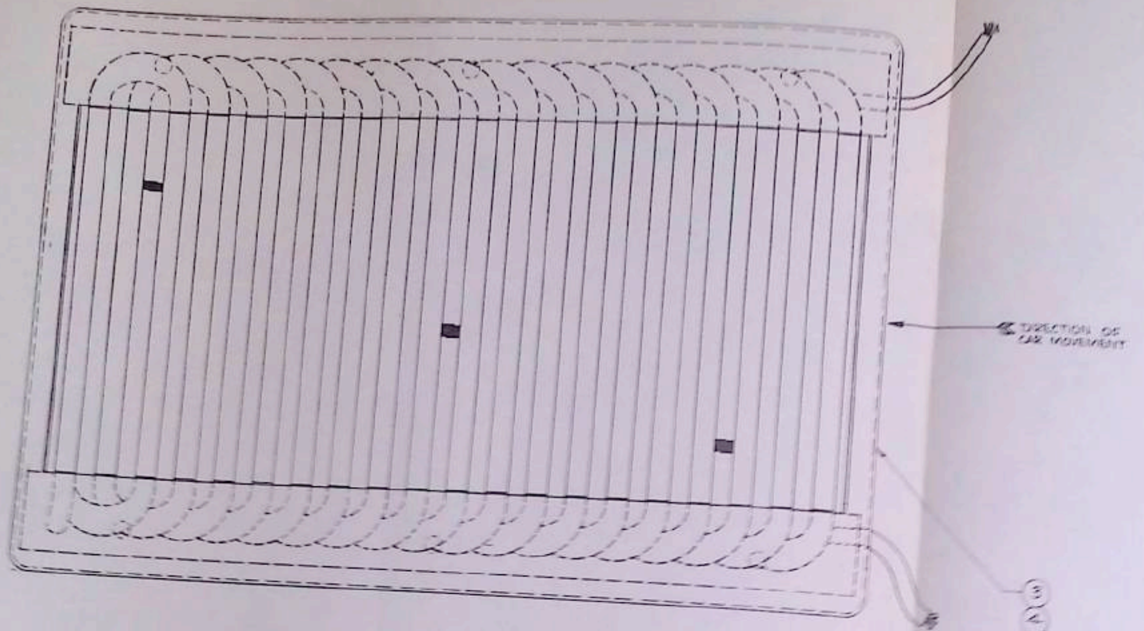
9 FOR HIGH TEMP. SERVICE (OPEN 266°F ±8°/CLOSE 236°F ±8°) W/2A LEADS.

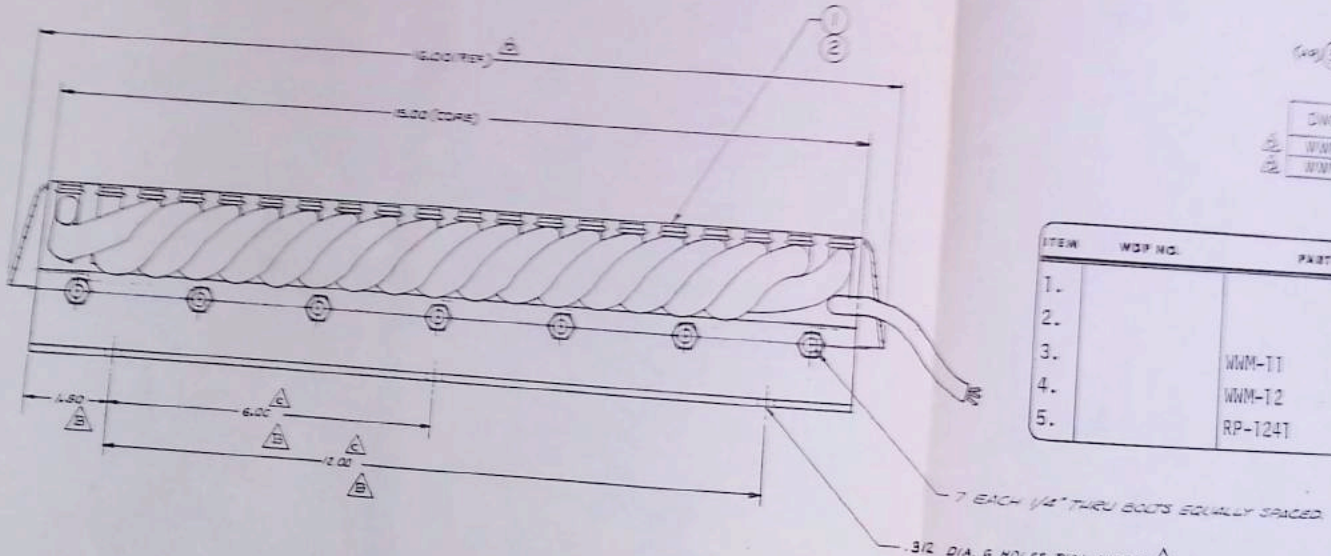
11 ALL MOTORS MANUFACTURED AS OF JULY 1977 TO BE FIELD-KITTED WITH THERMOSTAT PACKAGE (ITEMS 9, 31, 32, 33, 34 AND 35) AS REQUIRED IN SERVICING.

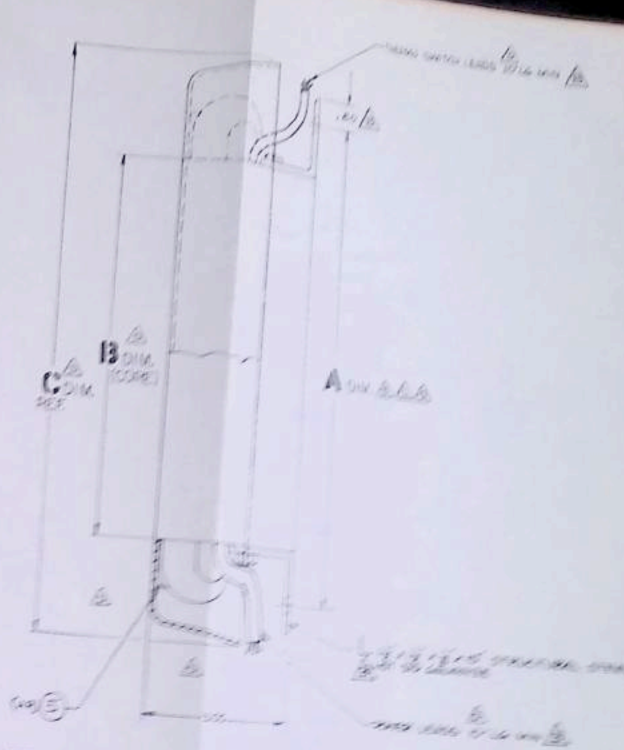
WWM-13
LINEAR DRIVE MODULE (WIDE)
SHEET 2 of 2

ITEM	WDP NO.	PART NO.	DESCRIPTION	QTY.
1.		WWM-10	MOTOR, LINEAR INDUCTION	1
2.		WWM-8	PLATE, COMPONENT MOUNTING	1
3.		WWM-14	MOUNTING CHANNEL	2
4.		WWM-4	BOX, POWER 5	1
5.		WWM-5	BOX, CONTROL/SENSING 6	1
6.		WWM-6	COVER, CONTROL/SENSING BOX	1
7.		WWM-7	GASKET, BOX TO PLATE SEALING	2
8.		WWM-15	BRACKET, PROXIMITY SENSOR	1
9.		WWM-17	BRACKET, MOUNTING, THERMOSTAT	1
10.		8-205-01	PROXIMITY SWITCH EDC	1
11.		L14TE5SON1	CONNECTOR BURNDY	1
12.		L22TE21PON1	CONNECTOR BURNDY	1
13.		P206183	COVER, RECEP. ASSY PYLE-NATIONAL CO.	1
14.		2632	CHASE FLEX CORD & CABLE CONNECTOR 3 THOMAS-BETTS CO.	1
15.		10-101949-22	GASKET - 22 SHELL SIZE BENDIX	1
16.		WWM-16	GASKET, CONNECTOR 7	1
17.		NAS1598-AY	WASHER - SEALING	4
18.		HA-211	NIPPLE, CONDUIT (1/2" X 1") 4 MIDLAND-ROSE	2
19.		111	SILICONE, RUBBER COMPOUND (WHITE) 2 DOW-CORNING	A/R
20.		1/4-20 X 3/4"	CAP SCREW, SOC. HEAD	8
21.		1/4-20 X 7/8"	CAP SCREW, SOC. HEAD	2
22.		1/4-20 X 1"	CAP SCREW, SOC. HEAD	4
23.		4-40 X 9/16"	MACHINE SCREW, PAN HEAD	8
24.		8-32 X 3/8"	CAP SCREW, SOC. HEAD	4
25.		22NM-40	NUT, LOCK (4-40) ESNA	8
26.		42NE-040	NUT, LOCK (1/4-20) ESNA	10
27.		1/4"	WASHER, FLAT	16
28.		#4	WASHER, SPLIT LOCK	8
29.		#8	WASHER, SPLIT LOCK	4
30.		#8	WASHER, FLAT	4
31.		4344-176	THERMOSTAT (KLIXON) 8 TEXAS INST.	1
32.		4344-176	THERMOSTAT (KLIXON) 9 TEXAS INST.	1
33.		PIF-150-7/16" X 18"	SLEEVING, FIBERGLASS BRAID ALPHA	1
34.		6-32 X 3/16"	MACHINE SCREW, RD HEAD	4
35.		2633	CHASE FLEX CORD & CABLE CONNECTOR THOMAS & BETTS CO.	1

WWM-13
LINEAR DRIVE MODULE (WIDE)







DWG. NO.	A DIM.	B DIM.	C REF DIM.	NEXT ASSY.	NO. REQ'D	FINAL ASSY.
WWM-9	9.00	[illegible]	10.75	WWM-1	[illegible]	WWM-1
WWM-10	12.00	[illegible]	4.25	WWM-13	[illegible]	WWM-13

ITEM	WSP NO.	PART NO.	DESCRIPTION	-9 QTY	-10 QTY
1.			LINEAR INDUCTION MOTOR	1	
2.			LINEAR INDUCTION MOTOR		1
3.		WWM-T1	PROTECTIVE COVER	1	
4.		WWM-T2	PROTECTIVE COVER		1
5.		RP-1241	BONDING ADHESIVE REN PLASTICS	A/R	A/R

WWM-9/-10
LINEAR INDUCTION MOTOR

SECTION 2

ELECTRICAL

FOR ADDITIONAL DETAILED ENGINEERING INFORMATION ON ASSEMBLIES/ SUB-ASSEMBLIES APPEARING IN THE ELECTRICAL SECTION OF THIS MANUAL CONTACT: DEPARTMENT HEAD - ELECTRICAL ENGINEERING - MAPO.

SECTION 2

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

1. GENERAL DESCRIPTION

1-1 INTRODUCTION

The following paragraphs contain general information not presented elsewhere in this manual and not necessarily pertinent to maintenance of the WEDWAY People Mover. This information is presented for familiarization purposes, principally in a physical sense.

1-2 TRACK

The mainline track covers approximately 7/8 mile with a minimum curve radius of 20 feet. The storage track (inside Space Mountain) covers 789 feet and has a 121-foot maintenance spur.

1-3 TRAINS

The number of 5-car trains varies from 19 to 32. The ride can handle up to 3,750 passengers per hour. Bumper-to-bumper length of a train is 41.75 feet. Car wheel base is 54 inches. Unladen weight of a train is 4,100 pounds and maximum gross weight is 7,500 pounds.

Ride speeds are as follows: up to 2.2 feet per second (F.P.S.) in the station; 3 to 4 F.P.S. in display areas; and approximately 10 F.P.S. (7 M.P.H.) between display areas.

Rolling resistance of a train at gross weight is approximately 65 pounds on straight track and 88 pounds on curves.

1-4 PROPULSION CONTROL

Over 700 linear induction motor assemblies provide propulsion for the trains. These are mounted at intervals along the track with associated speed and proximity sensors. The trains are moved by electromagnetic interaction (induction) between the linear motors and car-mounted platens. Power to the motors is controlled by electronic logic circuitry.

Most of the logic and associated electronic circuitry is housed in cabinets at strategic points along the route. There are 24 Wedway controllers, each consisting of 2 power cabinets, a lightning protection cabinet, and a motor logic cabinet.

Each power cabinet basically consists of 32 motor power PCBs, a load center assembly, a motor termination panel assembly, a transformer panel assembly, a power terminal panel assembly, and a contactor panel assembly.

Each lightning protection cabinet basically consists of 16 lightning protection panel assemblies and two sensor power supply assemblies.

Each motor logic cabinet houses an intercom panel, a sensor power supply, up to 32 motor logic PCBs, a data coupler PCB, 2 timing logic PCBs, 32 sensor interface PCBs, a 5-volt source panel, an Elco connector panel, a cook block assembly, a data coupler power supply assembly, and miscellaneous electronic circuitry.

1-5 TRACK SWITCHING

Eight track switches in Space Mountain are used to switch between the main line and the storage track and between the storage track and the maintenance spur. The switches themselves are operated by pneumatic actuators, which are controlled electrically via the 5 track switch control boxes (also located in Space Mountain).

1-6 OPERATOR CONTROLS

The ride is controlled from the ride control console at the station. Additionally, there are storage consoles along the route with EMERGENCY STOP pushbuttons.

In Space Mountain there is a storage track motor control console for propulsion control in the storage track and on the maintenance spur.

2. GENERAL OPERATION

2-1 INTRODUCTION

The ride is locally controlled with automatic adjustment of each motor in response to discrepancies in train speed as measured at each motor. Special operations such as adding or deleting cars, track switching, etc. are under manual control.

Provision is made for DACS computer control of the ride at a future date. Such automatic operation would supplement local control by adjusting speeds to compensate for position errors and by performing certain special operations.

2-2 STATION CONSOLE

Controls and indicators for the ride and the load/unload turntable are located on the station console. The operator controls the ride and monitors the status indicators at the console. The following table lists the functions of the various controls and indicators. Refer to figure 2-1.

RIDE CONSOLE CONTROLS AND INDICATORS

PLACARD NOMENCLATURE	REF. DES.	FUNCTION
EMERGENCY STOP LAMP	S3	Resets alarm and annunciator after occurrence of an alarm.
COMPUTER INHIBIT	S9	Allows or inhibits computer control of ride.
COMPUTER READY	DS3	Comes on green when computer is ready to be selected for ride control.
RIDE START-UP	S2	In STOP position, gives run inhibit. Gives start command when turned cw.
JOG FORWARD ZONE 1	PB4	Overrides automatic speed control in unload area to keep trains bumper to bumper.
JOG FORWARD ZONE 2	PB5	Same as above for load area.
EMERGENCY STOP	PB151	Reverses all platen-covered motors immediately.

RIDE CONSOLE CONTROLS AND INDICATORS (CONT.)

PLACARD NOMENCLATURE	REF. DES.	FUNCTION
DRIVES ON NO. 1 thru NO. 6	R1L1	Come on red when drive motor contactors are energized.
TURNTABLE MOTOR START	PB161	Energizes all motor contactors.
TURNTABLE MOTOR STOP	PB171	Deenergizes all motor contactors.
TRAINS IN SERVICE	S7	Sets turntable speed appropriate for number of trains in use.
RIDE MASTER	S1	Master ride on-off control.
RUN	PL2A	Comes on red when turntable is running.
STOP	PL1A	Comes on amber when turntable is stopped.
TURNTABLE SYSTEM START	PB141	Energizes all eddy current coupling circuits.
TURNTABLE SYSTEM STOP	PB131	Opens circuit to eddy current coupling circuits.
POWER ON	DS4	Comes on red when power is applied to ride console.
RIDE STATUS-101-102	S4	Used to alert operations of an outage, or "101" condition.
EMERGENCY LIGHTING	S8	Controls ride emergency lighting system.
SHOW	S5	Controls lighting in model city display.
TEST	S6	Tests indicators in annunciator display.
Route off-normal indicators	*	Come on red when there is an off-normal condition at the appropriate location.
Annunciator Indicators		Go-no-go indicators of the appropriate functions (red-green).
EMERGENCY STOP UPRAMP	S10	Removes power from up-ramp
EMERGENCY STOP DOWN RAMP	S11	Removes power from down ramp

* DS5-27, 38-42, 44, 45, and 46

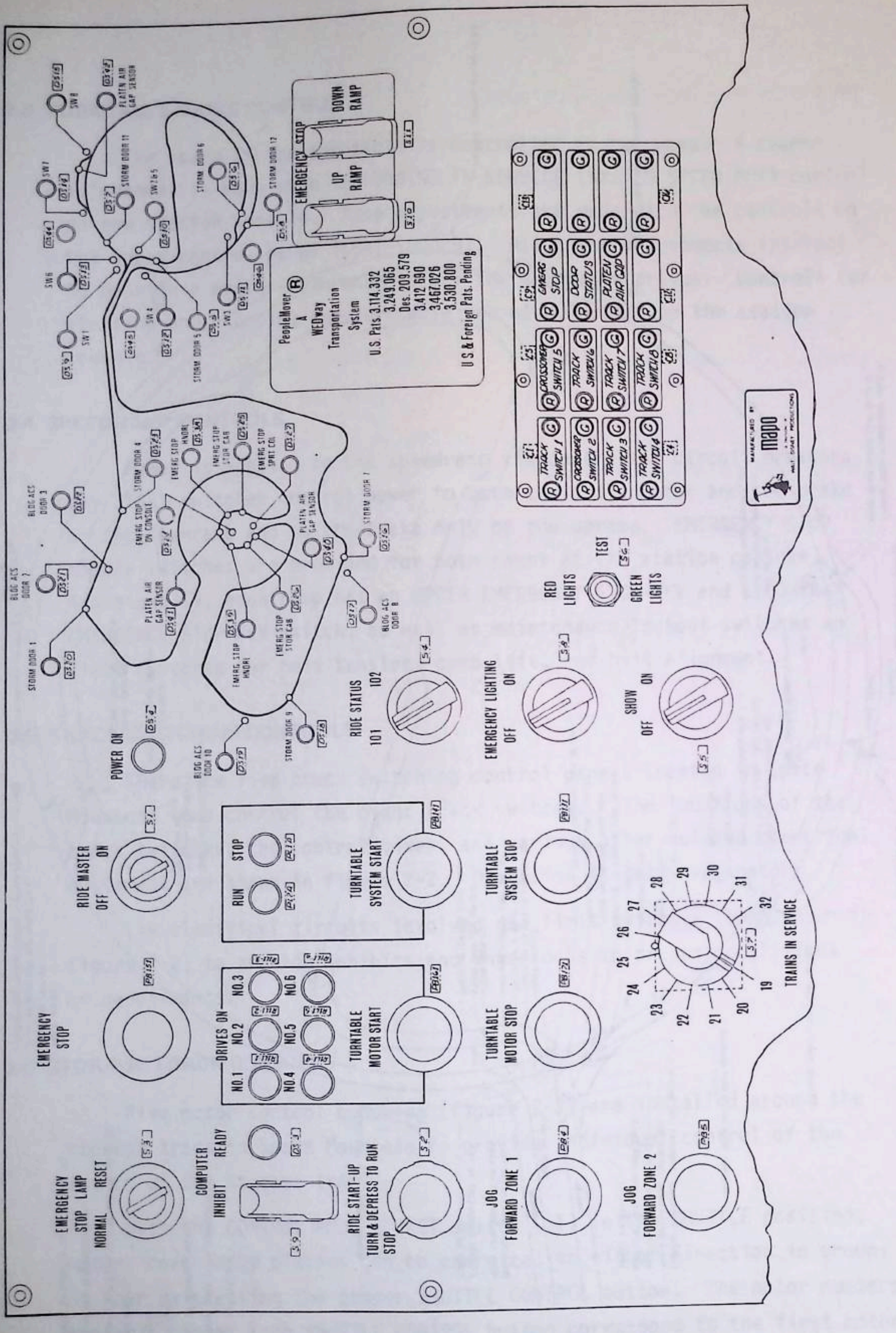


FIGURE 2–1
STATION CONSOLE RIDE CONTROLS AND INDICATORS

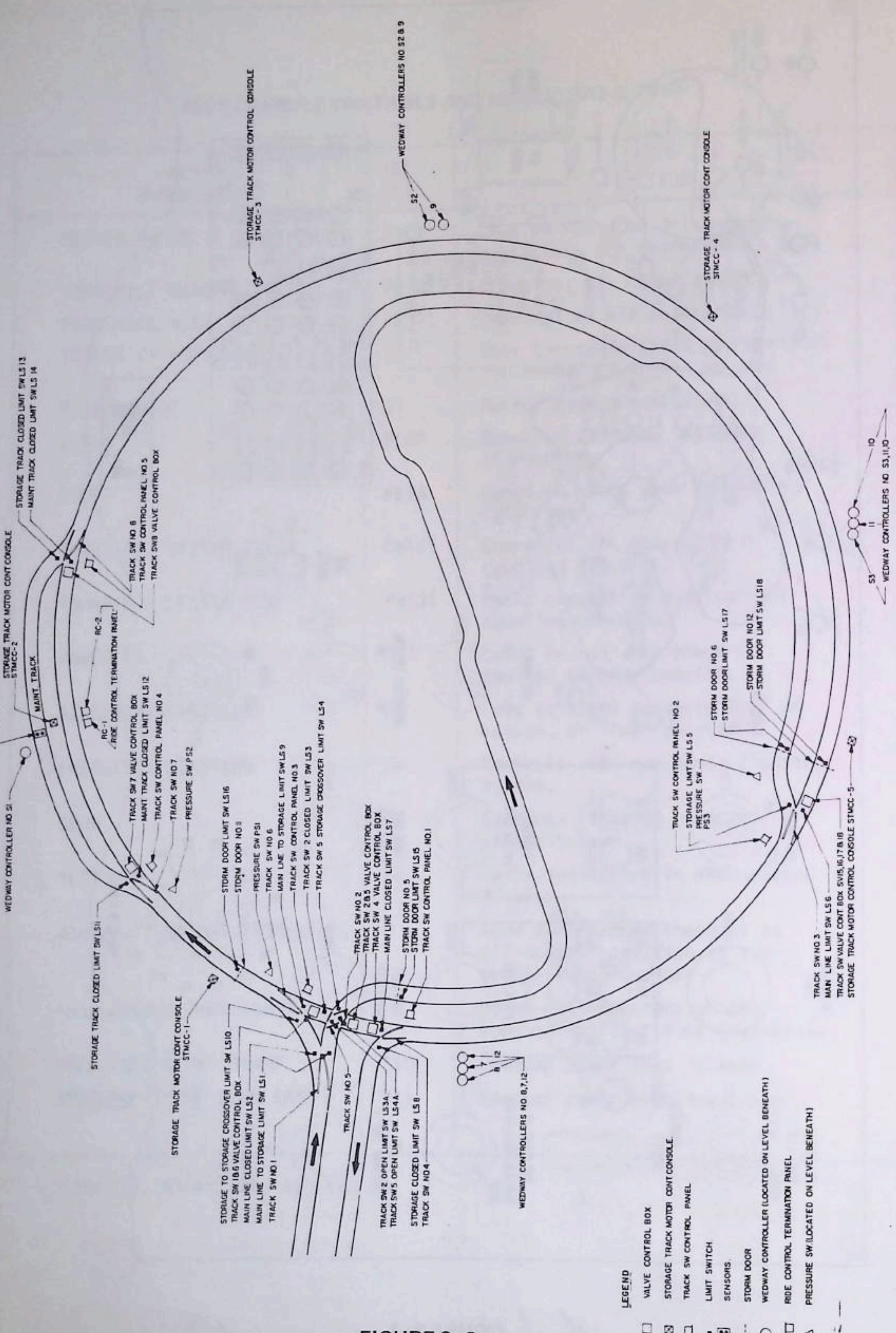


FIGURE 2–2
SPACE MOUNTAIN WEDWAY ELECTRICAL EQUIPMENT LOCATION

2-3 TURNTABLE DRIVE CONTROL

The speed of the turntable is controlled in two ways. A coarse adjustment is made with the TRAINS IN SERVICE (SYSTEM SPEED POT) control on the station console. Fine adjustments are made with the controls on the speed control panel (CONT-109029). All these adjustments interact to provide a master reference to all the turntable drives. Controls for starting and stopping the turntable are also located on the station console.

2-4 SPEEDRAMP CONTROLS

Power is applied to the speedramp via controller circuit breakers. Key START switches control power to both the drive motor and the brake on the downramp and to the brake only on the upramp. EMERGENCY STOP toggle switches are provided for both ramps at the station console. Additionally, each ramp has an UPPER EMERGENCY STOP-REV and a LOWER EMERGENCY STOP-REV switch, as well as maintenance lockout switches and limit switches for belt tension, comb lift, and belt alignment.

2-5 TRACK SWITCHING CONTROLS

There are five track switching control panels located in Space Mountain that control the eight track switches. The locations of the track switches, the control boxes, and various other related electrical equipment are shown in figure 2-2. Operation is self-explanatory.

The electrical circuits involved use limit switches (also shown in figure 2-2) to provide inhibits and interlocks to prevent collisions or derailments.

2-6 STORAGE TRACK CONSOLES

Five motor control consoles (figure 2-3) are installed around the storage track in Space Mountain to provide individual control of the motors of the storage track.

With the CONTROL MODE SELECT switch (S1) in the SHUTTLE position, motors covered by platens can be energized in either direction in groups of four by pressing the proper SHUTTLE CONTROL button. The motor numbers appearing under each SHUTTLE CONTROL button correspond to the first motor

2-6 STORAGE TRACK CONSOLES (CONT.)

in a group of four. For maintenance or other purposes, the track switches can be set to form a continuous loop in Space Mountain. The CONTROL MODE SELECT switch should be in the NORMAL position and the NORMAL CONTROL switch should be in the RUN ENABLE position for maintenance track loop operation. The trains are started with the NORMAL CONTROL PUSH TO START button.

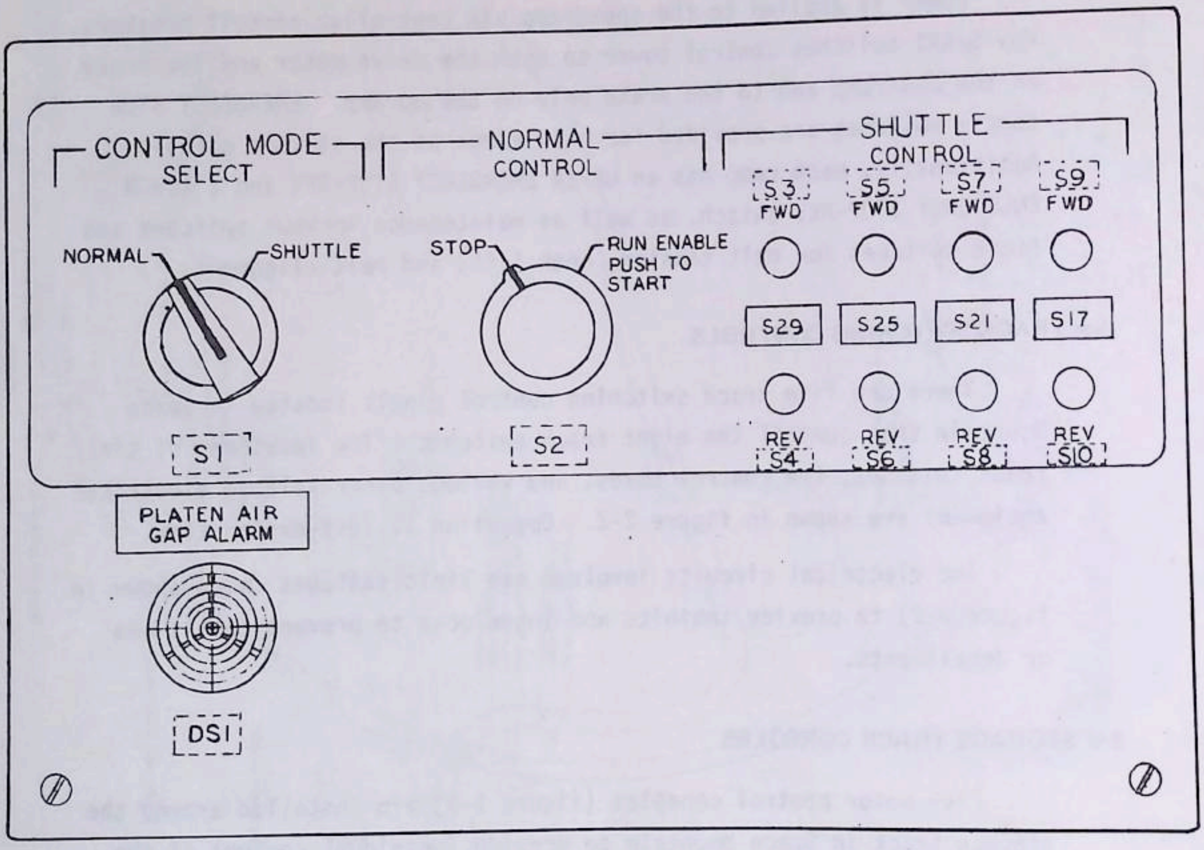


FIGURE 2 – 3
STORAGE TRACK MOTOR CONTROL CONSOLE CONTROLS AND INDICATORS

3. THEORY OF OPERATION

3-1 INTRODUCTION

This section attempts to explain how the electrical elements and subsystems of the ride interact when the ride is in operation. Figure 3-1 is a block diagram of the ride electrical equipment. For discussion purposes only, the block diagram is divided into four functional areas or subsystems (dotted lines).

Basically, the motor control subsystem functions to vary the amount of power applied to each linear induction motor in accordance with information gathered from the sensors. Sensor data is also transmitted to the monitor subsystem, which processes all the sensor information for storage and display at DACS. The sensors feed six remote computers, which are connected to a central processor at DACS. Provision is made for the ride to be controlled via DACS but the necessary software is not available at this time.

The Wedway station subsystem consists of the electrical equipment that controls power to the motor control subsystem and to the turntable and the speedramps.

The storage and maintenance track subsystem includes the electrical track switching controls and the storage and maintenance track drive motor controls. The ride control console has no control over the storage and maintenance tracks. Trains must be moved on these tracks with the local controls within Space Mountain.

The following paragraphs contain functional descriptions of elements of the system with little regard for their interrelationships with other elements. These descriptions are keyed to the appropriate schematic and logic diagrams toward the back of the manual. The theory of operation of non-repairable (replaceable) items is not given here since it is not necessary to have intimate knowledge of the workings of an item that is simply replaced when it fails (potted units, for example).

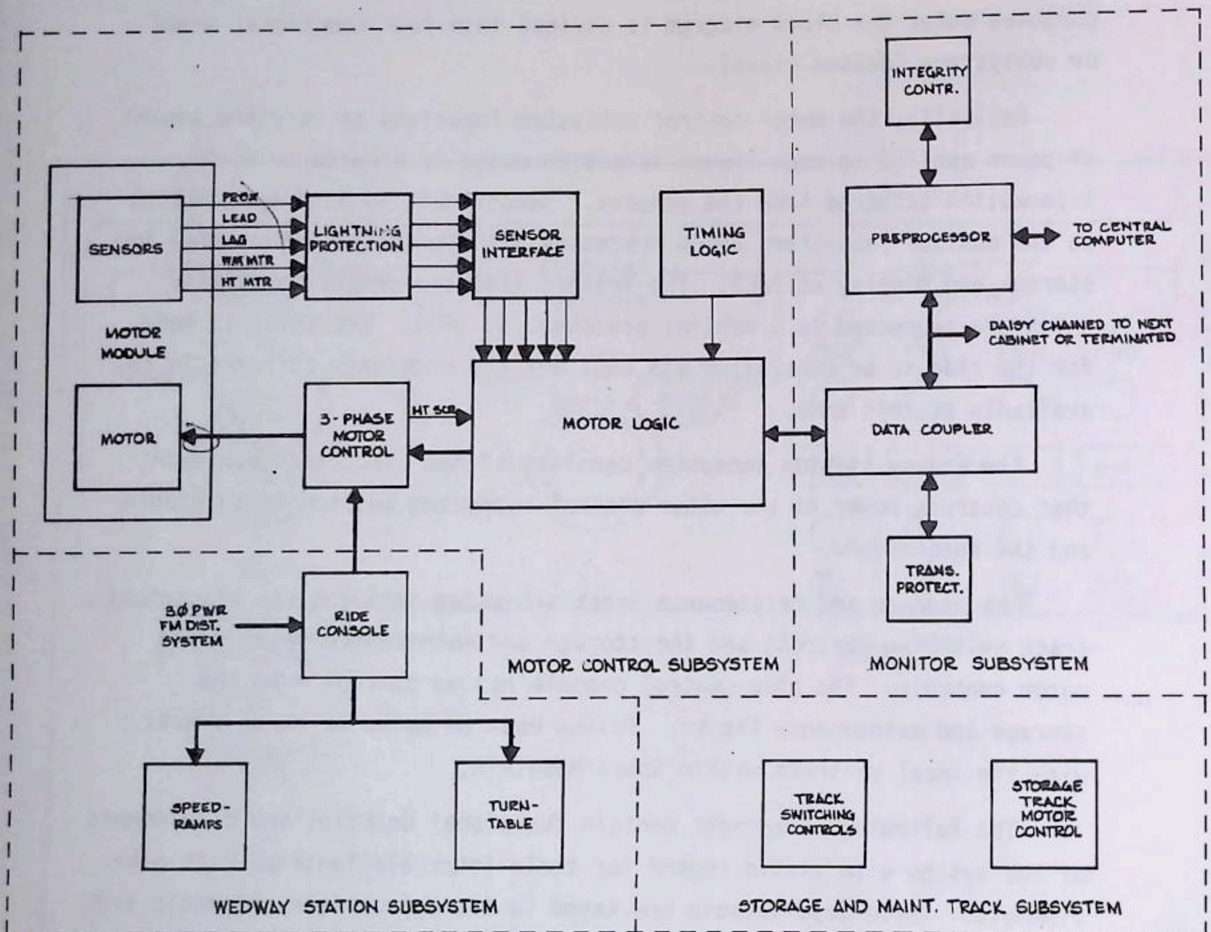


FIGURE 3 – 1
RIDE CONTROL FUNCTIONAL BLOCK DIAGRAM

3-2 STATION CONSOLE

Figures 6-1 through 6-6 are schematic diagrams of the circuitry inside the station console. Operation of the various switches, indicators, and associated relay circuitry is self explanatory. A complete wiring diagram of the console may be obtained from engineering (dwg. no. CONT-109059).

3-3 MOTOR ASSEMBLIES

Figure 3-2 is a representation of a motor assembly. Three-phase power is applied to the motor windings via one FS box while the other FS box handles the sensor information. Power is applied to alternate motors from two separate sources enabling operation for a minimum of one complete cycle on a 90° F day with one power source inoperative.

Two types of motors are used - a heavy duty (35% duty rating) unit for acceleration and station use, and the standard (25% duty rating) motor.

The proximity switch actuates when a train-mounted metal target is sensed. The speed sensor consists of two infra red light transmitters and receivers (LEAD and LAG) mounted a fixed distance apart. Train wheel bogeys interrupt the light beams and the logic circuitry determines speed and direction accordingly. In some areas, two speed sensors per motor are used to smooth the low speed control function.

The proximity sensors are also used to create a fixed gap between trains by inhibiting a number of motors behind a train (logic signal TRAIN AHEAD).

3-4 POWER CABINETS

There are two power cabinets per controller. Each has up to 32 three-phase motor control PCBs, a motor termination panel, a 5 VDC power panel, a transformer panel, a contactor panel, an Elco mounting panel, a power terminal panel, a Wedway power panel, and a 24 KVAR capacitor tray. Operation of all but the motor control PCBs is self explanatory. Refer to the reference drawing list for appropriate schematics and wiring diagrams.

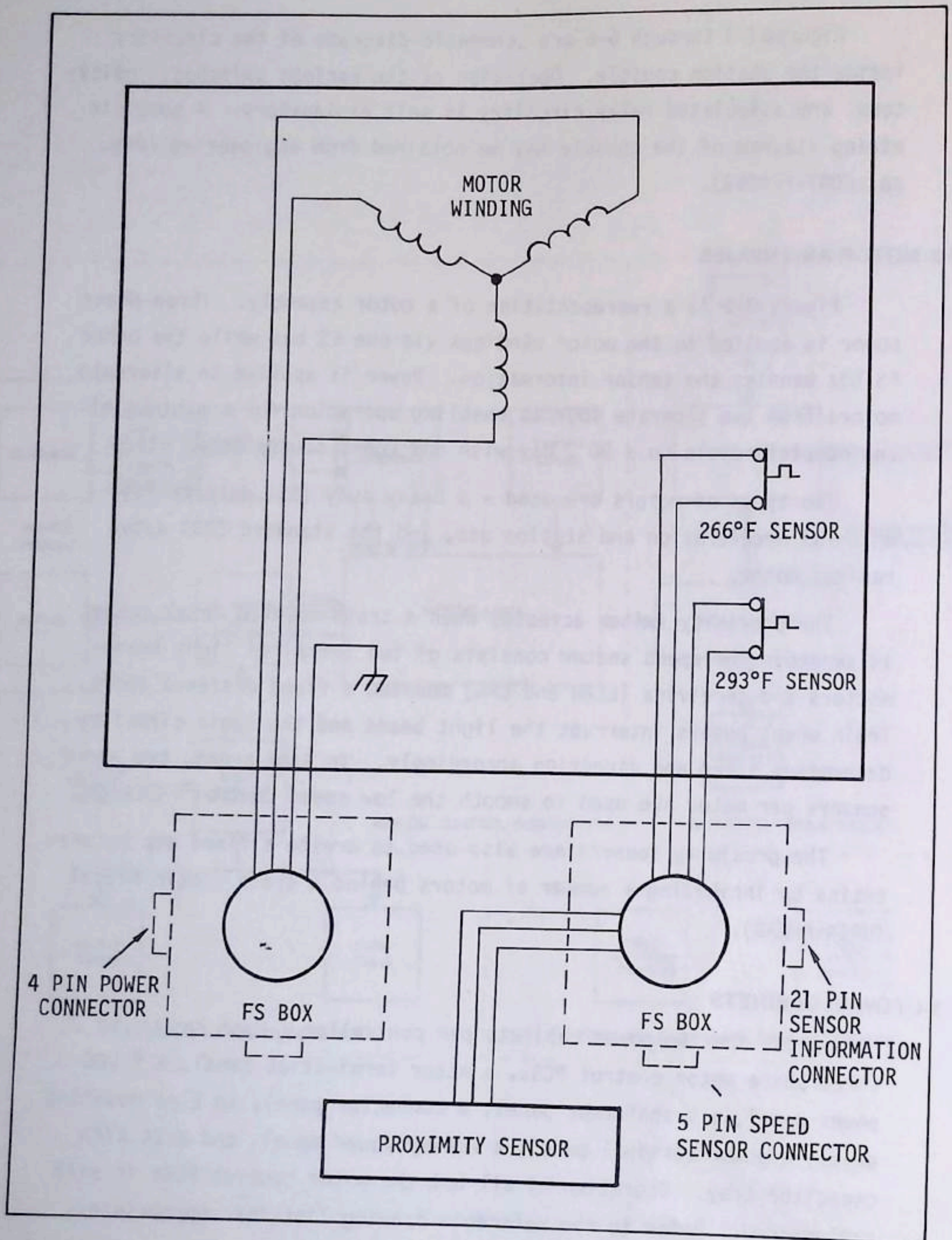


FIGURE 3 – 2
WEDWAY MOTOR ASSEMBLY

Figure 6-7 is a schematic diagram of the three-phase motor control PCB. This board proportionally feeds three-phase, 240-volt power to the linear induction motor windings. The power is isolated from the logic by optical couplers that have very high breakdown voltage (over 2KV).

Sheets 1, 2, and 3 show how the three phases are isolated and floating; each having a separate d-c power supply from a different transformer winding. The SCRs (CR1 through CR10, sheet 4) have a gate firing current of from 15 to 40 milliamperes.

Proportional control is fed to the gates to give the correct speed. Reverse or braking is accomplished by swapping the A and B phases. Inhibit control is fed to the idle drivers, shorting bases to emitters to prevent cross firing.

A 20-ampere fuse mounted on the rear of the heat sink limits card damage in the event of accidental shorting of the A and B phases. The fuse is monitored by two photo optic devices (OP-21 and U2 on PCB-2). OP-21 controls the red neon indicator on the front panel. The amber neon (L1) indicates current through the SCRs. On PCB-2, U1 (in conjunction with SCR Q1) in series with thermal switch S1 inhibits motor drive from the motor logic card by sending a HOT SCR signal to the motor logic. Thermal switch U2 also generates a HOT SCR signal if heat sink temperature exceeds 200° F.

Arc quenchers are installed across the A and B phase SCRs to overcome prefiring.

Maintenance personnel should be aware of the following WARNINGS pertaining to this board:

1. Never remove or insert the board with power applied.
2. The d-c returns have 240VAC potential as they are floating. Isolated or battery powered test equipment must be used when making measurements with the board installed.

Whenever possible, the board should be plugged into the tester for maintenance with only the A and B phase control voltage applied to the isolation transformers.

3-5 LIGHTNING PROTECTION CABINET

Each lightning protection cabinet contains up to 8 lightning protection panels and one sensor power supply. The lightning protection cabinet is cabinet D of each controller. Located electrically between the motor modules and the sensor interface circuits, the lightning protection panel PCBs serve to minimize damage to the system from electrical acts of God.

Figure 6-8 is a simplified schematic diagram of a lightning protection panel PCB. As can be seen from the diagram, all sense lines and sensor power lines are individually protected by lightning arrestor modules (MUSE-108541). Each PCB handles two sets of sense lines and provides short circuit protection for two sensor power lines.

The sensor power supply panel (MUSE-108531) is a simple full-wave rectified 24 VDC power supply. A 2.5A circuit breaker protects both sides of the 230 VAC input.

3-6 MOTOR CABINET

The motor cabinet is cabinet C of each controller. Each motor cabinet contains an Elco connector panel, a sensor module, two card cages, a cook block assembly, a 5-volt source panel, and a data coupler power supply. The card cages contain motor logic, timing logic, data coupler, Nova interface, and integrity-data-control PCBs.

3-6-1 SENSOR INTERFACE PCB

The sensor interface cards receive all the incoming information from the motor modules via the lightning cabinet. Figure 6-9 is a simplified schematic diagram of a sensor interface PCB. The five interface circuits are identical using a differential amplifier to drive an optical coupler.

The sense input is connected to the inverting input of the differential amplifier. Normally, the input is held high, making the output low, thus illuminating the red LED. A sense is characterized by a low input, which drives the differential amplifier output high. The sense also illuminates the green LED and the high output of the amplifier energizes the 4N35 optical coupler, pulling its output (pin 5) to ground.

3-6-1 SENSOR INTERFACE PCB (CONT.)

Thus, ground is the active signal for all sense inputs to the motor logic card, making the sensor interface outputs bar terms as shown on the simplified schematic diagram.

3-6-2 MOTOR LOGIC PCB

Refer to figure 6-10. When the system is in computer control, speed and divide-by information from the computer ($\overline{\text{DATA BIT 0}}$ through $\overline{\text{DATA BIT 15}}$) are fed into latches (sheets 2 and 3) at $\overline{\text{STROBE}}$ time if $\overline{\text{ACTIVITY}}$ is present and the address is correct. The ADDRESS comparator (sheet 1) decodes the address data for the card. If $\overline{\text{TRANSMIT}}$ is present, no data can be received.

The top output of the latch on sheet 3 is COMP CONT * (computer control). The sixth and seventh outputs of the latch are not used. The second, third, fourth, and fifth outputs are gated with COMP CONT * yielding $\overline{\text{MOTOR ON *}}$, $\overline{\text{MOTOR OFF *}}$, $\overline{\text{FWD *}}$, and $\overline{\text{REV *}}$, respectively. These signals are gated with computer inputs coming into the lower part of sheet 3 providing logic inputs to sheet 7.

In computer control mode, the outputs of the latch on sheet 2 are fed into the two multiplexers on sheet 4. The outputs of the lower multiplexer (R4) are side loaded into a counter (R6), which triggers the $F \div X$ signal, which slows down the speed counter clock on sheet 5 to extend proportional control at lower train speeds.

The eight most significant bits from the speed holding register (sheet 5) are applied to the two adders (P6 and N6) on sheet 4. The adder outputs are loaded into comparators (P5 and N5) as long as ENA is true. The N5 outputs become the direction signals (FWD, REV, and A=B) as well as $\overline{\text{ADD}}$. A=B indicates no direction change. $\overline{\text{ADD}}$ is generated when $A > B$ with D3-9 latched true. $A > B$ indicates the train is too slow. $A < B$, then indicates excessive speed and the resulting REV signal then resets the RS flip flop (E3) on sheet 7. A=B and $\overline{\text{ADD}}$ go to sheet 6 providing proportional speed control.

The proximity, lead, and lag sensor terminations are located on sheet 5. PROX SENSE D (proximity sense delayed) is generated by counter C4 and flip flop C5. PROX SENSE D allows a 1/2 second delay to compensate for spaces between cars so the motors will stay on for the entire train. PROX SENSE D also triggers SOUND START and $\overline{\text{TRAIN AHEAD}}$, which are fed to the preprocessor. PROX SENSE D inhibits the multiplexer on sheet 6, disabling the proportional speed control circuits. PROX SENSE D (inverted) also clears the speed count and hold registers allowing a new count to start on the next $\overline{\text{SPEED CLK}}$.

$\overline{\text{LEAD SENSE}}$ and $\overline{\text{LAG SENSE}}$ are triggered with F ÷ X and $\overline{\text{F ÷ X}}$ to generate REV SENSE, LOAD, END, SPD LOAD, READ SPEED, and SPEED CLK. SPD LOAD clocks the speed holding register while SPEED CLK clocks the speed count register. REV SENSE goes true at F ÷ X clock time whenever $\overline{\text{LAG SENSE}}$ preceeds LEAD SENSE.

The sub-count from sheet 5 (counter E7) is exclusive-ORed with $\overline{\text{ADD}}$ on sheet 6. The select input to the K5 multiplexer is A=B. When A=B is true, the multiplexer selects the "A" inputs (pinned high) causing full power to be applied. If A=B is false, the sub-count becomes the address for the PROM (programmable read-only memory), the output of which is side loaded by * LOAD A as a pre-count into the L6 and L7 counters. The counters are clocked by *1 DEG P. When both counters are full, the carry output of L7 triggers two flip flops (N7). The lower flip flop resets the counters until the next * LOAD A pulse. The upper flip flop resets the phase angle register, which generates the three motor power phases (AMP, BMP, and CMP). The motor power phases are shifted by an amount determined by the data stored in the PROM with respect to the line inputs. They are NORed with A360, B360, and C360, which are in phase with the line inputs and applied to the output buffers on sheet 7.

The output of the motor on flip flop (J4-9) is fed to a shift register (E4) that has two outputs. PRE ENA is gated with $\overline{\text{JAM FWD}}$, $\overline{\text{JAM REV}}$, and $\overline{\text{PROX SENSE D}}$ to produce ENA, the computer control enable signal. MTR INH is NANDed with $\overline{\text{HOT MOTOR}}$, $\overline{\text{HOT SCR}}$ and a function of TRAIN AHEAD, FORWARD *, and PROX SENSE D. The resulting MOTOR ENA must be true or motors will not energize.

MOTOR ON is a function of FORWARD, $\overline{\text{FORWARD}}$, and REVERSE. FWD and REV from sheet 4 are connected to the inputs of a J-K flip flop (E3), which is clocked by 6 DEG P. Two D flip flops (J4 and F5) are directly controlled by the two outputs of the J-K flip flop and also clocked by 6 DEG P. The outputs of the two D flip flops produce MOTOR ON.

A full two cycle safety margin (ample time to shut off an SCR) is provided by the two D flip flops (J4 and F5) and the corresponding shift registers (F3 and F4). The two flip flops are latched in opposite states after three $\overline{\text{A360}}$ pulses by the action of the E3 J-K flip flop and the two shift registers.

3-6-3 TIMING LOGIC PCB

Figure 6-11 is a simplified schematic diagram of the timing logic card. Three-phase reference power (6 volts, 60Hz) is applied to the card and termed APH, BPH, and CPH as shown at the left of sheet 1. The three phases are clipped, clamped and applied to a NOR gate. The result is inverted and termed TR PH OUT, a monitor term for checking the presence of all three phases.

A 10MHz crystal oscillator located in position H4 applies 10MHz to a pair of divide-by-16 counters (M3 & M4), the carry output of which (MC ÷ 256) is ANDed with 10MHz and further divided by 6 (modulo counter G4). The output of the modulo counter (153.6-microsecond pulses) is inverted and fed out of the card.

The crystal oscillator output is also applied to the clock input of a D flip flop, which divides the signal by two. Both the true and false outputs (Q and $\bar{Q}$) of the flip flop are used in the following divider chain for synchronization and timing. The 5MHz is used as the clock inputs to a pair of counters (M1 & M2) that are preset to count up to 376 from 31 (octal). The 376 count represents one degree of 60Hz (1 DEG P). The 377 count carry is used to clock the next stage on sheet 2. The two up counters are reset to 31 by the D flip flop/NAND gate combination at F3 and E1, which are driven by the 5MHz from F1-9.

The Q3 output of the G1 modulo counter (sheet 2) is a 6-degree pulse (6 DEG P). The Q1 output of G1 is a 2-degree pulse, which is NANDed with 1 DEG P to drive a flip-flop, the output of which is termed LOAD ANGLE.

3-6-3 TIMING LOGIC PCB (CONT.)

The $\bar{Q}$ output is inverted and termed * LOAD A and fed to all the driver cards. * LOAD A controls the phase control of the drive circuitry.

The next modulo counter (G2) yields a 30-degree pulse that is NANDed with 6 DEG P. The resultant pulse is NORed with 5MHz to drive the next modulo counter (G3). This stage drives a 3-bit shift register made up of a NAND gate at J4 and the two F4 flip flops. The buffered outputs of the shift register are 30Hz square waves termed *$\overline{\text{A360}}$, *$\overline{\text{B360}}$, and *$\overline{\text{C360}}$.

The three modulo counters (G1, G2, and G3) are reset by APH RESET, which comes from F2-9 on sheet 1. This reset signal represents the negative-going axis crossing of the A phase of the 60Hz input via optic isolators H1 and H2.

The lower half of sheet 2 shows common logic buffers. SHUT DOWN inhibits the motors from coming on. START UP applies full forward power to all motors that have a proximity sense. PANIC STOP applies full reverse power to all motors that have a proximity sense until the train stops and reverses. REVERSE SENSE removes power from the motors to which the reverse power is applied. The POWER FACTOR relay (D1) is energized when the track is operating.

3-6-4 DATA COUPLER PCB

Refer to figure 6-12. Address lines from the Nova interface PCB are shown coming into the data coupler PCB at the left of sheets 1 and 2. The two most significant bits represent the cabinet address (LOGIC CAB ADD) and are decoded in accordance with the location of the shorting pin (sheet 1). The balance of the address lines (sheet 2) are buffered by the data coupler and represent the addresses of all the motor logic PCBs in the cabinet.

Since there are two logic card modules per cabinet, it is necessary to invert the LSB of the bottom card module addresses. Although the bottom card module decodes the zero as its address, the actual address from the computer is a one. This inversion enables slot coding for motor logic cards in identical modules. Thus the bottom card module answers to even addresses just as the top one does, but appears to the computer to have odd addresses.

The TRANSMIT LINE signal (sheet 1) indicates when the data coupler PCB is transmitting and the preprocessor is receiving data.

The $\overline{\text{STROBE LINE}}$ comes in on sheet 1 and feeds a time-out circuit on sheet 3 that produces the ACTIVITY signal. If there is no STROBE pulse to reset the counter (B3) in a given time period, the carry output of the counter drops ACTIVITY, which zeros all the latches in the motor logic PCBs.

$\overline{\text{KILL}}$ (sheet 1) is used to prevent random data from entering the motor logic registers. DPACK (data path acknowledge) comes in (sheet 2) and is fed to the preprocessor with the KILL output. $\overline{\text{CAB ACT}}$ (CAB SEL and ACTIVITY) gate DPACK through the data coupler.

The INH COMP switch (sheet 1) is used to inhibit computer control of the card without affecting the monitoring function. The INH COMP SIG is from a switch on the main ride console that is also used to kill computer control. The $\overline{\text{INH}}$ signal gates $\overline{\text{ACTIVITY}}$ to the motor logic cards (sheet 3).

The two clocks feeding the time-out circuit on sheet 3 come from the two logic card modules. The circuit allows approximately 1/2 second delay between STROBE pulses before dropping ACTIVITY. Once ACTIVITY is dropped and another STROBE pulse is received, it can take as long as 16.6 milliseconds before ACTIVITY is restored as the A360 rate is that of the 60Hz power frequency.

The data lines (sheet 4) are bidirectional. Both cabinet and motor logic card addresses are necessary before data can be transmitted or received.

When there is no activity, all address lines to the motor logic cards go to address 31, as the $\overline{\text{CAB ACT}}$ line deactivates the line receivers (sheet 2) driving all outputs high (address 31).

3-6-5 NOVA INTERFACE PCB

Refer to figure 6-13. The control signals from the computer are applied (via the mother board) to the card at sheet 1. $\overline{\text{DS0}}$ through $\overline{\text{DS5}}$ are decoded into device codes (DEV 60, DEV 61, and DEV 62) as shown at the top of the sheet. The bottom half of the sheet shows buffers for IO reset, start, clear, data in and out of A bus, and data out of B bus signals.

The top and bottom halves of sheet 2 have similar circuits; the top being dedicated to DEV 60 and the bottom half to DEV 62. At the top, STRTSCN (start scan) is generated from START and DEV 60. STRTSCN is a strobe pulse for the receive data from the data coupler card. The circuits are basically delay lines to allow enough time for an address to get to the motor card, and for information to be put on the lines and return. MCABOK (motor cabinet OK) and DEV 61 are dot ORed with the $\overline{\text{SEL D}}$ line. MCABOK comes from the data path acknowledge (sheet 5).

The two circuits on sheet 2 form loops with the corresponding circuits on sheet 3. The two loops reset themselves with CS DONE and CC DONE, while $\overline{\text{IO RESET}}$ is used to reset the whole thing and CLEAR is used selectively with the appropriate device code.

Timing for the card is provided by the 1MHz oscillator at location C8 (sheet 3). On sheet 4, the clock signal is divided down to 15.26Hz. If there is a gap in computer output longer than 65.54 milliseconds (15.26Hz=65.536ms) between strobe pulses, a KILL signal is generated and sent to the data coupler cards, dropping the ACTIVITY line on the motor logic cards. The signal in turn resets all the latches on the motor logic cards, which return to local control.

On sheet 5, the two data path acknowledge (DPACK) signals are combined via optic isolators to generate motor cabinet OK (MCABOK). This signal is NANDed with $\overline{\text{XMIT}}$ to produce the REC1 and REC2 signals that must be present before reception of S DATA information is possible. REC1 and REC2 are inhibited if MCABOK is not present. $\overline{\text{XMIT}}$ is a function of DOB and DEV 60 and DEV 62.

On sheet 6, address bit 9 (A BIT 9) becomes logic cabinet address 2 (LOGIC CAB ADD L2), the MSB for the cabinet address. A BIT 10 becomes LOGIC CAB ADD L1, the LSB for the cabinet address.

3-6-5 NOVA INTERFACE PCB (CONT.)

The MSB and LSB for the motor address are A BIT 11 and A BIT 15, respectively. The motor addresses go from 0 to 31. Address lines AL1, AL2, AL4, AL8, and AL16 all true converts to the decimal number 31. The data coupler card interfaces with each motor logic card and the NOVA interface card. Sheet 7 shows the Nova I/O bus coming in at the top. Note that the data lines at the top are bar terms while the terms going out at the right are true terms. The outputs go to sheet 8 where DATA 0 becomes C DATA 0, etc. DEV 62 and DOA are used to gate these control data outputs to the dual line drivers on sheets 9 and 10. These dual line circuits are designed specifically for use in high speed data transmission systems that use balanced, terminated transmission lines. From the transmitters, the data goes out on transmission lines 0 throu 15, which are bidirectional with a common bus.

C DATA lines go out for motor control, equipment control, and display information. Motor status and monitor status (S DATA) is returned on the same lines and applied to the line receivers on sheets 9 and 10. The receiver ouputs go to holding registers (sheet 7) and are clocked in with a side load (CS DONE). The registers act as latches and the outputs are gated through to the Nova I/O bus by DIA and DEV 60.

3-6-6 INTEGRITY-DATA-CONTROL PCB

Figure 6-14 is a simplified schematic diagram of the integrity-data-control card. This is a multipurpose card that can be used to perform the following functions:

1. Loop checks between central Nova and remote Nova preprocessors.
2. Control Nova output displays at corresponding motor control cabinets.
3. Scanning and monitoring sixteen different local points.
4. Controlling sixteen different local operations.
5. Displaying the condition of selected functions. The functions that may be selected for display are as follows:

3-6-6 INTEGRITY-DATA-CONTROL PCB (CONT.)

a) System power
b) Data coupler power
c) Computer activity
d) Address bits 16,8,4,2, and 1
e) Data bits 0 through 15
f) Preprocessor data
g) Outputs of scanned motor logic cards

The five address lines are compared with the switch-selected setting (S1 through S5) by the comparator at location A3. When A=B, the address latch (location A4) is enabled and the address is latched for display (CR4 through CR8) at STROBE time. A=B, ACTIVITY, TRANSMIT, and STROBE are NANDed, enabling the data latches (E4 and M4). The outputs are routed to the data coupler. The data latch outputs are also displayed by CR10 through CR25.

The $\overline{\text{T STROBE}}$ signal is generated by a network of one-shot multivibrators and D flip-flops (locations J5 and J4) for use when the preprocessor is scanning and there is no control or refresh pulse to gate data into the latches.

3-7 TURNTABLE DRIVE SYSTEM

The turntable drive system consists of a G-E speed regulator providing a master speed reference for six G-E speed variators, which drive six 2-horsepower motors with integral eddy current couplers. Output speed is varied by varying the DC current applied to the coupler field.

Figure 6-15 is a functional schematic diagram of the system. Most of the components on sheet 1 are located in the master ride console while most of the components on sheet 2 are located in the master controller cabinet. There are five modules in the master controller cabinet that make up the regulator section of the system:

Power Supply Card
Linear Time Card
S-Curve Integrator Card

Relay Card

Universal High Power Amplifier Card

Three-phase, 460 VAC power is furnished from distribution board EDHA via 40 Amp fuses. Control voltage transformer CPT-M steps the voltage down to 115 VAC.

Station console pushbuttons PB161 (TURNTABLE MOTOR START) and PB171 (TURNTABLE MOTOR STOP) control all six drive motors simultaneously via relays MAC-1 and MAC-2 in the controller cabinet. Three pushbuttons (SYSTEM STOP, EMERGENCY STOP, and TURNTABLE SYSTEM STOP) and two limit switches (LS1 and LS2) all in series, control relay ST1. Relay ST2 is controlled via N.O. contacts of ST1 by either of two pushbuttons (SYSTEM START and TURNTABLE SYSTEM START). The RUN relay is energized via N.O. contacts of both ST1 and ST2 and latches through a pair of its own N.O. contacts in parallel with the ST2 N.O. contacts as ST2 is energized only momentarily. The RUN relay controls the SYSTEM RUN and SYSTEM STOP indicators at the controller cabinet and the RUN and STOP indicators on the station console.

Relay RA controls the regulator in conjunction with the RUN relay.

NOTE

> Two relays (RB and RC) are not shown on the functional schematic diagram because their coils are not connected. It must be noted here, however, that connections are made via N.C. contacts of those relays so they must remain installed.

The maximum speed pot (P1) and the minimum speed pot (P2) determine the range of voltage fed to the regulator.

The linear time card changes the speed pot signal from a step voltage (when the RUN relay is energized) to a ramp voltage in order to accelerate the load at a linear rate over a pre-determined time period of several seconds.

The S-curve integrator modifies the ramp voltage at the beginning and end so acceleration and deceleration are less than normal at start-up and just prior to achievement of run speed. This feature is desirable in a multi-drive system because it helps each drive circuit follow a master reference while maintaining equal shares of the total load during acceleration and deceleration. Load-sharing at steady run speed is manually adjustable with SPEED TRIM pots on each drive module. The controlled deceleration function is disabled whenever relay ST1 drops out.

The high power amplifier is a unity gain circuit used to provide enough current to drive the six motor drives. The ZERO ADJ. pot (P3) can offset the signal either side of zero for balance purposes. The power amplifier output is the master reference for the system. The reference speed meter (SVM) indicates what percent of maximum speed the system is running.

On sheet 2 of the functional schematic diagram, an individual speed variator is shown. The REGULATOR AND COUPLING CONTROL block represents a Coordination/Signal Amplifier card and a Power Amplifier/Supply card.

Transformer CPT provides control voltage for the motor starter circuit.

Transformer IT provides control voltage for the REGULATOR AND COUPLING CONTROL circuits. SPEED TRIM potentiometer TRH provides individual speed adjustment for each motor drive. The tachometer-generator (TG) feeds an A-C voltage proportional to the output shaft speed to the REGULATOR AND COUPLING CONTROL circuits. This A-C is full-wave rectified and used as feedback. At startup, the feedback is low so the coupler field signal is high. As shaft speed increases, the feedback causes the field signal to decrease until the circuit is balanced and the desired speed is achieved. A response potentiometer (not shown) adjusts the sensivity of the balancing circuit. It is adjusted for fast response without hunting or oscillation.

Potentiometer LRH limits the coupling field current as indicated on the ammeter (AM) associated with that circuit.

Additional information on the turntable drive equipment is provided in Section VII, VENDOR DATA.

3-8 STATION DOWNRAMP DRIVE (FIG. 6-16)

Input power is 480V, 3-phase, 60Hz from distribution board DHA. The ramp drive motor is a 7.5HP, 3-phase induction motor. With 60Hz applied, the drive motor rotates 1165 RPM.

The brake assembly release coil is connected across the motor leads so the brake is released as power is applied to the drive motor. Both the brake and drive motor are protected by a thermal overload relay (OL).

The control transformer steps two phases of input power down to 120V for the control circuits. Lockout switches are provided for maintenance work safety.

A small transformer steps the 120V down to 12V for the annunciator (A1 through A7), which is mounted on the upper structure between the two speed ramps. A time delay relay (ATR) disconnects the annunciator flag coil current a few seconds after shutdown.

The DRIVE V-BELT TENSION limit switch stops or prevents starting of the drive motor if the V-belt is too loose. In series with the DRIVE V-BELT TENSION limit switch are the COMB LIFT BELT ALIGN. limit switches as well as the EMERGENCY STOP-REV pushbutton switches. If the UPPER COMB LIFT switch is activated, the situation can be corrected by pressing the UPPER EMERGENCY STOP-REV switch long enough to clear the obstruction. The same is true for the LOWER COMB LIFT and EMERGENCY STOP-REV switches. Activation of either BELT ALIGN. limit switch must be manually corrected by maintenance personnel.

The key-operated master direction control switch on the control cabinet door determines the normal direction of the ramp (UP or DOWN). In the UP position the ramp will run in either direction, depending on which way the KEY START switch is set initially. However, once the ramp is started in the UP direction it will continue to run in that direction unless the master direction control switch position is changed. The opposite is true for the DOWN Position of the master direction control switch.

The ramp is normally stopped by pressing either EMERGENCY STOP-REV switch momentarily.

3-9 STATION UPRAMP DRIVE (FIG. 6-17)

Input power is 240V, 3-phase, 60Hz from a 30KVA transformer located in the underground room at the Star Jet gantry elevators. The ramp drive motor is a 15HP D-C variable speed motor connected to a Model GP-100 Solid State Controller (SCR POWER UNIT). A 60A fused disconnect isolates the GP-100. The brake and control circuits are protected by 2A fuses.

The brake assembly is just like the one in the downramp except that it is wired for 240V instead of 480V.

The remaining circuitry is functionally identical to corresponding circuits for the downramp discussed previously. Minor differences can be seen by comparison of the two schematics.

The GP-100 uses SCRs to vary the motor armature voltage in a closed servo loop. The SPEED REF. and MAX. SPEED pots provide a speed reference voltage to the input of a linear timing circuit that causes the motor speed to build up gradually instead of trying to achieve run speed instantaneously. The reference signal and the armature voltage (with current feedback) are applied to a summing amplifier, which determines how much power the SCRs deliver to the armature.

The GP-100 also has a Static IOC (Instantaneous Over Current) circuit that can sense arcing in the armature loop. This is strictly an electronic inhibit and the control relays will look normal after it occurs. However, the SCRs will not fire again until the run circuit has been stopped and restarted.

3-10 WEDWAY TRACK SWITCHING

Figure 2-2 shows the locations of the eight track switches and the five track switching control panels as well as the various limit switches, pressure switches, and valve control boxes. The normal positions for the track switches are as follows:

SW1 - main track connected with air CYL extended.
SW2 - main track connected with air CYL extended.
SW3 - main track connected with air CYL retracted.
SW4 - main track connected with air CYL retracted.
SW5 - open with air CYL retracted

3-10 WEDWAY TRACK SWITCHING (CONT.)

SW6 - storage track connected with air CYL retracted.

SW7 - storage track to storage track with air CYL retracted.

SW8 - storage track to storage track with air CYL retracted.

The following is a list of reference drawings applicable to maintenance of the track switching control and associated circuitry. As of this date, these drawings have not been changed to reflect field changes and are thus not reproduced herein. Corrected schematic and wiring diagrams will be provided when available.

Track Switching Reference Drawings

EQUIPMENT	SCHEMATIC	WIRING
Track Switch Control Panel 1	108924	108972
" " " " 2	109137	108973
" " " " 3	108923	108974
" " " " 4	108925	108975
" " " " 5	108926	108976

3-11 STORAGE TRACK MOTOR CONTROL

Figure 6-19 is a schematic diagram of one of the five storage track motor control consoles. Operation of this basic switching circuitry is self explanatory. The PLATEN AIR GAP ALARM sounds whenever one of the external sensors (N.O.) detects excessive platen height and feeds +24 VDC to the sonalert. The remainder of the console circuitry is switching returns rather than voltages.

4. MAINTENANCE

4-1 INTRODUCTION

The following pages contain brief descriptions of test equipment to be used in maintaining the motor control electronics of the Wedway ride.

Following the test equipment descriptions is a functional test procedure for checkout of the motor control logic circuitry. This is followed by a tabular listing of motor logic functions with test points and waveforms.

A similar tabular listing is provided for the timing logic.

Finally, there are two procedures for mechanical adjustments that are included here because of their effect on the electrical performance of the ride. The adjustments are of motor height and platen height.

Maintenance personnel should have a good understanding of the theory of operation of the equipment before attempting any maintenance action. Particular attention should be paid to locations of dangerous voltages. No one should work alone with power applied to equipment where dangerous voltages exist.

Personnel should also exercise caution when working with digital logic circuitry to avoid accidental shorting with tools or probes. Use test points whenever possible and test cards out of their cabinets whenever possible to avoid damage to other circuits.

4-2 TEST EQUIPMENT

4-2-1 POWER AND LOGIC TEST CARD

CONT-108705 is both an assembly and a schematic diagram of the test card. This card, when plugged into a power card slot, provides a simple visual check of SCR control signals from the logic. A HOT SCR toggle switch is provided to test the HOT SCR inhibit logic. A connector is provided to apply 3Ø power from the variac.

4-2-2 3Ø VARIAC

The output of the 3Ø variac is continuously variable from 0 to 240 VAC. It is used in conjunction with the power and logic test card and

4-2-2 3Ø VARIAC (CONT.)

has a built-in ammeter and ac voltmeter.

4-2-3 INTERFACE CARD TESTER

CONT-109036 and 109037 are the assembly and schematic diagrams, respectively, for this tester. Operating instructions are provided inside the cover for GO/NO GO testing of sensor interface cards.

4-2-4 SENSOR SIMULATOR AND DRIVE-BY TEST UNIT

CONT-108694 and 108699 are the assembly and schematic diagrams, respectively, for this unit. The sensor simulator provides a means of inserting a simulated speed count and subcount into the motor logic for testing motor logic and power cards. The divide-by portion provides a readout of the pinned divide-by settings of the card under test. Switches are provided to simulate proximity sense, warm motor, and hot motor signals.

4-2-5 POWER CARD TEST FIXTURE

CONT-108373 and 108374 are the assembly and schematic diagrams, respectively, for this fixture. The power card test fixture provides a means of GO/NO GO testing of power cards outside of the cabinet.

4-2-6 PREPROCESSOR SIMULATOR

CONT-108669 and 108670 are the assembly and schematic diagrams, respectively, for this unit. The simulator replaces a Nova minicomputer in the Wedway application for DACS test purposes only.

4-2-7 INFRARED DETECTOR SCOPE

This is a hand-held device used for checking the speed sensors. For obvious reasons, it is unreliable in bright daylight.

4-2-8 PYROMETER

This device is used to measure surface temperatures of motors for verification of warm or hot motor sensor indications.

4-2-9 HI-POT TESTER

This unit is used to check cables for opens or shorts.

4-2-10 OSCILLOSCOPE WITH CURRENT PROBE

The Tektronix 454 oscilloscope is recommended for Wedway maintenance.

4-3 MOTOR LOGIC FUNCTIONAL TEST

SETUP

1. Remove motor logic card and install extender in its place.
2. Disable associated motor control card by tripping appropriate circuit breaker.
3. Remove motor control card and install a power and logic test card in its place.
4. On the motor logic card under test, install switch matrices in sockets E5 and J1, then place all switches to ON.
5. Mate card with card extender.
6. Connect the appropriate sensor simulator connectors to the A test point connector of the card under test.
7. Install test point "glomp-ons" on the B test point connector and on the sensor interface card three slots to the right of the circuit under test.
8. Place the simulator POS switch in the up position with all other switches down.
9. Connect oscilloscope A trace to test point A53 and B trace to B16. Use LINE sync in AUTO mode.

PROCEDURE

1. While observing indicators on simulator, individually set all the switches on matrix J1 and switch 8 on matrix E5 to the off position. Divide-by indicators should increment accordingly.
2. Set matrix J1 for speed of six, divide by two.
3. Force card into reverse.
4. Set switch 6 of matrix E5 to the off position and verify oscilloscope B trace indicates full power condition.
5. Set switch 6 to the on position and verify B trace indicates minimum power. Return switch 6 to off.

6. Set switch 5 of matrix E5 to the off position and verify oscilloscope B trace pulse width indicates half power. Return switch 5 to on.
7. Set switch 4 of matrix E5 to the off position and verify B trace pulse width decreases.
8. Repeat step 7 for switches 3, 2, and 1 in succession. Return switches 1 through 4 to on.
9. Depress the START switch to obtain a motor on condition and verify A trace indicates +5VDC.
10. On the power card display board, place the HOT SCR switch to the up position and verify A trace indicates 0VDC. Return HOT SCR switch to down.
11. On the sensor simulator, place the HOT MTR switch to the up position and verify A trace indicates 0VDC. Return HOT MTR switch to down.
12. Place the POS switch to the down position and verify A trace indicates 0VDC. Return POS switch to up.
13. Move A trace probe to test point A8. Place sensor simulator WARM MTR switch to the up position and verify A trace indicates +5VDC. Return switch to down and move probe back to test point A53.
14. Ground test point 50 on the sensor interface PCB selected in step 7. Observe motor direction indicators on power card display board in conjunction with oscilloscope A trace. Verify A trace indicates 0VDC for forward and +5VDC for reverse.
15. Activate PANIC STOP and verify oscilloscope presentation does not change.
16. On the sensor simulator, set the REV TEST switch to the up position and verify A trace indicates 0VDC. Return REV TEST switch to down and force motor forward.
17. Deactivate PANIC STOP and verify motor cannot be restarted and that A trace indicates 0VDC.
18. Remove ground connected in step 14 and verify A trace indicates +5VDC.
19. Momentarily ground the following points on the extender board mother board connector and verify the corresponding indications:

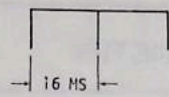
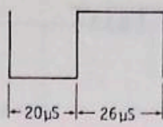
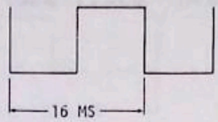
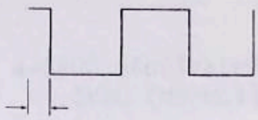
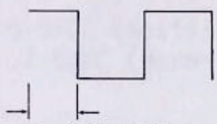
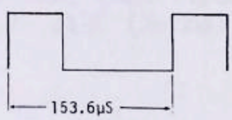
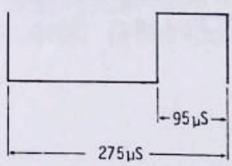
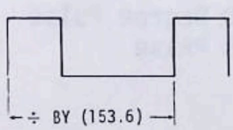
Connector Pin No.	Indications	
	Trace A	Trace B
47	0 VDC	-
44	+5 VDC	-
57	-	Full Power
63	From +5 to 0 to +5 (motor reversal)	Full Power
Connect B probe to test point B56.		
49	-	+5 VDC
Return B probe to test point B16.		
21	0 VDC	-
23	0 VDC	-
25	0 VDC	-
27	0 VDC	-
29	0 VDC	-
31	0 VDC	-
33	0 VDC	-
35	0 VDC	-

20. On the sensor simulator, set the SPEED TEST, SC1, SC2, SC4, and SC8 switches up. Verify read out display of 255. Return switches to down.

4-4 MOTOR LOGIC CARD TEST

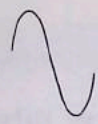
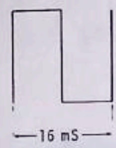
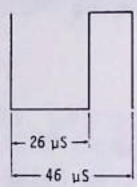
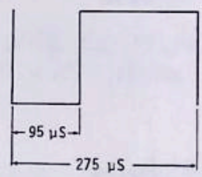
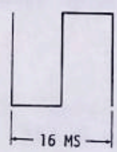
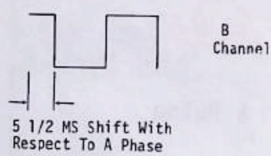
The following table lists the test points and the signals that should be observed for the listed functions. Use test points 62A and 62B as appropriate for reference. All waveforms are approximately 4 volts peak to peak.

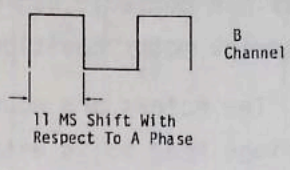
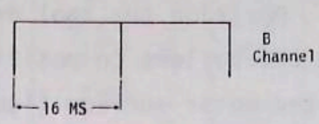
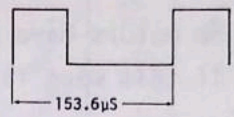
FUNCTION	TEST POINT	SIGNAL
Prox. Sense	12A	4-5VDC (Activated) .2-.6VDC (Normal)
Lead Sense	6A	4-5VDC (Activated) .2-.6VDC (Normal)
Lag Sense	2A	4-5VDC (Activated) .2-.6VDC (Normal)
Rev. Sense (Lag Before Lead)	16A	4-5VDC (Activated) .2-.6VDC (Normal)
Prox. Sense Delayed (Delayed Off)	47B	4-5VDC (Activated) .2-.6VDC (Normal)
Warm Motor	8A	4-5VDC (Activated) .2-.6VDC (Normal)
Hot Motor	14A	4-5VDC (Activated) .2-.6VDC (Normal)
Hot SCR	10A	4-5VDC (Activated) .2-.6VDC (Normal)
SCR Breaker	56B	4-5VDC (On) .2-.6VDC (Off)

FUNCTION	TEST POINT	SIGNAL
$\overline{\text{Load A Pulse}}$	44B	
1 Degree Pulse	22B	
360 Degree Pulse A Phase	21B	
360 Degree Pulse B Phase	21B 24B	 5 1/2 MS Shift With Respect To A Phase
360 Degree Pulse C Phase	21B 20B	 11 MS Shift With Respect To A Phase
153.6 Pulse	60A	
6 Degree Pulse	24A	
F ÷ X Pulse	49A	

4-5 TIMING CARD TEST

The following table lists the test points and the signals that should be observed for the listed functions. Use test point 62B for reference. All waveforms are approximately 4 volts peak to peak.

FUNCTION	TEST POINT	SIGNAL
$\overline{\text{Phase Loss}}$	44B	4-5VDC (Normal) .2-.6VDC (Activated)
Crystal Oscillator	34B	
Phase Set	38B	
$\overline{\text{1 Degree Pulse}}$	42B	
$\overline{\text{6 Degree Pulse}}$	52B	
360 Degree Pulse A Phase	54B	
360 Degree Pulse B Phase	58B 54B	

FUNCTION	TEST POINT	SIGNAL
360 Degree Pulse C Phase	56B 54B	
Load A Pulse	30B 54B	
153.6 Pulse	60B	
Start - Up	46B	4-5VDC (Activated) .2-.6VDC (Normal)
Shut - Down	48B	4-5VDC (Activated) .2-6VDC (Normal)
Panic Stop	50B	4-5VDC (Activated) .2-.6VDC (Normal)
Power Factor	40B	4-5VDC (Start-Up) .2-.6VDC (Shut-Down)

4-6 MOTOR HEIGHT ADJUSTMENT

Motor position is adjusted to within 0.010 inch of the top of the rails. A portable gaging tool with four dial indicators is used to determine motor position with respect to the rail tops.

The motors are mounted to angle stock by four 3/8-inch X 2-inch carriage head bolts with various shims for position adjustment.

Position the tool over the motor with the handle in the up position. Use the rollers to position the dial indicator stems over the four corners of the motor surface (laminations). Placing the handle in the down position lowers the gaging assembly to the rail top. The gages are color coded to indicate tolerance limits.

Some motors have a slight warp that is difficult to completely eliminate. If this warp is excessive, the motor assembly should be replaced.

4-7 PLATEN HEIGHT ADJUSTMENT

A gaging tool with two dial indicators is mounted under the maintenance spur track in Space Mountain. Nominal air gap should be 0.150 $\pm$ 0.010 inch. The platen assembly is mounted to the car undercarriage by four 1/2-inch X 3-1/2-inch bolts with six spring steel cup washers at each bolt for height adjustment.

Check the platen height over the entire length, but only make adjustments with reference to dial indicator readings taken at or near the bolts. It is not practical to attempt to maintain $\pm$ 0.010 inch tolerance over the entire length of the platen.

A T-handle wrench with 3/4-inch socket is provided for adjusting the platen. Adjustment is simply a matter of keeping the pointer centered in the green portion of the scale.

Make sure gaging tool is fully lowered before moving the car or train.

WEDWAY CONTROLLER ELECTRICAL DISTRIBUTION CHART

PRIMARY SOURCE	PRIMARY DISTRIBUTION	SECONDARY SOURCE	SECONDARY DISTRIBUTION	CONTROLLER SECTION	MOTOR NUMBERS
SUB-STATION P5L BKR #5	EDHF BKR #2	TS1-A 75 KVA	EDLF	S1-A	SBP, S2.6, S5, S7, S9, S11, S14, S16, S18, S20, S22, S25, S27
	EDHF BKR #3	TS1-B 75 KVA	EDLF	S1-B	S1.2, S4, S6, S8, S10, S12, S15, S17, S19, S21, S24, S26, S28
SUB-STATION P5L BKR #6	EDHB BKR #2	TS2-A 75 KVA	EDLB	S2-A	S29, S31, S33, S35, S37, S39, S41, S43, S45, S47, S49, S51, S53, S55
	EDHB BKR #3	TS2-B 75 KVA	EDLB	S2-B	S30, S32, S34, S36, S38, S40, S42, S44, S46, S48, S50, S52, S54, S56
SUB-STATION P5L BKR #3	EDHC BKR #5	TS3-A 75 KVA	EDLC	S3-A	S57, S59, S61, S63, S65, S67, S69, S71, S73, S75, S77
	EDHC BKR #6	TS3-B 75 KVA	EDLC	S3-B	S58, S60, S62, S64, S66, S68, S70, S72, S74, S76, S77.5
SUB-STATION P7B BKR #4	DHAA BKR #9	T1-A 75 KVA	DLAA	1-A	4, 5, 6, 7, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 14
	DHAA BKR #10	T1-B 75 KVA	DLAA	1-B	4.5, 5.5, 6.5, 7.5, 8.25, 8.75, 9.25, 9.75, 10.25, 10,75, 11.25, 11.75, 13, 15
SUB-STATION P7B BKR #4	DHAA BKR #5	T2-A 45 KVA	DLCC	2-A	16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42
	DHAA BKR #6	T2-B 45 KVA	DLCC	2-B	17, 19, 21, 23. 25, 27, 29, 31, 33, 35, 37, 39, 41, 43
SUB-STATION P7B BKR #4	DHAA BKR #7	T3-A 45 KVA	DLCC	3-A	44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70
	DHAA BKR #8	T3-B 45 KVA	DLCC	3-B	45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71

WEDWAY CONTROLLER ELECTRICAL DISTRIBUTION CHART (CONT.)

PRIMARY SOURCE	PRIMARY DISTRIBUTION	SECONDARY SOURCE	SECONDARY DISTRIBUTION	CONTROLLER SECTION	MOTOR NUMBERS
SUB-STATION P7B BKR #1	DHCC BKR #1	T4-A 75 KVA	DLEE	4-A	72, 74, 67, 78, 80, 82, 84, 86, 86.5, 87, 87.5, 88, 88.5, 89, 75, 91.25
	DHCC BKR #2	T4-B 75 KVA	DLEE	4-B	73, 75, 77, 79, 81, 83. 85, 86.25, 86.75, 87.25, 87.25, 87.75, 88.25, 89, 90.5, 92
SUB-STATION P7B BKR #1	DHCC BKR #3	T5-A 112 1/2 KVA	DLEE	5-A	92.75, 94.25, 95.75, 97.25, 98.25, 98.75, 99.25, 99.75, 100.25, 100.75, 101.25, 102, 104, 106, 108
	DHCC BKR #4	T5-B 112 1/2 KVA	DLEE	5-B	93.5, 95, 9615, 98, 98.5, 99, 99.5, 100, 100.5, 101, 101.5, 103, 105, 107, 109
PANEL EDHD BKR #1	EDHE BKR #2	T6-A 45 KVA	EDLE	6-A	110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136
	EDHE BKR #3	T6-B 45 KVA	EDLE	6-B	111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135
SUB-STATION P5L	EDHD BKR #6	T7-A 45 KVA	EDLD	7-A	137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163.1
	EDHD BKR #7	T7-B 45 KVA	EDLD	7-B	138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 161.9, 164
SUB-STATION P5L BKR #2	EDHD BKR #2	T8-A 75 KVA	EDLD	8-A	165, 167, 169 171, 173, 174.25, 174.75, 175.25, 175.75, 176.25, 177, 179, 181, 183
	EDHD BKR #3	T8-B 75 KVA	EDLD	8-B	166, 168, 170, 172, 174, 174.5, 175, 175.5, 176, 176.5, 178, 180, 182
SUB-STATION P5L BKR #6	EDHB BKR #4	T9-A 112 1/2 KVA	EDLB	9-A	184, 186, 188, 190. 192, 194, 196, 198, 199.25, 199.75, 200.25, 200.75, 201.25, 201.75, 202.25
	EDHB BKR #5	79-B 112 1/2 KVA	EDLB	9-B	185, 187, 189, 191, 193. 195, 197, 199, 199.5, 200, 200.5, 201, 201.5, 202

WEDWAY CONTROLLER ELECTRICAL DISTRIBUTION CHART (CONT.)

PRIMARY SOURCE	PRIMARY DISTRIBUTION	SECONDARY SOURCE	SECONDARY DISTRIBUTION	CONTROLLER SECTION	MOTOR NUMBER
SUB-STATION P5L BKR #3	EDHC BKR #1	T10-A 45 KVA	EDLC	10-A	203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229
	EDHC BKR #2	T10-B 45 KVA	EDLC	10-B	204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230
SUB-STATION P5L BKR #3	EDHC BKR #3	T11-A 45 KVA	EDLC	11-A	231, 233, 235.8, 238, 240 242, 244, 246, 248, 250, 252, 254.25, 257
	EDHC BKR #4	T11-B 45 KVA	EDLC	11-B	232, 234.25, 237, 239, 241, 243, 245, 247, 249, 251, 253, 255.75, 258
SUB-STATION P5L BKR #2	EDHD BKR #4	T12-A 45 KVA	EDLD	12-A	259, 261, 263, 265, 267, 269, 271, 273, 275, 277, 279, 281, 283, 285
	EDHD BKR #5	T12-B 45 KVA	EDLD	12-B	260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284, 286
PANEL EDHD BKR #1	EDHE BKR #4	T13-A	EDLE	13-A	287, 289, 291, 293, 295, 297, 299, 301, 303, 305, 307, 309, 311, 313
	EDHE BKR #5	T13-B 45 KVA	EDLE	13-B	388, 290, 292, 294, 296, 298, 300, 302, 304, 306, 308, 310, 312, 314
SUB-STATION P7D BKR #3	DHB BKR #1	T14-A 75 KVA	DLB	14-A	315, 317, 319, 321, 323, 325, 327, 329, 331, 333, 335, 337
	DHB BKR #2	T14-B 75 KVA	DLB	14-B	316, 318, 320, 322, 324, 326, 328, 330, 332, 334, 336
SUB-STATION P7D BKR #3	DHB BKR #3	T15-A 75 KVA	DLB	15-A	338, 340, 342, 344, 346, 348, 350, 352, 354, 356
	DHB BKR #4	T15-B 75 KVA	DLB	15-B	339, 341, 343, 345, 347, 349, 351, 353, 355

WEDWAY CONTROLLER ELECTRICAL DISTRIBUTION CHART (CONT.)

PRIMARY SOURCE	PRIMARY DISTRIBUTION	SECONDARY SOURCE	SECONDARY DISTRIBUTION	CONTROLLER SECTION	MOTOR NUMBERS
SUB-STATION P7D BKR #3	DHB BKR #5	T16-A 75 KVA	DLB	16-A	357, 359, 361, 363, 365, 367, 369, 370.25. 370.75, 371.25, 371.75, 372.25, 373, 375, 377, 379
	DHB BKR #6	T16-B 75 KVA	DLB	16-B	358, 360, 362, 364, 366, 368, 370, 370.5, 371, 371.5, 372, 372.5, 374, 376, 378
SUB-STATION P7B	DHBB BKR #5	T17-A 75 KVA	DLDD	17-A	380, 382, 384, 386, 386.5, 387, 387.5, 388.5, 389, 390, 392, 394, 396
	DHBB BKR #6	T17-B 75 KVA	DLDD	17-B	381, 383, 385, 386.25, 386.75, 387.25, 387.75, 388.25, 388.75, 389.25, 391, 393, 395, 397
SUB-STATION P7B BKR #3	DHBB BKR #3	T18-A 45 KVA	DLCC	18-A	398, 400, 402, 404, 406, 408, 410, 412, 414, 416, 418, 420, 422, 424
	DHBB BKR #4	T18-B 45 KVA	DLCC	18-B	399, 401, 403, 405, 407, 409, 411, 413, 415, 517, 419, 421, 423, 425
SUB-STATION P7B BKR #4	DHAA BKR #3	T19-A 75 KVA	DLAA	19-A	426, 428, 430, 432, 434, 436, 438, 440, 442, 442.5, 443, 443.5, 444, 444.5
	DHAA BKR E4	T19-B 75 KVA	DLAA	19-B	427, 429, 431, 433, 435, 437. 439, 441, 442.25, 442,75, 443.25, 443.75, 444.25, 445.25
SUB-STATION P7B BKR #3	DHBB BKR #7	T20-A 112 1/2 KVA	DLCC	20-A	446.25, 448.25, 448.75, 449.25, 450, 451, 452, 453, 454, 455, 456, 457, 0.5, 1.5, 2.5, 3.5
	DHBB BKR #8	T20-B 112 1/2 KVA	DLCC	20-B	447.25, 448.5, 449, 449.5, 450.5, 451.5, 452.5, 453.5, 454.5, 455.5, 456.5, 0.0, 1.0, 2.0, 3.0

WEDWAY MISCELLANEOUS ELECTRICAL DISTRIBUTION CHART

PRIMARY SOURCE	PRIMARY DISTRIBUTION	SECONDARY SOURCE	SECONDARY DISTRIBUTION		DESTINATION
SUB-STATION PG22D BKR #4	EDHA BKR #3				Distributed to six Kinatrol speed variators through main breaker on SP-200 Master Controller (Turntable)
SUB-STATION P7B BKR #5	DHA BKR #1	T-3 30 KVA	100 Amp Disconnect		Speedwalk Upramp Control Cabinet
SUB-STATION P7B BKR #5	DHA BKR #2				Speedwalk Downramp Control Cabinet
EDHA BKR #2	EHA BKR #38	T-8 45 KVA	ELA BKR #14		Track switch control panels #1 and #3 located near Wedway entrance to Space Mountain
EDHA BKR #2	EHA BKR #38	T-8 45 KVA	ELA BKR #18		Track switch control panel #2 located near Wedway exit from Space Mountain
EDHA BKR #2	EHA BKR #38	T-8 45 KVA	ELA BKR #16		Track switch control panels #4 and #5 located on each end of maintenance spur at Space Mountain
SUB-STATION P11L BKR #1	DHA BKR #1 TO T-4	DLA BKR #1	LA BKR #21		Storage Track Control Pedestal #1 and #2
SUB-STATION P11L BKR #1	DHA BKR #2	T-5 112 1/2 KVA	LD BKR #40		Storage Track Control Pedestal #3 and #4
SUB-STATION P11L BKR #1	DHA BKR #3	T-6 45 KVA	LF BKR #28		Storage Track Control Pedestal #5
SUB-STATION PG22D BKR #4	EDHA BKR #1	T-2 150 KVA	EDLA BKR #2 ELB - BKR#27		Wedway Ride Console

5. PARTS LIST

5-1 INTRODUCTION

This section contains lists of replaceable parts of the Wedway ride electrical systems. The lists do not include hardware items or such items as terminal strips, connectors, or sockets (items which do not fail in normal use). Piece parts of potted assemblies are also not listed since they are impossible to replace in the field.

In the lists, the parts are arranged in alpha-numerical order by reference designator (discreet components) or locator (integrated circuits or "chips") as applicable.

The following is an index to the parts lists that follow:

PARTS LISTS INDEX

PARTS LISTS INDEX (CONT.)

RIDE CONSOLE REPLACEABLE PARTS LIST

(REF. FIGURE 2-1)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	CONTROL PANEL Assy		CONT-109047
DS3	* COMPUTER READY indicator (green)	Dialco	177-8430-0972-503
DS4	* POWER ON lamp	GE	387
DS5-27 and DS38-42	* Route Status Group LEDs (red)	Dialco	507-4761-3331-500
PB4, PB5	* JOG FORWARD ZONE 1 & 2 Pushbutton (black)	Micro	PTP42R
PB131, PB171	* TURNTABLE SYSTEM STOP & MOTOR STOP Pushbutton (red)	Micro	PTP43C
PB141, PB161	* TURNTABLE SYSTEM START & MOTOR START Pushbutton (green)	Micro	PTP46C
PB151	* EMERGENCY STOP Pushbutton	Micro	PTY2153R
PL1A	* STOP Indicator (amber)	Dialco	181-8864-0933-513
PL2A & R1L1-1 thru - 6	* RUN & DRIVES ON Group Indicators (red)	Dialco	181-8864-0931-513
S1, S3	* RIDE MASTER & EMERGENCY STOP LAMP Key Switches	Micro	PTKBC2241C
S2	* RIDE START UP Selector Switch	Micro	PTUBJ1CTC02R
S4	* RIDE STATUS Selector Switch	Micro	PTSBC202R
S5 & S8	* SHOW & EMERGENCY LIGHTING Selector Switch	Micro	PTSBC202C
S6	* TEST Toggle Switch, Momentary, Center Off	C-H	8835K4
S7	* TRAINS IN SERVICE Selector Switch	C-H	2H00A16-10
S9	* COMPUTER INHIBIT Toggle Switch	C-H	8822K20

RIDE CONSOLE REPLACEABLE PARTS LIST (CONT.)

(REF. FIGURE 2-1)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
S10, S11	* EMERGENCY STOP UPRAMP & DOWNRAMP Toggle Switch	C-H	7360K8
	* Annunciator Panel		CONT-109190
	** LED (red)	Dialco	507-4761-3331-500
	** LED (green)	Dialco	507-4861-3331-500
	** Diode	Semtech	S4M
	EQUIPMENT PANEL Assy		CONT-109049
CB1	* Circuit Breaker, 10A	Airpax	AP-1-1R-6-1-103
K2-13, 44 & 45	* Relay, 4PDT, 24VDC	P & B	KHP17D12-24
K50-52	* Relay, Octal Base	P & B	R10T-E1-Y2-J2.5K
M1	* Timer, 10 sec Delay	P & B	CUC-41-30010
PC1	* PCB Assy, Matrix		CONT-108995
PS1	* Power Supply, 24VDC	Lambda	LOS-V-24
	* Transient Protector		CONT-109142
PS2	DIODE POWER SUPPLY		CONT-109128
CR1	* Diode, High Current	Semtech	3L05
PS1	* Power Supply, 2V	Lambda	LOS-Z-2
R1-10	* Resistor, 3.83Ω1% 5W	Dale	ARS-5-3.83Ω
DS38	Sonalert	Mallory	SC628P
K1	Relay, 3 Form C, 110VAC	P & B	KUP14A15-110
K16-43, 46-49, & 65	Relay, 4PDT, 110VAC	P & B	KHP17A13-110
K53-64, & 66	Relay, 4PDT, 24VDC	P & B	KHP17A13-24

ACEABLE PARTS LIST (CONT.)

FIGURE 2-1)

ION	MFG.	PART NO.
P RAMP	C-H	7360K8
nel		CONT-109190
	Dialco	507-4761-3331-500
	Dialco	507-4861-3331-500
	Semtech	S4M
Assy		CONT-109049
r, 10A	Airpax	AP-1-1R-6-1-103
4VDC	P & B	KHP17D12-24
se	P & B	R10T-E1-Y2-J2.5K
elay	P & B	CUC-41-30010
x		CONT-108995
4VDC	Lambda	LOS-V-24
ctor		CONT-109142
y		CONT-109128
ent	Semtech	3L05
	Lambda	LOS-Z-2
%	Dale	ARS-5-3.83Ω
	Mallory	SC628P
	P & B	KUP14A15-110
t	P & B	KHP17A13-110
	P & B	KHP17A13-24

MOTOR TERMINATION PANE

CARD CAGE

BLOWER ASSEMBLY

LOAD CENTER ASSEMBLY

CONTACTOR PANEL (NOT SHOWN)

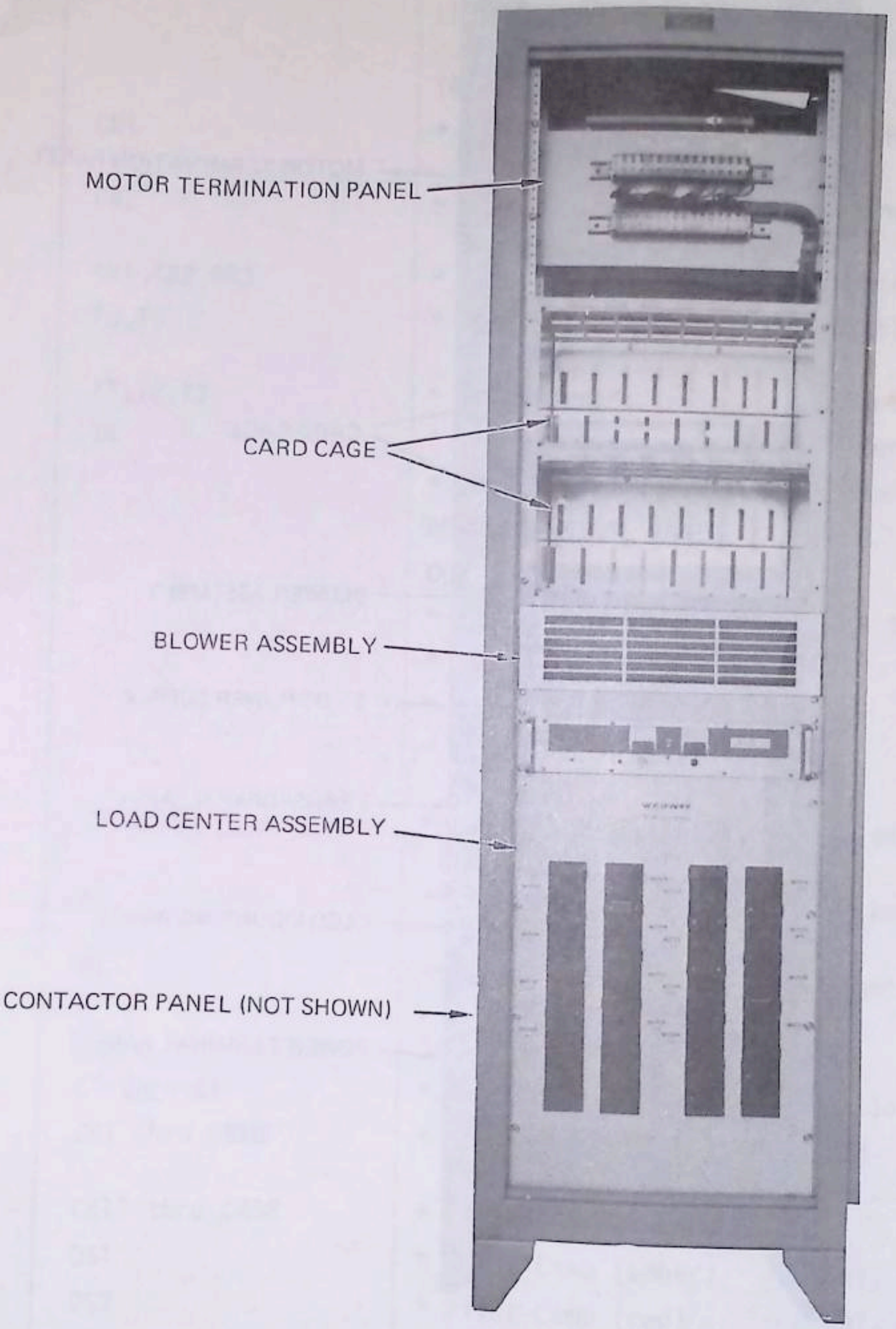


FIGURE 5–1
POWER CABINET, FRONT

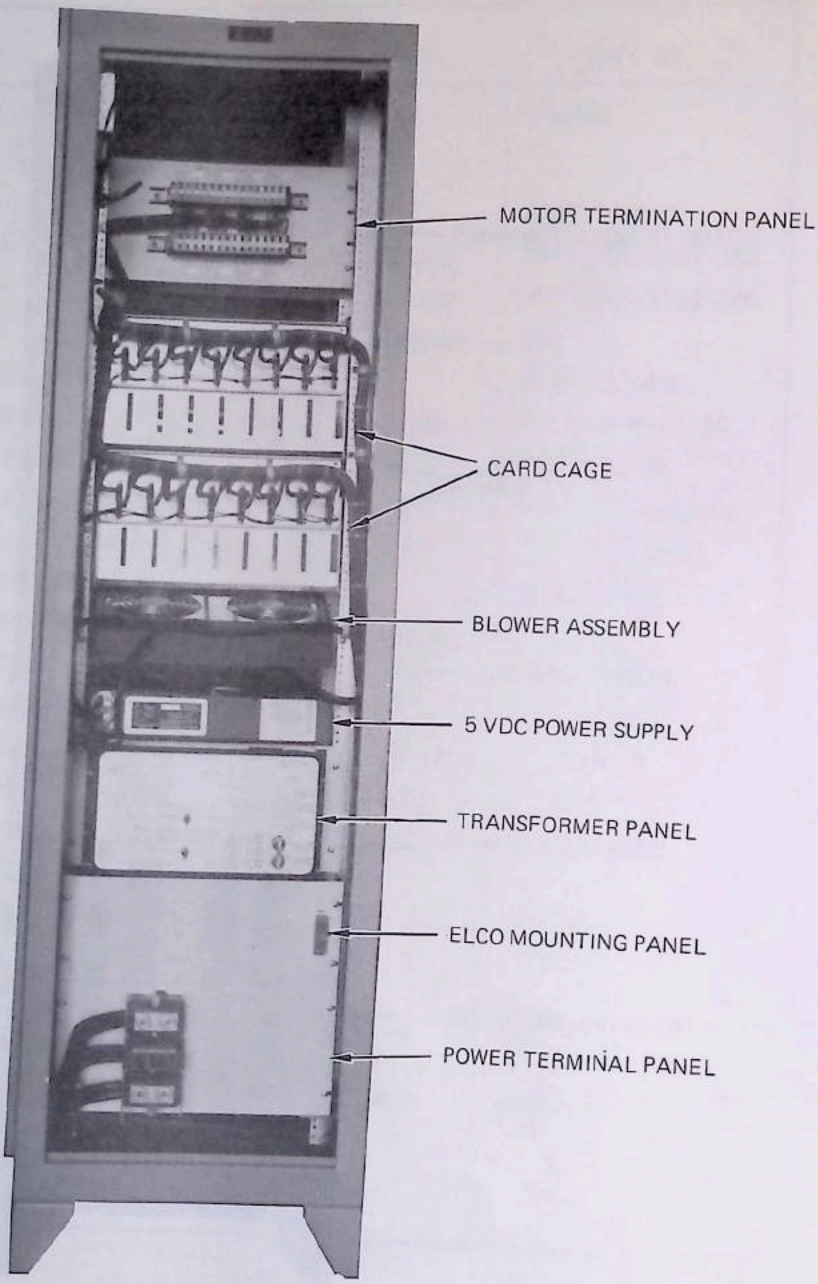


FIGURE 5–2
POWER CABINET, REAR

POWER CABINETS REPLACEABLE PARTS LIST

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	LOAD CENTER Assy	Square-D	6110-106366 C-49-42976
	TRANSFORMER PANEL		CONT-107770
CB1	* Circuit Breaker, .5A, 240V, 3Ø	Heineman	SM333-0.5-60-1
CB2	* Circuit Breaker, 5A, 240V, 3Ø	Heineman	SM333-5-60-1
CR1,CR2,CR3	* Bridge Rectifier	Semtech	SCBA2
F3,F4	* Fuse, 3AG, 20A,32V Slo Blo	Littlefuse	313020
T1,T2,T3	* Transformer	STancor	P-6375
T4	* Transformer	Aztec	13107
	* Power Supply, 5VDC	Lambda	LOS-V-5
	POWER TERMINAL PANEL		CONT-108304
	CONTACTOR PANEL		CONT-108961
	* Relay, 3PDT	P & B	KUP14D15-24VDC
	* Contactor, Magnetic	GE	CR205E0
	* Metal Oxide Varistor	GE	V250LA40
	* Power Factor Start-up PCB		CONT-109134
K1,K2,K3	** Relay, DPDT, 26.5V, (W/Diode)	Teledyne	712D-26
R1	** Potentiometer, 1/2W, 500K	Beckman	66XR500K
M1	** Time Delay, Solid State (delay on make)	Omnetics	MJS24D5N30
	3Ø MOTOR CONTROL PCB		CONT-106310
C1 thru C6	* Capacitor, 100MFD,25V	Mallory	MTV100DB25
CR1 thru CR10	* SCR (40683 selected w/lg tabs)	RCA	64314 (W/mtg kit)
CR11 thru CR38	* Diode		1N457
DS1	* Pilot Lamp (amber)	Chi. Min.	410013(w/retainer)
DS2	* Pilot Lamp (red)	Chi. Min.	410011(w/retainer)
F1	* Fuse	Bussman	KAB30
OP1 thru OP20	* Optical Coupler		MUSE-108213
OP21	* Optical Isolator	Clairex	CLM3120A075

POWER CABINETS REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
Q1-10,Q19 & 20	* Transistor	Fairchild	2N2907
QA12,34,56 & 78	* Arc Quencher, .1MFD, 600V, 150Ω	Paktron	QC150
R1,14,27,40,53 & 64	* Resistor, 10Ω ±5% 1/4W	Amperex	1-4-5P10E
R2,6,15,19,28, 32,41,45,54 - 58,65 & 69	* Resistor, 150Ω ±5% 1/4W	Amperex	1-4-5P150E
R3,7,16,20,29, 33,42,46,55,60, 66 & 71	* Resistor, 10K ±5%, 1/4W	Amperex	1-4-5P10K
R4,8,17,21,30, 34,43,47,56,61, 67 & 72	* Resistor, 5.6K ±5%, 1/4W	Amperex	1-4-5P5K6
R5,11,18,24,31, 37,44,50,62 & 73	* Resistor, 220Ω ±5% 1/4W	Amperex	1-4-5P220E
R9,22,35,48,59, 70 & 75 - 80	* Resistor, 27K ±5%, 1/4W	Amperex	1-4-5P27K
R10,23,36 & 49	* Resistor, 560K ±5%, 1/4W	Amperex	1-4-5P560K
R12,13,25,26, 38,39,51,52 63 & 74	* Resistor, 1K ±5%, 1/4W	Amperex	1-4-5P1K
R57,68	* Resistor, 180Ω ±5% 1/4W	Amperex	1-4-5P180E
R82,83	* Resistor, 470K ±5%, 1/4W	Amperex	1-4-5P470K
R84	* Resistor, 270K ±5%, 1/4W	Amperex	1-4-5P270K
S1	* Switch, Temperature	Klixon	207001-175-0053-L200-4
T1,T2	* Transformer	Stancor	P8361
PCB2	* PCB Assy (piggyback)		CONT-109213
Q1	** SCR	GE	C103B
R1	** Resistor, 270K ±5%, 1/4W	Mepco	1-4-5P270K
R2	** Resistor, 1M ±5%, 1/4W	Mepco	1-4-5P1M
R3	** Resistor, 10K ±5% 1/4W	Mepco	1-4-5P10K

POWER CABINETS REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART. NO.
R4	** Resistor, 1K ±5% 1/4W	Mepco	1-4-5P1K
R5	** Resistor, 470Ω ±5% 1/4W	Mepco	1-4-5P470E
U1	** Optical Isolator	GE	4N35
U2	** Optical Isolator	Clairex	CLM3120A025

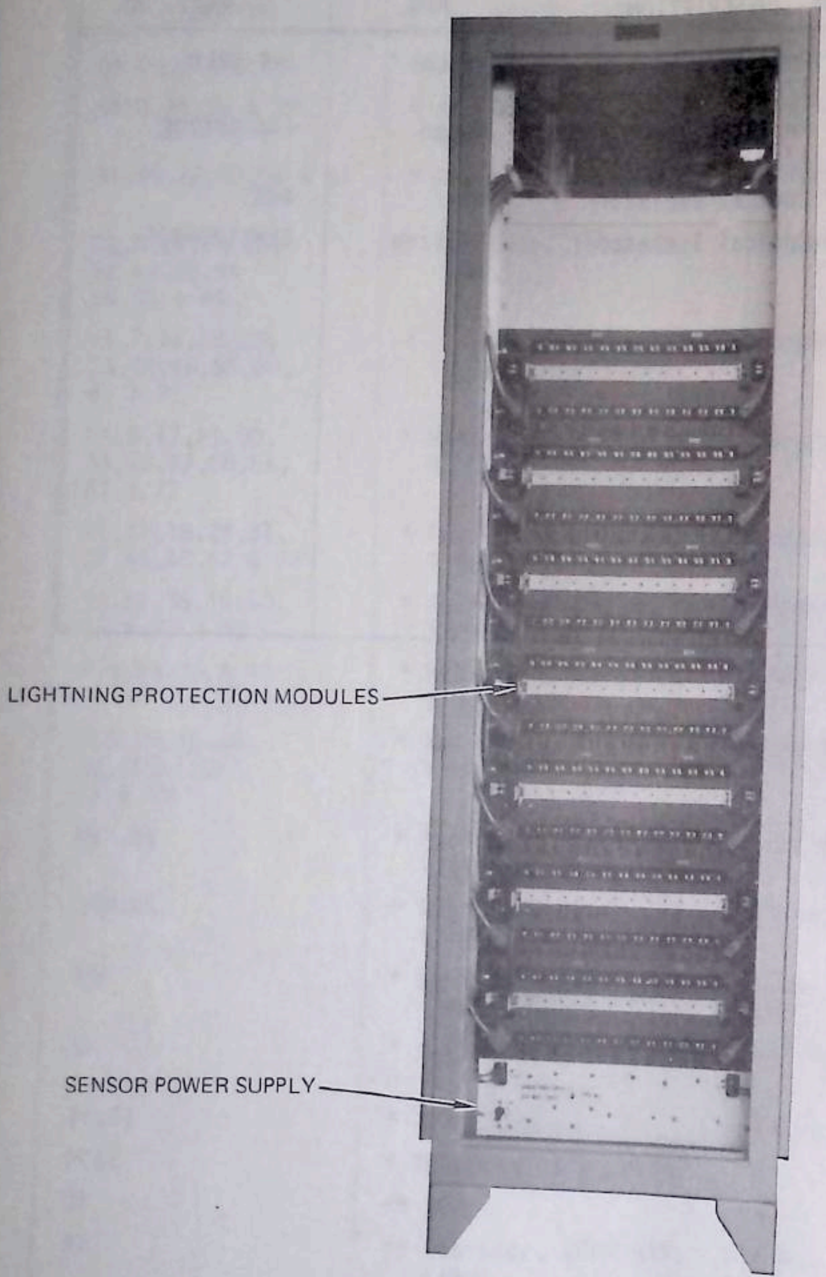


FIGURE 5–3
LIGHTNING CABINET

LIGHTNING PROTECTION CABINET REPLACEABLE PARTS LIST

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	LIGHTNING PROTECTION PANEL		MUSE-108724
CB1,CB2	* Circuit Breaker, 1A	Airpax	UPG6-1-5-2-102
R1,R2	* Resistor, 1Ω ±5%, 2W	TRW/IRC	BWH
	* Module Lightning Protection		MUSE-108541
E1,E2	** Protector, Mini Surge Voltage	Joslyn	2021-12
L1,L2	** Choke, Hash Filter, 100uh, 2A	Miller	5250
	** Diode, Zener, 50V ±10%, 5W	Unitrode	UZ5850
	SENSOR POWER SUPPLY		MUSE-108531
	* Circuit Breaker, Dual 2.5A	Airpax	UPG-66-1-6-2-252
	* Transformer		MUSE-108494
	* Bridge Rectifier	Semtech	SCBAR05
	* Capacitor, 31,000MFD, 40VDC	STM	91C40DC313

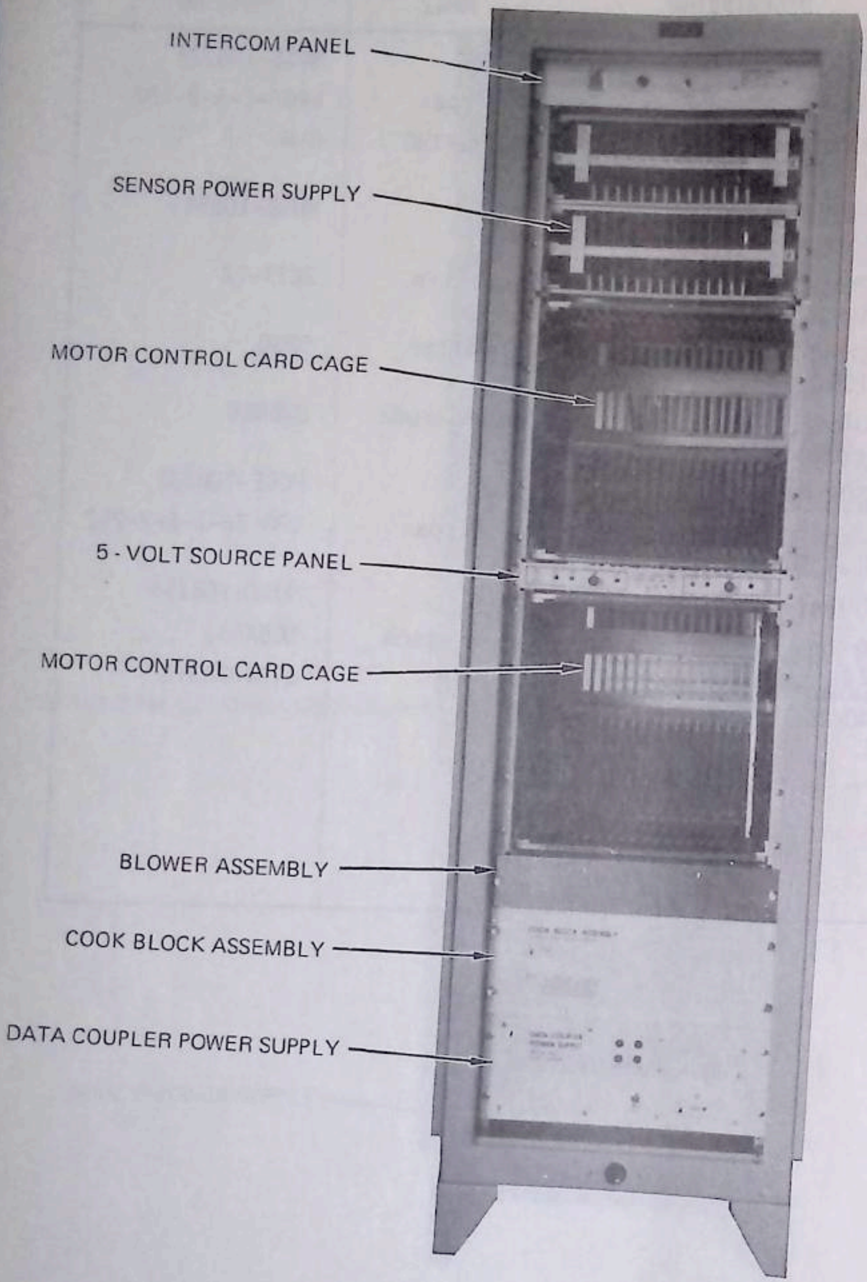


FIGURE 5–4
MOTOR CABINET, FRONT

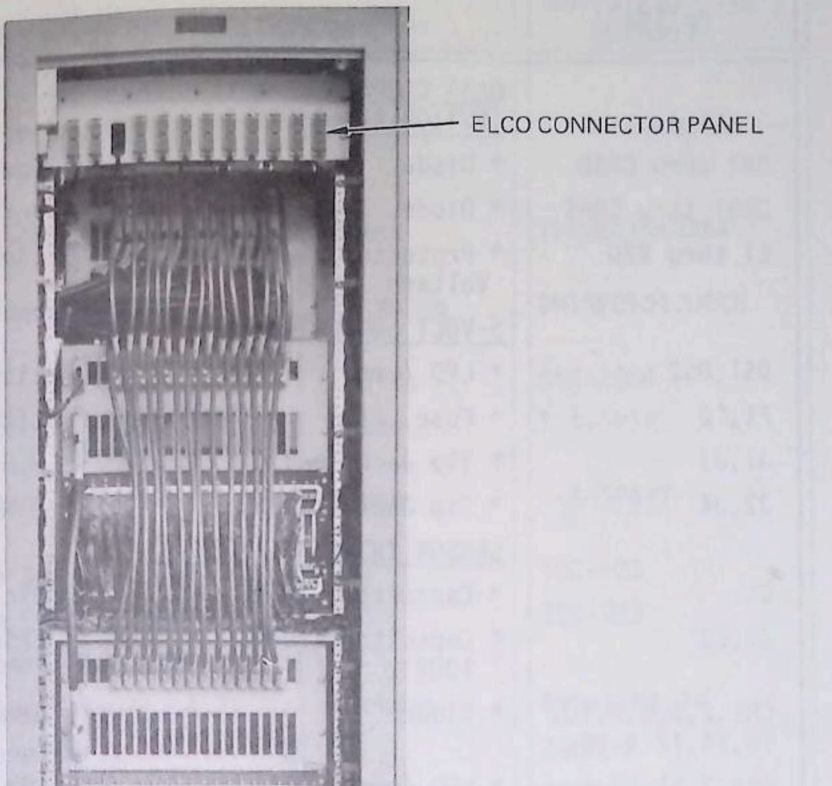


FIGURE 5–5
MOTOR CABINET, REAR

MOTOR CABINET REPLACEABLE PARTS LIST

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	DATA COUPLER TRANSIENT PROTECTION Assy.		CONT-109121
CR1 thru CR50	* Diode	Semtech	S2F
CR51 thru CR54	* Diode, Zener	Unitrode	UZ5806
E1 thru E29	* Protector, Surge Voltage	Siemans	B1-F90
	5-VOLT SOURCE PANEL		CONT-108720
DS1,DS2	* LED (red)	Litronix	RLC-200
F1,F2	* Fuse, 2A	Littlefuse	312002
J1,J3	* Tip Jack (red)	H.H. Smith	1505 (red)
J2,J4	* Tip Jack (black)	H.H. Smith	1505 (black)
	SENSOR INTERFACE PCB		CONT-107780
C1	* Capacitor, 1MFD, 50VDC	Dickson	D1R0GSA50M
C2,C3	* Capacitor, .01MFD, 100V	Erie	8121-100-651-103M
CR1,2,5,6,9,10, 13,14,17 & 18	* Diode	Semtech	S2F
CR3,7,11,15 & 19	* LED (red)	Dialco	550-0406
CR4,8,12,16 & 20	* LED (green)	Dialco	550-0206
CR21	* Diode	Semtech	S4M
R1,3,8,10,15, 17,22,24,29 & 31	* Resistor, 10K ±5%, 1/4W	Mepco	1-4-5P10K
R2,5,9,12,16, 19,23,26,30 & 33	* Resistor, 2.2K ±5%, 1/2W	Mepco	1-2-5P2K2
R4,11,18,25 & 32	* Resistor, 1K ±5%, 1/4W	Mepco	1-4-5P1K
R6,13,20,27 & 34	* Resistor, 820 ±5%, 1W	Ohmite	OG8215
R7,14,21,28 & 35	* Resistor, 100K ±5%, 1/4W	Mepco	1-4-5P100K
U1,U2	* Quad Op. Amp.	National	LM324D
	* Optical Coupler	GE	4N35
	INTEGRITY-DATA-CONTROL PCB		CONT-108675

MOTOR CABINET REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	* Discreet Components		
C1,3,5,7,9,11 thru 16,18,20, 22 & 24	** Capacitor, .1MFD, 35V	Kemet	T110A104K035AS
C2,4,6,8,10,17, 19,21,23 & 25	** Capacitor, 4.7MFD, 35V	Kemet	T110B475K035AS
C26,C27	** Capacitor, 100PFD, 500V	El Menco	DM15FD101J04CR
CR1 thru CR25	** LED	Dialco	547-2004
R1 thru R17	** Resistor, 1K ±5%, 1/4W	Mepco	1-4-5P1K
R18,R19	** Resistor, 4.7K ±5% 1/4W	Mepco	1-4-5P4K7
S1 thru S6	** Toggle Switch, SPDT	JBT	T02-123
S7	** Toggle Switch, DPDT	JBT	T02-223
	* Integrated Circuits		
A1,E1,M1	** Resistor Network, 4.7K	Beckman	898-1-R4.7K
A2,B1	** Hex Inverter	TI	74LS04
A3	** Comparator, 5-Bit	Fairchild	9324
A4,E4,M4	** Bistable Latch, 8-Bit	TI	74100
A5,C5,D4,F4 H5,K5,L4,N4,P5	** Hex Inverter	TI	7406
B3	** Triple 3-Input NAND	TI	7410
B4	** Quad 2-Input NAND	TI	7400
B5	** Resistor Network, 1K	Beckman	898-1-R1.0K
C1 & 2, D1 & 2, F1 & 2, H1 & 2, K1 & 2, L1 & 2, N1 & 2, P1 & 2	** Relay	GB	GB821A-4
C,D,F,H,K,L,N, & P3; J1 & J2	** Socket, 16-Pin	Amphenol	821-20012-164
C,H,K & P4	** Hex Inverter	TI	7404
D,F,L & N5	** Quad 2-Input NAND Buffer	TI	7438
E2 & 3, M2 & 3	** Quad 2-Input NOR	TI	74LS02
J4	** Dual D Flip Flop	TI	7474
J5	** Monostable MV	TI	74123

MOTOR CABINET REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
a/r	** Coding Matrix		CONT-108901-1
a/r	** Coding Matrix		CONT-108901-2
a/r	** Coding Matrix		CONT-108901-3
a/r	** Coding Matrix		CONT-108901-4
a/r	** Coding Matrix		CONT-108901-5
	<u>NOVA INTERFACE PCB</u>		CONT-108368
	* Discreet Components		
C1,3,5,7,9,11, 13,15,25 thru 32,34,36,38,40, 41,43,45,47,49, 51,53,55 & 58	** Capacitor, .1MFD ±10%, 35V	Kemet	T110A104K035AS
C2,4,6,8,10,12, 14,16,33,35,37, 39,42,44,46,48, 50,52,54,56 & 57	** Capacitor, 4.7MFD ±10%, 35V	Kemet	T110B475K035AS
C17,C18	** Capacitor, .01MFD ±10%, 50V	Centralab	CW15C103K
C19 thru C24	** Capacitor, 100PFD ±5%, 500V	Elect.-Mot.	DM15FD101J4CR
DS1,DS2	** LED (red)	Dialight	550-0406
R1,4,5,9 thru 15, and 20 thru 25	** Resistor, 1K ±5%, 1/4W	Mepco	1-4-5P1K
R2,R3	** Resistor, 330Ω ±5%, 1/4W	Mepco	1-4-5P330E
R6,R7	** Resistor, 51K ±5%, 1/4W	Mepco	1-4-5P51K
R8	** Resistor, 2.2K ±5%, 1/4W	Mepco	1-4-5P2K2
R16 thru R19	** Resistor, 680 ±5%, 1/4W	Mepco	1-4-5P680E
	* Integrated Circuits		
A1	** Quad 2-Input NAND Buffer	TI	7437N
A2,B1,B2,B5,C7 D4,D8,E4,G1,H1, J1,K1	** Hex Inverter	TI	7404N
A3,A4,D2,D3,D5, D6,E5	** Dual D Flip Flop	TI	7474N
A5 thru A8	** Synchronous Counter	TI	74161N

MOTOR CABINET REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
B3,B4,E2	** Dual 4-Input NAND	TI	7420N
B6,B7	** Optical Isolator	HWP	HP5082-4370
B8,C1,C2,C3,D7, E1,E3,E7	** Quad 2-Input NAND	TI	7400N
C5,D1,F8,G2,H2, J2,K2	** Quad 2-Input NAND Buffer	TI	7438N
C8	** 1MHz Oscillator	Mon. Prod.	969
E6,E8	** Dual J-K Flip Flop	TI	74107N
G3,H3,J3,K3	** 4-Bit Shift Register	TI	74195N
G4,G6,H4,H6, J4,J6	** Dual Line Receiver	TI	75107AN
G5,G7,H5,H7,J5, J7,K5,K7,L1,L2, L3,M1 & M2	** Dual Line Driver	TI	75109N
G8,H8,J8 & K8	** Quad 2-Input NAND	TI	7408N
L5	** 5-Bit Comparator	Fairchild	9324
M4,L4	** 4-Bit Bistable Latch	TI	7475N
M5	** Decoder, BCD to DEC	TI	7442AN
	<u>TIMING LOGIC PCB</u>		CONT-107777
	* Discreet Components		
C1,C2,C3	** Capacitor, 100MFD		
C4,6,8,10,12, 14,16,18,20 & 22	** Capacitor, .1MFD, 35V	kemet	T110A104K035AS
C5,7,9,11,13, 15,17,19,21 & 23	** Capacitor, 4.7MFD, 35V	Kemet	T110B475K035AS
C24	** Capacitor, .01MFD		
C25,C26,C27	** Capacitor, 1MFD		
CR1 thru CR6	** Diode	Semtech	S4M
CR7,CR8,CR9	** Diode		1N658
CR10,CR11,CR12	** Diode, Zener	Unitrode	UZ5806
D1,H3	** Relay	G-B	821A-4
R1,R4,R7	** Resistor, 75Ω, 1W		
R2,R5,R8	** Resistor, 1.8K ±5%, 1/4W	Mepco	1-4-5P1K8

MOTOR CABINET REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
R3,R6,R9	** Resistor, 1.5K ±5%, 1/4W	Mepco	1-4-5P1K5
R10,R12	** Resistor, 4.7K ±5%, 1/4W	Mepco	1-4-5P4K7
R11,R13	** Resistor, 27K ±5%, 1/4W	Mepco	1-4-5P27K
R14	** Resistor, 1K ±5%, 1/4W	Mepco	1-4-5P1K
	* Integrated Circuits		
D2	** Quad 2-Input OR	TI	7432
E1,E3	** Triple 3-Input NAND	TI	7410
E2,L1,L3	** Hex Inverter	TI	7406
F1,F2,F3	** Dual D Flip Flop	TI	7474
F4	** Dual J-K Flip Flop	TI	74107
G1 thru G4	** Variable Modulo Counter	Fairchild	9305
H1,H2	** Optical Isolator		MOC-1000
H4	** 10MHz Oscillator	Mon. Prod.	969
J4	** Quad 2-Input NAND	TI	7400
L2	** 3-Input NOR	TI	7427
L4	** Hex Inverter	TI	74LS04
M1 thru M4	** Synchronous Counter	TI	74161
	<u>MOTOR LOGIC PCB</u>		CONT-107783
	* Discreet Components		
C1 thru C41 (odd) & C42	** Capacitor, .1MFD, 35V	Datum	0221-0104
C2 thru C40 (even) & C43	** Capacitor, 4.7MFD, 35V	Datum	0220-0415
C44 thru C48	** Capacitor, 1MFD, 35V	Datum	0212-0105
C49	** Capacitor, .01MFD, 100V	Datum	0226-0103-1
C50	** Capacitor, .001MFD		
M6,M7	** Relay	G-B	821A-4
R1 thru R21, R34 & R35	** Resistor, 1K ±5%, 1/4W	Mepco	1-4-5P1K
R22 thru R33	** Resistor, 47Ω, 1/2W	Datum	0104-0470

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	* Integrated Circuits		
B2,F2,J6,K4	** Quad 2-Input NOR	TI	7402
B3,B5,B6,B7, C5,C6,C7,D3, F5,J4,N7 & P7	** Dual D Flip Flop	TI	7474
B4,D2,D5,H2, J5 & R5	** Hex Inverter	TI	7404
C3,D4,H4,J3, M4 & R7	** Quad 2-Input NAND	TI	7400
C4,D6,D7,E6, E7,F6,F7,L6, L7 & R6	** Synchronous Counter	TI	74161
DIA,DIB,ElA, ElB,FlA & FlB	** Dual 2-Input NAND Buffer	TI	75452
E2	** Dual 4-Input NAND	TI	7420
E3	** Dual J-K Flip Flop	TI	7476
E4,F3,F4	** 4-Bit Shift Register	TI	7495A
E5	** Coding Matrix	TI	
Hl,L3,L5	** Hex Inverter	TI	74LS04
H3	** Triple 3-Input NAND	TI	7410
H5,H6,H7	** Variable Modulo Counter	Fairchild	9305
J2	** Resistor Pack, 1K	Beckman	898-1-R1.0K
J7	** Dual J-K Flip Flop	TI	74107
K1	** Quad 2-Input NAND	TI	74LS00
K2	** Triple 3-Input NOR	TI	7427
K3	** Quad 2-Input Exclusive OR	TI	7486
K5,P4,R4	** Quad 2-to-1 line MUX	TI	74157
K6	** 256-Bit PROM	TI	74188A
K7,L1	** Resistor Pack, 2K	Beckman	898-1-R2.0K
L2	** 8-Input NAND	TI	7430
L4,N3,R3	** Resistor Pack, 4.7K	Beckman	898-1-R4.7K
M1,M2,P1,P2	** Quad 2-Input NOR	TI	74LS02
M3,P3	** 8-Bit Bistable Latch	TI	74100
M5	** Hex Inverter	TI	7406
N1,N2,R1,R2	** Quad 2-Input NAND	TI	7438

MOTOR CABINET REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
N4,N5,P5	** 5-Bit Comparator	Fairchild	9324
N6,P6	** 4-Bit Binary Adder	TI	7483
	DATA COUPLER PCB		CONT-107787
	* Discreet Components		
C1,3,5,6,8,10, 12,14,16,18,20, 22,24,26 & 28	** Capacitor, 4.7MFD, 35V	Datum	0220-0415
C2,4,7,9,11, 13,15,17,19, 21,23,25,27 & 29	** Capacitor, .1MFD, 35V	Datum	0221-0104
C30	** Capacitor, 1MFD, 35V	Datum	0212-0105
C31,C32	** Capacitor, .01MFD, 100V	Datum	0226-0103-1
CR1,CR2	** LED (red)	Dialco	550-0406
CR3	** Diode		1N658
CR4	** Zener Diode	Unitrode	UZ5806
R1,2,3,6,7,12 thru 21,25,29 & 30	** Resistor, 1K ±5%, 1/4W	Mepco	1-4-5P1K
R4,5,8,9,10 & 11	** Resistor, 680Ω ±5%, 1/4W	Mepco	1-4-5P680E
R22,R26	** Resistor, 330Ω ±5%, 1/4W	Mepco	1-4-5P330E
R23,R27	** Resistor, 2.2K ±5%, 1/4W	Mepco	1-4-5P2K2
R24,R28	** Resistor, 51K ±5%, 1/4W	Mepco	1-4-5P51K
S1	** Switch, Toggle	Datum	1202-0123
	* Integrated Circuits		
A1,A2,D2,E2, F2 & J1 thru J8	** Dual Line Receiver	TI	75107A
A3,A4,C4	** Dual D Flip Flop	TI	7474
A5	** Quad 2-Input NAND Buffer	TI	7437
B1	** Hex Inverter	TI	7404
B2,C2	** Quad 2-Input NOR	TI	7433
B3,B4	** Synchronous Counter	TI	74161

MOTOR CABINET REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
B1	** Hex Inverter	TI	7404
B2,C2	** Quad 2-Input NOR	TI	7433
B3,B4	** Synchronous Counter	TI	74161
B5,C1	** Quad 2-Input NAND	TI	7400
C3,E4 & K1 thru K8	** Quad 2-Input NAND	TI	7438
C5,D5	** Optical Isolator	H-P	5082-4370
D1,F1	** Hex Inverter	TI	7406
D3,L1,L3,L5 & L7	** Quad 2-Input NAND	TI	74LS00
E1,E3,L2 & L6	** Resistor Pack, 4.7K	Beckman	898-1-R4.7K
H1 thru H8	** Dual Line Driver	TI	75109A
	<u>DATA COUPLER POWER SUPPLY Assy.</u>		CONT-108138
C1,C3	* Capacitor, 2200MFD, 50V	Sprague	36D223G050DC2A
C2,C4	* Capacitor, 1600MFD, 10V	Sprague	39D168G010FL4
CR1	* Integrated Rectifier, Common Cathode	Varo	45527-200/FS
CR2	* Integrated Rectifier, Common Anode	Varo	45528-200/FS
DS1,DS3	* LED, 14V	Dialight	249-7871-3331-504
DS2,DS4	* LED, 5V	Dialight	249-7868-3331-504
R1,R2	* Resistor, 1Ω ±5%, 11W	Ohmite	4730
S1	* Switch, DPST	C-H	7360K7
VR1	* Regulator, +5V	Lambda	LAS2105
VR2	* Regulator, -5.2V	Lambda	LAS2705

TRACK SWITCHING CONTROL CIRCUITS REPLACEABLE PARTS LIST

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
	PANEL #1 TRACK SWITCHING CONTROL BOX		CONT-108914
CB2	* Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS15 thru 28 & DS50	* Lamp, Neon (NE-2J)	Dialco	C9A
F1 thru F12	* Fuse, 1/8A	Littlefuse	312.125
K36,K58	* Relay, 24VDC	P & B	KHP17D12-24
K37	* Relay, 24VDC	P & B	KUP14D15-24
K38 thru K42	* Relay, 120VAC	P & B	KHP17A12-120
PB100	* Switch, Pushbutton	Micro	PTY2153C
PS2	* Power Supply, 24VDC	Lambda	LOS-Z-24
S2,S100	* Switch, 2 POS, Key	Micro	PTKBC2221C
S8	* Switch, Selector	Micro	PTSHA212C
	PANEL #2 Track SWITCHING CONTROL BOX		CONT-108916
CB2	* Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS41 thru 48 & DS53	* Lamp, Neon (NE-2J)	Dialco	C9A
F1 thru F12	* Fuse, 1/8A	Littlefuse	312.125
K30	* Relay, 24VDC	P & B	KHP17D12-24
K31	* Relay, 24VDC	P & B	KUP14D15-24
K32 thru 35, 56 & 57	* Relay, 120VAC	P & B	KHP17A12-120
PB101	* Switch, Pushbutton	Micro	PTY2153C
PS5	* Power Supply, 24VDC	Lambda	LOS-Z-24
S5,S101	* Switch, 2 Pos, Key	Micro	PTKBC2221C
S7	* Switch, Selector	Micro	PTSHA212C
	PANEL #3 TRACK SWITCHING CONTROL BOX		CONT-108912
CB2	* Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS1 thru 14 & DS49	* Lamp, Neon (NE-2J)	Dialco	C9A
F1 thru F12	* Fuse, 1/8A	Littlefuse	312.125
K12	* Relay, 24VDC	P & B	KHP17D12-24
K13	* Relay, 24VDC	P & B	KUP14D15-24

TRACK SWITCHING CONTROL CIRCUITS REPLACEABLE PARTS LIST (CONT.)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
K14 thru 29,43, 54 & 55	* Relay, 120VAC	P & B	KHP17A12-120
PB102	* Switch, Pushbutton	Micro	PTY2152C
PS1	* Power Supply, 24VDC	Lambda	LOS-Z-24
S1,S102	* Switch, 2 Pos, Key	Micro	PTKBC2221C
S6	* Switch, Selector	Micro	PTSHA212C
	PANEL #4 TRACK SWITCHING CONTROL BOX		CONT-108918
CB2	* Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS29 thru 34, & 51	* Lamp, Neon (NE-2J)	Dialco	C9A
F1 thru F12	* Fuse, 1/8A	Littlefuse	312.125
K44	* Relay, 24VDC	P & B	KHP17D12-24
K45	* Relay, 24VDC	P & B	KUP14D15-24
K46 thru K49	* Relay, 120VAC	P & B	KHP17A12-120
PS3	* Power Supply, 24VDC	Lambda	LOS-Z-24
S3	* Switch, 2 Pos, Key	Micro	PTKBC2221C
S9	* Switch, Selector	Micro	PTSHA212C
	PANEL #5 TRACK SWITCHING CONTROL BOX		CONT-108920
CB2	* Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS35 thru 40 & 52	* Lamp, Neon (NE-2J)	Dialco	C9A
F1 thru F12	* Fuse, 1/8A	Littlefuse	312.125
K50 thru 53	* Relay, 120VAC	P & B	KHP17A12-120
K58	* Relay, 24VDC	P & B	KHP17D12-24
K59	* Relay, 24VDC	P & B	KUP14D15-24
PS4	* Power Supply, 24VDC	Lambda	LOS-Z-24
S4	* Switch, 2 Pos, Key	Micro	PTKBC2221C
S10	* Switch, Selector	Micro	PTSHA212C

STORAGE TRACK MOTOR CONTROL CONSOLE REPLACEABLE PARTS LIST (REF. FIG. 2-3)

PARTS LIST (REF. FIGURE 2-3)

REF. DESIG. OR LOCATOR	DESCRIPTION	MFG.	PART NO.
DS1	Sonalert	Mallory	SC628P
K1	Relay, 4 form C, 115VAC	P & B	R10EY4115VAC
M1	Timer, 10-Sec Delay	P & B	CUC-41-30010
PS1	Power Supply, 24VDC	Lambda	LOS-Z-24
S1	Switch, 2 Pos Rotary	Micro	PTSBC202R
S2	Switch, 2 Pos Rotary	Micro	PTUBJ1CTC02R
S3 thru S10	Switch, Pushbutton DPDT	Alco	MPA206R

6. DRAWINGS

6-1 INTRODUCTION

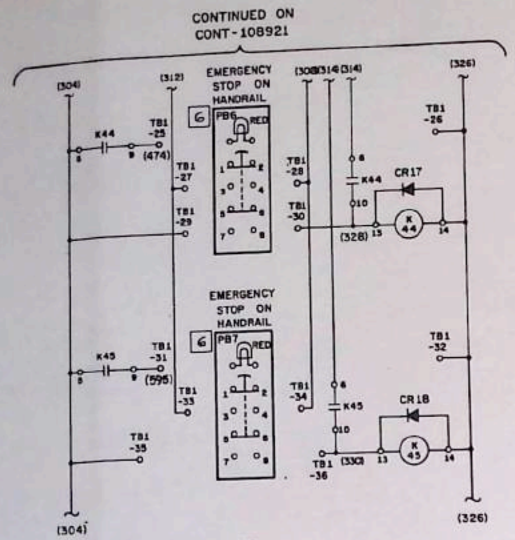
This section contains fold-out schematic and logic diagrams referred to in section III, Theory of Operation. They are placed here for reader convenience so that they can easily be viewed in conjunction with the theory of operation discussions, which are keyed to these drawings. It is also for reader convenience that these drawings are printed on one side of the paper.

On the logic diagrams, different symbols are used to differentiate between connectors, however the circles with numbers or letters enclosed are for reference between sheets of the same diagram and should not be confused with connector symbols. Signal flow is always left-to-right with all inputs and outputs to a sheet brought out to the left and right.

The tables beginning on the next page are provided in place of power distribution diagrams. It is hoped that they are found to be more convenient to use.

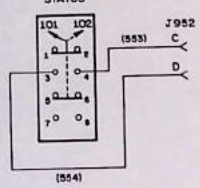
The following is an index to the figures herein:

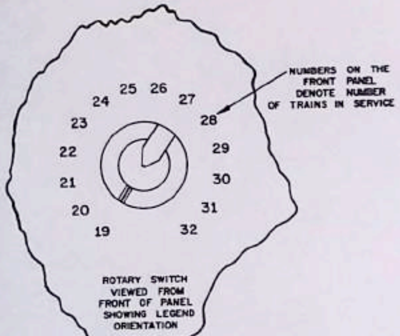
Figure No.	Title
6-15	Turntable Drive Functional Schematic
6-16	Downramp Drive Control Functional Schematic
6-17	Upramp Drive Control Functional Schematic
6-18	Track Switching Controls
6-19	Storage Track Motor Control Console



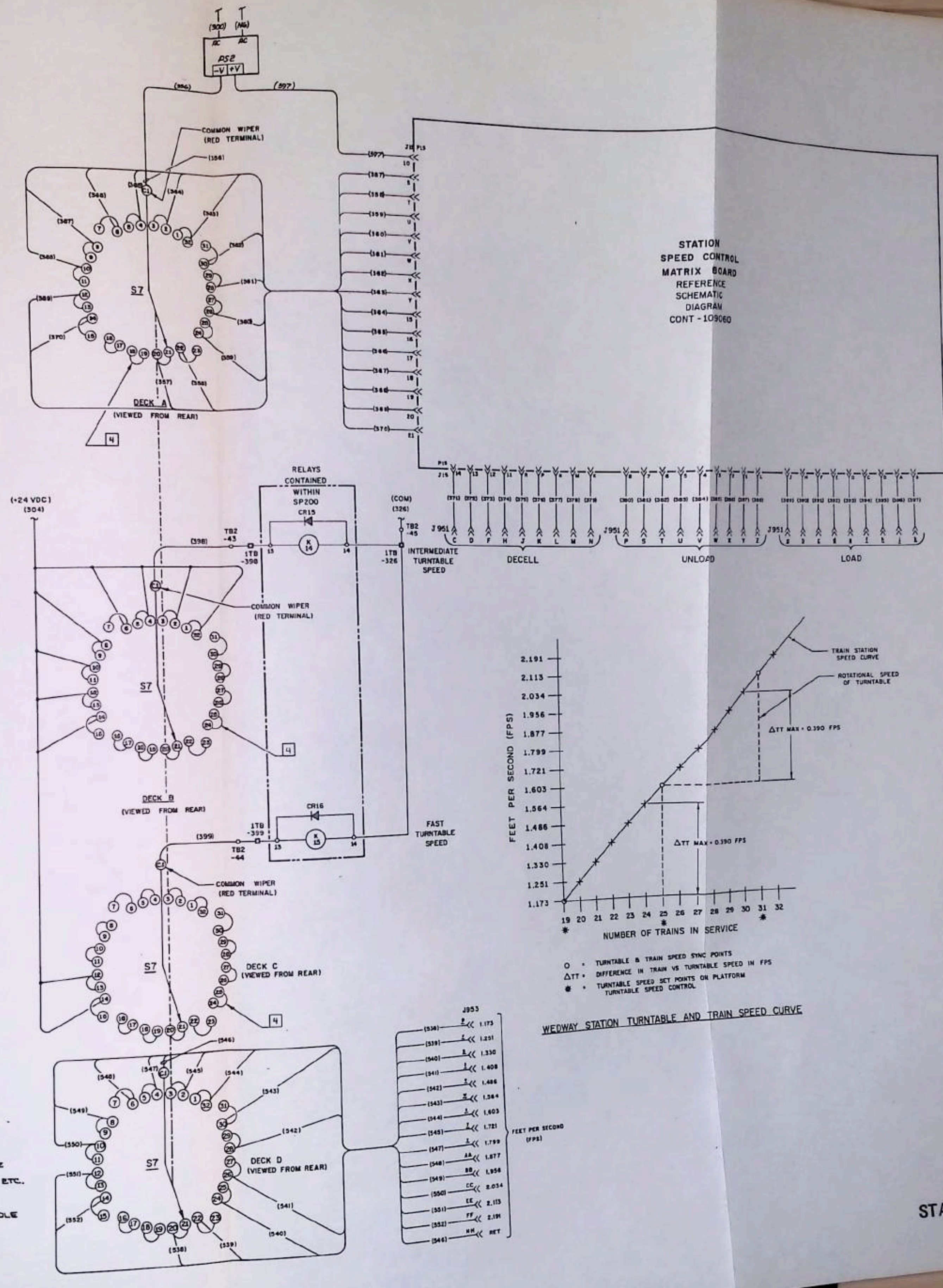
S 4
RIDE STATUS

CONTACT	101	102
1 - 2	O	X
3 - 4	X	O
5 - 6	O	X
7 - 8	X	O





FRONT PANEL LEGEND	DECK A, OR B, OR C
NUMBER OF TRAINS IN SERVICE	WIPER CONTACT CONNECTED TO CONTACT NO.
19	21
20	23
21	25
22	27
23	29
24	31
25	1
26	3
27	5
28	7
29	9
30	11
31	13
32	15
NOT USED	17
NOT USED	19



6 UNIT NOT WIRED INTO SYSTEM

5. REFERENCE DOCUMENT: CONSOLE ASSY CONT-109066
WIRING DIAGRAMS CONT-109069, CONT-108921, CONT-108969
CONT-108945

4 INSTALL JUMPERS APPROX. AS SHOWN USING NO. 22 AWG BUSWIRE

3. DECK A IS NEAREST PANEL, DECK B IS SECOND DECK FROM PANEL ETC.

2. O DENOTES TERMINAL AT STATION CONSOLE

1. □ DENOTES REMOTE TERMINAL WITH RESPECT TO STATION CONSOLE

NOTES: UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DWG

FIGURE 6 – 1
CONT – 108922
STATION SPEED CONTROLS

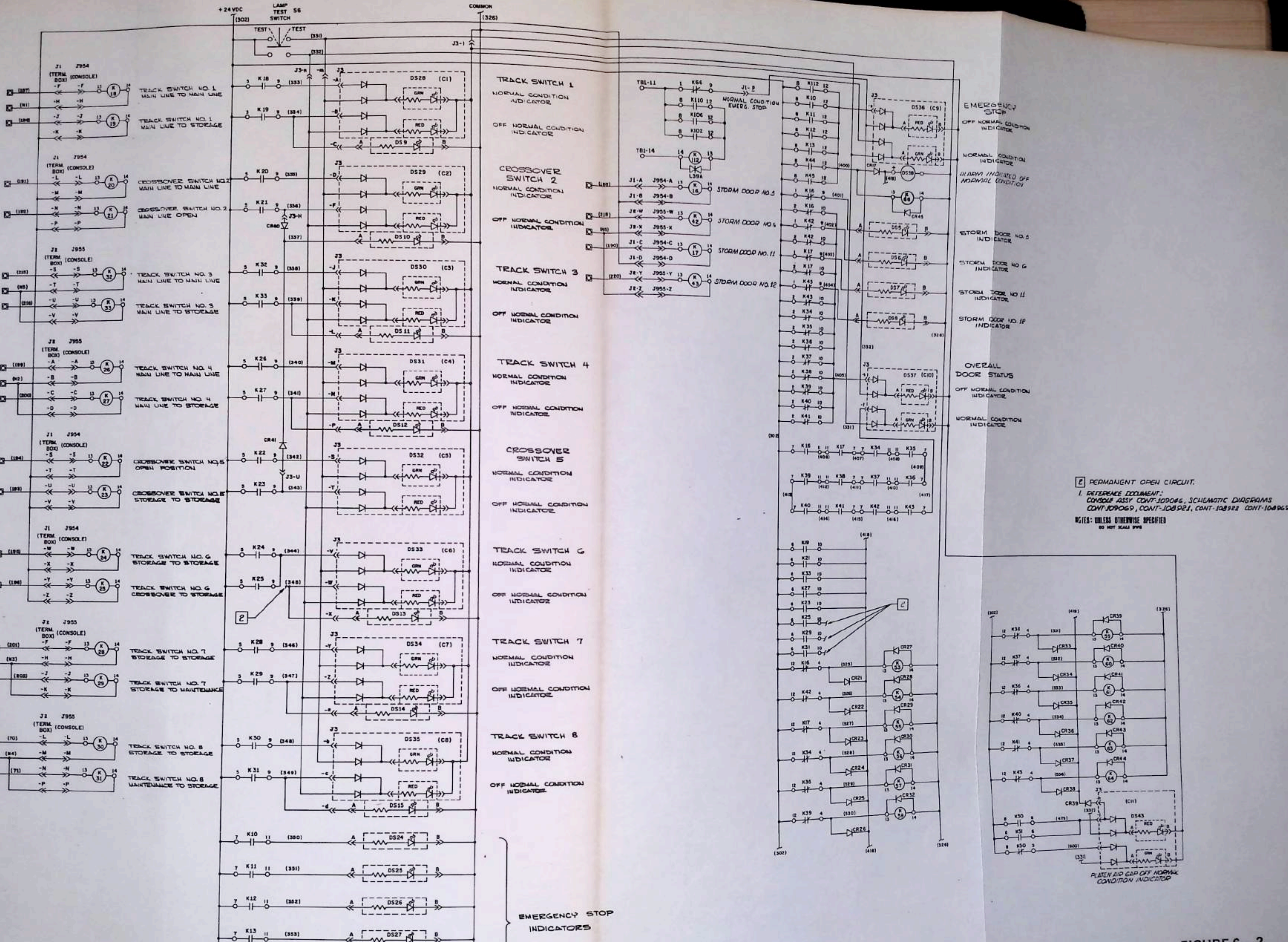


FIGURE 6 – 2
CONT – 108945
RIDE OFF NORMAL CIRCUITS

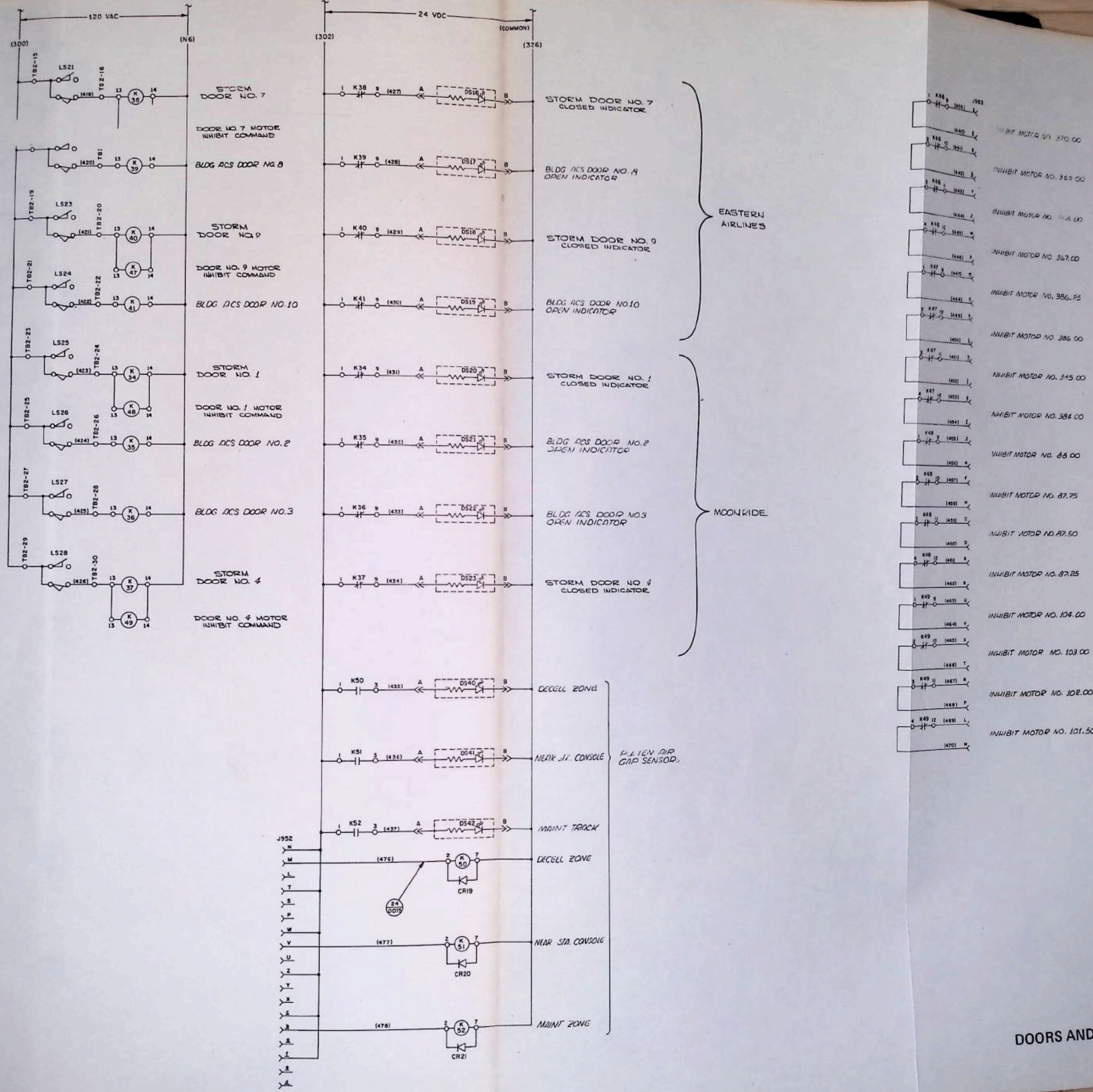


FIGURE 6 – 3
CONT – 109069
DOORS AND PLATEN AIR GAP CIRCUITS

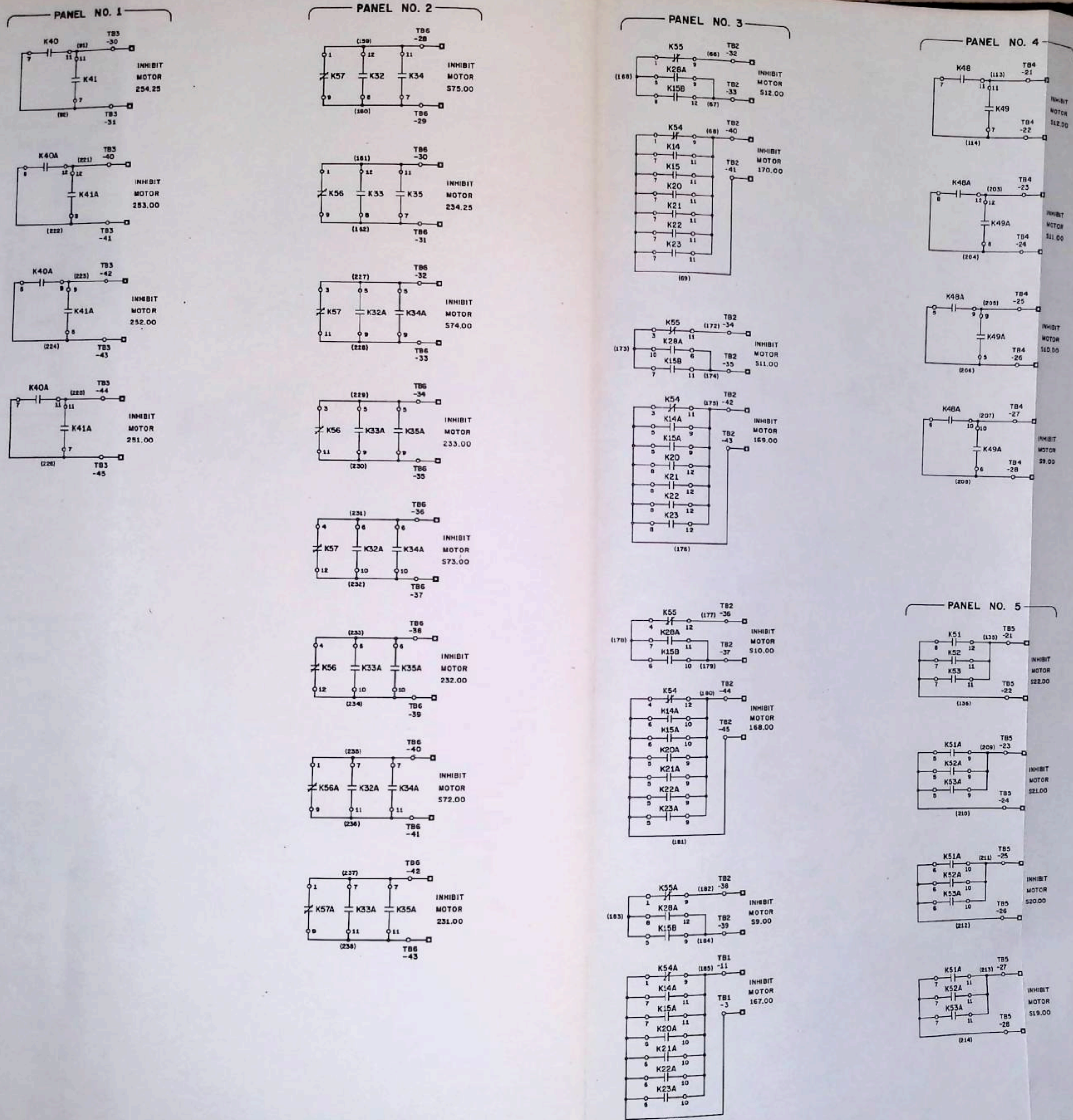


FIGURE 6 – 4
CONT - 109058
TRACK SWITCHING MOTOR INHIBITS

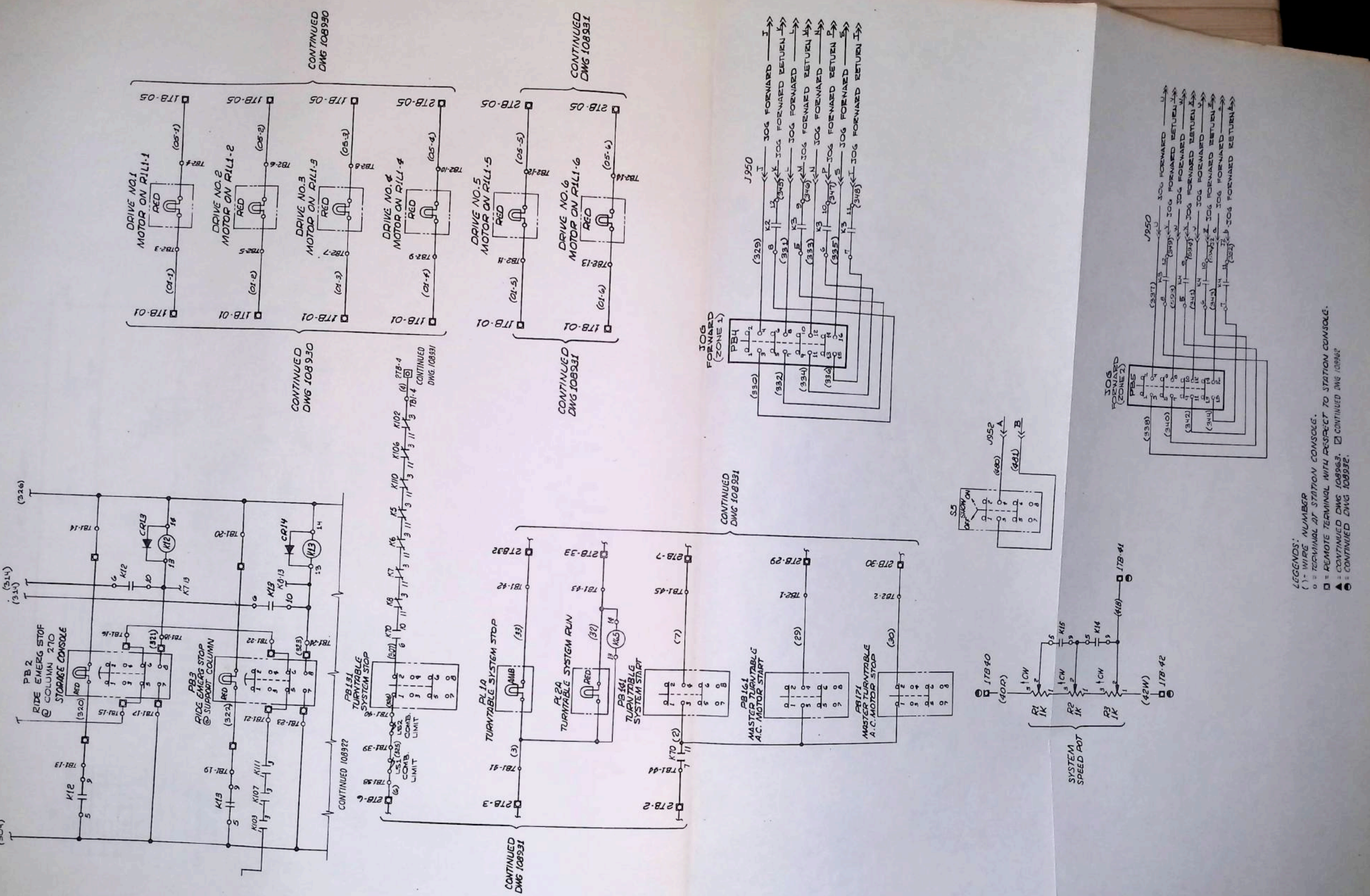


FIGURE 6 – 5
CONT - 108921
RIDE/TURNTABLE START/STOP CONTROLS

S1
RIDE MASTER

CONTACT	OFF	ON
1-2	O	X
3-4	X	O
5-6	O	X
7-8	X	O

X = CONTACT CLOSED
O = CONTACT OPEN
KEY OPERATED
KEY REMOVABLE IN THE OFF POSITION

S8
EMERGENCY LIGHTING

CONTACT	OFF	ON
1-2	O	X
3-4	X	O
5-6	O	X
7-8	X	O

KEY OPERATED
KEY REMOVABLE IN THE OFF POSITION

S2
RIDE START

CONTACT NO.	CONTACT STATE	STOP	PUSH TO RUN
1-2	FREE	X	O
	DEPRESS	O	O
3-4	FREE	O	O
	DEPRESS	X	X
5-6	FREE	X	O
	DEPRESS	X	O
7-8	FREE	O	O
	DEPRESS	O	X

S3
EMERGENCY STOP LAMP

CONTACT	NORMAL	RESET
1-2	O	X
3-4	X	O
5-6	O	X
7-8	X	O

KEY OPERATED
KEY REMOVABLE IN NORMAL POSITION

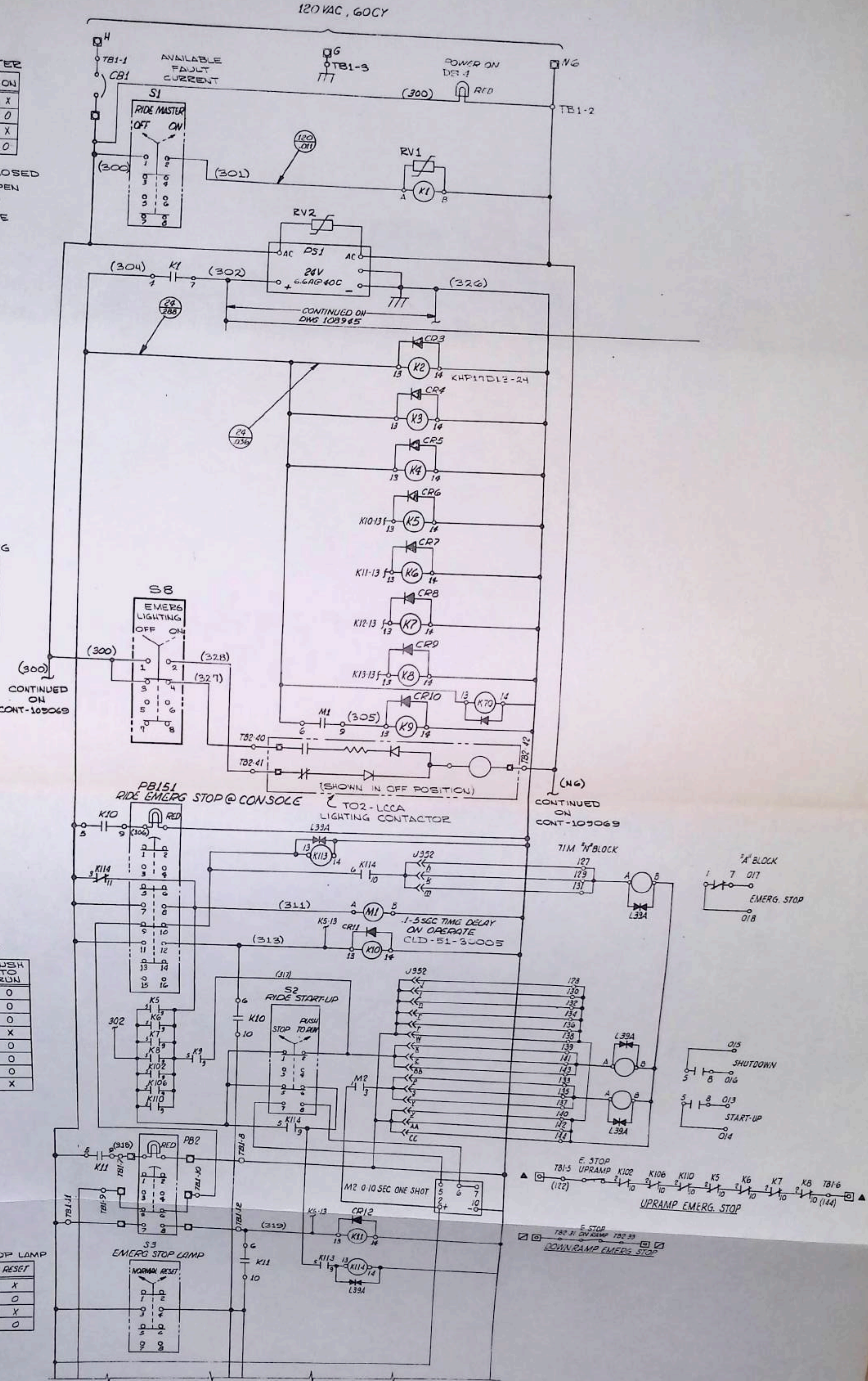


FIGURE 6 – 6
CONT – 108921
RIDE CONTROLS

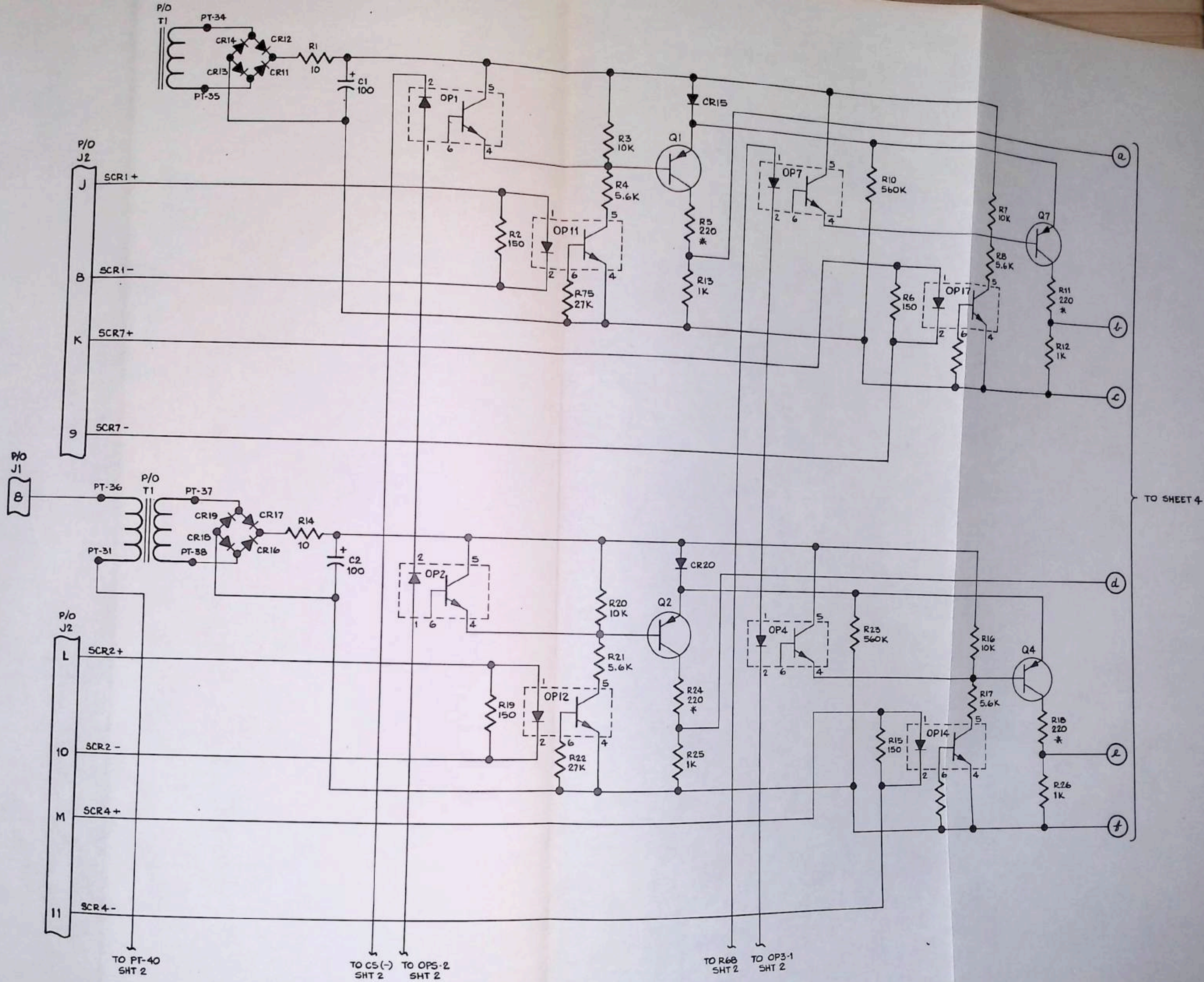


FIGURE 6 – 7
THREE-PHASE MOTOR CONTROL PCB
SHEET 1 OF 4

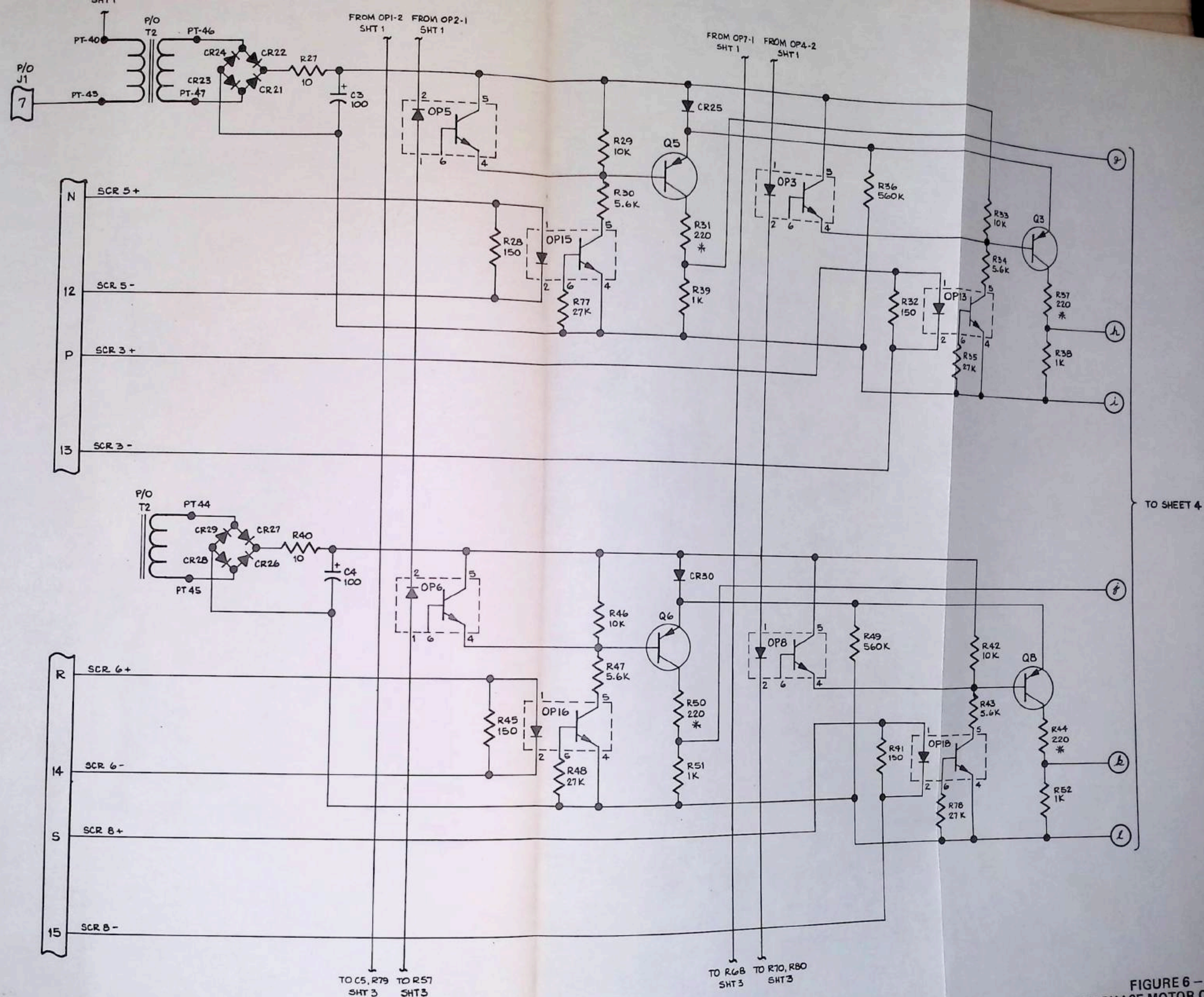


FIGURE 6 – 7
THREE-PHASE MOTOR CONTROL PCB
SHEET 2 OF 4

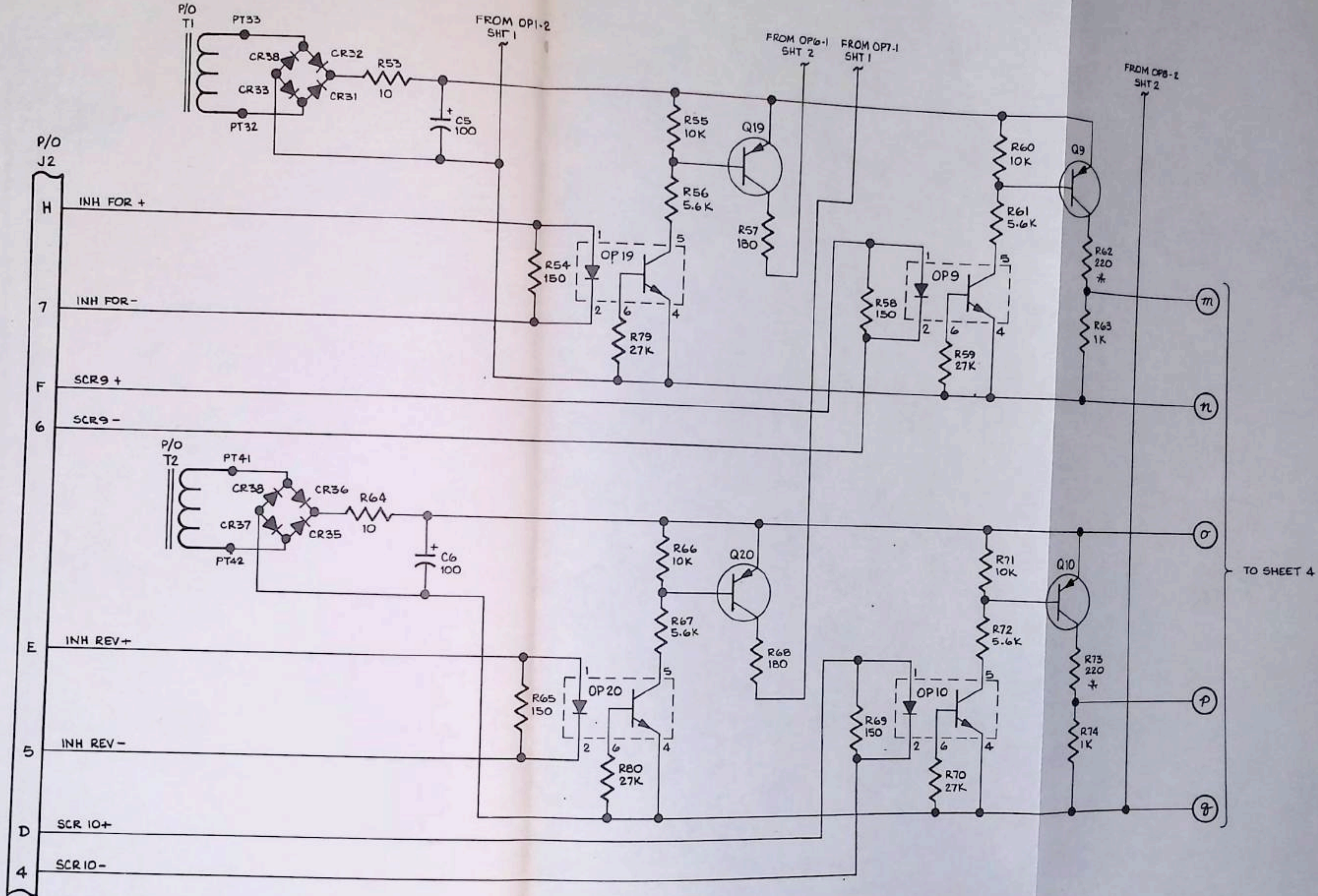


FIGURE 6 – 7
THREE-PHASE MOTOR CONTROL PCB
SHEET 3 OF 4

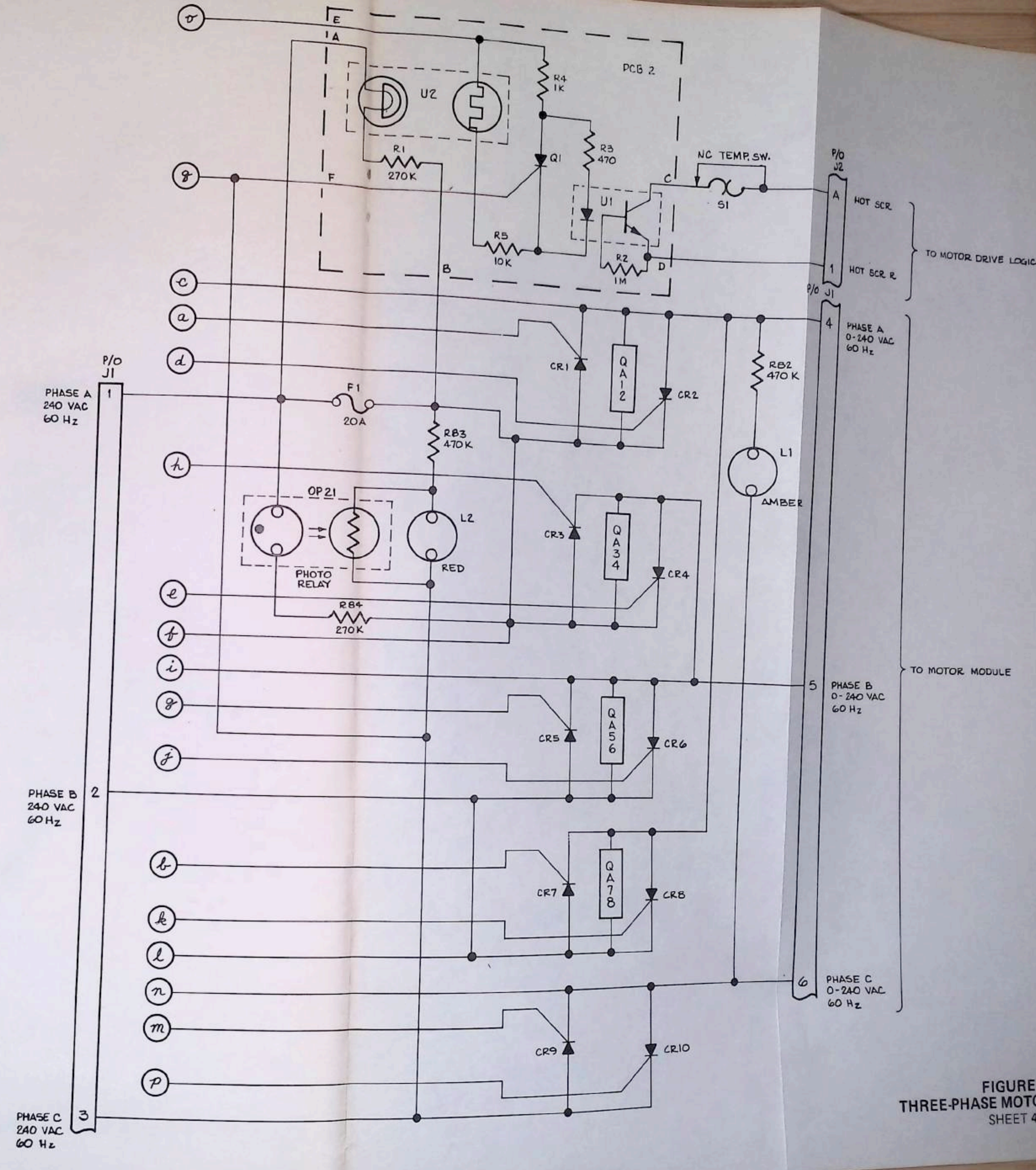


FIGURE 6 – 7
THREE-PHASE MOTOR CONTROL PCB
SHEET 4 OF 4

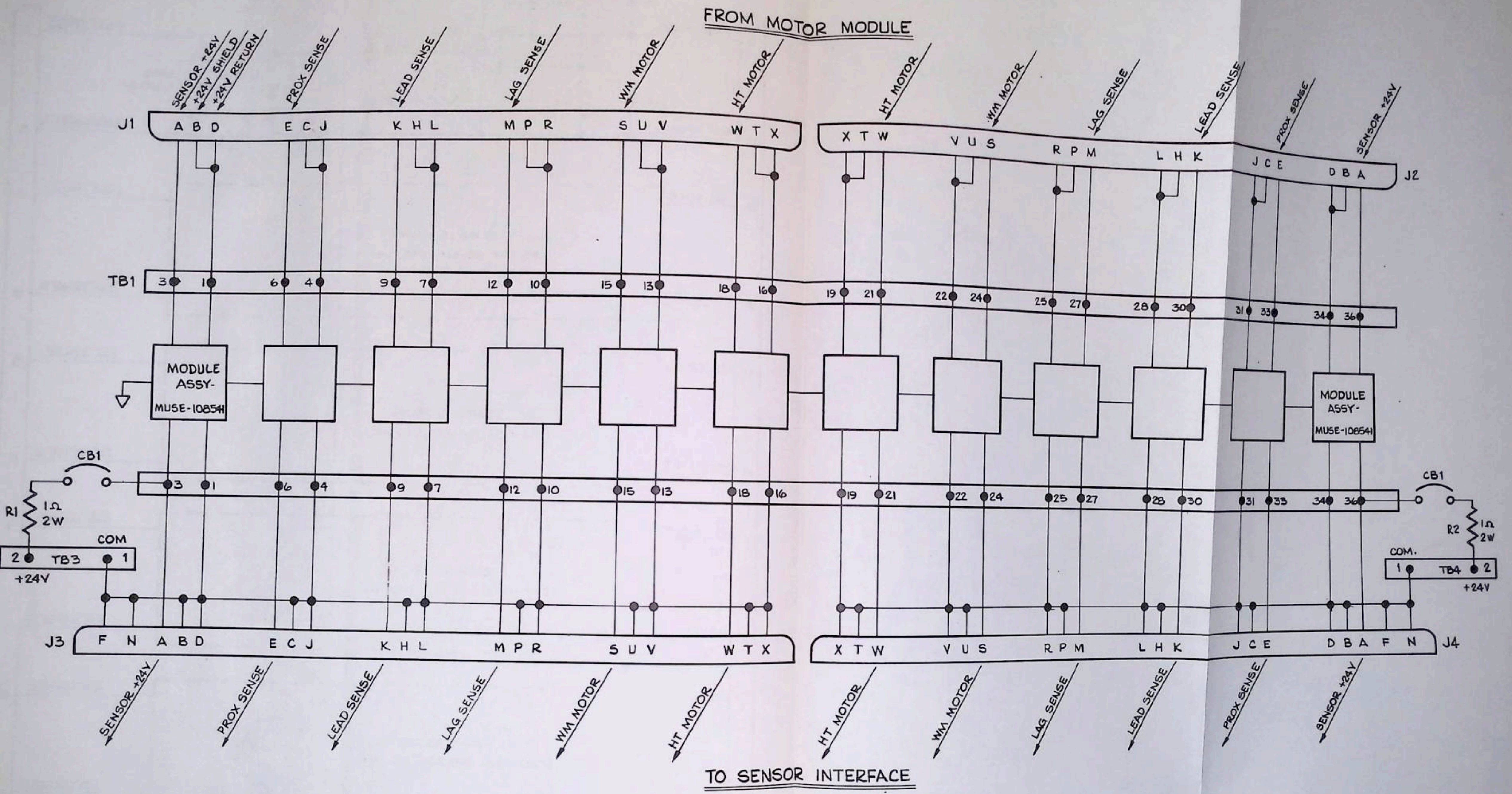


FIGURE 6 – 8
LIGHTNING PROTECTION PANEL PCB

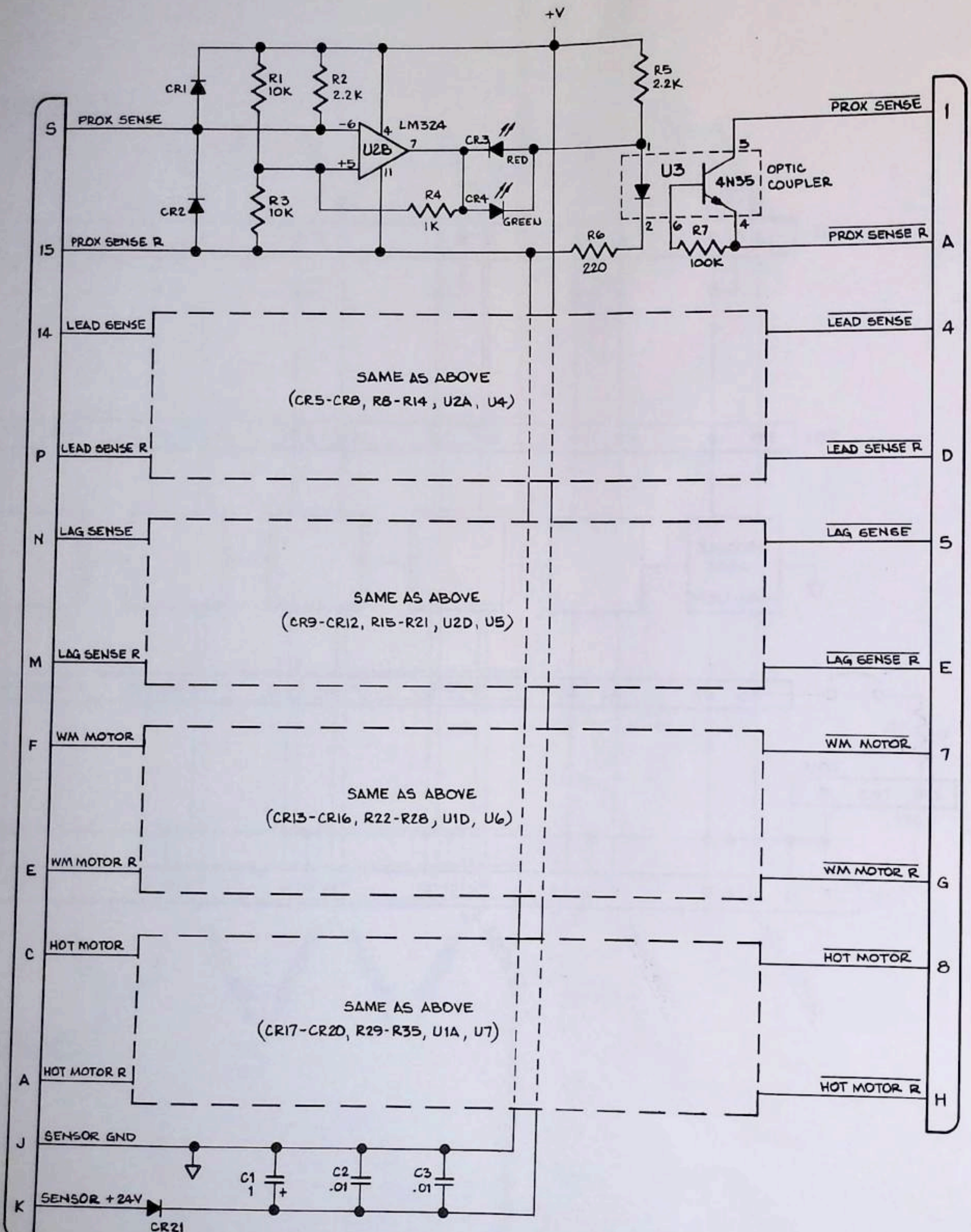


FIGURE 6 – 9
SENSOR INTERFACE PCB

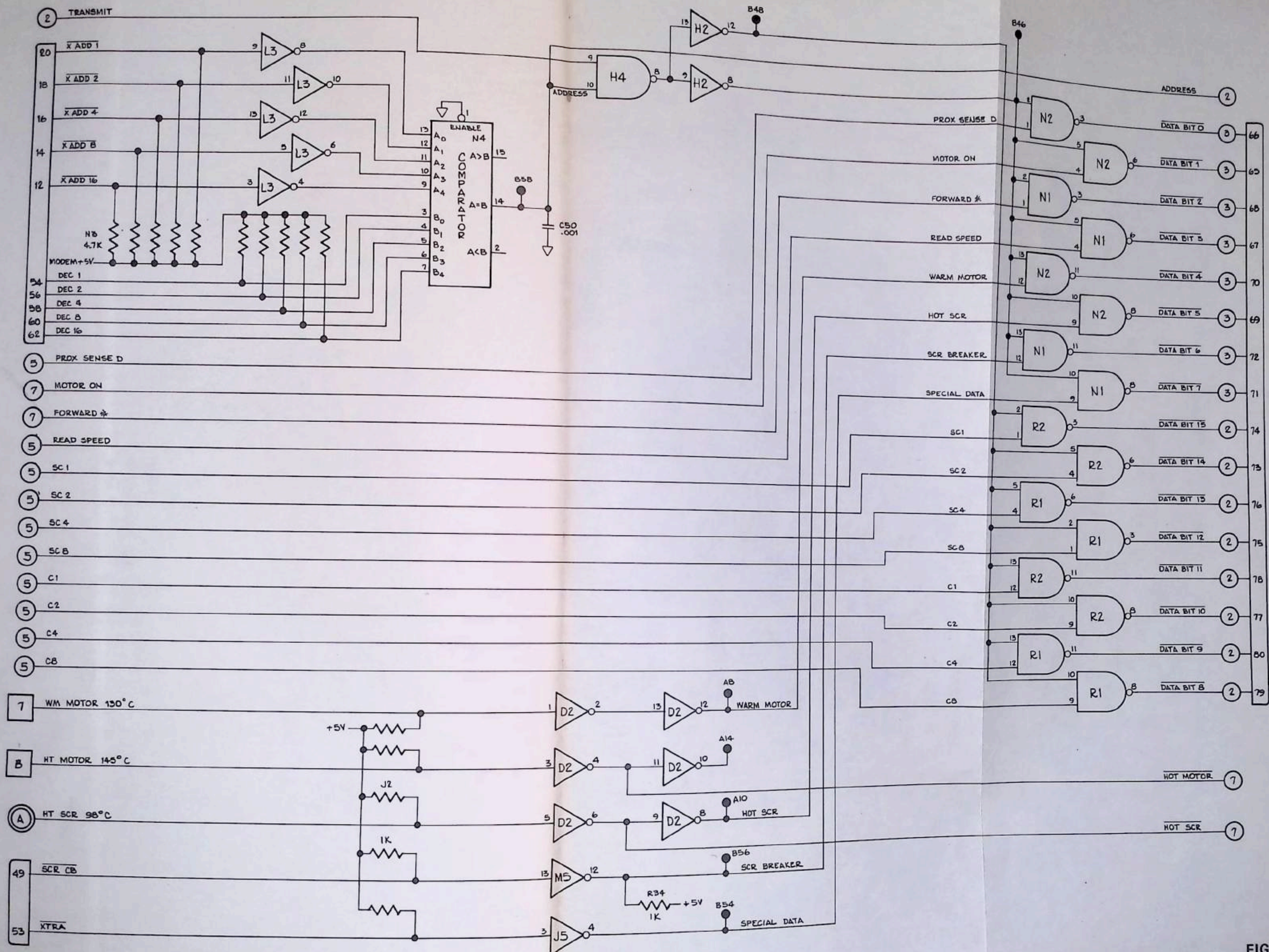


FIGURE 6 – 10
MOTOR LOGIC PCB
SHEET 1 OF 7

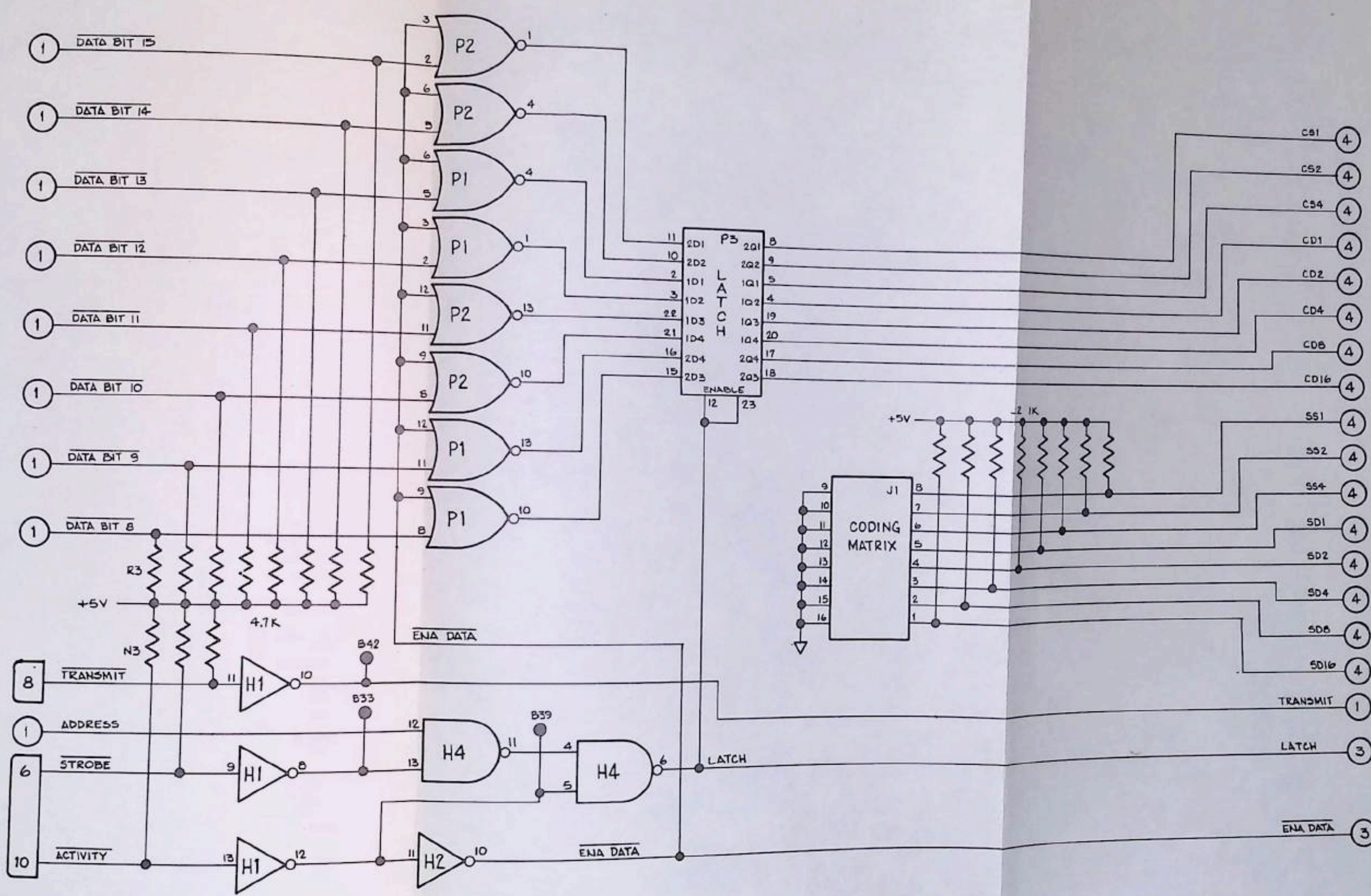


FIGURE 6 – 10
MOTOR LOGIC PCB
SHEET 2 OF 7

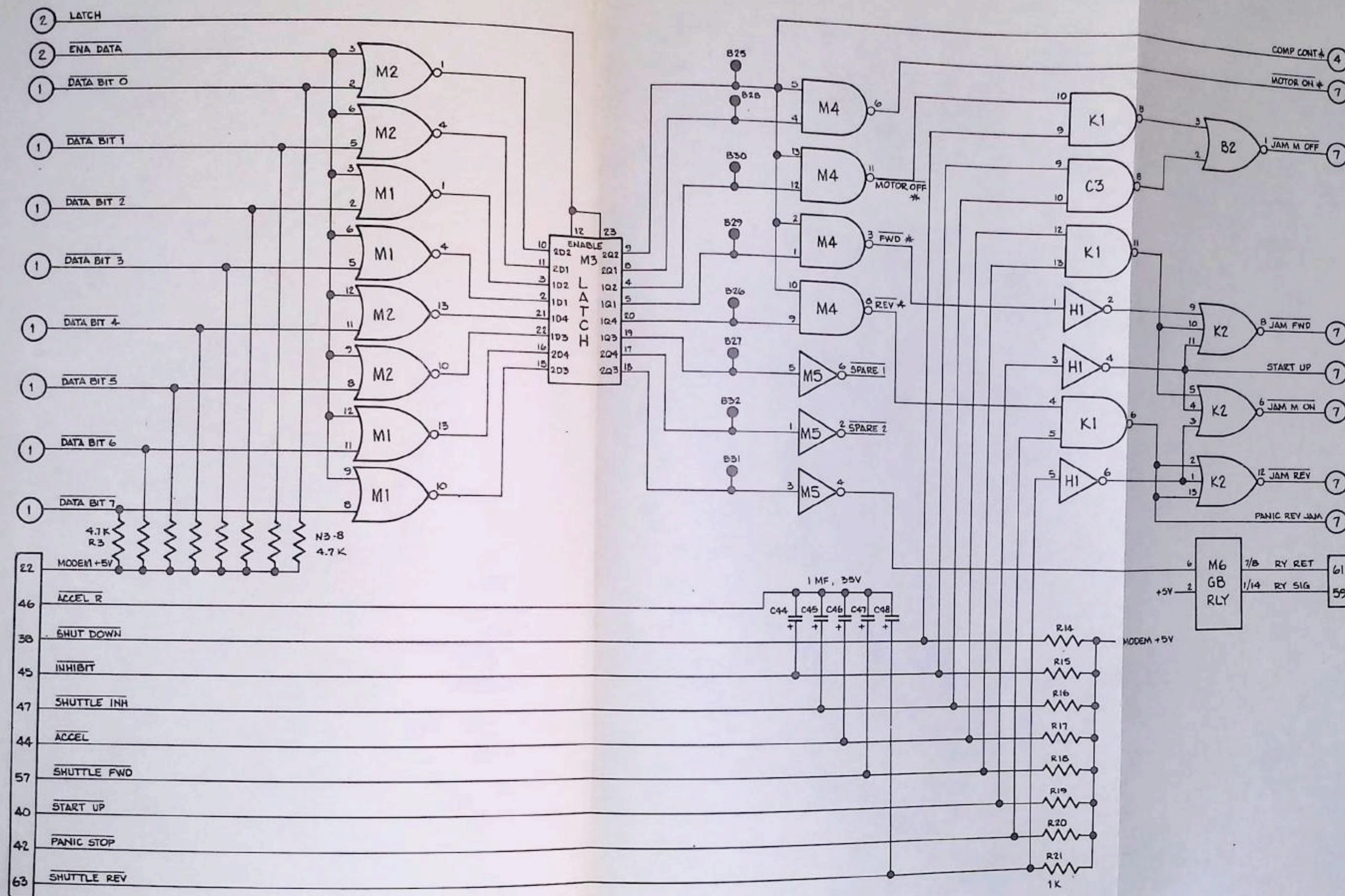


FIGURE 6 – 10
MOTOR LOGIC PCB
SHEET 3 OF 7

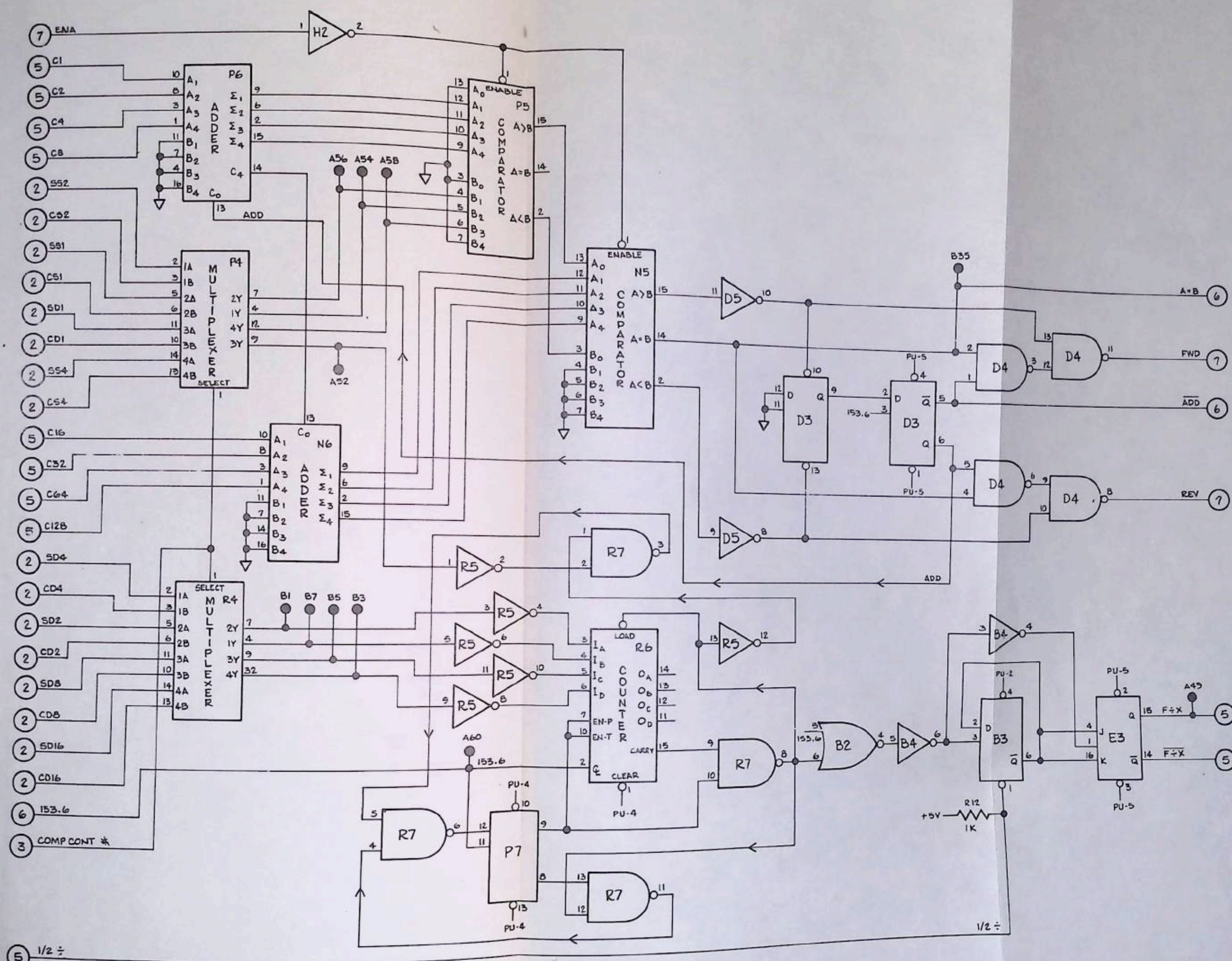


FIGURE 6 – 10
MOTOR LOGIC PCB
SHEET 4 OF 7

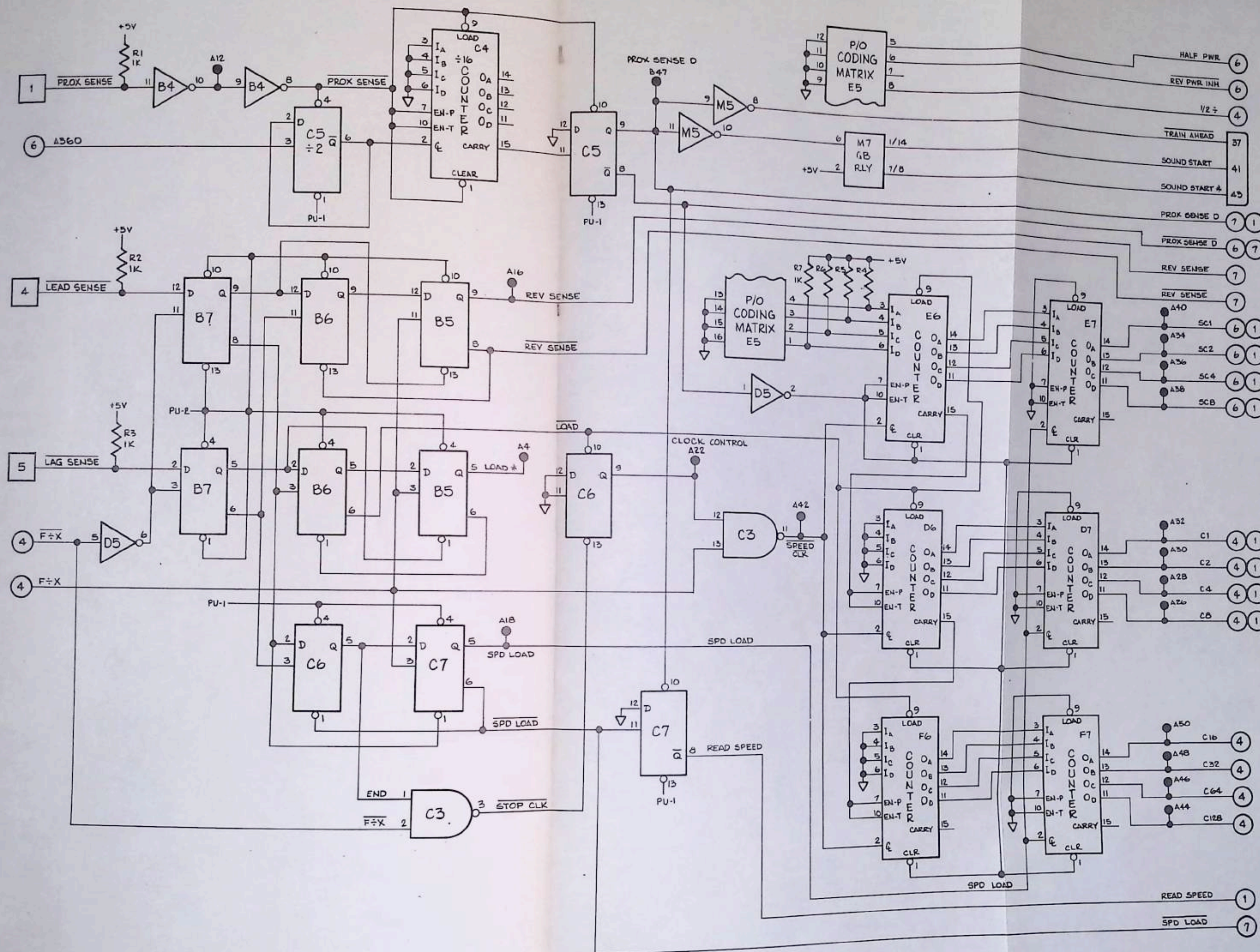


FIGURE 6 — 10
MOTOR LOGIC PCB
SHEET 5 OF 7

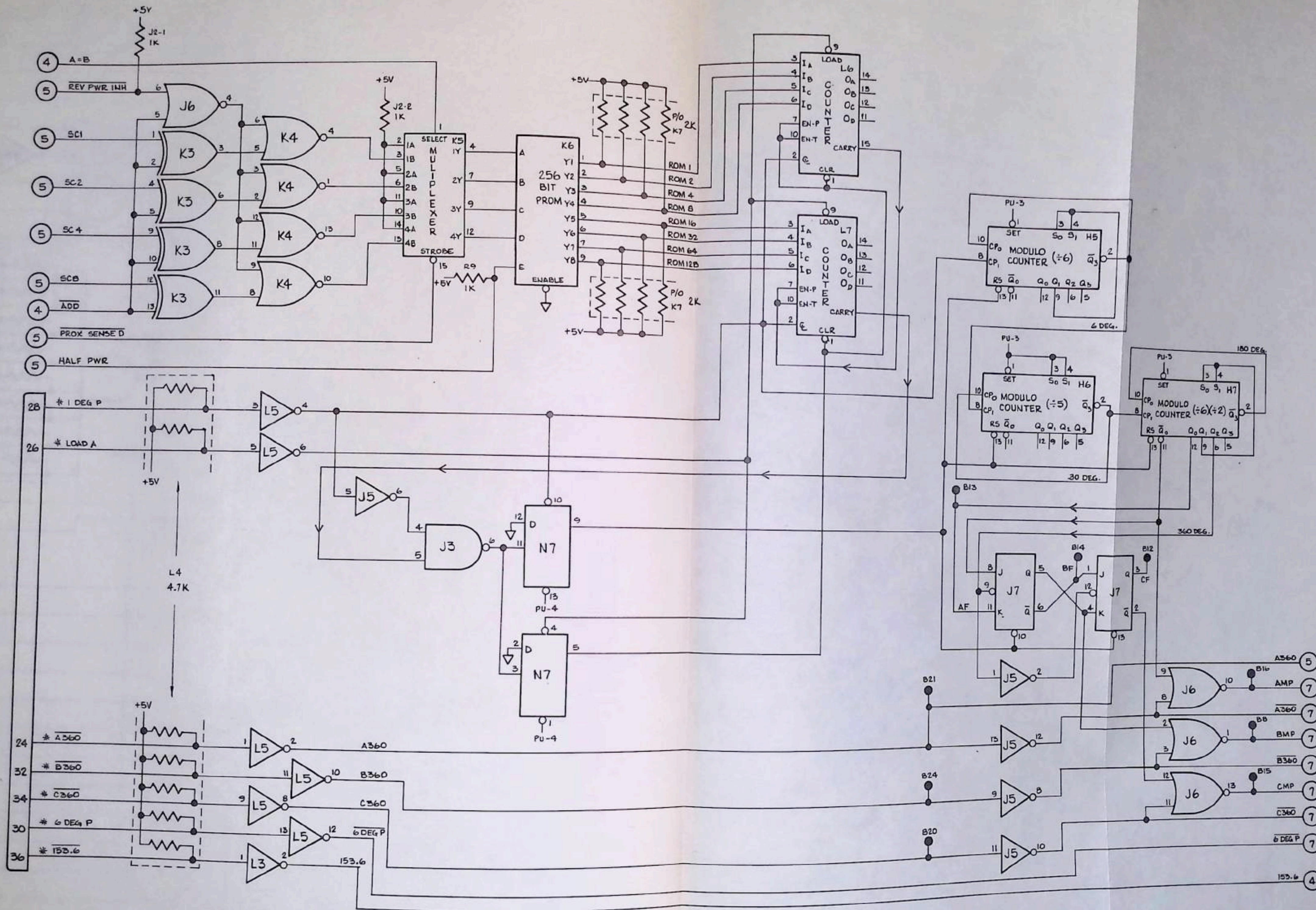


FIGURE 6 — 10
MOTOR LOGIC PCB
SHEET 6 OF 7

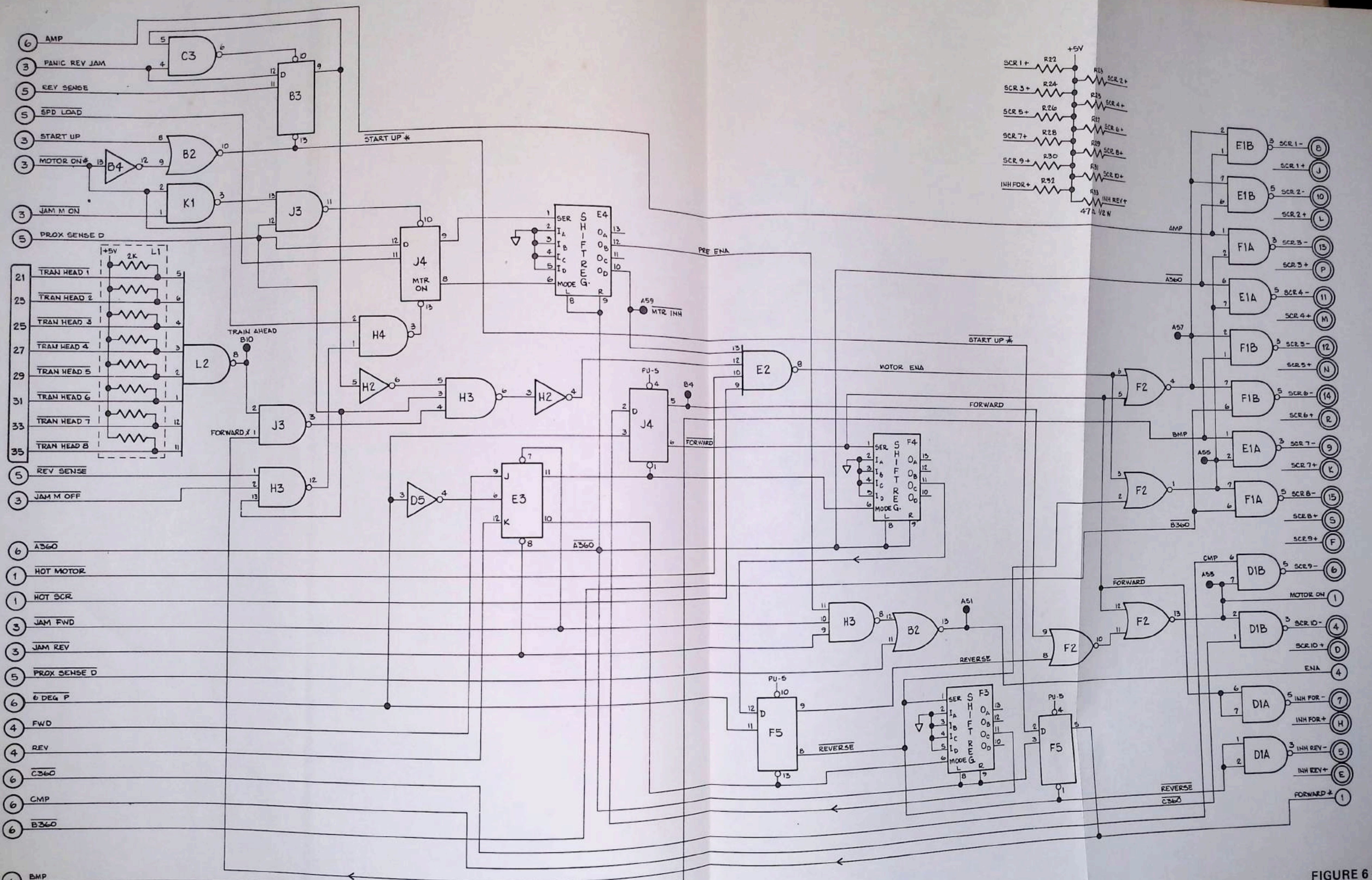


FIGURE 6 – 10
MOTOR LOGIC PCB
SHEET 7 OF 7

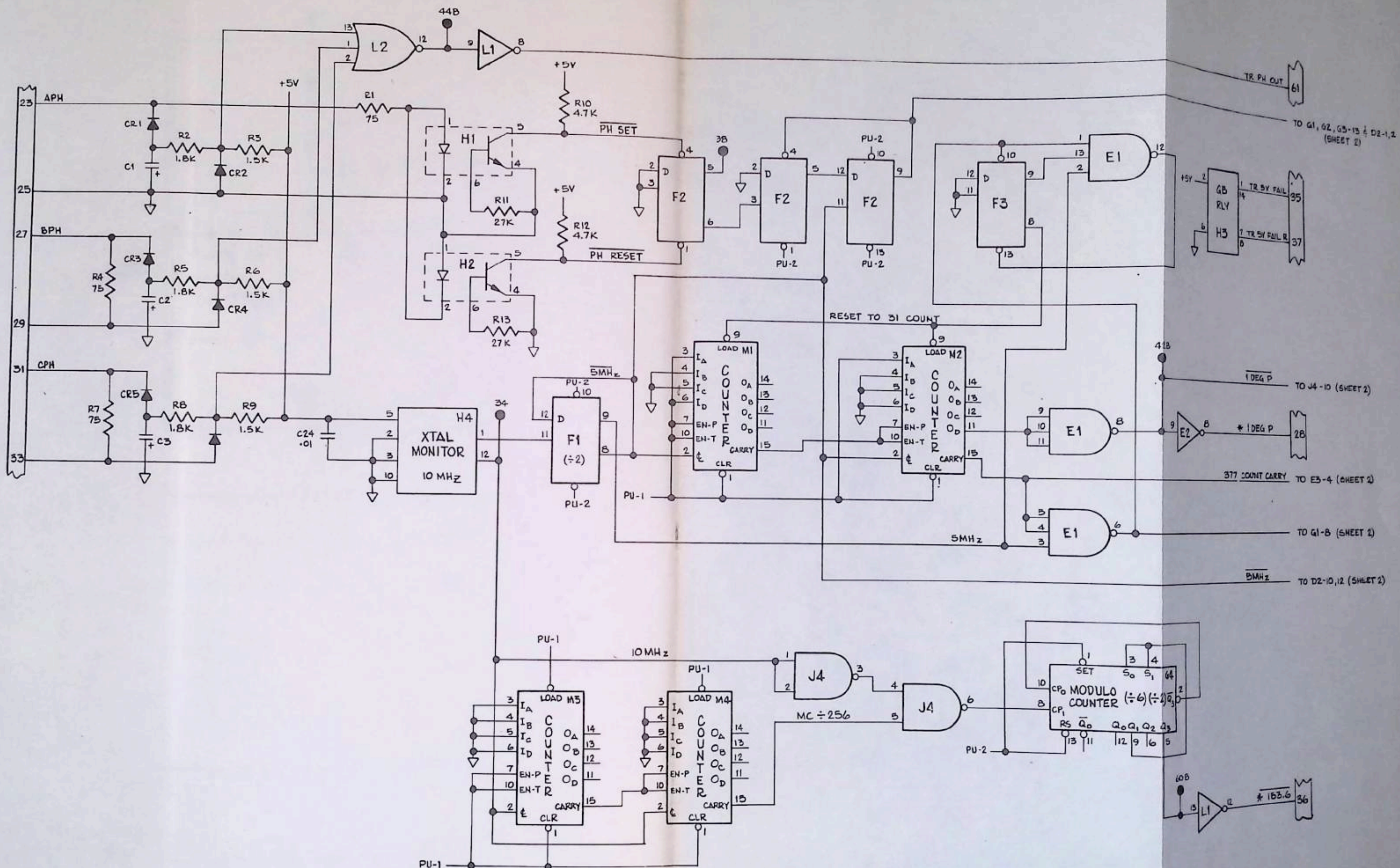


FIGURE 6 – 11
TIMING LOGIC PCB
SHEET 1 OF 2

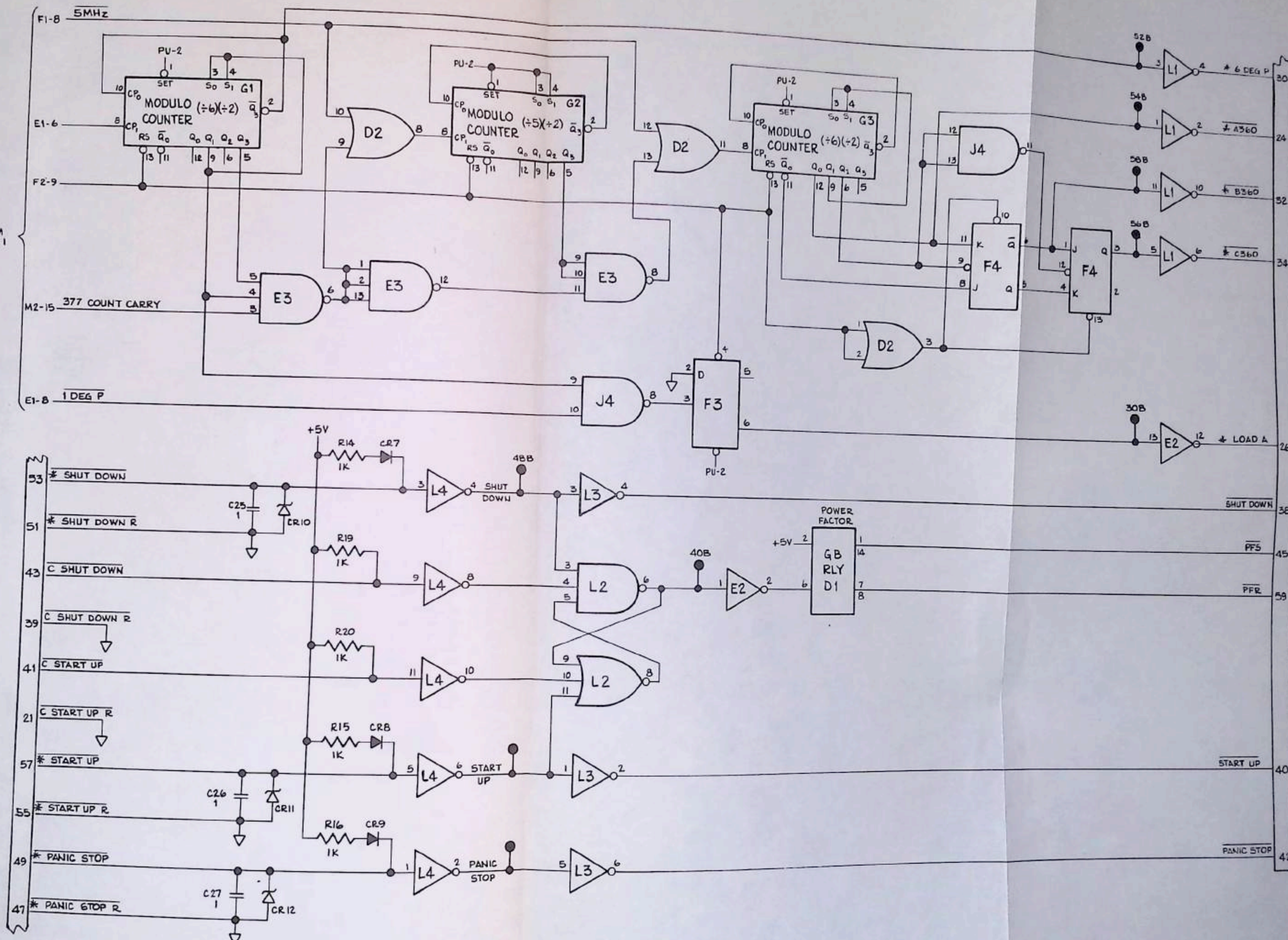


FIGURE 6 – 11
TIMING LOGIC PCB
SHEET 2 OF 2

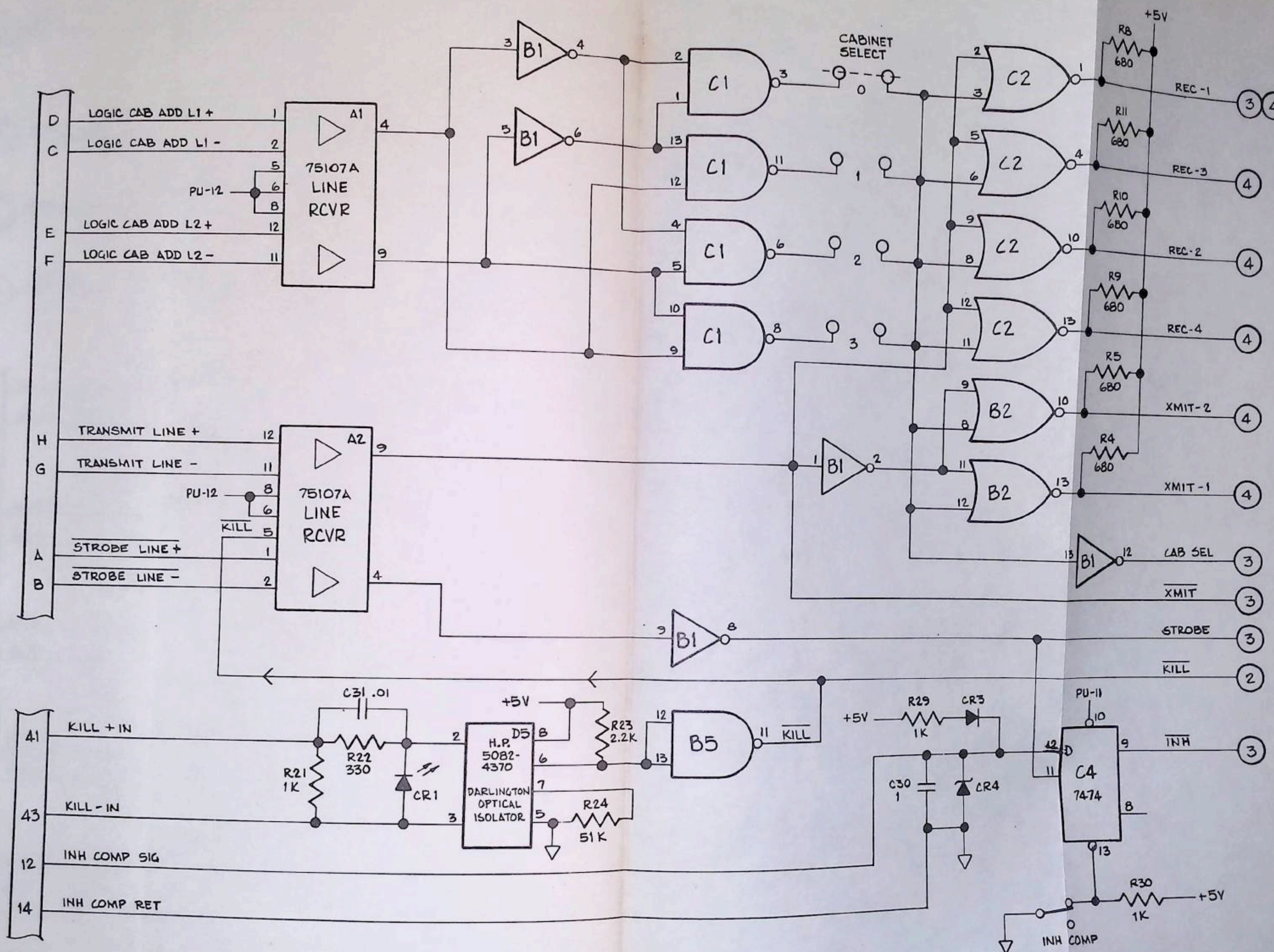


FIGURE 6 – 12
DATA COUPLER
SHEET 1 OF 4

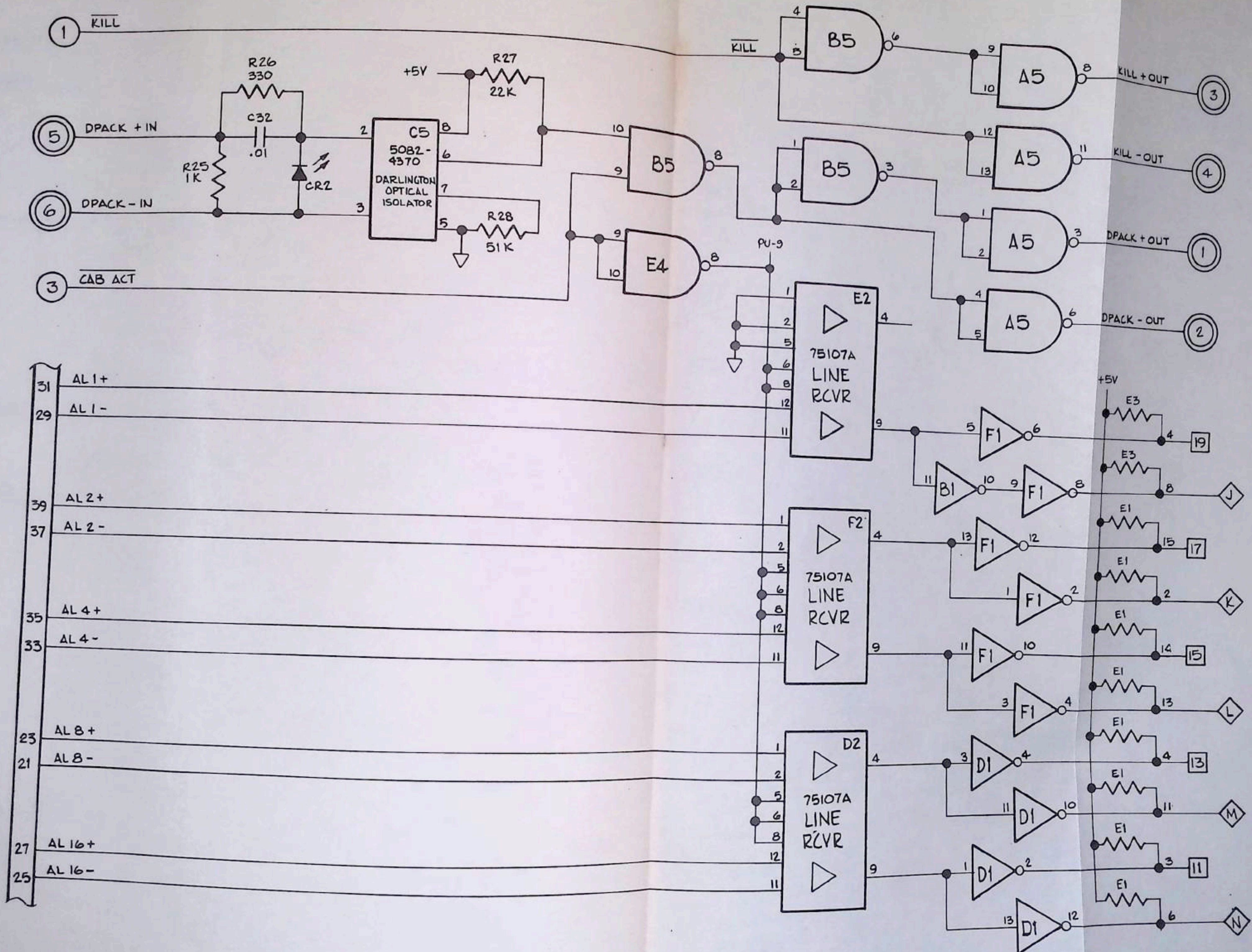


FIGURE 6 – 12
DATA COUPLER
SHEET 2 OF 4

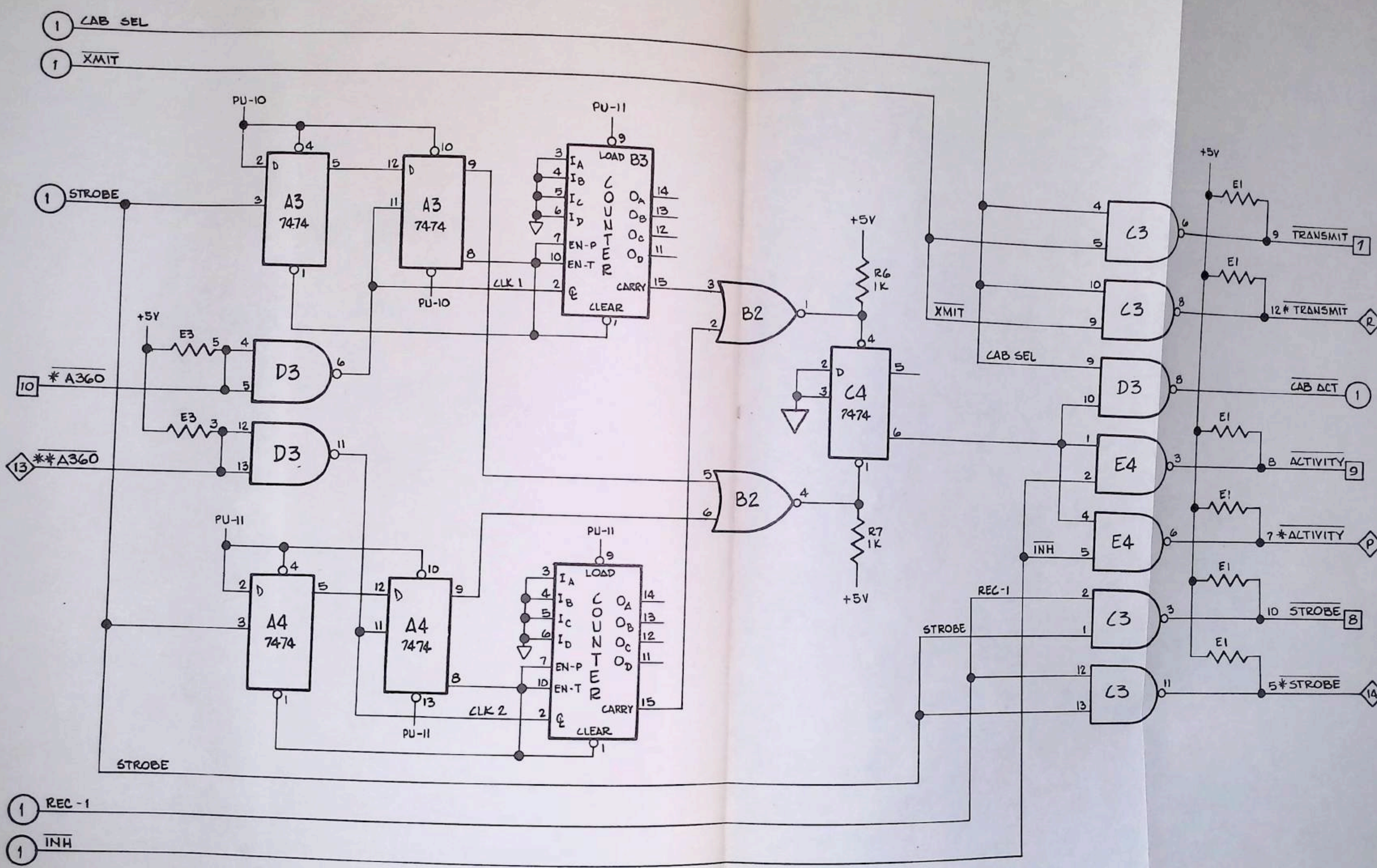


FIGURE 6 – 12
DATA COUPLER
SHEET 3 OF 4

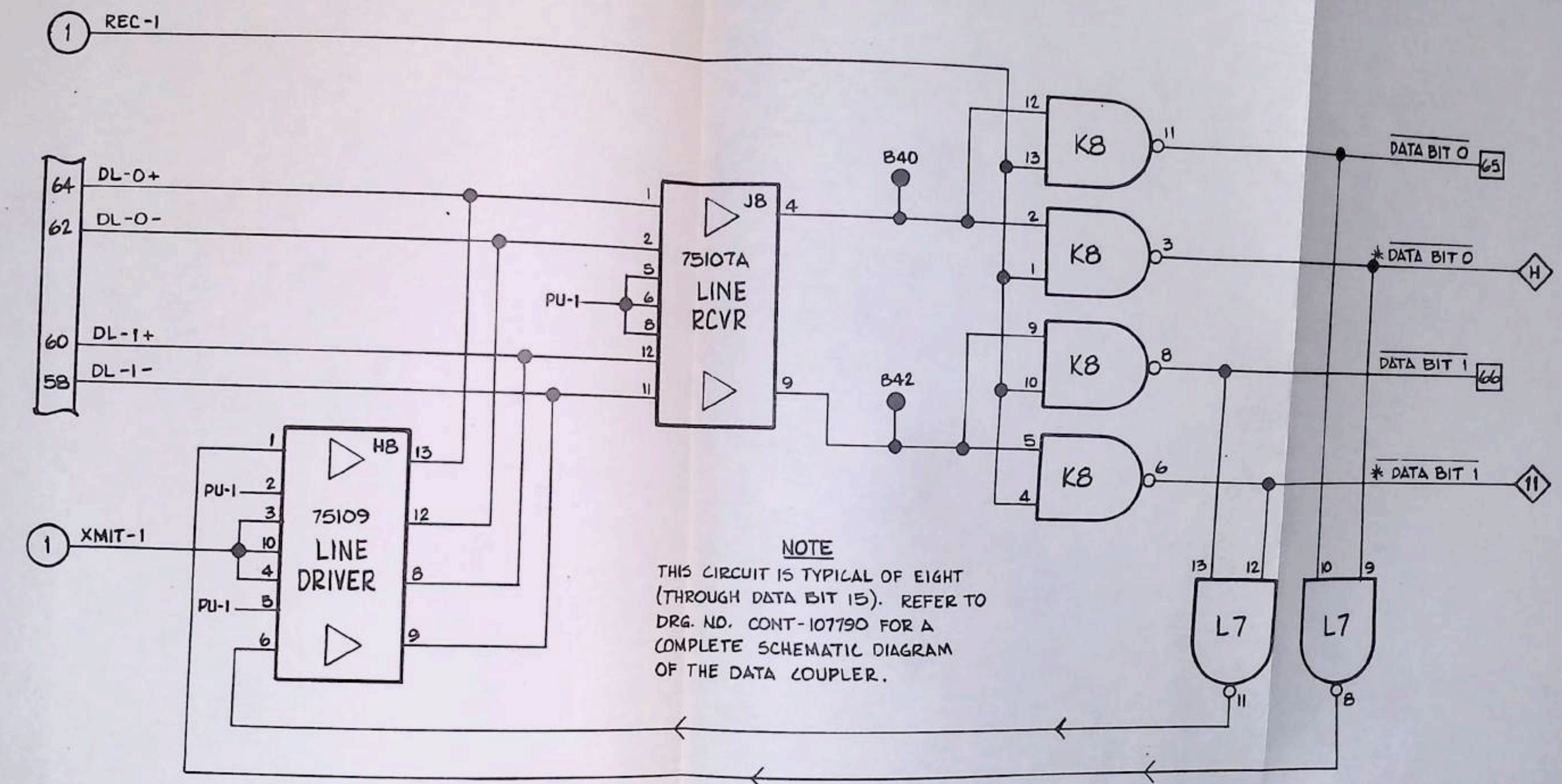


FIGURE 6 – 12
DATA COUPLER
SHEET 4 OF 4

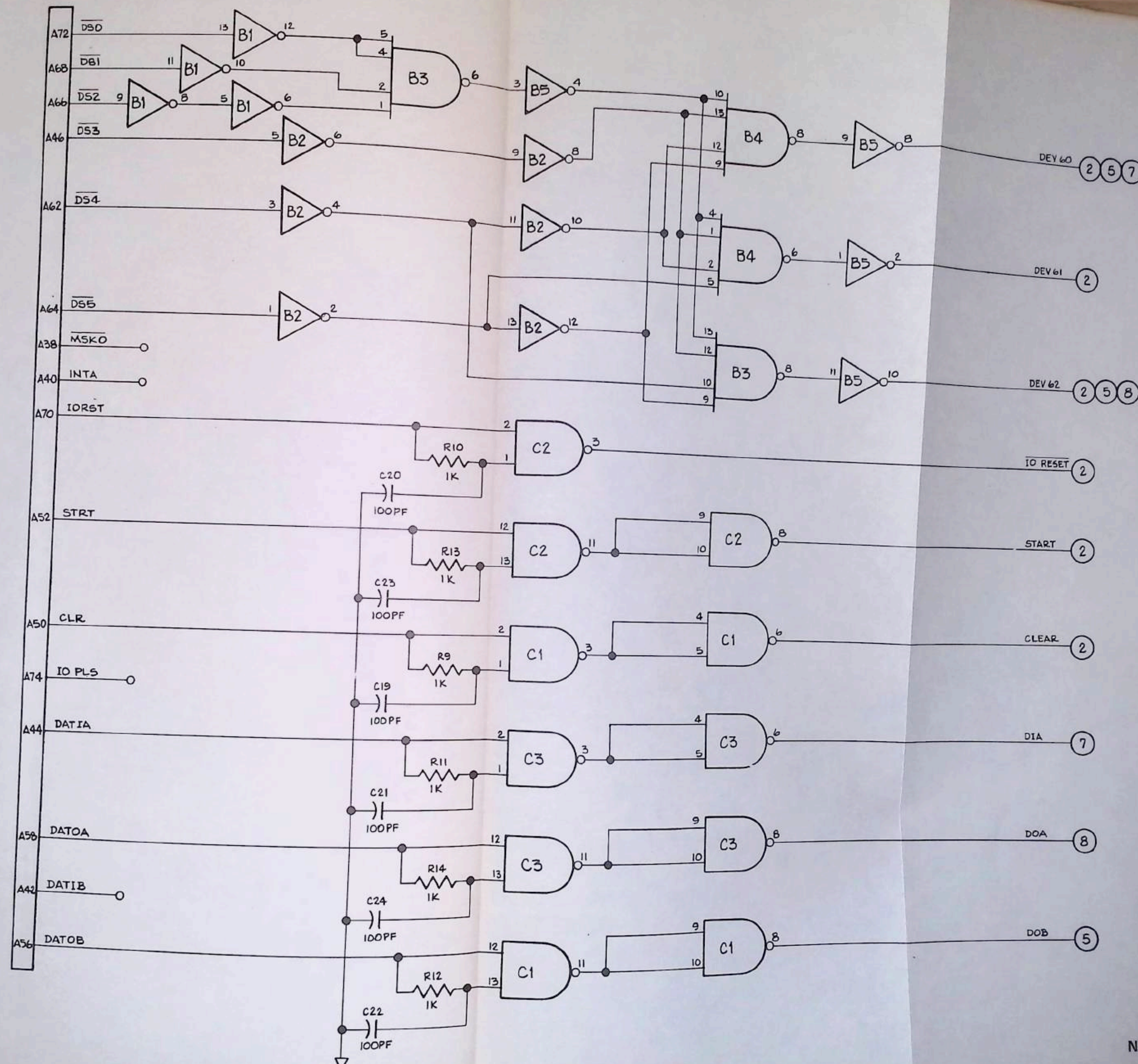


FIGURE 6 — 13
NOVA INTERFACE PCB
SHEET 1 OF 10

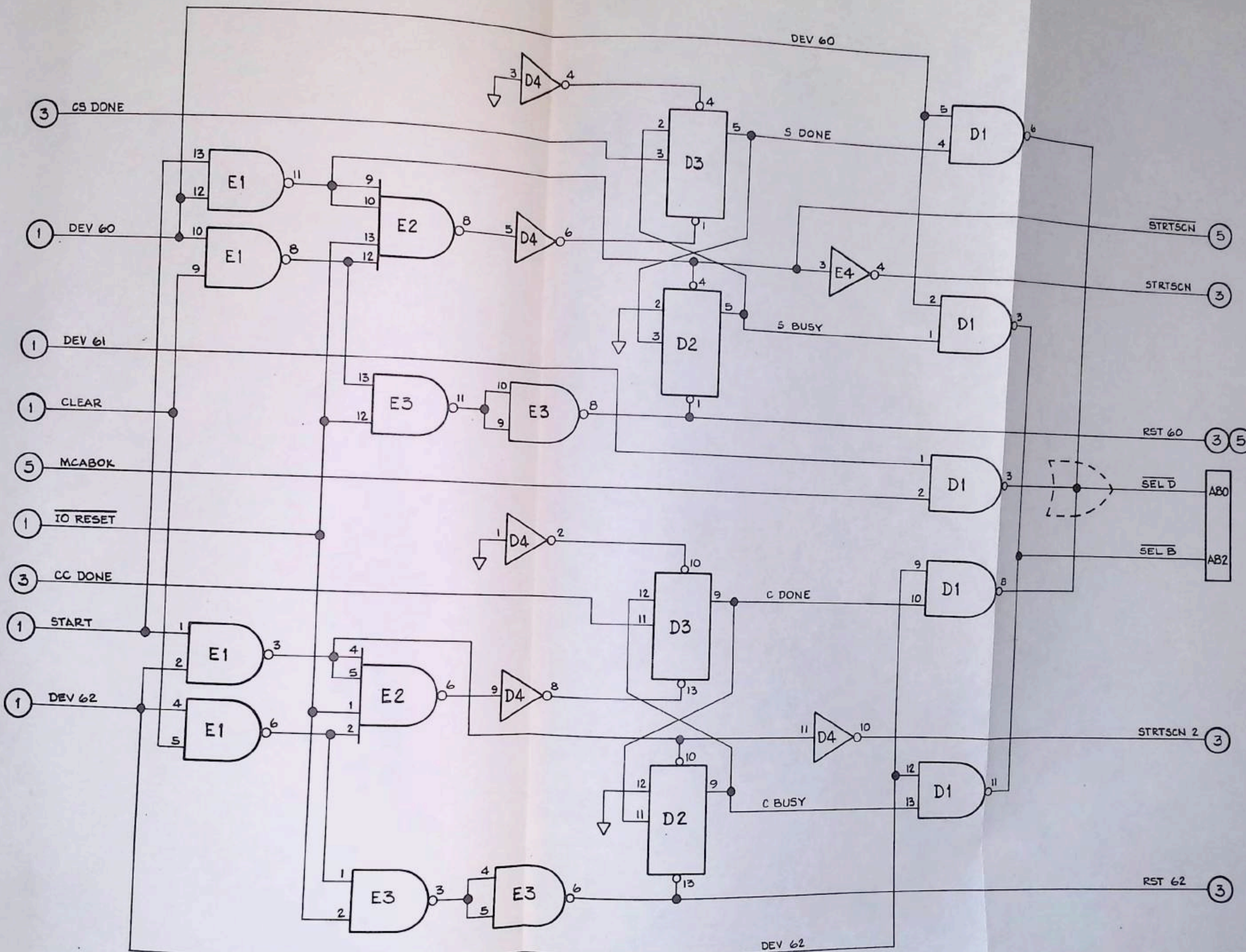


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 2 OF 10

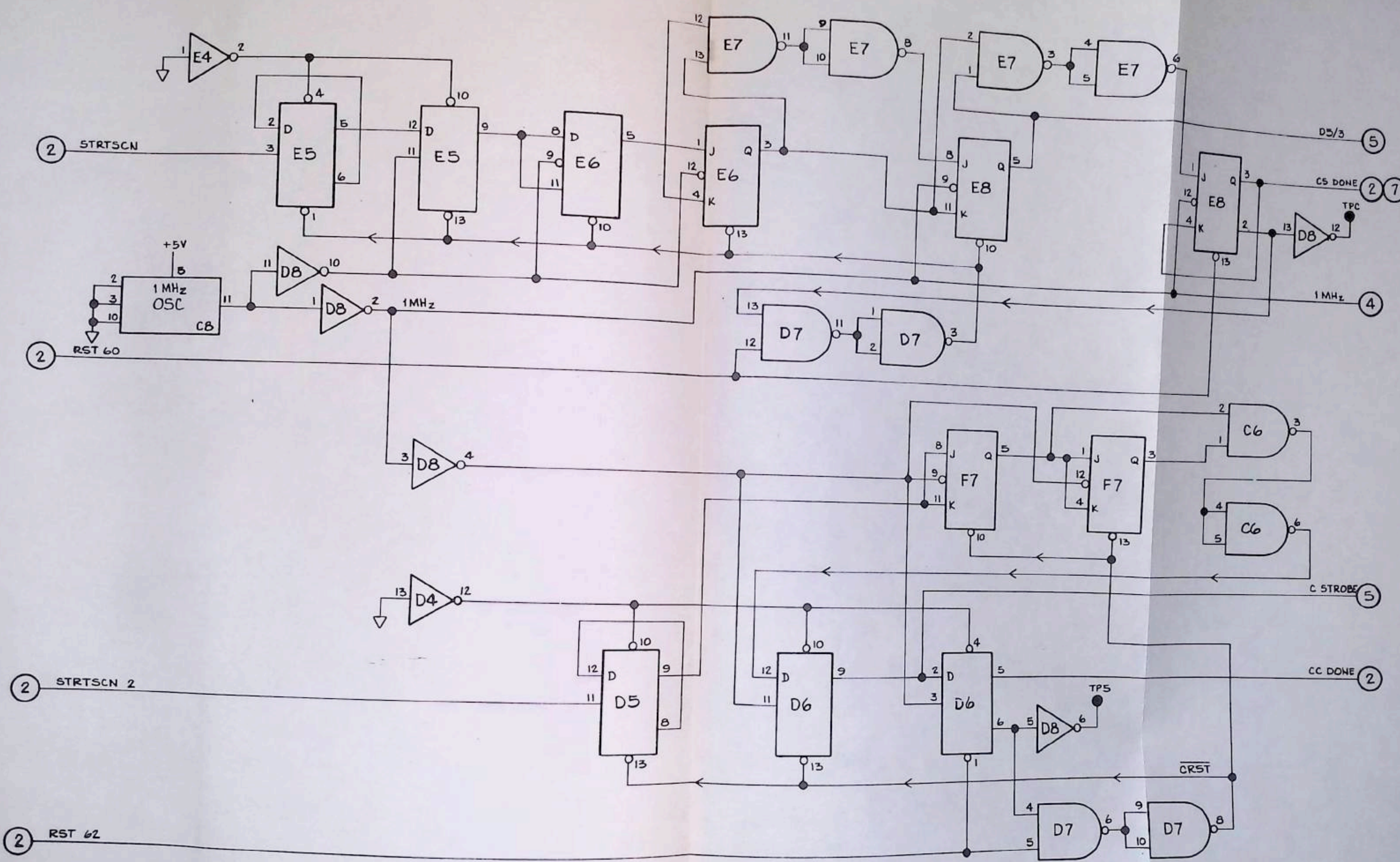


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 3 OF 10

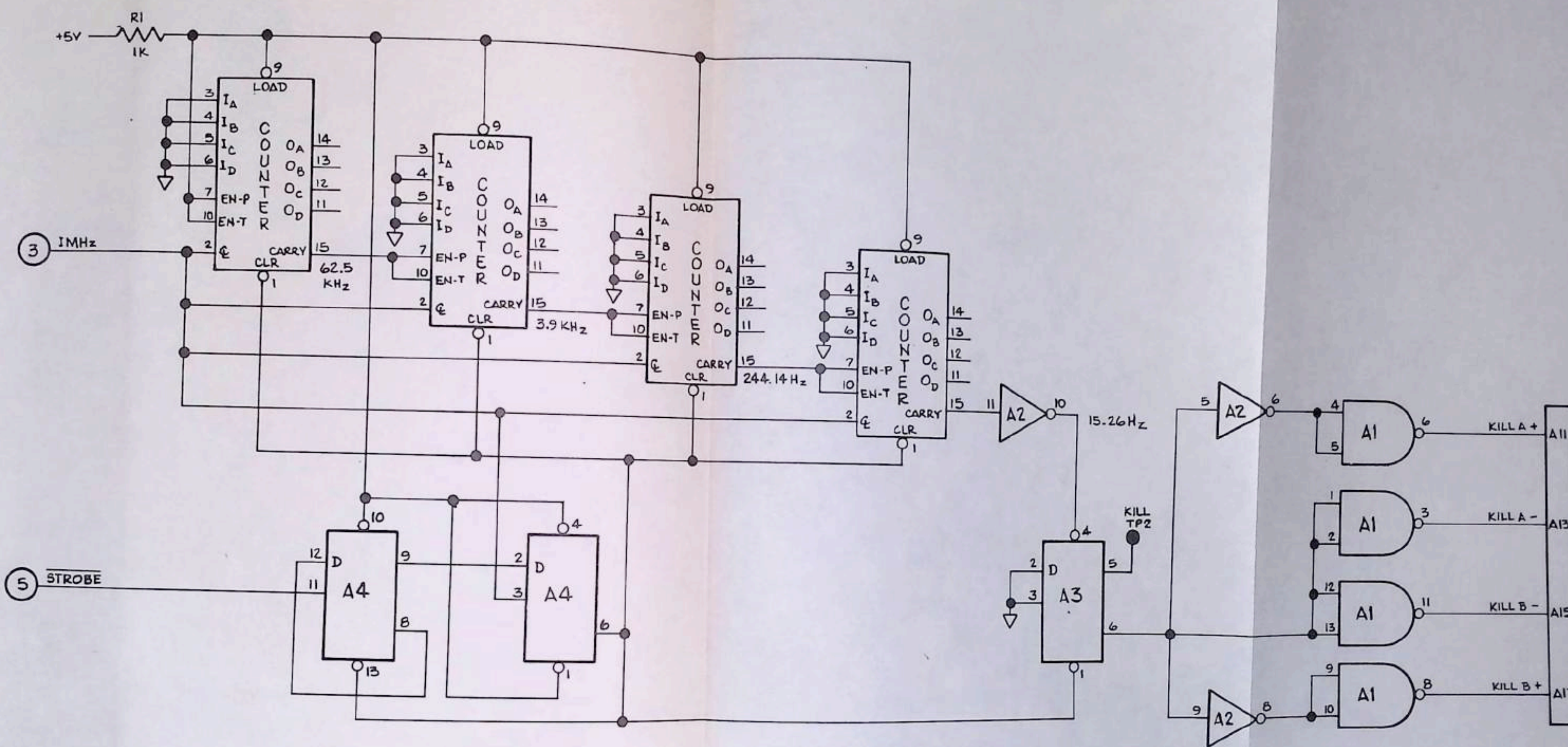


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 4 OF 10

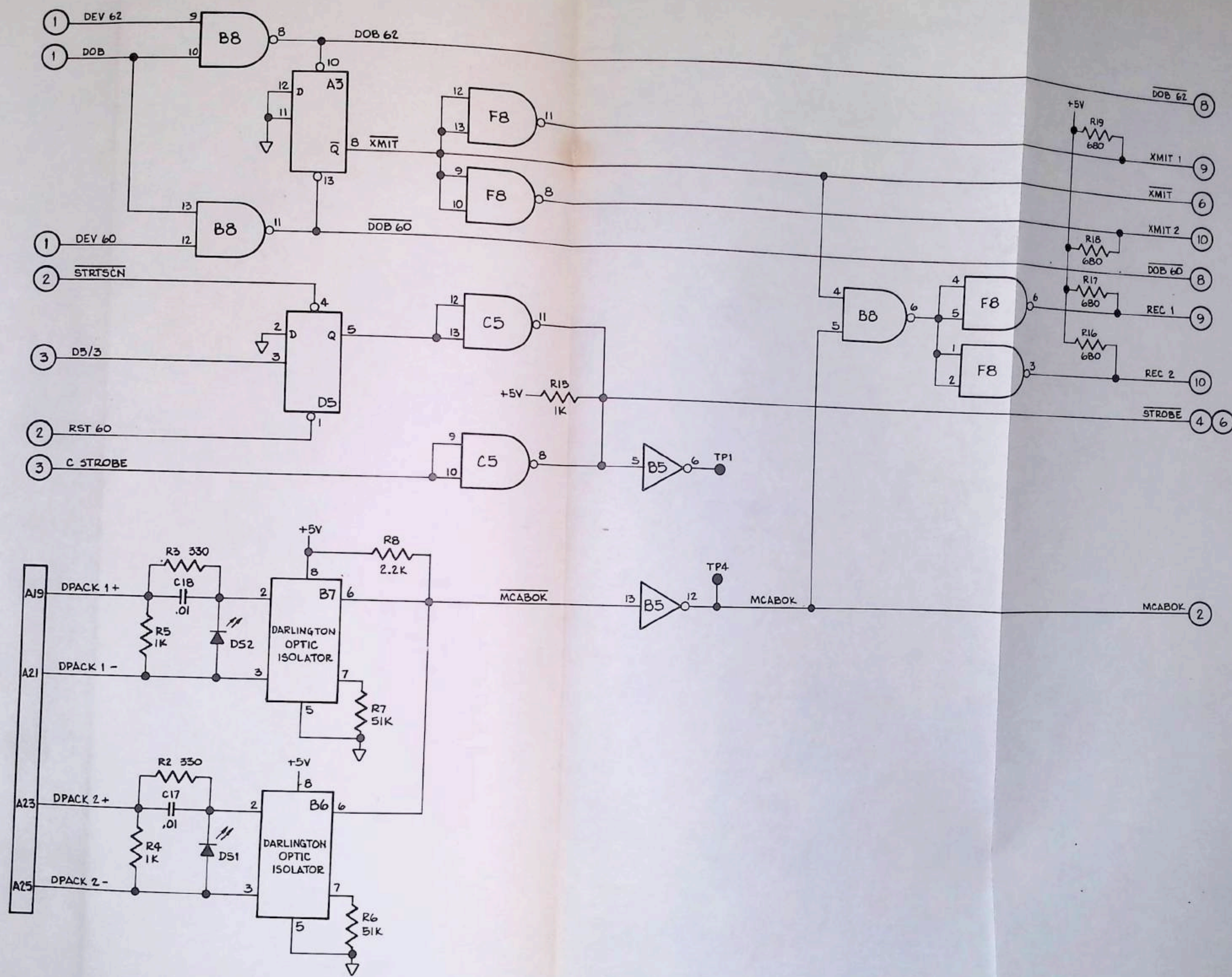


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 5 OF 10

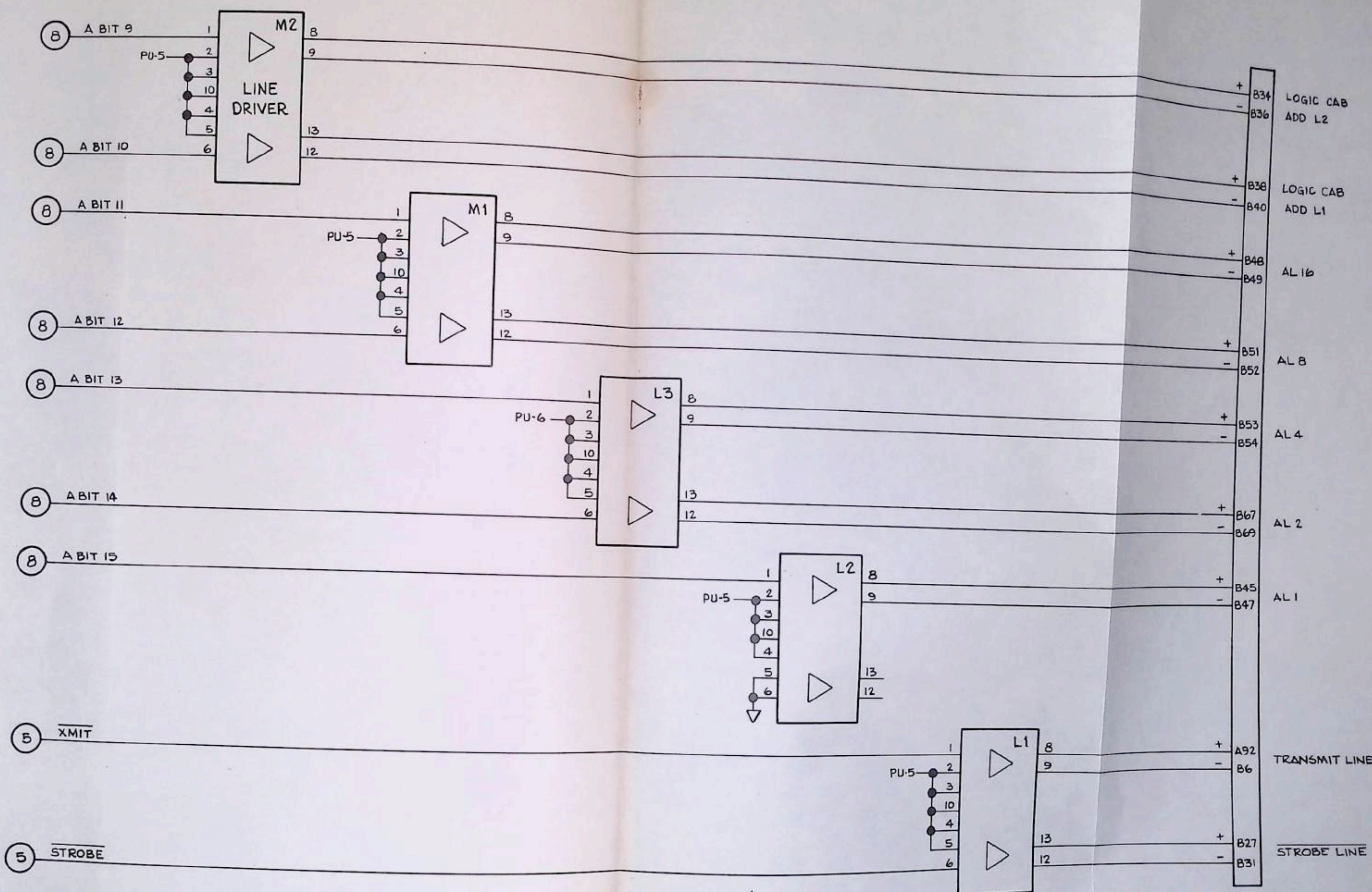


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 6 OF 10

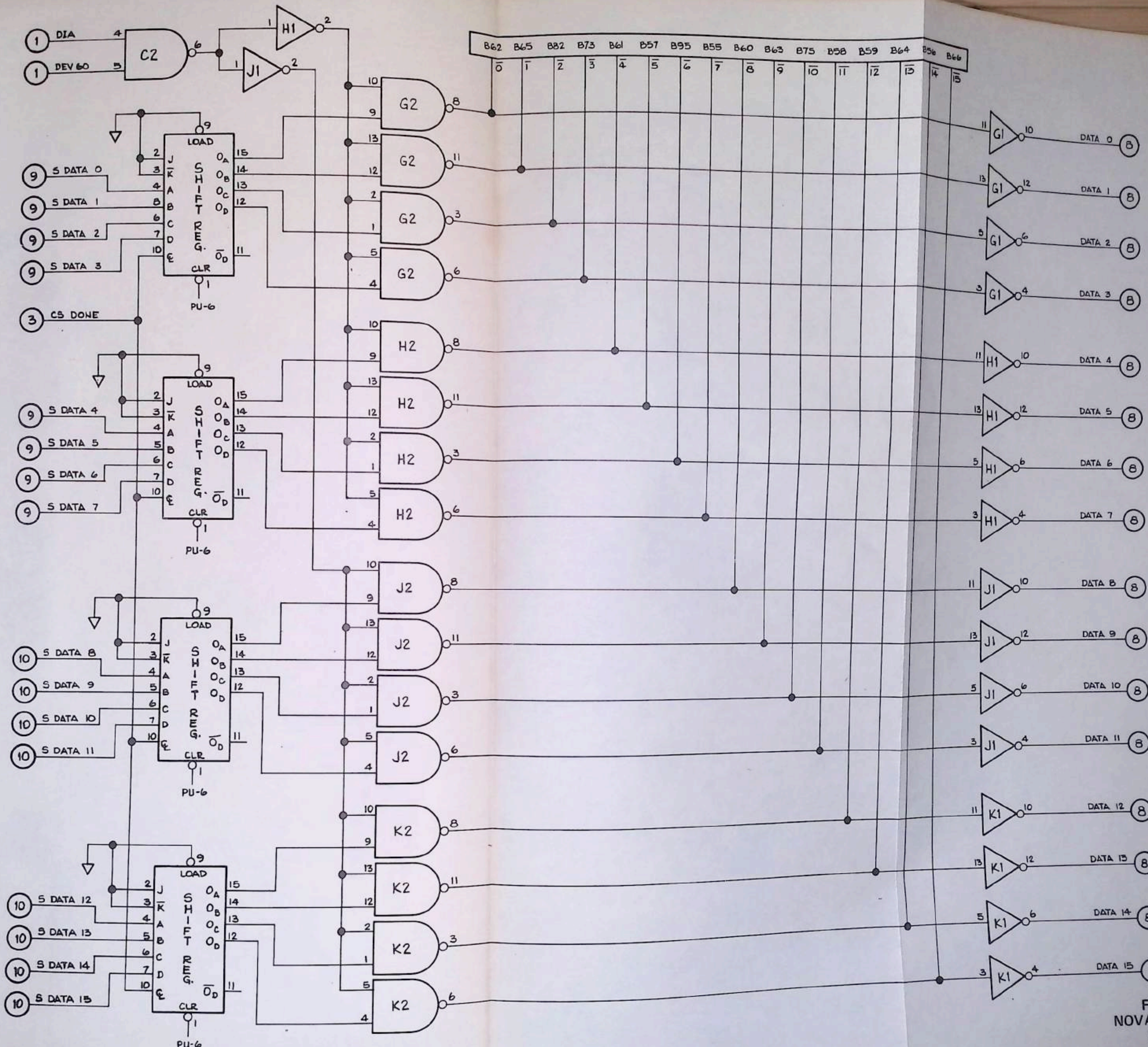


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 7 OF 10

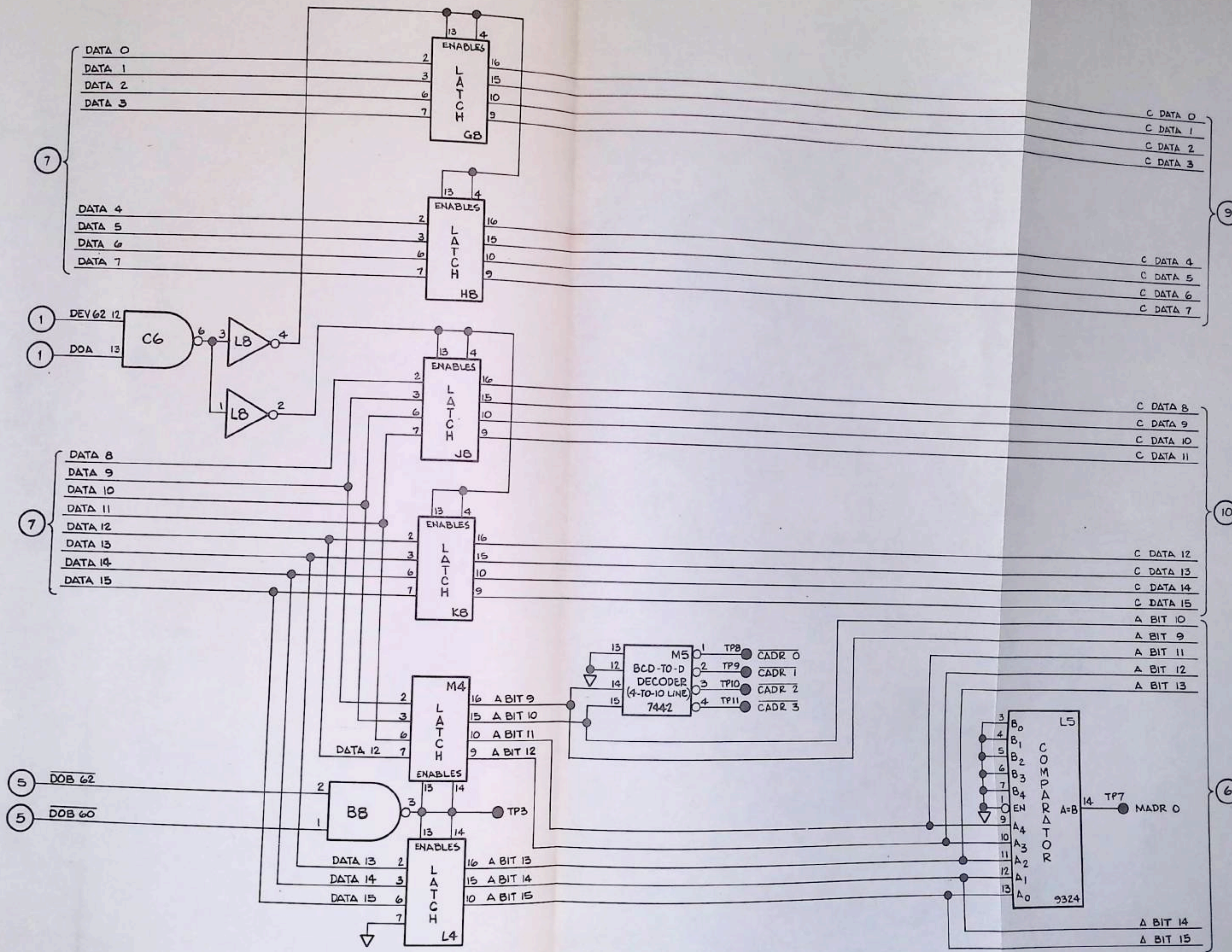


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 8 OF 10

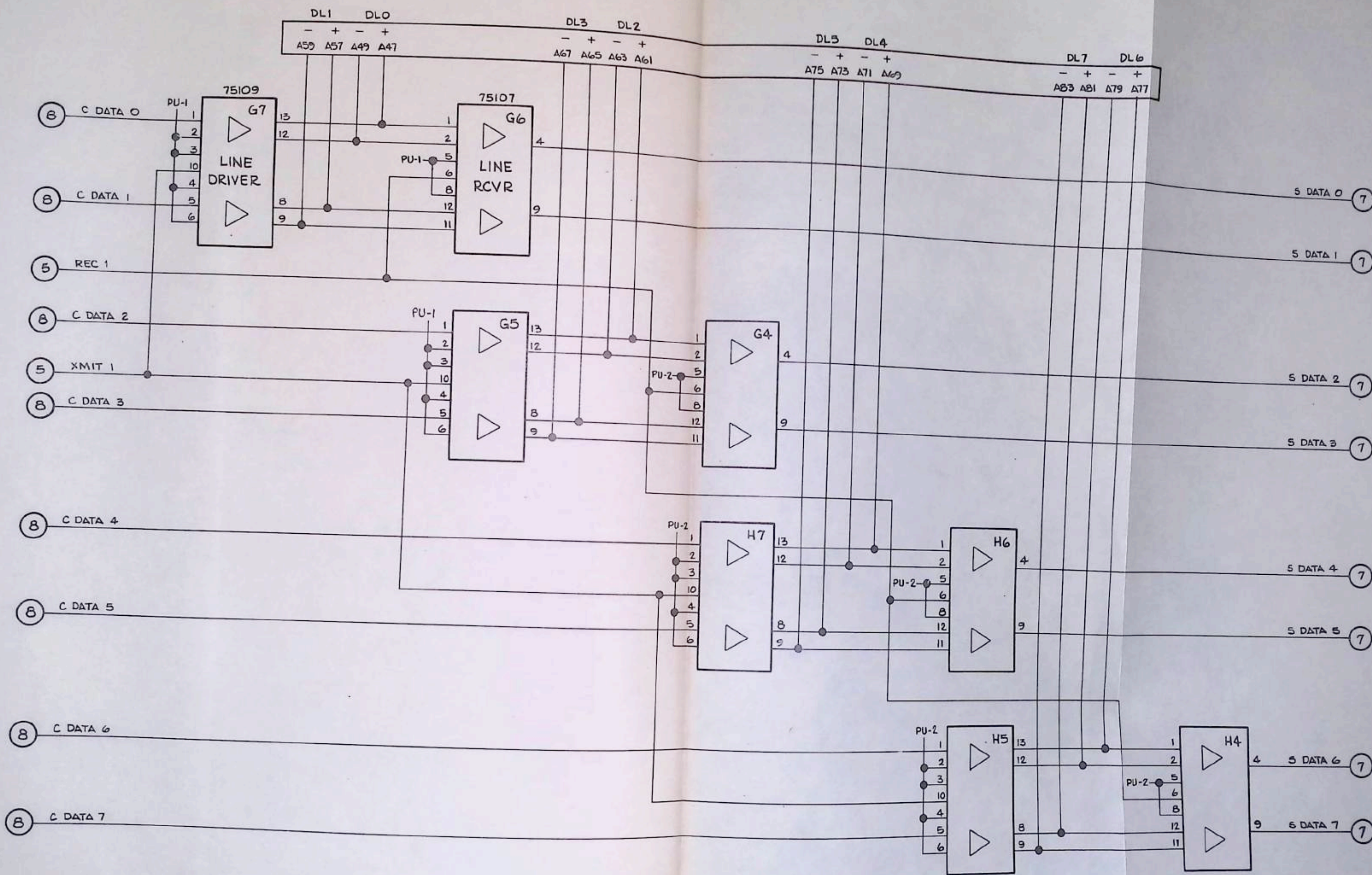


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 9 OF 10

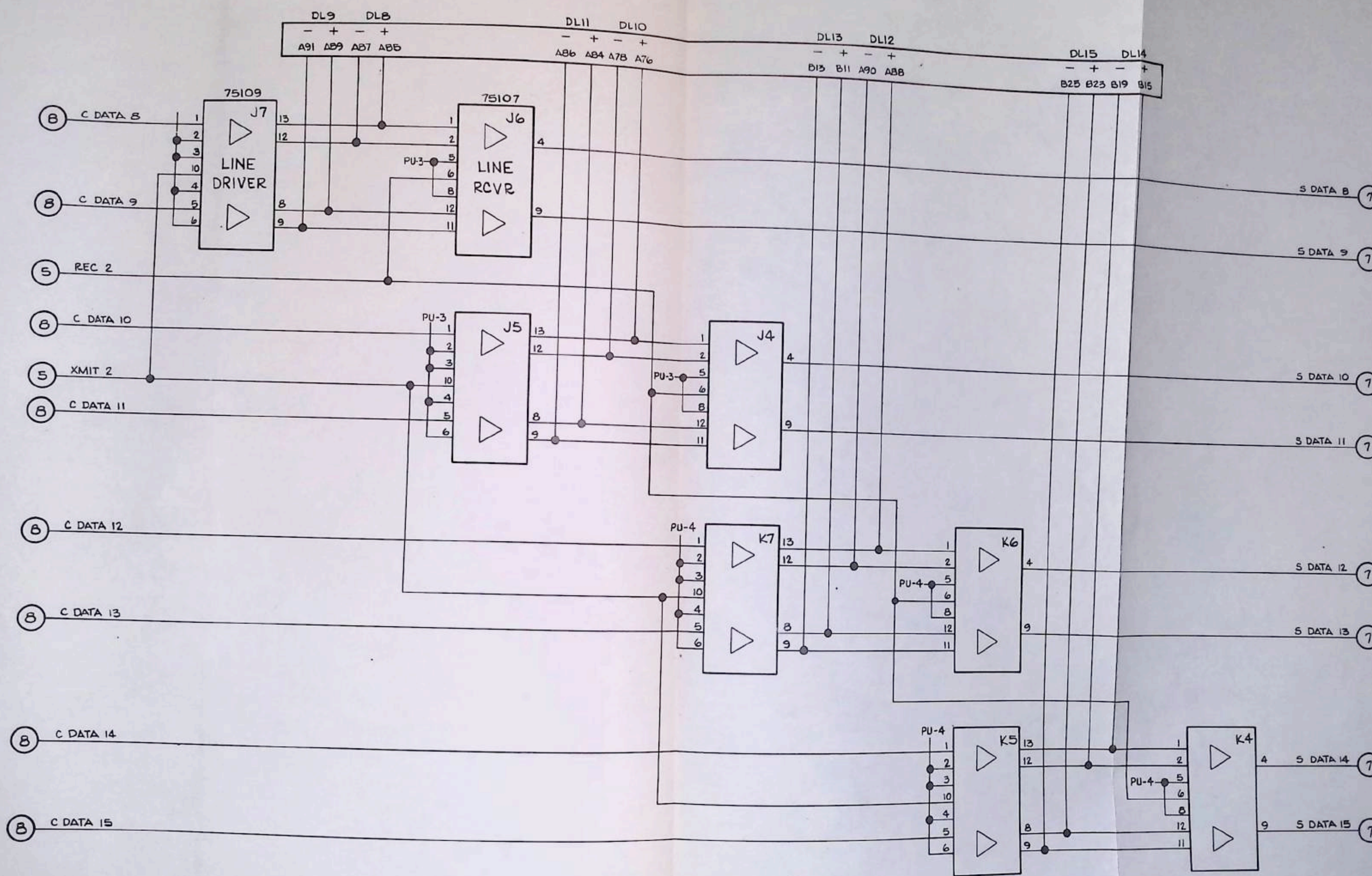


FIGURE 6 – 13
NOVA INTERFACE PCB
SHEET 10 OF 10

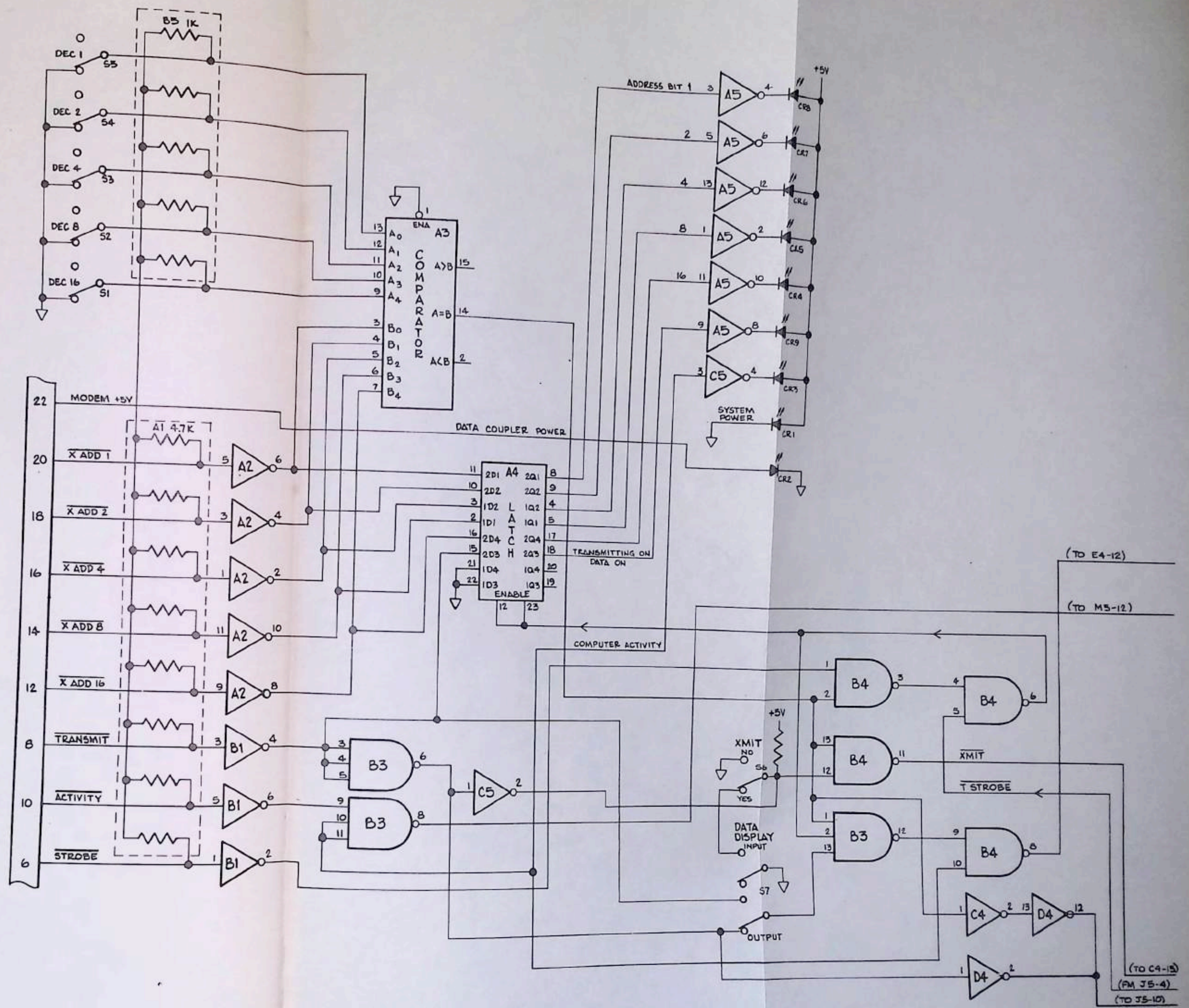


FIGURE 6 – 14
INTEGRITY – DATA CONTROL PCB
SHEET 1 OF 2

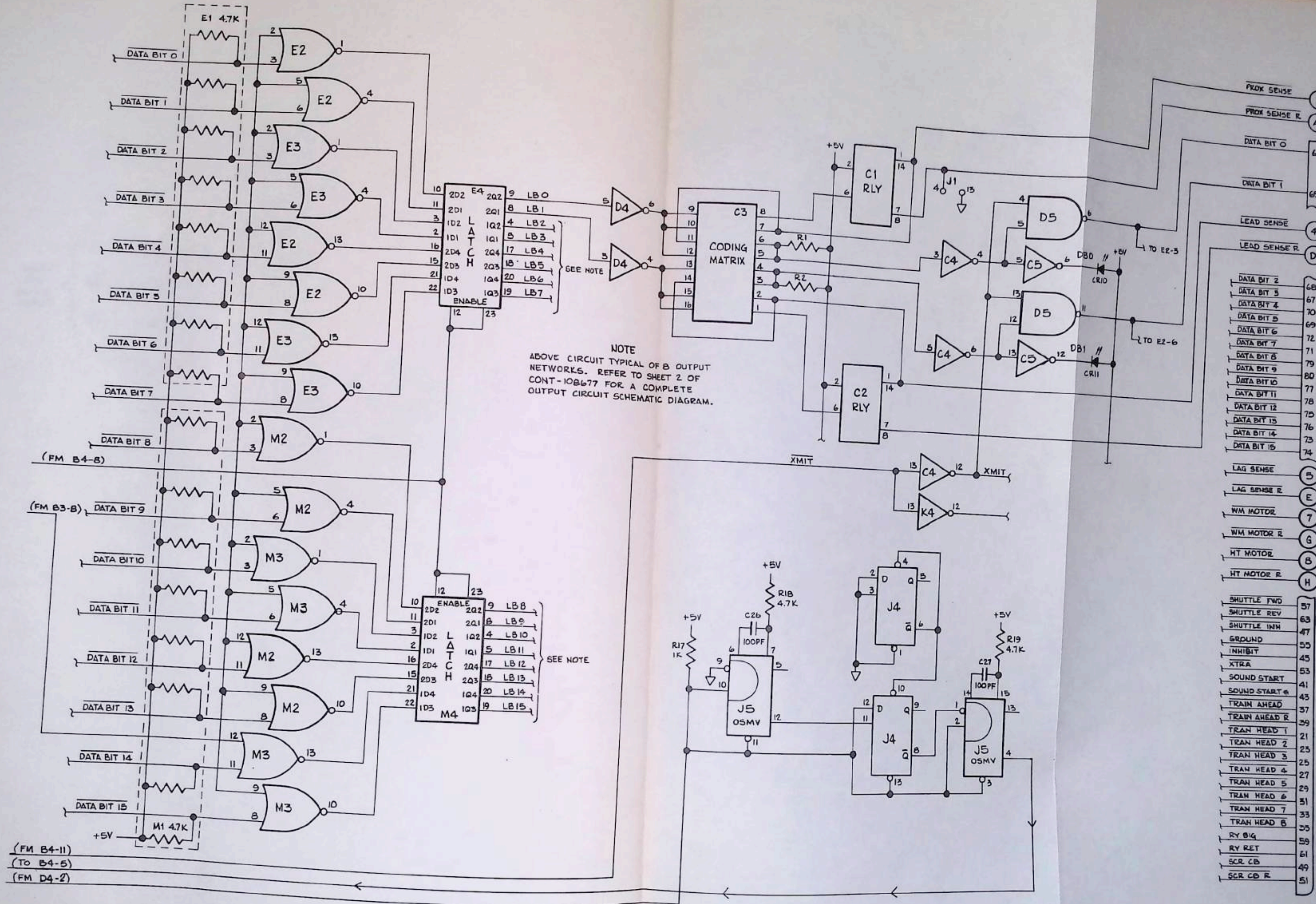


FIGURE 6 – 14
INTEGRITY – DATA CONTROL PCB
SHEET 2 OF 2

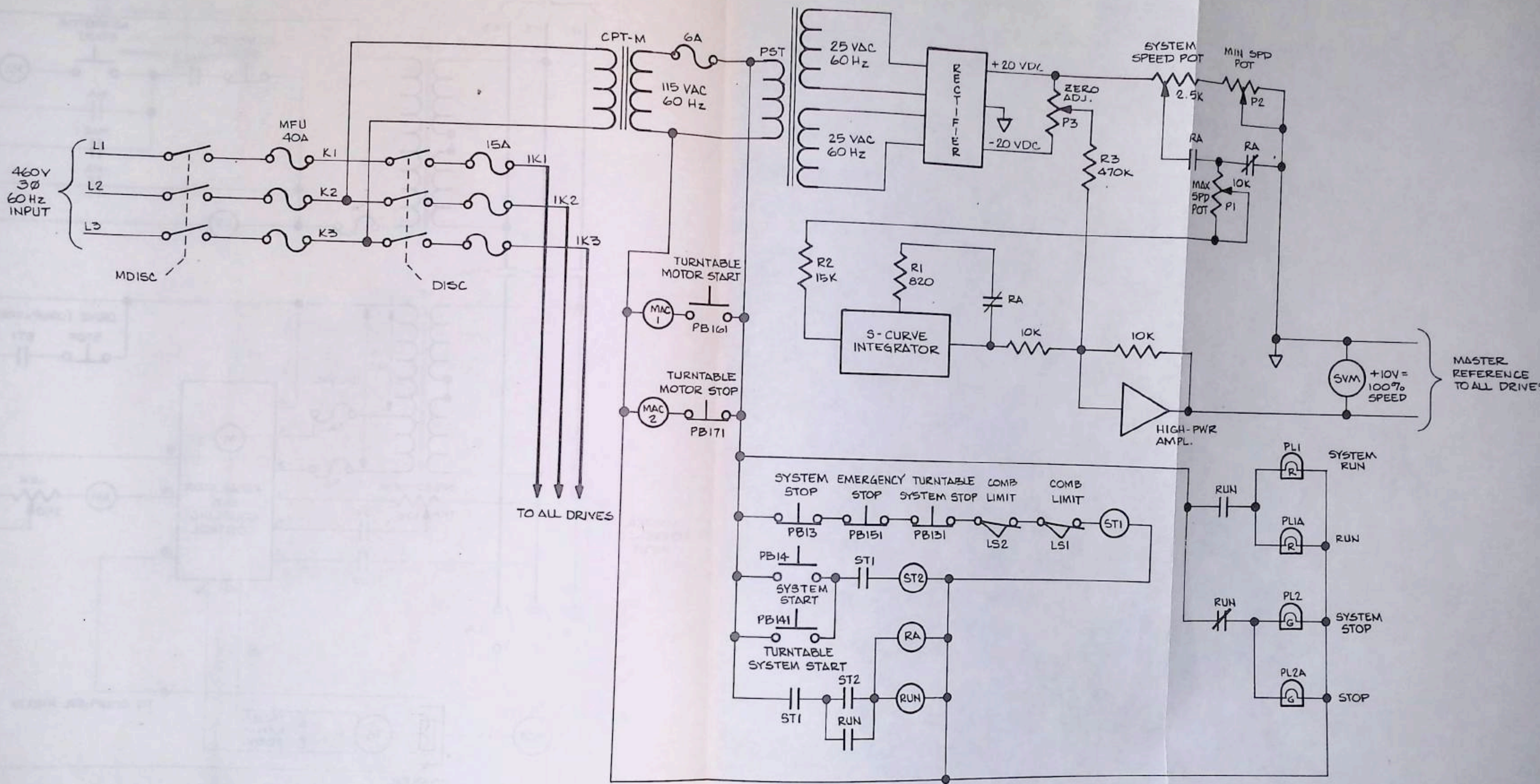


FIGURE 6 – 15
TURNTABLE DRIVE FUNCTIONAL SCHEMATIC
SHEET 1 OF 2

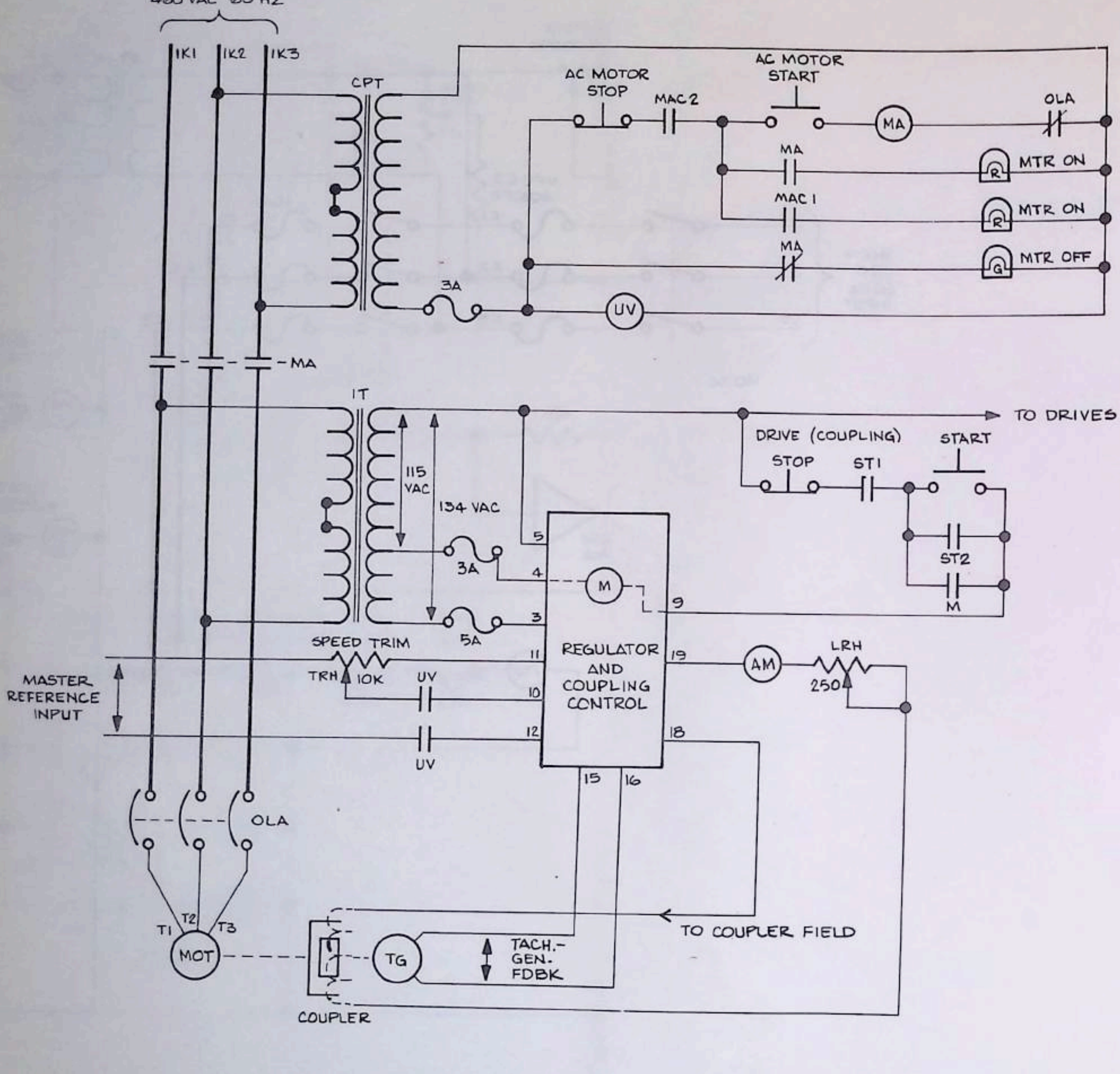


FIGURE 6 – 15
TURNTABLE DRIVE FUNCTIONAL SCHEMATIC
SHEET 2 OF 2

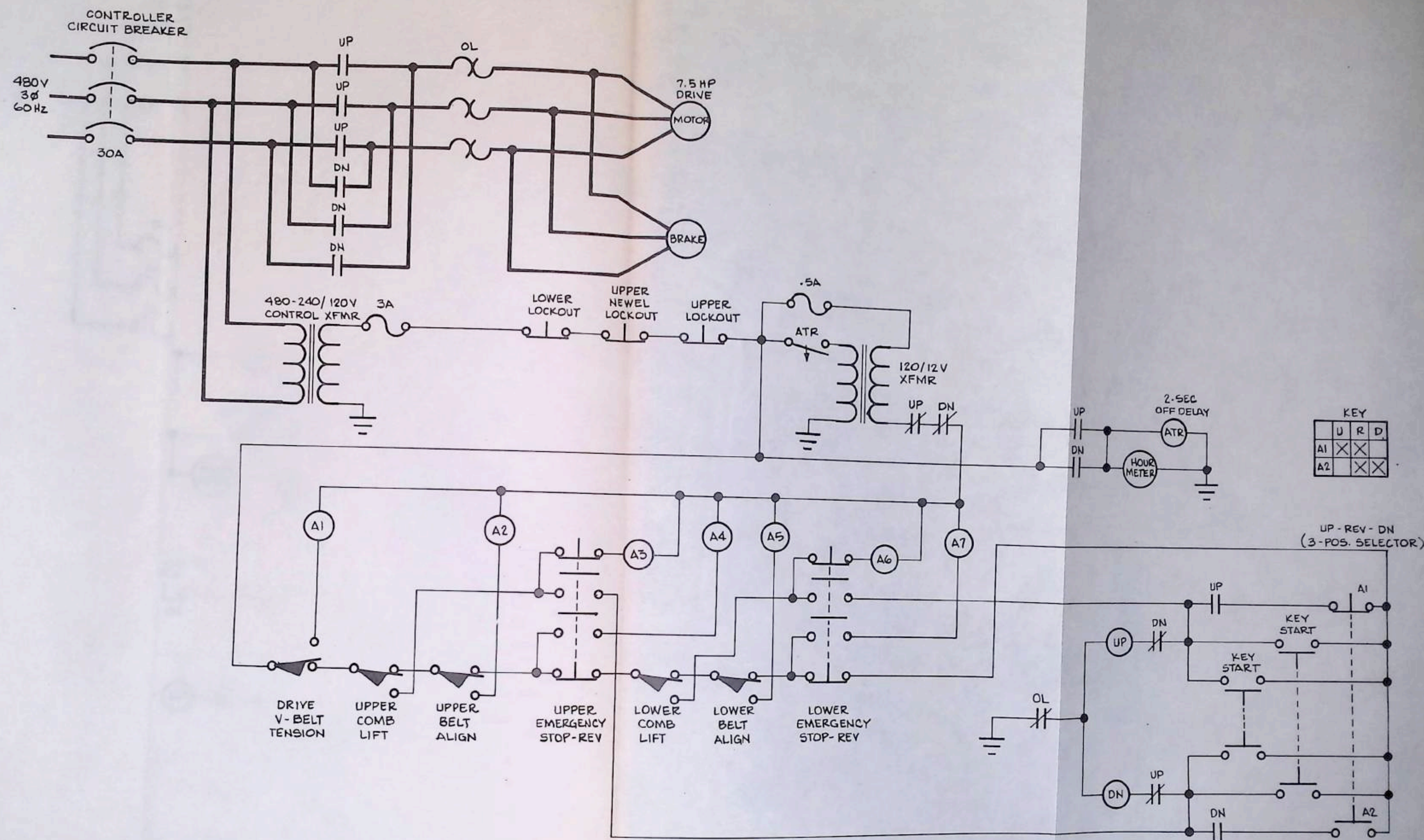
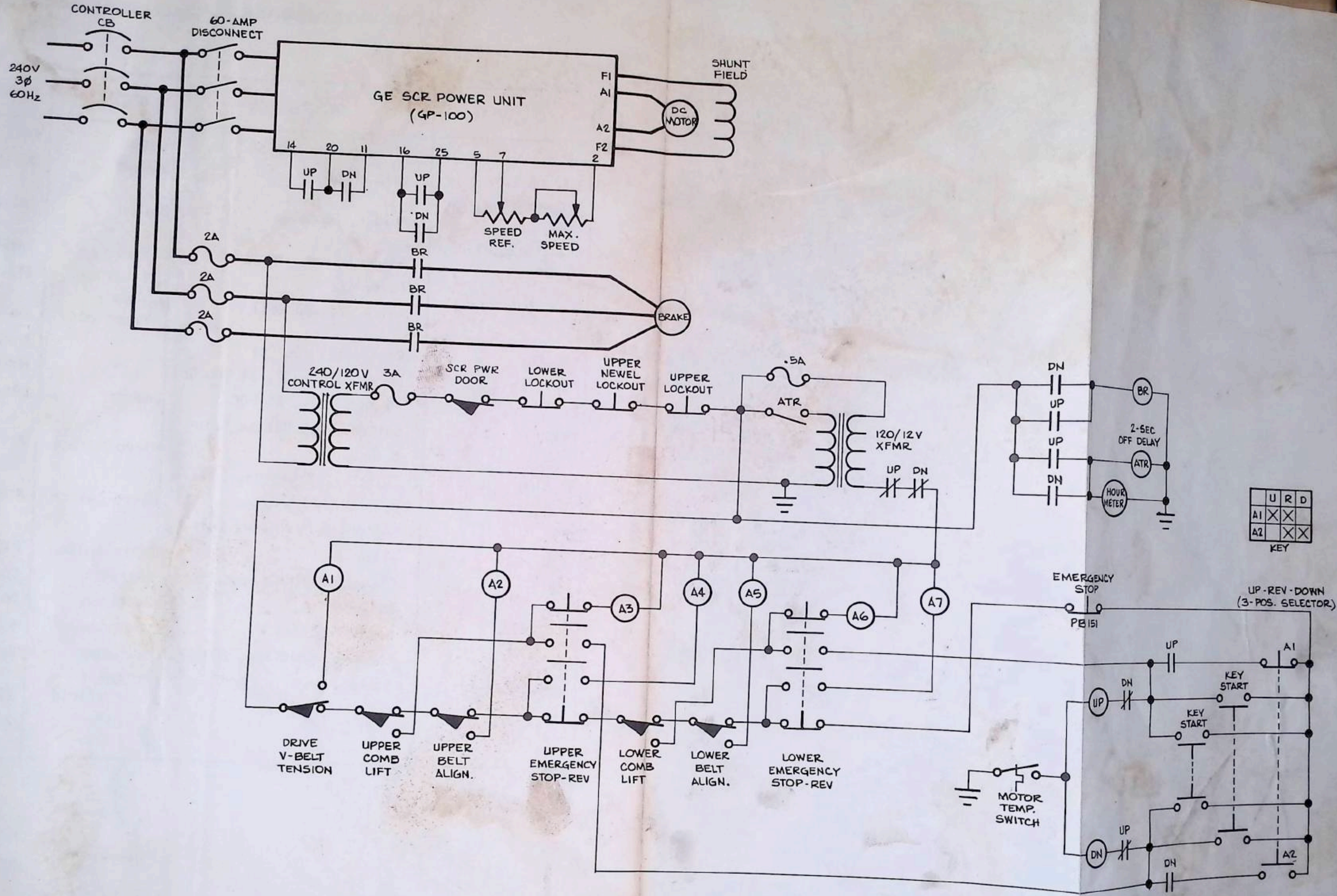


FIGURE 6 – 16
DOWNRAMP DRIVE CONTROL FUNCTIONAL SCHEMATIC



	U	R	D
A1	X	X	
A2		X	X

FIGURE 6 – 17
UPRAMP DRIVE CONTROL FUNCTIONAL SCHEMATIC

TRK. SW. CONT. CIRCUITS REPLACEABLE PARTS LIST

REF. DESIG.	DESCRIPTION	MFG.	PART NO.
CB2	Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS50,DS15-28	Bulb, Neon	Dialco	C9A(NE-2J)
DS15,17,19,50,22, 24,25,28	Holder, Lamp, Red	Dialco	181-8864-0931-513
DS16,18,20,21,23, 26,27	Holder, Lamp, Amber	Dialco	181-8864-0933-513
F1-12	Fuse, 1/8 A	Littlefuse	312.125
K36,58	Relay, 24 VDC Coil	Potter & Brumfield	KHP17 12-24
K38-42	Relay, 120 VAC Coil	"	KHP17A12-120
K37	Relay, 3 Form C, 24 VDC Coil	"	KHP14D15-24
PS2	Power Supply, 24 VDC	Lambda	LOS-Z-24
PB100	Switch, Push Button Maintained	Micro Switch	PTY2153C
S2,S100	Switch, 2 Position, Selector, Key Operated	Micro Switch	PTKBC2221C
S8	Switch, 3 Position, Selector	Micro Switch	PTSHA212C
TB3,7	Clamp, Tubular, Type TC	Buchanan	0625
TB3,7	End Section	Buchanan	0630
TB3,7	Clamp, Channel	Buchanan	61
TB3,7	Channel, Mounting, 20" Lg.	Buchanan	60
XK36,58,38-42	Socket, KHP	Potter & Brumfield	27E166
XK37	Socket, KUP	"	27E121

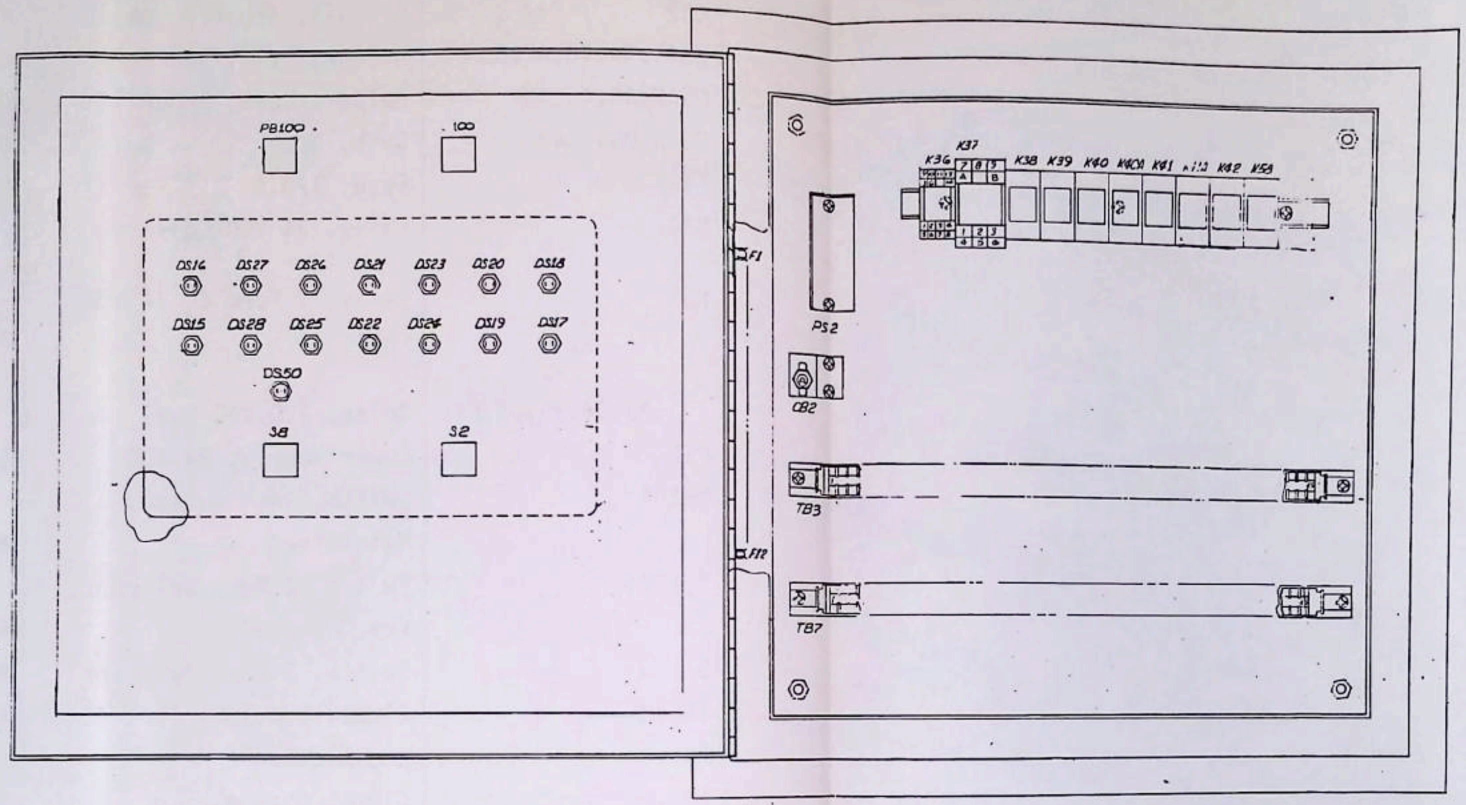


FIGURE 6 – 18
ASSY, PNL # 1, TRK. SW. CONT. BOX

REF. DESIG.	DESCRIPTION	MFG.	PART NO.
CB2	Circuit, Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS41,44,45,47,53	Holder, Lamp, Red	Dialco	181-8864-0931-513
DS42,43,46,48	Holder, Lamp, Amber	Dialco	181-8864-0933-513
DS53,DS41-48	Bulb, Neon	Dialco	C9A(NE-2J)
F1-12	Fuse, 1/8 A	Littlefuse	312.125
K30	Relay, 24 VDC Coil	Potter & Brumfield	KHP17D12-24
K31	Relay, 3 Form C, 24 VDC Coil	Potter & Brumfield	KUP14D15-24
K32,33,34,35,56,57	Relay, 120 VAC Coil	"	KHP17A12-120
PS5	Power Supply, 24 VDC	Lambda	LOS-Z-24
PB101	Switch, Push Button, Maintained	Micro Switch	PTY2153C
S5,101	Switch, 2 Pos. Selector, Key Operated	Micro Switch	PTKBC2221C
S7	Switch, 3 Pos. Selector	Micro Switch	PTSHA212C
TB6,8	Clamp, Tubular, Type TC	Buchanan	0625
TB6,8	End Section	Buchanan	0630
TB6,8	Clamp, Channel	Buchanan	61
TB6,8	Channel, Mounting, 20" Lg.	Buchanan	60
XK31	Socket, KUP	Potter & Brumfield	27E121
XK30,32-35,56,57	Socket, KHP	"	27E166

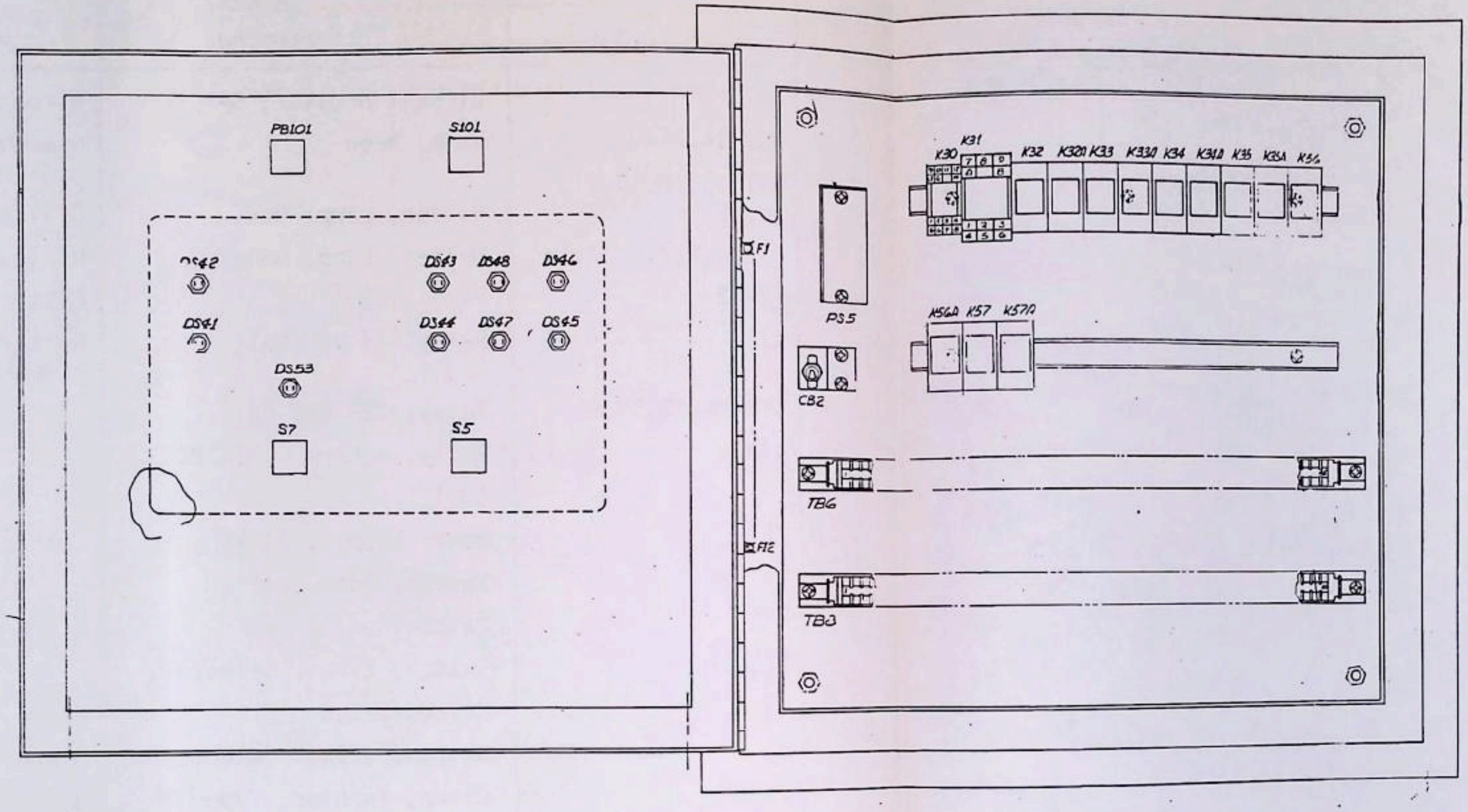


FIGURE 6 – 19
ASSY, PNL #2, TRK. SW. CONT. BOX

TRK. SW. CONT. CIRCUITS REPLACEABLE PARTS LIST

REF. DESIG.	DESCRIPTION	MFG.	PART NO.
CB2	Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS1-14,DS49	Bulb, Neon	Dialco	C9A(NE-2J)
DS1,3,5,8,10,11, 14,49	Holder, Lamp, Red	Dialco	181-8864-0931-513
DS2,4,6,7,9,12,13	Holder, Lamp, Amber	Dialco	181-8864-0933-513
F1-12	Fuse, 1/8 A	Littlefuse	312.125
K12	Relay, 24 VDC Coil	Potter & Brumfield	KHP17D12-24
K14-29,43,54,55	Relay, 120 VAC Coil	"	KHP17A12-120
K13	Relay, 3 Form C, 24 VDC Coil	"	KUP14D15-24
PS1	Power Supply, 24 VDC	Lambda	LOS-Z-24
PB102	Switch, Push Button Maintained	Micro Switch	PTY2152C
S1,S102	Switch, 2 Pos. Selector, Key Operated	Micro Switch	PTKBC2221C
S6	Switch, 3 Pos. Selector	Micro Switch	PTSHA212C
TB1,2	Clamp, Tubular, Type TC	Buchanan	0625
TB1,2	End Section	Buchanan	0630
TB1,2	Clamp, Channel	Buchanan	61
TB1,2	Channel, Mounting, 20" Lg.	Buchanan	60
XK12,14,29,43, 54,55	Socket, KHP	Potter & Brumfield	27E166
XK13	Socket, KUP	"	27E121

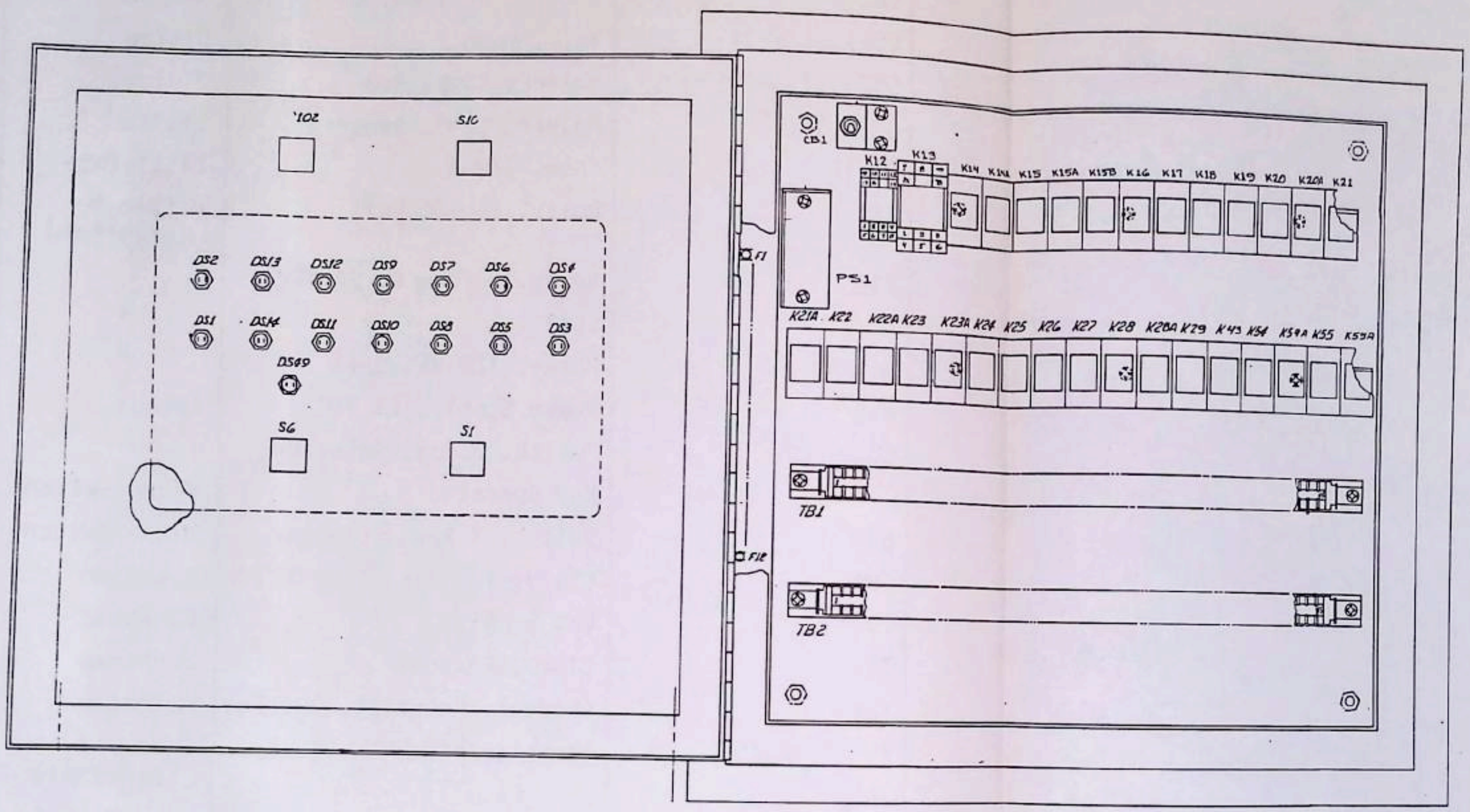


FIGURE 6 – 20
ASSY, PNL #3, TRK. SW. CONT. BOX

TRK. SW. CONT. CIRCUITS REPLACEABLE PARTS LIST

REF. DESIG.	DESCRIPTION	MFG.	PART NO.
CB2	Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS51,DS29-34	Bulb, Neon	Dialco	C9A(NE-2J)
DS29,32,34,51	Holder, Lamp, Red	Dialco	181-8864-0931-513
DS30,31,33	Holder, Lamp, Amber	Dialco	181-8864-0933-513
F1-12	Fuse, 1/8 A	Littlefuse	312.125
K44	Relay, 24 VDC Coil	Potter & Brumfield	KHP17D12-24
K45	Relay, 3 Form C, 24 VDC Coil	"	KUP14D15-24
K46-49	Relay, 120 VAC Coil	"	KHP17A12-120
PS3	Power Supply, 24 VDC	Lambda	LOS-Z-24
S3	Switch, 2 Pos. Selector, Key Operated	Micro Switch	PTKBC2221C
S9	Switch, 3 Pos. Selector	Micro Switch	PTSHA212C
TB4	Clamp, Tubular, Type TC	Buchanan	0625
TB4	End Section	Buchanan	0630
TB4	Clamp, Channel	Buchanan	61
TB4	Channel, Mounting, 20" Lg.	Buchanan	60
XK-44,46-49	Socket, KHP	Potter & Brumfield	27E166
XK45	Socket, KUP	"	27E121

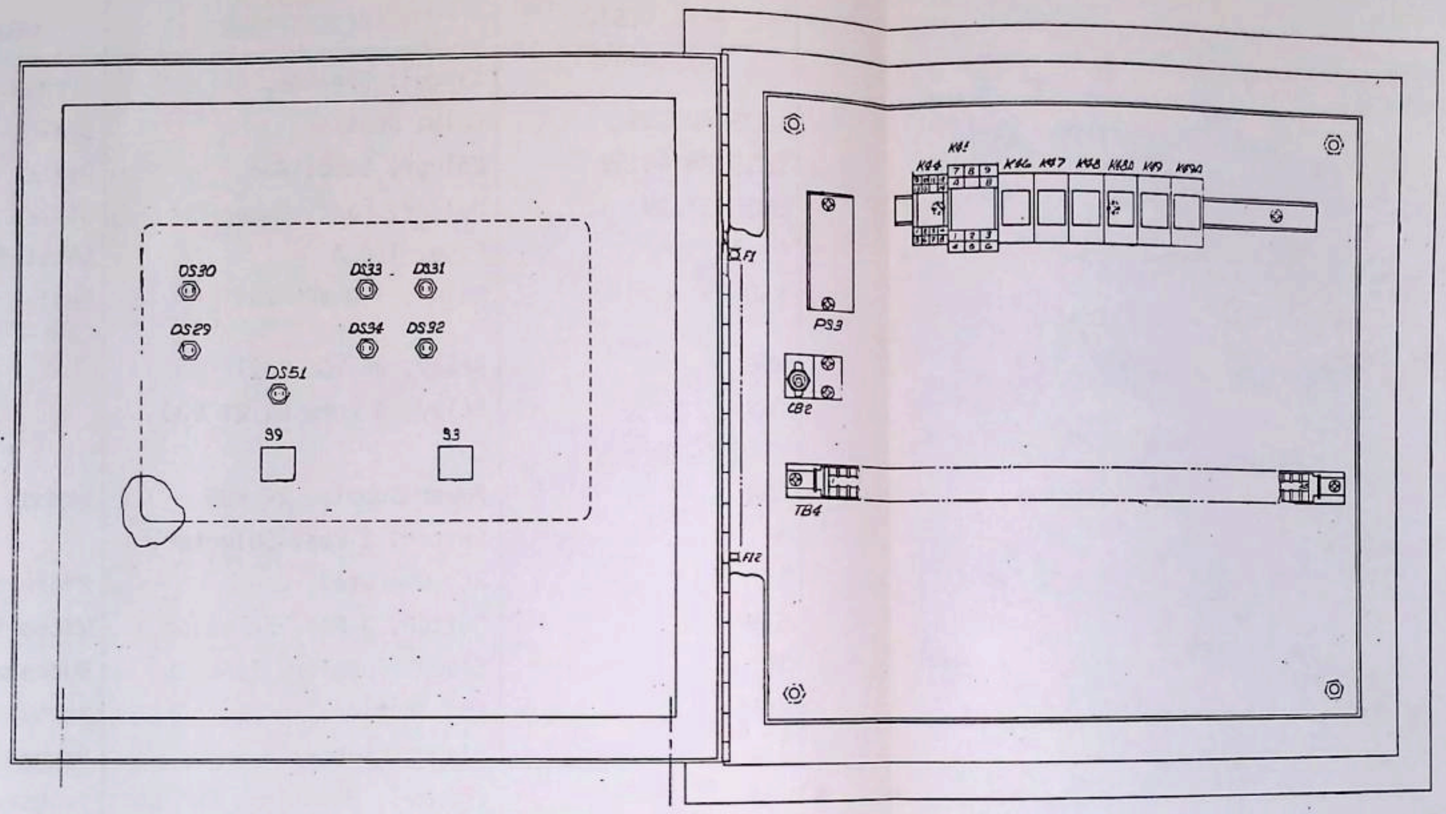


FIGURE 6 — 21
ASSY, PNL #4, TRK. SW. CONT. BOX

TRK. SW. CONT. CIRCUITS REPLACEABLE PARTS LIST

REF. DESIG.	DESCRIPTION	MFG.	PART NO.
CB2	Circuit Breaker, 5A	Airpax	AP-1-1R-6-2-502
DS35-40,DS52	Bulb, Neon	Dialco	C9A(NE-2J)
DS35,38,40,52	Holder, Lamp, Red	Dialco	181-8864-0931-513
DS36,37,39	Holder, Lamp, Amber	Dialco	181-8864-0933-513
F1-12	Fuse, 1/8 A	Littlefuse	312.125
K50-53	Relay, 120 VAC Coil	Potter & Brumfield	KHP17A12-120
K58	Relay, 24 VDC Coil	"	KHP17D12-24
D59	Relay, 3 Form C, 24 VDC Coil	"	KUP14D15-24
PS4	Power Supply, 24 VDC	Lambda	LOS-2-24
S4	Switch, 2 Pos. Selector, Key Operated	Micro Switch	PTKBC2221C
S10	Switch, 3 Pos. Selector	Micro Switch	PTSHA212C
TB5	Clamp, Tubular, Type TC	Buchanan	0625
TB5	End Section	Buchanan	0630
TB5	Clamp, Channel	Buchanan	61
TB5	Channel, Mounting, 20" Lg.	Buchanan	60
XK58,50-53	Socket, KHP	Potter & Brumfield	27E166
XK59	Socket, KUP	"	27E121

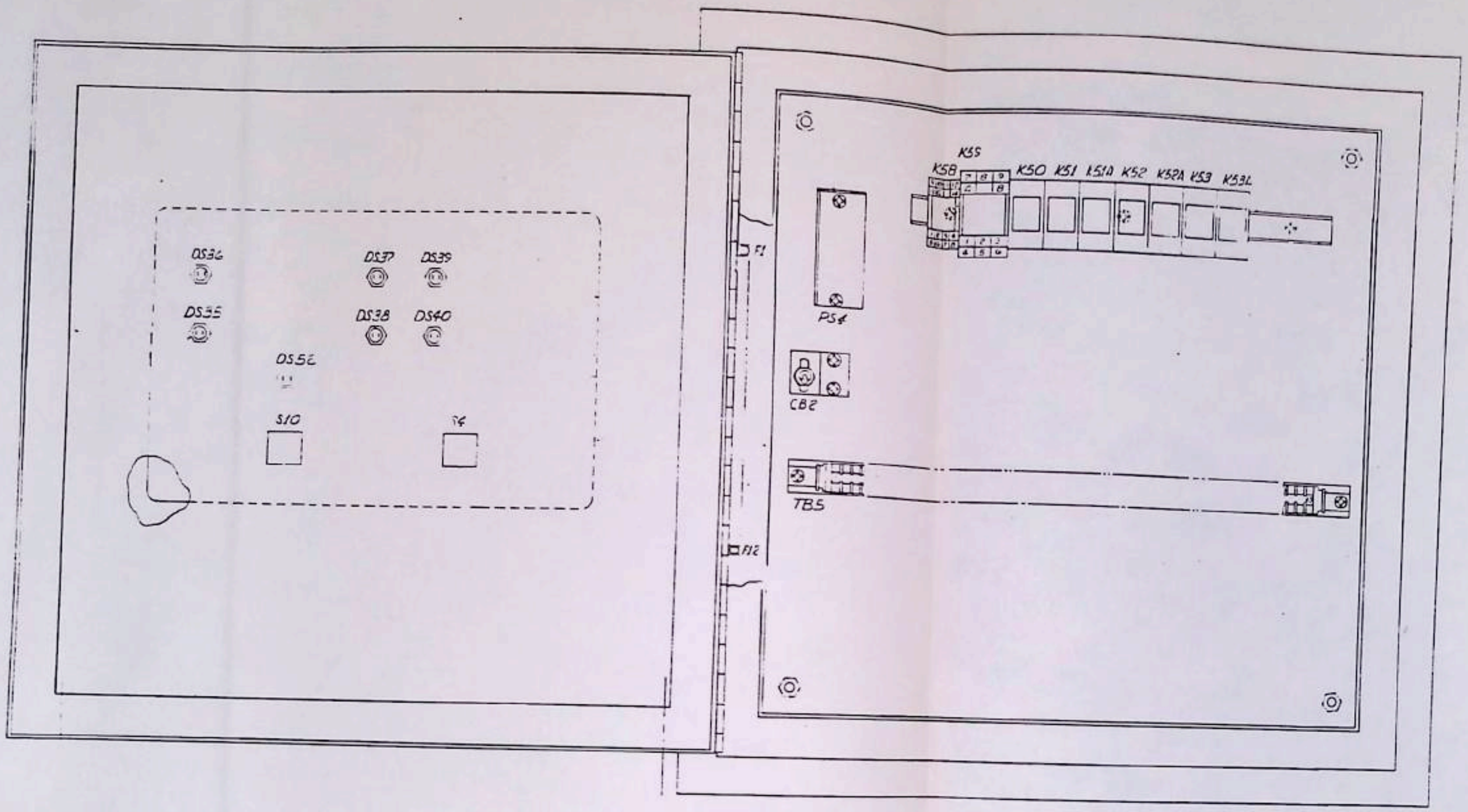


FIGURE 6 – 22
ASSY, PNL #5, TRK. SW. CONT. BOX

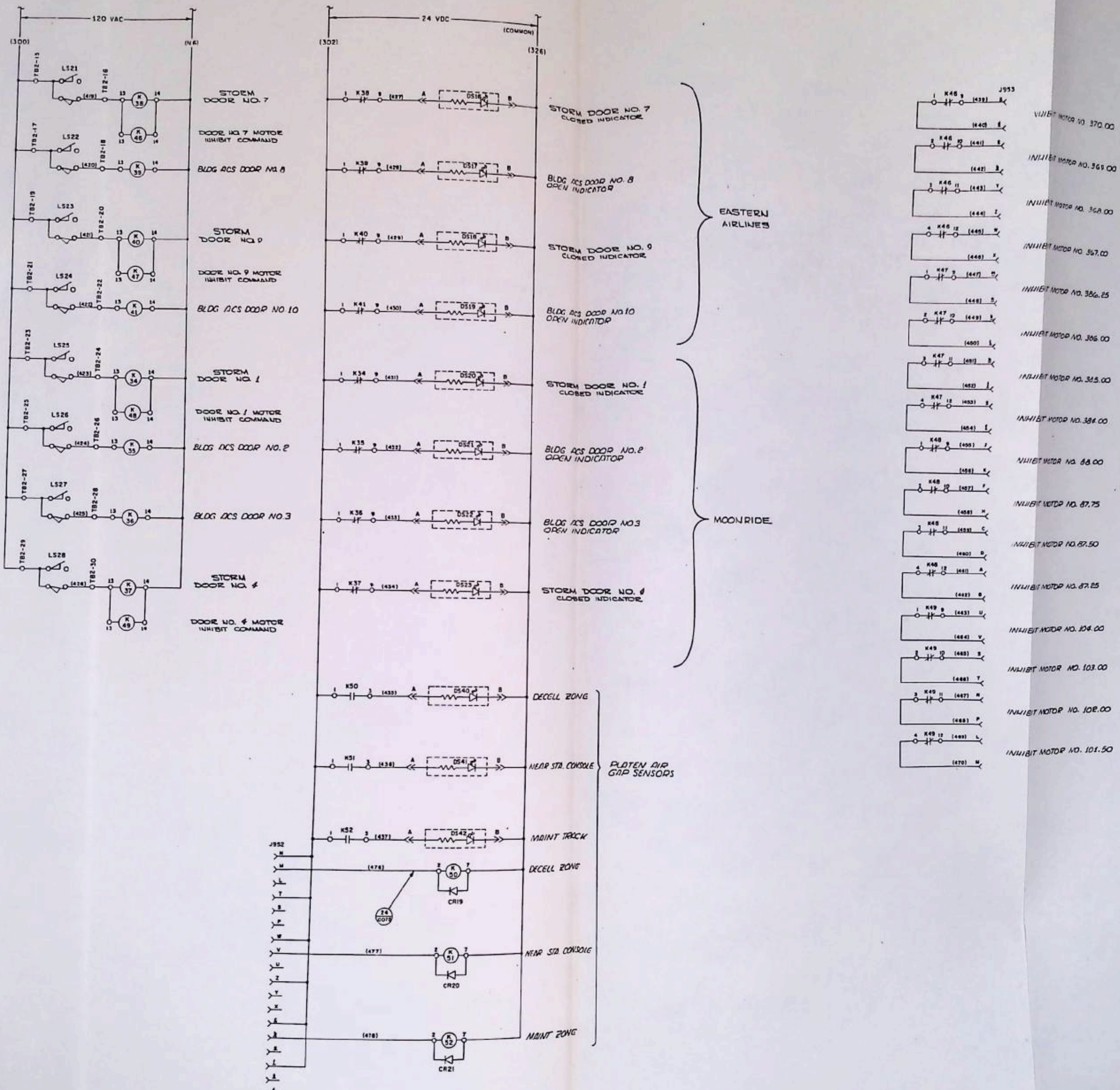


FIGURE 6 – 23
SCHEM. DIAG., TRK. SW. STATION CONSOLE STATUS

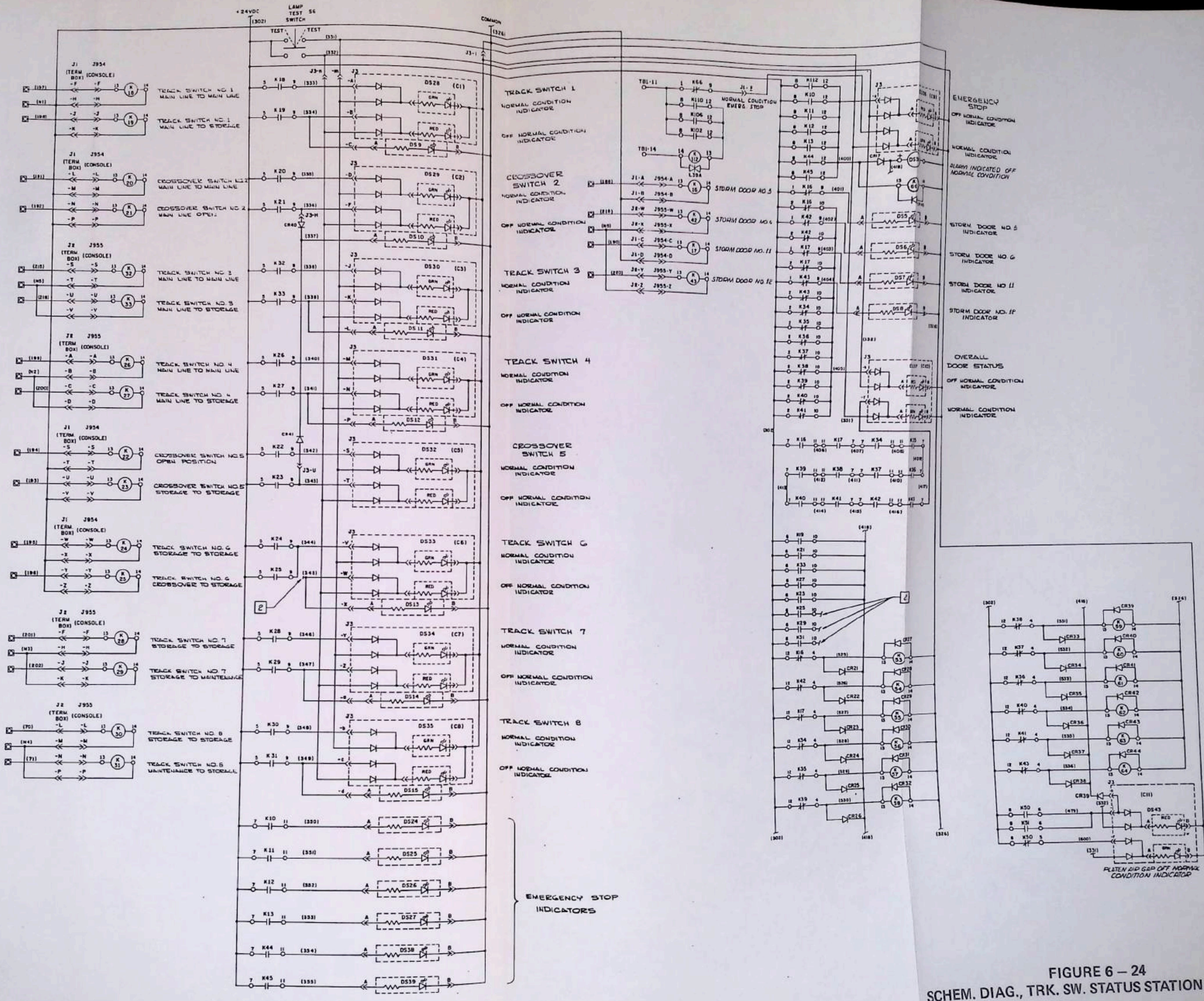


FIGURE 6 – 24
SCHEM. DIAG., TRK. SW. STATUS STATION CONSOLE

S2
TRACK SWITCH CONTROL

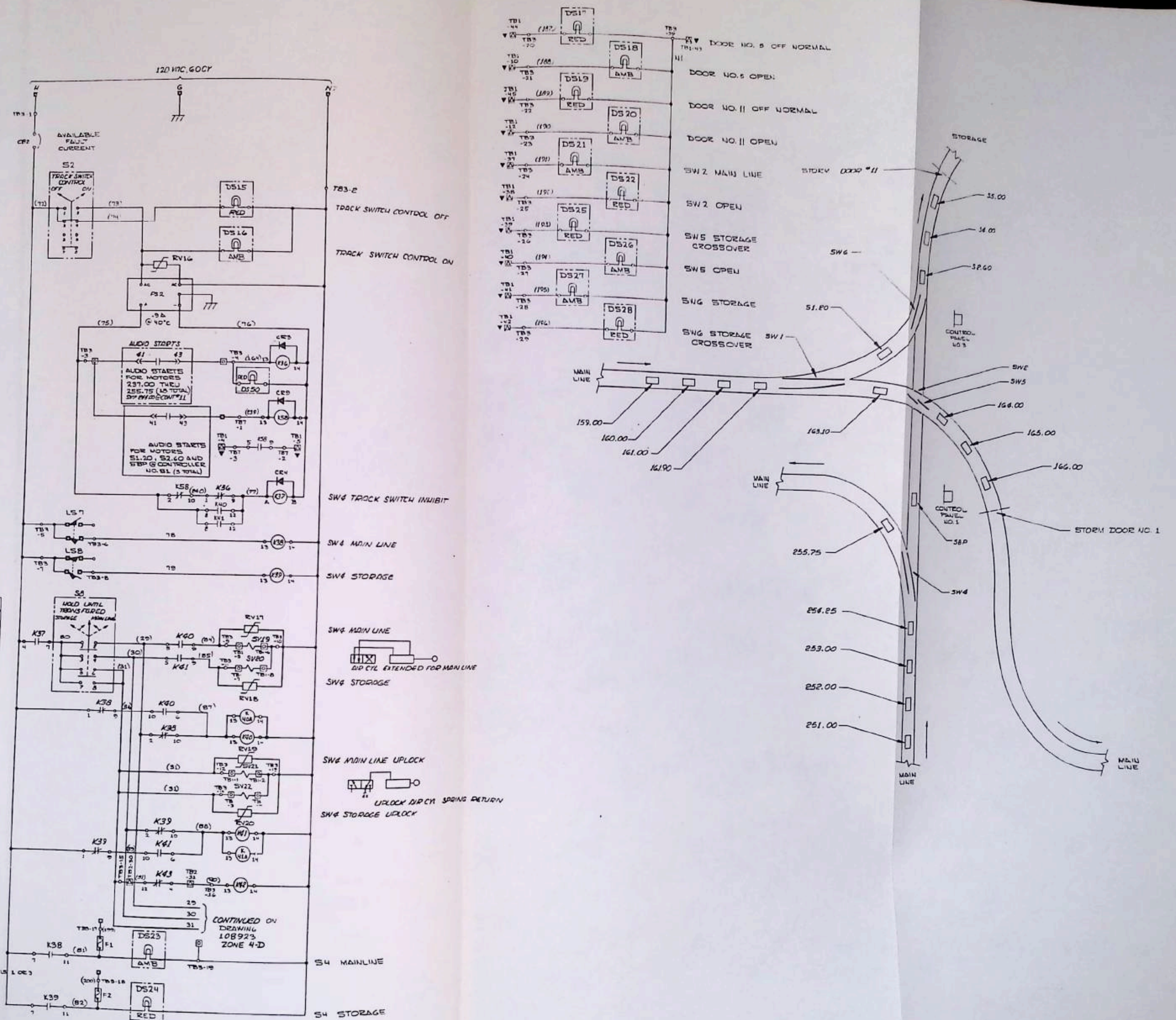
CONTACT	OFF	ON
1-2	O	X
3-4	X	O
5-6	O	X
7-8	X	O

X = CONTACT CLOSED
O = CONTACT OPEN
KEY OPERATED
KEY REMOVABLE IN OFF POSITION

S8
TRANSFER SWITCH

CONTACT	STORAGE	NORMAL	MAIN LINE
1-2	0	0	X
3-4	X	0	0
5-6	X	0	0
7-8	0	0	X

X = CONTACT CLOSED
0 = CONTACT OPEN
KNOB OPERATED - SPRING RETURN FROM EITHER POSITION TO NORMAL

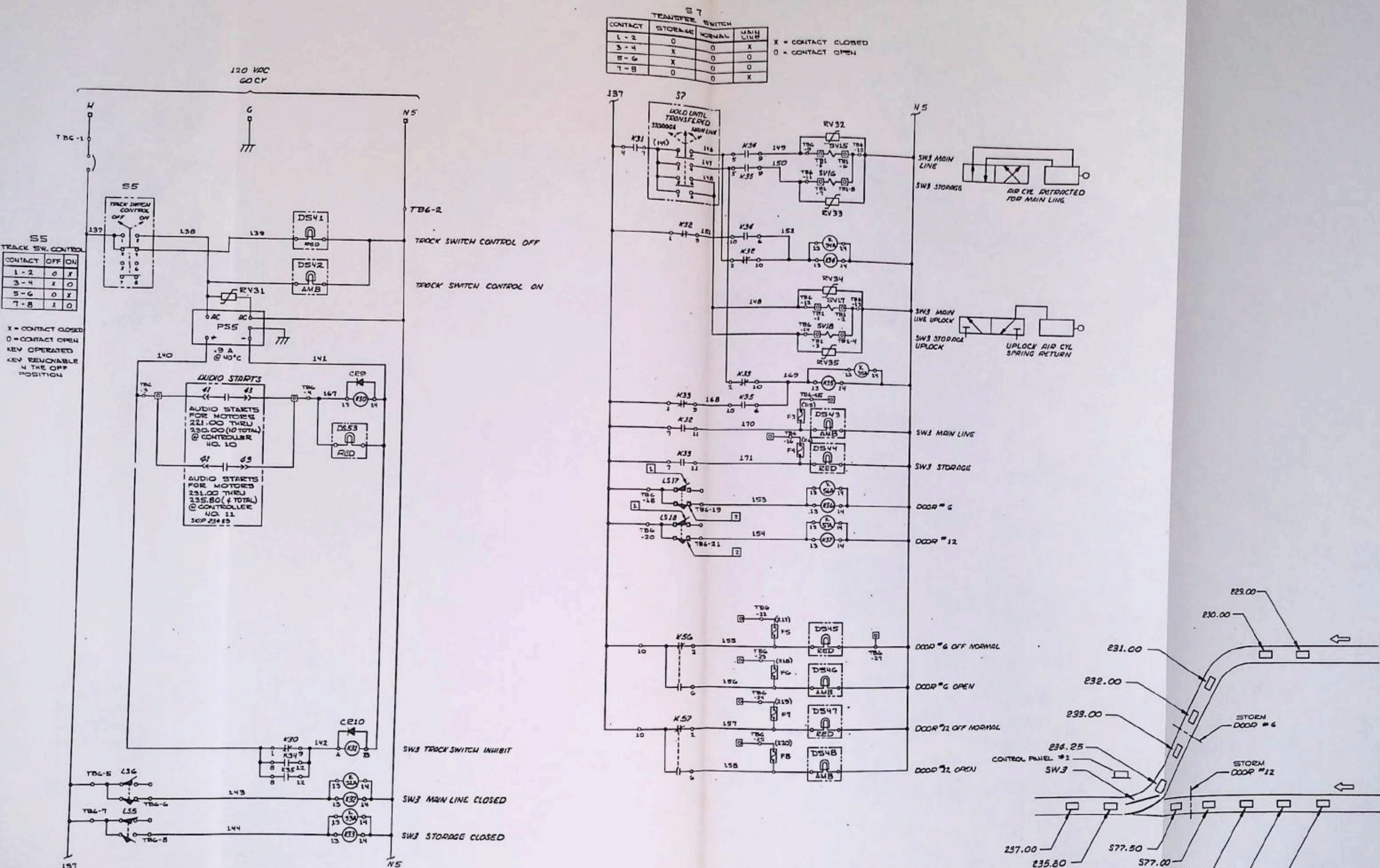


2. LEGENDS AS FOLLOWS:
- ○ - TERM. POINT, PANEL NO. 1
- ⊡ - TERM. POINT, EQUIP NOT ON PANELS 1 OR 3
- ⊠ - TERM. POINT, PANEL NO. 3
- ▼ - CONTINUED, DWG 108923

1. REFERENCE DOCUMENT WWT-247 ASSEMBLY AND WIRING DIAGRAM CONTROL VALVE BOX SWITCH = SW4

NOTES: UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DWG

FIGURE 6 – 25
SCHEM. DIAG., TRK. SW. CONT. PNL. # 1
(SW. 2, SW. 4, SW. 5, SW. 6)



S5 TRACK SW. CONTROL

CONTACT	OFF	ON
1 - 2	O	X
3 - 4	X	O
5 - 6	O	X
7 - 8	X	O

S7 TRANSFER SWITCH

CONTACT	STORAGE	NORMAL	MAIN LINE
1 - 2	O	O	X
3 - 4	X	O	X
5 - 6	X	O	O
7 - 8	O	O	X

FIGURE 6 – 26
SCHEM. DIAG., TRK. SW. CONT. PNL. #2 (SW. 3)

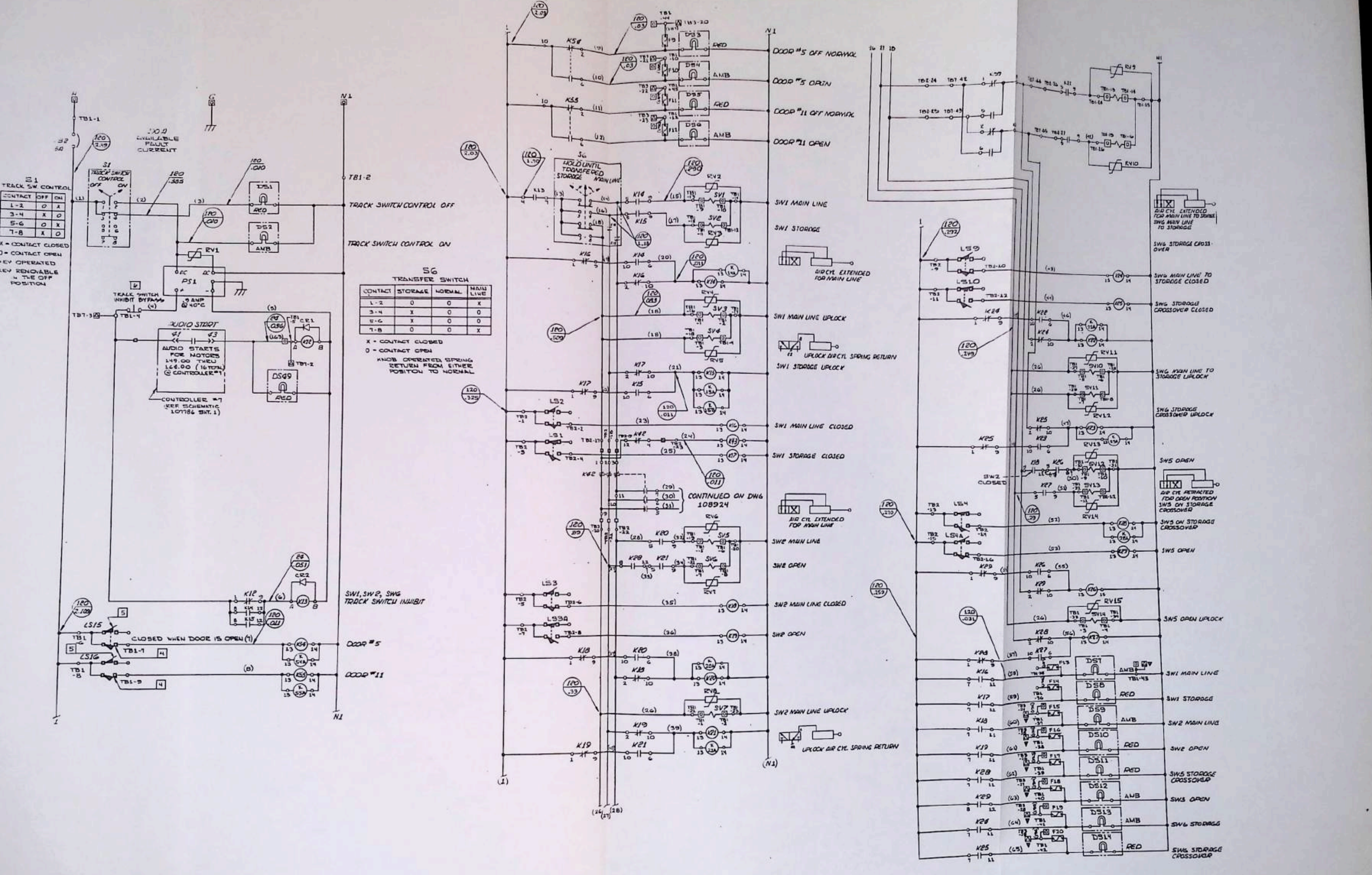


FIGURE 6 – 27
SCHEM DIAG. TRK. SW. CONT. PNL. # 3
(SW. 1, SW. 2, SW. 5, SW. 6)

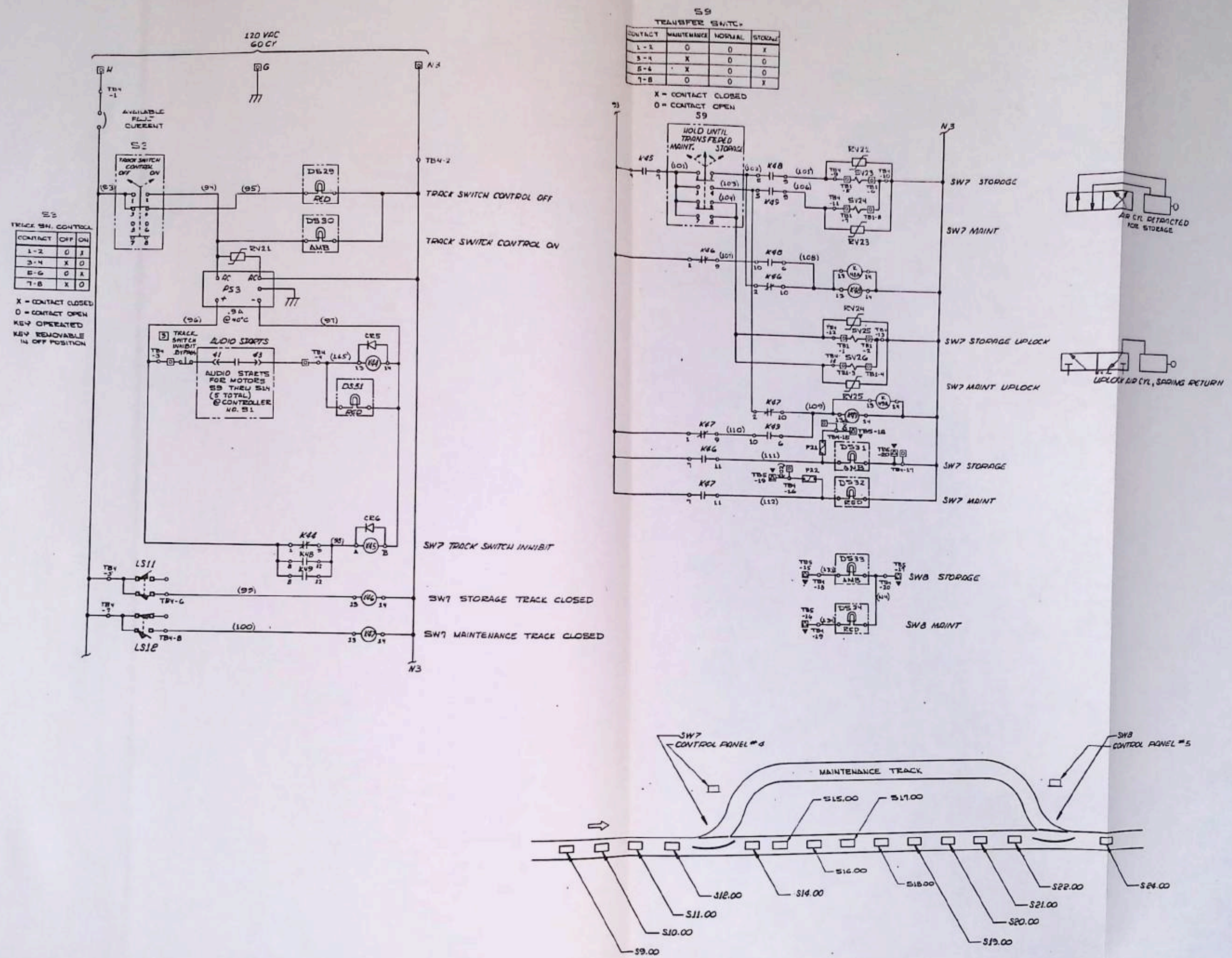
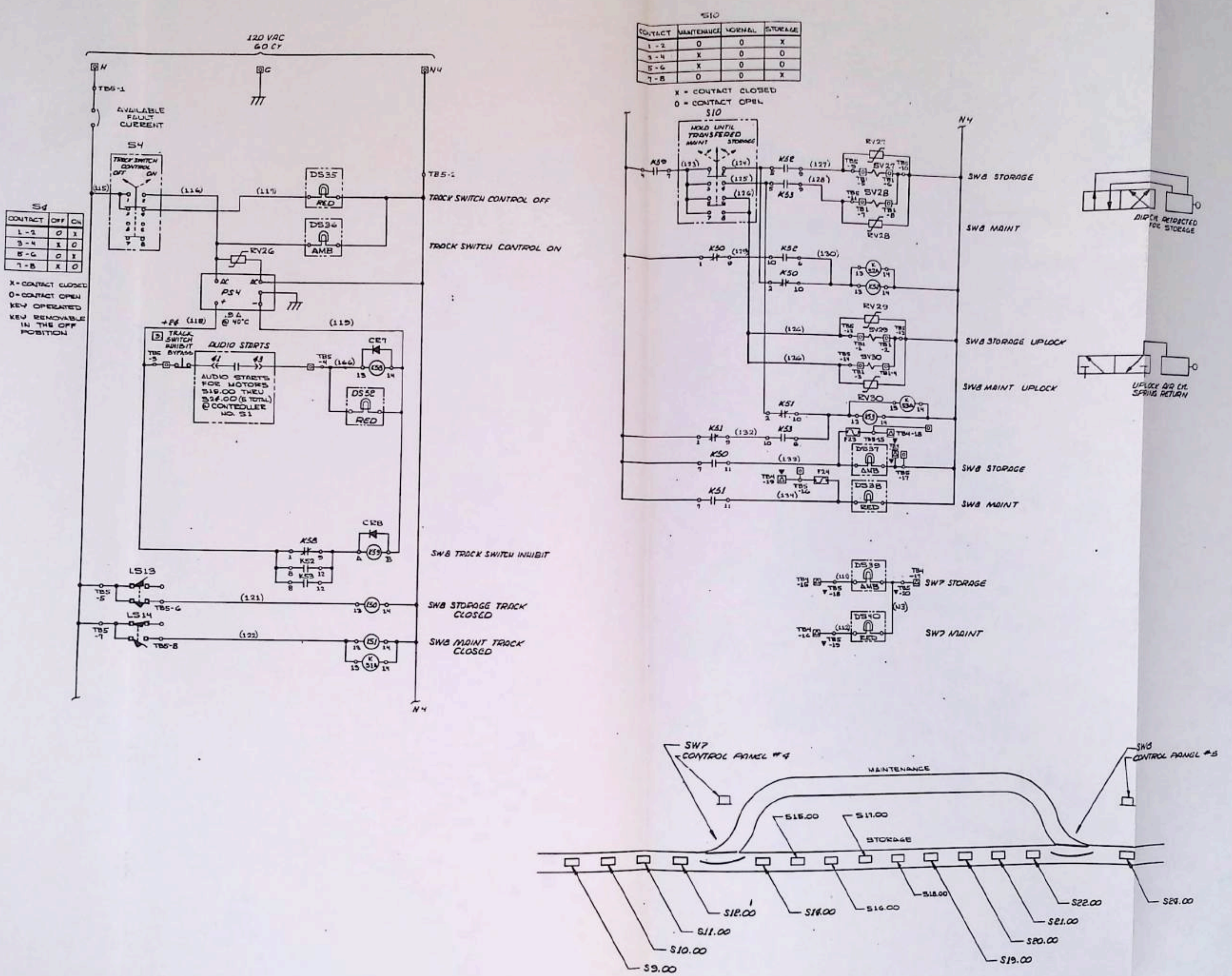


FIGURE 6 – 28
SCHEM. DIAG. TRK. SW. CONT. PNL. # 4 (SW. 7)



S4

CONTACT	OFF	ON
1-2	0	X
3-4	X	0
5-6	0	X
7-8	X	0

S10

CONTACT	MAINTENANCE	NORMAL	STORAGE
1-2	0	0	X
3-4	X	0	0
5-6	X	0	0
7-8	0	0	X

FIGURE 6 – 29
SCHEM. DIAG. TRK. SW. CONT. PNL. # 5 (SW. 8)

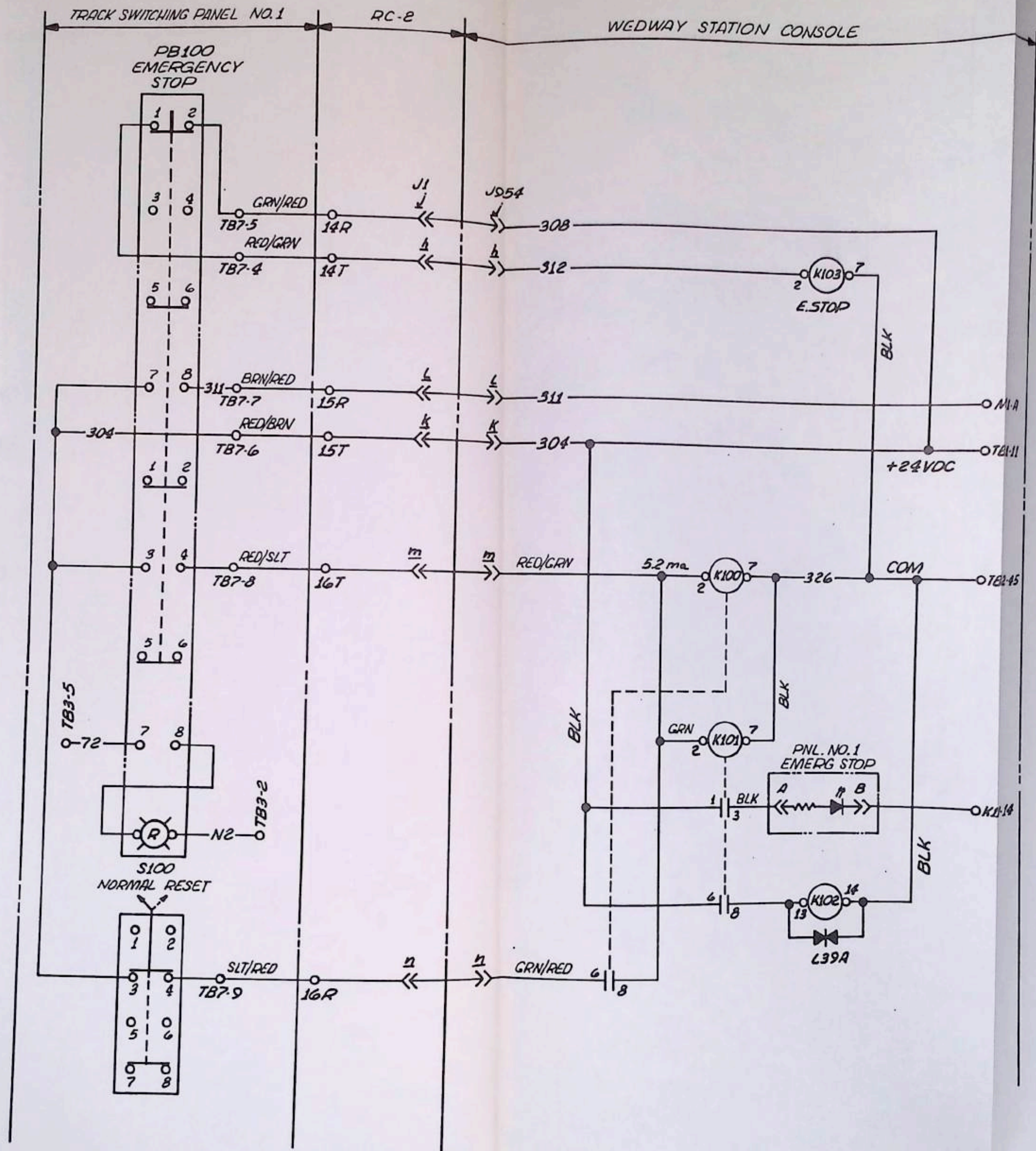


FIGURE 6 – 30
SCHEM. DIAG. TRK. SW. PNL. # 1 EMERG. STOP

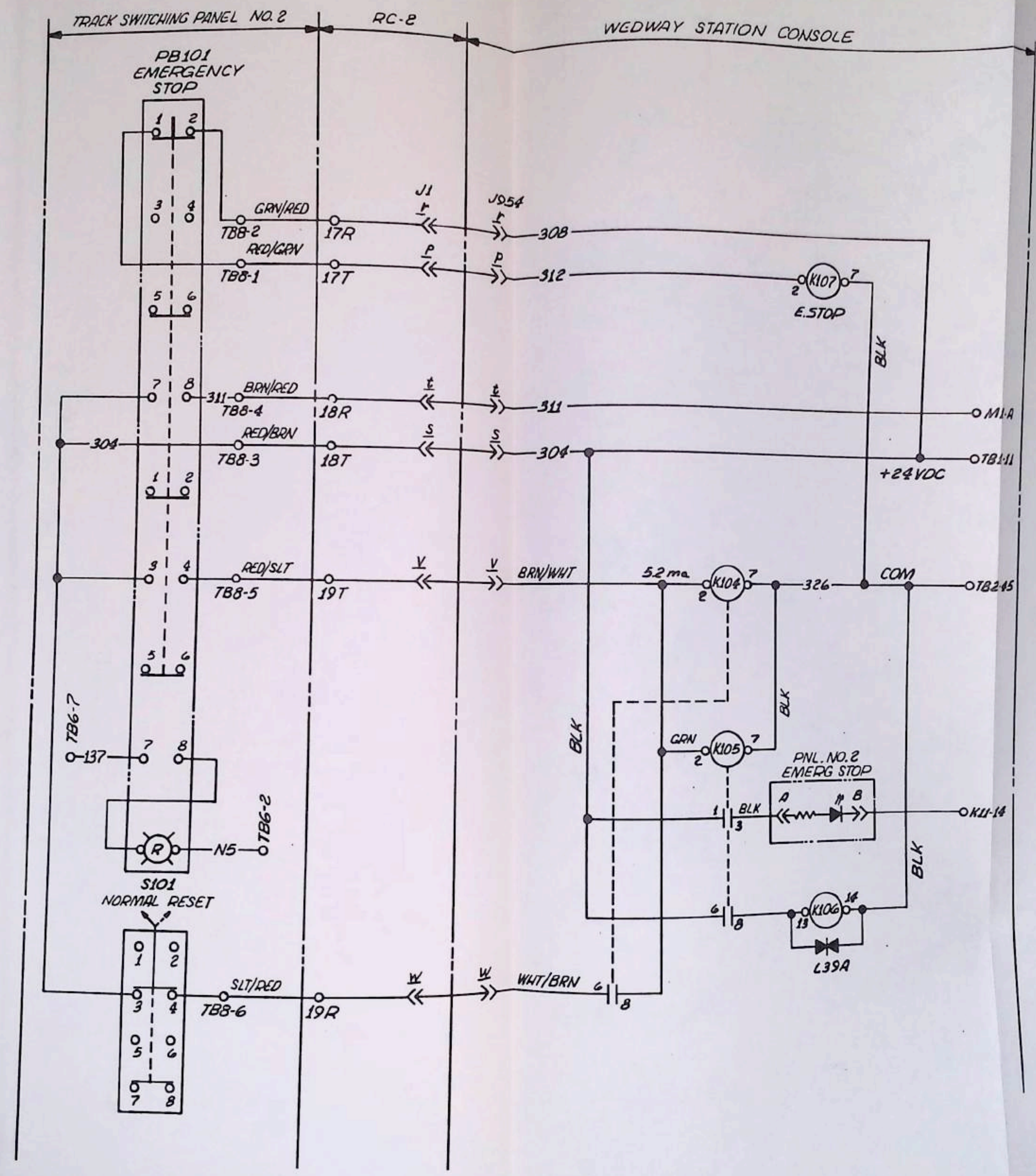


FIGURE 6 — 31
SCHEM. DIAG. TRK. SW. PNL # 2 EMERG. STOP

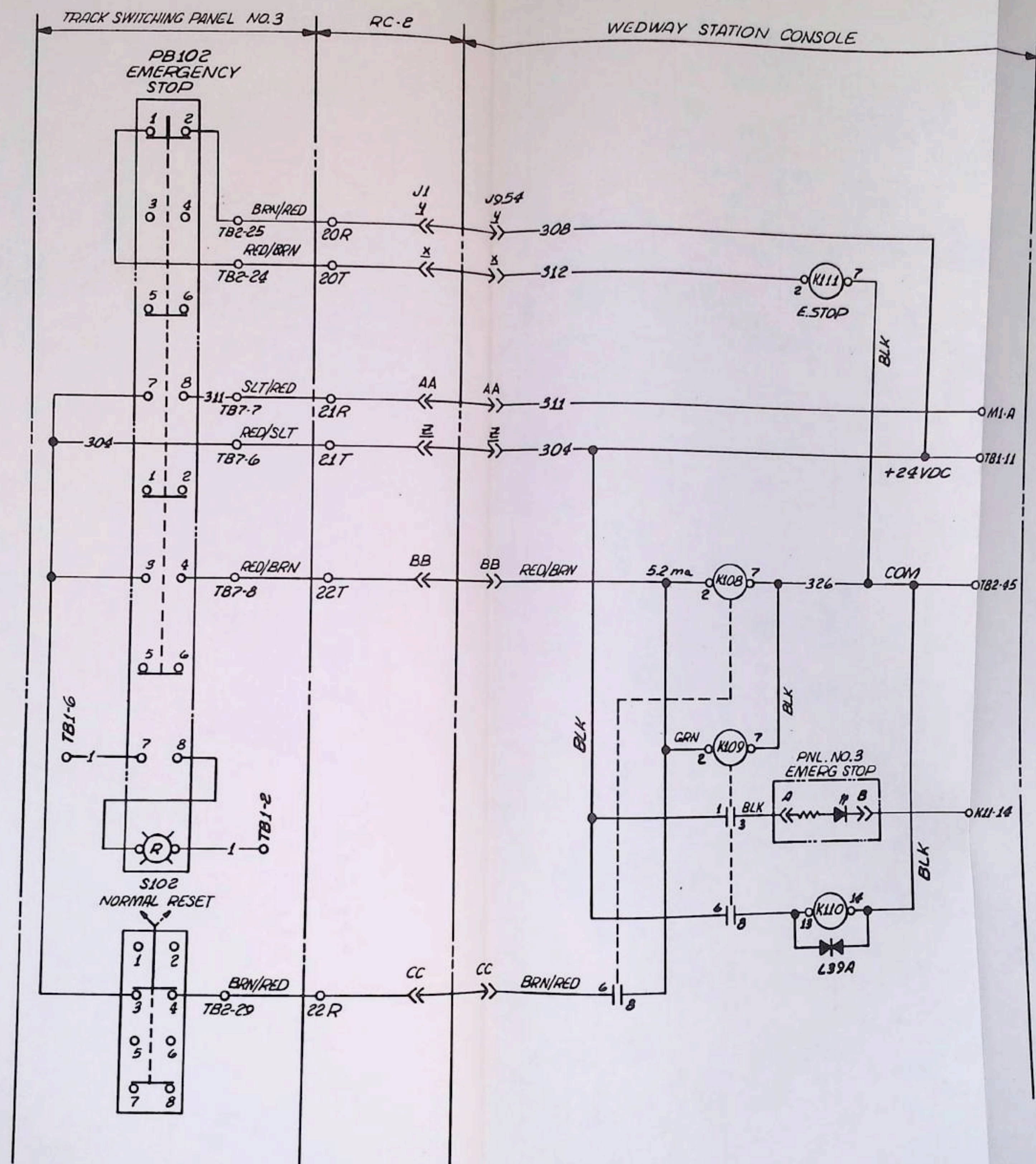


FIGURE 6 – 32
SCHEM. DIAG. TRK. SW. PNL. # 3 EMERG. STOP

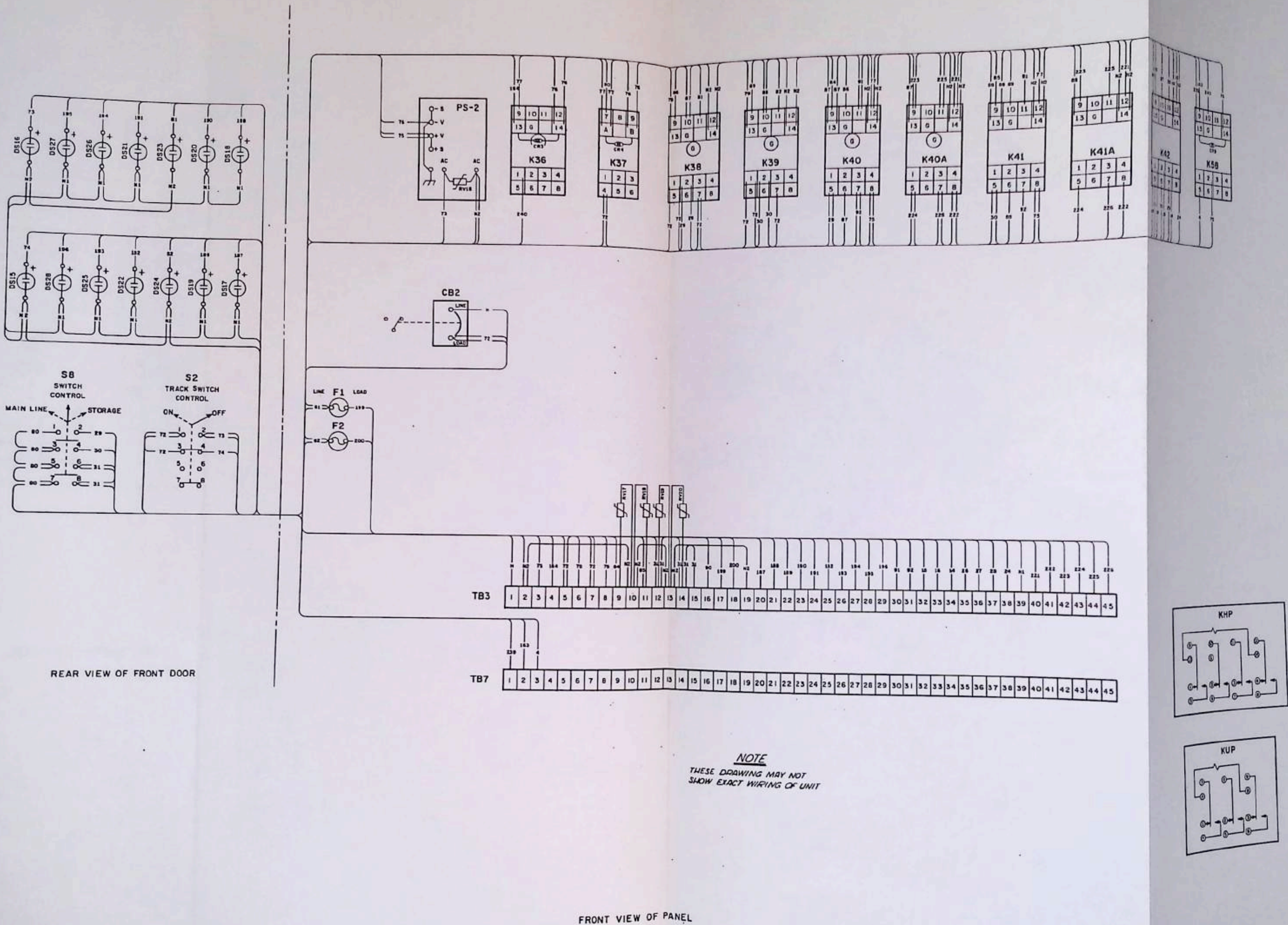


FIGURE 6 – 33
WIRING DIAG., TRK. SW. PNL. # 1

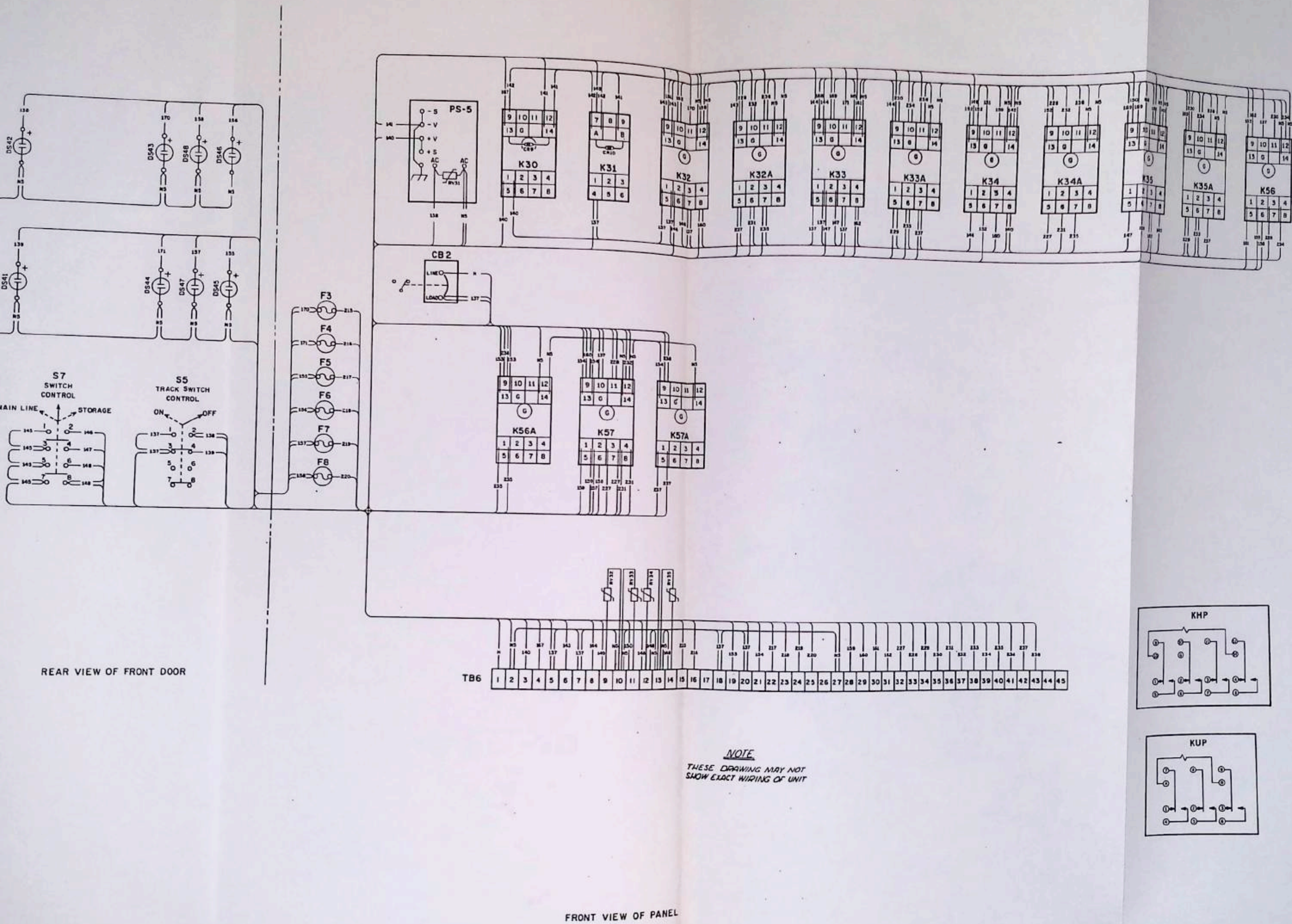


FIGURE 6 – 34
WIRING DIAG., TRK. SW. PNL. # 2

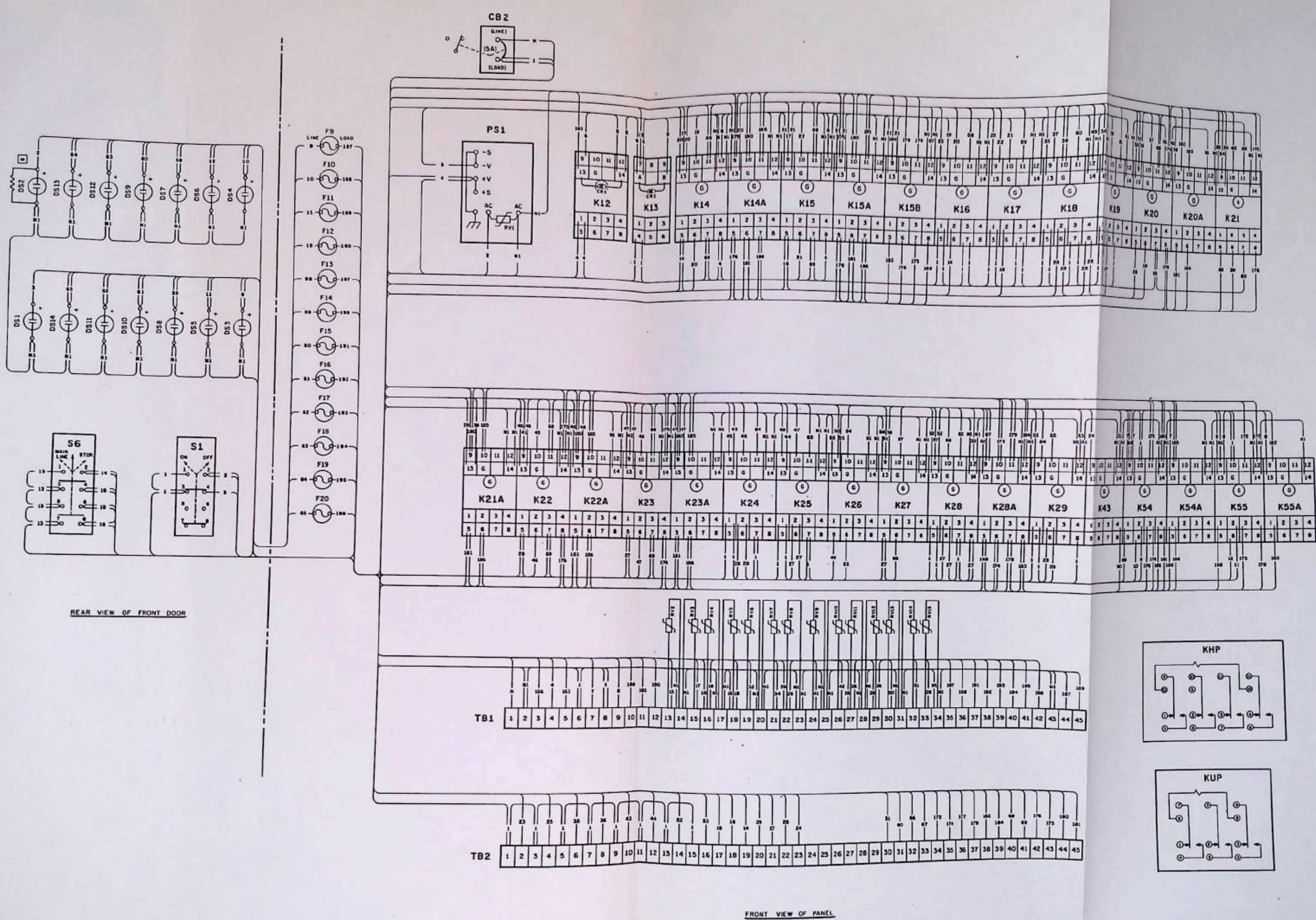


FIGURE 6 – 35
WIRING DIAG., TRK. SW. PNL # 3

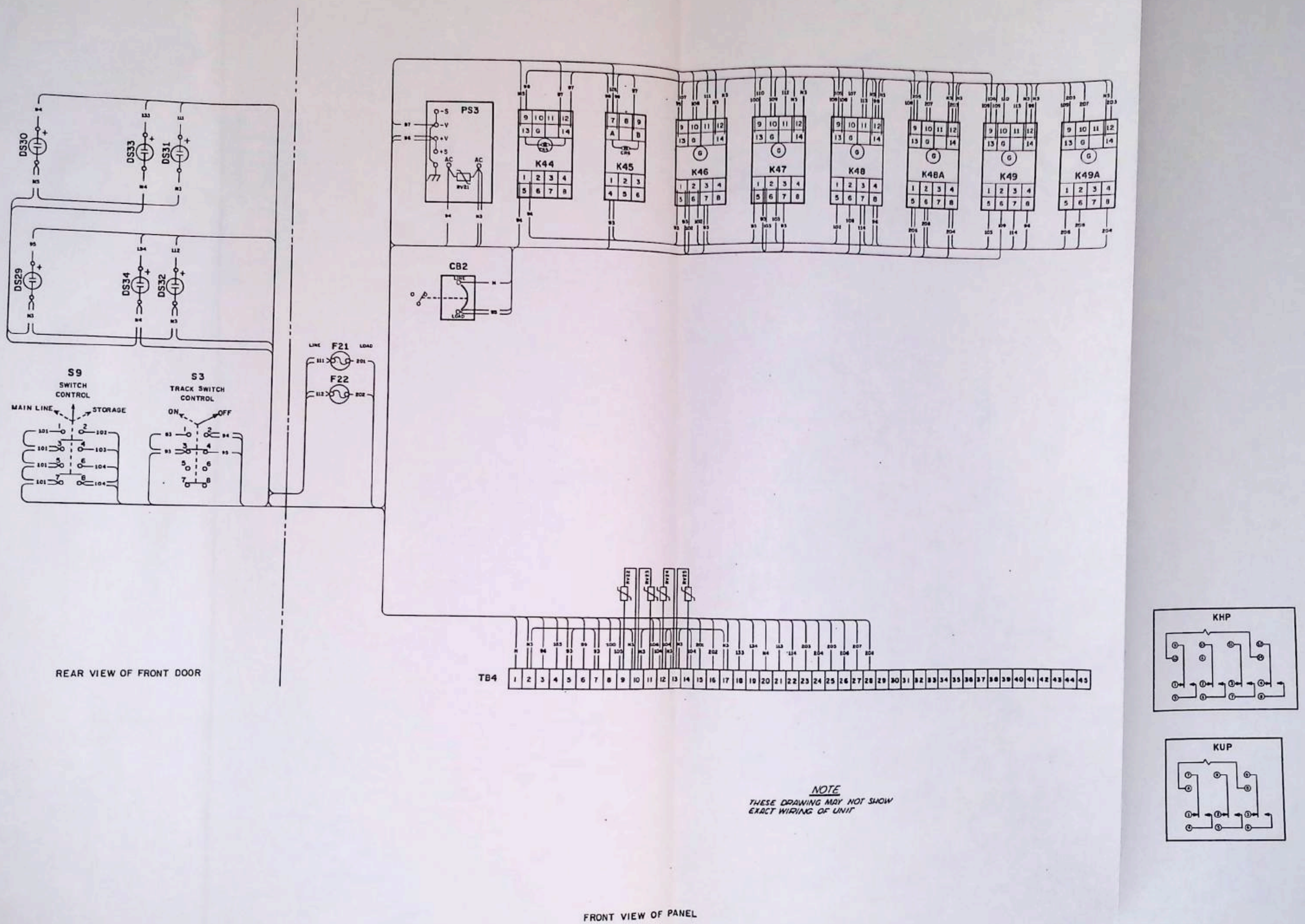


FIGURE 6 – 36
WIRING DIAG., TRK. SW. PNL. #4

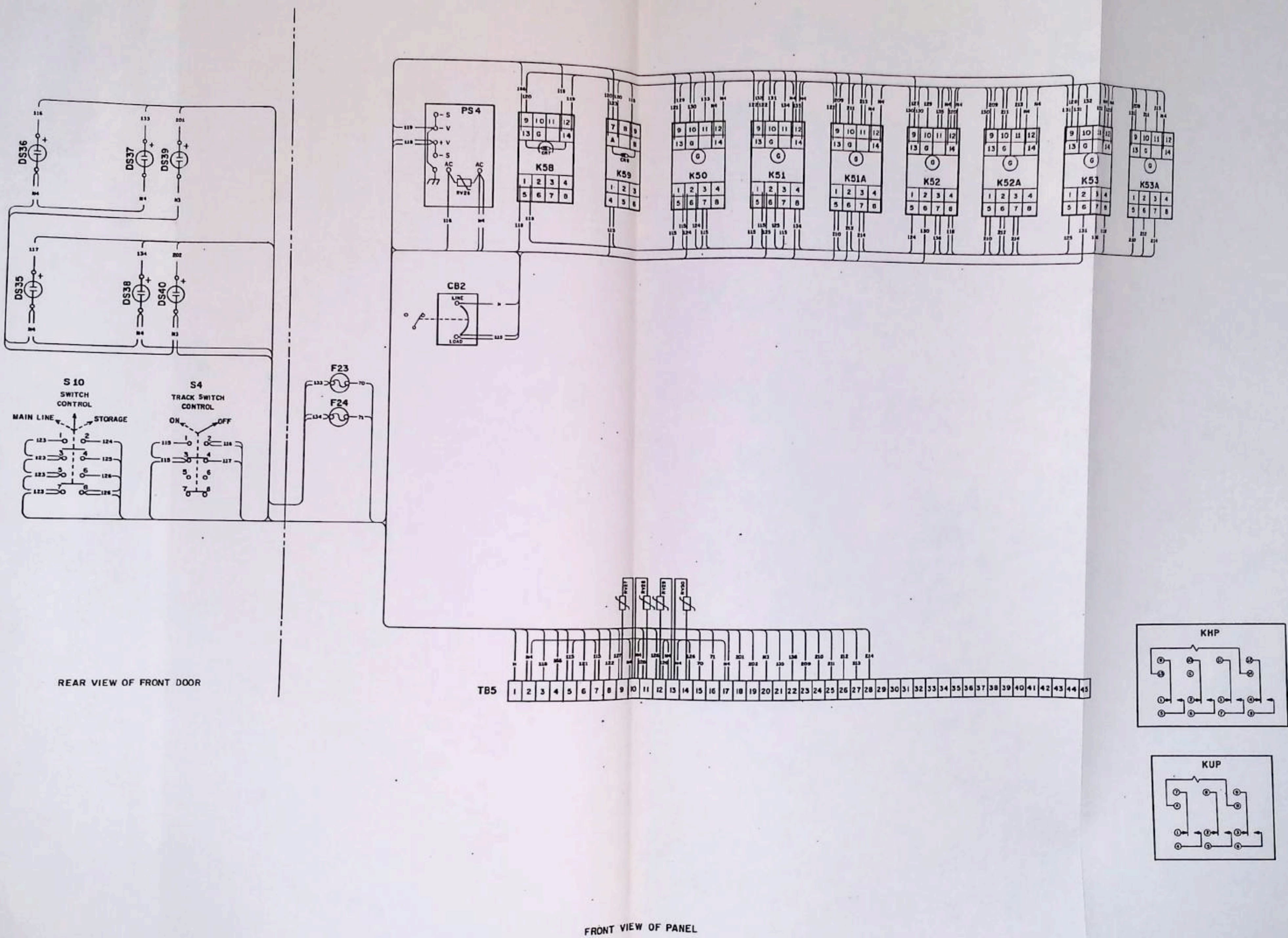
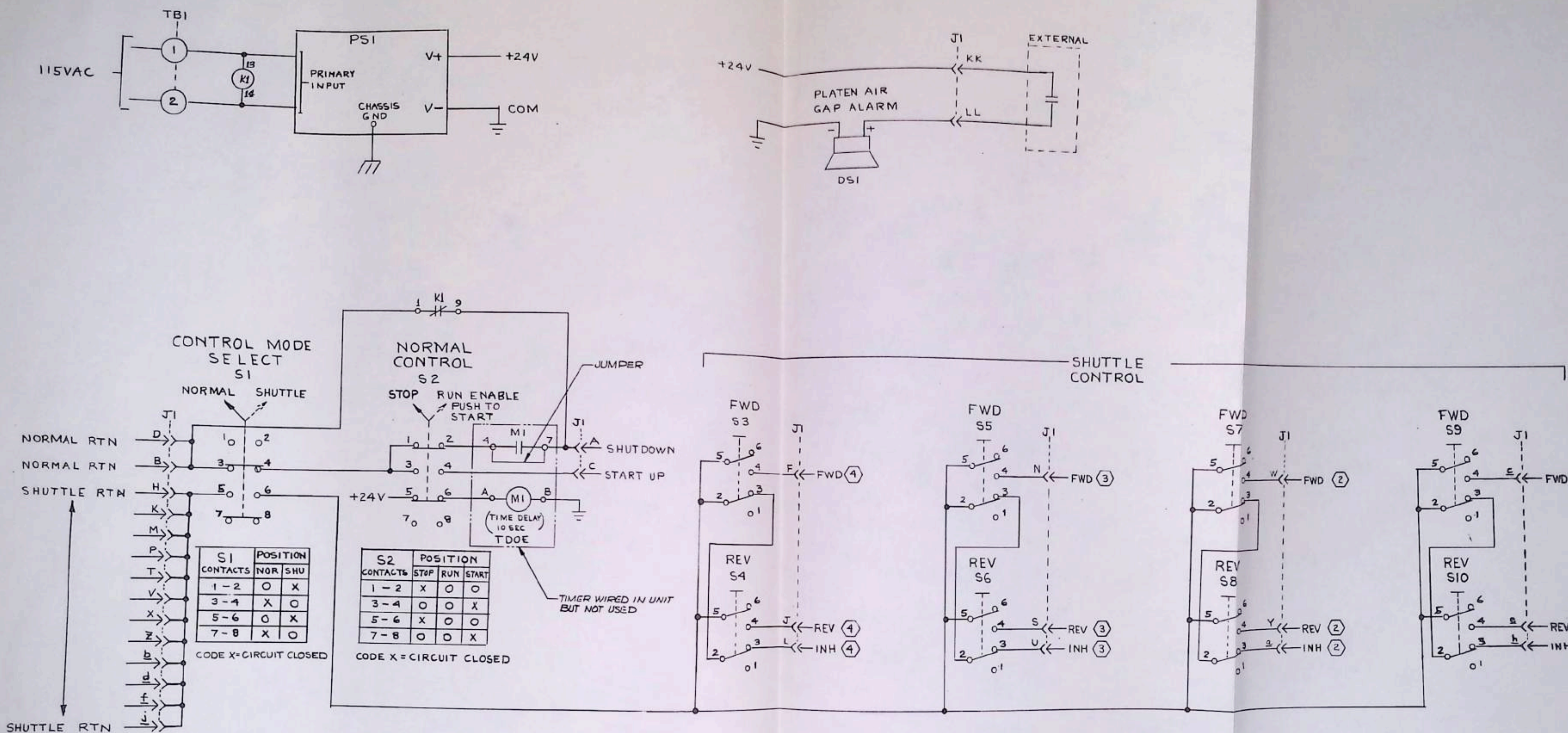


FIGURE 6 – 37
WIRING DIAG., TRK. SW. PNL. #5



S1 CONTACTS	POSITION NOR	POSITION SHU
1 – 2	O	X
3 – 4	X	O
5 – 6	O	X
7 – 8	X	O

CODE X= CIRCUIT CLOSED

S2 CONTACTS	POSITION STOP	POSITION RUN	POSITION START
1 – 2	X	O	O
3 – 4	O	O	X
5 – 6	X	O	O
7 – 8	O	O	X

CODE X = CIRCUIT CLOSED

SIGNAL IDENTIFICATION TABLE					
CODE	–1 ASSY	–2 ASSY	–3 ASSY	–4 ASSY	–5 ASSY
1	MOT/S1.2-S4	MOT/S17-S20	MOT/S33-S36	MOT/S49-S52	MOT/S65-S68
2	MOT/S5-S8	MOT/S21-S24	MOT/S37-S40	MOT/S53-S56	MOT/S69-S72
3	MOT/S9-S12	MOT/S25-S28	MOT/S41-S44	MOT/S57-S60	MOT/S73-S76
4	MOT/S14-S16	MOT/S29-S32	MOT/S45-S48	MOT/S61-S64	MOT/S77-S77.5

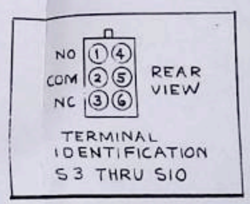


FIGURE 6 – 38
STORAGE TRK. MOTOR CONT. CONSOLE

SECTION 3

VENDOR DATA

SECTION 3

TABLE OF CONTENTS

INSTRUCTIONS

GEK-24902

ADJUSTABLE SPEED DRIVES ENVIRONMENTAL FACTORS

RELATED TO:

STORAGE

INSTALLATION

OPERATION

MAINTENANCE

GENERAL ELECTRIC

TABLE OF CONTENTS

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

EQUIPMENT ENVIRONMENT

STORAGE, OPERATING CONDITIONS & CLEANING INSTRUCTIONS

INTRODUCTION

Environmental conditions encountered in storage, installation, operation and maintenance affects the performance and operational life of a drive system. Proper performance and normal operational life can be expected by maintaining a proper environment for the drive system. Environments which include one or more of the following characteristics should be considered hostile to drive performance and life.

1. Dirt, dust and foreign matter
2. Vibration and shock
3. Moisture and vapors
4. Temperature extremes
5. Caustic fumes
6. Power line fluctuations
7. Electromagnetic interference (noise)

The more common types of environmental problems can be avoided by proper storage, installation and maintenance procedures. In addition, once a hostile environment is recognized, certain measures can be incorporated into the design of the equipment to lessen the likelihood of premature failure or reduced life.

The following will provide information and instructions to lessen or eliminate certain types of potential problems.

Storage Requirements

The equipment must be placed under adequate cover immediately upon receipt as most packing cases are *not* suitable for out-of-doors or unprotected storage.

If the equipment is not to be installed immediately, it should be stored in a clean, dry location at ambient temperatures of from −20°C (−4°F) to +55°C (131°F). The surrounding air must be free of chemical and electrically conductive contaminants. The equipment can normally be stored at 55°C for a period up to six months. If stored at 40°C or lower, the storage normally can be up to one year.

Precautions should be taken to prevent condensation from forming within the equipment enclosure. If the storage environment exceeds a 15°C (27°F) drop in temperature at 50% humidity over a 4 hour period, a space heater should be installed inside each enclosure to prevent condensation. Higher humidities with smaller temperature changes will also cause condensation.

Condensation occurs when air containing some moisture is cooled below its dew point. The dew point represents saturation of the air, and is the temperature at which the moisture starts to condense into water. It is not a fixed temperature but rather is related to the initial temperature of the air and its relative humidity at that temperature. The amount of moisture that can be held in the air is related to the air temperature. The following examples illustrate some of these relationships.

Air Temp		Relative Humidity	Wgt. of Moisture in 1 lb. of	Dew Point	
F	C	%	Dry Air, Grains	F	C
104	40	100	345	104	40
104	40	80	270	97	36
104	40	40	130	75	24
104	40	10	32	37	3
50	10	100	54	50	10
50	10	80	42	43	6
50	10	40	21	25	−4

In industrial drives, condensation is a possibility in applications where air temperature changes are large and rapid and/or the air is moist. For example, an outdoor crane operating in sunshine on a winter day, which then is shut down and parked in the shade will experience a rapid drop in temperature. This can result in condensation inside the drive. Adding heat to keep the air temperature above its dew point can prevent condensation.

If storage temperatures below −20°C (−4°F) are likely to be present, then auxiliary heat should be added in each enclosure to maintain temperature at or above −20°C. For assistance in heater size selection contact the General Electric Company.

When a drive that has been in operation is shut down for either a short or extended period of time, it is recommended the environmental conditions be maintained the same as when in operation. Power, ventilation, or heating and air conditioning (if used) should be left on during the downtime to prevent large changes in temperature and possible moisture condensation.

Installation

The drive system is designed for operation in ambient temperatures ranging from 10°C (50°F) to 40°C (104°F) and relative humidities up to 90 percent. It should be recognized, however, that since the life expectancy of any electronic component decreases with increased ambient temperature, reduction of the ambient temperature will bring about extended component life. For example, longer component life should be expected if the ambient temperature is held between 20°C (68°F) and 30°C (86°F).

WARNING

EQUIPMENT SHOULD NEVER BE INSTALLED WHERE HAZARDOUS, INFLAMMABLE OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT UNLESS IT IS EXPLOSION PROOF RATED EQUIPMENT.

Drive system power units equipped with filters are suitable for most factory areas where other industrial equipment is installed. Locations subject to steam vapors or excess moisture, oil vapor or chemical fumes should be avoided. Power units should be installed in a well-ventilated area not subject to excessive heat.

Be sure to protect the interior equipment from metal particles when cutting or drilling entrances for interconnection wiring and cables.

It is recommended that the signal leads be isolated or separated from power leads by using separate conduits. The input speed command (reference) and tachometer feedback (if supplied) or other external feedback signals be twisted pairs with at least ten twists per foot or twisted shielded cable with the shield grounded at only one end. Reference the elementary or interconnection diagram.

If additional relays or contactors are added in the SCR equipment enclosure, RC suppression networks should be added across the coils.

CAUTION

DO NOT USE POWER FACTOR CORRECTION CAPACITORS WITH THIS EQUIPMENT WITHOUT CONSULTING THE SPEED VARIATOR PRODUCTS DEPARTMENT, GENERAL ELECTRIC COMPANY. DAMAGE CAN RESULT FROM HIGH VOLTAGES GENERATED WHEN CAPACITORS ARE SWITCHED.

Before power is applied to the drive system, checks should be made to see that all internal connections are tight, that plug-in printed circuit cards are fully seated and that all open relays and contactors operate freely by hand. Check that the equipment is clean and that no metal chips are present.

Equipment Operation

Erratic or abnormal equipment operation due to some environmental conditions and suggested remedies are listed in the following environmental checklist:

ENVIRONMENTAL CHECK LIST*

CONDITION	POTENTIAL PROBLEM	SUGGESTED REMEDIES
Electrical Power Line		
"Soft" ac power lines droop under steady state load or when heavy loads—such as large induction motors or electric arc welders—are applied.	Can affect unregulated power supplies; can drop ac line voltage out of limits specified for drive equipment (+10%, −5%); can cause fuse blowing on static regenerative drives.	Stiffen up source (substation, etc.); shift load to different load center.
Noisy ac line, full of voltage "spikes" or "holes"; high frequency noise generated by SCR drives on ac feeder; transient high voltages on line.	Can cause SCR misfiring, erratic system performance/operation; overvoltages can destroy semiconductor devices, other components.	Shift to less noisy load center; suppress noise source or drive system if practical; use isolation transformer on offending system.
"Stiff" ac line (high short circuit capability).	Can be hazardous to equipment and personnel due to high short circuit current levels.	Provide adequate short circuit protection between drive and substation.
Line voltage dips for several cycles or disappears entirely, single or polyphase, due to lightning strikes on transmission lines; ac supplied through collector rings or shoes.	Equipment may be shut down, blow fuses, or behave intermittently.	MG set can provide some ride-through due system inertia (flywheel effect).
Electrical Noise		
"Noisy" power conductors induce noise into low level signal wire by coupling; operating relays produce noise; improper shielding or no shielding of low level signal leads can affect drive operation.	Any noise inserted into regulator or firing circuitry can cause misfiring, fuse blowing, and erratic drive operation.	Isolate signal leads from power leads, place in separate conduits; if leads must cross, cross at right angles; provide shielded twisted leads for all low level signals; ground shield at one end of cable only; ground power unit cabinet; suppress relay coils.
Mechanical Vibration		
Equipment subjected to vibrations external to system such as coupling misalignment, belt or chain drive whip, sprocket run-out, misaligned or eccentric rolls; drive vibrates due to vibrations from nearby equipment such as slow speed compressor.	Can generate signals each revolution, causing apparent electrical system instability; can cause general deterioriation of connections and wire breakage; can shorten life of bearings in drive motor.	Realign rotating members; shorten belt lengths; true up driven rolls; isolate system from external vibrating masses.
Equipment subjected to vibrations generated within systems such as large starters or contactors being operated.	Can cause general deterioration of terminations, wiring connections, wire breakage; parts can be shaken loose and dropped onto devices, reducing electrical clearances; contact tips of low level signal relays can bounce, producing erratic drive operation.	Isolate vibration sensitive devices; relocate offending devices, dampen vibrations by using some form of rubber cushioning.
Motor bearings are noisy, indicating wear due to vibration.	Can cause short brush life and poor commutation.	Replace bearings and remove any motor load vibration that may lead to further bearing failure.

CONDITION Atmospheric Effects	POTENTIAL PROBLEM	SUGGESTED REMEDIES
Temperature is too high due to adjacent heat sources such as ovens, process heat, or exhaust from other equipment; air flow blocked or restricted.	Can cause drifting of regulated paramenters such as speed, higher than normal card and/or component failure, reduced motor bearing life, or shortened insulation life.	Remove heat source; relocate equipment; supply cooler air; remove any obstructions; keep filters clean; flood with conditioned air during extended downtime.
Temperature is too low in operating area; prior to installation, drive is stored in unheated warehouse.	Can cause accumulation of frost or moisture inside power unit/motor, poor regulation, ground hazards, or fuse blowing. Some semiconductors and capacitors can deteriorate. SCR's become more difficult to fire reliably. Rust can form on devices and equipment.	Supply space heaters for sustained storage or operation at low temperatures. Minimum storage temperature —20°C, minimum operating temperature is 10°C usually.
Accumulation of dust or dirt in power unit, oil vapors in air, motor, or filters.	Particulate matter can reduce contact clearances on terminals and relays; contacts can become contaminated; leakage paths can be formed; contacts can close but not make circuits; motor brush life can be reduced; ground hazards can exist; motor temperature or power unit can be elevated due to improper air flow.	Maintain filters on a planned basis; inspect power unit and motor for dirt accumulation; clean equipment, but avoid use of air hoses that may be contaminated with oil particles; remove equipment from dirty air paths or use air ducts to bring in clean air.
Excess humidity in area caused by water vapor or steam from process; condensation from water and steam pipes; area humidifying equipment set too high.	Can cause collection of moisture in power unit or motor, rusting, reduction in creepage paths, or ground hazards.	Locate equipment in less humid area; remove source of moisture or shield drive equipment.
Process vapors combine with moisture in air to form corrosive chemicals such as hydrogen, sulfide, chlorine compounds, sulfur dioxide mixtures; silicone vapors in air.	Can cause corrosion of contacts, electrical components and printed circuit card tabs etchings; can cause deterioration of motor insulation and commutator films; high resistance; can cause ground hazards.	Supply clean air to equipment; add special motor enclosures; place equipment in clean environment—such as in a motor control center.

*This Check List supersedes the one in GER-2862.

Equipment Maintenance

Periodically inspect the equipment filters (when supplied) and change or clean when required. Be sure to install filter with the air flow direction as indicated on the filter. Check all electrical connections for tightness, look for signs of poor connections or overheating (arcing, discoloration) and manually check cooling fans or blowers for easy rotation (if supplied).

Equipment Cleaning

SCR Conversion Modules, Assemblies, Relays and Contactors

1. Dry dust—Vacuum clean, then blow with dry, filtered compressed air (low pressure).

CAUTION

SOLVENT CAN HARM NON-METAL COMPONENTS.

2. Oily dirt—Use dry or barely moist (with solvent) non-linting cloth. Repeat until cloth remains clean. All contact tips must be cleaned with dry non-linting cloth after solvent has been used. Recommended solvent: Freon TE or TF (E.I. DuPont Co.).

Regulator and Printed Circuit Cards

1. Dry dust—Vacuum clean, then blow with dry, filtered compressed air (low pressure supply).
2. Oily dirt—Certain components (electrolytic capacitors, switches, meters, potentiometers and transformers) can be damaged by solvent, so its use is not recommended. If necessary, use solvent sparingly on a small brush, and avoid above components. Clean contact terminals with dry non-linting cloth after solvent has been used.
3. If the card is badly contaminated or corroded, replace.

Air Filters

To clean metal filters, flush only with warm water, dry and recoat lightly with RP Super Filter Coat or equivalent (light oil) or replace the filter.

Motors

Motor maintenance is covered by the motor instruction book supplied with the motor and should be followed in all cases. If the motor is supplied with filters be sure to check and clean or replace periodically.

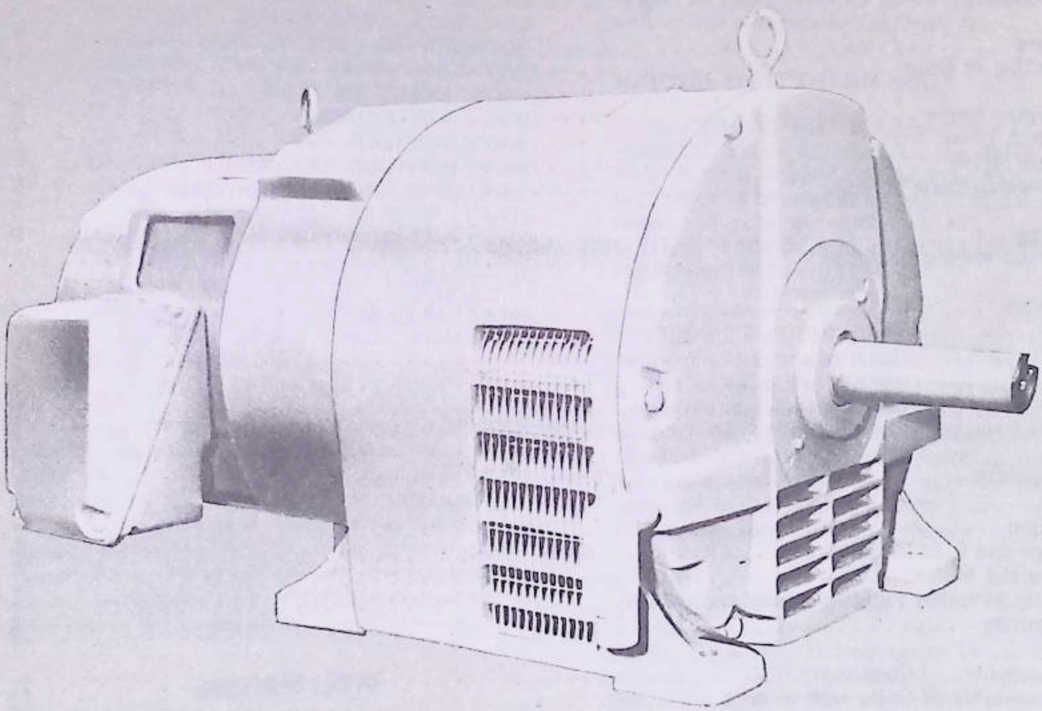
INSTRUCTIONS

GEH-2587E

KINATROL®

AIR-COOLED EDDY CURRENT COUPLING ROTATING EQUIPMENT

7½-75 HP AT 1200 RPM   10-125 HP AT 1800 RPM



GENERAL ELECTRIC

CONTENTS

KINATROL®

AIR-COOLED EDDY CURRENT COUPLING ROTATING EQUIPMENT

INTRODUCTION

These instructions provide information on the handling, installation, operation and maintenance of Kinatrol Eddy Current Coupling rotating equipment. Instructions pertaining to controls are covered separately.

> **WARNING:** *HIGH VOLTAGE AND ROTATING PARTS CAN CAUSE SERIOUS OR FATAL INJURY. THE USE OF ELECTRIC MACHINERY, LIKE ALL OTHER UTILIZATION OF CONCENTRATED POWER AND ROTATING EQUIPMENT, CAN BE HAZARDOUS. INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRIC MACHINERY SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. FAMILIARIZATION WITH NEMA SAFETY STANDARD FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION AND USE OF INTEGRAL HP MOTORS AND GENERATORS, NATIONAL ELECTRICAL CODE AND SOUND LOCAL PRACTICES IS RECOMMENDED.*

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency or hazard to be met in connection with installation, operation and maintenance. Should further information be desired or should particular problems or special operating conditions arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

DESCRIPTION

EDDY CURRENT COUPLING

An eddy current coupling is an electrical machine which transmits torque from a motor to a load at a controlled-adjustable speed. It is called an "eddy current" coupling because torque is transmitted by interaction of flux from magnetic poles, and the eddy currents that are induced in a solid-iron drum by this flux.

Figure 1 shows a typical eddy current coupling drive unit with an integral induction motor. The drum, driven by the motor, turns at a constant speed; while the pole structure, attached to the output shaft, turns at a slower speed determined by the field strength of the magnetic poles. The speed of the output shaft is thus controlled by the current supplied to the field winding.

INTEGRAL TACHOMETER GENERATOR

The tachometer generates an a-c voltage signal which is proportional to speed. This a-c voltage signal is available for speed indication purposes and/or for a regulator feedback signal.

INTEGRAL EDDY CURRENT BRAKE

The integral eddy current brake is an electromagnetic brake mounted on the drive end of the eddy current coupling drive unit. Adjustable braking torque is developed by energizing the stationary field and pole assembly, thereby inducing eddy currents in the rotating assembly that interact with the stationary field.

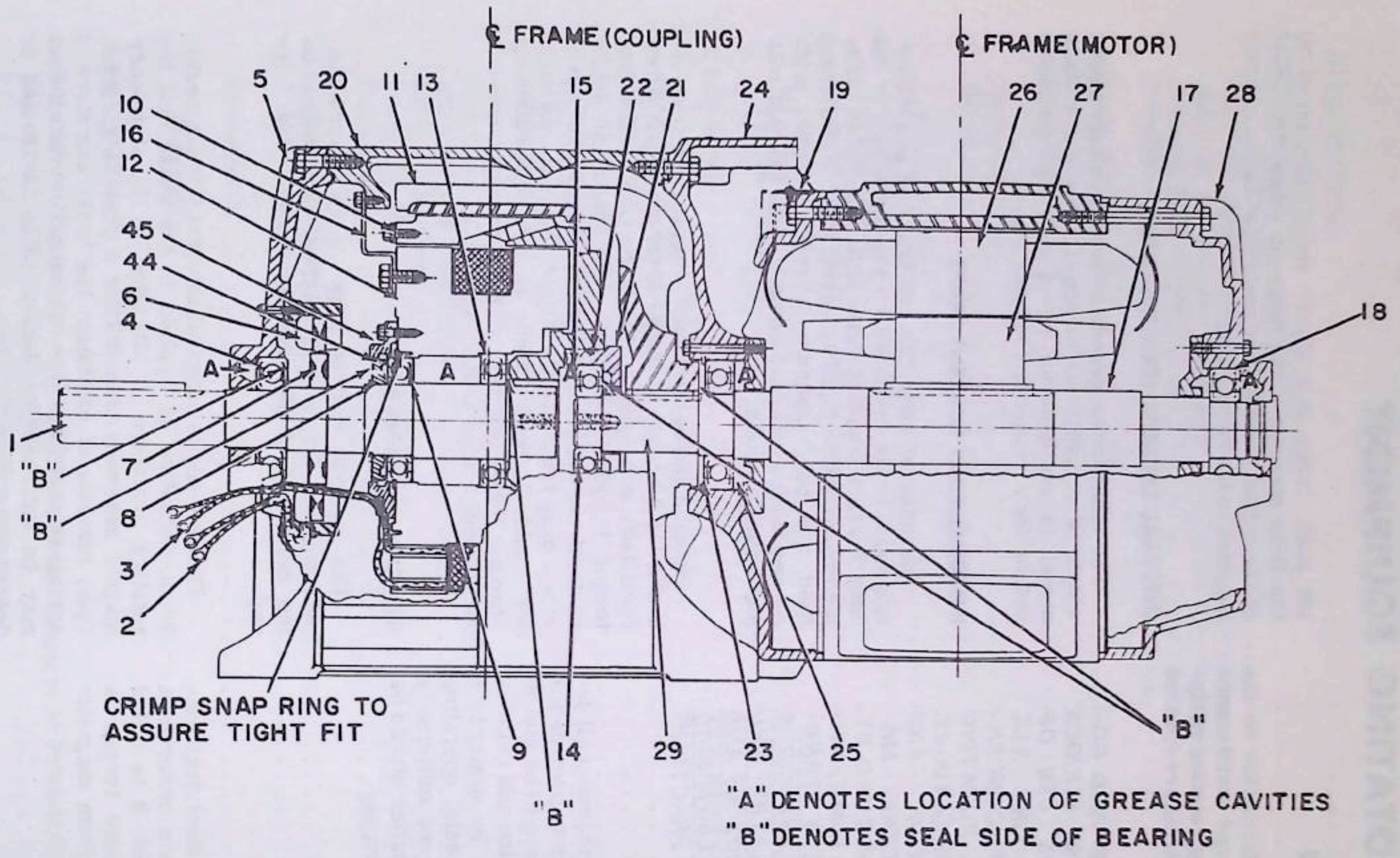
Figure 3 shows the typical integral eddy current brake modification to the Kinatrol drive unit. When excitation is applied to the brake field a retarding torque is developed which will brake the output shaft of the Kinatrol drive to a standstill, or provide a drag torque on the output shaft for overhauling loads. Braking torque may be controlled by changing brake excitation. Eddy current brakes do not provide torque at zero speed.

INTEGRAL FRICTION BRAKE

The integral friction brake is an electro-mechanical, dry-friction, disk-type brake mounted on the drive end of the eddy current coupling drive unit.

Figure 4 shows a typical integral friction brake. When excitation is applied to the brake coil the rotating armature is attracted to the stationary magnet assembly transmitting a retarding torque. Upon removal of excitation the brake armature is spring-released and free to rotate. The brake torque may be increased or decreased by increasing or decreasing coil excitation.

A special disk brake which is "spring set," energize-to-release, is available and supplied for some special applications.



1 Output shaft
2 Tachometer leads
3 Coupling field leads
4 Ball bearing (endshield)
5 Coupling endshield
6 Tachometer stator
7 Tachometer rotor
8 Snap ring (coupling field bearing)
9 Ball bearing (coupling field, drive end)
10 Pole assembly
11 Drum
12 Field assembly
13 Ball bearing (coupling field, motor end)
14 Ball bearing (pole assembly)
15 Snap ring (pilot bearing)
16 Bracket
17 Motor shaft
18 Ball bearing (motor endshield)
19 Cap
20 Coupling frame
21 Cartridge
22 "O" ring
23 Snap ring (adapter bearing)
24 Adapter
25 Ball bearing (adapter)
26 Motor stator
27 Motor rotor
28 Motor endshield
29 Input shaft
30 Input endshield
31 Ball bearing (input endshield)
*44 Slinger labyrinth
*45 Labyrinth seal
* EC447 and Coupling with Bearing Protection

Fig. 1. Coupling with integrally mounted a-c motor

Recommended Spare Parts

4	Ball bearing (endshield)	18	Ball bearing (motor endshield) - figure 1 only
9	Ball bearing (coupling field, drive-end)	22	"O" ring
13	Ball bearing (coupling field, motor-end)	25	Ball bearing (adapter)
14	Ball bearing (pole assembly)	31	Ball bearing (input endshield) - figure 2 only

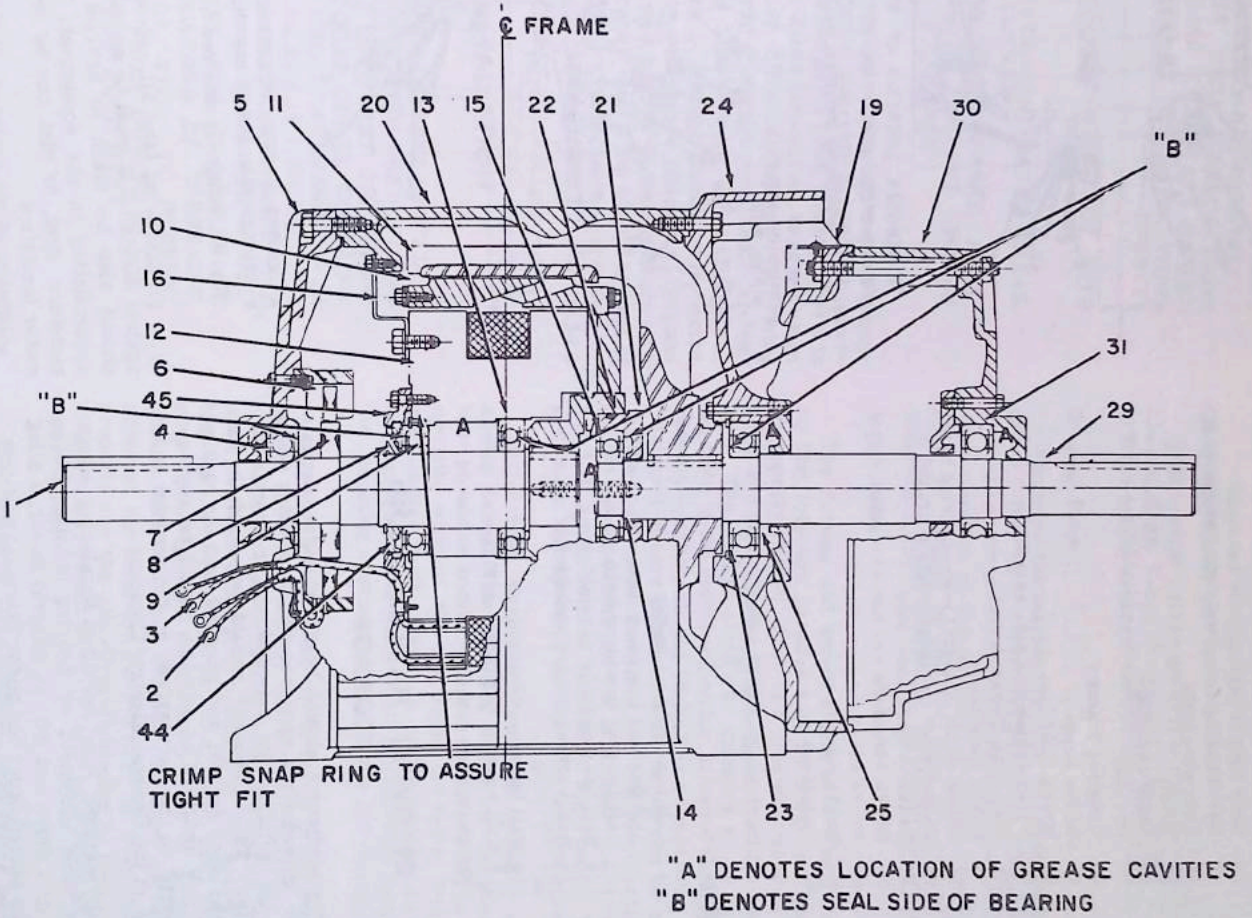


Fig. 2. Coupling, free standing

2 Tachometer leads
3 Coupling field leads
4 Ball bearing (endshield)
5 Coupling endshield
6 Tachometer stator
7 Tachometer rotor
8 Snap ring (coupling field bearing)
9 Ball bearing (coupling field, motor end)
10 Pole assembly
11 Drum
12 Field assembly
16 Bracket
20 Coupling frame
32 Brake drum
33 Brake field coil
34 Brake frame and pole assembly
35 Snap ring (brake drum)
36 Brake field leads
37 Output shaft (integral eddy-current brake)
38 Output shaft (integral friction brake)
39 Brake magnet assembly
40 Brake armature and hub assembly
41 Brake cover
42 Brake adapter
43 Endshield

Recommended Spare Parts

Part No.

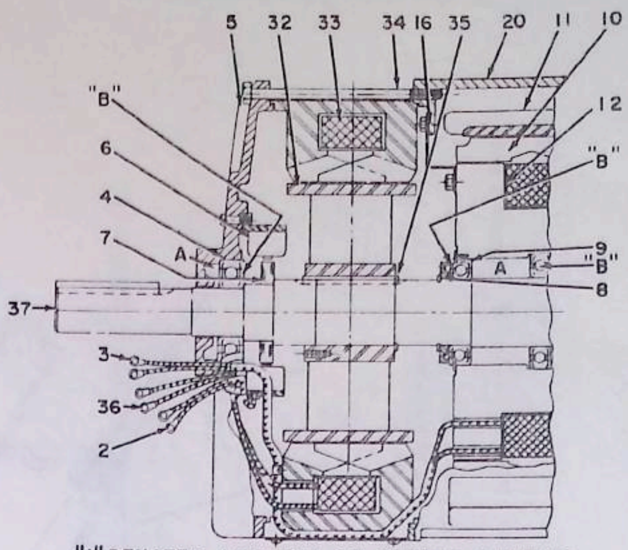
4 Ball bearing (endshield)
9 Ball bearing (coupling field, drive-end)
13* Ball bearing (coupling field, motor-end)
14* Ball bearing (pole assembly)
18* Ball bearing (motor endshield)
22* "O" ring
25* Ball bearing (adapter)
31* Ball bearing (input endshield)
*Shown in Fig. 1 and/or 2

RECEIVING, HANDLING AND STORAGE

The equipment should be placed under adequate cover immediately upon receipt, as packing cases are not suitable for out-of-doors or unprotected storage. Each shipment should be carefully examined upon arrival and checked with the packing list. Any shortage or damage should be reported promptly to the carrier and to the nearest sales office of the General Electric Company.

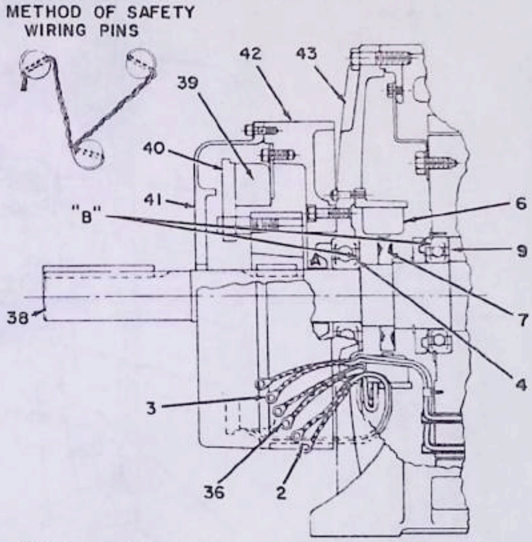
The machine may be lifted by placing slings under each endshield or bearing housing. In the case of a drive unit with an integral motor, a sling may be placed under the motor frame.

If the equipment is not to be installed immediately, it should be stored in a clean, dry location and protected from accidental damage. If possible, avoid storing it in an area where construction work is in progress, or take all necessary precautions against damage if it must be so placed. Precautions should also be taken to prevent moisture from accumulating in the equipment. The entrance of moisture, dust, or dirt can be detrimental to the motor insulation.



"A" DENOTES LOCATION OF GREASE CAVITIES
"B" DENOTES SEAL SIDE OF BEARING

Fig. 3. Integrally mounted eddy current brake



"A" DENOTES LOCATION OF GREASE CAVITIES
"B" DENOTES SEAL SIDE OF BEARING

Fig. 4. Integrally mounted friction brake

All exposed machined-steel parts are coated with a rust preventive before shipment. These surfaces should be examined carefully for signs of rust and moisture, and recoated if necessary. Once started, rust will continue if the surface is recoated without

first removing all rust and moisture. Rust may be removed by careful use of fine abrasive paper. Slushing compound can be removed by use of a solvent such as toluene, xylene, or mineral spirits.

WARNING: *TOLUENE AND XYLENE ARE FLAMMABLE AND MODERATELY TOXIC. THE USUAL PRECAUTIONS FOR HANDLING CHEMICALS OF THIS TYPE SHOULD BE OBSERVED. THESE INCLUDE:*

A. *AVOID EXCESSIVE CONTACT WITH SKIN.*

B. *USE IN WELL-VENTILATED AREAS.*

C. *USE AWAY FROM SPARKS, HEAT, OR FLAME TO PREVENT FIRE OR EXPLOSION HAZARDS.*

Care must be taken when cleaning to avoid damaging machined surfaces. Extreme care must be exercised to prevent these parts from rusting since it is difficult, and sometimes impossible, to remove rust from these surfaces without damaging or deforming the surface. If burrs or bumps result from careless handling, carefully remove them, using a fine file or scraper. Machines in storage should be inspected, have the insulation resistance checked at frequent and regular intervals with an instrument such as a hand-operated megger, and a log should be kept of pertinent data. If the log indicates a decreasing insulation resistance, the unit should be moved to a drier location.

INSTALLATION

WARNING: *INSTALLATION SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND CONSISTENT WITH ALL LOCAL CODES. COUPLING, BELT AND CHAIN GUARDS SHOULD BE INSTALLED AS NEEDED TO PROTECT AGAINST ACCIDENTAL CONTACT WITH MOVING PARTS. MACHINES ACCESSIBLE TO THE PUBLIC SHOULD BE FURTHER GUARDED BY SCREENING, GUARD RAILS, ETC., TO PREVENT THE PUBLIC FROM COMING IN CONTACT WITH THE EQUIPMENT.*

LOCATION

Because this machine requires ample quantities of cooling air, particular care should be taken to avoid obstructions near the air inlets or exhaust outlets that would tend to reduce air flow or cause recirculation of the heated exhaust air.

Unless otherwise stated on the nameplate, the machine is designed to operate in an ambient temperature not to exceed 40 C (104 F), and at altitudes under 3300 ft. For applications at higher temperatures or altitudes, consult your General Electric sales representative.

CONNECTING TO LOAD

This section covers general information on flexible couplings, V-belt drives and chain drives. Consult the manufacturers' instructions for details.

Coupled Drive

Whenever the machine is to be direct-connected to the driven load, a flexible coupling should be used to avoid undue stresses on the bearings and excessive vibration of the machine. Flexible couplings must be aligned so that the hubs are concentric and square within 0.002-inch. total indicator runout.

V-Belt Drive

The driving and driven shafts should be located so that they are parallel and the sheaves aligned. If properly aligned, there is a minimum wear on the belts and no excessive thrust on the machine bearings. The sheave should be mounted as close as possible to the machine bearing. General Electric's recommendation should be followed concerning the minimum sheave pitch diameter which can be used for the particular machine. The belt manufacturer should be consulted for the maximum speed ratio and belt speed for the particular application. The maximum belt speed is usualy 6000 feet per minute.

Belt-driven machines should be equipped with sliding bases. The adjusting screw on the sliding base should be located nearest the sheave and on the opposite side of the unit from the belts. Proper and constant belt tension is easily maintained and the replacement of belts is simplified. This reduces the operating cost and increases the efficiency.

Belt idlers reduce the life of the belts and should not be used if any other method is available. The belts should never be forced over the sheaves. When the drive is started and operating at full speed and full load the take-up should be adjusted until only a slight bow appears in the slack side. If slippage occurs after the belt tension has been correctly adjusted, the belts and pulleys have not been chosen properly for the job. Over-tightening to avoid this slippage may result in early failures of belts, shafts and bearings.

Matched belts run smoother, look better and last longer. Longer belt life results if the belts and sheaves are kept clean and the belts are prevented from rubbing against the belt guards or other obstructions.

Chain Drive

The driving and driven shafts should be located so that they are parallel and the sprockets aligned. The sprocket should be mounted as close as possible to the machine bearing. General Electric's recommendations should be followed concerning the minimum sprocket diameter which can be used for the particular machine. It is desirable that the machine be mounted on a sliding base so that excessive slack may be taken up to compensate for wear.

For the best mechanical arrangement, the upper side of the chain should be the slack side. However, on long drives or small sprocket drives, the lower side may be the slack side to prevent chain interference.

The limiting amount of elongation before the chain must be replaced is dependent upon design of the drive. The chain manufacturer should be consulted. The chain manufacturer should also be consulted concerning the maximum sprocket diameter, and the best means of lubricating the chain.

Allowable Shaft Loading

The following table lists the maximum allowable radial shaft loading for acceptable bearing and shaft life. In belted or chained drives, these allowable loads, therefore, establish minimum sheave and sprocket diameters. These diameters may be calculated from the following equation:

$$D = \frac{K \times HP}{R \times N/1000}$$

where D = minimum pitch diameter – inches
HP = horsepower
R = allowable overhung load (see table below)
N = output shaft speed – RPM
K = 189 for V belts
158 for chains

Coupling Frame Size	Maximum Overhung Load at Center of Shaft Extension Key			
	Standard Drive		With Friction Brake	
	1200 RPM	1800 RPM	1200 RPM	1800 RPM
287	465	407	260	230
366	835	730	400	400
447	1100	970	940	850

MOUNTING

Standard couplings may be mounted in any position, horizontally, vertically, or sidewall. The construction, however, is dripproof only for horizontal mountings.

Shims should be used as needed under the feet when bolting the unit down, to prevent distortion or twisting of the frame in any way. The mounting surface or platform should be sufficiently rigid to prevent vibration of the unit and to prevent transfer of vibration from other machinery.

When the rotating equipment includes integral reduction gears, consult the gear instructions for mounting limitations.

ELECTRICAL WIRING

It is standard practice to locate the motor conduit box on the right side of the motor as viewed from the end opposite the output shaft. Similarly, all coupling leads are normally brought out of a right-hand conduit opening in the coupling endshield.

The motor-conduit box may be moved to the opposite side by first removing the motor endshield from the stator, and the stator from the adapter (see "Disassembly"). Turn the stator end-for-end and reassemble.

All coupling leads may be brought out of the opening on the opposite side by removing the coupling endshield (see "Disassembly") and repositioning the leads. Make certain that all leads are tied down securely.

Induction motor connections are shown on the connection plate on the motor frame. Be certain that the voltage and frequency stamped on the motor correspond with that of the line.

The coupling field excitation leads are labeled F1 and F2, the tachometer leads are labeled T1 and T2 and the brake leads are labeled B1 and B2 when a brake is supplied. When excitation panels are not furnished with this equipment, check the capacity of the direct current source against the coil rating shown on the nameplate. This is a maximum current rating and should not be exceeded.

When excitation panels are furnished, consult the exciter-regulator instruction book before installing conduit or wiring.

OPERATION

EDDY CURRENT COUPLING

The coupling nameplate shows the rated horsepower, torque and continuous speed range at rated torque. When the drive is operated at rated torque the full NEMA motor service factor is not available as a safety margin for unusual operating conditions, such as low line voltage.

The minimum speed rating of most Kinatrol couplings is listed as 100 rpm, as this is the lowest speed at which specified speed regulation may be expected when excitation power is furnished by a Kinatrol exciter-regulator panel. A minimum-speed rating higher than 100 rpm means that the ability of the drum to dissipate head does not permit operating the drive unit continuously at lower speeds and at full load torque. If it is necessary to operate the equipment at less than the rated minimum speed, consult your General Electric field representative.

NOTE: *The rated input speed of a free-standing coupling must be maintained to permit continuous operation at the rated torque and rated minimum speed.*

NOTE: *In dirty and dusty atmospheres prolonged idle operation of the Kinatrol drive unit should be avoided. To prevent excessive build up of dust and dirt in the coupling, shut down the drive motor (or prime mover) when the drive is not in use.*

MOTOR

WARNING: *HIGH-VOLTAGE. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. DISCONNECT POWER BEFORE TOUCHING ANY INTERNAL PART. HIGH VOLTAGE MAY BE PRESENT EVEN WHEN THE MACHINE IS NOT ROTATING. IF USED WITH A RECTIFIER POWER SUPPLY, DISCONNECT ALL AC LINE CONNECTIONS TO POWER SUPPLY. WITH OTHER POWER SUPPLIES, DISCONNECT ALL CONNECTIONS. ALSO, DISCONNECT POWER FROM AUXILIARY DEVICES.*

WARNING: *GROUND THE MACHINE PROPERLY TO AVOID SERIOUS INJURY TO PERSONNEL. GROUNDING SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND CONSISTENT WITH SOUND LOCAL PRACTICES.*

Check the direction of rotation after starting the motor. The direction of rotation may be changed in three-phase motors by interchanging any two line leads, or in two-phase motors by interchanging leads T_1 and T_3. The coupling is designed for operation in either direction of rotation.

Induction driving motors will operate satisfactorily, but not necessarily in accordance with the standards established for operation at normal rating, at other than the exact nameplate values of voltage and frequency, providing they are within the following ranges.

Voltage is within plus or minus 10 percent of the values stamped on the nameplate.

Frequency is within plus or minus 5 percent of the values stamped on the nameplate.

Combined frequency variation (±5 percent maximum) and voltage variation is within plus or minus 10 percent of the values stamped on the nameplate.

INTEGRAL EDDY CURRENT BRAKE

The coupling nameplate shows the maximum continuous current to be applied to the brake field. With this excitation maximum torque and shortest stopping time are obtained. By reducing this excitation a load can be brought to a softer stop.

INTEGRAL FRICTION BRAKE

The coupling nameplate shows the maximum continuous direct current to be applied. For holding action this excitation can be applied continuously. By varying the excitation a soft cushioned stop or a rapid stop can be obtained. Maximum wear life of a friction brake will be realized when minimum excitation is maintained for a desired stop. Friction brakes should not be applied as drag brakes without first consulting your General Electric field representative.

MAINTENANCE

WARNING: *HIGH-VOLTAGE. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. DISCONNECT POWER BEFORE TOUCHING ANY INTERNAL PART. HIGH VOLTAGE MAY BE PRESENT EVEN WHEN THE MACHINE IS NOT ROTATING. IF USED WITH A RECTIFIER POWER SUPPLY, DISCONNECT ALL AC LINE CONNECTIONS TO POWER SUPPLY. WITH OTHER POWER SUPPLIES, DISCONNECT ALL CONNECTIONS. ALSO DISCONNECT POWER FROM AUXILIARY DEVICES.*

WARNING: *GROUND THE MACHINE PROPERLY TO AVOID SERIOUS INJURY TO PERSONNEL. GROUNDING SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND CONSISTENT WITH SOUND LOCAL PRACTICES.*

INSPECTION

Inspect the Kinatrol Coupling at regular intervals for cleanliness, free flow of ventilating air, quiet operation, and vibration-free operation.

The factory vibration limit is 0.002-inch displacement on the bearing housings. Excessive vibration can result from inadequate rigidity of the mounting, vibration transmitted from other machinery, misalignment of the coupling and the load, or a faulty bearing. The cause should be determined and corrected to avoid the possibility of damage and shutdown.

BEARINGS AND LUBRICATION

The bearings in the coupling are either single seal or shield-seal bearings, except the opposite drive end bearing. This bearing is double shielded. The shield-seal and double shield bearings have been lubricated by the bearing manufacturer for normal bearing life. Their life is extended due to the supply of additional lubricant that has been placed in the external grease cavities. The lubricant seeps, or "bleeds," through the clearance between the bearing shield and inner race.

The grease in the bearing and in the external cavity and the bearing internal radial clearance has been carefully selected to give maximum bearing life in this application and for this type of construction. <u>All replacement bearings should be obtained from the General Electric Company.</u>

When bearings are replaced, the grease cavity should be approximately two-thirds full of grease after the machine has been assembled. Avoid placing too much grease in the blind cavity next to the pilot bearing (see Fig. 1).

Inspect the pilot bearing cartridge No. 21 (Fig. 1) for nicks or scratches. The rubber "O" ring No. 22 should be replaced if it is cut or damaged in any way. This assembly keeps the lubricant from leaking out of the pilot bearing No. 14.

Use General Electric grease Spec. D6A2C5 in these cavities. Alvania No. 2 (Shell) and Atlantic 54 are greases which meet this specification.

The following table lists the maintenance periods during which it is recommended that the grease cavities be repacked and bearings checked for roughness or other signs of wear:

Type of Service	Application	Horsepower 7 1/2-25	Horsepower 30-125
Normal	Machine tools, fans, pumps, conveyors, feeders, textile machines, etc.:		
	8 hours per day	8 yr	6 yr
	24 hours per day	3 yr	3 yr
Severe	Operation in key locations subject to vibration or hot environment:		
	8 hours per day	5 yr	3 yr
	24 hours per day	3 yr	2 yr

NOTE: *For vertical applications, multiply above values by 60 percent.*

CLEANING THE MOTOR

WARNING: *SAFETY GLASSES AND/OR OTHER PROTECTIVE EQUIPMENT SHOULD BE USED TO PREVENT POSSIBLE EYE INJURY.*

WARNING: *HIGH VOLTAGES. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.*

ELECTRICAL CIRCUITS MUST BE DE-ENERGIZED PRIOR TO CLEANING OR OTHER MAINTENANCE ACTIVITIES. GROUND ELECTRICAL CIRCUITS TO DISCHARGE CAPACITORS PRIOR TO CLEANING OR MAINTENANCE.

The interior and exterior of the motor should be kept free from dirt, oil, and grease. Assembled motors may be blown out with dry, compressed air of moderate pressure. If possible, clean by suction because of the danger of moisture in compressed air, and blowing metal chips, etc. into the insulation. Motors operating in dirty places should be disassembled and cleaned periodically.

Whenever the motor is disassembled, the windings should be given a thorough inspection and the insulation cleaned, as may be necessary. The inspection should cover the condition of the windings and insulation, the tightness of the windings in the slots, and the effectiveness of the supporting ties as evidenced by the rigidity of the coil end turns.

WARNING: *TOLUENE AND XYLENE ARE FLAMMABLE AND MODERATELY TOXIC. THE USUAL PRECAUTIONS FOR HANDLING CHEMICALS OF THIS TYPE SHOULD BE OBSERVED. THESE INCLUDE:*

A. AVOID EXCESSIVE CONTACT WITH SKIN.

B. USE IN WELL-VENTILATED AREAS.

C. USE AWAY FROM SPARKS, HEAT, OR FLAME TO PREVENT FIRE OR EXPLOSION HAZARDS.

The cleaning fluid used to clean the coils must have grease-dissolving properties, but must not affect the electrical insulation or varnish. Many cleaning fluids in common use, which are suitable with respect to the foregoing, may be extremely hazardous because of their toxicity, inflammability, or both. The following mixture is a suitable solvent for cleaning windings with standard insulation, bearings, and the bearing housing:

25 percent methylene-chloride (if unavailable, use trichlorethylene)
70 percent Stoddard solvent (petroleum spirits)
5 percent perchlorethylene

WARNING: *CLEANING FLUIDS MAY BE TOXIC AND/OR FLAMMABLE AND CAN CAUSE SERIOUS OR FATAL INJURY. FOR SAFETY, USE ONLY WITH ADEQUATE VENTILATION; AVOID CONTACT WITH SKIN, AVOID INHALATION*

OF FUMES, AND DO NOT EXPOSE TO FLAME OR SPARKS.

For best results, after cleaning, the windings should be varnished with an air-drying varnish and then covered with GE Dri-Film* water repellent. More than one coat of varnish may be required, depending upon the condition of the winding.

The General Electric Company can furnish insulating varnish best suited for definite operating conditions. Consult the nearest General Electric sales office.

CAUTION: *FOR CLEANING POLYSEAL* INSULATED MOTORS, A SOLUTION OF SOAP OR DETERGENT AND WARM WATER SHOULD BE USED FOR MOTOR WINDINGS. DO NOT USE ANY OTHER TYPE OF CLEANING SOLVENT AND DO NOT APPLY VARNISH TO THE WINDINGS.*

INTEGRALLY MOUNTED FRICTION BRAKE

No maintenance should be required throughout the life of the brake. During normal operation shallow grooves will develop on the brake armature and magnet surface. This is normal, and should not result in loss of torque.

The armature and magnet surfaces should never be machined. Only when replacing an armature should the magnet surface be machined to remove only enough material to clean up. In doing so, the face should be held parallel within 0.005-inch with the mounting face. The molded facing material of the magnet surface should be undercut 0.002-inch to 0.004-inch below the pole face. For more detailed maintenance instructions and renewal of parts, consult the Brake Service Manual.

DISASSEMBLY

Disassembly of Coupling (Freestanding or with Integrally Mounted Motor)

For ease of disassembly and to minimize the possibility of damage to parts, the Kinatrol coupling should be securely held in a vertical position, drive shaft up. If it is necessary to disassemble in the horizontal position, care should be taken to support the heavy weight of the pole and field assembly. Refer to Figs. 1 and 2 for construction, and identification of parts.

A. To completely disassemble the coupling, proceed as follows:

1. To remove the endshield and the tachometer stator:

a) Remove the bolts holding the endshield to the frame.

b) Withdraw the endshield, pulling the field leads through the opening. The tachometer leads remain attached to the endshield. The drive bearing is now exposed.

c) The tachometer stator may now be removed from the endshield. Some EC447 units have an oversize drive end bearing (4), making the a-c tachometer stator captive. To remove the endshield, it first is necessary to remove four 1/4-inch screws securing the tachometer stator to the endshield and tapping the tachometer stator loose from the endshield using the 1/4-inch screws.

2. To remove the pole and field assemblies:

a) Remove two bolts that secure bracket to coupling frame.

b) Withdraw the drive shaft – the pole and field assemblies are attached. It is recommended that an eyebolt be screwed into the end of the shaft and this assembly lifted with a crane. The pilot bearing, next to the drum, will now be exposed in its cartridge.

3. To remove the field assembly from the pole assembly:

a) Remove the snap ring from the outer diameter of the field assembly bearing.

b) Insert the eyebolts into the threaded holes in the field assembly. Lift the core and tap the end of the shaft with a soft mallet. Care should be taken to avoid damaging the tachometer rotor. The core bearings are now exposed.

4. To remove the coupling frame:

a) Remove the four bolts connecting the frame to the adapter, and withdraw the frame. The bolts are located under the adapter drip cover.

5. To remove the drum:

a) Remove the pilot bearing by pulling on the cartridge.

b) Remove the drum, using a wheel-type puller. Two threaded holes are provided in the drum hub for this purpose.

6. To remove the adapter:

a) Remove the baffle.

* Registered trade-mark of General Electric Company.

b) Remove the four inner bolts holding the bearing cap to the adapter.

c) Withdraw the adapter, exposing the adapter bearing.

B. To remove the motor in the horizontal position without disassembling the coupling, proceed as follows:

1. Remove the motor endshield.

a) Remove the four inner bolts holding the bearing cap to the endshield.

b) Remove the four bolts holding the endshield to the stator and withdraw the endshield.

2. Remove the motor stator.

a) Remove the four bolts holding the motor stator to the adapter. Where wrench space is restricted on some frame sizes, it may be necessary to put an offset in a standard box wrench by heating and bending the shank of the wrench. Motors in sizes K-215 and smaller are held to the adapters by through studs.

b) Withdraw the stator, exercising special care, as the windings are easily damaged.

Disassembly of Units with Brakes

A. To remove the eddy-current brake (see Fig. 3):

1. Remove bolts holding endshield to frame.

2. Remove endshield and tachometer stator assembly, pulling the field leads and brake leads through the opening. The tachometer leads remain attached to the endshield. Some EC447 units have an oversize drive end bearing (4), making the a-c tachometer stator captive. To remove the endshield, it first is necessary to remove four 1/4 inch screws securing the tachometer stator to the endshield and tapping the tachometer stator loose from the endshield using the 1/4-inch screws.

3. Remove the brake frame and pole assembly.

4. For other parts of the coupling follow the previous disassembly instructions.

B. To remove the friction brake (see Fig. 4):

1. Remove the four screws holding the brake cover to the brake adapter.

2. Loosen the set screws in the taper lock bushing and remove the armature hub and armature.

3. Remove the four screws holding the field and fan assembly to the brake adapter and remove the field and face assembly.

4. Remove the friction brake adapter by removing the four screws holding the adapter to the coupling endshield.

5. To further disassemble the coupling, follow the instruction for disassembly of basic drive.

REASSEMBLY

When reassembling a Kinatrol coupling, observe the following special precautions:

Bearings

If a bearing has been removed from a shaft by pulling on the outer race, replace the bearing, as it may run rough and soon fail.

The bearings must be assembled with the seal side of the bearing positioned as shown in Figs. 1 and 2. The seal may not be visible on Hoover bearings; however, the seal side will be distinguished by a black oxide shield or number 9__ on the seal side of the bearing.

The pilot bearing should be assembled into its cartridge by pressing on the outer race. The cartridge assembly should then be assembled onto the shaft. The open side of the cartridge must be toward the drive end, as shown in Fig. 1.

Use the correct bearing, the correct grease, and the correct quantity of grease. (See Bearings and Lubrication.) Refer to Figs. 1 and 2 for location of bearings.

If a bearing is driven or pressed on a shaft, the force should be exerted only on the inner race.

When replacing the field assembly bearing snap ring, align the split in the snap ring with the roll-pin hole in the field assembly, and insert the roll pin.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY
DIRECT CURRENT MOTOR & GENERATOR DEPT.
ERIE, PENNSYLVANIA 16501

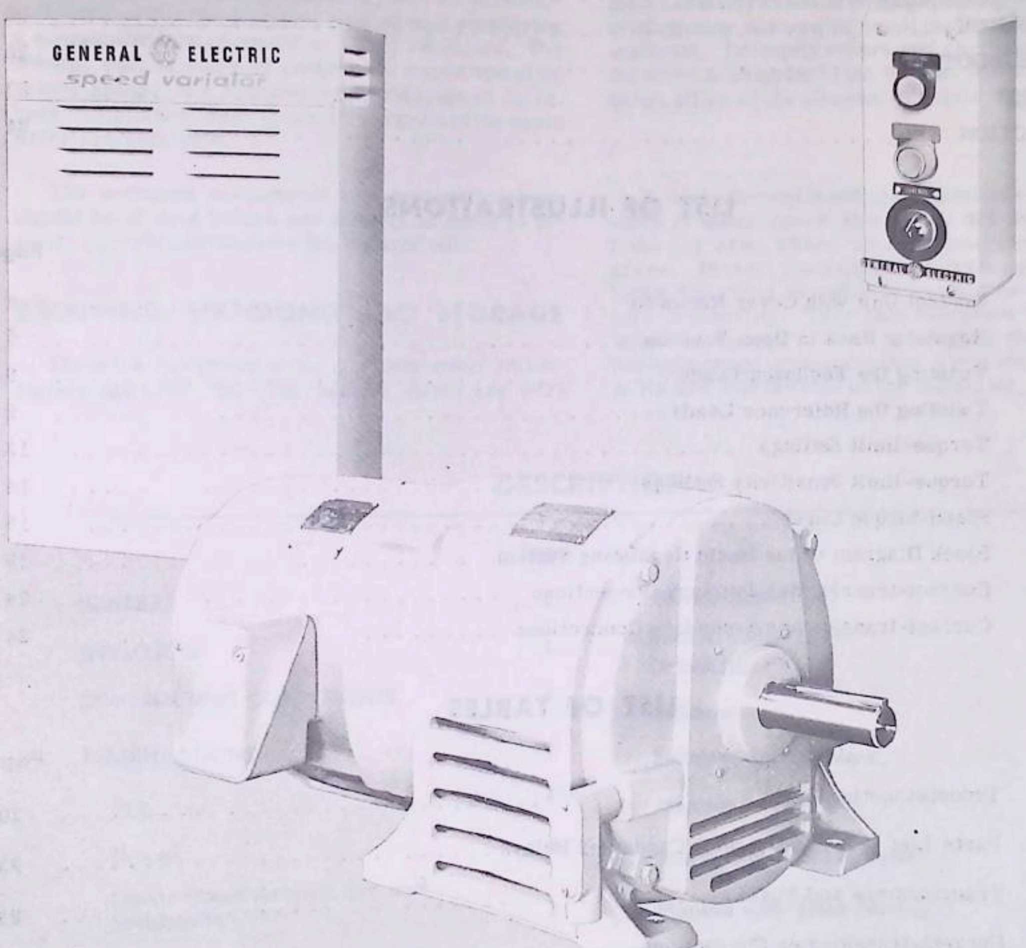
5-70 (5M)

PRINTED IN U.S.A.

INSTRUCTIONS

KINATROL®
speed variator

EDDY CURRENT COUPLING CONTROL UNIT



These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

WARNING: HIGH VOLTAGE. ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. MAKE CERTAIN THAT THE ENCLOSING CASE, THE FRAME OF THE KINATROL DRIVE UNIT, AND ALL OPERATOR'S STATIONS AND, OR DESKS ARE GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE IN ORDER TO AVOID SERIOUS INJURY TO PERSONNEL.

KINATROL®

speed variator

EDDY CURRENT COUPLING CONTROL UNIT

INTRODUCTION

GENERAL

This instruction book contains the installation, interconnection, setup, operating, and maintenance instructions for the Kinatrol control unit employing a silicon-controlled-rectifier (SCR) regulator. The control unit is used to control the output speed or output torque of a Kinatrol adjustable-speed drive. Both "regulated" and "manual" versions of the basic drive are available.

The pertinent sections of this instruction book should be studied before any attempt is made to install, operate, or service the control unit.

RECEIVING, HANDLING AND STORAGE

Place the equipment under adequate cover immediately upon receipt. The packing cases are NOT suitable for out-of-doors or unprotected storage. Examine each shipment carefully on its arrival, and check it against the packing list. Unpack the equipment carefully to avoid damage, taking care to avoid mislaying or discarding small parts with the packing material. Promptly report any shortage or damage incurred in shipping to the carrier and to the nearest sales office of the General Electric Company.

If the equipment is not to be installed immediately, store it under cover in a clean, dry location away from any area where construction work is in progress. Protect the equipment from low temperatures and rapid or extreme variations in temperature or humidity. Take care to prevent the accumulation of moisture, dust, or dirt in the equipment during storage or installation, since these contaminants are detrimental to the insulation.

DESCRIPTION

GENERAL

The basic Kinatrol drive consists of a drive unit, an operator's station, and a control unit, as shown on the front cover. This instruction book deals with the basic control unit and modifications of this control unit, and does not cover all details of every type of Kinatrol drive.

The drive unit includes the motor, eddy current coupling (which may be integral with the motor), and integral tachometer generator. Both air-cooled and water-cooled eddy current couplings and brakes are available.

The basic operator's station contains a set of START-STOP push buttons for the eddy current cou-

DESCRIPTION (CONT'D)

pling and a speed CONTROL potentiometer which allows the operator to select or to preset the desired output speed.

The control unit includes all control equipment for the eddy current coupling except the devices mounted on the operator's station, and the current transformer, if supplied. The regulator in the control unit controls the output speed of the Kinatrol adjustable-speed drive by varying the field excitation of the eddy current coupling.

ENCLOSURE

The basic control unit is housed in a wall mounted NEMA Type 1 enclosure as shown on the front cover.

The front cover of the control unit can be removed to permit installation and wiring of the unit, by completely removing the screw located at the center of the underside of the enclosure. By pulling outward at the bottom of the cover a distance of approximately three inches, the cover is then free to slide upward, thereby releasing it from the back of the unit.

CONTROL UNIT COMPONENTS

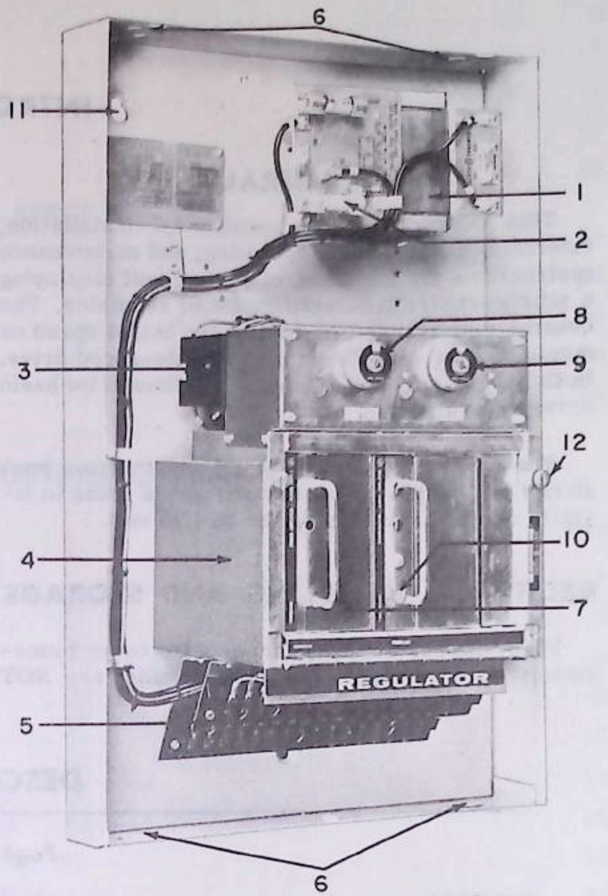
The basic control unit consists of an isolating transformer and a regulator assembly as shown in Fig. 1.

The isolating transformer is mounted in the upper portion of the enclosure. Two fuses are mounted on the transformer terminal board. One fuse (NEC) protects the control circuit, and the other fuse (current limiting) protects the power amplifier SCR circuit.

The regulator is mounted in the lower portion of the enclosure. Two potentiometer knobs on the front of the regulator rack (MAX SPEED and MIN SPEED) are used to set the maximum and minimum drive speed. The handles below the potentiometer knobs on the front of the regulator rack are attached to printed-circuit cards on which are mounted the components which make up the regulator circuitry. The basic regulator contains two printed-circuit cards: a "power amplifier/power supply" card, and a "coordination and signal amplifier" card.

The auxiliary terminal boards are located behind the regulator and are accessible when the regulator is swung forward as shown in Fig. 2. The terminal boards can be exposed by loosening the knurled retaining screws on the regulator rack (see part 12, Fig. 1). The rack can be swung forward approximately 90 degrees where it will rest against a mechanical stop.

All required relays are mounted on the regulator assembly behind the adjustment potentiometers.



1	Isolating transformer	8	Minimum-speed potentiometer
2	Fuse	9	Maximum-speed potentiometer
3	Magnetic relays	10	Response-potentiometer
4	Regulator rack	11	Mounting hole
5	Main terminal board	12	Regulator rack retaining screws
6	Knockout plugs for conduit		
7	Printed-circuit-card cover		

Fig. 1. Control unit with cover removed

The main terminal boards are located below the regulator. All outgoing power and control leads are brought to these boards.

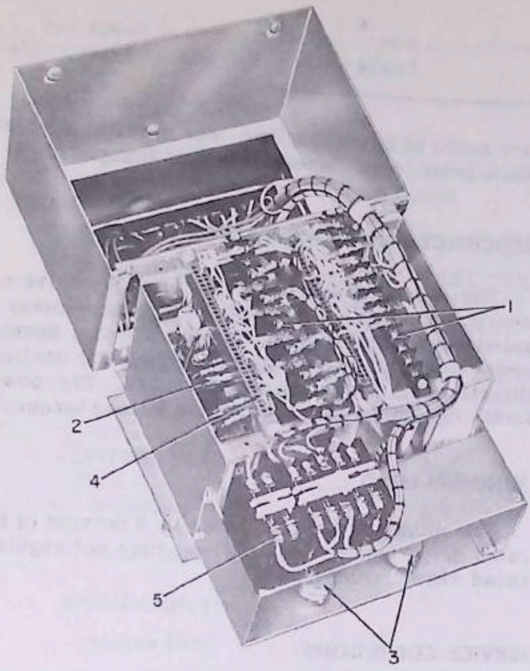
MODIFICATIONS

JOG

Two types of "jog" modifications are available: "jog at run speed" and "jog at preset speed".

For the "jog at run speed" modification, a push-turn RUN/JOG push button is mounted on the operator's station.

DESCRIPTION (CONT'D)



1 Auxiliary terminal boards
2 Printed-circuit card
3 Potentiometers for system speed adjustments
4 Card receptacle
5 Relay

Fig. 2. Regulator rack in open position

For the "jog at preset speed" modification, a separate JOG push button is mounted on the operator's station, and a JOG speed adjustment potentiometer is mounted on the front of the regulator rack.

THREAD

For the "thread-speed" modification, a THREAD speed adjustment potentiometer is mounted on the front of the regulator rack, and a THREAD push button is mounted on the operator's station.

LINEAR TIMED ACCELERATION AND DECELERATION

For the "linear timed acceleration and deceleration" modification, a "coordination and signal amplifier with timed acceleration" printed-circuit card is supplied instead of the basic "coordination and signal amplifier" card.

TORQUE LIMIT

For the "torque limit" modification, a "coordination and signal amplifier with torque limit" printed-circuit card is supplied instead of the basic "coordination and signal amplifier" card. A current transformer is supplied for separate mounting by the purchaser. If an a-c motor starter is supplied as a modification, the current transformer will be mounted and wired at the factory.

ALTERNATE MODES OF OPERATION

FOLLOWER

For "follower" drives, the speed CONTROL potentiometer on the operator's station is replaced by a SPEED RATIO potentiometer.

FOLLOWER/INDEPENDENT

For "follower/independent" drives, the speed CONTROL potentiometer on the operator's station is retained for speed control in the "independent" mode of operation. A SPEED RATIO potentiometer is added on the operator's station for use in the "follower" mode of operation. Also a FOLLOWER/INDEPENDENT selector switch is added to the operator's station.

MANUAL

For "manual" drives the speed CONTROL potentiometer on the operator's station is replaced by a torque CONTROL potentiometer.

SPEED REGULATED/MANUAL

For "speed regulated/manual" drives, a SPEED REGULATED/MANUAL selector switch is added to the operator's station. With the selector switch in MANUAL, the CONTROL potentiometer controls the drive torque. With the selector in SPEED REGULATED, the CONTROL potentiometer controls the drive speed.

MANUAL WITH BLOCK FORCING

For "manual with block forcing" drives, the CONTROL potentiometer on the operator's station adjusts torque rather than speed. A FORCING ADJUST potentiometer is added to the front of the regulator rack, and an adjustable timing attachment is added to the run (M) relay in the regulator assembly.

SPECIFICATIONS

BASIC DRIVES

POWER SUPPLY

Voltage – 230, 460 or 575 v, 3-phase; +10 percent, -5 percent

Frequency – 60 cycles, ±2 percent

Other voltages and 50-cycle ratings are available as modifications.

SPEED RANGE

The control unit is capable of controlling drive speed down to 100 rpm (with an a-c tachometer), but the available speed range at rated torque may be limited by the thermal capability of the drive unit. Refer to the drive unit nameplate for the minimum, full-torque, continuous operating speed.

SPEED REGULATION

The speed regulation is 2 percent of rated speed for a 75-percent load change (100 percent to 25 percent) over the specified speed range.

Speed regulation is specified under steady-state conditions and with constant line voltage, frequency, and ambient temperature. Speed may also be affected by changes in line voltage, frequency, and ambient temperature. These variables (other than load) are referred to as "all other variables."

Variable	Change	Maximum Speed Change in Percent of Rated
Voltage	10 percent	2 percent
Frequency	2 percent	2 percent
Ambient Temperature	15 C	2 percent
Drift with time after warmup	8 hours	

SERVICE FACTOR – 1.0

OVERLOAD

MAXIMUM LOAD IS 200 PERCENT OF RATED

Overload capability varies depending upon speed and duty cycle and may be established either by the a-c motor or by the coupling. For specific information, refer to the General Electric Company.

EFFICIENCY AND POWER FACTOR

The efficiency and power factor of the drive are nearly the same as those of the induction motor at rated speed and torque. As with all slip devices under constant torque loading, efficiency declines directly with output speed decrease. The power factor decreases with a reduction in load torque.

MINIMUM LOAD

The minimum load is equal to 5 percent of the rated drive-unit torque. Drives may not regulate speed when "running light".

SERVICE CONDITIONS

Ambient Temperature – 10 C to 40 C (104 F)

Altitude – sea level to 3300 feet.

MODIFICATIONS

LINEAR TIMED ACCELERATION AND DECELERATION

Total accelerating time (to full speed) is continuously adjustable within three ranges; 2-8, 4-16, and 8-32 seconds. This complete time range is only available when the drive rating has been selected to provide adequate accelerating torque. Acceleration and deceleration time are not separately adjustable. If normal "coasting" time exceeds the time setting, the load characteristics determine the deceleration time.

TORQUE LIMIT

Adjustable from 80 to 200 percent rated torque.

JOG AT RUN SPEED

Jog speed is at the speed set on speed CONTROL potentiometer on the operator's station.

SPECIFICATIONS (CONT'D)

JOG AT PRESET SPEED

Jog speed is an independent, preset speed adjustable from 100 rpm to 1/3 rated speed.

THREAD

Thread speed is an independent, preset speed adjustable from 100 rpm to 1/3 rated speed.

IMPROVED SPEED REGULATION

Speed regulation may be improved to 1 percent due to a 75 percent load change and 2 percent due to all other variables using the a-c tachometer, or to 1/2 percent due to a 75 percent load change and 2 percent due to all other variables using a d-c tachometer if the improved speed-regulation modifications were ordered.

INSTALLATION

WARNING: HIGH VOLTAGE. ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. MAKE CERTAIN THAT THE ENCLOSING CASE, THE FRAME OF THE KINATROL DRIVE UNIT, AND ALL OPERATOR'S STATIONS AND/OR DESKS ARE GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE IN ORDER TO AVOID SERIOUS INJURY TO PERSONNEL.

CONTROL UNIT

LOCATION

Kinatrol Speed Variator control units are suitable for use in most factory areas where other industrial equipment is installed. Install the control unit in a well ventilated area which is not subject to ambient temperatures above 40 C (104 F). Avoid locations subject to steam vapors, oil vapors, chemical fumes, excessive moisture, or excessive dirt, dust, or lint.

WARNING: TO AVOID A POSSIBLE FIRE HAZARD, NEVER INSTALL THE CONTROL UNIT AND ITS ACCESSORIES SUCH AS CURRENT TRANSFORMERS, REFERENCE RESISTORS AND METERING EQUIPMENT WHERE HAZARDOUS, INFLAMMABLE, OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT.

If the control unit is used with a drive unit suitable for use in hazardous locations, install the control unit away from the hazardous area.

All standard control unit enclosures are convection-cooled. Air enters through the bottom of the enclosure and exits through the upper part of the front and sides. Make sure that there is clearance of at least four inches around the outside of the enclosure to allow a normal flow of cooling air.

MOUNTING

Mount the enclosure on any firm, reasonably flat, vertical surface by means of the mounting holes provided in the back of the enclosure. Refer to the outline drawings for the location and dimensions of the mounting holes and the over-all dimensions of the enclosure.

Knockout plugs are provided at the top and bottom of the standard enclosure for bringing in external leads.

MODIFICATIONS

TORQUE LIMIT

If the Kinatrol control unit has been modified by the addition of a-c motor control, the current transformer required for torque-limit control will be mounted and wired at the factory.

On basic control units, the current transformer is supplied for mounting and enclosure by the purchaser. Mount the current transformer in a convenient location in or near the a-c motor starter, so that it can be wired into the load of the a-c motor starter.

WARNING: HIGH VOLTAGE. ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. MAKE CERTAIN THAT THE SECONDARY CIRCUIT OF THE CURRENT TRANSFORMER IS ALWAYS

INSTALLATION (CONT'D)

COMPLETE BEFORE APPLYING POWER, SINCE EXTREMELY HIGH VOLTAGE MAY APPEAR ON THE SECONDARY TERMINALS OF AN OPEN-CIRCUITED CURRENT TRANSFORMER.

If "follower" or "follower/independent" mode of operation is ordered with the Kinatrol drive, an external reference resistor must be supplied by the purchaser. Select this external reference resistor in accord with the formula given on page 26 under the Data section of this instruction book.

Mount the external reference resistor in a convenient location where it can be easily wired in series with the SPEED RATIO potentiometer on the operator's station.

SPEED INDICATOR

If the optional speed indicator is ordered with the Kinatrol drive, mount the speed indicator in a convenient location near the operator's station.

KINATROL DRIVE UNIT

Follow the installation instructions supplied with the Kinatrol drive unit. Couple the output shaft of the eddy current coupling to the driven equipment at this time.

OPERATOR'S STATION

The front cover of the operator's station must be removed to allow installation and wiring of this equipment. To remove this cover, remove the four retaining screws on the front of the operator's station and pull the cover straight off.

Conduit should be run and leads pulled through the conduit before the operator's station is mounted. Required leads are shown on the connection and interconnection diagram.

When the conduit has been run and the leads have been pulled through the conduit, mount the operator's station on any firm, reasonably flat surface by means of the four mounting holes in the back plate.

WARNING: TO AVOID A POSSIBLE FIRE HAZARD, NEVER INSTALL THE OPERATOR'S STATION WHERE HAZARDOUS, INFLAMMABLE, OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT.

If the operator's station is used with a drive unit suitable for use in hazardous locations, install the operator's station away from the hazardous area.

ELECTRICAL INTERCONNECTION

WARNING: DO NOT SUPPLY A-C POWER TO THE A-C MOTOR STARTER UNTIL AFTER THE CHECK OF INSTALLATION AND INTERCONNECTIONS (PAGE 9) IS COMPLETED.

NOTE: When connecting the Kinatrol equipment, run power leads and control leads to the control unit in separate conduits to minimize the effect of stray pickup in the control leads.

CONTROL UNIT AND AC MOTOR TO AC MOTOR STARTER

Wire the control unit to the a-c motor starter as shown on the connection and interconnection diagram.

Wire the a-c drive motor to the a-c motor starter as shown in the connection and interconnection diagram. Refer to the drive unit and control unit nameplates for the current rating, and to the National Electrical Code and/or local code requirements for appropriate wire sizes.

CONTROL UNIT TO KINATROL DRIVE UNIT

Wire the control unit to the Kinatrol drive unit as shown in the connection and interconnection diagram. Before the control leads are placed in the conduit, the two tachometer (feedback) leads must be twisted together at least five turns per foot, as shown in Fig. 3.

ELECTRICAL INTERCONNECTION (CONT'D)

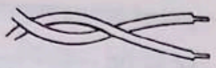


Fig. 3. Twisting the feedback leads

CONTROL UNIT TO OPERATOR'S STATION

Wire the control unit to the operator's station as shown in the connection and interconnection diagram. Before the control leads are placed in the conduit, the three CONTROL potentiometer (reference) leads must be twisted together at least five turns per foot, as shown in Fig. 4.

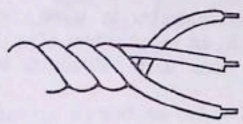


Fig. 4. Twisting the reference leads

MODIFICATIONS

CONTROL UNIT TO PURCHASER'S FOLLOWER REFERENCE

If the "follower" or "follower/independent" mode of operation is ordered with the Kinatrol drive, wire the external reference resistor (supplied by the purchaser) in series with the SPEED RATIO potentiometer located on the operator's station.

CONTROL UNIT TO CURRENT TRANSFORMER

If the "torque limit" modification is ordered with the Kinatrol drive, refer to "Current Transformer Connections" in the Data section of this instruction book. Make the connections specified in the Data section. Wire the control unit to the current transformer as shown on the connection and interconnection diagram.

CONTROL UNIT TO SPEED INDICATOR

If the optional speed indicator is ordered with the Kinatrol drive, wire the control unit to the speed indicator as shown on the connection and interconnection diagram, twisting the leads as shown in Fig. 3.

CHECK OF INSTALLATION AND INTERCONNECTIONS

When the installation and interconnection of the drive is complete, make the following checks:

☐ 1. Recheck all of the interconnections shown on the connection and interconnection diagram to assure that all necessary connections have been made as specified.

☐ 2. Measure the voltage of the a-c power supply. Refer to the Specifications section of this instruction book to assure that the measured power supply is within the specified limits of voltage and frequency variation.

☐ 3. Check the a-c drive motor connections to make sure they are in accord with the motor-nameplate connection diagram for the measured values of the power supply.

☐ 4. Check the transformer primary connections in the control unit to make sure they are in accord with the measured values of the power supply.

☐ 5. Replace the cover on the operator's station and refasten the four retaining screws.

SETUP AND ADJUSTMENT

WARNING: HIGH VOLTAGE. ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. THIS EQUIPMENT IS AT LINE VOLTAGE ANY TIME THE INCOMING LINE IS CLOSED, WHETHER THE UNIT IS IN OPERATION OR NOT IN OPERATION. A-C POWER MUST BE DISCONNECTED FROM THE CONTROL UNIT BEFORE IT IS SAFE TO MAKE ANY SET-UP ADJUSTMENTS OR TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT.

INSTRUMENTS REQUIRED

The following instruments are required for proper setup and adjustment of the control unit:

1. A hand tachometer to measure the output speed of the drive.

2. A multimeter with a sensitivity of 20,000 ohms per volt.

3. An a-c ammeter with a rating of at least 200 percent of the a-c motor full-load current as listed on the motor nameplate. This ammeter is desirable for setup and adjustment of all drives, and is essential for drives with the "manual" mode of operation or with the "torque-limit" modification. To protect the ammeter from the a-c motor starting current, the ammeter should have a shorting jumper or a shorting switch in place whenever the drive motor is started. Wire the ammeter or its associated current transformer in series with one phase of the a-c power supply to the motor.

STARTUP PROCEDURE

NOTE: After all setup and adjustment procedures are completed, replace the cover on the control unit enclosure.

BASIC DRIVES (AC OR DC TACHOMETER)

Direction of Rotation

To check the direction of rotation of the drive, complete the following steps:

1. Remove the power-amplifier fuse (PAFU) from the front of the isolating transformer.

2. Remove the bearing dust cap from the a-c motor.

3. Momentarily start and stop the a-c motor while observing the direction of rotation of the shaft.

4. If the shaft rotates in the desired direction, stop the a-c motor and proceed to step 6.

5. If the shaft does not rotate in the desired direction, stop the a-c motor, remove a-c power from the starter and interchange any two of the three a-c motor leads, either at the motor or at the a-c motor starter. Repeat step 3.

6. Replace the bearing dust cap on the a-c motor.

7. If a d-c tachometer is used, proceed to "DC Tachometer". If an a-c tachometer is used, proceed to "Maximum and Minimum Speed Setting" (page 11).

DC Tachometer (If Used)

If a d-c tachometer is used with the Kinatrol drive, the required tachometer-feedback resistance is 1000 ohms per volt of tachometer-feedback signal. Refer to "Feedback Resistance Connections" in the Data section of this instruction book and make proper connections.

Remove the jumpers which connect main terminal board terminals 14 and 15 and terminals 16 and 17. Proceed to check the polarity of the d-c tachometer by completing the following steps:

1. Replace the power-amplifier fuse (PAFU) on the front of the isolating transformer.

2. Set the speed CONTROL potentiometer on the operator's station in the mid-position.

3. Start the a-c motor.

4. Momentarily start and stop the eddy current coupling and use the d-c voltmeter to check the polarity of the d-c voltage at main terminal board points 15 and 16. Make sure that the plus side of the tachometer is connected to terminal 15.

SETUP AND ADJUSTMENT (CONT'D)

5. Replace the wire jumpers between main terminal board terminals 14 and 15, and terminals 16 and 17.

6. Proceed to "Maximum and Minimum Speed Setting".

Maximum and Minimum Speed Setting

For "Follower" Drives – Refer to "Follower" on page 14.

For "Follower/Independent" Drives –

1. Turn the FOLLOWER/INDEPENDENT selector switch on the operator's station to INDEPENDENT and adjust maximum and minimum speed as specified below for basic Speed Regulated Drives.

2. Turn the selector switch to FOLLOWER and refer to "Follower/Independent" on page 14.

For "Manual" Drives – Refer to "Manual" on page 14.

For "Speed Regulated/Manual" Drives –

1. Turn the SPEED REGULATED/MANUAL selector switch on the operator's station to SPEED REGULATED and adjust maximum and minimum speed as specified below for Basic Speed Regulated Drives.

2. Turn the selector switch to MANUAL and refer to "Speed Regulated/Manual" on page 16.

For "Basic Speed Regulated" Drives –

To set the maximum and minimum speed of the drive, complete the following steps:

1. Turn the speed CONTROL potentiometer on the OS fully counterclockwise (CCW) to zero.

2. Replace the PAFU on the front of the isolating transformer.

3. Start the a-c motor.

4. Turn the RESPONSE potentiometer on the front of the "coordination and signal amplifier" printed-circuit card fully clockwise (CW).

5. Turn the MAX SPEED potentiometer on the front of the regulator rack fully CCW to zero.

6. Press and release the eddy current coupling START push button.

7. Slowly turn the speed CONTROL potentiometer CW to 100-percent speed.

8. Use the hand tachometer to measure the output speed of the coupling, either at the mechanical coupling or at a convenient point on the driven equipment. Slowly turn the MAX SPEED potentiometer CW until rated drive speed (or desired lower maximum speed) is reached as indicated on the hand tachometer.

CAUTION: DO NOT SET THE MAXIMUM DRIVE SPEED AT A VALUE HIGHER THAN THE MAXIMUM SPEED SPECIFIED ON THE EDDY CURRENT COUPLING NAMEPLATE. OPERATION OF THE DRIVE WITH THE MAX SPEED POTENTIOMETER SET HIGHER THAN REQUIRED TO JUST GIVE RATED OUTPUT SPEED CAN RESULT IN OVEREXCITATION AND OVERHEATING OF THE EDDY CURRENT COUPLING.

NOTE: If maximum speed cannot be obtained within the range of the MAX SPEED potentiometer, it will be necessary to reconnect the tachometer-feedback resistors. Refer to "Feedback Resistor Connections" in the Data section of this instruction book.

9. If instability (hunting) occurs before the maximum-speed setting is reached, turn the RESPONSE potentiometer CCW until the drive becomes stable.

10. Turn the speed CONTROL potentiometer CCW to zero.

11. Adjust the MIN SPEED potentiometer on the front of the regulator rack until the desired minimum drive speed is reached as indicated on the hand tachometer.

CAUTION: IF THE MINIMUM SPEED LISTED ON THE EDDY CURRENT COUPLING NAMEPLATE IS GREATER THAN 100 RPM, THE COUPLING IS NOT THERMALLY CAPABLE OF CONTINUOUS OPERATION BELOW THIS (NAMEPLATE) MINIMUM SPEED. CONTINUOUS OPERATION AT RATED TORQUE BELOW THE RATED MINIMUM SPEED CAN DAMAGE THE EDDY CURRENT COUPLING.

NOTE: Operation for more than one minute must be considered as continuous.

Lock the MIN SPEED potentiometer at the desired setting by tightening the locking screw on the potentiometer knob.

12. Repeat steps 7, 8, and 9.

13. Lock the MAX SPEED potentiometer at the desired setting by tightening the locking screw on the potentiometer knob.

SETUP AND ADJUSTMENT (CONT'D)

14. Press and release the eddy current coupling STOP push button on the operator's station.

15. Stop the a-c motor.

MODIFICATIONS

Jog

CAUTION: SETTING THE JOG SPEED MUST NOT BE A PROLONGED OPERATION IF THE MINIMUM SPEED LISTED ON THE EDDY CURRENT COUPLING NAMEPLATE IS GREATER THAN 100 RPM. THE COUPLING IS NOT THERMALLY CAPABLE OF OPERATING BELOW THIS (NAMEPLATE) SPEED AT RATED TORQUE FOR LONGER THAN ONE MINUTE. CONTINUOUS OPERATION AT RATED TORQUE BELOW THE RATED MINIMUM SPEED CAN DAMAGE THE EDDY CURRENT COUPLING.

No adjustment is required for the "jog at run speed" modification.

To set the jog speed for the "jog at preset speed" modification, complete the following steps:

1. Turn the JOG potentiometer on the front of the regulator rack fully CW to 100 percent.

2. Start the a-c motor.

3. Press and hold down the JOG push button on the operator's station, and at the same time, turn the JOG potentiometer on the front of the regulator rack CCW until the eddy current coupling runs at the desired jog speed.

4. Release the JOG push button to stop the eddy current coupling.

5. Lock the JOG potentiometer at the desired setting by tightening the locking screw on the potentiometer knob.

6. Stop the a-c motor.

Thread

CAUTION: SETTING THE THREAD SPEED MUST NOT BE A PROLONGED OPERATION IF THE MINIMUM SPEED LISTED ON THE EDDY CURRENT COUPLING NAMEPLATE IS GREATER THAN 100 RPM. THE COUPLING IS NOT THERMALLY CAPABLE OF OPERATING BELOW THIS (NAMEPLATE) SPEED AT RATED TORQUE FOR LONGER THAN ONE MINUTE. CONTINUOUS OPERATION AT RATED TORQUE BELOW THE RATED MINIMUM SPEED CAN DAMAGE THE EDDY CURRENT COUPLING.

To set the thread speed, complete the following steps:

1. Turn the THREAD potentiometer on the front of the regulator rack fully CCW to zero.

2. Start the a-c motor.

3. Press and release the THREAD push button on the operator's station, and turn the THREAD potentiometer on the front of the regulator rack CW until the eddy current coupling starts and runs at the desired thread speed.

4. Press and release the eddy current coupling STOP push button on the operator's station.

5. Stop the a-c motor.

6. Lock the THREAD potentiometer at the desired setting.

Linear Timed Acceleration and Deceleration

The linear timed acceleration and deceleration circuit is set at the factory for a time range of 4 to 16 seconds from standstill to top rated speed. To set the circuit for the 2-to-8 second range or the 8-to-32 second range, make the wiring changes shown in Table I on the regulator connection diagram.

To adjust the acceleration and deceleration time within any of the three ranges, complete the following steps:

1. Turn the speed CONTROL potentiometer on the operator's station fully CW to 100 percent.

2. Start the a-c motor.

3. Press and release the eddy current coupling START push button on the operator's station, and note the time required for the coupling to reach top rated speed.

4. Adjust the acceleration time by turning the TIME ADJUST potentiometer on the front cover of the "coordination and signal amplifier with linear time" printed-circuit card in the regulator. Turning the TIME ADJUST potentiometer CW increases the time interval.

5. Press and release the eddy current coupling STOP push button on the operator's station.

SETUP AND ADJUSTMENT (CONT'D)

6. Repeat steps 3, 4, and 5 until the desired time interval is obtained.

7. Stop the a-c motor.

Torque Limit

Recheck the current transformer connections to make sure they are in accord with "Current Transformer Connections" in the Data section of this instruction book.

The "torque limit" modification is normally used for two purposes:

1. To control the rate of acceleration of the drive by limiting the available acceleration torque.

2. To limit the maximum output torque under all operating conditions to protect the driven equipment.

Output torque is approximately proportional to a-c motor current (rated current approximately equals rated torque). The torque limit is normally adjusted for 150 percent of the rated a-c motor current. To adjust the torque limit, complete the following steps:

1. Connect the shorting jumper or switch across the a-c ammeter.

2. Start the a-c motor.

3. Remove the shorting jumper or switch from the a-c ammeter.

4. Turn the speed CONTROL potentiometer fully CW to the maximum speed.

5. While watching the ammeter, press and release the eddy current coupling START push button on the operator's station. If the maximum ammeter deflection was less than required (for the desired torque limit), turn the UP LIMIT potentiometer on the front of the "coordination and signal amplifier with torque limit" card CW. If the deflection was greater than desired, turn the UP LIMIT potentiometer CCW.

6. Press the eddy current coupling STOP push button on the operator's station.

7. Repeat steps 5 and 6 until the desired value is obtained; omit steps 9 through 15. If the desired value cannot be obtained, proceed with steps 8 through 15.

8. Stop the a-c motor.

9. Connect the shorting jumper or switch across the a-c ammeter.

10. Block the output shaft.

11. Turn the CONTROL potentiometer to the mid-position.

12. Start the a-c motor.

13. Remove the shorting jumper or switch from across the a-c ammeter.

14. Press and release the coupling START push button and adjust the UP LIMIT potentiometer on the front of the "coordination and signal amplifier with torque limit" card for the desired value of a-c motor current.

> **CAUTION:** TO AVOID DAMAGE TO THE EDDY CURRENT COUPLING, IF THIS ADJUSTMENT TAKES LONGER THAN 30 SECONDS, PRESS THE COUPLING STOP PUSH BUTTON AND LET THE A-C MOTOR RUN FOR 5 MINUTES. THEN REPEAT STEP 14.

A graphic picture of this adjustment is shown in Fig. 5.

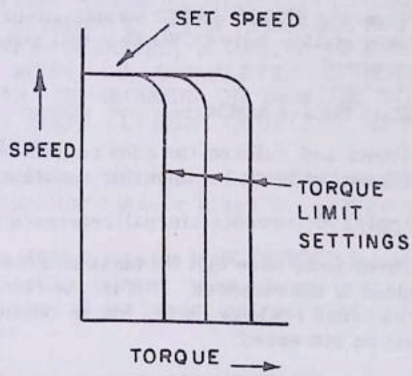


Fig. 5. Torque-limit settings

> **NOTE:** The DOWN LIMIT potentiometer is inoperative for this limit application.

15. Adjust the LIMIT SENSITIVITY potentiometer on the front of the "coordination and signal amplifier with torque limit" printed-circuit card to the desired degree of sensitivity of the torque-limiting circuit. A graphic picture of this adjustment is shown in Fig. 6.

SETUP AND ADJUSTMENT (CONT'D)

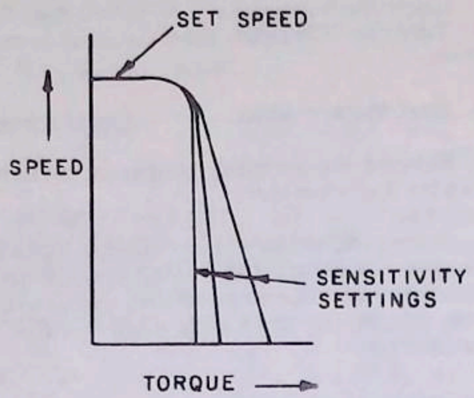


Fig. 6. Torque-limit sensitivity settings

ALTERNATE MODES OF OPERATION

Follower

To adjust follower drives, complete the following steps:

1. Lock the MAX SPEED potentiometer on the regulator rack in the mid-position.

2. Turn the SPEED RATIO potentiometer on the operator's station fully CCW. This will give a high follower speed.

3. Start the a-c motor.

4. Press and release the eddy current coupling START push button on the operator's station.

5. Apply 100-percent (external) reference signal.

6. Check to be sure that the maximum rated coupling speed is not exceeded. If it is, the reference-signal external resistor is too low in ohmic value and must be increased.

> **CAUTION:** DO NOT SET THE MAXIMUM DRIVE SPEED AT A VALUE HIGHER THAN THE MAXIMUM SPEED SPECIFIED ON THE EDDY CURRENT COUPLING NAMEPLATE. OPERATION OF THE DRIVE WITH AN EXTERNAL RESISTOR OF LOWER OHMIC VALUE THAN REQUIRED TO JUST GIVE RATED OUTPUT SPEED CAN RESULT IN OVEREXCITATION AND OVERHEATING OF THE EDDY CURRENT COUPLING.

7. Turn the SPEED RATIO potentiometer CW until the lowest desired follower speed (with maximum signal) is reached.

8. Apply the minimum external reference signal.

9. Adjust the MIN SPEED potentiometer on the regulator rack for the desired minimum drive speed with minimum reference signal applied.

> **CAUTION:** IF THE MINIMUM SPEED LISTED ON THE EDDY CURRENT COUPLING NAMEPLATE IS GREATER THAN 100 RPM, THE COUPLING IS NOT THERMALLY CAPABLE OF CONTINUOUS OPERATION BELOW THIS (NAMEPLATE) MINIMUM SPEED. CONTINUOUS OPERATION AT RATED TORQUE BELOW THE RATED MINIMUM SPEED CAN DAMAGE THE EDDY CURRENT COUPLING.

> **NOTE:** Operation for more than one minute must be considered as continuous.

10. Lock the MIN SPEED potentiometer at the desired setting by tightening the locking screw on the potentiometer knob.

11. Repeat steps 6 and 7. Adjustment of the minimum speed may have changed the maximum speed.

12. Press and release the eddy current coupling STOP push button on the operator's station.

13. Stop the a-c motor.

Follower/Independent

To adjust "Follower/Independent" drives for "follower" operation, refer to "Follower" on page 14, and complete steps 2 through 13 inclusive.

To adjust "Follower/Independent" drives for "independent" operation, complete the "Maximum and Minimum Speed Setting" procedure on page 11. No additional adjustment is required.

Manual

To adjust "manual" drives, complete the following steps:

1. Connect the shorting jumper or switch across the a-c ammeter.

2. Turn the torque CONTROL potentiometer on the operator's station fully counterclockwise (CCW) to zero.

3. If the Kinatrol drive is <u>not</u> used as a "helper" drive, proceed to step 4.

SETUP AND ADJUSTMENT (CONT'D)

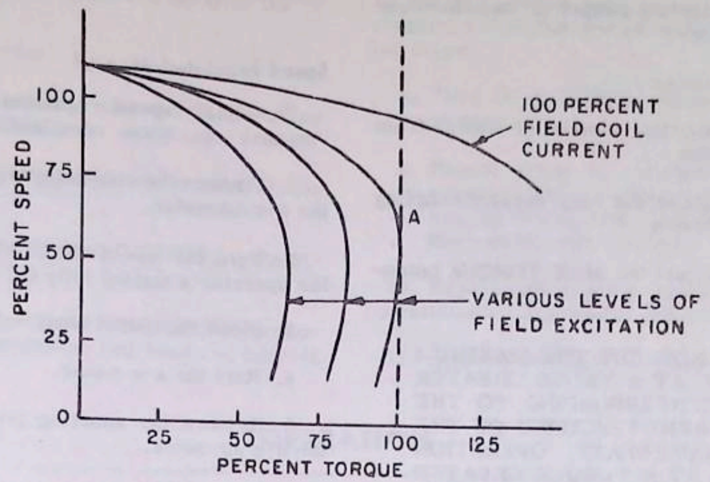


Fig. 7. Speed-torque curve

If the Kinatrol drive is used as a "helper" drive, omit step 4 and step 16 in the following procedure. The following adjustments should be made with the main drive and the Kinatrol drive operating together at approximately 50 percent of the top rated Kinatrol drive speed. Without the presence of the main drive, the steepness of the speed-torque curves (as shown in Fig. 7) makes adjustment of the Kinatrol drive extremely difficult.

4. Block the output shaft.

5. Turn the MIN TORQUE potentiometer on the front of the regulator rack fully clockwise (CW) to 100 percent.

6. Turn the MAX TORQUE potentiometer on the front of the regulator rack fully CCW to zero.

7. Start the a-c motor.

8. Remove the shorting jumper or switch from the a-c ammeter.

9. Press and release the eddy current coupling START push button on the operator's station.

10. Note the full-load a-c current rating listed on the a-c motor nameplate.

CAUTION: READ STEPS 11, 12 AND 13 BEFORE ATTEMPTING ANY FURTHER ADJUSTMENTS. WITH THE OUTPUT SHAFT BLOCKED, STEPS 11, 12 AND 13 MUST BE COMPLETED <u>IN LESS THAN 30 SECONDS</u> OR <u>DAMAGE TO THE EDDY CURRENT COUPLING</u> MAY OCCUR.

11. Cautiously turn the CONTROL potentiometer on the operator's station fully CW to 100 percent.

12. Cautiously turn the MAX TORQUE potentiometer CW until maximum drive torque is reached as indicated by full load motor current read on the a-c ammeter.

If the range of the MAX TORQUE potentiometer is exceeded before maximum drive torque is reached, complete the following steps:

a. Press and release the eddy current coupling STOP push button on the operator's station.

b. Stop the a-c motor.

c. Increase the resistance of resistor 2RS (shown on the connection and interconnection diagram) by moving the sliding contact toward the bottom of the control unit enclosure.

SETUP AND ADJUSTMENT (CONT'D)

d. Connect the shorting jumper or switch across the a-c ammeter.

e. Start the a-c motor.

f. Remove the shorting jumper or switch from the a-c ammeter.

g. Press and release the eddy current coupling START push button.

h. Continue to adjust the MAX TORQUE potentiometer.

CAUTION: DO NOT SET THE MAXIMUM DRIVE TORQUE AT A VALUE GREATER THAN THAT CORRESPONDING TO THE MAXIMUM CURRENT SPECIFIED ON THE A-C MOTOR NAMEPLATE. OPERATION OF THE DRIVE AT A TORQUE GREATER THAN THIS (NAMEPLATE) MAXIMUM TORQUE CAN RESULT IN OVERHEATING OF THE EDDY CURRENT COUPLING.

13. Press and release the eddy current coupling STOP push button on the operator's station.

14. Lock the MAX TORQUE potentiometer at the desired setting by tightening the locking screw on the potentiometer knob.

15. Stop the a-c motor.

16. Remove the blocking from the output shaft.

17. Connect the shorting jumper or switch across the a-c ammeter.

18. Turn the CONTROL potentiometer fully CCW to zero.

19. Start the a-c motor.

20. Remove the shorting jumper or switch from across the a-c ammeter.

21. Press and release the eddy current coupling START push button.

22. Turn the MIN TORQUE potentiometer CCW until the required minimum torque is obtained, and lock the MIN TORQUE potentiometer at this setting.

23. Press and release the eddy current coupling STOP push button.

24. Adjust the jog torque and block forcing as described in the notes on the elementary diagram.

25. Stop the a-c motor.

Speed Regulated/Manual

To adjust "speed regulated/manual" drives for "manual" operation, complete the following steps:

1. Connect the shorting jumper or switch across the a-c ammeter.

2. Turn the speed CONTROL potentiometer on the operator's station fully CCW to zero.

3. Block the output shaft.

4. Start the a-c motor.

5. Remove the shorting jumper or switch from the a-c ammeter.

6. Note the full-load a-c current rating listed on the a-c motor nameplate.

CAUTION: READ STEPS 7 AND 8 BEFORE ATTEMPTING ANY FURTHER ADJUSTMENTS. STEPS 7 AND 8 MUST BE PERFORMED CAREFULLY TO AVOID POSSIBLE DAMAGE TO THE EDDY CURRENT COUPLING.

7. Press and release the eddy current coupling START push button.

8. Cautiously turn the CONTROL potentiometer CW while observing the a-c ammeter until the full CW position of the CONTROL potentiometer is reached just as the full-load current is reached.

CAUTION: IF THE A-C CURRENT EXCEEDS THE FULL-LOAD CURRENT RATING LISTED ON THE A-C MOTOR NAMEPLATE, STOP THE DRIVE IMMEDIATELY BY PRESSING AND RELEASING THE EDDY CURRENT COUPLING STOP PUSH BUTTON OR DAMAGE TO THE EDDY CURRENT COUPLING MAY OCCUR.

If rated full-load current is exceeded before the full CW position of the CONTROL potentiometer is reached, complete the following steps:

a. Stop the a-c motor.

b. Increase the resistance of resistor 2RS (shown on the connection and interconnection diagram) by moving the sliding contact toward the bottom of the control unit enclosure.

SETUP AND ADJUSTMENT (CONT'D)

c. Connect the shorting jumper or switch across the a-c ammeter.

d. Start the a-c motor.

e. Press and release the eddy current coupling START push button.

f. Remove the shorting jumper or switch from the a-c ammeter.

g. Continue to adjust the CONTROL potentiometer.

9. If the full CW position of the CONTROL potentiometer is reached before the full load a-c current is reached, press and release the eddy current coupling STOP push button and complete the following steps:

a. Turn the CONTROL potentiometer fully CCW to zero.

b. Repeat steps 8a through 8f inclusive, decreasing the resistance of resistor 2RS by moving the sliding contact toward the top of the control unit enclosure.

10. Repeat step 8 and/or step 9 until the CONTROL potentiometer is adjusted properly.

11. Remove the blocking from the output shaft.

OPERATION

NOTE: Drives should be readjusted only by authorized personnel, in accord with the procedures outlined under "Setup and Adjustment".

BASIC DRIVES

To start the basic Kinatrol drive:

1. Set the speed CONTROL potentiometer on the operator's station to the desired output speed.

2. Start the a-c motor. The a-c motor runs continuously during normal operation.

3. Press and release the eddy current coupling START push button on the operator's station. The coupling will start and accelerate to the speed set on the CONTROL potentiometer.

To stop the basic Kinatrol drive:

1. Press and release the eddy current coupling STOP push button on the operator's station. The coupling will coast to a stop at a rate determined by the friction and inertia of the drive and the driven equipment.

2. Stop the a-c motor if the drive is not to be operated for an extended time period.

To adjust the output speed of the basic Kinatrol drive during normal operation, turn the CONTROL potentiometer counterclockwise to decrease drive output speed, and turn it clockwise to increase drive output speed.

MODIFIED DRIVES

JOG

To jog drives with the "jog at run speed" modification:

1. With the a-c motor running, turn the RUN/JOG push button on the operator's station to the JOG position, press the push button, and hold it in. The coupling will start and accelerate to the speed set on the speed CONTROL potentiometer, and will run at this speed as long as the JOG push button is held in.

OPERATION (CONT'D)

2. To stop the coupling, release the JOG push button.

3. To return to "run" operation, turn the RUN/JOG push button to RUN and press and release the eddy current coupling START push button. The drive will run at the preset speed until the STOP button is pressed.

To jog drives with the "jog at preset speed" modification:

1. With the a-c motor running, press and hold in the JOG push button on the operator's station. The coupling will start and accelerate to the speed preset on the JOG potentiometer on the front of the regulator rack, and will continue to run at this speed as long as the JOG push button is held in.

2. To stop the coupling, release the JOG push button.

3. To return to "run" operation, press and release the eddy current coupling START push button on the operator's station.

THREAD

To operate a drive with the "thread speed" modification at thread speed:

1. With the a-c motor running, press and release the THREAD push button on the operator's station. The coupling will start and accelerate to the speed preset on the THREAD potentiometer on the front of the regulator rack.

2. To stop the coupling, press and release the eddy current coupling STOP push button on the operator's station.

3. To return to "run" position, press and release the eddy current coupling START push button on the operator's station. It is not necessary to stop the coupling before going from "thread" to "run" operation.

ALTERNATE MODES OF OPERATION

FOLLOWER

To operate the Kinatrol drive as a "follower" drive:

1. Start the a-c motor of the Kinatrol drive.

2. Press and release the eddy current coupling START push button on the operator's station.

3. Apply the follower reference signal to the Kinatrol drive.

4. Set the SPEED RATIO potentiometer on the operator's station for the desired speed relationship between the master drive and the follower drive.

5. To stop the drive, complete the following steps:

a. Remove the follower reference signal from the Kinatrol drive.

b. Press and release the eddy current coupling STOP push button on the operator's station.

FOLLOWER/INDEPENDENT

To operate drives with the "follower/independent" modes of operation:

1. For operation as a "follower" drive, turn the FOLLOWER/INDEPENDENT selector switch on the operator's station to FOLLOWER, and follow the operating instructions given under the heading "Follower" on page 18.

2. For operation as a "speed regulated" drive, turn the FOLLOWER/INDEPENDENT selector switch on the operator's station to INDEPENDENT, and follow the operating instructions given under the heading "Basic Drives" on page 17. If the "jog" or "thread speed" modifications were ordered with the drive, also refer to "Modified Drives" on page 17.

MANUAL

To operate a drive with the "manual" mode of operation:

1. Start the a-c motor.

2. Set the torque CONTROL potentiometer on the operator's station to the desired operating torque.

3. Press and release the eddy current coupling START push button on the operator's station. The coupling will start and accelerate to speed depending upon the torque set on the CONTROL potentiometer and the torque requirements of the driven machine. Drive speed will most often be established by another machine or process. For this condition, make sure that the coupling speed at full torque is not lower than the minimum speed specified on the eddy current coupling nameplate.

4. To stop the drive, press and release the eddy current coupling STOP push button on the operator's station. The coupling will coast to a stop at a rate determined by the friction and inertia of the drive and the driven equipment.

OPERATION (CONT'D)

5. To adjust the output torque of the drive during normal operation, turn the CONTROL potentiometer clockwise to increase drive output torque.

SPEED REGULATED/MANUAL

To operate drives with the "speed regulated/ manual" mode of operation:

1. For operation as a "speed regulated" drive, turn the SPEED REGULATED/MANUAL selector switch on the operator's station to SPEED REGULATED, and follow the operating instructions given under the heading "Basic Drives" on page 17. If the "jog" or "thread speed" modifications were ordered with the drive, also refer to "Modified Drives" on page 17.

2. For operation as a "manual" drive, turn the SPEED REGULATED/MANUAL selector switch on the operator's station to MANUAL, and follow the operating instructions given under the heading "Manual" on page 18 .

TECHNICAL INFORMATION

HOW THE CONTROL UNIT WORKS

ISOLATING TRANSFORMER

The isolating transformer supplies a-c control power for the relays, the regulator power supply, and the power amplifier for exciting the coupling field coil.

REGULATOR

Figure 8 is a block diagram of the basic regulating system. A-c power is applied to the induction motor which runs at essentially constant speed. The

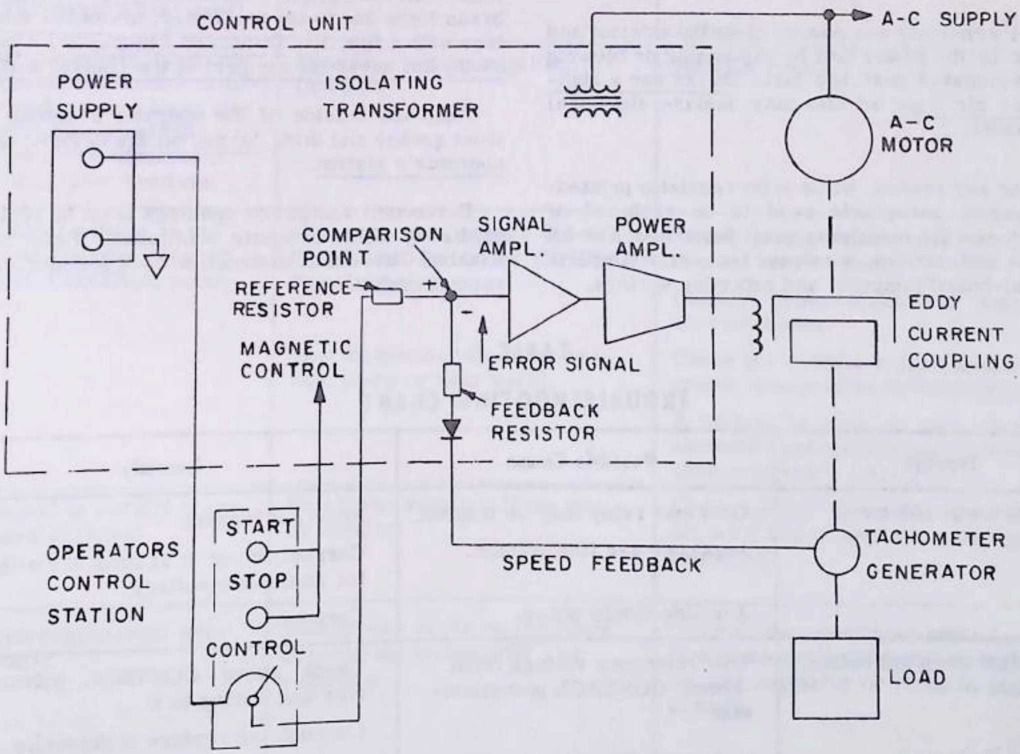


Fig. 8. Block diagram of the basic regulating system

TECHNICAL INFORMATION (CONT'D)

torque output of the motor is transmitted to the load through the eddy current coupling, and a tachometer generator supplies a voltage signal proportional to the speed of the output shaft. The reference-voltage signal from the speed CONTROL potentiometer on the operator's station is compared to the feedback signal at a "comparison point," and the difference between the reference and feedback signals is the "error" signal. The error signal is amplified and used to control the excitation of the eddy current coupling field coil which controls the speed of the output shaft.

At the instant the drive is started, there is no initial excitation on the eddy current coupling field coil and no feedback signal from the tachometer generator. The output from the comparison point is the reference signal from the CONTROL potentiometer on the operator's station. This reference signal is large enough to turn the power amplifier fully on. The power amplifier supplies d-c to the eddy current coupling field coil, and torque from the a-c motor is transmitted through the eddy current coupling to accelerate the load. Acceleration continues until the feedback signal is nearly large enough to cancel the reference signal. This results in a reduction of the error signal, and excitation to the eddy current coupling field coil settles at a value just sufficient for the eddy current coupling to supply the required torque to the load at the output speed set on the CONTROL potentiometer on the operator's station.

MAINTENANCE

Maintenance of the Kinatrol Speed Variator Drive is primarily a matter of periodic inspection and cleaning of the three drive components, the control unit, the drive unit, and the operator's station.

After removing a-c power, clean the exterior and interior of the power unit by vacuuming or blowing out accumulated dust and dirt. Do not use a high-pressure air hose as this may damage electrical components.

If, for any reason, wires in the regulator printed-circuit-card receptacle need to be replaced or changed, use the maintenance kit furnished. The kit includes instructions, a release tool, wire jumpers, terminal-board jumpers, and retaining springs.

Check all electrical connections for tightness and examine the electrical contacts on contactors. Both copper and silver contacts discolor and become roughened during normal operation. Generally contacts will not require attention but, if prominent beads form due to severe arcing, dress the contact face with a fine file. Do not use sandpaper or emery cloth, and never oil any part of the control unit.

Keep the outside of the operator's station free from grease and dirt. Do not oil the devices on the operator's station.

Drive-unit ventilation openings must be kept free of dirt to allow adequate ventilation. Refer to the Kinatrol drive unit instruction book for lubrication recommendations.

TABLE I

TROUBLESHOOTING CHART

Trouble	Possible Cause	Remedy
A-c motor will not start.	Overload relay may be tripped.	Reset, if tripped.
	Improper a-c line voltage.	Correct, if not in accordance with motor nameplate voltage.
	A-c line single phase.	Correct.
Output shaft does not rotate.	Low reference voltage from speed CONTROL potentiometer.	Check speed CONTROL potentiometer and wiring to it. Correct, or replace if defective.
	Defective 20-volt d-c power supply.	Replace power-amplifier card.

TROUBLESHOOTING (CONT'D)

TABLE I

TROUBLESHOOTING CHART

Trouble	Possible Cause	Remedy
"M" contactor does not operate.	Check both START and STOP push button wiring for open circuit.	Correct, if open.
	Check "M" contactor coil for open circuit.	Replace, if defective.
Blown fuse.	Check fuses located on the transformer.	Replace, if open.
Speed reference from speed CONTROL potentiometer is correct but no timed reference from linear time function (drives with linear time).	Defective linear time function.	Replace card.
Correct reference and feedback voltages but zero output from signal amplifier (approximately 2. 5 milliamperes d-c in output tab 11 of signal-amplifier card).	Defective signal-amplifier function.	Replace card.
Correct power amplifier input (approximately 2. 5 milliamperes d-c rated input into tab 4 of power-amplifier card) but zero output from power-amplifier function.	Defective power-amplifier function.	Replace card.
Output shaft rotates at top speed and does not respond to speed CONTROL potentiometer.	High reference voltage (18-20 v) not affected by speed CONTROL potentiometer.	Check potentiometer and wiring for open or short circuits. Replace potentiometer if defective; correct wiring.
	Low tachometer-feedback voltage (zero or near zero).	Check for rated a-c tachometer-generator voltage at main terminal board. If voltage is zero or low, check tachometer and connections between tachometer and regulator.
Drive speed is erratic (random speed changes).	Reference supply voltage may be erratic.	Check wiring. If trouble not found after wire check, replace power-amplifier card.
Tachometer-generator voltage erratic.	Pickup may occur on the leads between the tachometer and regulator.	"Twist" the tachometer leads (at least five turns per foot) between tachometer and regulator or place in separate conduit.

TROUBLESHOOTING (CONT'D)

TABLE I

TROUBLESHOOTING CHART

Trouble	Possible Cause	Remedy
Drive speed oscillates (hunting).	Mechanical load unbalance or mechanical mis-alignment.	Observe the hunting frequency at two different speeds. If the hunting frequency changes in proportion to the speed, the oscillation is caused by mechanical load unbalance or mechanical mis-alignment. If this condition exists, correct mechanical problem.
	RESPONSE potentiometer needs adjustment.	If the hunting frequency stays constant when the speed is changed, adjust RESPONSE potentiometer (mounted on front of "coordination and signal amplifier" card) for minimum hunting.
	Need for alternate stability connection.	If satisfactory operation cannot be obtained as described under "RESPONSE potentiometer needs adjustment", remove power from drive and make the following wire changes on back of regulator. (Remove wires from receptacle according to instructions in maintenance kit.) A. Remove the wire between AG-TB(11) and AE(25). B. Remove the wire between AC-TB(1) and AE(3). C. Remove the wire between AC-TB(4) and AE(20) by cutting from common terminal at AC-TB(4). D. Remove the wire between AC-TB(2) and AE(4). E. Add a wire between AC-TB(7) and AE(4). F. Turn the RESPONSE potentiometer on front of "coordination and signal amplifier" card fully clockwise. G. Start the coupling. H. Turn RESPONSE potentiometer counterclockwise until hunting disappears. I. Readjust MAX SPEED. Start with step 7 on page 11 for this adjustment.

PARTS LIST
TABLE II
PRINTED-CIRCUIT CARDS AND RELAYS

Printed Circuit	Cat. No.
Power Amplifier and Power Supply	
6 amp, 60 volt d-c output 12 amp, 60 volt d-c output 12 amp, 120 volt d-c output	193X803BEG03
Coordination and Signal Amplifier	193X800DAG01
Coordination and Signal Amplifier with Linear Time	193X801DAG01, G02
Coordination and Signal Amplifier with Torque Limit	193X802DAG01, G02
Relays (115-volt a-c, 60-cycle coil)	**Cat. No.**
with 3 normally open, 1 normally closed interlocks	104X127AC002
with 5 normally open, 1 normally closed interlocks	104X127RBG02
2 normally open (Fixed Tip Adder, No Coil)	104X127DA001

NOTE: If the relay coil is to be used on a 115-volt a-c, 50-cycle supply, order per the following example:

1 - Relay Cat. 104X127----, except with 50-cycle coil 104X102BA002.

Determine the catalog numbers required for your drive by physical inspection of the equipment.

TABLE III
TRANSFORMERS AND FUSES

VOLTAGE				CYCLES		D-C LOAD 60 Volts D-c AMPS				D-C LOAD 120 Volts D-c AMPS		TRANS	FUSE	
230/460	575	208	380	50	60	4.2	6.0	8.4	12.0	8.4	12.0	104X	CPFU 104X109	PAFU 104X109
X				X	X	X						350AA002	AA001	AD002
X				X	X		X					350AA003	AA001	AD003
X				X	X			X				350AA004	AA001	AD005
X				X	X				X			350AA005	AA001	AD006
X				X	X					X		350AA006	AA001	AD005
X				X	X						X	350AA007	AA001	AD006
	X	X			X	X						352AA002	AA001	AD002
			X	X		X						352AA002	AA001	AD002
	X	X			X		X					352AA003	AA001	AD003
			X	X			X					352AA003	AA001	AD003
	X	X			X			X				352AA004	AA001	AD005
			X	X				X				352AA004	AA001	AD005
	X	X			X				X			352AA005	AA001	AD006
			X	X					X			352AA005	AA001	AD006
	X	X			X					X		352AA006	AA001	AD005
			X	X						X		352AA006	AA001	AD005
	X	X			X						X	352AA007	AA001	AD006
			X	X							X	352AA007	AA001	AD006

Determine the catalog number required for your drive by physical inspection of the equipment.

DATA SECTION

TABLE IV

CURRENT TRANSFORMER CONNECTIONS

PRIMARY AMPERES (NOTE 1)	PRIMARY TURNS (NOTE 2)	SECONDARY CONNECTION FIGURE NO.	CURRENT TRANSFORMER CAT. NO.
0.5 - 0.99	30	10A	9T53Y2446
1.0 - 1.39	25	10A	9T53Y2446
1.4 - 1.99	18	10A	9T53Y2446
2.0 - 2.79	13	10A	9T53Y2446
2.8 - 3.99	9	10A	9T53Y2446
4.0 - 5.59	6	10A	9T53Y2446
5.6 - 7.99	5	10A	9T53Y2446
8.0 - 11.1	3	10A	9T53Y2446
11.2 - 15.9	5	10B	9T53Y2446
16.0 - 31.9	3	10B	9T53Y2446
32.0 - 63.9	2	10B	9T53Y2446
64.0 - 124.0	1	10B	9T53Y2446
125 - 249	2	10A	9T53Y2473
250 - 800	1	10B	9T53Y2473

Note 1: Primary amperes in the tabulation are 110 percent of a-c motor nameplate current.

Note 2: Primary turns is the number of conductors (a-c motor lead) through the window, not the number of loops around a leg of the core. (See Fig. 9.)

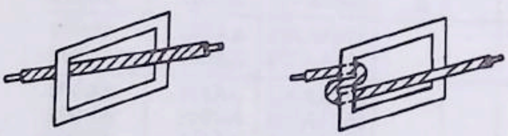


Fig. 9. Current-transformer primary connections

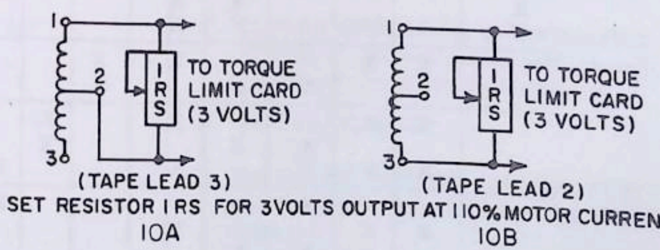


Fig. 10. Current-transformer secondary connections

FEEDBACK RESISTANCE

GENERAL

The regulator feedback resistance should be approximately 1000 ohms per tachometer volt (either a-c or d-c) at rated speed. For 1700-rpm drives, the a-c tachometer voltage will be 170 (100 volts/1000 rpm) and the 168K resistance will be factory-connected on all drives.

It may be necessary to change the value of feedback resistance for one of the following reasons.

A. Drive unit rated speed is higher (more resistance) or lower (less resistance) than 1700 rpm.

B. A d-c tachometer is used, producing substantially more or less than 170 volts at rated speed.

C. Rated speed cannot be obtained with both the speed CONTROL potentiometer and MAX SPEED potentiometer fully CW. Increase feedback resistance.

D. Rated speed is produced (or exceeded) with the MAX SPEED potentiometer in the CCW position. Reduce feedback resistance.

Since the feedback resistance may be any of several combinations of three resistors on the printed-circuit card, its value may be changed by changing interconnections between receptacle AE and auxiliary terminal board AC-TB as shown in Table V.

To change the feedback resistance, proceed as follows.

1. Remove all jumpers between points 3, 4, 5 and 6 (only) on auxiliary terminal board AC-TB.

2. Select the value of resistance required from column A of Table V and insert jumpers on AC-TB as indicated in columns B and C.

3. Identify the wire from point 12 on receptacle AE. Terminate the other end of this wire as indicated in column D of Table V. See the maintenance kit instructions, if the wire is to be disconnected from receptacle AE.

TABLE V

FEEDBACK-RESISTOR CONNECTIONS

Req'd Ohms	Req'd Jumpers on AC-TB		Termination Point on AC-TB of Wire from Point 12 on Receptacle AE
A	B	C	D
28K	4-6	-	5
39K	-	-	5
68K	5-3	4-6	Remove Wire
79.5K	5-6	-	3
100K	5-6	-	4
107K	5-3	-	6
139K	5-6	-	Remove Wire
168K	5-3	-	4
207K	5-3	-	Remove Wire

EXTERNAL REFERENCE RESISTOR (FOLLOWER DRIVE OPERATION)

FOLLOWER VOLTAGE SIGNAL

The follower reference signal required by the Kinatrol Speed Variator drive is 1 milliampere at 20 volts d-c maximum voltage. If the available signal voltage is higher than 20 volts d-c, a 2-watt series resistor must be added by the purchaser. Determine the value of this resistance as follows:

Series Resistance (Ohms) = (Signal Voltage - 20) x 1000

The maximum follower signal voltage permissible is 300 volts d-c. An armature voltage signal from a rectifier drive is not an acceptable follower signal without adequate filtering.

If only a portion of the available speed-ratio range is required, it may be possible to obtain better vernier control of the follower-drive speed by replacing the SPEED RATIO potentiometer with a potentiometer having a lower value of resistance.

SIGNAL AMPLIFIER

INTRODUCTION

THIS GEI COVERS THE DESCRIPTION, APPLICATION, OPERATION AND TROUBLE SHOOTING OF THE SIGNAL AMPLIFIER FUNCTION. THE HARDWARE FOR THIS FUNCTION IS PHYSICALLY COMBINED WITH THE HARDWARE OF OTHER FUNCTIONS ON A SINGLE PRINTED CIRCUIT CARD. THE FUNCTION AND PRINTED CIRCUIT CARD DIAGRAMS CONTAIN DETAILED INFORMATION AS FOLLOWS:

FUNCTION DIAGRAM	PRINTED CIRCUIT DIAGRAM
FUNCTIONAL SCHEMATIC	CARD SCHEMATIC
FUNCTIONAL CONNECTION	TAB NUMBERS
SPECIFICATIONS	COMPONENT VALUES
NOMENCLATURE	COMPONENT LAYOUT
VOLTAGE CHECK LIST	

REFER TO THE CONTENTS PAGE FOR THE LISTING AND LOCATION OF THESE DIAGRAMS.

DESCRIPTION AND APPLICATION

THIS IS A DIRECTLY COUPLED TWO STAGE TRANSISTOR AMPLIFIER. THE AMPLIFIER EMPLOYS AN NPN AND A PNP TRANSISTOR. THE PRIMARY FUNCTION OF THE AMPLIFIER IS TO AMPLIFY THE ERROR SIGNAL INPUT TO A USEABLE POWER LEVEL.

OPERATION

THE AMPLIFIER OPERATION IS BEST DESCRIBED BY FOLLOWING THE SIGNAL THROUGH THE CIRCUIT. THE SIMPLIFIED AMPLIFIER CIRCUIT IS SHOWN IN FIG. 1. WHEN THE ERROR SIGNAL INPUT INCREASES (BASE OF T426 POSITIVE WITH RESPECT TO REGULATOR COMMON), THE COLLECTOR CURRENT OF T426 INCREASES. THIS INCREASES THE BASE CURRENT OF T427 WHICH INCREASES ITS COLLECTOR CURRENT WHICH INCREASES THE OUTPUT. THE NET RESULT IS THAT AN INCREASE IN ERROR SIGNAL INPUT CAUSES AN INCREASE IN OUTPUT AT A MUCH HIGHER VOLTAGE AND CURRENT LEVEL.

RESISTORS R427 AND R432 FORM A VOLTAGE DIVIDER ACROSS THE POWER SUPPLY WHICH PLACES AN EMITTER BIAS ON TRANSISTOR T427. THE VOLTAGE DROP ACROSS R427 IS APPROXIMATELY 5 VOLTS. THE PURPOSE OF THE EMITTER BIAS IS TO ASSURE THAT T427 TRANSISTOR IS TURNED OFF WHEN T426 IS TURNED OFF. WHEN T426 IS TURNED OFF, THE VOLTAGE DROP ACROSS R426 DEPENDS ONLY UPON THE REQUIREMENTS OF T427. RESISTOR R426 BIASES THE BASE OF T427 POSITIVE WITH RESPECT TO ITS EMITTER TO ASSURE THE SHUT OFF ABILITY OF T427. RESISTOR R428 LIMITS THE MAXIMUM BASE CURRENT OF T427.

SIGNAL AMPLIFIER

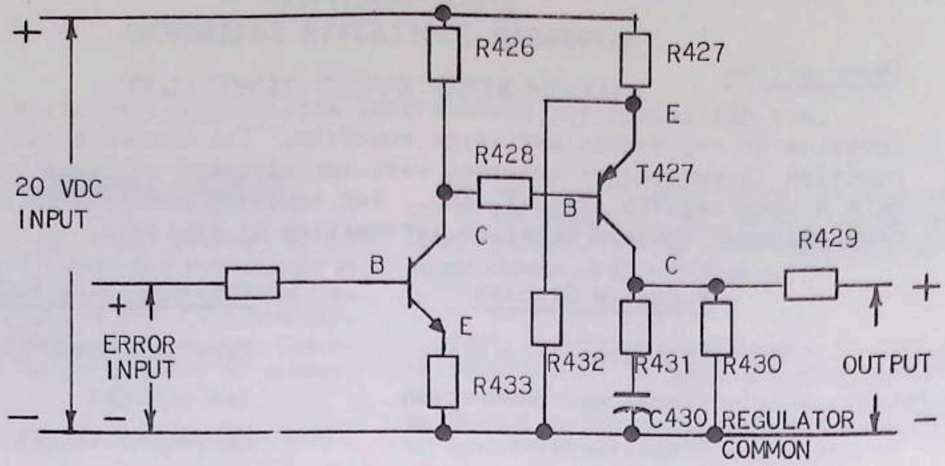


FIG. 1. SIMPLIFIED DIAGRAM OF THE SIGNAL AMPLIFIER.

RESISTOR R430, R431 AND CAPACITOR C430 ARE A RIPPLE SUPPRESSION NETWORK. THIS PREVENTS THE RIPPLE FROM THE POWER AMPLIFIER CONTROL WINDING FROM AFFECTING THE SIGNAL AMPLIFIER OPERATION.

TROUBLE SHOOTING

A. CHECK THE VOLTAGE INPUTS AND CURRENT OUTPUT.
   1. CONNECT A MILLIAMETER IN THE OUTPUT LEG, TAB 11, CAPABLE OF MEASURING 5 MILLIAMPERES.
   2. MEASURE 20 VOLTS D-C BETWEEN TABS 8 AND 2.
   3. MEASURE APPROXIMATELY 18 VOLTS BETWEEN TABS 6 AND 2 AT RATED REFERENCE INPUT (CONTROL POTENTIOMETER CW).
   4. IF APPROXIMATELY 2MA IS READ ON THE OUTPUT MILLIAMETER THE SIGNAL AMPLIFIER IS FUNCTIONING PROPERLY.

B. IF THE SIGNAL AMPLIFIER OUTPUT IS APPROXIMATELY ZERO AS DETERMINED IN (A) ABOVE, MAKE THE FOLLOWING CHECKS:
   1. CHECK THE TRANSISTORS (T426, T427.) SEE SEMICONDUCTOR TROUBLE SHOOTING (GEI 95529).
   2. CHECK THE DIODES. SEE SEMICONDUCTOR TROUBLE SHOOTING (GEI 95529).
   3. CHECK TRANSISTOR BIAS VOLTAGES.
      A. T426 COLLECTOR TO REGULATOR COMMON SHOULD BE APPROXIMATELY 15 VOLTS D-C
      B. T427 BASE TO REGULATOR COMMON SHOULD BE APPROXIMATELY 15 VOLTS D-C
      C. T427 EMITTER TO REGULATOR COMMON SHOULD BE APPROXIMATELY 15 VOLTS D-C
      D. IF ABOVE VOLTAGES ARE NOT MEASURED, CHECK RESISTORS R426, R427, R428, AND R432 WITH AN OHMETER.
   4. CHECK CAPACITOR C430 WITH AN OHMETER TO MAKE SURE THAT IT IS NOT SHORTED.

INTRODUCTION

THIS GEI COVERS THE DESCRIPTION, APPLICATION, OPERATION, ADJUSTMENT, AND TROUBLE SHOOTING OF THE LINEAR TIME FUNCTION. THE HARDWARE FOR THIS FUNCTION IS PHYSICALLY COMBINED WITH THE HARDWARE OF OTHER FUNCTIONS ON A SINGLE PRINTED CIRCUIT CARD. THE FUNCTION AND PRINTED CIRCUIT CARD DIAGRAMS CONTAIN DETAILED INFORMATION AS FOLLOWS:

FUNCTION DIAGRAM	PRINTED CIRCUIT DIAGRAM
FUNCTIONAL SCHEMATIC	CARD SCHEMATIC
FUNCTIONAL CONNECTION	TAB NUMBERS
SPECIFICATIONS	COMPONENT VALUES
NOMENCLATURE	COMPONENT LAYOUT
VOLTAGE CHECK LIST	

REFER TO THE CONTENTS PAGE FOR THE LISTING AND LOCATION OF THESE DIAGRAMS.

DESCRIPTION AND APPLICATION

THE LINEAR TIME FUNCTION PROVIDES A RAMP CHANGE IN OUTPUT VOLTAGE FOR A STEP CHANGE IN INPUT REFERENCE VOLTAGE. RAMP TIME IS ADJUSTABLE FROM 2 TO 32 SECONDS FOR 100% CHANGE IN INPUT. THIS TOTAL RANGE IS SPLIT UP INTO THREE SEPARATE OVERLAPPING RANGES (2-8, 4-16, 8-32 SECONDS.) THE RANGES ARE SELECTED BY CHANGING CONNECTIONS TO THE TIMING CAPACITORS. THE TIME WITHIN A SELECTED RANGE IS ADJUSTABLE BY POTENTIOMETER SETTING.

THIS FUNCTION IS OFTEN EMPLOYED AS A PROTECTIVE DEVICE FOR THE ELECTRICAL EQUIPMENT AND/OR THE DRIVEN MACHINE DURING ACCELERATION AND DECELERATION.

OPERATION

THE LINEAR TIME CIRCUIT IN SIMPLIFIED FORM IS ILLUSTRATED IN FIG. 1. THE BASIC PRINCIPLE EMPLOYED IN THE CIRCUIT IS THE CHARGING OF A CAPACITOR WITH A CONSTANT CURRENT AND USING THE VOLTAGE ACROSS THE CAPACITOR AS THE OUTPUT. DURING THE TIME A CAPACITOR IS BEING CHARGED, IF THE CURRENT IS KEPT CONSTANT, THE VOLTAGE ACROSS THE CAPACITOR INCREASES LINEARLY WITH RESPECT TO TIME.

THE FOUR DIODES CONNECTED IN A BRIDGE NETWORK DECOUPLE THE OUTPUT FROM THE INPUT. CURRENT FLOW CAUSED BY A CHANGE IN INPUT VOLTAGE MUST FLOW THROUGH TRANSISTOR T440.

Linear Time

Assume initial conditions to be zero for both output voltage and input voltage. Upon application of an input voltage, current flows through D441, T440, P440, D443 to the timing capacitor (C440, C441) and the output. The return path is through regulator common.

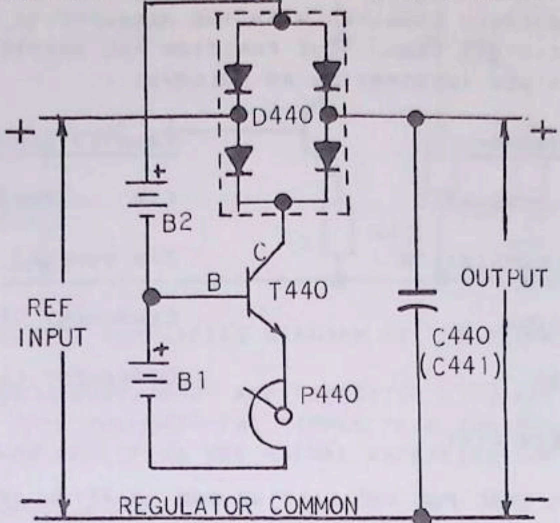


Fig. 1. Simplified diagram of the linear time function.

If the input voltage is then decreased, current flows from the charged capacitor, through D442, T440, P440, D440 back to the input and returns through the regulator common. In both cases the current flows through the transistor. One of the characteristics of a transistor is its ability to cause constant current to flow through collector and emitter, proportional to its base current flow. The current regulating ability is made useable by the addition of an adjustable emitter resistance (P440) across which the transistor regulates a constant voltage. The magnitude of the constant voltage is dependent upon the base-emitter current. The base emitter current is adjustable by potentiometer P440. An increase in the resistance of P440, decreases the base current which decreases the collector-emitter current (capacitor charging current). Therefore P440 controls the amount of capacitor charging current, and thus the time for the capacitor to be charged (or discharged).

The constant current flow through the transistor is independent of the magnitude of voltage difference between input and output, except when the input is equal to the output. Under this condition, no current flows through the transistor. It is desirable to have a current flow with a very small difference in potential between input and output. Bias voltage B2 is required to assure this current flow near zero voltage difference. The diodes and transistor have a forward voltage drop (approximately 0.5 volt per device). The bias voltage (B2) causes a constant current to flow in the diodes and transistor at all times. This keeps these components in their desirable operating range, so that any small difference in potential between input and output switches current either into or out of the charging capacitor.

INTRODUCTION

THIS GEI COVERS THE DESCRIPTION, APPLICATION, OPERATION AND TROUBLE SHOOTING OF THE TORQUE LIMIT FUNCTION. THE HARDWARE FOR THIS FUNCTION IS PHYSICALLY COMBINED WITH THE HARDWARE OF OTHER FUNCTIONS ON A SINGLE PRINTED CIRCUIT CARD. THE FUNCTION AND PRINTED CIRCUIT CARD DIAGRAMS CONTAIN DETAILED INFORMATION REGARDING THESE COMBINATIONS AND ARE AS FOLLOWS:

FUNCTION DIAGRAM	PRINTED CIRCUIT DIAGRAM
FUNCTIONAL SCHEMATIC	CARD SCHEMATIC
FUNCTIONAL CONNECTION	TAB NUMBERS
SPECIFICATIONS	COMPONENT VALUES
NOMENCLATURE	COMPONENT LAYOUT
VOLTAGE CHECK LIST	

REFER TO THE CONTENTS PAGE FOR THE LISTING AND LOCATION OF THESE DIAGRAMS.

DESCRIPTION AND APPLICATION

THE TORQUE LIMIT FUNCTION IS EMPLOYED TO LIMIT THE MAXIMUM TORQUE OF A DRIVE BY MEASUREMENT AND ULTIMATE CONTROL. THIS FUNCTION PROVIDES PROTECTION TO THE ELECTRICAL EQUIPMENT OR TO THE MECHANICALLY COUPLED LOAD WHEN THE FASTEST POSSIBLE ACCELERATION REQUIREMENTS ARE DESIRED.

THE CIRCUIT IS BASICALLY OF THE OVERRIDE TYPE. UNDER NORMAL DRIVE OPERATION THE CIRCUIT IS EFFECTIVELY DECOUPLED FROM THE REGULATOR AND DOES NOT INFLUENCE THE CONTROL. IF THE TORQUE LOAD EXCEEDS THE PRESET VALUE, A DIODE BECOMES FORWARD BIASED AND THE LIMIT CONTROL TAKES OVER.

THE FUNCTION IS DESIGNED TO ACCEPT AN A-C OR D-C INPUT SIGNAL. WHEN THE A-C LIMIT INPUT SIGNAL IS USED, THIS FUNCTION PRODUCES A LIMITING ACTION IN THE ACCELERATION (UP) DIRECTION ONLY. WHEN A D-C LIMIT INPUT SIGNAL IS USED WHICH REVERSES POLARITY BETWEEN ACCELERATION AND DECELERATION, THIS FUNCTION PROVIDES LIMITING ACTION IN BOTH DIRECTIONS (UP AND DOWN).

OPERATION - WITH AN A-C LIMIT INPUT SIGNAL

THE TORQUE LIMIT CIRCUIT IN SIMPLIFIED FORM IS SHOWN IN FIG. 1. AN A-C TORQUE SIGNAL (NORMALLY OBTAINED FROM A CURRENT TRANSFORMER) IS RECTIFIED BY THE FULL WAVE BRIDGE CONSISTING OF DIODES D446, D447, D448 AND D449. THE RECTIFIED TORQUE SIGNAL IS FILTERED BY CAPACITOR C446 AND RESISTOR R446.

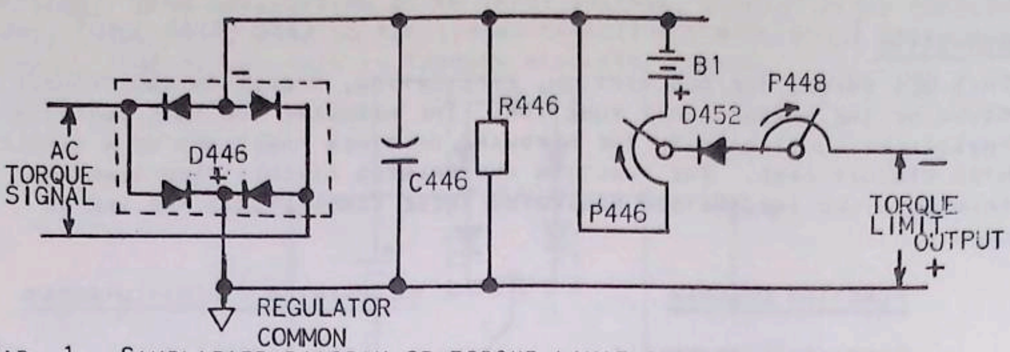


FIG. 1. SIMPLIFIED DIAGRAM OF TORQUE LIMIT CIRCUIT WITH AN A-C LIMIT INPUT SIGNAL.

THE POSITIVE TERMINAL OF THE BRIDGE IS CONNECTED TO REGULATOR COMMON AND THE NEGATIVE TERMINAL IS CONNECTED TO A POTENTIOMETER (P446) AND A BIAS VOLTAGE (B1). THE POTENTIOMETER ADJUSTS THE BACK BIAS VOLTAGE ON DIODE D452. WHEN THE TORQUE LIMIT SIGNAL BECOMES GREATER THAN THE BACK BIAS VOLTAGE ON D452, THE DIODE CONDUCTS. THIS TORQUE LIMIT OUTPUT SIGNAL OVERRIDES THE REGULATOR REFERENCE SIGNAL AND LIMITS THE DRIVE OUTPUT TORQUE.

OPERATION - WITH A D-C LIMIT INPUT SIGNAL

THE SIMPLIFIED LIMIT CIRCUIT FOR ACCELERATION (UP) IS SHOWN IN FIG. 2. THE POSITIVE INPUT SIGNAL IS CONNECTED TO REGULATOR COMMON AND THE NEGATIVE TO A POTENTIOMETER (P446) AND A BIAS VOLTAGE (B1). THE POTENTIOMETER ADJUSTS THE BACK BIAS VOLTAGE ON DIODE D452. WHEN THE TORQUE LIMIT SIGNAL BECOMES GREATER THAN THE BACK BIAS VOLTAGE ON D452, THE DIODE CONDUCTS. THIS TORQUE LIMIT OUTPUT SIGNAL OVERRIDES THE REGULATOR REFERENCE SIGNAL AND LIMITS THE DRIVE OUTPUT TORQUE WHEN ACCELERATING.

FIG. 3 ILLUSTRATES THE SIMPLIFIED LIMIT CIRCUIT FOR DECELERATION (DOWN). THE NEGATIVE INPUT SIGNAL IS CONNECTED TO REGULATOR COMMON AND THE POSITIVE IS CONNECTED TO A POTENTIOMETER (P447) AND A BIAS VOLTAGE (B2). THE POTENTIOMETER ADJUSTS THE BACK BIAS VOLTAGE ON DIODE 453. WHEN THE TORQUE LIMIT SIGNAL BECOMES GREATER THAN THE BACK BIAS VOLTAGE ON D453, THE DIODE CONDUCTS. THIS TORQUE LIMIT OUTPUT SIGNAL OVERRIDES THE DECELERATING REFERENCE SIGNAL AND LIMITS THE DRIVE OUTPUT BRAKING TORQUE.

OPERATION - GENERAL NOTES

THE ABOVE ANALYSIS DISCUSSED THE OPERATION OF THE TORQUE LIMIT FUNCTION DURING ACCELERATION AND DECELERATION. THE TORQUE LIMIT FUNCTION OPERATES IN THE SAME MANNER DURING RUN CONDITIONS. IF THE TORQUE LIMIT SIGNAL BECOMES GREAT ENOUGH TO CAUSE D452, OR D453 TO CONDUCT, THE DRIVE OUTPUT TORQUE IS LIMITED.

POTENTIOMETER P448, CONNECTED IN THE OUTPUT OF THE TORQUE LIMIT FUNCTION, IS A SENSITIVITY ADJUSTMENT.

A SECOND TRANSISTOR (NOT SHOWN IN FIG. 1) IS USED IN THE LINEAR TIME CIRCUIT TO AMPLIFY THE TIMING SIGNAL CURRENT AND THUS REDUCE THE CURRENT DRAIN ON THE TIMING CAPACITOR. THE SECOND TRANSISTOR (T441) PROVIDES A CURRENT GAIN OF ABOUT 30. THIS RESULTS IN A 1/30 OF A MILLIAMPERE DRAIN FROM HE CHARGING CAPACITOR TO PRODUCE A ONE MILLIAMPERE OUTPUT. BY CIRCUIT DESIGN THE MINIMUM CAPACITOR CHARGING CURRENT IS KEPT HIGH IN COMPARISON WITH THE MILLIAMPERE BASE CURRENT OF T441, ASSURING NEGLIGIBLE AFFECT OF LOADING DUE TO THE IMPEDANCE OF THE CIRCUIT CONNECTED TO THE OUTPUT OF THE LINEAR TIME FUNCTION.

THE TIME RANGE DEPENDS UPON TWO PARAMETERS: THE MAGNITUDE OF THE CHARGING CURRENT AND THE SIZE OF THE CAPACITOR TO BE CHARGED. TWO CAPACITORS ARE INCLUDED WHICH MAY BE CONNECTED SINGLY, IN SERIES, OR IN PARALLEL, PROVIDING THREE SEPARATE RANGES. THE RAMP TIME, WITHIN A SELECTED RANGE, IS ADJUSTABLE BY SELECTING MAGNITUDES OF CHARGING CURRENT. THIS IS DONE BY ADJUSTMENT OF THE BASE CURRENT OF THE CONSTANT CURRENT TRANSISTOR (T440). THIS IS ACCOMPLISHED BY THE "TIME ADJUST" POTENTIOMETER. ONLY ONE ADJUSTMENT IS PROVIDED FOR BOTH ACCELERATION AND DECELERATION TIME.

ADJUSTMENT

(1) SELECTION OF THE TIME RANGES IS ACCOMPLISHED BY MANIPULATING THE CONNECTIONS TO THE RECEPTACLE HOLDING THE LINEAR TIME CARD. THIS CONNECTS VARIOUS MAGNITUDES OF CHARGING CAPACITANCE. REFER TO THE SPECIFIC REGULATOR CONNECTION DIAGRAM FURNISHED WITH THE DRIVE AND/OR TO THE PROPER FUNCTION DIAGRAM IN THIS INSTRUCTION BOOK FOR DETAILS OF WIRING CONNECTIONS TO OBTAIN THE DESIRED TIME RANGE OF 2-8 SECONDS, 4-16 SECONDS, OR 8-32 SECONDS.

(2) ADJUSTMENT OF TIME WITHIN THE SELECTED RANGE IS MADE BY POTENTIOMETER ADJUSTMENT. IF THIS POTENTIOMETER IS CARD MOUNTED, AS IS USUALLY THE CASE, IT IS TERMED P440 AND ITS SHAFT EXTENDS THROUGH THE CARD FOR EASE OF ADJUSTMENT. THIS POTENTIOMETER IS SOMETIMES FURNISHED EXTERNAL TO THE CARD.

TROUBLE SHOOTING

A. CHECK THE INPUT AND OUTPUT VOLTAGES.
   1. 20 VOLTS D-C BETWEEN TABS 8 AND 2.
   2. 6.3 VOLTS A-C BETWEEN TABS 29 AND 32.
   3. APPLY A VOLTAGE STEP (APPROXIMATELY 18 VOLTS D-C AT THE INPUT TABS (TAB 30 TO 2).

B. IF THE OUTPUT VOLTAGE (TAB 22 TO TAB 2) DOES NOT TIME UP WHEN THE CONDITIONS OF "A" ARE MET, THE LINEAR TIME FUNCTION IS DEFECTIVE.
   1. CHECK THE TRANSISTORS AND DIODES. SEE SEMICONDUCTOR TROUBLE SHOOTING (GEI 95529).

2. CHECK CAPACITORS (C440, C441) WITH AN OHMMETER TO MAKE SURE THAT THEY ARE NOT SHORTED IN THE "RUNNING" MODE OF OPERATION. (THESE CAPACITORS ARE USUALLY SHORTED BY CIRCUITRY EXTERNAL TO THE CARD IN THE "OFF" MODE OF OPERATION.)

This adjustment attenuates the torque limit output signal and provides stability during the limiting action. This can also be adjusted to soften the limiting action. The "up limit" and "down limit" potentiometers are provided on the card, they are designated P446 for "up limit" and P447 for "down limit".

Adjustments

(1) Up limit - Potentiometer (P446 when mounted on printed circuit card) adjusts for desired torque limit during acceleration of the drive. Range of adjustment is normally from 80% to 200% of full load torque.

(2) Down limit - Potentiometer (P447 when mounted on printed circuit card) adjusts for desired torque limit during the deceleration of the drive. Range of adjustment is normally from 80% to 200% of full load torque. (This is used only on drives that are capable of providing braking torque by regeneration).

(3) Limit sensitivity - Potentiometer P448 adjusts for a soft or sharp limit. This also adjusts for stability during the limiting action.

Trouble Shooting

A. Check the input and output voltages.

1. 20 volts D-C between tabs 8 and 2.
2. 6.3 volts A-C between tabs 30 and 29.
3. Approximately 3 volts A-C between tabs 21 and 22 at 100% torque.

B. If the torque limit potentiometer does not limit the drive's maximum output when adjusted, the torque limit circuit is defective.

1. Check the diodes. See semiconductor trouble shooting (GEI 95529).
2. Check the capacitors using an ohmmeter to make sure that they are not shorted.

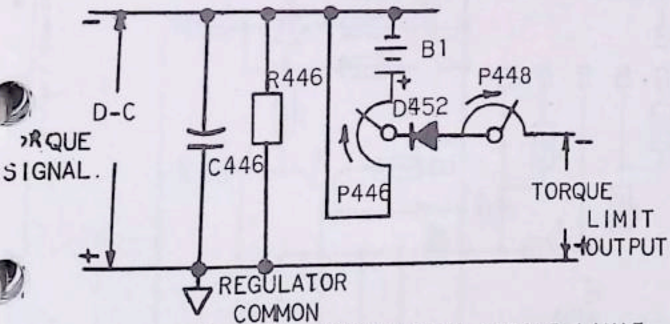


Fig. 2. Simplified torque limit circuit with a D-C limit input signal (up direction)

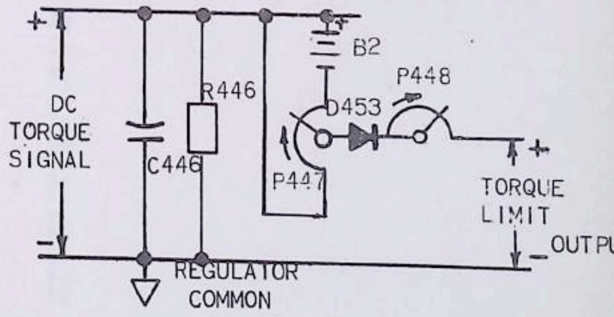


Fig. 3. Simplified torque limit circuit with a D-C limit input signal (down direction)

GENERAL ELECTRIC — 36C759762EA

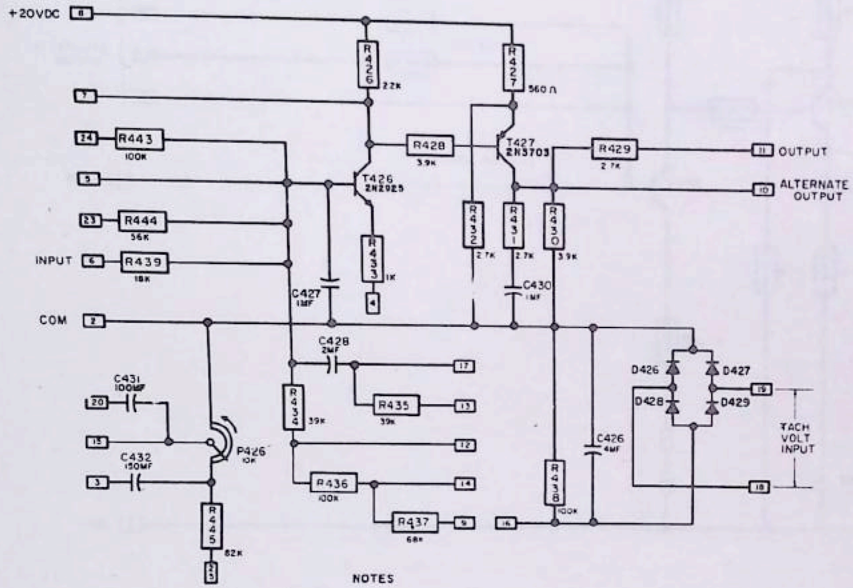
TITLE: PRINTED CIRCUIT DIAGRAM
COORDINATION AND SIGNAL AMPLIFIER

FIRST MADE FOR STANDARD LINE
193X800DAG01

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING -

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS: FRACTIONS	DECIMALS	ANGLES
718A515	✓	±	±	±

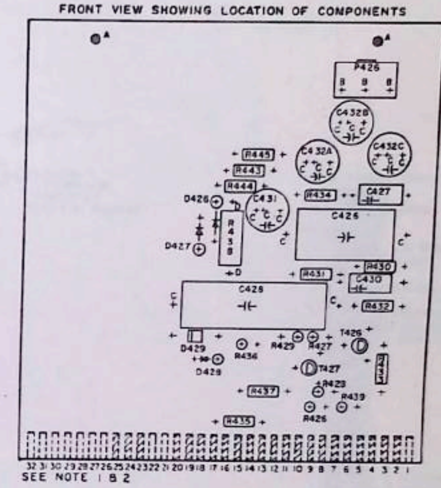
SCHEMATIC DIAGRAM



NOTES

I. NUMBERS INSIDE SMALL RECTANGLES INDICATE TAB NUMBERS WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS

FRONT VIEW SHOWING LOCATION OF COMPONENTS



SEE NOTE 1 & 2

NOTE 1 INDICATED TAB NUMBERS CORRESPOND TO MATCHING RECEPTACLE NUMBERS.
2. CROSS HATCHED TABS INDICATE TABS USED.
3. CARD SIZE, $5.500^{+.000}_{-.003}$ X $5.130^{+.002}_{-.008}$

HOLE TABULATION

ALL HOLES .040 DIA. EXCEPT THE HOLES TABULATED BELOW

LOC.	DIA.	QUAN.
A	.157	2
B	.078	3
C	.052	16
D	.062	2

TRANSISTOR LEAD SKETCH
TOP VIEW)

SKETCH FOR
T426, T427

SCALE	ETCHED CIRCUIT BOARD DWG.	SPACE UNIT REQUIREMENT FRONT	BACK
FULL	769891BDA001	2	0

REVISIONS

No revisions are to be made to this drawing without the specific approval of the Development Engineering Section of the Speed Variator Department.

PRINTS TO: 5 (S), 5D(BK), 5OC(BK) 5, 5B(2122), 5(TS50), 5OC(B)

REV NO. 0

MADE BY: D. Mattis MAY 17, 1971 — D. Tasner MAY 17, 1971 — APPROVALS

SPEED VARIATOR — ERIE

36C759762EA

PROPRIETARY INFORMATION OF THE GENERAL ELECTRIC COMPANY

36C759856CA

GENERAL ELECTRIC 36C759856CA

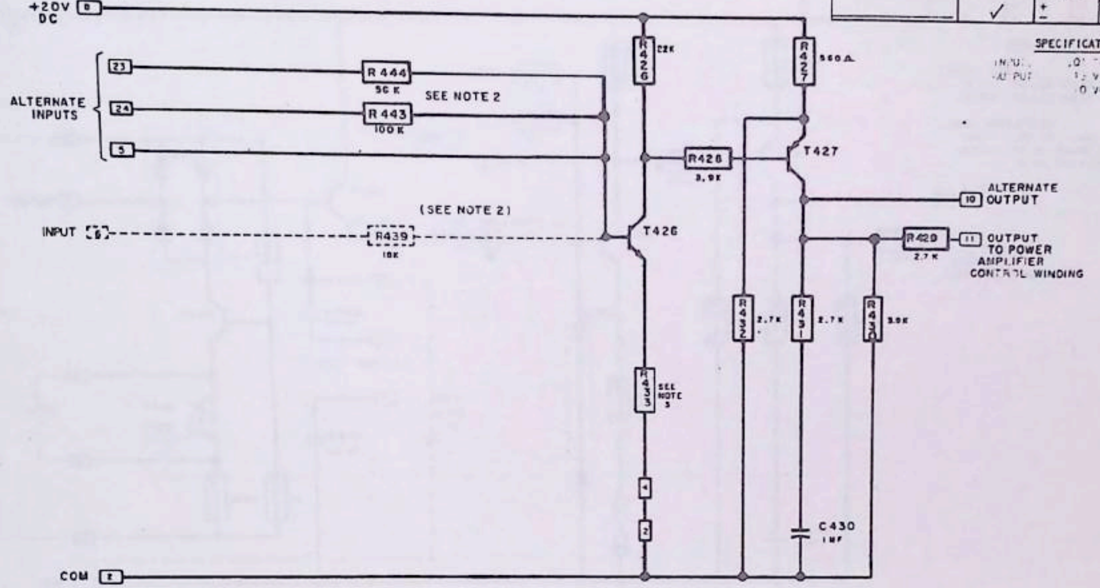
TITLE FUNCTION DIAGRAM SIGNAL AMPLIFIER

FIRST MADE FOR 193X850CAG01,02

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING -

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS: FRACTIONS	DECIMALS	ANGLES
	✓	±	±	±

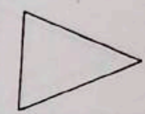
FUNCTIONAL SCHEMATIC



SPECIFICATION

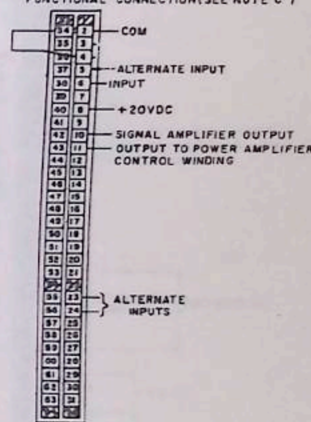
INPUT [illegible]
OUTPUT 12 VOLTS NO LOAD
0 VOLTS 10 MA MAX POWER

FUNCTIONAL SYMBOL



SIGNAL AMPLIFIER

FUNCTIONAL CONNECTION (SEE NOTE C)



193X800DAG01,02

NOMENCLATURE

[illegible]

R426 [illegible] FOR T427
R427 [illegible] FOR T427
R428 [illegible] LIMITING RESISTOR FOR T427
R433 OUTPUT CURRENT LIMIT RESISTOR - POWER AMPLIFIER COUPLING
R430 FILTER RESISTOR
R431 FILTER RESISTOR
R432 BIAS RESISTOR FOR T427
R433 EMITTER RESISTOR FOR T426
T426 NPN TRANSISTOR
T427 PNP TRANSISTOR

NOTES

1. NUMBERS INSIDE THE SMALL RECTANGLES INDICATE TAB NUMBERS WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS.
2. R439, R443, AND R444 ARE RESISTORS FROM THE COORDINATION PORTION OF 193X800DAG01,G02 AND ARE SHOWN ONLY FOR CLARIFICATION.
3. R433 RESISTOR VALUE

CARD NO.	RESISTANCE
193X800DAG01	1K
193X800DAG02	330Ω

VOLTAGE CHECK LIST

(WITH +20V CONNECTED BETWEEN TAB 8 AND TAB 2

+	-	VOLTAGE
TAB 10	TAB 2	0 TO 12 VOLTS (WHEN TAB 11 IS CONNECTED TO POWER AMPLIFIER CONTROL FIELD)

NOTES

A. INDICATES RETAINING SPRING

B — THE SEQUENCE WIRING OF RECEPTACLE MAY REQUIRE WIRES FOR BOTH ENTERING AND LEAVING A TERMINAL. THIS IS ACCOMPLISHED BY MAKING THE CONNECTIONS TO THE HORIZONTALLY ADJACENT TERMINALS AND INSERTING A JUMPER SPRING BETWEEN THE TERMINALS.

C — CONNECTIONS SHOWN ARE FOR THE SIGNAL AMPLIFIER ONLY. SEE SYSTEM ELEMENTARY DIAGRAM FOR COORDINATION CONNECTIONS.

D. — INDICATES A JUMPER SPRING

36C759856CA

REV NO 8 2

REVISIONS		PRINTS TO
1	[illegible]	5(S)
2	[illegible]	50(BK)
		5(TS)50
		5 P/M 150
		58(2)
		5(QC)

MADE BY [illegible] NOV 5 1964 — [illegible] NOV 9 1964 — APPROVALS [illegible]

D.C. MOTOR & GEN. ERIE

36C759856CA

GENERAL ELECTRIC 36C759857CA

TITLE FUNCTION DIAGRAM
SIGNAL AMPLIFIER WITH LINEAR TIME

FIRST MADE FOR 193X851CA G01,02,03,04

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES	SURFACES	FRACTIONS	DECIMALS	ANGLES
	✓	±	±	±

FUNCTIONAL SCHEMATIC

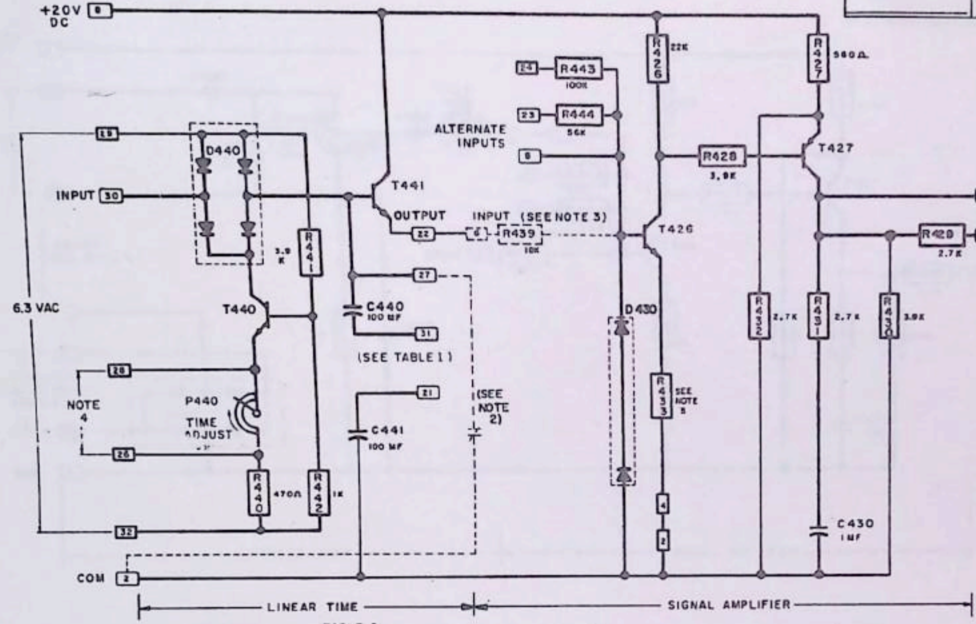


TABLE I

RANGE	SECONDS	JUMPER CONNECTION	CAPACITANCE
1	2 – 8	TAB 21 TO TAB 31	50 MF
2 *	4 – 16	TAB 21 TO TAB 27	100 MF
3	8 – 32	TAB 21 TO TAB 27 & TAB 31 TO TAB 2	200 MF

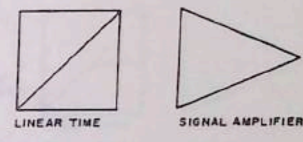
* STANDARD TIME RANGE

SPECIFICATION

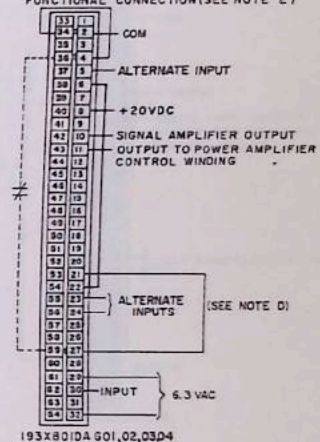
LINEAR TIME:
INPUT: 18—20 VOLTS MAX
OUTPUT: 17—19 VOLTS MAX

SIGNAL AMPLIFIER:
INPUT: .01 TO .1 MA
OUTPUT: 13 VOLTS—NO LOAD
10 VOLTS—10 MA MAX POWER

FUNCTIONAL SYMBOLS



FUNCTIONAL CONNECTION (SEE NOTE E)



193X801DA G01,02,03,04

NOMENCLATURE

LINEAR TIME

C440, 441	-TIMING CAPACITORS
D440	-SWITCH DIODE
P440	-TIME ADJUST POTENTIOMETER
T440	-CONSTANT CURRENT TRANSISTOR
T441	-OUTPUT TRANSISTOR (EMITTER-FOLLOWER)

SIGNAL AMPLIFIER

C430	-FILTER CAPACITOR
D430	-NEGATIVE ERROR LIMIT DIODES
R426	-BIAS RESISTOR FOR T427
R427	-EMITTER RESISTOR FOR T427
R428	-BASE CURRENT LIMITING RESISTOR FOR T427
R429	-OUTPUT CURRENT LIMIT RESISTOR FOR POWER AMPLIFIER COUPLING
R430	-FILTER RESISTOR
R431	-FILTER RESISTOR
R432	-BIAS RESISTOR FOR T427
T426	-NPN TRANSISTOR
T427	-PNP TRANSISTOR
R433	-EMITTER RESISTOR FOR T426

NOTES

1. NUMBERS INSIDE THE SMALL RECTANGLES INDICATE TAB NUMBERS WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS.
2. A RELAY INTERLOCK IS USED TO COMPLETELY DISCHARGE THE INTEGRATING CAPACITOR.
3. R439, R443, AND R444 ARE RESISTORS FROM THE COORDINATION PORTION OF 193X801DA001,002;003 & 004 CARDS AND ARE SHOWN ONLY FOR CLARIFICATION.
4. POTENTIOMETER P440 IS SUPPLIED ON CARD #193X801DAG01, G03 BUT IS MOUNTED EXTERNALLY WHEN CARD #193X801DAG02, G04 IS USED.
5. R433 RESISTOR VALUE

CARD NO.	RESISTANCE
193X801DAG01, G02	1K
193X801DAG03, G04	330 Ω

VOLTAGE CHECK LIST

(WITH +20V CONNECTED BETWEEN TAB 8 AND TAB 2, AND 6.3VAC BETWEEN TAB 29 AND TAB 32)

+	-	VOLTAGE
TAB 10	TAB 2	0 T. 10 VOLTS (WHEN TAB 11 IS CONNECTED TO POWER AMPLIFIER CONTROL FIELD)
TAB 22	TAB 2	0 T. 18 VOLTS

NOTES

A. [hatched box] INDICATES RETAINING SPRING

B. —— A RELAY INTERLOCK IS USED TO COMPLETELY DISCHARGE THE TIMING CAPACITOR.

C. —— THE SEQUENCE WIRING OF RECEPTACLE MAY REQUIRE WIRES FOR BOTH ENTERING AND LEAVING A TERMINAL. THIS IS ACCOMPLISHED BY MAKING THE CONNECTIONS TO THE HORIZONTALLY ADJACENT TERMINALS AND INSERTING A JUMPER SPRING BETWEEN THE TERMINALS.

D. —— CONNECTED FOR STANDARD TIME RANGE 2 (4--16 SECONDS). FOR OTHER RANGES RECONNECT PER TABLE I.

E. —— CONNECTIONS SHOWN ARE FOR THE SIGNAL AMPLIFIER AND LINEAR TIME FUNCTIONS ONLY. SEE SYSTEM ELEMENTARY DIAGRAM FOR COORDINATION CONNECTIONS.

F. ^ — INDICATES A JUMPER SPRING.

REVISIONS		PRINTS TO
1	C J Mechalske MAY 3, 1965	5(PCM)
RETRACED WITH CHANGES		50(BK)
2	OCT 7, 1965	5EL(BK 100)
3		

MADE BY C.J. Mechalske OCT 19, 1964 — B. Tabor NOV 9, 1964 — APPROVALS — D.C. MOTOR & GEN. ERIE — 36C759857CA

36C759858CA

GENERAL ELECTRIC

36C759858CA

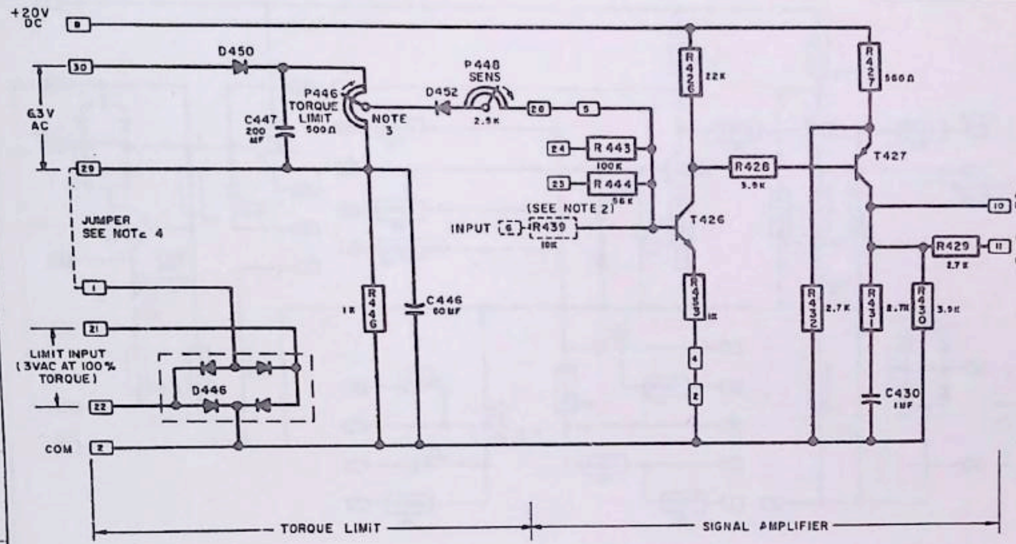
TITLE FUNCTION DIAGRAM
SIGNAL AMPLIFIER WITH TORQUE LIMIT

FIRST MADE FOR 193X852CAG01,G02

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING—

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS: FRACTIONS	DECIMALS	ANGLES
	✓	±	±	±

FUNCTIONAL SCHEMATIC

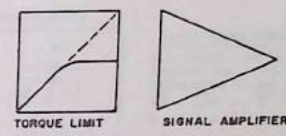


SPECIFICATION

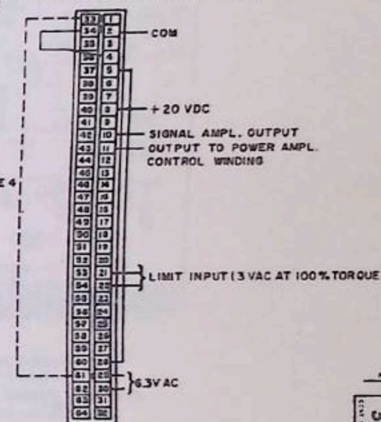
TORQUE LIMIT:
INPUT: AC LIMIT INPUT— 1 TO 8 VOLTS
— 3VAC AT 100% TORQUE
OUTPUT: LIMIT INPUT VOLTAGE MINUS VOLTAGE AS SET BY TORQUE LIMIT ADJ POT P446

SIGNAL AMPLIFIER:
INPUT: .01 TO .1 MA
OUTPUT: 13 VOLTS--NO LOAD
10 VOLTS--10MA MAX POWER

FUNCTIONAL SYMBOLS



FUNCTIONAL CONNECTION (SEE NOTE C)



NOMENCLATURE

TORQUE LIMIT

C446	-LIMIT SIGNAL FILTER CAPACITOR
C447	-LIMIT BIAS FILTER CAPACITOR
D446	-AC LIMIT VOLTAGE RECTIFIER
D450	-LIMIT BIAS RECTIFIER
D452	-HOLD OFF LIMIT DIODE
P446	-TORQUE LIMIT ADJUST
P448	-LIMIT SENSITIVITY
R446	-RECTIFIED LIMIT VOLTAGE LOADING RESISTOR

SIGNAL AMPLIFIER

C430	-FILTER CAPACITOR
R426	-BIAS RESISTOR FOR T427
R427	-EMITTER RESISTOR FOR T427
R428	-BASE CURRENT LIMITING RESISTOR FOR T427
R429	-OUTPUT CURRENT LIMIT RESISTOR FOR POWER AMPLIFIER COUPLING
R430	-FILTER RESISTOR
R431	-FILTER RESISTOR
R432	-BIAS RESISTOR FOR T427
R433	-EMITTER RESISTOR FOR T426
T426	-NPN TRANSISTOR
T427	-PNP TRANSISTOR

NOTES

1. NUMBERS INSIDE THE SMALL RECTANGLES INDICATE TAB NUMBERS WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS.
2. R439, R443 AND R444 ARE RESISTORS FROM THE COORDINATION PORTION OF 193X802DAG01 & G02 CARDS AND ARE SHOWN ONLY FOR CLARIFICATION.
3. POTENTIOMETER P446 IS SUPPLIED ON CARD #193X802DAG01 BUT IS MOUNTED EXTERNALLY WHEN CARD #193X802DAG02 IS USED.
4. IF AC IS USED CONNECT JUMPER FROM TAB 1 TO TAB 29. IF DC-SIGNAL IS USED, CONNECT SIGNAL DIRECTLY BETWEEN TAB 2 AND TAB 29.

VOLTAGE CHECK LIST

(WITH +20V CONNECTED BETWEEN TAB 8 AND TAB 2, AND 6.3V AC BETWEEN TAB 29 AND TAB 30)

+	-	VOLTAGE
TAB 27	TAB 29	8 VOLTS
TAB 2	TAB 29	0 TO 8 VOLTS DEPENDING UPON TORQUE LIMIT INPUT SIGNAL
TAB 10	TAB 2	0 TO 10 VOLTS (WHEN TAB 11 IS CONNECTED TO POWER AMPLIFIER CONTROL FIELD)

NOTES

A. ▨ INDICATES RETAINING SPRING.

B. ——— THE SEQUENCE WIRING OF RECEPTACLE (IF USED) MAY REQUIRE WIRES FOR BOTH ENTERING AND LEAVING A TERMINAL. THIS IS ACCOMPLISHED BY MAKING THE CONNECTIONS TO THE HORIZONTALLY ADJACENT TERMINALS AND INSERTING A JUMPER SPRING BETWEEN THE TERMINALS.

C. ——— CONNECTIONS SHOWN ARE FOR THE SIGNAL AMPLIFIER AND TORQUE LIMIT FUNCTIONS ONLY. SEE SYSTEM ELEMENTARY DIAGRAM FOR COORDINATION CONNECTIONS.

D. ⌒ — INDICATES A JUMPER SPRING.

REVISIONS: 1 — MAY 28, 1965

PRINTS TO: 5(PCM) 5D(BK) 5E(BK 100)

REV NO. 1

MADE BY: Nov 5 1964 — Nov 9, 1964 — APPROVALS: M.O.

D. C MOTOR & GEN — ERIE

36C759858CA

GENERAL ELECTRIC

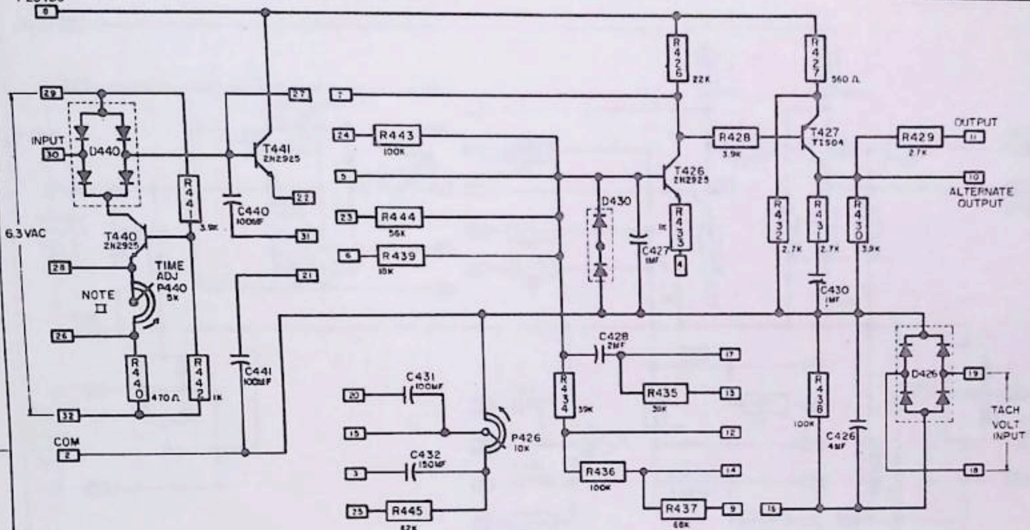
36C759882DA

TITLE **PRINTED CIRCUIT DIAGRAM**
COORDINATION AND SIGNAL AMPLIFIER WITH LINEAR TIME

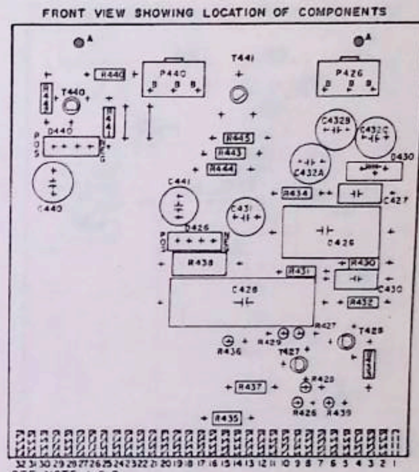
FIRST MADE FOR 193X801DAG01,02

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING —				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS: FRACTIONS	DECIMALS	ANGLES
718A515	✓	±	±	±

SCHEMATIC DIAGRAM



FRONT VIEW SHOWING LOCATION OF COMPONENTS



SEE NOTE 1 & 2

HOLE TABULATION

ALL HOLES .052 DIA.
EXCEPT THE HOLES
TABULATED BELOW

LOC.	DIA.	QUAR.
A	.157	2
B	.078	6

NOTE 1. INDICATED TAB NUMBERS CORRESPOND TO MATCHING RECEPTACLE NUMBERS.
2. CROSS HATCHED TABS INDICATE TABS USED.
3. CARD SIZE, $5.500^{+.000}_{-.015}$ X $5.130^{+.002}_{-.008}$

NOTES

I. NUMBERS INSIDE SMALL RECTANGLES INDICATE TAB NUMBERS, WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS.

II. POTENTIOMETER P440 IS SUPPLIED ON CARD #193X801DAG01 BUT IS MOUNTED EXTERNALLY WHEN CARD #193X801DAG02 USED.

TRANSISTOR LEAD SKETCHES (TOP VIEW)

SKETCH FOR T440 | SKETCH FOR T441 | SKETCH FOR T426, T427

SCALE	ETCHED CIRCUIT BOARD DWG.	SPACE UNIT REQUIREMENT FRONT	BACK
FULL	769891TCA	2	0

REVISIONS

		PRINTS TO
1	MAY 28 1965	5 (S)
2	OCT 2 1965	5D(BK)
		5PCM50
		5B(2)
		5TR50
		5DC

APR 1965
MAY 8 1965

D.C. MOTOR & GEN
ERIE

36C759882DA

REV NO. 2

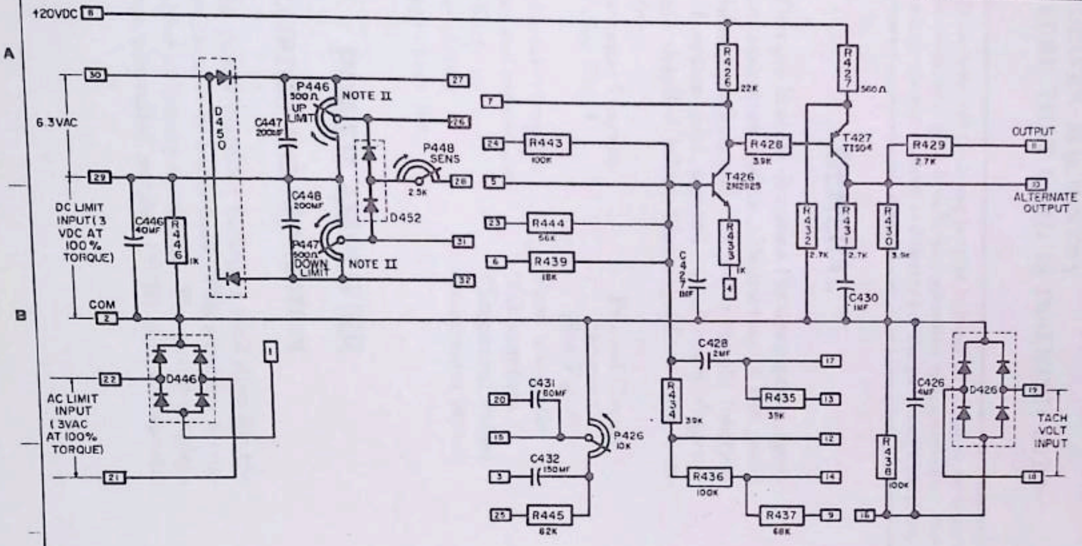
GENERAL ELECTRIC 36C759883DA

TITLE PRINTED CIRCUIT DIAGRAM
COORDINATION AND SIGNAL AMPLIFIER WITH TORQUE LIMIT

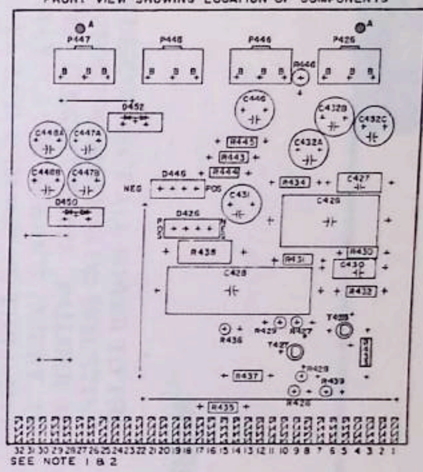
FIRST MADE FOR 193X802DAG01,02

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING –				
APPLIED PRACTICES	SURFACES	FRACTIONS	DECIMALS	ANGLES
718A515	✓	±	±	±

SCHEMATIC DIAGRAM



FRONT VIEW SHOWING LOCATION OF COMPONENTS



HOLE TABULATION

ALL HOLES .052 DIA. EXCEPT THE HOLES TABULATED BELOW

LOC	DIA.	QUAN.
A	.157	2
B	.078	12

NOTE 1. INDICATED TAB NUMBERS CORRESPOND TO MATCHING RECEPTACLE NUMBERS.

2. CROSS HATCHED TABS INDICATE TABS USED.

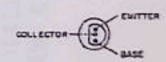
3. CARD SIZE, $5.500^{+.000}_{-.015}$ X $5.130^{+.002}_{-.008}$

NOTES

I. NUMBERS INSIDE SMALL RECTANGLES INDICATE TAB NUMBERS, WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS.

II. POTENTIOMETERS P446 AND P447 ARE SUPPLIED ON CARD #193X802DAG01 BUT ARE MOUNTED EXTERNALLY WHEN CARD #193X802DAG02 IS USED.

TRANSISTOR LEAD SKETCH
(TOP VIEW)



SKETCH FOR T426, T427

SCALE	ETCHED CIRCUIT BOARD DWG.	SPACE UNIT REQUIREMENT FRONT	BACK
FULL	769B918CA	2	0

REVISIONS

PRINTS TO: 5 (S), 5D(BK), 5(PCM50), 5B(2), 5(TS50), 5(OC)

MAY 25, 1964
MAY 28, 1965

D.C. MOTOR & GEN ERIE

36C759883DA

REV NO 0

REGULATOR (HALF-WAVE) POWER AMPLIFIER AND SUPPLY

WARNING

ALWAYS DISCONNECT ALL POWER TO THE DRIVE BEFORE REMOVING OR INSERTING A PRINTED CIRCUIT CARD. FAILURE TO DO SO MAY CAUSE SERIOUS INJURY TO PERSONNEL AND DAMAGE TO THE DRIVE OR DRIVEN MACHINERY.
BE SURE THAT CARD IS INSERTED INTO THE CORRECT REGULATOR RACK SLOT. CARD IDENTIFICATION NUMBER AND SLOT MARKING NUMBER MUST BE IN AGREEMENT. IF THEY ARE NOT, CONTACT SPEED VARIATOR PRODUCTS DEPARTMENT, GENERAL ELECTRIC COMPANY, ERIE, PA. 16501.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL

This publication discusses the description, application, operation and troubleshooting of the power amplifier function, and the power supply function. The function and printed circuit card diagrams contain detailed information regarding these combinations.

Functional Diagram (See Fig. 4)	Printed Circuit Diagram) (See Fig. 5)
Functional schematic	Card schematic
Functional connection	Tab numbers
Specifications	Component values
Nomenclature	Component layout
Voltage check list	

POWER AMPLIFIER

DESCRIPTION AND APPLICATION

The power amplifier furnishes excitation for the conversion unit or motor field. This amplifier is connected for half-wave operation. The circuit employs a silicon controlled rectifier (SCR) with a magnetic amplifier firing device. The SCR and free-wheeling diode are mounted on a finned heat sink on one side of the card. The magnetic amplifier and associated components are mounted on the reverse side.

OPERATION

The heart of the power amplifier is the SCR. The SCR operates on one-half cycle of the a-c source and is phase controlled by a magnetic amplifier (REAC). An increase in error signal causes the magnetic amplifier to saturate, passing a pulse of current every cycle of the a-c source into the gate lead of the SCR. This control pulse triggers the SCR into the conducting mode (fire), allowing current to flow through the load. When the a-c source reverses polarity, the magnetic amplifier comes out of saturation, removing the control signal to the SCR. The a-c reversal also turns off the SCR. The circuit is ready for another pulse of current when the a-c source again reverses.

Variable d-c output is therefore provided by turning on the SCR at various times during the conducting half-cycle. This is shown in Fig. 1.

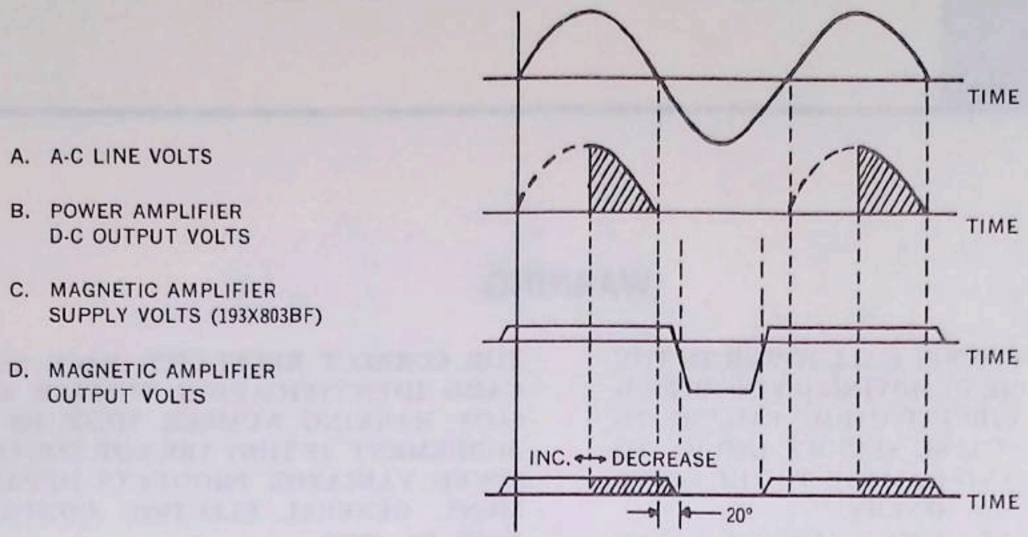


FIG. 1. POWER AMPLIFIER WAVE FORMS.

A positive voltage applied to the gate of the SCR with respect to the cathode during the half-cycle when the anode voltage is also positive, causes the SCR to allow current to flow (fire). This is the inherent characteristic of the SCR. The 115 volts a-c input and the 134 volts a-c (or 268 volts) input must be connected in the proper phase relationship to assure the above SCR phase relationships.

The amplifier saturates at a point during the application of the supply voltage dependent upon its bias and control winding conditions. With zero control signal, potentiometer P606 is usually adjusted to bias the magnetic amplifier to saturate near the end of the wave. This fires the SCR at the very end of the anode to the cathode forward voltage of the SCR, producing a very small output. If a positive control signal is applied to the magnetic amplifier, saturation occurs earlier in the cycle. This is called "phase control". The magnetic amplifier phases "on" with increasing control current to cause saturation to occur near the beginning of the flat-topped portion of the wave.

Saturation of the magnetic amplifier reduces its high impedance to a low impedance. The resulting current flows in the gate-cathode circuit of the SCR (D604). The firing point of the SCR is therefore controlled by the saturation point of the magnetic amplifier.

Diode D601 provides a half-wave rectified a-c for the bias circuit and gate supply circuit. The half-wave is clipped by Zener Z601 to form an asymmetrical square wave.

The magnetic amplifier bias circuit consists of potentiometer P606 and choke L603. The choke holds the current through the bias circuit constant at about 20 ma (depending on the bias requirement of the particular core). The choke absorbs energy during the time when Tab Group 8-12 is positive relative to Tab 31, and then "free wheels" through Zener Z601 when the line voltage reverses and diode D601 blocks.

Capacitor C601 couples the voltage across Zener Z601 to transformer TX601, blocking the d-c component and coupling only the a-c portion of fire voltage. The a-c portion is a square wave with one side lower in amplitude and 220 degrees wide and the other side higher in amplitude and 140 degrees wide, (curve "C" Fig. 1). The voltage is stepped down 4:1 in transformer TX601 to Section 1 of the secondary. This voltage is then applied to the magnetic amplifier gate winding circuit. The high

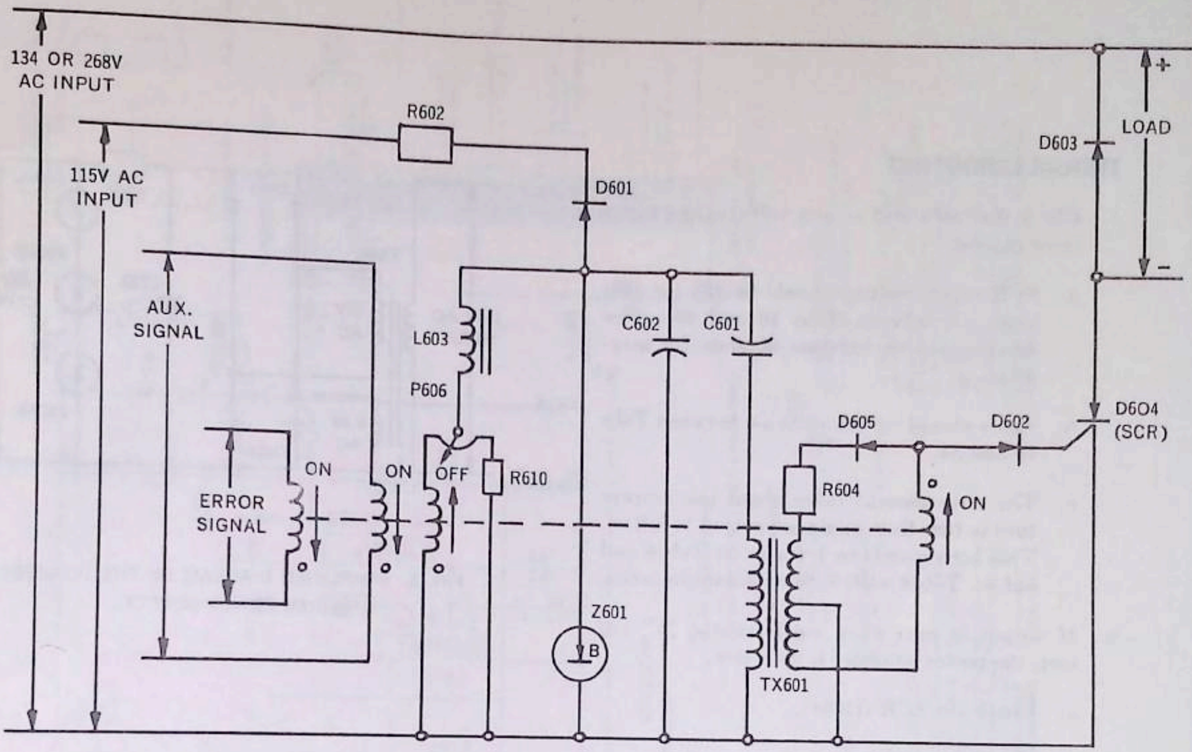


FIG. 2. SIMPLIFIED DIAGRAM OF THE 193X803BF SERIES POWER AMPLIFIER.

magnitude narrow portion is used in the re-set direction of the magnetic amplifier, reverse current being blocked by diode D602. The wider portion is applied in the forward direction (curve "D" Fig. 1). This allows the magnetic amplifier to be controlled over a full 180 degrees because of the 20-degree margin provided at each end. This assures SCR control from completely "off" to completely "on".

Capacitor C602 compensates for the excitation current of transformer TX601 so that no phase shift is introduced between the line a-c and the firing wave by the exciting current dropping through R602. Section 2 of the transformer secondary, resistor R604 and diode D605 provide an auxiliary loading circuit on the magnetic amplifier to divert the magnetic amplifier exciting current prior to the point of firing. This prevents accidental pre-firing of unusually sensitive SCR's. The choke in series with the control windings make the magnetic amplifier gain higher and less sensitive to external resistance. When the magnetic amplifier fires, primary current must be drawn by transformer TX601. This energy is supplied by capacitor C601 discharging back through Zener Z601. The Zener is held in conduction by the inductive current of choke L603.

ADJUSTMENT

Adjust the bias potentiometer P606 for about 0.5 volt power amplifier output with zero error signal input. Do not open circuit to the control windings to obtain zero error signal. The power amplifier must maintain its input impedance for this adjustment.

TROUBLESHOOTING

1. Check the input and output voltages and input error current.

   a. SCR supply voltage should be 134 (or 268) volts a-c between Tabs 10 and 20. (See specification on function diagram for magnitude).

   b. There should be 115 volts a-c between Tabs 10 and 31.

   c. The error current takes about one ampere turn to turn from minimum output to full on. This corresponds to 1 ma in on Tab 4 and out on Tab 2 with 2.2k minimum in series.

2. If output is zero when conditions of "1" are met, the power amplifier is defective.

   a. Check the SCR (D604).

   b. Check the diodes.

POWER SUPPLY

(Group 3 Only)

DESCRIPTION AND APPLICATION

The power supply is a basic element of the regulator. It provides the regulated d-c bus used by reference, emitter, and bias circuits of the regulator system. Zener diodes are the devices used to regulate the d-c power supply.

OPERATION

The power supply is isolated from the a-c supply by transformer TX602. Diode bridge D606 rectifies the transformer output and capacitor C603 is connected across the bridge to reduce the ripple. Resistor R606 feeds current to the regulating Zeners Z602A, B, C. The circuit is depicted in Fig. 3.

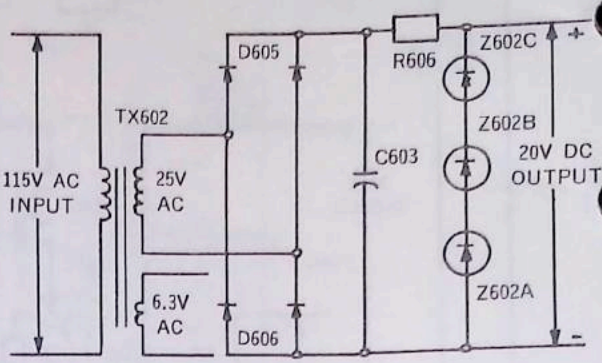


FIG. 3. SIMPLIFIED DIAGRAM OF THE 193X803BF SERIES POWER SUPPLY.

TROUBLESHOOTING

1. Check voltage input and output.

   a. Input volts—should be 115 volts a-c between Tabs 8 and 31.

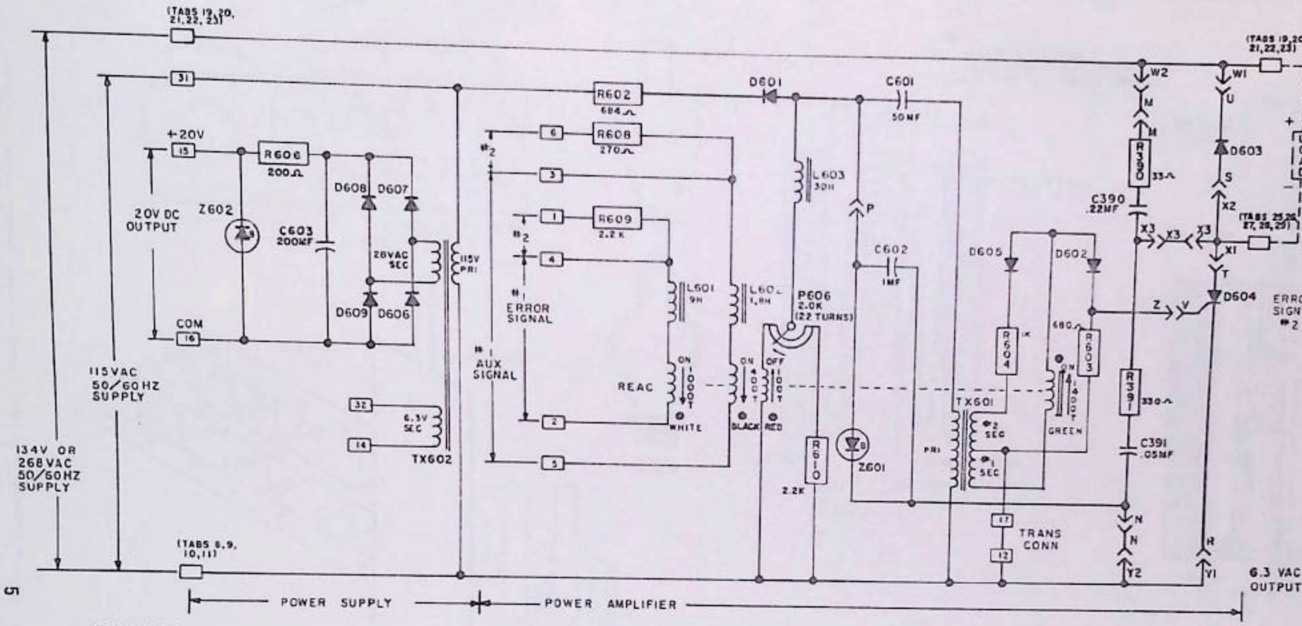
   b. Output volts—should be 18-21 volts d-c between Tabs 15 and 16.

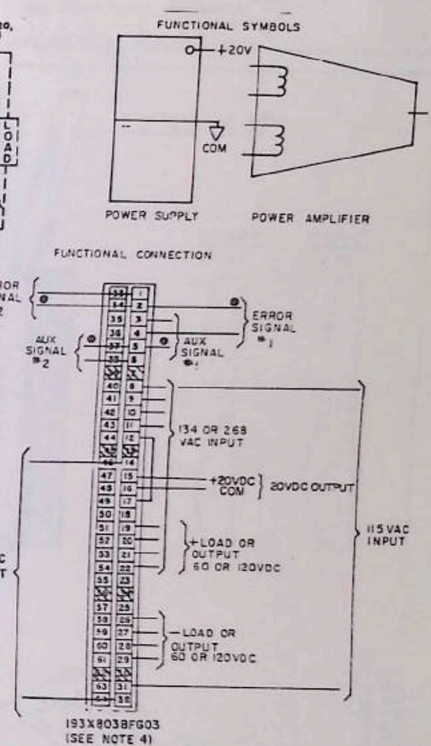
2. If the input voltage reading is correct but the output voltage is incorrect, the power supply is defective.

   a. Check components.

   b. Check capacitor C603 with an ohmmeter to be sure that it is not short circuited.

   c. Check resistor R606 with an ohmmeter to be sure that it is not open circuited.





NOMENCLATURE

C601 GATE SUPPLY COUPLING CAPACITOR
C602 PHASE SHIFT COMPENSATING CAPACITOR
C603 POWER SUPPLY FILTER CAPACITOR
D601 RECTIFIER FOR BIAS CIRCUIT AND GATE SUPPLY
D602 MAGNETIC AMPLIFIER RECTIFIER
D603 LOAD COMMUTATING (FREE WHEELING RECTIFIER)
D604 SILICON CONTROLLED RECTIFIER
D605 LOADING RECTIFIER
D606 RECTIFIER BRIDGE
L601,
L602 FILTER CHOKE
L603 MAGNETIC AMPLIFIER BIAS CHOKE
P606 MAGNETIC AMPLIFIER BIAS ADJUST
R602 VOLTAGE DROPPING RESISTOR
R603 GATE SHUNT RESISTOR
R604 MAGNETIC AMPLIFIER LOAD TRIMMING
R606 POWER SUPPLY DROPPING RESISTOR
R608 AUX. SIGNAL FEEDBACK RESISTOR
R609 ERROR SIGNAL FEEDBACK RESISTOR
R610 BIAS RESISTOR
REAC SATURABLE REACTOR
TX601 GATE SUPPLY TRANSFORMER
TX602 POWER SUPPLY TRANSFORMER
Z601 CLIPPING ZENER DIODE
Z602 POWER SUPPLY ZENER DIODE
R390 SUPPRESSION RESISTOR
C390 SUPPRESSION CAPACITOR
R391 SUPPRESSION RESISTOR
C391 SUPPRESSION CAPACITOR

NOTES

1. NUMBERS INSIDE THE SMALL RECTANGLES INDICATE TAB NUMBERS WHICH CORRESPOND TO MATCHING RECEPTACLE NUMBERS.
2. TO TURN THE POWER AMPLIFIER ON, CURRENT MUST FLOW WITH THE ARROW - OUT OF THE DOTTED LEAD.
3. THE 115V AC INPUT MUST HAVE THE SAME PHASE RELATIONSHIP AS THE 134 OR 268V AC INPUT WITH RESPECT TO TABS 8-11. TABS 8-11 MUST BE CONNECTED TO TERMINAL (X1) ON STANDARD TRANSFORMER.
4. TABLE:

FUNCTION CAT. NO.	DIRECT REPLACEMENT FUNCTION CAT. NO.	DIRECT REPLACEMENT PRINTED CIRCUIT CARD CAT. NO.
193X853ABG01*	193X853ABG01*, G02	193X803ABG01*▲ G02*▲ 193X803BBG01*▲ G02*▲ G03*▲ 193X803BCG03*▲ 193X803BDG03*▲, 193X803BEG03,▲ 193X803BFG03
193X853ABG02	--------------	193X803ABG02*▲ 193X803BBG02*▲ G03*▲ 193X803BCG03*▲ 193X803BDG03*▲, 193X803BEG03▲, 193X803BFG03
193X853ABG03	--------------	193X803ABG03*▲ 193X803BBG03*▲ 193X803BCG03*▲ 193X803BDG03*▲ 193X803BEG03▲, 193X803BFG03

* -INDICATES CARD OR FUNCTION HAS BEEN DELETED
▲ -INDICATES CARD IS LESS SUPPRESSION CIRCUITS (R390, C390, R391, C391)

SPECIFICATION

POWER AMPLIFIER:

OUTPUT: 60 VOLT DC
12 AMP (193X853ABG02)
INPUT: 134 VAC
115 VAC FOR FIRING CIRCUIT & POWER SUPPLY

OUTPUT: 120 VOLTS DC
12 AMP (193X853ABG03)
INPUT: 268 VAC
115 VAC FOR FIRING CIRCUIT & POWER SUPPLY

POWER SUPPLY:

OUTPUT: 20V DC (60MA MAX.)

VOLTAGE CHECK LIST

NORMAL VOLTAGE ON FIRING CIRCUIT AND POWER SUPPLY TAB 31 TO TAB GROUP 8-11 IS 115 VOLTS.
VOLTAGE ON POWER PORTION OF CIRCUIT (TAB GROUP 19-23 TO TAB GROUP 8-11 IS AS FOLLOWS)
193X853ABG02 134 VOLTS
193X853ABG03 268 VOLTS

NOTES

A. ▨ - INDICATES RETAINING SPRING
B. ● - TO TURN THE POWER AMPLIFIER ON, CURRENT MUST FLOW OUT OF THE DOTTED LEAD.
C. ——— - THE SEQUENCE WIRING OF RECEPTACLES MAY REQUIRE WIRES FOR BOTH ENTERING AND LEAVING A TERMINAL. THIS IS ACCOMPLISHED BY MAKING THE CONNECTIONS TO THE HORIZONTALLY ADJACENT TERMINALS AND INSERTING A JUMPER SPRING BETWEEN THE TERMINALS.
D. - THE 115V AC INPUT MUST HAVE THE SAME PHASE RELATIONSHIP AS THE 134 OR 268V AC INPUT WITH RESPECT TO TABS 8-11. TABS 8-11 MUST BE CONNECTED TO TERMINAL (X1) ON STANDARD TRANSFORMER.

FIG. 4. FUNCTION DIAGRAM OF 20 VOLTS D-C AND UNIDIRECTIONAL HALF-WAVE 60 or 120 VOLTS D-C POWER AMPLIFIER.

36C759321
CONT ON SHEET 2 SH. NO. 1

TITLE 921 MAINTENANCE KIT DRAWING

FIRST MADE FOR S21 REGULATOR

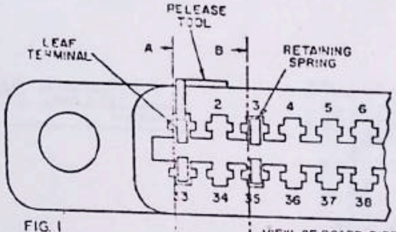


FIG. 1

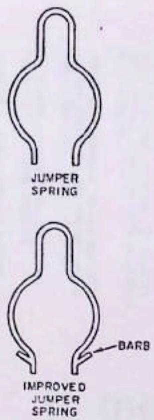


FIG. 9

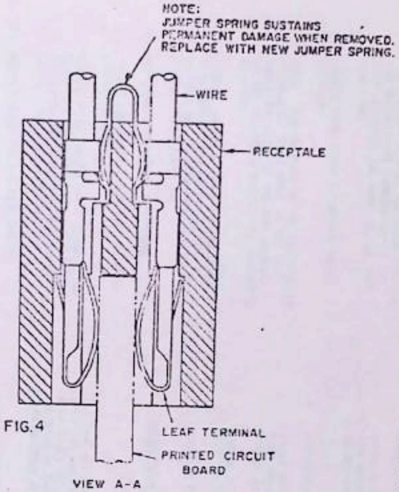


FIG.4

VIEW A-A

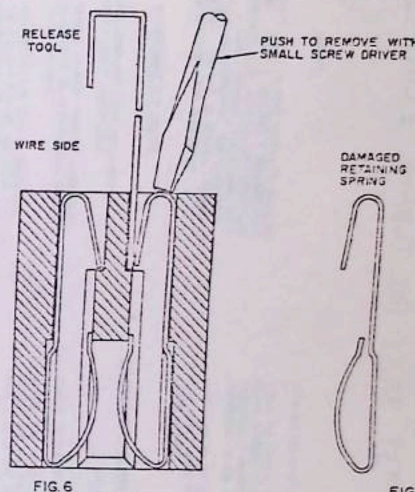


FIG.6

VIEW B-B

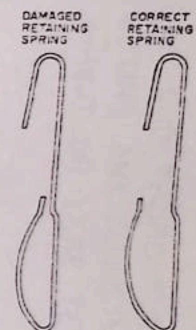


FIG.7

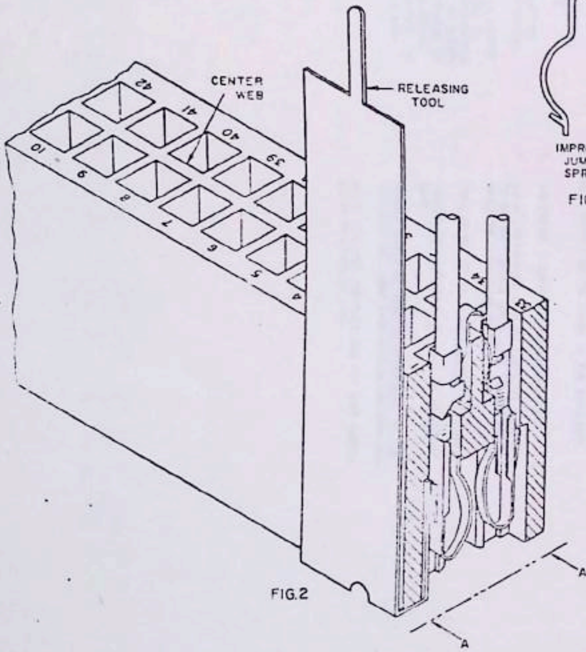


FIG.2

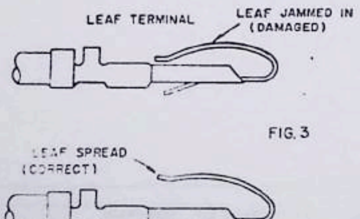


FIG. 3

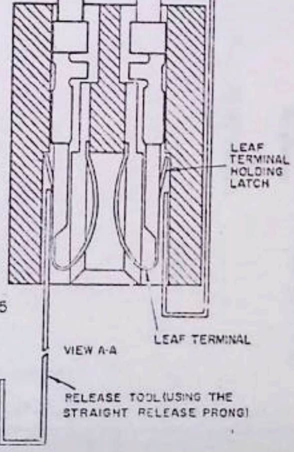


FIG.5

VIEW A-A

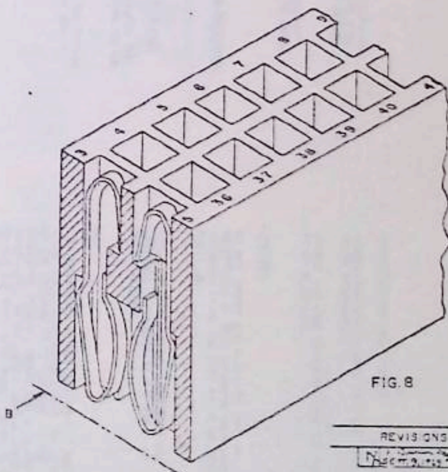


FIG. 8

36C759321
CONT ON SHEET 2 SH. NO. 1

REV

REVISIONS

SPEED VARIATOR

CAUTION! READ AND THOROUGHLY UNDERSTAND THESE INSTRUCTIONS BEFORE ATTEMPTING ANY ADJUSTMENT OR MAINTENANCE OF THE S-21 RECEPTACLE WIRING OR LEAF TERMINALS.

GENERAL

A MAINTENANCE KIT IS FURNISHED WITH EACH S21 REGULATOR. THE KIT INCLUDES A RELEASE TOOL, JUMPER SPRINGS, WIRE JUMPERS, AND RETAINING SPRINGS. A CARD EXTENDER IS AVAILABLE AS A MODIFICATION AND THEREFORE, SUPPLIED ONLY WHEN ORDERED. THE KIT IS NORMALLY STORED IN THE SPEED VARIATOR CASE BOOKHOLDER.

MAINTENANCE KIT USEAGE

A. INSTRUCTIONS FOR CHANGING WIRES IN THE PRINTED CIRCUIT RECEPTACLE.

1. REMOVE PRINTED CARD OR CARDS FROM RECEPTACLE OR RECEPTACLES THAT ARE TO BE REWIRED.

2. OPEN REGULATOR CASE BY RELEASING THE TWO LATCHES ON REGULATOR SUPPORT AND ROTATE CASE FORWARD UNTIL THE STOP SUPPORTS THE CASE IN THE OPEN POSITION.

3. LOCATE WIRE POINT OR POINTS TO BE CHANGED.

   NOTE: THE NUMBERS ON THE RECEPTACLES CORRESPOND TO NUMBERS IN THE WIRE TABLE AND ALSO TO THE TAB NUMBERS ON THE PRINTED CIRCUIT CARD SCHEMATIC DIAGRAM.

4. REMOVE JUMPER SPRINGS (IF PRESENT) FROM CONNECTIONS WHICH ARE TO BE CHANGED BEFORE REMOVING OR ADDING WIRES. SEE FIGURE #4.

5. REMOVING WIRES FROM RECEPTACLE:

   INSERT THE RELEASE TOOL AS SHOWN ON FIGURE #2 OR #5.

   REMOVE WIRE, WHICH HAS A CRIMPED ON LEAF TERMINAL, AS THE RELEASE TOOL DEPRESSES THE LEAF TERMINAL HOLDING LATCH. SEE FIGURE #2 OR #5.

6. ADDING WIRES TO THE RECEPTACLE.

   CHECK EACH LEAF TERMINAL FOR DAMAGED LEAF, BEFORE INSERTING INTO RECEPTACLE. SEE FIGURE #3.

   INSERT LEAF TERMINAL IN DESIRED LOCATION AND PUSH UNTIL THE HOLDING LATCH SNAPS INTO PLACE. SEE FIGURE #4.

   ADD JUMPER SPRINGS, WHERE NECESSARY, TO COMPLETE THE WIRE SEQUENCE.

   IMPORTANT: JUMPER SPRINGS MUST BE ADDED ONLY AFTER WIRES ARE INSERTED.

   NOTE: INSERT JUMPER SPRING ON CENTER WEB ONLY (HORIZONTALLY ADJACENT TO TERMINALS) AND PUSH WITH A SCREWDRIVER OR SIMILAR TOOL UNTIL SPRING IS SEATED ON RECEPTACLE SHOULDER. SEE FIGURE #4. TOO MUCH PRESSURE WILL EITHER DAMAGE THE SPRING OR PUSH THE SPRING OVER THE RECEPTACLE SHOULDER, CAUSING A MALFUNCTION.

7. WHEN MAKING WIRE CHANGES.

   CHECK THE ENTIRE WIRE RUN FOR EACH WIRE BEING CHANGED TO MAKE CERTAIN THE WIRE SEQUENCE IS MAINTAINED AND CONTINUOUS, ACCORDING TO THE WIRE TABLE.

   WORK ONLY TO AN ORIGINAL OR MARKED-UP WIRE TABLE WHEN MAKING CHANGES TO REGULATOR WIRING.

B. INSTRUCTIONS FOR REMOVING OR ADDING RETAINING SPRINGS

1. REMOVE RETAINING SPRING (SEE FIGURE #6).

   INSERT THE RELEASE TOOL PRONG BETWEEN THE CENTER WEB AND THE RETAINING SPRING ON THE WIRE SIDE OF THE RECEPTACLE.

   USING A SMALL SCREWDRIVER, PUSH THE RETAINING SPRING THROUGH THE RECEPTACLE AND OUT OF THE CARD SIDE.

2. ADD RETAINING SPRING:

   CHECK EACH RETAINING SPRING FOR DAMAGE BEFORE INSERTING INTO RECEPTACLE. SEE FIGURE #7.

   INSERT RETAINING SPRING INTO THE SELECTED SLOT IN THE CARD SIDE OF THE RECEPTACLE.

   PUSH UNTIL THE SPRING SNAPS INTO PLACE.

C. INSTRUCTIONS FOR USE OF A "CARD EXTENDER" (IF FURNISHED)

THE CARD EXTENDER IS DESIGNED TO ENABLE TROUBLE SHOOTING AND TESTING OF A PRINTED CIRCUIT CARD WITH POWER ON. WHEN A PRINTED CIRCUIT CARD IS INSERTED IN THE CARD EXTENDER, ANY POINT ON THE CARD BECOMES ACCESSIBLE FOR PROBING.

EACH PRINTED CIRCUIT CARD HAS AN ANTI-TARNISH PROTECTIVE COATING ON THE ETCHED SIDE OF THE CARD. WHEN PROBING ON THE ETCHED SIDE OF THE CARD, THE PROBE MUST PENETRATE THE PROTECTIVE COATING IN ORDER TO MAKE SATISFACTORY CONTACT.

THE CARD EXTENDER MAY ALSO BE USED TO EXTEND THE TEST POINTS TO THE FRONT OF THE REGULATOR.

1. EXTENDING A CARD FOR TROUBLE SHOOTING:

   LOCATE DEFECTIVE CARD BY CHECKING EACH TEST POINT PER VOLTAGE CHECK LIST ON THE SPEED VARIATOR ELEMENTARY DIAGRAM.

   TURN POWER OFF AND REMOVE DEFECTIVE CARD.

   INSERT CARD EXTENDER IN PLACE OF DEFECTIVE CARD.

   INSERT DEFECTIVE CARD IN RECEPTACLE OF CARD EXTENDER AND CLAMP CARD WITH MEANS PROVIDED.

   CHECK CARD PER INSTRUCTIONS FOR THAT PARTICULAR FUNCTION OR CARD.

2. EXTENDING THE TEST POINTS:

   REMOVE THE SPACER CARD FROM THE TEST POINT RECEPTACLE.

   INSERT THE CARD EXTENDER INTO THE TEST POINT RECEPTACLE.

   CAUTION:

   DO NOT INSERT ANY FUNCTION CARD IN RECEPTACLE OF CARD EXTENDER WHEN CARD EXTENDER IS IN THE TEST POINT RECEPTACLE POSITION.

   PROBE THE TEST POINTS FROM THE CARD EXTENDER RECEPTACLE AT THE FRONT OF THE REGULATOR.

   NOTE:

   THE RECEPTACLE IS NOT DESIGNED TO HOLD A TEST PROBE; THEREFORE, CLIP ONE LEAD OF THE INSTRUMENT TO "COMMON" ON THE REGULATOR TERMINAL BOARD AND WITH THE OTHER LEAD, WHICH SHOULD HAVE A PHONO-NEEDLE TIP TYPE TEST PROBE, PROBE POINTS FOR READINGS.

D. SEE GEI-87501A-14

GENERAL ELECTRIC

TITLE: S 21 MAINTENANCE KIT DRAWING

FIRST MADE FOR S21 REGULATOR

DC MOTOR & GEN. ERIE

REVISIONS

PRINTS TO: 5B(2) 5B(S) 5D(DM)

GEI-80757

INSTRUCTIONS

KINATROL*

EDDY CURRENT COUPLING DRIVE

EXCITER-REGULATOR

104X600

*Trade-mark of General Electric Company.

GENERAL ELECTRIC

CONTENTS

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

KINATROL EDDY CURRENT COUPLING DRIVE
EXCITER-REGULATOR
104X600

INTRODUCTION

This manual contains installation, operation, and servicing instructions for the 104X600 line of exciter-regulators. Field current to the KINATROL coupling is supplied by the exciter-regulator at whatever value required to hold output speed at a desired value. Only the basic line of exciter-regulators is described in this book. Special information on exciter-regulators in the modified line, or exciter-regulators used with co-ordinated systems will appear in composite instructions furnished for equipment of that type.

DESCRIPTION

The exciter-regulator is composed of:

1. A thyratron rectifier tube and silicon power rectifiers, sometimes called back rectifiers, arranged in a free-wheeling circuit.

2. A reference power supply consisting of silicon rectifiers, a voltage-regulator tube and filter.

3. A tachometer rectifier and filter.

4. Grid control circuits for the thyratron tube.

5. A filament, reference supply, and grid transformer.

Almost all circuit components are mounted flat on a printed board so their leads are readily accessible for measurements.

The thyratron tube is either socket-mounted with an anode cap or bracket-mounted with grid and filament leads which attach to screw terminals, and an anode cap. The screw terminals are used for connections for tubes of the higher ratings. The tubes, with their ratings are listed on the elementary diagrams.

Both incoming lines are fused. The fuse type has been selected to provide fast interruption and maximum protection of the back rectifier. Replacement fuses must be the same type.

Adjustments are provided for maximum speed, tube bias and sensitivity.

Screw terminals are provided for all customer's connections.

INSTALLATION

RECEIVING, HANDLING AND STORAGE

Immediately upon receipt, the equipment should be carefully unpacked to avoid damaging the apparatus. Particular care should be exercised to prevent small parts from being mislaid or thrown away in the packing material.

As soon as the equipment is unpacked, it should be examined for any damage sustained in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company, and the nearest General Electric Sales Office should be notified promptly.

If the equipment is not to be used as soon as it is unpacked, it should be stored in a clean, dry place and protected from accidental damage. Particular care should be exercised to avoid storing the equipment in a location where construction work is in progress.

GENERAL

It is strongly recommended that all setup and servicing adjustments and measurements covered in this section should be made only by qualified personnel using appropriate safety procedures applicable to electrical equipment. While voltages indicated in this section are nominal values, higher voltages may be encountered if measuring instrument leads are placed on incorrect terminals in the equipment, or if a malfunction exists in the equipment. Voltmeter or oscilloscope probes should be insulated against the highest voltages encountered in the equipment. Normal voltages up to 350 volts are present.

All of the installation instructions furnished with the equipment should be read carefully before any work is performed on the equipment. Do not apply power until the instructions have been studied and understood. Check for and remove any connections between regulator terminals and ground before applying power. Should it be required to ground any portion of the circuitry not shown as grounded on the diagram, please refer to the company. It is recommended that the control and operator's enclosures and machine frame be grounded.

The principles of operation are helpful in understanding how the exciter-regulator functions and provide a valuable aid in servicing the equipment. However, the information in that section of the book is not essential for installation or normal operation and maintenance of the drive.

Possible damage to wiring and machinery will be avoided if all of the connections are made correctly in accordance with the INSTRUCTIONS AND CONNECTION DIAGRAMS.

INITIAL SETUP

The following procedure should be followed on all basic unmodified drives. More complex drives including modifications have been pretested and adjusted at the factory, so that installation procedure should be limited to trimming adjustment, only. If trouble is encountered during startup, refer to the trouble-shooting section of these instructions.

There are four major adjustments which affect the regulator and regulated-drive performance.

1. SPEED CONTROL POTENTIOMETER - located in the operator's pushbutton station, it is the means by which the operator controls the drive-shaft speed.

2. MAXIMUM SPEED - a potentiometer located on the regulator. It sets the maximum speed that can be obtained by the operator turning the Speed-Control knob to the maximum speed position (full CW).

3. TUBE BIAS - potentiometer adjustment (on regulator) of the minimum regulator output. The operator's speed control will have continuous speed control above this minimum setting. May be used to adjust minimum speed.

4. SENSITIVITY - a potentiometer located on the regulator. It effects a compromise between the minimum change in speed due to load changes (increased sensitivity) and stable operation (decreased sensitivity).

Adjustment of sensitivity and tube bias affect, to some degree, the proper adjustment of maximum speed.

1. Initially set:

SENSITIVITY at mid position
TUBE BIAS at full CW position
MAXIMUM SPEED at full CCW position
SPEED CONTROL at full CCW position

2. Insert the tubes and apply power but do not depress the start button. Allow 15-minutes initial warmup time to evaporate condensed mercury from the thyratron grid and anode. After this initial protective measure the drive may be started within the much shorter time (30 to 60 seconds) after power is applied. However, when the thyratron tube is replaced, the 15 minute period should again be adhered to for maximum tube life.

3. When the start button is pressed with potentiometers set as in (1) above, the output shaft should remain at standstill. If the output shaft should rotate, then consult the elementary diagram and the trouble-shooting chart on pages 6 and 7 for the probable cause, and correct the trouble before proceeding.

4. Turn the tube bias potentiometer in the CCW direction until there is a barely discernable glow in the thyratron tube. This corresponds to minimum tube current. This adjustment should be made with the shaft at standstill.

5. Gradually turn the SPEED CONTROL potentiometer to the required top speed (CW) position within the nameplate rating (the coupling must be loaded). Turn the MAXIMUM SPEED potentiometer in the increase direction (CW) until 90 volts appears across the output of the exciter regulator (points 6 and 9). This will correspond to approximately rated top speed, full torque. If for any reason it is desired to limit the top speed to something less than rated speed, then adjust the MAXIMUM SPEED potentiometer until the desired top speed is reached, as indicated by a hand tachometer. Refer to the data nameplate on the eddy current coupling for the correct top rated speed.

If there is an indication of instability or hunting at any speed in the range traversed, decrease the sensitivity to the point where the instability is eliminated. The MAXIMUM SPEED and TUBE BIAS may need to be readjusted slightly if the sensitivity is changed.

6. As a check it is suggested that the speed control potentiometer be gradually turned to the

full CW and then the CCW position, checking for proper top rated speed and minimum tube current respectively. Trim the adjustment of maximum speed and tube bias, as necessary, until the rated top speed and the described minimum tube output are obtained.

7. If the drive proves stable throughout the preceding, with the SENSITIVITY potentiometer at mid position, the drive sensitivity (gain) and regulating ability may be improved by turning the SENSITIVITY potentiometer in the increase direction (CW). The maximum value of sensitivity is the setting just below which drive instability may occur at any speed within the speed range of the drive. If sensitivity is changed, recheck operation in accordance with step 6.

MAINTENANCE

GENERAL

One of the principal advantages of electronic control is the small number of moving parts. Because of the nature of the components — such as resistors, capacitors and transformers — this type of G-E control requires a minimum of maintenance.

Maintenance of this equipment is primarily a matter of routine inspection of the panel, tubes and wiring. The equipment should be kept as clean as possible. It is recommended that dust and dirt be brushed or blown off at regular intervals, preferably once a month.

TUBE INSPECTION

During normal operation, the thyratron tube (2V) will have a blue glow. The intensity of tube glow will vary with drive speed and load and may vary in intensity from tube to tube. The voltage reference tube (1V) has a steady pink glow when functioning normally.

CONTACTOR INSPECTION

A. Contactors should be inspected at regular intervals, preferably about once a month. The following is a check list of items which could cause trouble:

1. Collection of dirt or gum.

2. Excessive heating of parts: evidenced by discoloration of metal parts, charred insulation or odor.

3. Binding or sticking of moving parts.

4. Corrosion of metal parts.

5. Little remaining wear allowance on contacts.

6. Too little contact pressure.

7. Loose connections.

8. Worn or broken mechanical parts.

9. Excessive arcing in opening circuits.

B. Refer to individual instructions for specialized contactors and relays which may be present depending on the application.

SERVICING

GENERAL

When incorrect operation is first noticed, it is often possible to reduce greatly the over-all servicing time by studying all of the symptoms. The trouble can often be isolated by observing or inspecting the suspected component, or by the process of elimination if the circuit functions are clearly understood. In some cases, however, a systematic check of the entire system may be required.

WIRING DIAGRAMS

The wiring diagrams (showing the relative location of the components) and the system elementary diagram (showing the circuit operation) are most useful in trying to locate trouble. The diagrams are supplied with the equipment.

EQUIPMENT FOR TESTING CIRCUITS

Since circuits in electronic controls often contain high impedances, meters with high impedance are required to service this equipment properly. The radio service multimeter, having a resistance of 20,000 ohms per volt, is a very useful instrument. The cathode-ray oscilloscope and a vacuum-tube voltmeter are also useful but not essential.

THYRATRON TUBE

If the thyratron tube is suspected of causing improper drive operation, replace it with a tube known to be good. If the drive operation is now correct, the tube was defective. (See the troubleshooting chart which follows for further details.)

TROUBLESHOOTING CHART

The following troubleshooting chart is intended as a guide for one not experienced in electronic control. The same fundamentals apply as in any electric circuit. Only those components more likely to fail are listed in the tables. Transformers, resistors and potentiometers usually have long life and seldom fail. As a supplement to this chart, a table of nominal a-c and d-c voltages is given to aid in troubleshooting.

TROUBLESHOOTING CHART

TROUBLE 1 — OUTPUT SHAFT DOES NOT ROTATE

PROBABLE CAUSE	CHECK AND REMEDY
1. Low Reference Voltage	(a) Speed Control potentiometer 2P may be open or shorted. Connections to 2P may be open. Replace potentiometer if defective.
	(b) Capacitor 2C may be shorted. Replace.
	(c) Capacitor 1C may be shorted. Replace.
	(d) Tube 1V may be defective. Replace.
	(e) Rectifiers 2 REC, 3 REC may be open or shorted. Replace.
2. "M" Contactor Does Not Energize	(a) Connections from start or stop pushbutton may be open. Check wiring.
	(b) "M" Contactor coil may be open — replace contactor.
3. Blown Fuse	(a) Check 1FU and 2FU. If open, replace. Check for and remove all grounds in the regulator circuitry, speed control potentiometer, coupling start-stop pushbutton leads, tachometer generator leads and coupling field leads. Check for open or shorted back rectifier cells (11 REC) which may have been faulted as a result of the ground.
4. Defective Thyratron Tube	
5. Shorted Back-Connected Rectifier 11 REC.	(a) Shorted rectifiers will blow fuses. If fuse is replaced and new fuse blows after power is applied, check rectifiers, and for grounds (see 3).

TROUBLE 2 — OUTPUT SHAFT ROTATES AT TOP SPEED AND DOES NOT RESPOND TO SPEED CONTROL POTENTIOMETER

PROBABLE CAUSE	CHECK AND REMEDY
1. High Reference Voltage	(a) Speed Control potentiometer 2P may be open or connections may be open. Replace if defective.
2. Insufficient Tachometer Feedback	(a) Check for rated a-c voltage from tachometer generator between points 4 and 3 in exciter-regulator. If voltage is absent or low, check tachometer and connections between tachometer and panel.
	(b) Rectifier 1 REC, may be open. Replace.
	(c) Capacitor 3C or 6C may be shorted. Replace.
3. Thyratron Tube 2V has lost control and is firing full on	(a) Tube 2V is defective. Replace.
	(b) Capacitor 5C is shorted. Replace.

TROUBLE 3 — OUTPUT SHAFT RUNS AT SPEED LOWER THAN THAT CALLED FOR OR WILL NOT HOLD SPEED AS LOAD IS APPLIED

PROBABLE CAUSE	CHECK AND REMEDY
1. Coil Excitation is Low	(a) Open back rectifier 11 REC. Check for grounds before replacing.
	(b) Defective thyratron tube. Replace.

TROUBLE 4 — DRIVE SPEED IS UNSTABLE (SPEED HUNTS OR OSCILLATES ABOUT SET SPEED IN A REGULARLY RECURRING CYCLE)

PROBABLE CAUSE	CHECK AND REMEDY
1. Sensitivity Potentiometer 4P is Turned Too High	(a) Turn 4P in decrease direction until drive is stable (turn CCW).
2. Phase-Shifting Circuit is Defective	(a) Capacitor 4C open or shorted. Replace 4C.
3. Cyclic Load	(a) Turn sensitivity to minimum. If the drive is still unstable the loading must be modified to minimize its cyclic nature.

TROUBLE 5 — DRIVE SPEED IS ERRATIC

PROBABLE CAUSE	CHECK AND REMEDY
1. Reference Voltage Itself may be Erratic	(a) Capacitor 2C may be open. Replace. (b) Tube 1V may be defective. Replace.
2. Spikes From Line Voltage Are Causing Thyratron Tube to Fire Erratically	(a) Capacitor 5C is open. Replace.
3. Thyratron Fires Erratically	(a) Thyratron may be defective. Replace.
4. Tachometer Feedback Voltage is Erratic	(a) Pickup may exist on the leads between the tachometer and exciter-regulator. Shield the tachometer leads or place in a separate conduit.
5. Phase-Shifting Circuit is Defective	(a) Capacitor 4C open or shorted. Replace.

SERVICING

NOMINAL VOLTAGE CHART

VOLTAGE BETWEEN POINTS	A-c Voltage	D-c Voltage	COMMENTS
15-16	220		
44-16	less than 1	180	
45-16		150	
1-4		0	2P Min., 1P any position, 3P any position
46-16		25	3P Max.
1-4		100	1P Min., 2P Max., 3P any position
1-4		150	1P Max., 2P Max. 3P any position
4-3	155-180		At Top Speed
4-27		120-140	At Top Speed
10-35	110		
20-28	30		
21-28	30		
37-9	220		
40-23	2.5		
6-9		+5 to +15 +20 to +90	Any speed, no load Any speed, full load

PRINCIPLES OF OPERATION

GENERAL

The KINATROL Eddy Current Coupling Exciter-regulator utilizes a closed-loop regulator to hold output speed of the coupling nearly constant at the setting called for by the operator, regardless of changes in line voltage or loading.

Figure 1 illustrates the Eddy Current Coupling System in block-diagram form. A-c power is applied to an induction motor which runs at essentially constant speed. The mechanical output of the induction motor is transmitted through an Eddy Current Coupling to the load. A small a-c tachometer generator which supplies a voltage proportional to output speed is mounted within the coupling.

The speed-control potentiometer transmits a portion of a regulated d-c voltage to the regulator comparison point for a reference signal. If we assume that we are starting the drive from rest (no excitation on the coupling field coil), there will be no speed-feedback signal from the a-c tachometer generator. Therefore, the output of the comparison point will equal the input-voltage signal from the speed-control potentiometer. This signal will be of sufficient magnitude to call for the regulator amplifier and phase shifter to turn the regulator thyratron full on. The thyratron will then supply direct current to the field coil of the coupling. As a result, torque from the induction motor will be transmitted through the coupling to accelerate the load. Acceleration will continue until the regulator receives a feedback signal from the tachometer generator large enough to almost cancel out the signal being received from the operator's control potentiometer. (Note in Fig. 1 that the polarity of the d-c voltage from the speed-feedback signal is opposite from that of the speed-control potentiometer.) When the net or difference signal being fed into the regulator amplifier decreases, the output of the regulator rectifier will be reduced. Excitation to the field

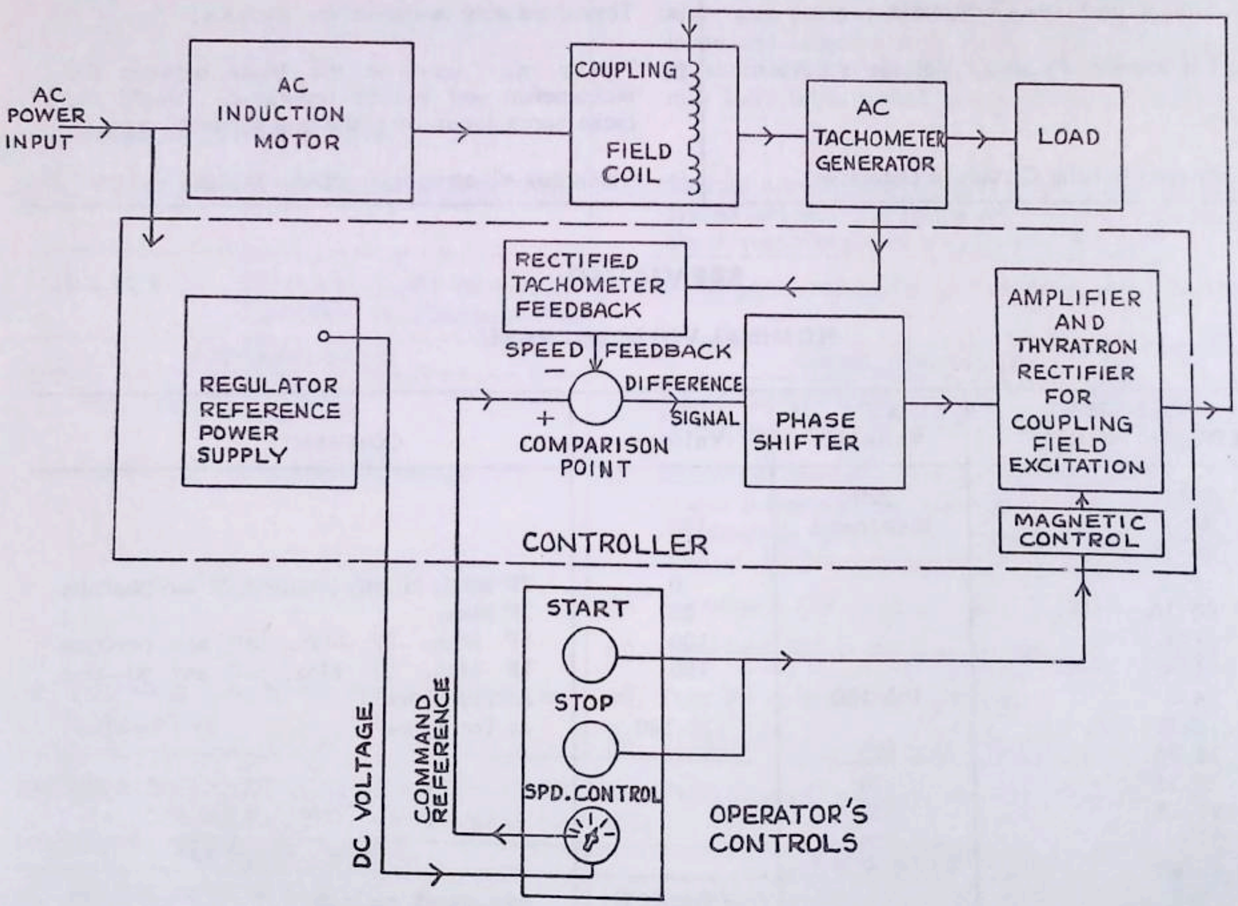


Fig. 1. Basic Kinatrol block diagram.

coil of the coupling will then settle out at a value just sufficient to supply the connected-torque load.

The gain or amplification in the regulator allows a small change in tachometer feedback at the comparison point to vary the rectifier output to the coupling coil over the full required range. Thus, at a given reference setting, the tachometer voltage bucking out this reference need change only slightly for any changes in load or line voltage within the rating of the drive. Since the tachometer voltage is directly proportional to drive speed, change in drive speed or "regulation" will also be small.

DETAIL BREAKDOWN

A detailed breakdown of the regulator elements shown within the dotted box in Fig. 1 will now be made.

1. REGULATOR REFERENCE

Figure 2 illustrates the reference-voltage power supply for the speed-control potentiometer. A secondary winding of transformer 1T supplies 220-volts a-c power. Two silicon diodes, 2 REC and 3 REC are connected in series to supply half-wave rectified d-c output. A conventional filter circuit consisting of resistors 4R and 5R, capacitors 1C and 2C are used to smooth out the pulsating d-c voltage from the half-wave rectifier. The voltage appearing at the output of this power supply between points 44 and 16 is approximately 180 volts d-c. In order to make the reference voltage to the speed-control potentiometer relatively insensitive to changes in a-c line voltage, tube 1V is added to the circuit. This tube is a gas-filled voltage-regulator tube. When a high enough voltage is applied across the terminals of the tube to initiate gaseous conduction within the tube, the voltage across the tube drops to approximately 150 volts and adheres closely at this value. The speed-control potentiometer, mounted external to the regulator controller, is connected across the reference glow tube, with the maximum speed rheostat mounted within the regulator enclosure connected in series with the speed-control potentiometer. The latter rheostat may be adjusted to limit the speed range available to the operator through control of the speed potentiometer.

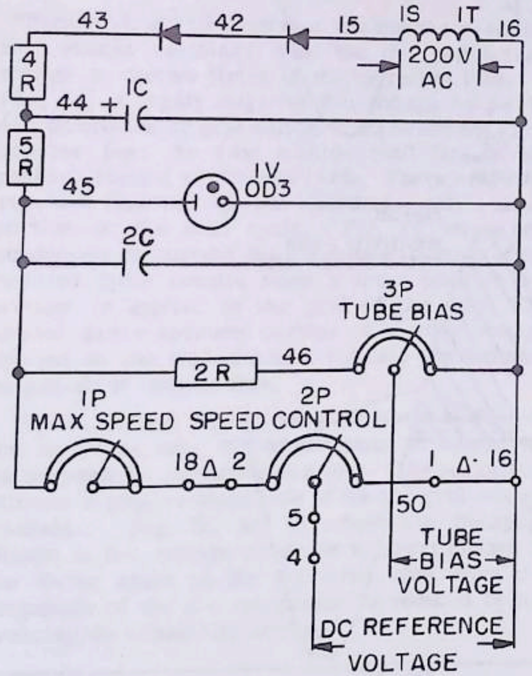


Fig. 2. Regulator reference-voltage power supply.

2. REGULATOR FEEDBACK

The circuit which is used to convert the a-c tachometer-generator voltage to a form usable by the regulator is shown in Fig. 3. A half-wave rectifier consisting of silicon diode 1 REC is used to convert the a-c tachometer feedback voltage to a d-c voltage. This voltage is then filtered by resistors 3R, 8R, 6R and capacitor 3C in addition to capacitor 6C. The rectifier is so connected that feedback-voltage output is positive at circuit point 4. Resistors 3R, and 8R divide the tachometer-output voltage down to desired level and act as a bleeder load for capacitor 6C. In addition, resistor 8R provides a d-c path for the grid circuit of thyratron tube 2V which is discussed in section 4. The net d-c feedback voltage appears between 4(+) and 27(-).

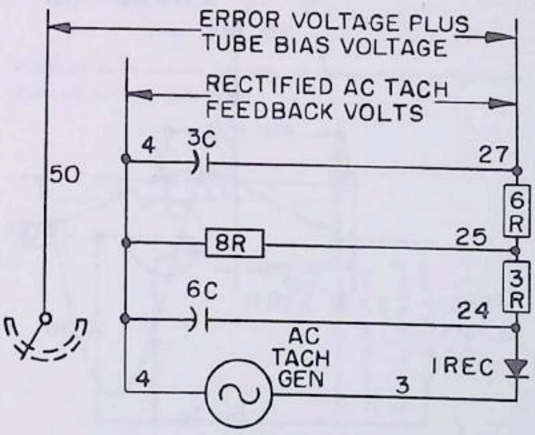


Fig. 3. Regulator-feedback circuit.

3. REGULATOR AMPLIFIER AND PHASE SHIFTER

The circuitry which accepts the d-c error signal from the reference-feedback section of the regulator and modifies it for controlling a thyratron tube is shown in Fig. 4. The elements of the phase-shifting bridge consist of center-tapped transformer winding 2S1T, resistors 7R, and 9R, potentiometer 4P and capacitor 4C. These components provide an a-c voltage between circuit points 28 and 49 which is approximately 100 degrees lagging with respect to the voltage appearing at the anode of the thyratron tube. The amplitude

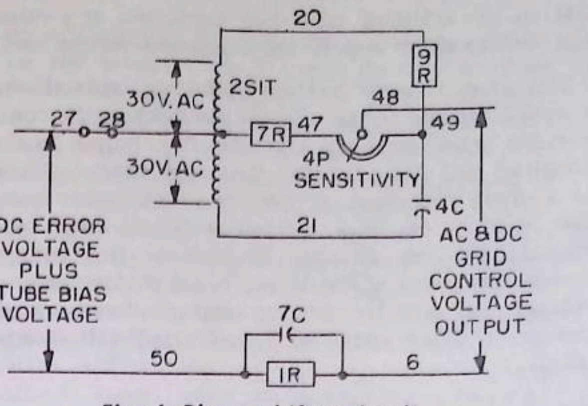


Fig. 4. Phase-shifter circuit.

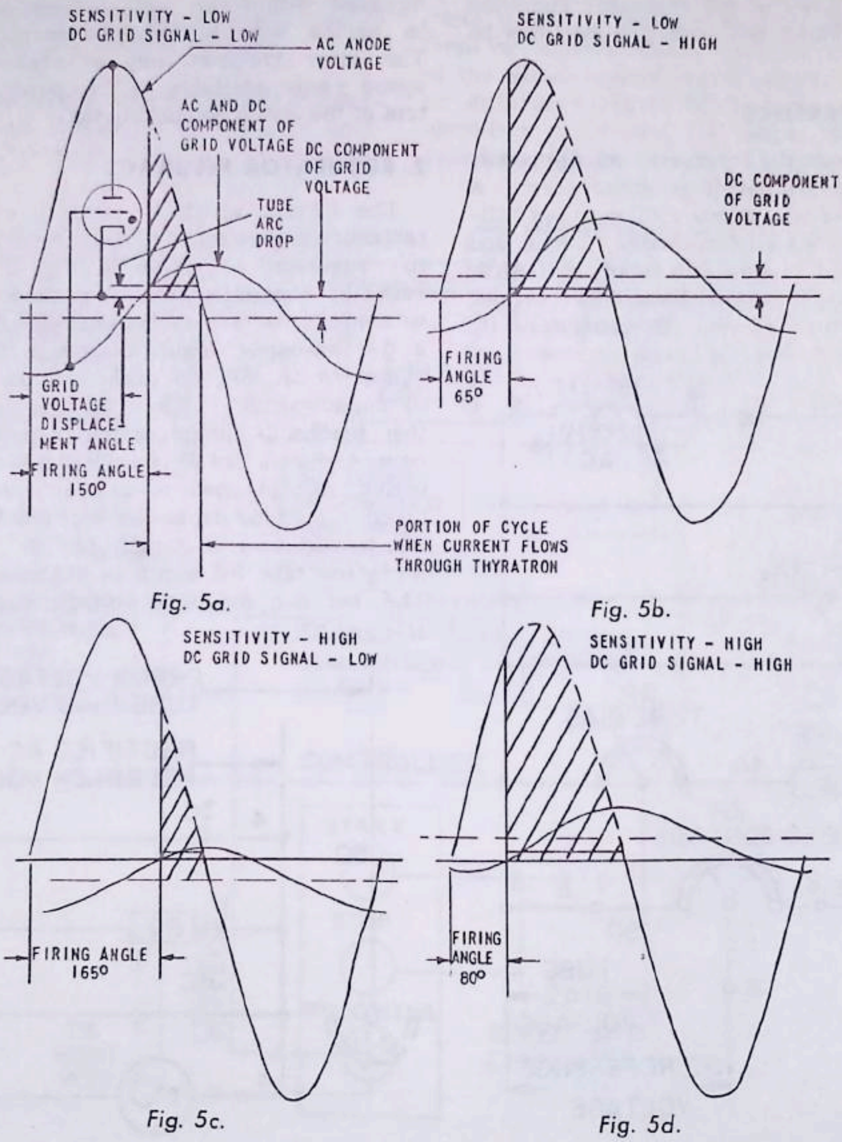


Fig. 5. Regulator waveforms.

of this voltage is adjustable over a wide range by potentiometer 4P. The output of the phase-shifting circuitry between points 48 and 6 consists of this phase-shifted a-c voltage wave superimposed on the d-c voltage from the comparison point.

In order to better explain the operation of this circuitry in controlling the thyratron tube, a brief review of the operating characteristics of a thyratron tube follows. For the purpose of the present discussion, it will be assumed that whenever the grid of a thyratron tube is negative with respect to the cathode, the tube will not conduct current, and any time the grid goes positive with respect to the cathode (but only during that portion of the cycle when the anode is also positive with respect to the cathode), the tube will conduct. After the first instant of conduction, the voltage across the tube drops to a low level of approximately 15 volts (arc-drop) and remains at this level for the conduction period. The tube will conduct current at a rate limited only by the load impedance in series with the tube until the anode voltage of the tube has gone negative with respect to the cathode. At this time, conduction will cease and the tube will remain nonconductive even after its anode again goes positive until the grid again goes positive with respect to the cathode.

*Figure 5A and 5B illustrate how the phase-shifted a-c voltage combines with the d-c comparison voltage to control firing of the thyratron tube. In Fig. 5A, a highly negative d-c voltage keeps the a-c component of grid voltage from becoming more positive than the tube cathode until late in the positive portion of the tube cycle. Therefore, current will flow through the tube during only a small portion of the total cycle. Fig. 5B shows how conduction of current over a greater portion of the positive cycle results when a more positive d-c voltage is applied to the grid of the tube. The shaded areas indicate periods of positive voltage applied to the load and thus indicate approximate magnitude of current flow.

Figure 5A and 5B represent the phase shifting of the thyratron tube for a low value of sensitivity as adjusted by potentiometer 4P. This sensitivity utilizes a greater magnitude of the a-c grid voltage available. Fig. 5C and 5D show how the same change in d-c voltage produces a larger change in the firing angle of the thyratron tube when the magnitude of the a-c component is reduced by increasing the sensitivity setting.

*These waveforms are not to scale. The grid voltage is shown larger than actual value as compared to the anode voltage in order to present a clearer picture.

4. REGULATOR POWER RECTIFIER

The 220-volt a-c line is applied between terminals 8 and 7 of the regulator, fuses 1FU and 2FU providing short-circuit protection. Refer to Fig. 6A. Action of the thyratron tube in controlling current to the coupling coil during the positive half cycles of anode voltage at the thyratron was explained in section 3. Since conventional current always flows from anode to cathode within an electronic tube, circuit point 6 of the coupling coil will always be positive with respect to circuit point 9. As soon as the anode voltage (illustrated in Fig. 5A through 5D) goes negative with respect to the cathode voltage of the thyratron tube, back-connected rectifier 11 REC will conduct.

Figure 6A illustrates the path for current flow during the portion of the positive half cycle when tube 2V is conducting. Figure 6B shows the path for current flow during the remainder of the cycle when tube 2V is rendered non-conducting. The

CURRENT PATH DURING PORTION OF CYCLE WHEN THYRATRON TUBE 2V IS CONDUCTING.

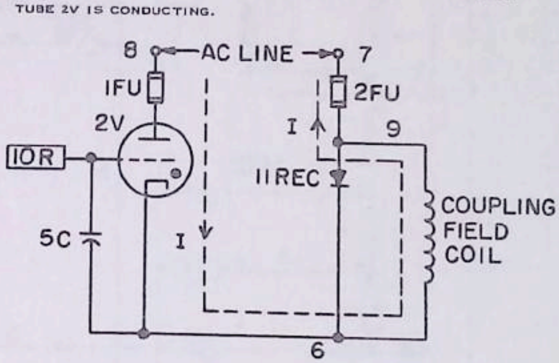


FIG. 6a

CURRENT PATH DURING PORTION OF CYCLE WHEN THYRATRON TUBE 2V IS NOT CONDUCTING.

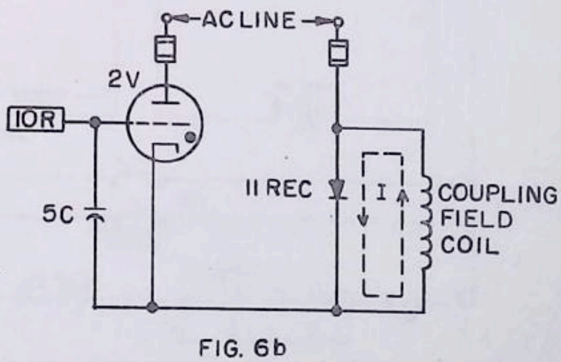


FIG. 6b

Fig. 6. Regulator power rectifier.

energy which has been stored in the magnetic field of the clutch field coil during the half cycle when the thyratron is conducting is transformed into electrical energy during the negative half cycle. Thus, current flow through the coil is maintained in the same direction during the portion of the cycle when no external power is supplied. This means that current flow through the clutch coil will be essentially constant even though the voltage appearing across the clutch coil is of a pulsating nature. Two additional elements in the thyratron power circuitry consist of resistor 10R and capacitor 5C. Resistor 10R appearing between the output of the phase-shifting panel and the grid of the thyratron tube limits the value of grid current flow within the thyratron tube to recommended levels. Capacitor 5C is connected between the grid and the cathode of the thyratron tube. Due to the inter-electrode capacitance between the grid and anode of the thyratron tube, a sharp transient spike of line voltage appearing at the anode of the tube would attempt to pull the grid positive and thereby cause the tube to fire. By connecting a capacitance of sufficient magnitude between the grid and the cathode of the tube, the grid is prevented from going positive due to transient disturbances and allows firing only when so commanded by the phase-shifting circuitry.

5. MAGNETIC CONTROL

Refer to the operating notes provided on the diagrams furnished with the equipment.

DESCRIPTION OF OPERATION

THIS EQUIPMENT PROVIDES FORWARD, OR FORWARD AND REVERSE DRIVE SHAFT ROTATION, DEPENDING ON THE TYPE OF AC MOTOR STARTER AND STARTER CONTROL OBTAINED BY THE PURCHASER WITH THE SPEED BEING ADJUSTABLE BY MEANS OF THE SPEED CONTROL KNOB. THE OUTPUT SHAFT SPEED IS AUTOMATICALLY REGULATED TO MINIMIZE THE CHANGES IN SPEED FROM THAT SET BY THE OPERATOR DUE TO LOAD CHANGES.

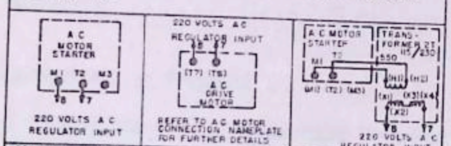
CHECK FOR AND REMOVE ALL CONNECTIONS BETWEEN REGULATOR TERMINALS AND GROUND BEFORE APPLYING POWER. SHOULD IT BE REQUIRED TO GROUND ANY PORTION OF THE CIRCUITRY NOT SHOWN AS GROUNDED, ON THE DIAGRAM, PLEASE REFER TO THE COMPANY. IT IS RECOMMENDED THAT THE CONTROL AND OPERATORS ENCLOSURES AND MACHINE FRAMES BE GROUNDED.

OPERATING GUIDE:

1. APPLY AC LINE VOLTAGE TO THE AC MOTOR STARTER OF THE EDDY CURRENT COUPLING DRIVE UNIT BY CLOSING THE AC POWER DISCONNECT DEVICE.
2. START THE AC MOTOR BY PRESSING THE AC MOTOR "START" BUTTON. POWER MAY BE REMOVED FROM THE AC DRIVE MOTOR AND THE COUPLING FIELD DE-ENERGIZED BY PRESSING THE AC MOTOR "STOP" BUTTON. THE OUTPUT SHAFT WILL COAST TO A STOP AT A RATE DEPENDING ON THE TOTAL INERTIA AND FRICTIONAL FORCES ACTING ON THE OUTPUT SHAFT. A DISCONNECT SWITCH OR CIRCUIT BREAKER SHOULD BE OPENED TO MORE COMPLETELY REMOVE AC POWER AND LINE VOLTAGE.
3. START THE OUTPUT DRIVE SHAFT BY PRESSING THE COUPLING "START" BUTTON. IT IS RECOMMENDED THAT THE SPEED CONTROL BE TURNED TO THE MINIMUM SPEED POSITION (FULL CCW) BEFORE PRESSING THE COUPLING "START" BUTTON.
4. PRESSING THE COUPLING "STOP" BUTTON WILL REMOVE EXCITATION FROM THE EDDY CURRENT COUPLING FIELD AND CAUSE THE DRIVE SHAFT TO COAST TOWARD STANDSTILL AT A RATE DEPENDING ON THE INERTIA AND FRICTIONAL FORCES ACTING ON THE OUTPUT SHAFT. THE TUBE BIAS ADJUSTMENT IS PROVIDED TO COUNTERACT THE SMALL RESIDUAL TURNING FORCES PRODUCED BY THE EDDY CURRENT COUPLING.
5. UNLESS THE DRIVE WAS PURCHASED WITH THE TUBE WARM-UP ACCESSORY TO THE STANDARD CONTROL, ABOUT 30 SECONDS SHOULD BE ALLOWED AFTER PRESSING THE AC MOTOR "START" BUTTON AND BEFORE PRESSING THE COUPLING "START" BUTTON, DURING INITIAL START UP IN ORDER TO INSURE MAXIMUM TUBE LIFE.
6. FOR REGULATOR DESCRIPTION OF OPERATION AND SET UP PROCEDURE, REFER TO THE REGULATOR INSTRUCTION BOOK.

SKETCH #1

OBTAIN 220 VOLTS AC REGULATOR POWER INPUT IN ACCORD WITH THE PROPER FIGURE BELOW FOR THE A C LINE VOLTS TO WHICH THE EQUIPMENT TO BE CONNECTED. CONNECT WIRES 7 & 8 TO REGULATOR TERMINALS 7 & 8



220 V A C LINE VOLTS	440 V A C LINE VOLTS	550 V A C LINE VOLTS
FACTORY CONNECTION	PURCHASER'S CONNECTION	FACTORY CONNECTION

NOTES:

1. THE VALUE ON ALL RESISTORS IS IN MEGOHMS UNLESS OTHERWISE SPECIFIED. ALL RESISTORS ARE RATED 1 WATT; ALL POTENTIOMETERS 2 WATTS UNLESS OTHERWISE SPECIFIED. VALUES ON CAPACITORS ARE MICROFARADS.
2. THE ROTATION OF ALL POTENTIOMETERS AND RHEOSTATS IS VIEWED FROM SHAFT END. THE ARROW ADJACENT TO THE SYMBOL INDICATES CW ROTATION.
3. FEEDBACK APPROXIMATELY 130 VOLTS DC AT TOP SPEED OF COUPLING.
4. TO AVOID INTERFERENCE WITH REGULATOR OPERATION, CONNECT NO MORE THAN TWO OF THE STANDARD (M) TYPE RELAYS.
5. $ - INDICATES RECOMMENDED SHIELDED CABLE LOCATION.
6. * - SUPPLIED IF ORDERED.
7. [R] - REMOTELY MOUNTED.

NOMENCLATURE

C - CAPACITOR
FU - FUSE
M - CLUTCH CONTACTOR
P - POTENTIOMETER
PIT - TRANSFORMER PRIMARY
R - RESISTOR
REC - RECTIFIER
SIT - TRANSFORMER SECONDARY
THY - THYRECTOR

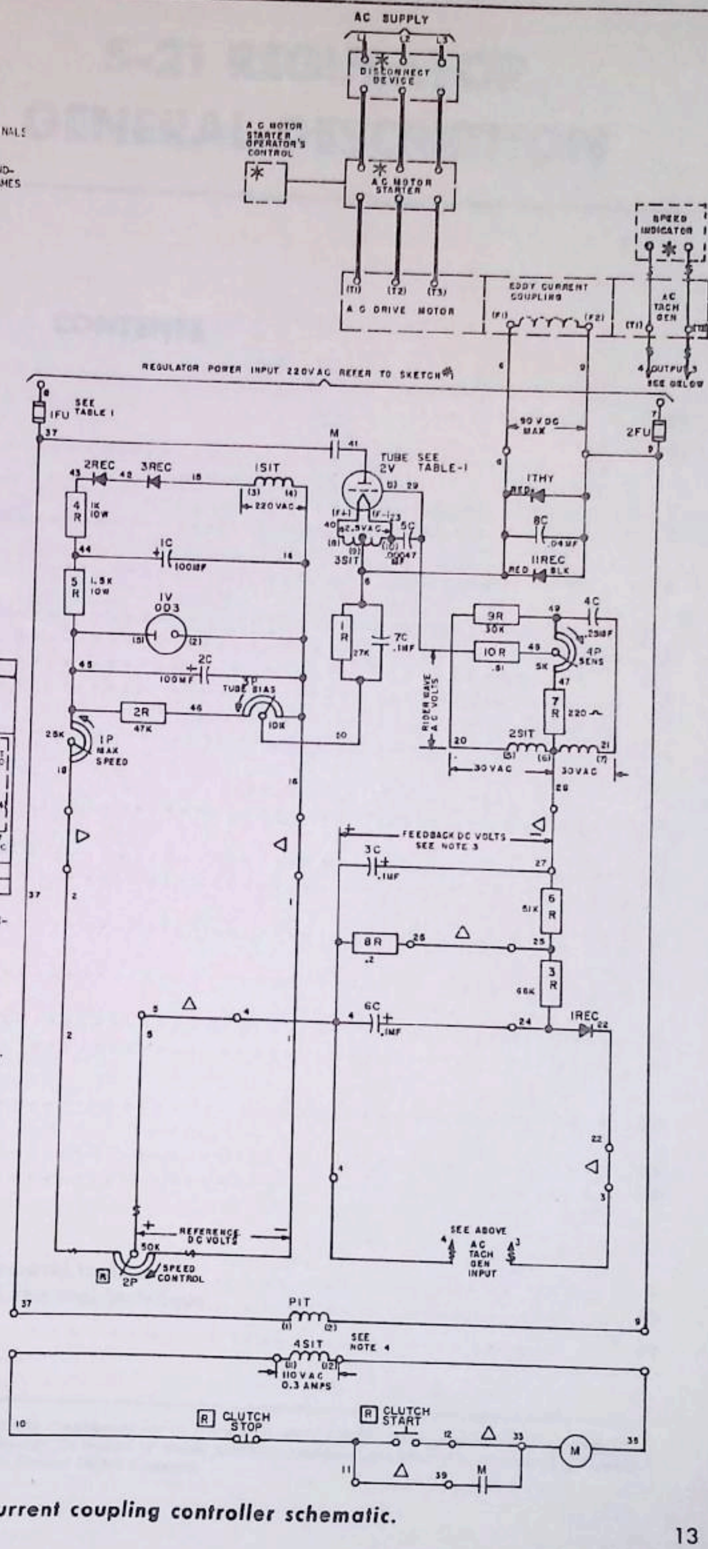


TABLE 1		
REG.	FUSES	TUBE
WATTS	1FU 2FU	2V
220	4AMP	GL3C23
360	4AMP	GL6011/710
540	7AMP	GL6857/740P
900	10AMP	GL6859/760P

Fig. 7. Eddy current coupling controller schematic.

INSTRUCTIONS

Speed variator

S-21 REGULATOR GENERAL DESCRIPTION

CONTENTS

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

INTRODUCTION

These instructions cover the S-21 silicon-controlled rectifier regulator used with Speed Variators. Regulator operation, specific function operation, adjustment, troubleshooting, and diagram practices and usage are described.

MECHANICAL CONSTRUCTION

The components of each function are mounted on one or more printed circuit boards, called cards. The cards are inserted in guides and mated in properly spaced receptacles on a rack assembly. A handle on each card provides accessibility for removing individual cards for inspection.

The cards that require functional adjustments have provision for screwdriver adjustments through the front cover, where these adjustments are clearly identified. Certain cards, which rarely need adjustment except at initial setup, are accessible for bias adjustments from the top or the bottom of the regulator. A Phillips-type screwdriver with an insulated shaft should be used.

Interconnection of the cards is made by plug-in jumpers on the back of the receptacles. External connections are wired to a terminal board. Access to the jumper connections is provided by loosening the catches on the side of the rack and rotating it. The rack rotates approximately 110 degrees to a mechanical stop.

DEFINITIONS

BOARD: An insulated base with conductive electrical circuit paths.

CARD: A printed circuit board with components mounted and soldered.

CARD COVER: A sheet metal cover attached to the front of the card.

CIRCUIT PATH: That portion of conductive material, having low electrical resistance, intended primarily to provide point-to-point electrical connections.

FILLER CARD: A card used to fill the unused area in the rack.

HEAT SINK: An extruded section of aluminum used to dissipate the maximum amount of heat away from the controlled rectifier.

JUMPER SPRING: A jumper used on the wire side of the receptacle to connect two adjacent terminal slots (horizontally, never vertically).

LEAF TERMINAL: The terminal used for making wire connections at the rear of the receptacle.

NUT STRIP: A metal strip used (instead of nuts) to hold the card cover to the board.

RACK: The assembly that accepts and retains the cards, guides and receptacles.

RECEPTACLE: The component that accepts the card and makes electrical connection between the printed circuit card and the external wiring.

RETAINING SPRING: A metal spring inserted in the card side of the receptacle to apply pressure to the card to prevent the card from inadvertently slipping out.

SPACE UNIT: A space of 0.76 inches which is used to determine space requirements of individual cards. The total space used by a card is a multiple of this dimension.

TAB: That portion of a circuit path that connects the circuit to a receptacle and performs the function of a pin in a male plug.

TEST POINT: A designated receptacle point at which a voltage measurement may be made.

TEST RECEPTACLE: A receptacle to which a number of circuits are wired for testing purposes.

ELECTRICAL DIAGRAM PRACTICE

GENERAL NOTES

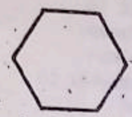
1. The arrows on the potentiometers on the function and card diagrams indicate clockwise rotation.

2. Capacitors connected in series (such as stabilizing capacitors on the coordination card) with their negatives connected together merely depolarize the capacitor connection. Two 100-mf polarized capacitors connected in series have 100-mf capacitance for either polarity.

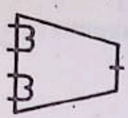
REGULATOR ELEMENTARY DIAGRAM

The diagram practice for the S-21 silicon-controlled rectifier regulator uses symbolic representation for the subdivisions of the regulating system. See Table I for the symbol legend. A function may consist of one or more printed circuit cards. However, the functional symbols remain the same regardless of the actual hardware needed to perform the function.

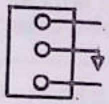
TABLE I



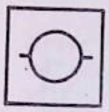
COORDINATION CARD: Ties the cards into a system by use of resistors, potentiometers, capacitors, etc.



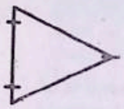
POWER AMPLIFIER: Provides controlled excitation to conversion units and motor fields.



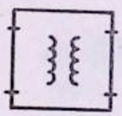
POWER SUPPLY: Supplies d-c power for all functions and reference.



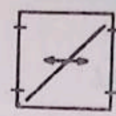
RELAY: Provides magnetic switching of regulator reference signals.



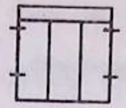
UNIVERSAL AMPLIFIER: Active element in many analog functions and functions as a system preamplifier.



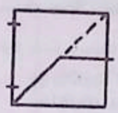
SIGNAL ISOLATOR



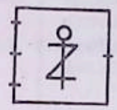
DISCRIMINATOR: Discriminates angular position (selsyn) or linear position (differential transformer).



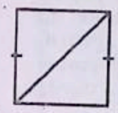
FILTER: Suppresses undesirable pick-up voltages.



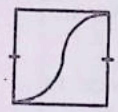
LIMIT: Armature current, voltage, or speed limit.



SOLENOID CONVERTER: Dancer loop position regulator applications.



TIMED ACCELERATION AND DECELERATION, LINEAR: Provides linear time reference.



TIMED ACCELERATION AND DECELERATION, S-CURVE: Coordinated drive master reference.

Normally only output and input connections are shown. Where functions require two or more inputs or outputs, they are appropriately labeled. Most functions require power supply connections (a common connection plus a positive and negative bus supply and an a-c supply), but these non-functional connections are not shown on the Speed Variator elementary diagram. Voltage test points are listed on the Speed Variator elementary at the inputs and outputs of the various functions. This permits easy isolation, by function, when trouble-shooting.

SIMPLIFIED DIAGRAM

The simplified diagram is an electrical schematic corresponding to the word description of a function. This diagram does not indicate tab numbers and component quantitative values but supplements the text.

FUNCTION DIAGRAM

The function diagram shows the components and circuitry for a particular function. This diagram indicates non-functional as well as functional connections, such as a-c inputs, d-c bus voltages, etc. In addition, the diagram indicates the correct connections for obtaining the required operation. Nomenclature, specifications, and a voltage check list are included as an aid to understanding the function.

CARD DIAGRAM

A card diagram shows the entire circuitry (except sub-card circuitry) and all components for a given card. An individual card can be used to perform a variety of functions, a single function, or as a part of a function requiring several cards. The card diagram includes the component layout as well as tab (printed circuit board termination) information.

SUB-CARD

A sub-card is smaller than and normally mounted on a standard size card. The elementary diagrams for both cards are similar. The universal amplifier is an example of a sub-card.

TROUBLESHOOTING, GENERAL

S-21 REGULATOR TROUBLESHOOTING PROCEDURE

To troubleshoot the S-21 regulator, proceed with the following steps:

1. Analyze the regulator portion of the Speed Variator elementary diagram.

2. Measure voltages at the specified voltage check points tabulated on the Speed Variator elementary diagram.

3. Determine the function that requires further analysis.

4. Refer to the instruction book sheets for information on the function in question. Check the voltages at the receptacles of the function according to the function voltage check list. (Remember that a function may consist of more than one card.)

5. Determine which card requires further analyzing.

6. Refer to the card or sub-card diagram for component layout and circuitry.

CARD TROUBLESHOOTING PROCEDURE

A faulty card should be replaced by a good one. Troubleshooting should be done only by persons highly skilled in the repair of printed circuit cards. The procedure is as follows:

1. Check the card visually for any obvious defects.

2. If the card contains a diode, transistor, or silicon-controlled rectifier, check these components first. The checks can be performed without disconnecting the component from the card. De-energize the card and use a volt-ohmmeter with multiple scales for checking.

a. Diode Check

1) Connect the ohmmeter across the diode. Measure and record the resistance.

2) Reverse the ohmmeter leads; measure and record the resistance.

3) Compare the two readings. One must be at least twice the ohmic value of the other.

b. Transistor Check

1) To measure resistance about the base:

(a) Connect either lead of an ohmmeter to the base of the transistor.

(b) Touch the collector and then the emitter with the second lead.

(c) Record the ohmic values.

(d) Disconnect the lead selected in (a), and connect the other ohmmeter lead to the base of the transistor.

(e) Measure and record the resistance to the collector and emitter again.

(f) Compare the two readings. One set of values must be at least twice as high as the other. If the two sets of values are nearly equal or if any value is near zero, the transistor is defective and should be replaced.

2) If the transistor passes the requirement of note b. 1-(f), measure the resistance between the emitter and collector.

(a) Connect the ohmmeter between the emitter and collector.

(b) Measure and record the resistance.

(c) Reverse the ohmmeter leads; measure and record the resistance.

(d) These resistance values should be approximately the same as the set of maximum readings taken when measuring about the base. If the value is appreciably lower or approaching zero, the transistor is defective and should be replaced.

c. Silicon-controlled Rectifier Check

1) Disconnect the push-on tabs from the printed board.

2) Measure the cathode (head of arrow)-to-anode (tail of arrow) resistance.

(a) Connect the ohmmeter to the anode and cathode. Measure and record the resistance.

(b) Reverse the ohmmeter leads. Measure and record the resistance.

(c) Both measurements must indicate a high resistance (several thousand ohms) for a good silicon-controlled rectifier.

3) Measure the gate lead (projection from head of arrow)-to-cathode (head of arrow) resistance.

(a) Connect the ohmmeter leads to the gate lead and the cathode. Measure and record the resistance.

(b) Reverse the ohmmeter leads. Measure and record the resistance.

(c) These values should be lower than the cathode-to-anode measurement but not zero.

3. Measure voltages according to the voltage check list on the card layout.

TROUBLESHOOTING CHART

SYMPTOMS	OBSERVATIONS	CORRECTION
1. Erratic operation such as: a. Continuous random variations in the controlled variable. (Amplitude and frequency not an observable function of line voltage, output shaft speed, or load.) b. Non-linearity of output to reference input. c. Output varies with stability adjustment. d. Soft or sagging limit circuits.	Undesirable high-frequency noise at various error points, power supply leads etc. (observe with an oscilloscope).	1. If observed noise is random and shows no sign of having been clipped (top and/or bottom of wave shape flattened in a straight line), the probability is that the noise is not troublesome. If clipping is apparent, noise level must be reduced by the following methods: a. If random noise is present everywhere, with a high content of some harmonic of line frequency, connect the regulator common lead to earth ground through a 1- to 10-microfarad capacitor. b. If noise is present at the output of a function that contains a standard universal amplifier, connect a 0.1 microfarad (or smaller) capacitor from the output to the No. 1 input of the universal amplifier. If this capacitor eliminates the noise, continue searching until the source of the ripple is found and then eliminate the source. c. If noise is present at the output of a function that does not have a standard universal amplifier, connect a shunting capacitor across the output. d. In general, noise is best eliminated at its source. The addition of a shunting capacitor across the input leads to the regulator from the source often eliminates the difficulty without compromising system stability.
2. Cyclic variations	a. Frequency not variable with load or output speed.	2. This is system instability. a. Frequencies higher than 3 cps, generally indicate an inner loop instability. The inner loop may be formed by the stabilizing feedback. The best solution to this problem is the elimination of a time constant in the forward element of the inner loop.

TROUBLESHOOTING CHART (Cont'd)

SYMPTOMS	OBSERVATIONS	CORRECTION
2. Cyclic variations (cont'd)	a. Frequency not variable with load or output speed.	Frequencies lower than 3 cps are generally caused by over-all system instability. This problem is solved by increasing the effect of the stability circuits. Any change in a stability network intended to stabilize it should have two effects: 1) Reduce the oscillation amplitude. 2) Shift the oscillation frequency. If only the amplitude is affected, the variation is not generated within the system; the system is merely following it. Examine various signals entering the system, also remembering mechanical connections, such as a process web.
	b. Frequency variable with speed, whose amplitude is dependent on load.	b. Examine the mechanical assembly to determine if there is any binding. This can be localized by determining the exact frequency at a particular speed and examining those portions of the machinery that have an equal angular velocity. Examine the tachometer generator (if present) to determine proper alignment. It should be noted that many of the problems of variations in mechanical gears, chains, bearings, etc., disappear when the machine is properly loaded.
	c. Frequency resonates at various speeds.	c. Follow corrections listed under "b" with additional checks on tachometer voltage (ripple frequencies in low multiples of power frequency).
3. Slow variations in the controlled variable, not observably associated with ambient temperature (around regulator).	After continuous operation individual components or system elements are unusually warm.	Physically relocate components if they are normally expected to run at elevated temperatures, so that they cannot heat adjacent components. If component is not supposed to heat up, direct cooling air to the component or determine why component is heating.
4. Slow variations in the controlled variable as a function of ambient temperature.	Determine expected performance of equipment.	For those equipments employing a standard universal amplifier, adjust the impedance from input No. 2 to common to be nearly equal to that connected from input No. 1 to common.

TROUBLESHOOTING CHART (Cont'd)

SYMPTOMS	OBSERVATIONS	CORRECTION
		For those equipments employing a high performance amplifier, check for carbon or temperature-variable components in both the reference and feedback circuits. Also, check limit function, compensation signals, etc.
5. Cyclic variations at certain speeds only (usually near 900, 1800, 2700, 3600 rpm); no variation at other speeds. Frequency varies as speed moves away from null point.		This is a heterodyning effect produced by modulation of two close frequencies (usually one of the two is a 60-cycle or a multiple of a 60-cycle signal.)
	a. Frequency at a given speed varies with load.	a. Check all generator feedbacks to the regulating system since one of the frequencies causing modulation is generator ripple. Remove feedback if possible, or filter all generator leads to regulator.
	b. Running system open loop removes cyclic beat.	b. Indicates that tachometer ripple is one cause of "beating" effect. Check tachometer alignment and mounting. Pre-load the tachometer shaft by putting stress on the shaft with piece of wood. If this diminishes the heterodyning effect, tachometer mounting is definitely faulty. If not, filter tachometer leads. Check shielding of tachometer leads.
	c. Running system open loop does not remove cyclic beat. Oscilloscope reading of armature voltage shows "beat" frequencies.	c. Indicates that a dummy coil in the d-c motor causes a "pip" in armature voltage every time this ineffective coil passes a pole. This effect can be minimized by careful adjustment of stabilizing components and steps listed in "a" above. In extreme cases, it may be necessary to replace the motor armature.

MAINTENANCE KIT

CAUTION: READ AND THOROUGHLY UNDERSTAND THESE INSTRUCTIONS BEFORE ATTEMPTING ANY ADJUSTMENTS OR MAINTENANCE OF THE S-21 RECEPTACLE WIRING OR LEAF TERMINALS.

GENERAL

A maintenance kit is furnished with each S-21 regulator. The kit includes a release tool, jumper springs, wire jumpers, and retaining springs. A card extender is available as a modification but is supplied only when ordered. The kit is normally stored in the Speed Variator case bookholder.

MAINTENANCE KIT USAGE

A. Changing wires in the printed circuit receptacle.

1. Remove the printed card(s) from the receptacle(s) that are to be rewired.

2. Open the regulator case by releasing the two latches on the regulator support and rotate the case forward until the stop supports the case in the open position.

3. Locate the wire point(s) to be changed.

NOTE: The numbers on the receptacles correspond to numbers in the wire table and also to the tab numbers on the printed circuit card schematic diagram.

SECTION 4 SOFTWARE

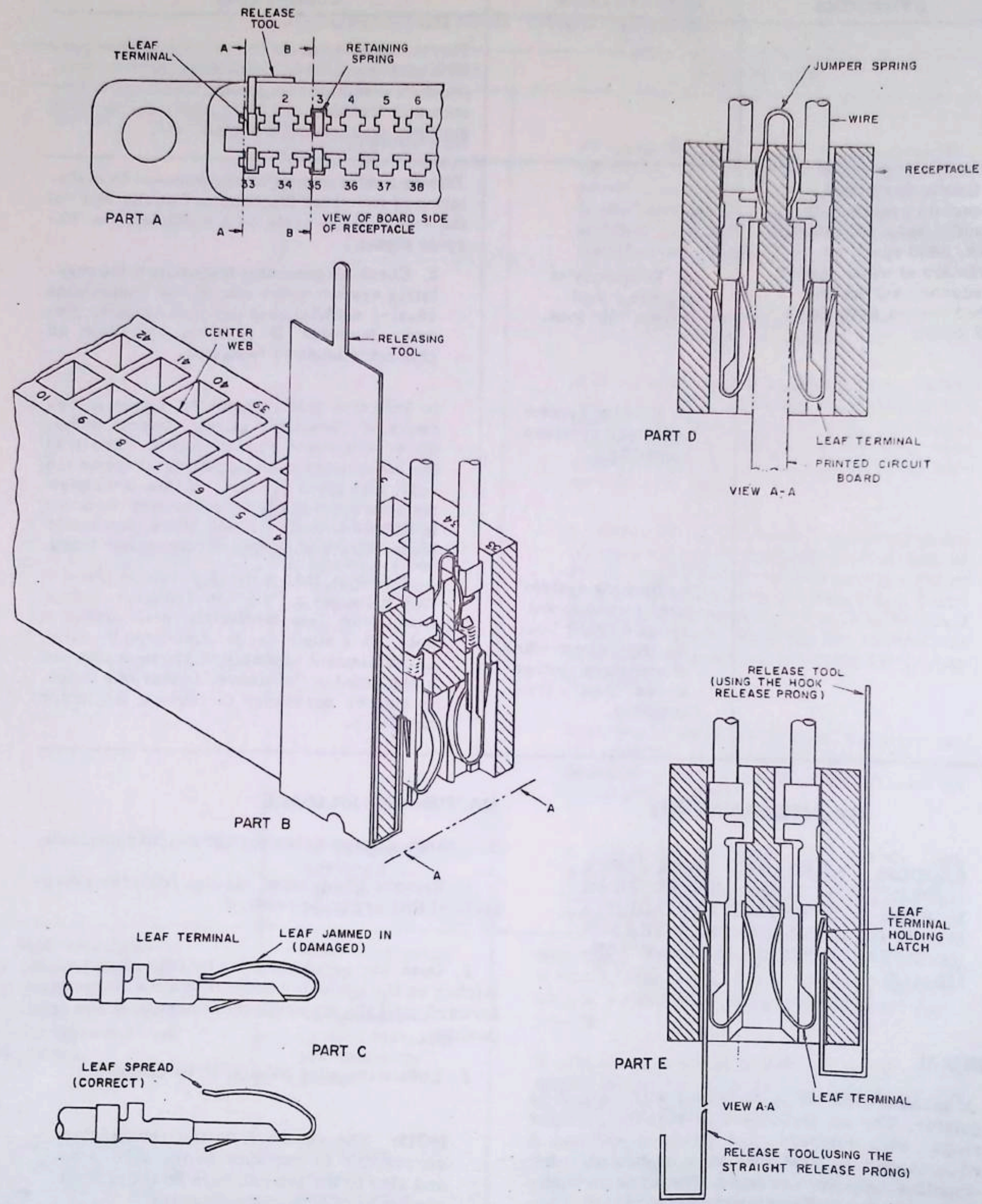


Fig. 1. Leaf terminal construction and removal technique

4. Remove the jumper springs (if present) from connections which are to be changed BEFORE removing or adding wires. See Fig. 1, part A.

5. Remove wires from the receptacle.

a. Insert the release tool as shown in Fig. 1, part B or E.

b. Remove the wire, which has a crimped-on leaf terminal, as the release tool depresses the leaf terminal-holding latch. See Fig. 1, part B or E.

6. Adding wires to the receptacle.

a. Check each leaf terminal for damage before inserting it into the receptacle. See Fig. 1, part C.

b. Insert the lead terminal in desired location and push until the holding latch snaps into place. See Fig. 1, part D.

c. Add jumper springs, where necessary, to complete the wire sequence.

IMPORTANT: Jumper springs must be added only after wires are inserted.

NOTE: Insert the jumper spring on the center web only (horizontally adjacent terminals) and push with a screwdriver or similar tool until the spring is seated on the receptacle shoulder. See Fig. 1, part D. Too much pressure will either damage the spring or push the spring over the receptacle shoulder, causing a malfunction.

7. When making wire changes:

a. Check the entire wire run for each wire being changed to make certain the wire sequence is maintained and continuous, according to the wire table.

b. Work only to an original or marked-up wire table when making changes to regulator wiring.

B. Removing or adding retaining springs.

1. Remove the retaining spring (see Fig. 2, part A).

a. Insert the release tool prong between the center web and the retaining spring on the wire side of the receptacle.

b. Using a small screwdriver, push the retaining spring through the receptacle and out of the card side.

2. Add the retaining spring.

a. Check each retaining spring for damage before inserting it into the receptacle. See Fig. 2, part B.

b. Insert the retaining spring into the selected slot in the card side of the receptacle.

c. Push until the spring snaps into place.

C. Use of a card extender (if furnished).

The card extender is designed to permit the troubleshooting and testing of a printed circuit card with power on. When a printed circuit card is inserted in the card extender, any point on the card becomes accessible for probing.

Each printed circuit card has a protective coating on its etched side. Therefore, when the etched side of the card is probed, the probe must penetrate the protective coating in order to make contact.

The card extender may also be used to extend the test points to the front of the regulator.

1. Extending a card for troubleshooting.

a. Locate the defective card by checking each test point listed in the voltage check list on the Speed Variator Elementary diagram.

b. Turn the power off and remove the defective card.

c. Insert the card extender in place of the defective card.

d. Insert the defective card in the receptacle of the card extender.

e. Check the card in accordance with the instructions for that particular function or card.

2. Extending the test points

a. Remove the spacer card from the test point receptacle.

b. Insert the card extender into the test point receptacle.

CAUTION: DO NOT INSERT ANY FUNCTION CARD IN RECEPTACLE OF CARD EXTENDER WHEN CARD EXTENDER IS IN THE TEST POINT RECEPTACLE POSITION.

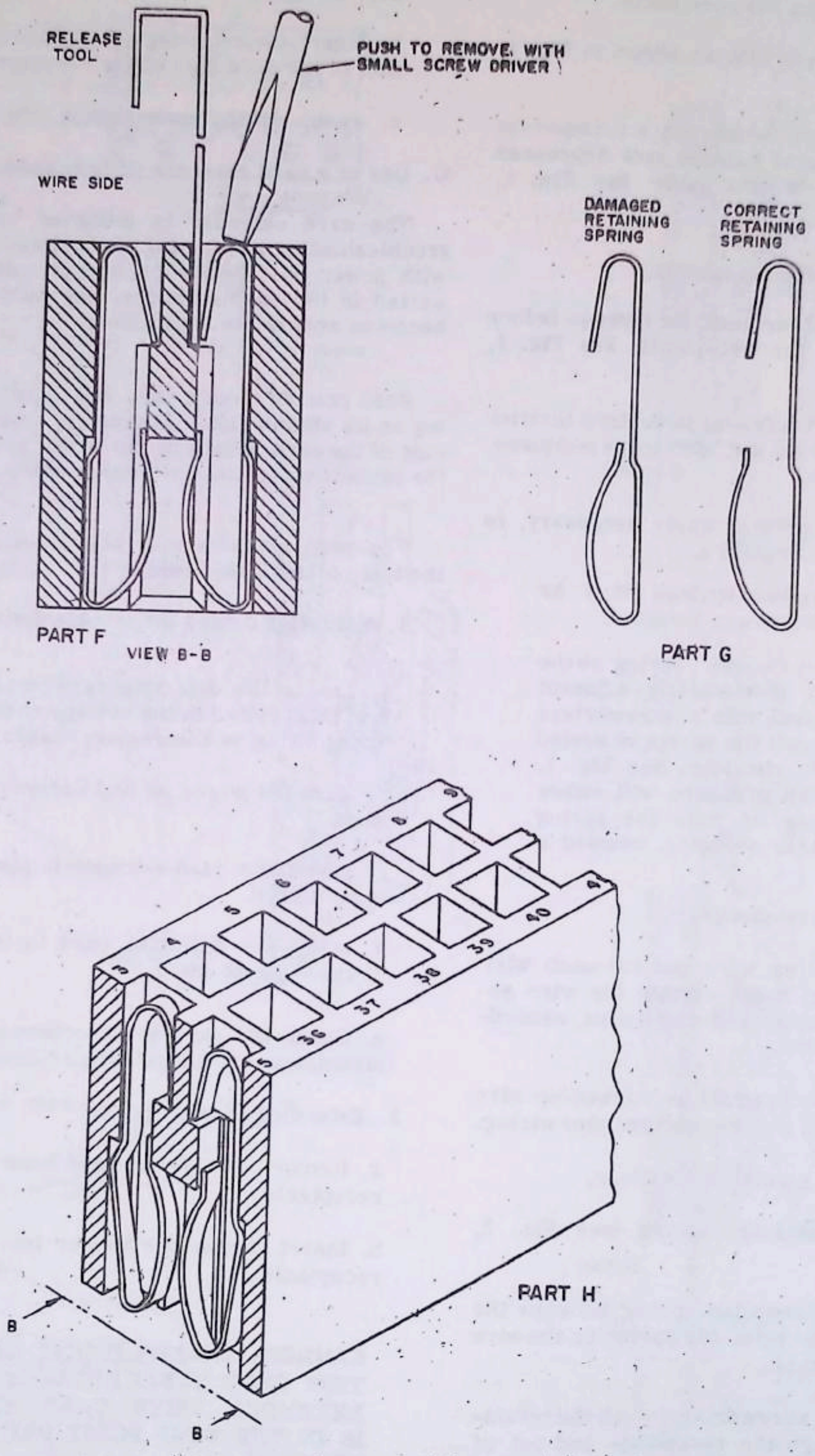


Fig. 2. Retaining spring construction and removal technique

Fig. 2. (PBB-64849)

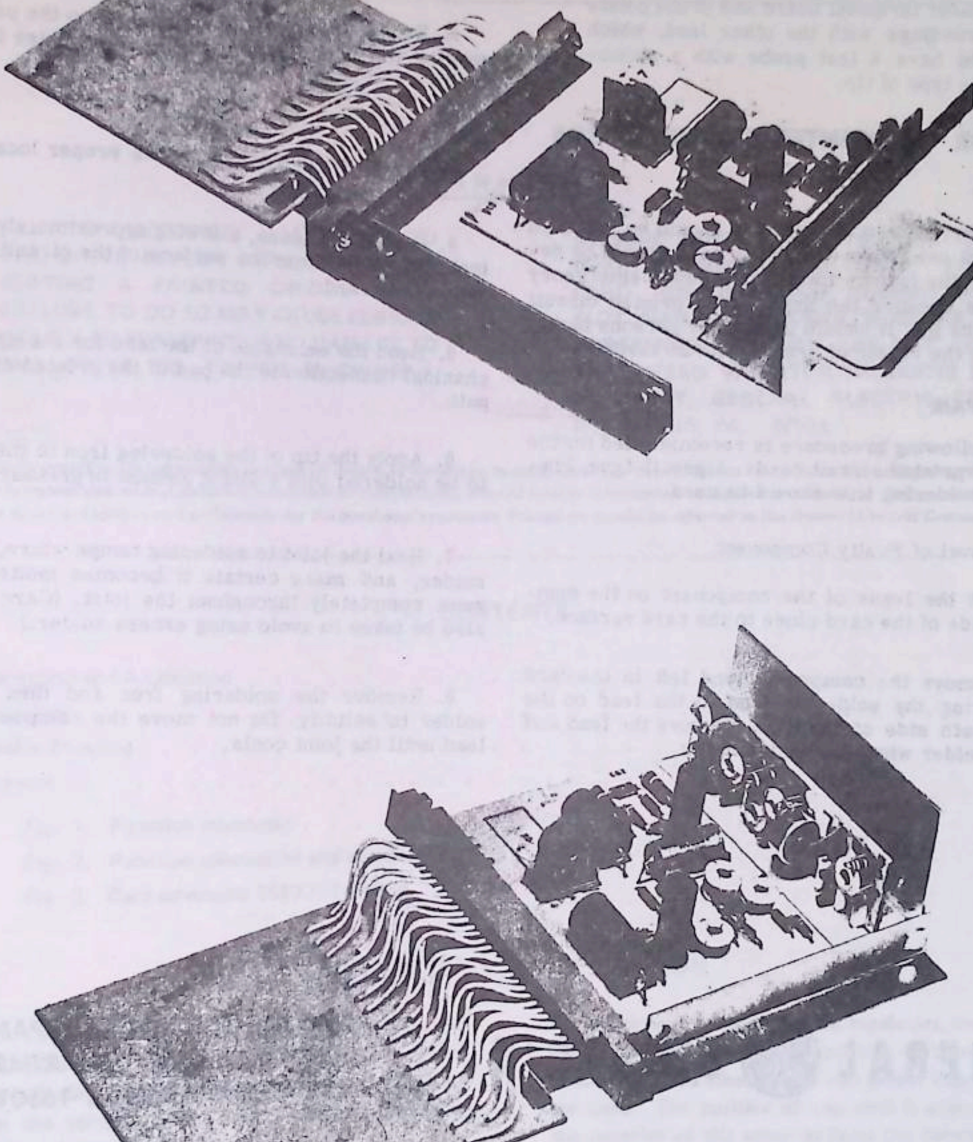


Fig. 3. Card extender

c. Probe the test points from the card extender receptacle at the front of the regulator.

NOTE: The receptacle is not designed to hold a test probe. Therefore, clip one lead of the instrument to common on the regulator terminal board and probe points for readings with the other lead, which should have a test probe with a phono-needle type of tip.

REPAIR OF PRINTED CIRCUIT CARDS

GENERAL

A faulty printed circuit card should be replaced by a good one. Then the faulty card should be returned to the factory for repair. Should emergency measures require the repair of a printed circuit card on the job, it should be done by persons highly skilled in the repair of printed circuit cards.

CARD REPAIR

The following procedure is recommended for the repair of printed circuit cards. A pencil-type, low-wattage soldering iron should be used.

A. Removal of Faulty Component

1. Cut the leads of the component on the component side of the card close to the card surface.

2. Remove the component lead left in the card by applying the soldering iron to the lead on the circuit-path side of the card. Remove the lead and excess solder when the solder melts.

B. Installation of Component

1. Clean the surface of the circuit pad to be soldered to be sure that it is free from corrosion, dirt, grease, and solder.

2. Bend the lead on the component to the proper spacing for inserting into the correct holes in the card.

3. Insert the component in its proper location.

4. Cut off the leads, allowing approximately 1/4-inch extension from the surface of the circuit-path side of the card.

5. Bend the extension of the lead for a snug mechanical connection to the pad of the printed circuit path.

6. Apply the tip of the soldering iron to the joint to be soldered with a slight amount of pressure.

7. Heat the joint to soldering temperature, apply solder, and make certain it becomes molten and runs completely throughout the joint. (Care must also be taken to avoid using excess solder.)

8. Remove the soldering iron and then allow solder to solidify. Do not move the component or lead until the joint cools.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY
SPEED VARIATOR DEPARTMENT
ERIE, PENNSYLVANIA 16501

INSTRUCTIONS

REGULATOR POWER SUPPLY CARD

WARNING

ALWAYS DISCONNECT ALL POWER TO THE DRIVE BEFORE REMOVING OR INSERTING A PRINTED CIRCUIT CARD. FAILURE TO DO SO MAY CAUSE SERIOUS INJURY TO PERSONNEL AND DAMAGE TO THE DRIVE OR DRIVEN MACHINERY.

BE SURE CARD IS INSERTED INTO THE CORRECT REGULATOR RACK SLOT. CARD IDENTIFICATION NUMBER AND SLOT MARKING NUMBER MUST BE IN AGREEMENT. IF THEY ARE NOT, CONTACT SPEED VARIATOR PRODUCTS DEPARTMENT, GENERAL ELECTRIC COMPANY, ERIE, PA. 16501.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

CONTENTS

DESCRIPTION AND APPLICATION

The power supply employs all the essential parameters of a feedback regulating system. It uses Zener diodes for a constant reference, a feedback from the voltage divider, and a reference amplifier capable of changing the output.

The basic element in most regulators, the power supply, furnishes reference and bias voltages for all functions. Two identical 20 volt power supply cards are used. The positive of one card is connected to the negative of the other to form the common bus. One card then furnishes +20 volts and the other furnishes −20 volts with respect to the common.

SOFTWARE

OPERATION

The operation can be followed on either card diagram (Fig. 1) or function diagram (Fig. 2).

The a-c voltage is supplied to transformer TX126 which has an isolated 6.3 volt a-c output for auxiliary use on other cards. The output from the 25 volt secondary winding is connected to the diode bridge D126, where it is rectified and filtered with the capacitor C126. The voltage across C126 is the unregulated d-c supply. The regulated output appears across C129 and C128 (output filter capacitors). The actual regulation is done by controlling the emitter-to-collector voltage of power transistor T129.

The reference appears between B and Z terminals of reference amplifier T128, which consists of a transistor and a Zener diode built in one enclosure. The temperature coefficient of the base-to-emitter drop of the transistor is matched to that of the Zener, so that a very stable reference is obtained.

The feedback is taken from the voltage divider, consisting of resistors R134, R135 and R136. Because of the manufacturing tolerances of the referance amplifier (6.3 to 7.7 volts d-c), this voltage divider has to be adjustable. This adjustment is done in the factory by selecting either resistor R138 or R139 and adding the selected value to the printed circuit card, if necessary.

If the output voltage is too high, transistor T128 turns on and the drop across resistor R133 increases. This turns off transistor T127, which in turn turns transistor T126 on, thereby turning transistor T129 more off and decreasing the output voltage to the value determined by the reference and feedback divider. The Zeners Z128 to Z129 are in to bias the emitters with respect to minus without having to use resistance which would decrease the gain.

Zenar Z129 also keeps the collector voltage of T128 constant, and this improves the temperature performance. Resistors R128 and R130 carry bias current to hold the Zeners in their regulating range.

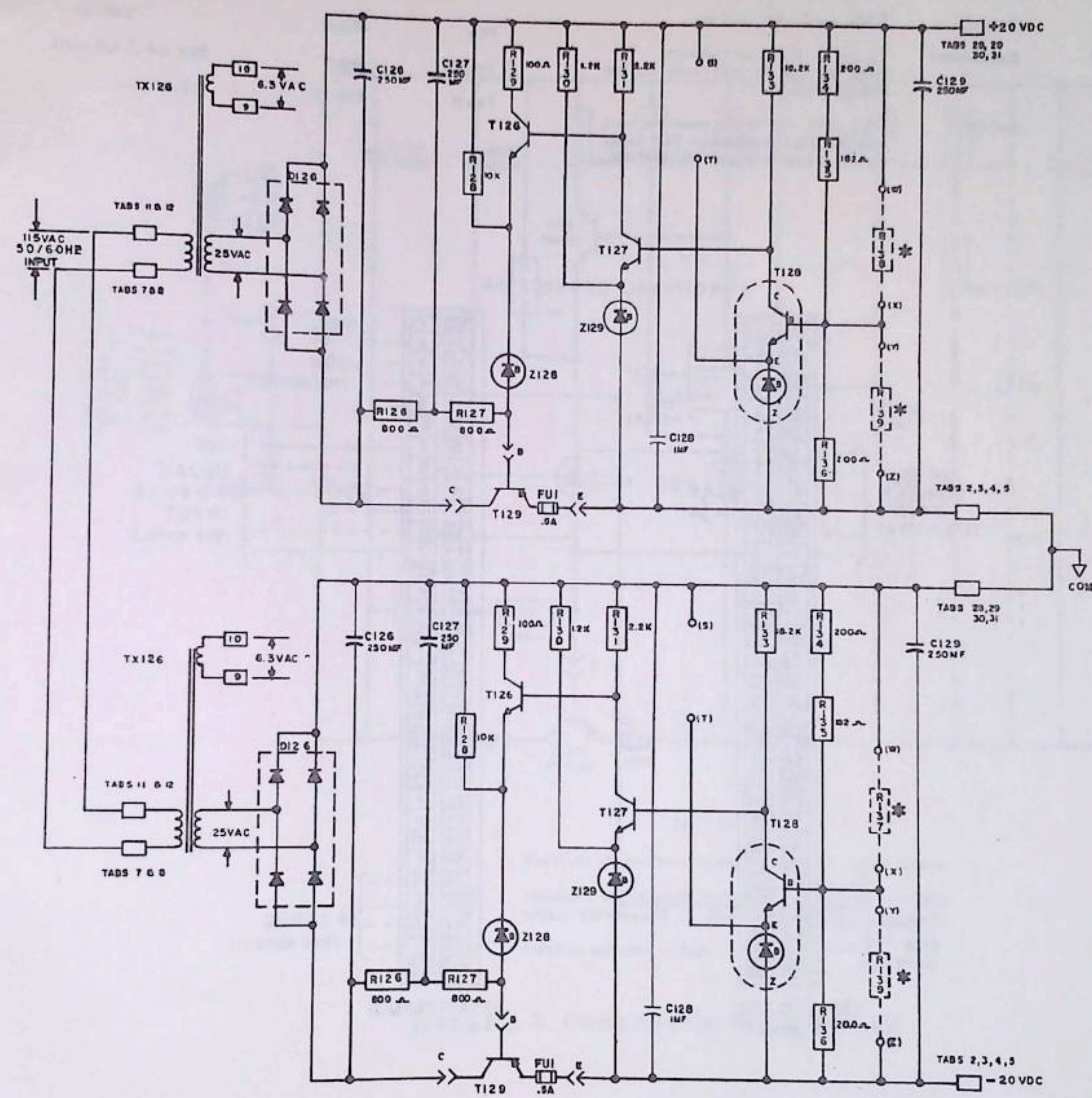
Resistors R126 and R127 carry the forward bias current to transistor T129. C127 capacitor filters this bias supply.

TROUBLESHOOTING

CAUTION

THIS CARD MAY BE WIRED TO PROVIDE AN INTERLOCK FUNCTION DEPENDING ON THE CONFIGURATION OF THE INTERCONNECTION WIRING TO THE CARD; REMOVAL OF THE CARD (WHEN OPERATING) MAY CAUSE THE DRIVE TO SHUT DOWN AND INHIBIT RESTART.

This is a high performance, factory adjusted card. Do not attempt to repair this card in the field. If card fails to meet specifications, replace with a new card.



NOMENCLATURE

C126, C127, C128, C129	Filter capacitor
D126	Full wave rectifier bridge
R126, R127, R128	Bias resistor
R129	Dropping resistor
R130	Bias resistor
R131	Dropping resistor
R133	Dropping resistor
R134, R135, R136, R138, R139	Feedback bridge resistor
T126, T127	Transistor
T128	Reference amplifier
T129	Power transistor
TX126	Transformer
Z128, Z129	Zener diode
FU1	.5 amp fuse

NOTES

1. Numbers inside small rectangles indicate tab numbers which correspond to matching receptacle numbers.

2. *Resistor values selected in test.

Fig. 1. Function schematic

SPECIFICATION

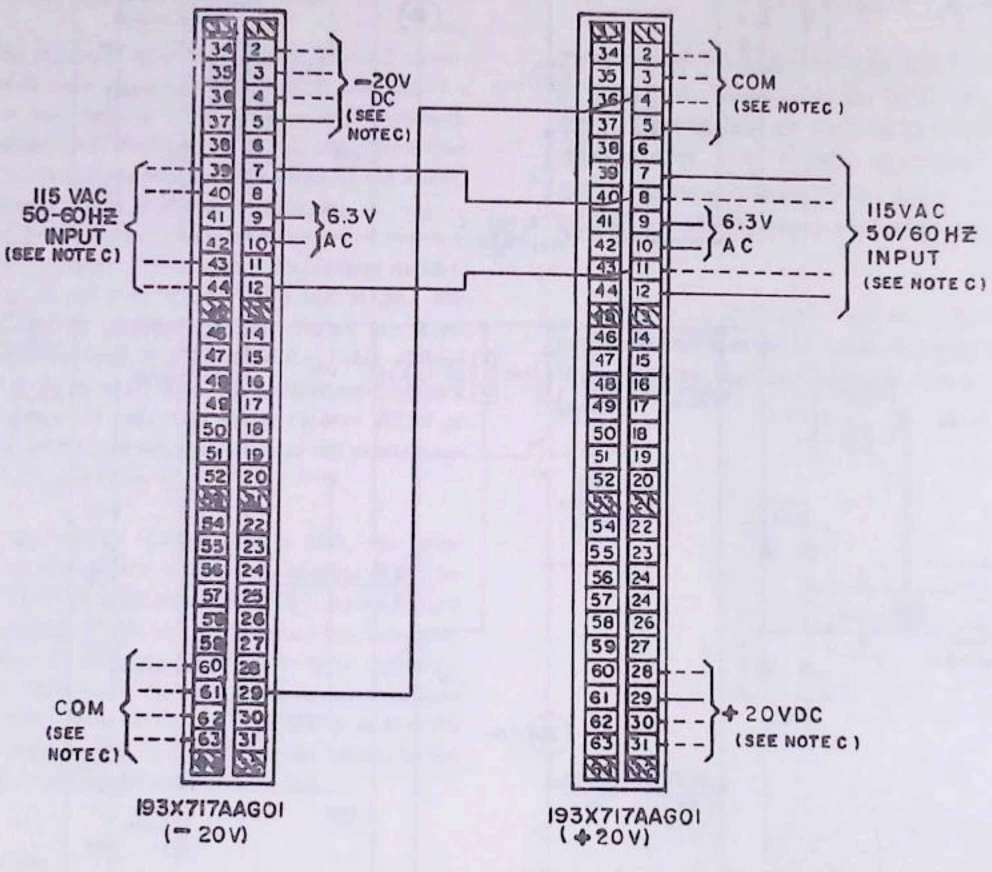
Input:	115V a-c 50/60 HZ, 15 va
Output:	±20V d-c ±1.0V, 200 ma
Regulation:	1% for a 100% load change 0.5% for 105 to 130 volts a-c line voltage change
Stability:	±0.1 volts (0.5%) for constant load, constant line voltage and a 15 C temperature change between 10C and 40C.

VOLTAGE CHECK LIST

(With 115 volts a-c between Tab 7 and Tab 12, each receptacle)

Plus	Minus	Voltage
Tab 29	Tab 5	20V d-c (±1.0 volt)
Tab 9	Tab 10	6.3 volts a-c

FUNCTIONAL CONNECTION



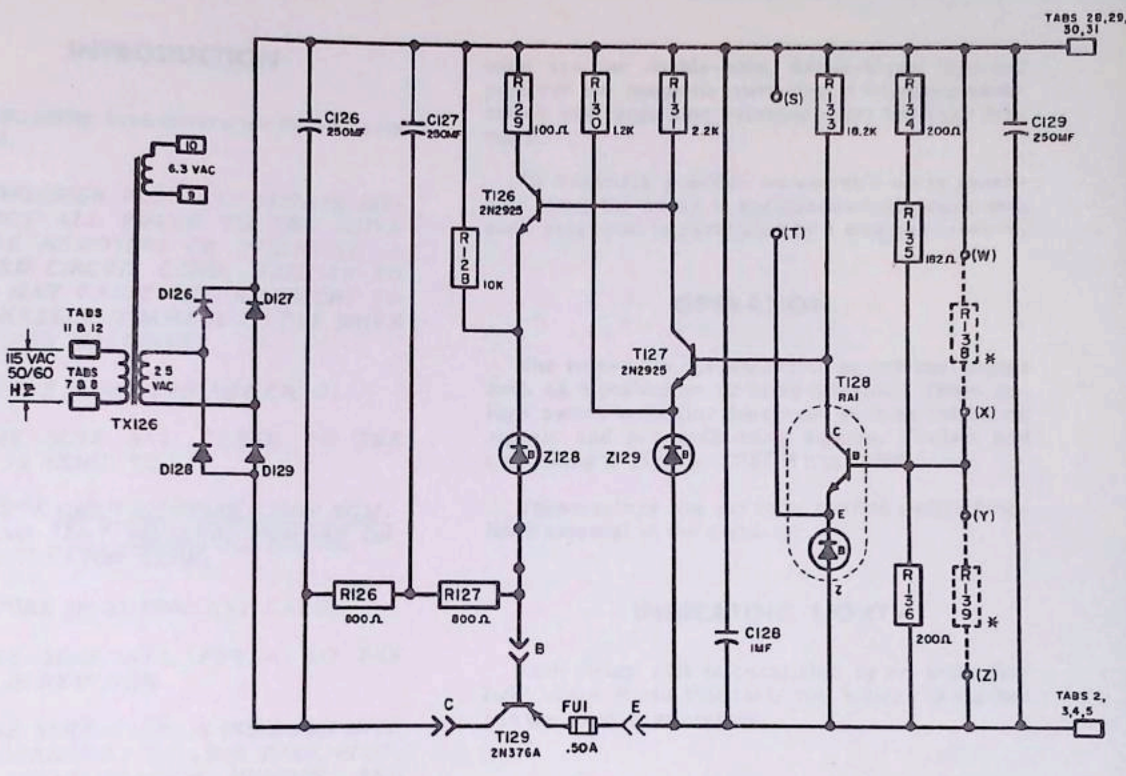
NOTES

1. Indicates retaining spring

2. The sequence wiring of receptacles may require wires for both entering and leaving a terminal. This is accomplished by making the connections to the horizontally adjacent terminals and inserting a jumper spring between the terminals. The jumper is called for in the wire table sequence, e.g. (4-36).

3. Extra tabs for +20 volts, common, −20 volts, and 115 volts a-c were added. Thus, it is now possible and advantageous, in some cases, to have two or more wire sequences with fewer loops in each daisy chain.

Fig. 2. Function connection and specification data



NOTES

1. Refer to instruction book for detailed information.
2. Numbers inside small rectangles indicate tab numbers which correspond to matching receptacle numbers.
3. *Values selected in test.

Fig. 3. Card schematic 193X717AAG01

speed variator

RELAY CARD

INTRODUCTION

This instruction book covers the Speed Variator Relay Card.

WARNING: *HIGH VOLTAGE. ALWAYS DISCONNECT ALL POWER TO THE DRIVE BEFORE REMOVING OR INSERTING A PRINTED CIRCUIT CARD. FAILURE TO DO SO MAY CAUSE SERIOUS INJURY TO PERSONNEL AND DAMAGE TO THE DRIVE OR DRIVEN MACHINERY.*

A. BEFORE REMOVING ANY CARD:

1. BE SURE ALL POWER TO THE DRIVE IS REMOVED.

2. NOTE CARD IDENTIFICATION NUMBER AND SLOT MARKING NUMBER ON THE REGULATOR RACK.

B. BEFORE INSERTING ANY CARD:

1. BE SURE ALL POWER TO THE DRIVE IS REMOVED.

2. BE SURE CARD IS INSERTED INTO THE CORRECT REGULATOR RACK SLOT. CARD IDENTIFICATION NUMBER AND SLOT MARKING NUMBER MUST BE IN AGREEMENT.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency or hazard to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

DESCRIPTION AND APPLICATION

The relay card contains circuit paths and mounting positions for four relays. The relays normally used are the double-pole, double-throw type and perform the magnetic switching of functions associated with regulator reference and feedback circuits.

To minimize possible undesirable noise generated when the relay is energized or de-energized, each relay coil is paralleled by a snubber network.

OPERATION

The relays are operated from an external signal such as a pushbutton or relay interlock. These relays switch regulator functions, such as reference signals and preconditioning signals. Contact and coil rating is given in SPECIFICATIONS.

These relays are not to be used to switch functions external to the regulator.

INDICATING LIGHTS

Each relay coil is paralleled by an indicating light which shows that relay coil voltage is applied and the relay is energized.

SPECIFICATIONS

Relay: General-purpose double-pole, double-throw
Voltage: 115 volts a-c, ±10%, 60 Hz ± 2 Hz or 95 volts a-c, 50 Hz
DC Coil Resistance: 3600 ohms, ±10% at 25 C
Operate Time: 15 milliseconds or less (including contact bounce)
Release Time: 15 milliseconds or less (including contact bounce)
Contact Resistance: At 6 volts and 0.1 amp, 0.05 ohms max (initial)
Pull-in: 70 volts a-c to 85 volts a-c (60 Hz)
Temperature Range: -45 C to +75 C
Dielectric Strength: 1230 volts RMS, 60 Hz, 1 minute
Contact Rating: 1 amp resistive at 115 volts a-c or 29 volts d-c continuous; contact to make and break 1 amp.

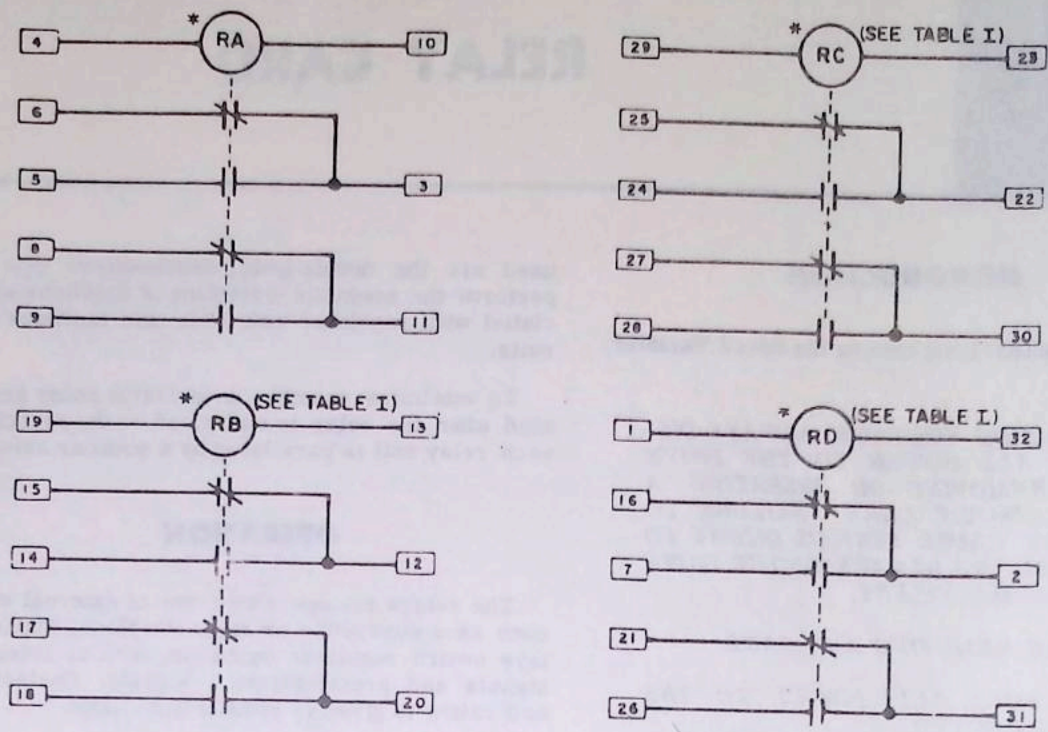


TABLE I

Functional No.	Card Catalog No.	Qty of Relays	Relay Nomenclature*	Tab Connection
193X755BBG01	193X703ABG01 193X703ACG01	1	RA	See Schematic Above for Tabs Associated with Relay Nomenclature
193X755BBG02	193X703ABG02 193X703ACG02	2	RA, RB	
193X755BBG03	193X703ABG03 193X703ACG03	3	RA, RB, RC	
193X755BBG04	193X703ABG04 193X703ACG04	4	RA, RB, RC, RD	

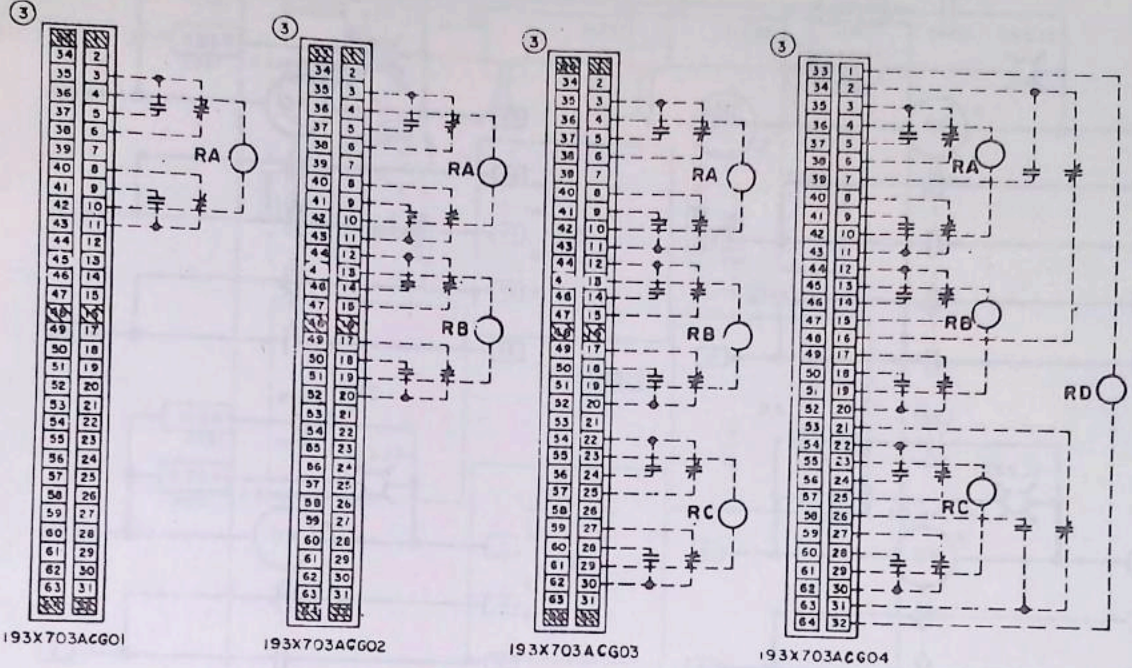
NOTES:

1. *Numbers inside small rectangles indicate tab numbers which correspond to matching receptacle numbers.*
2. *This diagram is a functional representation for versions of Relay Card 193X703ABG01 through G04 and 193X703ACG01 through G04.*

**Present relay nomenclature replaces that listed below. Refer to system diagrams for a cross reference.*

Relay Nomenclature	Replaces	Relay Nomenclature	Replaces
RA RB	RX226 RX227	RC RD	RX228 RX229

Fig. 1. Function schematic



NOTES:

1. ▧ *Indicates retaining spring*

2. *——The sequence wiring of receptacle may require wires for both entering and leaving a terminal. This is accomplished by making the connections to the horizontally adjacent terminals and inserting a jumper spring between the terminals. For correct insertion of jumper springs, refer to Instruction Book GEI-92001.*

Fig. 2. Function connection

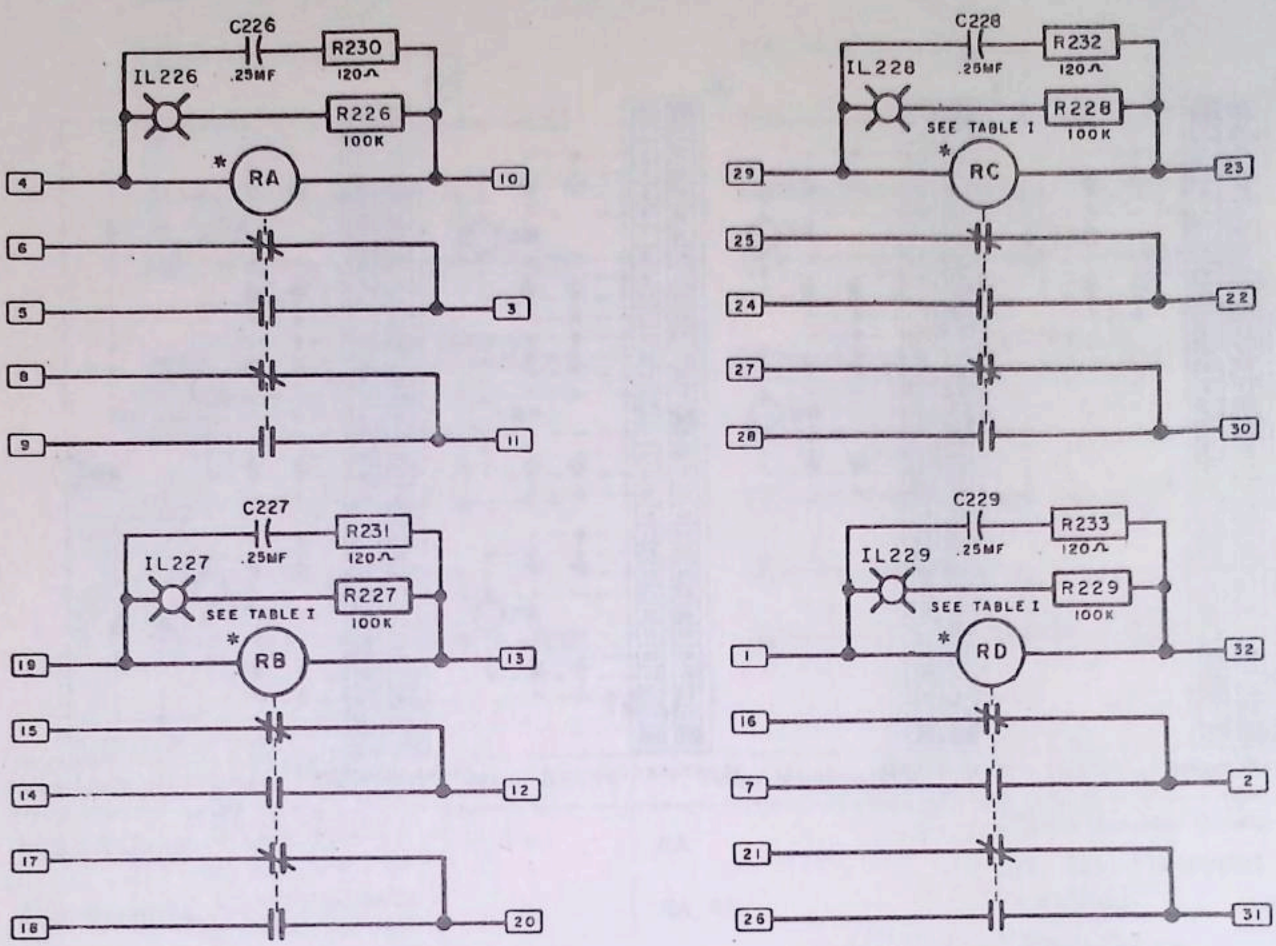


TABLE II

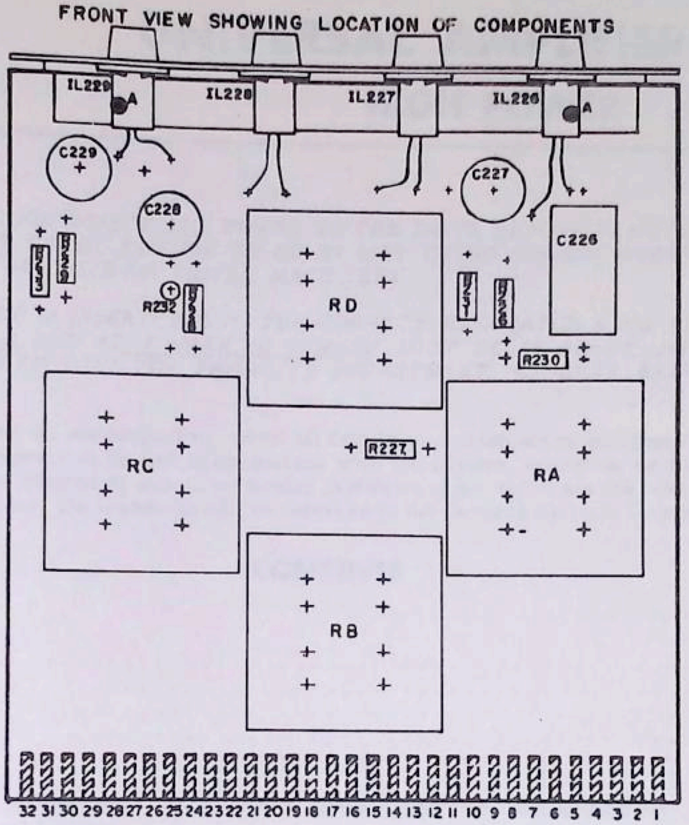
Card Catalog No.	Qty of Relays	Relay Nomenclature*	Tab Connection
193X703ACG01	1	RA	See Schematic Above
193X703ACG02	2	RA, RB	for Tabs Associated
193X703ACG03	3	RA, RB, RC	with Relay
193X703ACG04	4	RA, RB, RC, RD	Nomenclature

NOTES:

1. *Numbers inside small rectangles indicate tab numbers which correspond to matching receptacle numbers.*
**Present relay nomenclature replaces that listed below. Refer to system diagrams for a cross reference.*

Relay Nomenclature	Replaces	Relay Nomenclature	Replaces
RA RB	RX226 RX227	RC RD	RX228 RX229

Fig. 3. Card schematic 193X703ACG04



NOTES:

1. *Indicated tab numbers correspond to matching receptacle numbers.*

2. *Cross-hatched tabs indicate tabs used.*

Fig. 4. Card layout 193X703ACG04

INSTRUCTIONS

SCR REGULATOR UNIVERSAL AMPLIFIER CARD

HIGH POWER

WARNING: *ALWAYS DISCONNECT ALL POWER TO THE DRIVE BEFORE REMOVING OR INSERTING A PRINTED CIRCUIT CARD. FAILURE TO DO SO MAY CAUSE SERIOUS INJURY TO PERSONNEL AND DAMAGE TO THE DRIVE OR DRIVEN MACHINERY.*

BE SURE THAT CARD IS INSERTED INTO THE CORRECT REGULATOR RACK SLOT. CARD IDENTIFICATION NUMBER AND SLOT MARKING NUMBER MUST BE IN AGREEMENT. IF THEY ARE NOT, CONTACT SPEED VARIATOR PRODUCTS DEPARTMENT, GENERAL ELECTRIC COMPANY, ERIE, PA. 16501.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

CONTENTS

PBA-56622A

DESCRIPTION

The high-power universal amplifier increases the output rating of a regulator function and is used as a preamplifier for a high-power regulator. The high-power amplifier is also commonly used to increase timing-circuit output ratings for handling the reference requirements of a large number of preamplifiers.

APPLICATION

1. The high-power amplifier, when connected as shown in Fig. 1, provides unity gain with an inversion. The output of the function that requires power boost is connected to the input on resistor

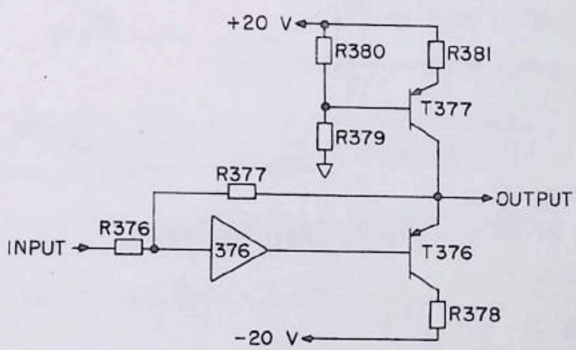


Fig. 1. High-power amplifier connected for typical power-boosting application

R376; the load is connected to the output. A 10-volt input is required for a rated output of 10 volts. This application does not disturb connections of the originating function.

2. If the rated output of a function is other than 10 volts, an external input resistor is used, selected at 1K/max volt. An external feedback or gain resistor of the desired value is also used. The simplified diagram for this application of the high-power universal amplifier is the same as Fig. 1 except that resistors R376 and R377 are replaced by external resistors.

OPERATION

In forming the high-power amplifier, the high-power stage is added to the standard universal amplifier in the feedback resistor loop normally connected around the amplifier. The output of the standard universal amplifier is connected to the base of transistor T376. As this output varies the base of T376, the emitter of T376 varies also. Since the base-to-emitter voltage on a transistor is extremely small, the emitter voltage follows that of the base. The advantage of this circuit is power gain rather than voltage gain.

The current flowing in the base of T376, which is the load on the standard universal amplifier, is equal to the emitter current of T376 divided by the current gain in the transistor. The emitter current is the load current of the high-power amplifier. Therefore, the high-power amplifier output is increased over the standard universal amplifier by a factor equal to the current gain of the transistor.

A transistor conducts in only one direction. When the base of T376 goes negative, current flows through the load and T376. This produces a negative output from the high-power amplifier with T376 supplying the load current.

The network consisting of resistors R379, R380, R381 and transistor T377 furnishes a constant current to T376 and the load. Resistors R379 and R380 establish a bias voltage on the base of T377. Since the base-to-emitter voltage drop is very small, the voltage across R381 is approximately equal to the voltage across R380, which is constant. The constant voltage causes a constant current to flow through R381 and T377. The collector of T377 is connected to T376 and the load. When the base voltage of T376 goes positive, the current flow through T376 is reduced and T377 supplies the load current.

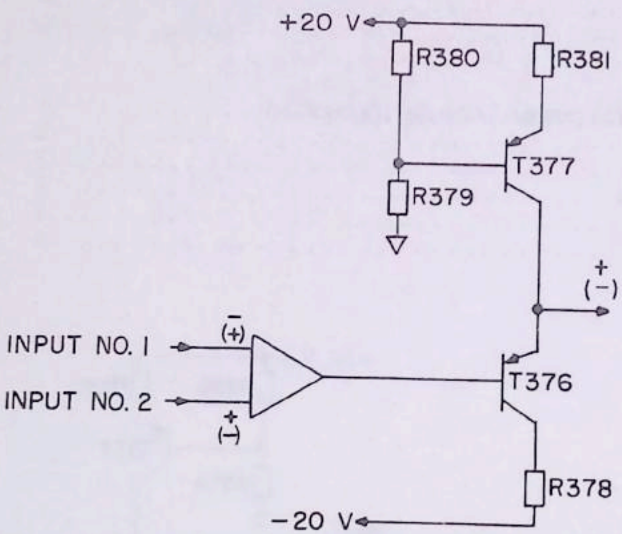


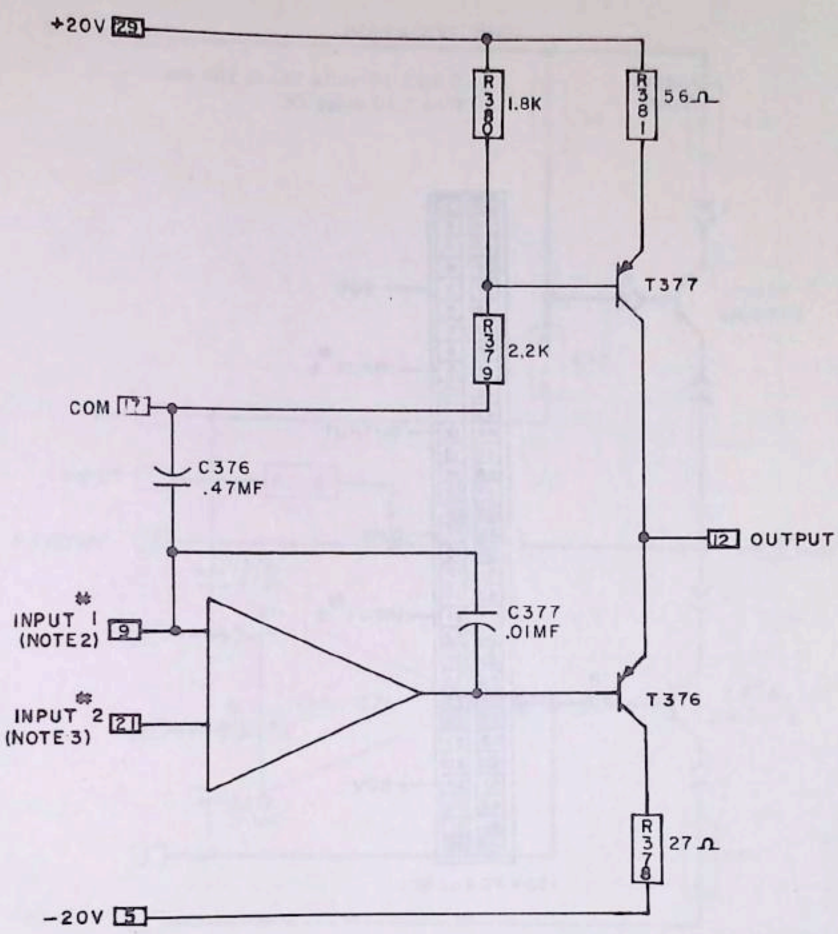
Fig. 2. Simplified diagram

TROUBLESHOOTING

CAUTION: *THIS CARD MAY BE WIRED TO PROVIDE AN INTERLOCK FUNCTION DEPENDING ON THE CONFIGURATION OF THE INTERCONNECTION WIRING TO THE CARD; REMOVAL OF THE CARD (WHEN OPERATING) MAY CAUSE THE DRIVE TO SHUT DOWN AND INHIBIT RESTART.*

1. Follow the troubleshooting procedure in GEI-92001, "General Description."

2. Check the voltages in accordance with the voltage check list on the card layout (Fig. 6 and/or the function specification and connection data (Fig. 4).



NOMENCLATURE

R378	Collector Current Limiter
R379, R380	Voltage Divider
R381	T377 Emitter Resistor
T376	Output Transistor
T377	T376 Emitter Bias Transistor
C376	Noise Suppression Capacitor
C377	Noise Suppression Capacitor

NOTES

1. Numbers inside the small rectangles indicate tab numbers, which correspond to matching receptacle numbers.

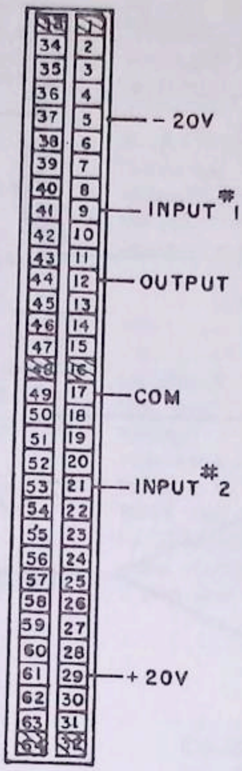
2. Input No. 1 to output has an inversion (output polarity opposite of input polarity).

3. Input No. 2 to output has no inversion.

Fig. 3. Function schematic

SPECIFICATION

Output: 0 to ± 10 volts DC at 100 ma
Input: 0 to ± 10 volts DC



VOLTAGE CHECK LIST

(With +20 volts DC between Tab 29 and Tab 17, and -20 volts DC between Tab 5 and Tab 17.)

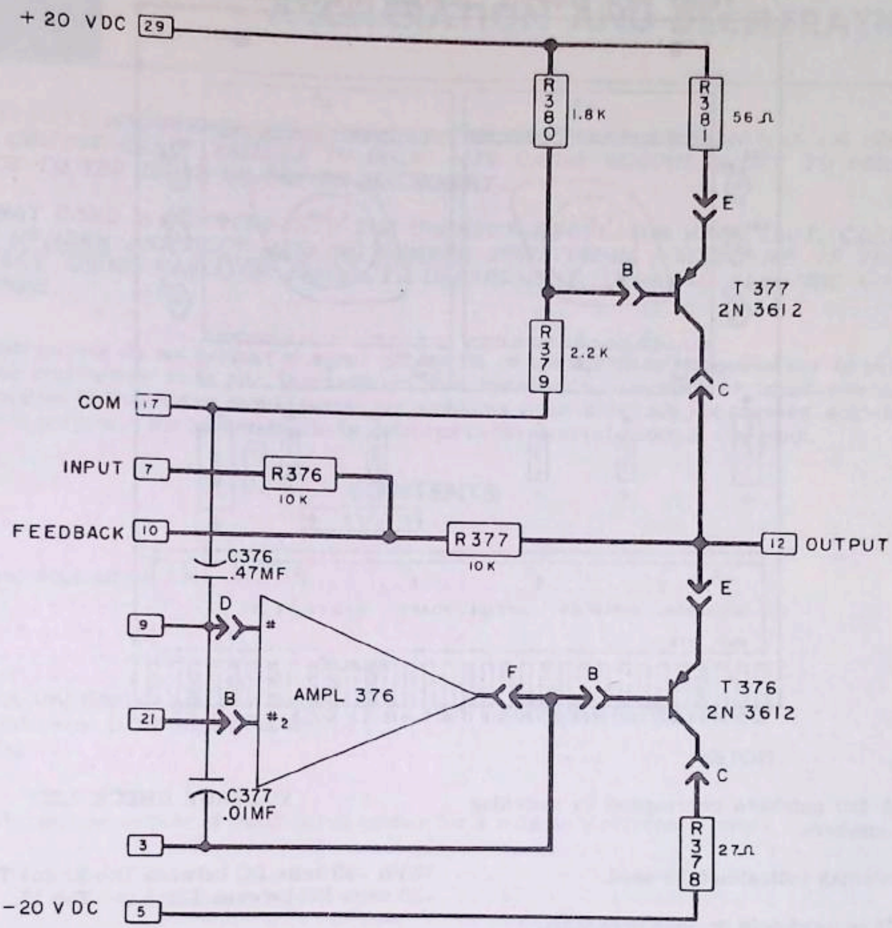
Plus	Minus	Voltage
Tab 12	Tab 17	0 to ± 10 volts DC (depends on input)
Tab 3	Tab 17	0 to ± 10 volts DC (depends on input)

NOTES

1. Indicates retaining spring

2. ___The sequence wiring of receptacles may require wires for both entering and leaving a terminal. This is accomplished by making the connections to the horizontally adjacent terminals and inserting a jumper spring between the terminals. The jumper spring is called for on the wire table sequence, e.g., (4-36).

Fig. 4. Function connection and specification data



NOTES

1. Numbers inside small rectangle indicate tab numbers, which correspond to matching receptacle numbers.

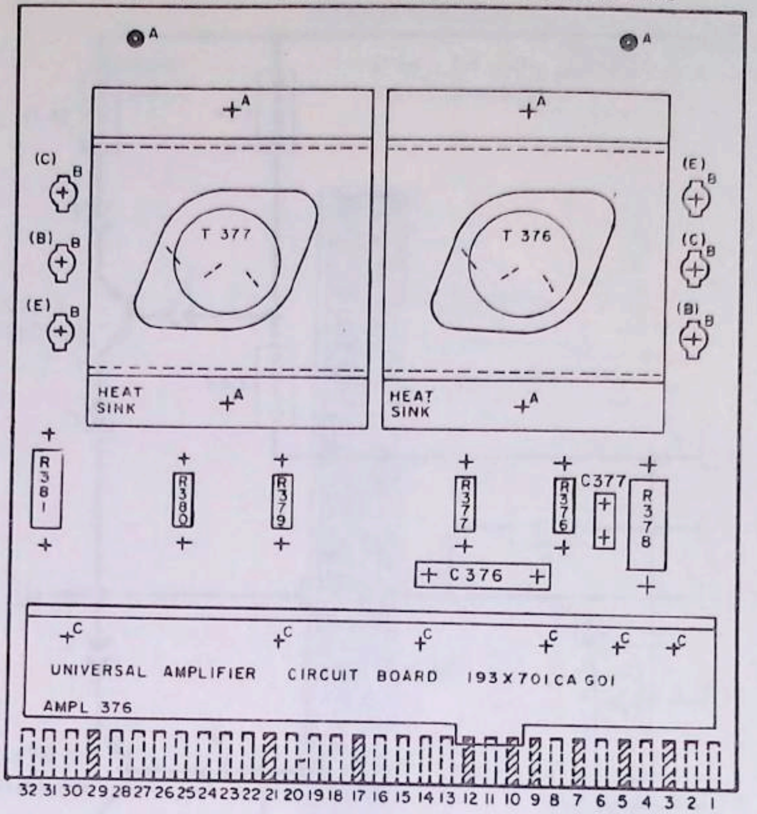
2. AMPL 376 is used only on 193X709AAG01. (This is the only difference between G01 and G02.) Refer to GEI-92016 for a description of this amplifier.

3. The functional symbol shows only the signal inputs. For the power supply connections, refer to the schematic diagram of that function.

Fig. 5. Card schematic 193X709AAG01, -G02

SOFTWARE

FRONT VIEW SHOWING LOCATION OF COMPONENTS



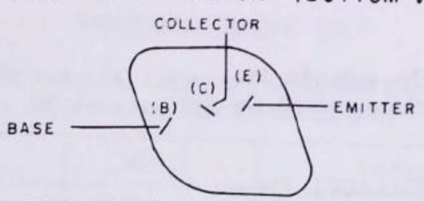
NOTES

1. Indicated tab numbers correspond to matching receptacle numbers.

2. Cross-hatching indicates tabs used.

3. AMPL376 is used only on 193X709AAG01.

TRANSISTOR LEAD SKETCH (BOTTOM VIEW)



SKETCH FOR T376 AND T377

VOLTAGE CHECK LIST

(With +20 volts DC between Tab 29 and Tab 17, and -20 volts DC between Tab 5 and Tab 17.)

Plus	Minus	Voltage
Tab 12	Tab 17	Equal to and same sign as input
Tab 17	T376(C)	17 to 18 volts DC (with zero input)
T377(E)	Tab 17	13 volts DC (Approx.)
T377(B)	Tab 17	13 volts DC (Approx.)

Fig. 6. Card layout 193X709AAG01, -G02

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCTS DEPARTMENT
ERIE, PENNSYLVANIA 16501

7-71 (1M)

PRINTED IN U.S.A.

SCR REGULATOR S-CURVE CARD

ACCELERATION AND DECELERATION

WARNING: *ALWAYS DISCONNECT ALL POWER TO THE DRIVE BEFORE REMOVING OR INSERTING A PRINTED CIRCUIT CARD. FAILURE TO DO SO MAY CAUSE SERIOUS INJURY TO PERSONNEL AND DAMAGE TO THE DRIVE OR DRIVEN MACHINERY.*

BE SURE THAT CARD IS INSERTED INTO THE CORRECT REGULATOR RACK SLOT. CARD IDENTIFICATION NUMBER AND SLOT MARKING NUMBER MUST BE IN AGREEMENT. IF THEY ARE NOT, CONTACT SPEED VARIATOR PRODUCTS DEPARTMENT, GENERAL ELECTRIC COMPANY, ERIE, PA. 16501.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

CONTENTS

DESCRIPTION AND APPLICATION

When a linear timing circuit is used to control the acceleration of a motor, the most severe transient (shock) to the motor and equipment generally occurs during start-up. The effect is similar to that experienced when an elevator begins to move from a standstill. In order to minimize the transients, the acceleration rate (for linear time) is made much longer than is needed. The smaller transients are not a problem; however, the total time required to reach ultimate speed is relatively longer.

The S-curve function minimizes acceleration transients but permits the motor to accelerate in a minimum amount of total time. This is accomplished by changing the acceleration rate gradually until the desired rate is attained. Then the drive accelerates at a fixed rate until just prior to reaching ultimate speed, when the acceleration rate is decreased. These changes in the acceleration rate have a rounding effect, thus producing the acceleration S-curve.

The S-curve function is used on drives that require a controlled amount of acceleration rate change, primarily in coordinated drives. A coordinated system requires matching all of the drives, not only of the initial starting, but also the change of acceleration rate. Since two drives are never identical, even on identical applications,their response is different; that is, their transient regulating ability is different. The S-curve function has an initial acceleration rate of zero and is adjusted to increase this rate slowly enough that the slowest drive can follow the output.

OPERATION

The S-curve function consists of three subfunctions, each of which employs a universal amplifier. These three subfunctions are:

1. Constant Generator: Produces a constant output voltage for an error between the S-curve output and reference.

2. First Integrator (Limited): Integrates* the constant generator output into a ramp voltage, which represents drive acceleration. The output of the first integrator has an adjustable limit so that the maximum acceleration can be limited.

3. Second Integrator: Integrates* the ramp voltage generated by the first integrator to produce the S-curve speed reference.

The constant generator senses and amplifies any difference between the input and output. A very small differential error saturates the amplifier. The input is coupled to the amplifier through R_{ref}. The output is coupled back through resistor R284. The constant generator output is modified by resistor R258, potentiometers P251 and P252, and diodes D253 and D254. These components act as a variable clamp, limiting the magnitude of the voltage output. Therefore the output is a constant whose magnitude depends upon the setting of P251 and P252.

The constant generator output is fed into the first integrator which consists of resistor R259-61. capacitor C251-4, and another universal amplifier. The function of this integrator is to convert the constant voltage into a voltage that varies linearly with time. When neither diode D276 nor diode D277 is conducting, AMPL 252 has capacitive feedback but no direct feedback. If a constant voltage is connected to the input side of R259-61, a constant current flows through. For the amplifier input voltage to remain near zero, the input current through R259-61 must be cancelled by a feedback current from C251-4. C251-4 provides a constant current when the voltage across it increases linearly with time. The voltage across C251-4 is essentially the output voltage; therefore, the amplifier regulates the output to satisfy the near-zero input voltage.

Diodes D276 and D277, with potentiometers P276 and P277, limit the output of the first integrator (AMPL 252). This limited output represents a signal proportional to acceleration, the limits are maximum acceleration limits.

The output of the first integrator is fed into the second integrator which consists of resistor R280-2, capacitor C276-9, and a universal amplifier AMPL 276. When the output of the first integrator varies linearly with time, the second integrator varies with time squared. When the output of the first integrator increases negatively, the output of the second integrator increases at an increasing rate until the first integrator is limited, at which time the second integrator increases linearly. When the first integrator decreases negatively, the second integrator increases at a decreasing rate, reaching zero rate when the first integrator reaches zero output. This completes the acceleration cycle. The deceleration cycle functions in a similar fashion. These signals are shown in Fig. 1.

The various slopes of the two integrator signals shown in Fig. 1 are proportional to two parameters: the input value of voltage, and the integration gain of each integrator. The integration gain depends upon the value of input resistance and feedback capacitance. Therefore the slopes of the curves are adjustable by three elements. The rate of change can be increased by:

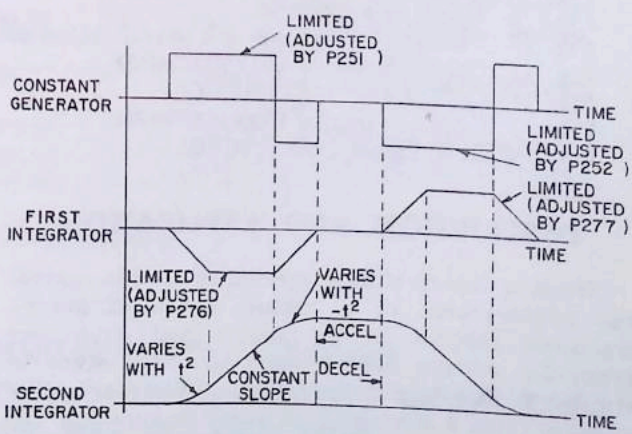


Fig. 1. Sub-function outputs of the S-curve (shown for a minimum reference input)

* The output is a function of the input times time. A constant input produces a constant rate of change of the output.

1. Decreasing the value of input resistance to the integrator,

2. Decreasing the value of feedback capacitance, or

3. Increasing the value of input voltage.

The feedback capacitor and input resistor to each integrator are arranged for three interconnectable values to provide various ranges. The adjustable limit of the input voltage provides in-between points.

The stability adjustment prevents the function from becoming an oscillator and also permits the adjustment of over- or under-shoot. The output of the first integrator is fed back to the input of the constant generator. This initiates a change of polarity in the constant when the first integrator starts decreasing. The decrease of output from the first integrator levels off the output of the second integrator. There are actually two stability adjustments so that both the acceleration and deceleration total times can be varied independently.

Potentiometer P254 permits the output voltage to be zeroed. Potentiometer P253 is part of a temperature compensation circuit. Under normal operating conditions, this circuit need not be adjusted (turn P253 counterclockwise).

ADJUSTMENT

GENERAL

1. Adjustments can best be made by using a chart recorder and observing the output of amplifiers AMPL252 and AMPL276. However, except for the most exacting application, adjustments can also be made with a voltmeter connected to the output of AMPL252. The output of AMPL276 is the controlled-speed reference output. The output of AMPL252 is proportional to the rate of acceleration or deceleration.

While accelerating, the output of AMPL252 increases linearly for a time, remains at a fixed voltage for another period, and finally decreases linearly. This signal output can be used for inertia compensation for follower drives.

The total time during which the output of AMPL 252 is not at zero is the total acceleration time. The time during which the voltage is increasing (or decreasing) linearly indicates the amount of "S" or rounding in the output of AMPL276. The longer it takes to reach the fixed voltage level (relative to the total time), the more rounding occurs.

2. Normally, the preset reference input voltage is negative and the controlled output voltage (AMPL 276) is positive. For this condition, the potentiometers perform as follows:

NEGATIVE PRESET REFERENCE VOLTAGE

Accel.	Decel.	Parameter Controlled
P251	P252	Rounding or "S" in output
P276	P277	Linear time portion of output
P279	P278	Stability of function
P254	P254	Zero adjust
P253	P253	Temperature compensation

NOTE: If a positive preset reference voltage is used, interchange "Accel." and "Decel." in the above tabulation. Example: P251 is now "Decel." and P252 is for "Accel."

ZERO ADJUST

These adjustments are performed during factory testing.

1. Disconnect the relay interlock which discharges AMPL276.

2. Set the preset reference input at zero volts.

3. Turn potentiometer P253 counterclockwise.

4. Adjust potentiometer P254 for zero volts output (±0.5 volt maximum from AMPL276.) If AMPL 276 cannot be zeroed, reconnect resistor R264 (Tab 23) from +20 volts to -20 volts.

Steps 5, 6, 7 are seldom required.

5. Adjust potentiometer P101 on AMPL252 for zero output (±0.5 volt) from AMPL251 (if necessary).

6. Adjust potentiometer P101 on AMPL276 for zero output (±0.5 volt) from AMPL252 (if necessary).

7. Repeat Steps 4, 5, and 6 as a check (if necessary).

TIME ADJUSTMENT (INITIAL)

The adjustments listed below are performed at the factory. Unless specified otherwise on the Speed Variator System elementary diagram (see legend for regulator nomenclature), the total acceleration and deceleration time is selected for approximately midpoint of the selected range (14, 28, or 55 seconds) and with a rounding or "S" characteristic of from 5 to 25 percent of the total time (both at the beginning and end). These adjustments assume a negative preset reference voltage. For a positive preset reference voltage, the potentiometer functions will be interchanged. (Refer to previous listing). The motor need not be energized for the following:

1. Turn potentiometers P251, P252, P276, P277, and P278 fully clockwise.

2. Turn potentiometer P279 fully counterclockwise.

3. Apply the preset reference voltage. If the system is unstable (see Fig. 2), turn P279 clockwise until the system is stable.

4. Short the preset reference voltage. If the system is unstable (see Fig. 2), turn P278 counterclockwise until the system is stable.

5. Turn P251 and P252 counterclockwise about three-fourths of a turn.

6. Turn P276 and P277 counterclockwise about one-half turn.

7. Apply the preset reference and compare the strip-chart recordings obtained to Figs. 2 through 7.

8. Make any necessary adjustments, as indicated by Figs. 2 through 7.

9. Short the preset reference and compare the strip-chart recordings to Figs. 2 through 7.

10. Make any necessary adjustments, as indicated by Figs. 2 through 7.

11. Repeat Steps 7, 8, 9, and 10 (if necessary).

TIME READJUSTMENT (AFTER INITIAL SET-UP)

Readjustments should be made in relatively small increments.

1. Turn P276 or P277 clockwise for less acceleration or deceleration time.

2. Turn P251 or P252 clockwise for less "S" or rounding of output.

3. Compare the strip-chart recordings to Figs. 2 through 7 after each adjustment and make further adjustments accordingly.

4. Repeat Steps 1, 2, and 3 (it necessary).

TROUBLESHOOTING

CAUTION: *THIS CARD MAY BE WIRED TO PROVIDE AN INTERLOCK FUNCTION DEPENDING ON THE CONFIGURATION OF THE INTERCONNECTION WIRING TO THE CARD; REMOVAL OF THE CARD (WHEN OPERATING) MAY CAUSE THE DRIVE TO SHUT DOWN AND INHIBIT RESTART.*

Follow the troubleshooting procedure outlined in GEI-92001, "General Description."

Start by applying and removing the preset reference voltage and observing the output of each amplifier (251, 252, 276). The outputs of each amplifier should record a chart similar to Figs. 2 through 7. Under normal operating conditions, AMPL276 or 252 should never exceed approximately 10 volts in either direction. AMPL251 should never exceed 17 volts. The polarity of the controlled output voltage is opposite to that of the preset reference. If an amplifier is suspected, check the components (including the wiring) connected to this one. Interchanging the suspected amplifier with one of the others is a good way of determining whether the amplifier or the components are at fault.

The following list of symptoms and remedies may be helpful in correcting malfunction.

1. Drive will not accelerate (See item 2 also): The voltage at Tab 16 (at D253-D254) is limited at or very near zero. Turn P251 (P252) clockwise. The minimum limited voltage at Tab 16 should be about 1.0 volt.

2. Drive will not decelerate (See item 1 also): The output of AMPL252 is limited at or very near zero volts. Turn P277 (P276) clockwise. The minimum limited voltage should be about 1.0 volt.

3. No output from AMPL252 (When the preset reference voltage is applied or removed):

See items 1 and 2.

4. Output of AMPL276 jump Starts (when initiating the reference): Function not zeroed. See ADJUSTMENTS "Zero Adjust."

Characteristic Outputs of Amplifier 252 and 276
(For Accelerating and Decelerating with Negative Preset Reference Input)

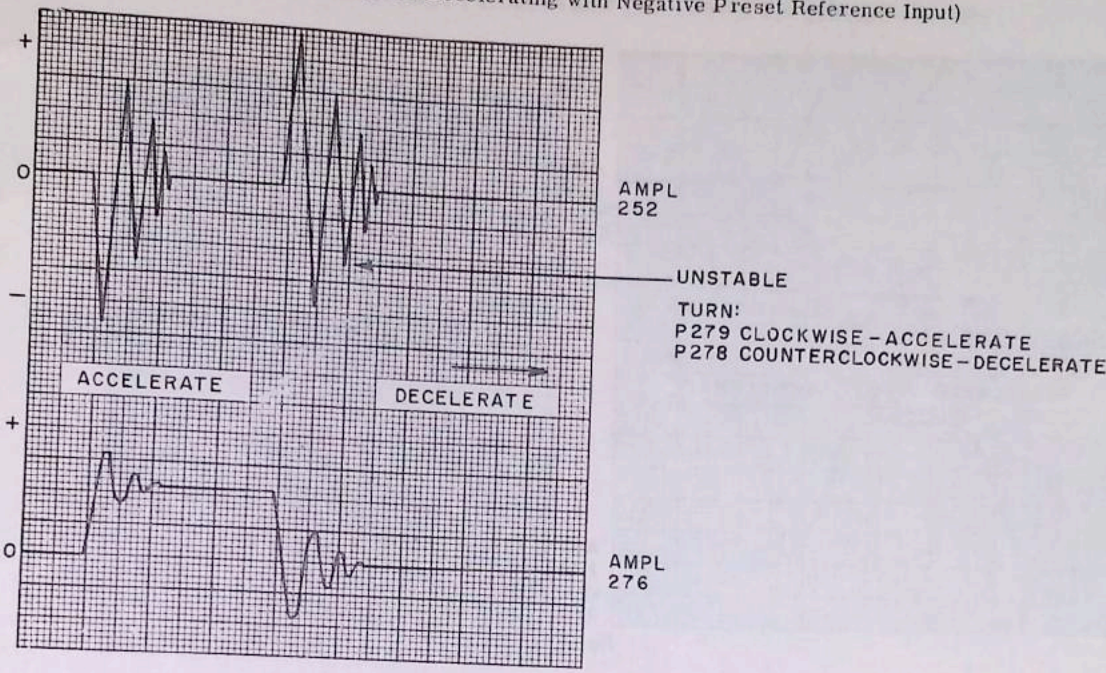


Fig. 2.

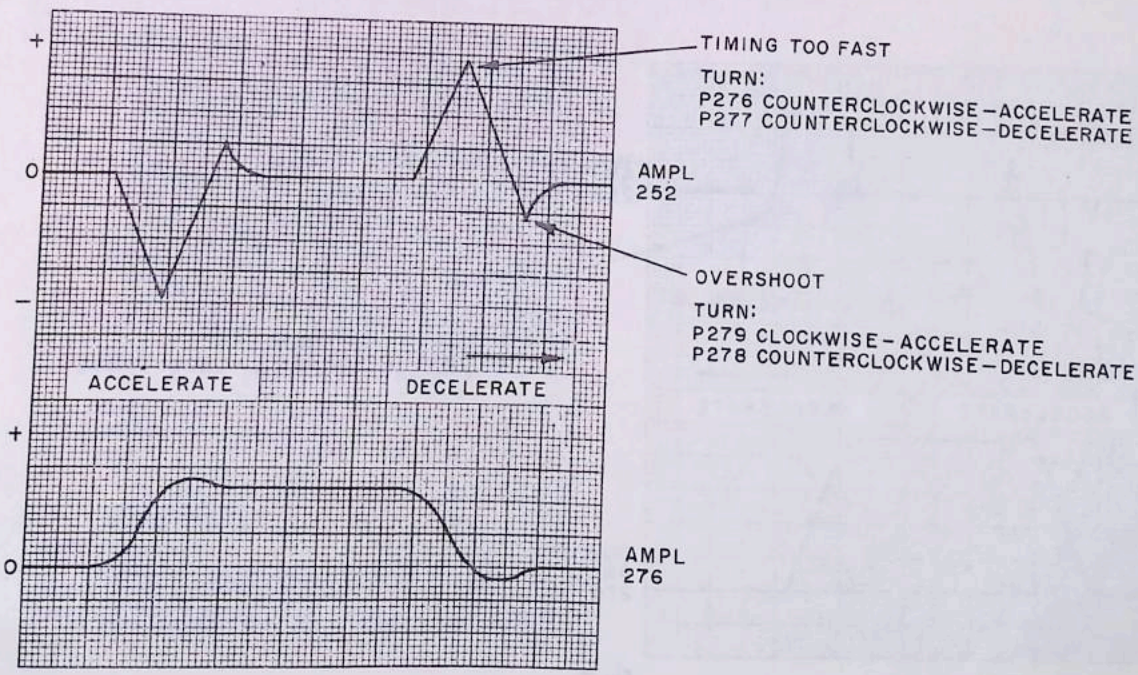


Fig. 3.

PBA-56626A

SECTION 4 SOFTWARE

Characteristic Outputs of Amplifier 252 and 276
(For Accelerating and Decelerating with Negative Preset Reference Input)

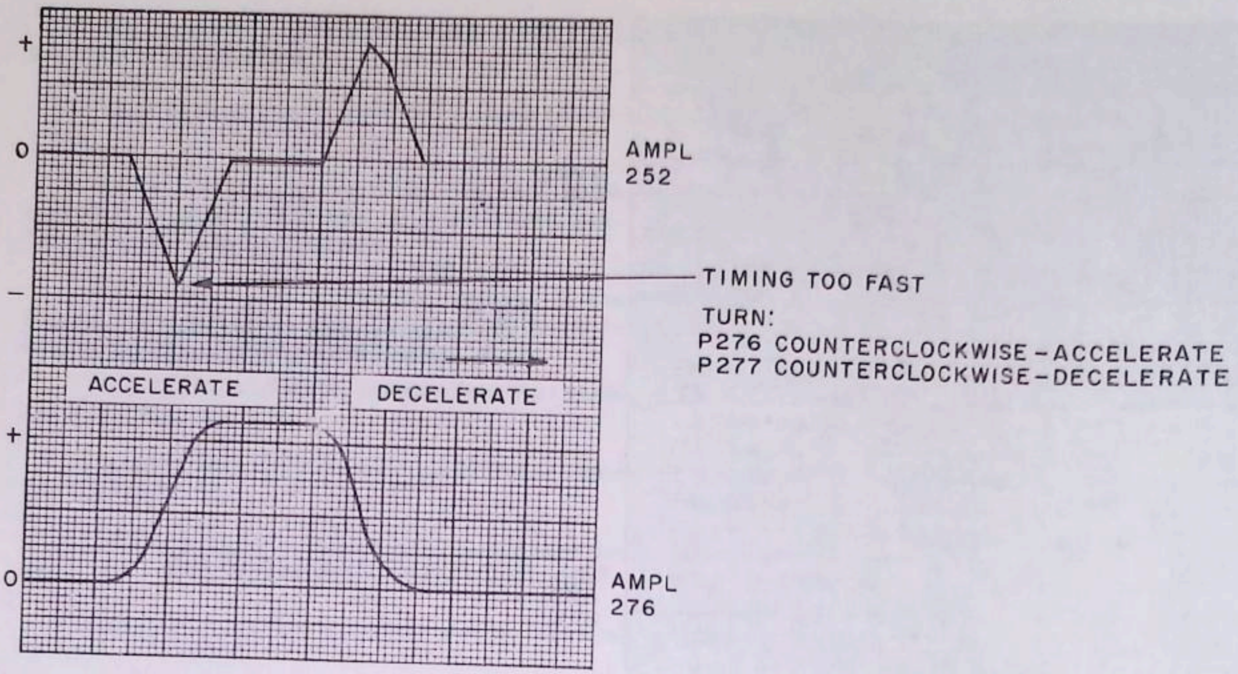


Fig. 4.

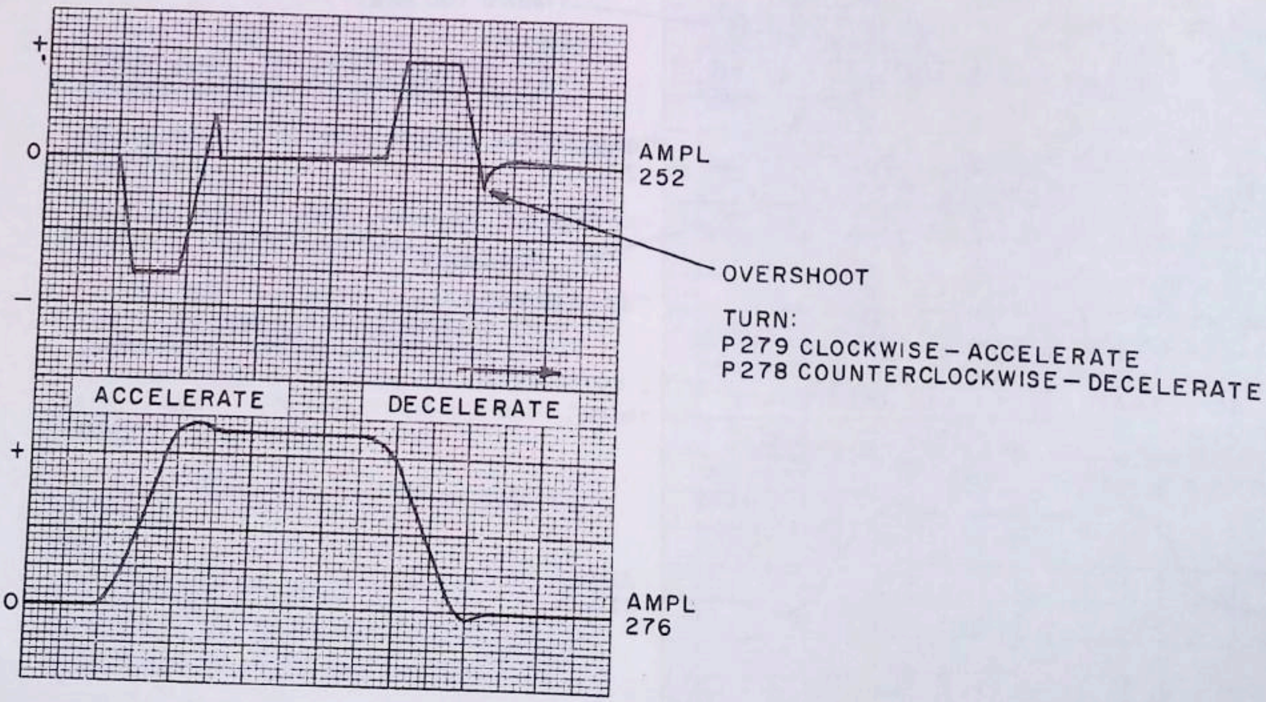


Fig. 5.

Characteristic Outputs of Amplifier 252 and 276
(For Accelerating and Decelerating with Negative Preset Reference Input)

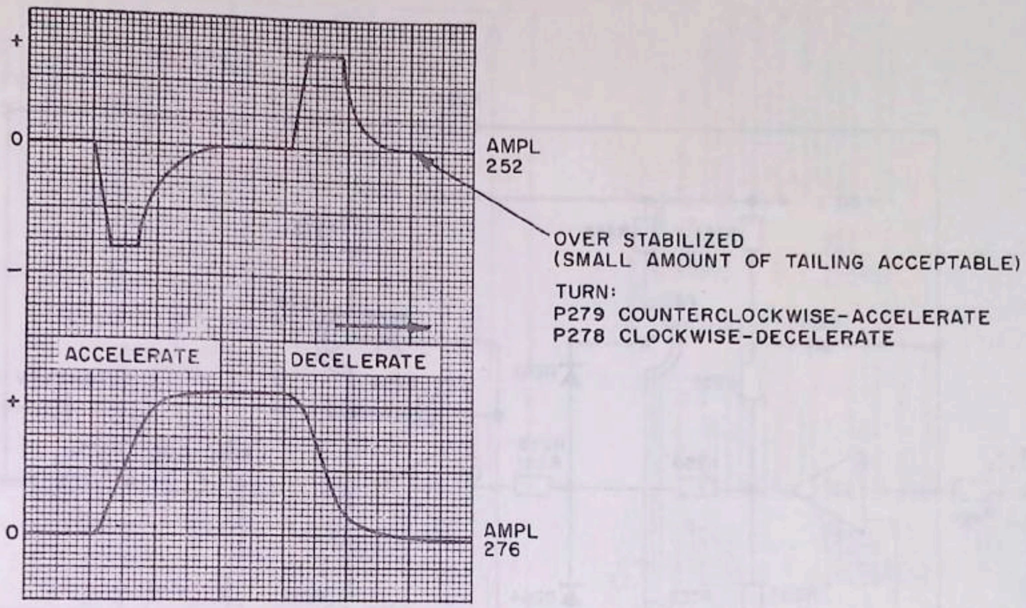


Fig. 6.

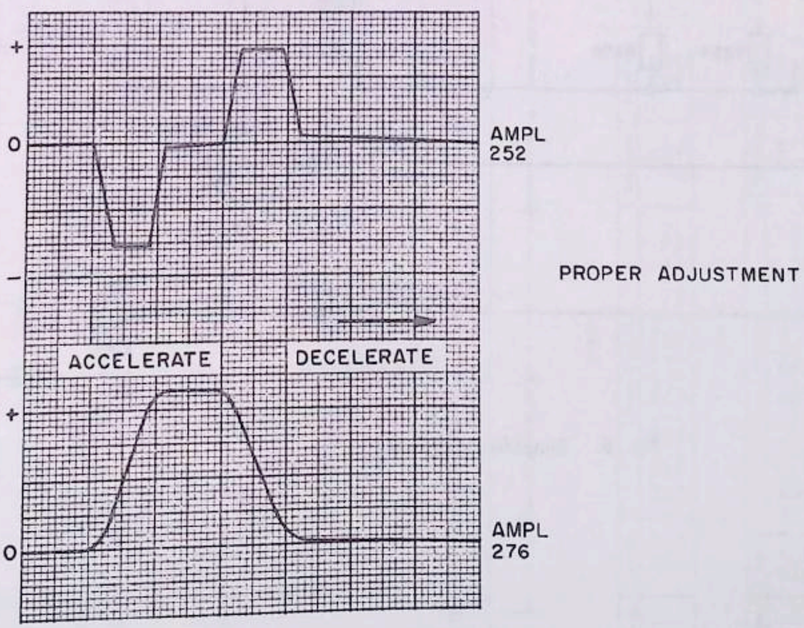


Fig. 7.

PBA-566 28A

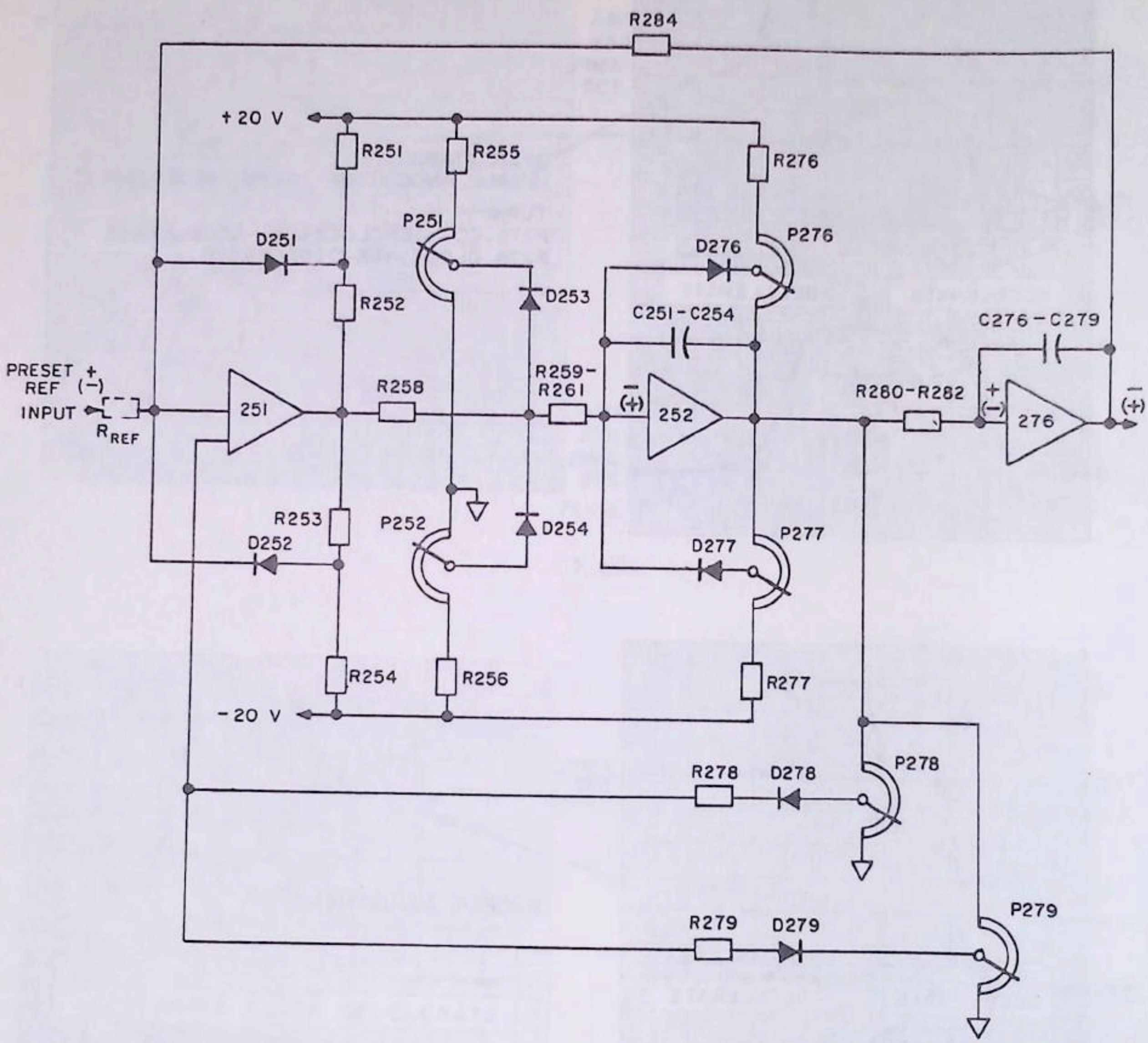


Fig. 8. Simplified diagram

PBA-566 29A

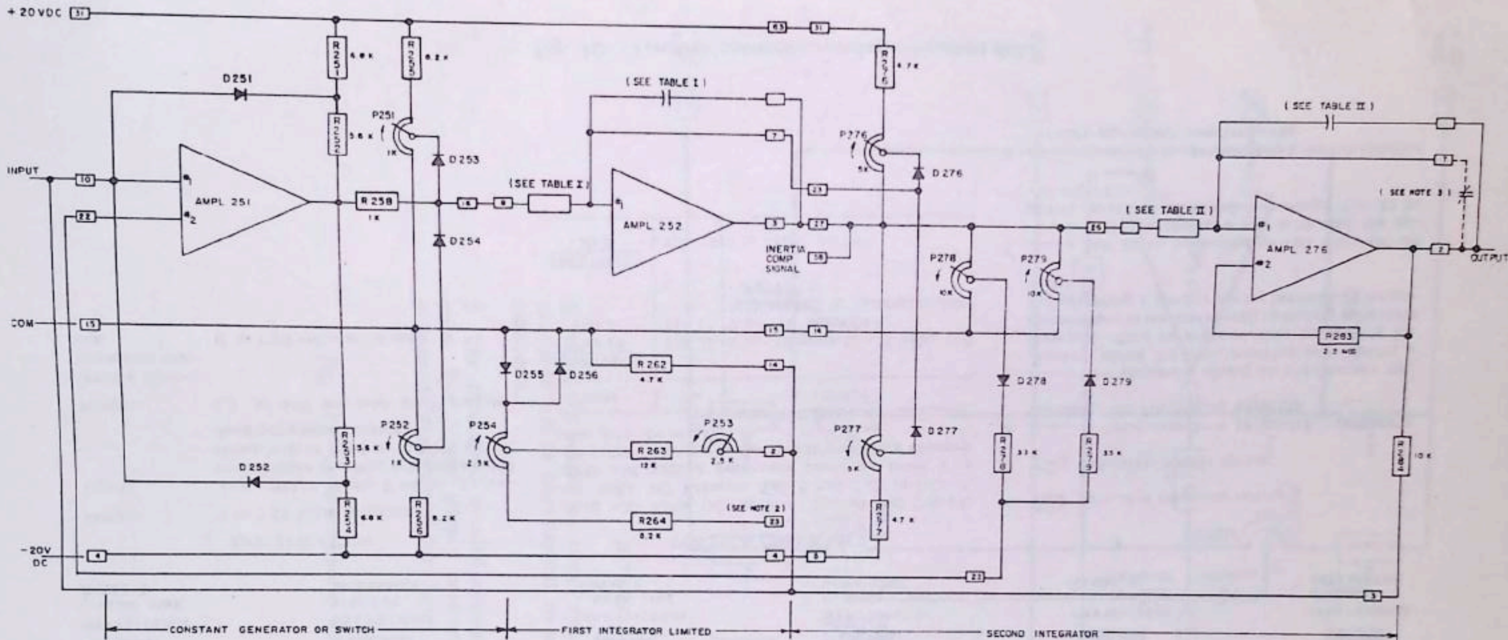


TABLE I

Range	Seconds	Jumper Connection	Resistance	Capacitance
1	2.5-25	Tab 16 to Tab 8, Tab 21 to Tab 3	8.2K	250 mf
2	5-50	Tab 16 to Tab 8, Tab 21 to Tab 3, Tab 30 to Tab 7	8.2K	500 mf
3	12-120	Tab 16 to Tab 9, Tab 21 to Tab 3, Tab 30 to Tab 7	22 K	500 mf

TABLE II

Range	Seconds	Jumper Connection	Resistance	Capacitance
1	2.5-25	Tab 26 to Tab 9, Tab 21 to Tab (output)	8.2K	250 mf
2	5-50	Tab 26 to Tab 9, Tab 7 to Tab 30, Tab 21 to Tab (output)	8.2K	500 mf
3	10-100	Tab 26 to Tab 10, Tab 7 to Tab 30, Tab 21 to Tab (output)	22 K	500 mf

NOTES

1. Numbers inside the small rectangles indicate tab numbers which correspond to matching receptacle numbers.

2. Tab 23 is connected to +20 volts DC. If the parameters are such that the opposite sense is required, reconnect Tab 23 to -20 volts DC.

3. A relay interlock is used to completely discharge the integrating capacitor.

NOMENCLATURE

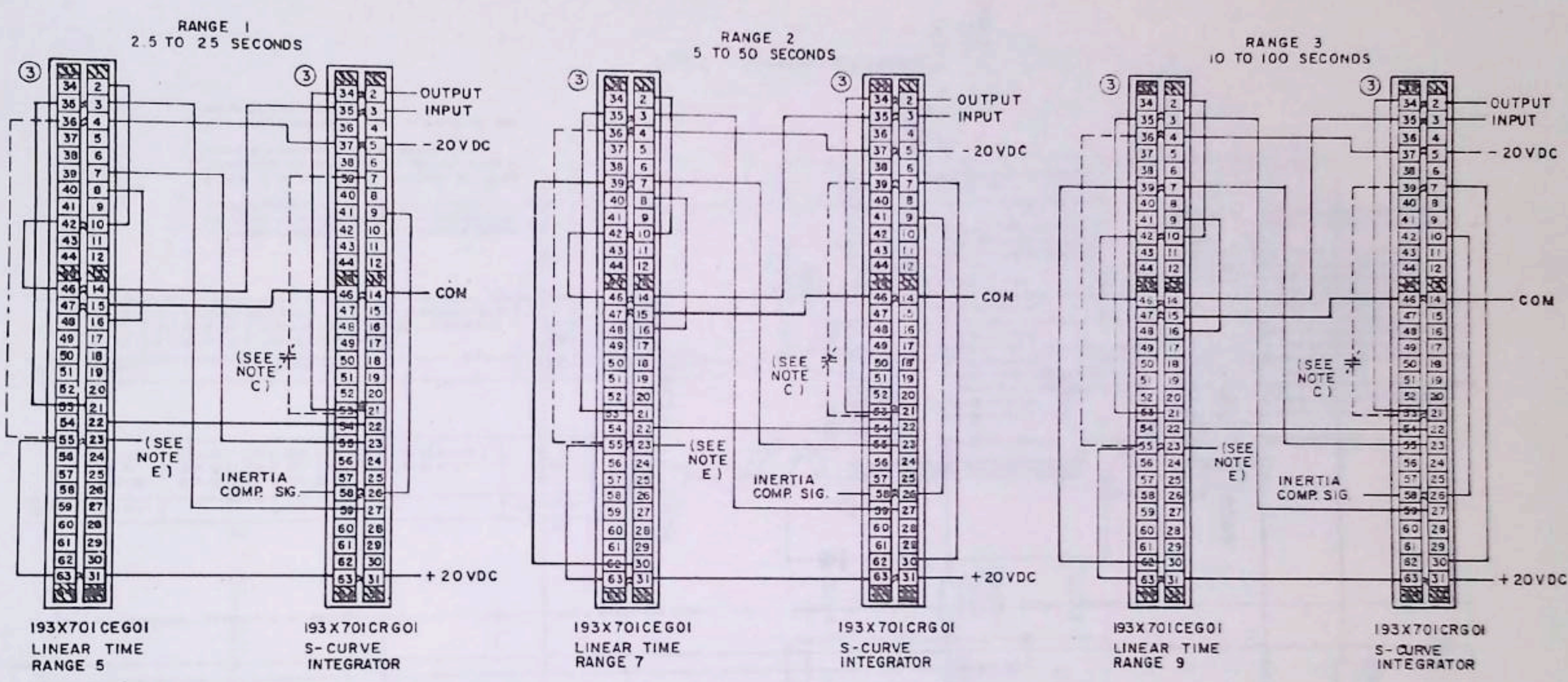
Constant Generator and First Integrator

C251, C252, C253, C254	Integrating Capacitor
D251, D252	Maximum Limit Diode
D253, D254	Rate-limit Diode
D255, D256	Temperature Compensating Diode
P251	Negative-going output rate adjust Potentiometer
P252	Positive-going Output Rate Adjust Potentiometer
P253	Temperature Compensation Adjust Potentiometer
P254	Zero Adjust Potentiometer
R251, R252, R253, R254	Voltage Divider
R255, R256	Voltage Dropping Resistor
R258	AMPL251 Output Current Limit
R259, R260, R261	Integrating Rate Resistor
R262	AMPL251 Commoning Resistor
R263	Zero Bias
R264	Voltage Dropping Resistor

Second Integrator

C276, C277, C278, C279	Integrating Capacitor
D276, D277	Rate-of-change Limiting Diode
D278, D279	Stability Discriminating Diode
P276	Maximum-positive-going rate adjust Potentiometer
P277	Maximum-negative-going rate adjust Potentiometer
P278	Negative-going Output Stability adjust Potentiometer
P279	Positive-going Output Stability adjust Potentiometer
R276, R277	Voltage Dropping Resistor
R278, R279	Stability Feedback Resistor
R280, R281, R282	Integrating Rate Resistor
R283	Capacitor Leakage Compensating
R284	Function Feedback Resistors

Fig. 9. Function schematic



SPECIFICATION

Output: 0 to ± 10 volts to 10 ma.

Input: Any voltage above 5 volts. An external input resistor selected at 1000 ohms/volt is used so that the output does not exceed rating.

Range: 2.5 to 100 seconds in 3 ranges.

Inertia Compensation Output: 0 to ± 10 volts at 10 ma.

VOLTAGE CHECK LIST

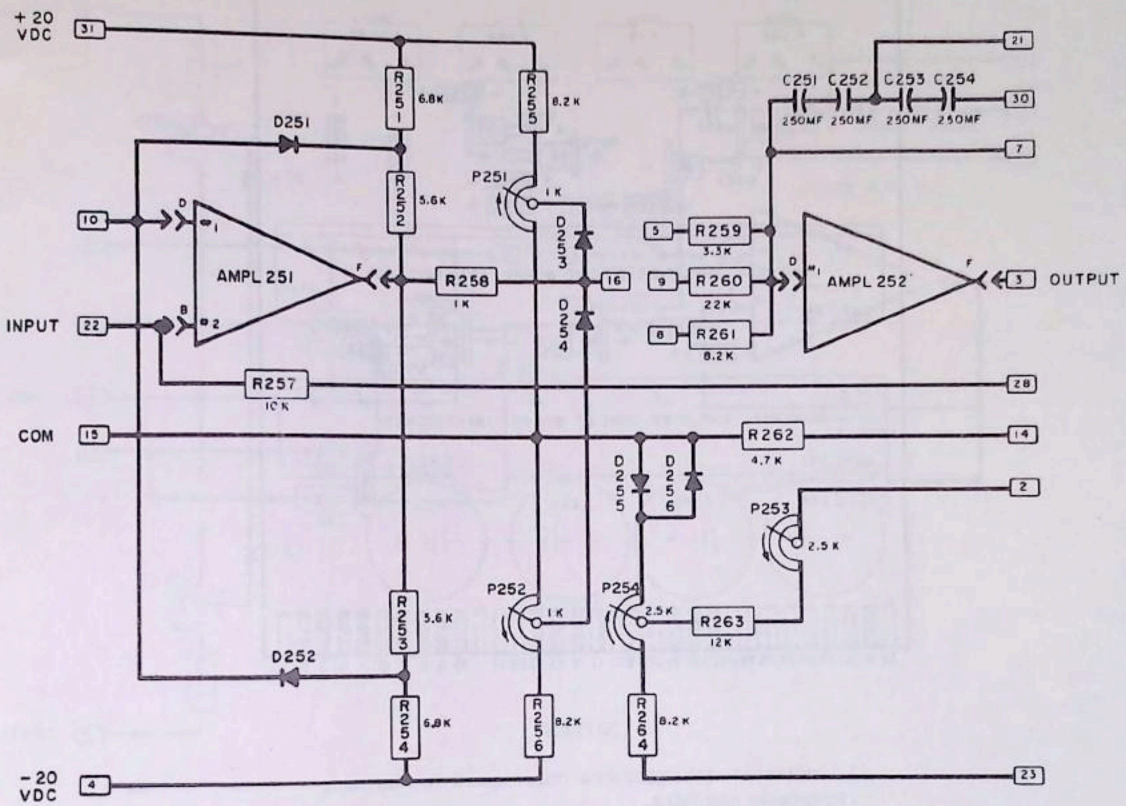
(With +20 volts DC between Tab 31 and Tab 14, -20 volts DC between Tab 5 and Tab 14 (701CR card) and with a reference increase from 0 to +10 volts (opposite polarities if reference changes from 0 to -10 volts).

From	To	Voltage
193X701CE		
Tab 16	Tab 15	0 to -14 volts to +14 volts to 0
Tab 3	Tab 15	0 to +10 volts to 0 (adjustable by potentiometer P277)
193X701CR		
Tab 2	Tab 14	0 to -10 volts DC

NOTES

1. Indicates retaining spring
2. Indicates jumper spring
3. —— A relay interlock is used to completely discharge the integrating capacitor
4. —— The sequence wiring of receptacles may require wires for both entering and leaving a terminal. This is accomplished by making the connections to the horizontally adjacent terminals and inserting a jumper spring between the terminals.
5. —— Tab 23 is connected to +20 volts DC as shown if the parameters are such that the opposite sense is required, reconnect Tab 23 to -20 volts DC.
6. ——Numbers in circles at side of receptacles indicate space unit requirements.

Fig. 10. Function connection and specification data



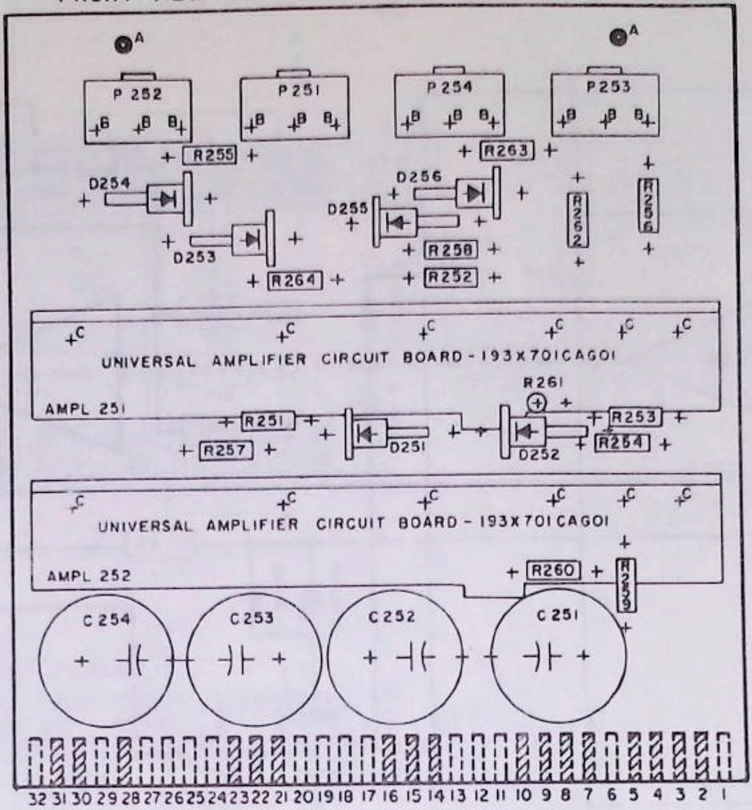
NOTES

1. Numbers inside the small rectangles indicate tab numbers which correspond to matching receptacle numbers.

2. The functional symbol shows only the signal inputs. For power supply connections, refer to the schematic diagram of that function.

Fig. 11. Card schematic 193X701CEG01

FRONT VIEW SHOWING LOCATION OF COMPONENTS



NOTES

1. Indicated tab numbers correspond to matching receptacle numbers.

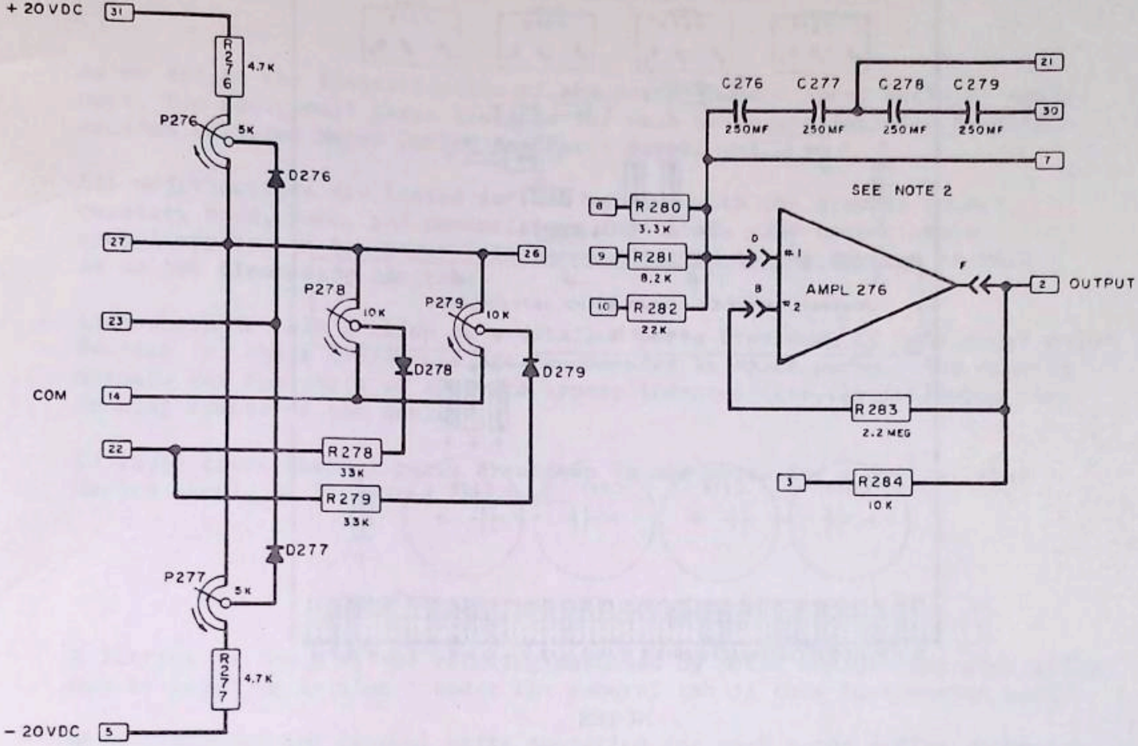
2. Cross-hatching indicates tabs used.

VOLTAGE CHECK LIST

(With +20 volts DC between Tab 31 and Tab 15, and -20 volts DC between Tab 4 and Tab 15.)

With input at zero	R251-R252	to	Tab 15	+9 volts
	R253-R254	to	Tab 15	-9 volts
	R255-P 251	to	Tab 15	+2.5 volts
	R256-P 252	to	Tab 15	-2.5 volts
	Tab 16	to	Tab 15	$\pm$0.5 volt
	Tab 3	to	Tab 15	Zero
After input change but before output stops changing	R252-R253	to	Tab 15	$\pm$14 volts
	Tab 16	to	Tab 15	$\pm$1 volt to $\pm$10 volts (depends on P 251 and P 252)
After output stops changing	Tab 3	to	Tab 15	0 to $\pm$10 volts (depends on input)

Fig. 12. Card layout 193X701CEG01



NOTES

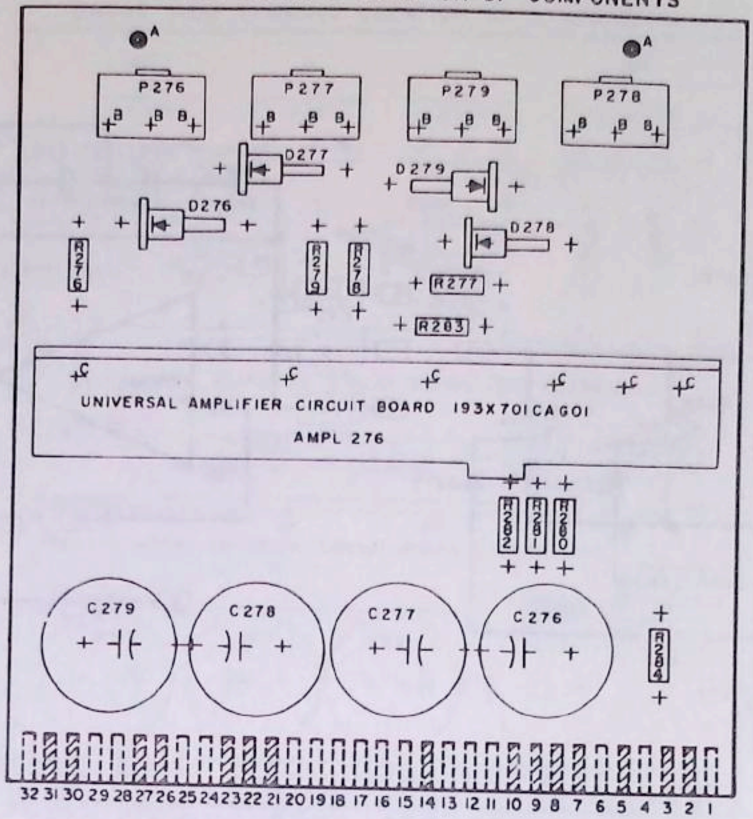
1. Numbers inside the small rectangles indicate tab numbers which correspond to matching receptacle numbers.

2. The functional symbol shows only the signal inputs. For power supply connections, refer to the schematic diagram of that function.

Fig. 13. Card schematic 193X701CRG01

SOFTWARE

FRONT VIEW SHOWING LOCATION OF COMPONENTS



NOTES

1. Indicated tab numbers correspond to matching receptacle numbers.

2. Cross-hatching indicates tabs used.

VOLTAGE CHECK LIST

(With +20 volts DC between Tab 31 and Tab 14, and -20 volts DC between Tab 5 and Tab 14).

Plus	Minus	Voltage
P276-R276	Tab 14	10 volts
Tab 14	P277-R277	10 volts
Tab 2	Tab 14	0 to ± 10 volts (depends on input)

Fig. 14. Card layout 193X701CRG01

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCTS DEPARTMENT
ERIE, PENNSYLVANIA 16501

7-71 (500)

PRINTED IN U.S.A.

SECTION 5-2

PRINCIPLE PARTS LISTS

As an aid to the identification of the parts in your Speed Variator equipment, two additional parts listings for each drive are included in this section entitled Major Device and Parts Breakdown.

All major devices are listed in this section with the drawing number, quantity used, name, and nomenclature indicated. The nomenclature symbol appears on the power unit panel adjacent to the devices as well as on the elementary diagrams.

Also shown in this section is a detailed parts breakdown of only those major devices for which components are recommended as spare parts. The drawing numbers for the parts of a device appear indented directly following the drawing number of the device.

In those cases where a parts breakdown is not shown for a device, that device should be purchased complete.

MODEL NUMBERS FOR THE ROTATING EQUIPMENT

A listing for each of the rotating machines by motor and/or generator model may be found in Section 1 under the general tab in this instruction book.

When a recommended renewal parts quotation for each motor and/or generator associated with your Speed Variator drive is desired, refer your requests to your General Electric Company Industrial Sales office or General Electric franchised distributor. Be sure and include in your request the model number and, if possible, the serial number found on the rotating machine nameplate. Your request will be referred to:

Mr. D. H. Curry, Manager-Renewal Parts Sales
Direct Current Motor and Generator Products Dept.
General Electric Company, Building 13-2
3001 East Lake Road
Erie, Pennsylvania 16501

IMPORTANT NOTE: Starters, contactors, and relays included in Speed Variator drives are often modified by changing coils, contacts, interlocks, or heaters to tailor the device to your application requirements. Major parts to assemble the modified device are included among the recommended renewal parts. (In a few cases, parts not used may be included on a starter, contactor or relay renewal part. Always check the coils, contacts, interlocks and/or heaters of original device in your drive before placing renewal parts in service.)

SECTION 4
SOFTWARE

PRINCIPAL PARTS LIST
SECTION A - CONTROL PARTS
PARTS BREAKDOWN

REQUISITION NO 480-23792 ITEM NO 1C PAGE 1

S.O. 5LJ467 07/11/73

SPEED VARIATOR MODEL 347X241AA G01

DRAWING NUMBER	QTY	NAME	NOMENCLATURE
347X241BA G01	1	REGULATOR	REG
193X416AA G01	1	FUNCTION	PS
193X755B3 G03	1	RELAY CORD	1R
193X767AB G01	1	FILTER S21	HPA
193X757AA G01	1	S CURVE S21	S
193X418AA G01	1	TP	TP
104X123AA 030	1	RESISTOR	R1
104X123AA 045	1	RESISTOR	R2
104X123AA 063	1	RESISTOR	R3
104X138AA 004	2	POT	P1 P3
104X138AA 001	1	POT	P2
7693475AA G02	3	KNOB LOCK	P1P2P3
193X416AA G01	1	FUNCTION	PS
193X741A3 G01	1	PWR SUPPLY	CARD
193X755B3 G03	1	RELAY CORD	1R
193X703AD G03	1	RELAY CARD	CARD
193X767AB G01	1	FILTER S21	HPA
193X709AA G01	1	HP UNIV AMPL	CARD
193X757AA G01	1	S CURVE S21	S
193X701CE G01	1	LINEAR TIME	CARD
193X701CR G01	1	S CURVE CD *	CARD
193X416AA G01	1	TP	TP
193X233AA G01	1	TEST NO METR	CARD
799C2706A G01	1	TRANSF KIT	PST
104X156CA 002	1	TRANSFORMER	T-ANS

PRINCIPAL PARTS LIST
SECTION A - CONTROL PARTS
MAJOR DEVICE

REQUISITION NO 480-23792 ITEM NO 1C PAGE 1

S.O. 5LJ467 07/11/73

SPEED VARIATOR MODEL 347X241AA G01

DRAWING NUMBER		QTY	NAME	NOMENCLATURE
347X241AA	G01			
347X241BA	G01	1	SV 1 JE	
104X152EB	G07	1	REGULATOR	REG
104X109AB	015	1	SWITCH HCI	MDISC
104X127RD	G03	3	FUSE CLF	MFUA
104X127RD	G01	1	RELAY	RUN
104X127RD	G01	1	RELAY	ST1
104X156AA	110	1	RELAY	ST2
799C270BA	G01	1	TRANSFORMER	CPT
104X109AA	002	1	TRANSF KIT	PST
104X190AR	002	2	FUSE	CPT FU
104X190AR	002	3	NAMEPLATE	NPPB1
104X190AR	002	3	NAMEPLATE	NPPB11
104X190AR	002	3	NAMEPLATE	NPPL3
104X191EA	G01	3	NAMEPLATE	NPPL13
104X191EA	G01	1	PB	PB2
104X191RB	G01	6	PB	PB14
104X191RB	G01	1	PB	PB1
104X190EC	G03	6	PB	PB13
104X190EC	G03	1	IND LIGHT	PL1
104X190ED	G03	6	IND LIGHT	PL13
104X190ED	G03	1	IND LIGHT	PL2
104X139AC	005	6	IND LIGHT	PL14
104X139AC	005	1	RHEOSTAT	POT SP
104X139AB	005	6	RHEOSTAT	TRH1 6
104X139AB	003	13	RHEO ACCES	KNOB
36A349028AC001		13	RHEO ACCES	DIAL
50-250300LCLC		1	METER	METER
104X127RD	G01	6	METER	AM1 6
104X127RD	G01	1	RELAY	MAC1
104X190EY	G01	1	RELAY	MAC2
104X191EA	G01	1	SWITCH	SS1
104X191EA	G01	3	PB	PB15
104X191RB	G01	3	PB	PB25
104X191RB	G01	3	PB	PB16
OHM-16358		3	PB	PB26
		6	RHEOSTAT	LRH1 6

SECTION 4

SOFTWARE

SECTION 4

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

WEDWAY PREPROCESSOR MONITOR SUBSYSTEM

INTRODUCTION

At various intervals along the WEDway Peoplemover track in Tomorrowland are several hundred linear induction motors, with their associated speed and proximity sensors. These motors form the propulsion system for the WEDway. Each motor has a corresponding motor control logic card (MCL) housed in cabinets at strategic points off the track.

The track is divided into 6 sections or zones. A zone consists of a sequence of linear induction motors at the track and the corresponding MCL cards. There are up to 32 MCL cards per cabinet and every zone has four cabinets.

Six remote computers or preprocessors form an integral part of the WEDway Monitor System. Each preprocessor is a Data General NOVA 2/10 computer with eight thousand words of memory.

Preprocessors communicate with the MCL cards by a data coupler card which interfaces each cabinet to the preprocessor. Hence status information from the motors and sensors of any zone is collected at a preprocessor.

The preprocessors continually monitor their zones for unusual conditions. Any error or unusual condition is immediately transmitted to the WEDway Central Computer situated at DACS. A serial, full-duplex communication link enables messages to be transmitted between preprocessors and the WEDway central computer.

1. SUBSYSTEM FUNCTIONAL DESCRIPTION

The functions of the preprocessor monitor subsystem may be broken down and summarized as follows:

1. Communications with the WEDway central computer
   a. Transmitting messages from preprocessor to central computer including clock synchronization.
   b. Receiving messages from the central computer.
   c. Transmitting READY signals from preprocessor to central computer every 50 seconds.
2. Zone Monitoring
   a. Obtaining status data from all motors in each zone.
   b. Detecting error conditions (HOT SCR, WM MTR, etc.).
   c. Obtaining speed and proximity data from the sensors and thus monitoring the speed of each train and its position relative to the next train.
   d. Detecting slow trains.
   e. Detecting special track conditions (PANIC STOP, SHUT DOWN, etc.).
3. Diagnostic testing
   a. Monitoring DATA PATH ACKNOWLEDGE signals between preprocessors and motor logic cabinets.
   b. Loop testing INTEGRITY-DATA-CONTROL cards to verify conditions of both the INTEGRITY-DATA-CONTROL and the DATA COUPLER cards.
   c. Monitoring the DONE flag at the NOVA INTERFACE printed circuit board (PCB).
   d. Recovery after computer power failure.
   e. Monitor transmission buffers for overflow conditions from too many messages.

2. PREPROCESSOR PHYSICAL DESCRIPTION

Each preprocessor consists of a DATA GENERAL NOVA 2/10 mainframe with the following interface boards:

a. NOVA CPU board
b. 8K Memory board
c. 4007/4008/4010 board (for basic I/O, real time clock, and teletype)
d. 4075/77/78 cassette I/O board (for 4800 baud communications link to central computer)
e. 5561 Custom Products driver/receiver
f. Nova interface board (interface to cabinets)

The following peripherals are considered part of each preprocessor:

a. Real Time Clock (1 kHz)
b. Communications link to central computer
c. Nova Interface and Data Coupler cards (for track zone communications)
d. (Optional) Teletype (used only for debugging)

Operating System: RTOS, rev. 3.02

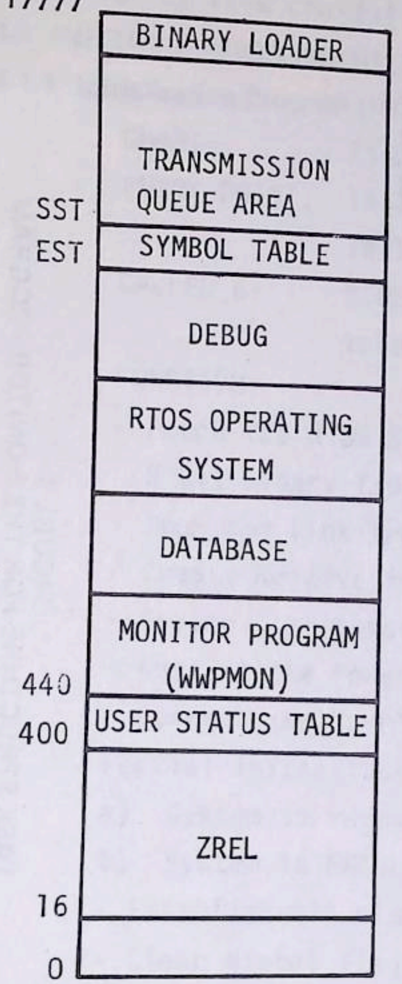
Program Start/Restart: Location 40

Real Time Clock frequency: 1000 Hz

3. PROGRAM ORGANIZATION

The following paragraphs outline the organization of main storage as well as the structure of the monitor program.

The preprocessor 8K memory is divided into 7 distinct areas:



1. The monitor program (WWPMON) - performs all preprocessor functions. Identical in each preprocessor.
2. The Motor/Sensor information tables (DATABASE) - contain the data required for monitoring a zone. Different from preprocessor to preprocessor.
3. The operating system (RTOS) - handles multi-tasking, input/output, and interrupt servicing.
4. The symbolic debugger (DEBUG).
5. Symbol tables EST to SST - used by the symbolic debugger.
6. System queue area - used to store messages for transmission to central computer.
7. Binary loader - loads data from central computer. Always resides at top of memory.

The monitor program is divided into 3 concurrently executable parts called tasks. INITZ, the main task, creates the subtasks RECV and XMIT.

RECV processes all incoming messages from the communications link (central computer). XMIT facilitates transmission of messages to the central computer.

The use of tasks permits overlap between the input/output operations and those performed by the Nova CPU. Figure 1 illustrates the task structure.

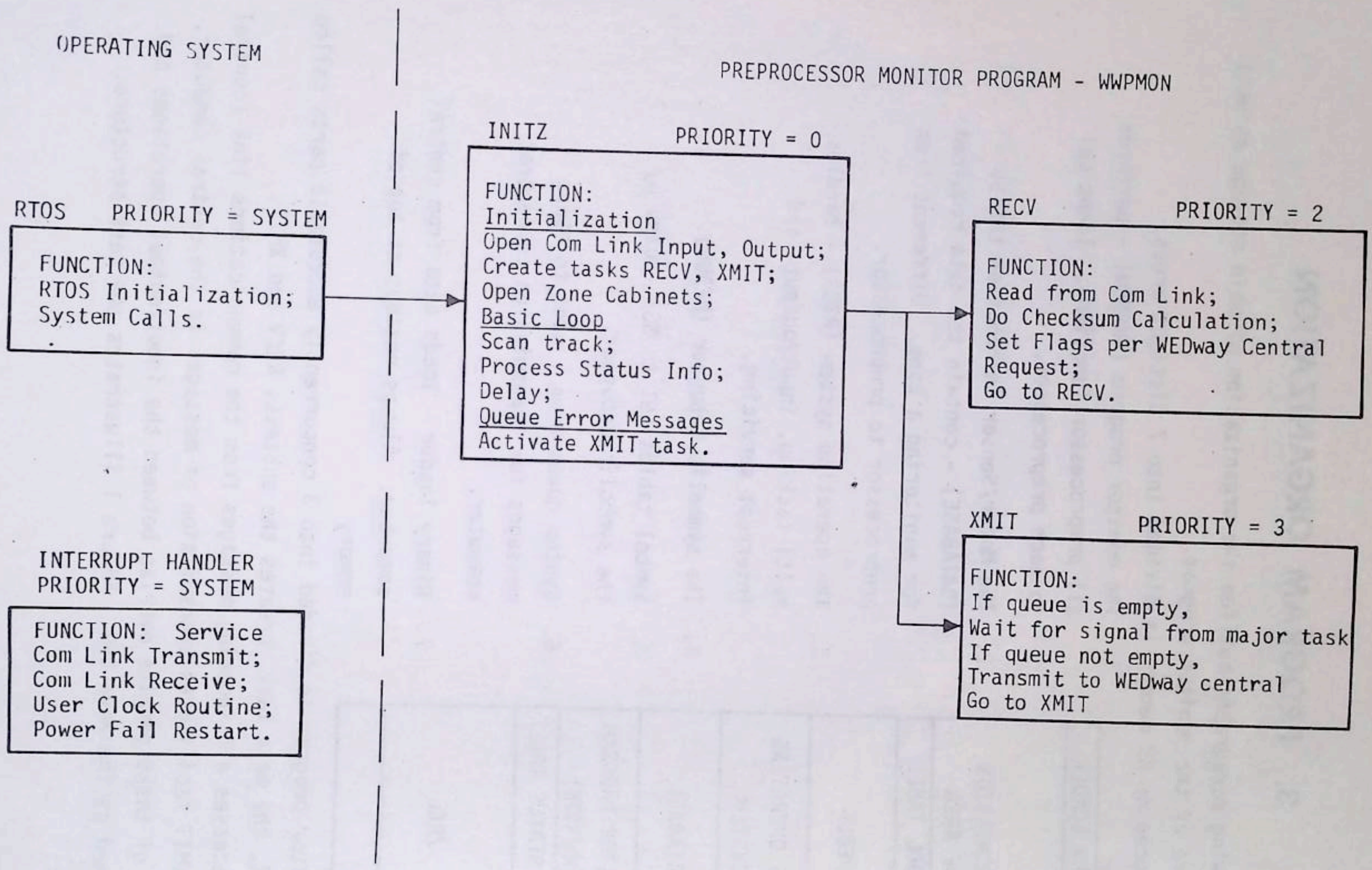


FIGURE 1
TASK STRUCTURE FOR THE MONITOR PROGRAM

4. PROGRAM DESCRIPTION

The following pages contain a detailed description of the preprocessor monitor program in terms of the routines charted in figure 2. The descriptions that follow are in outline form containing the name of the routine, its function, inputs, outputs, and exits from the routine. The outlines are supported by flow charts (figures 3 through 14).

4-1 INITIALIZATION MODULE

4-1-1 Initialization Program (INITZ)

CHART: Figure 3

ENTRY POINT: INITZ (Full Initialization)
INI10 (Partial Initialization)

CALLED BY· RTOS Initialization when full initialization takes place.

FUNCTION:

- Patch the RTOS $TTO Driver to inhibit echoing and to allow 8 bit binary I/O.
- Open com link input ($TTI1), com link output ($TTO1).
- Create Receive Task (RECV).
- Create Transmission Task (XMIT).
- Connect the Power Fail Restart code.
- Connect the User's Clock Routine.

Partial Initialization occurs when

a) System is restarted after a Power Fail.

b) System is ENABLED by WEDway central.

- Establish all clock counters at zero.
- Clear global flags.
- Set the front and rear pointers of the transmission buffer queue.
- Set ready timer for 50 seconds.
- Queue the 1st Time/Acknowledge Message to WEDway central.
- Call subroutine, MLOPN, to establish link with the WEDway controllers and track.

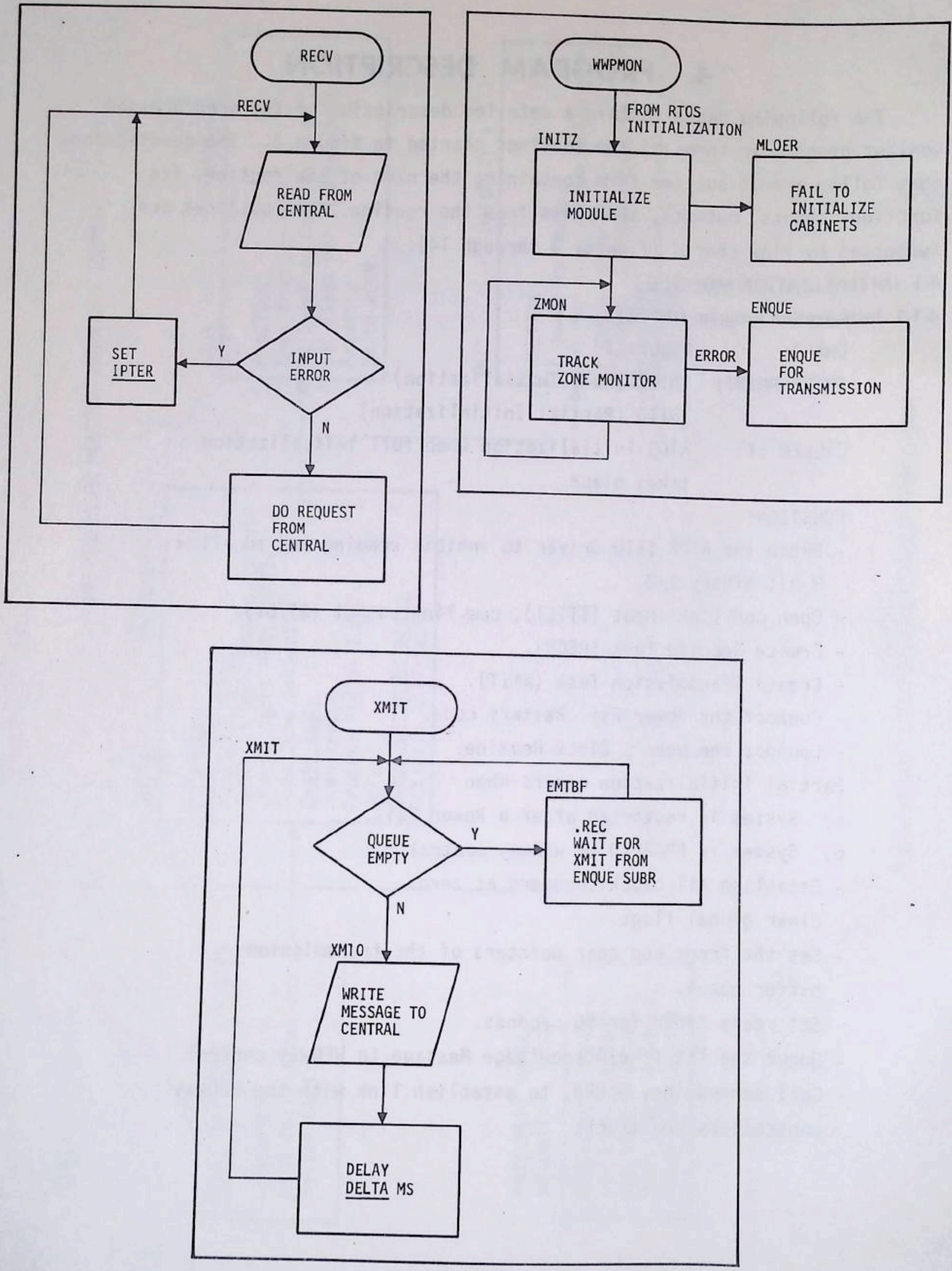


FIGURE 2
PREPROCESSOR MONITOR PROGRAM OVERALL FLOW

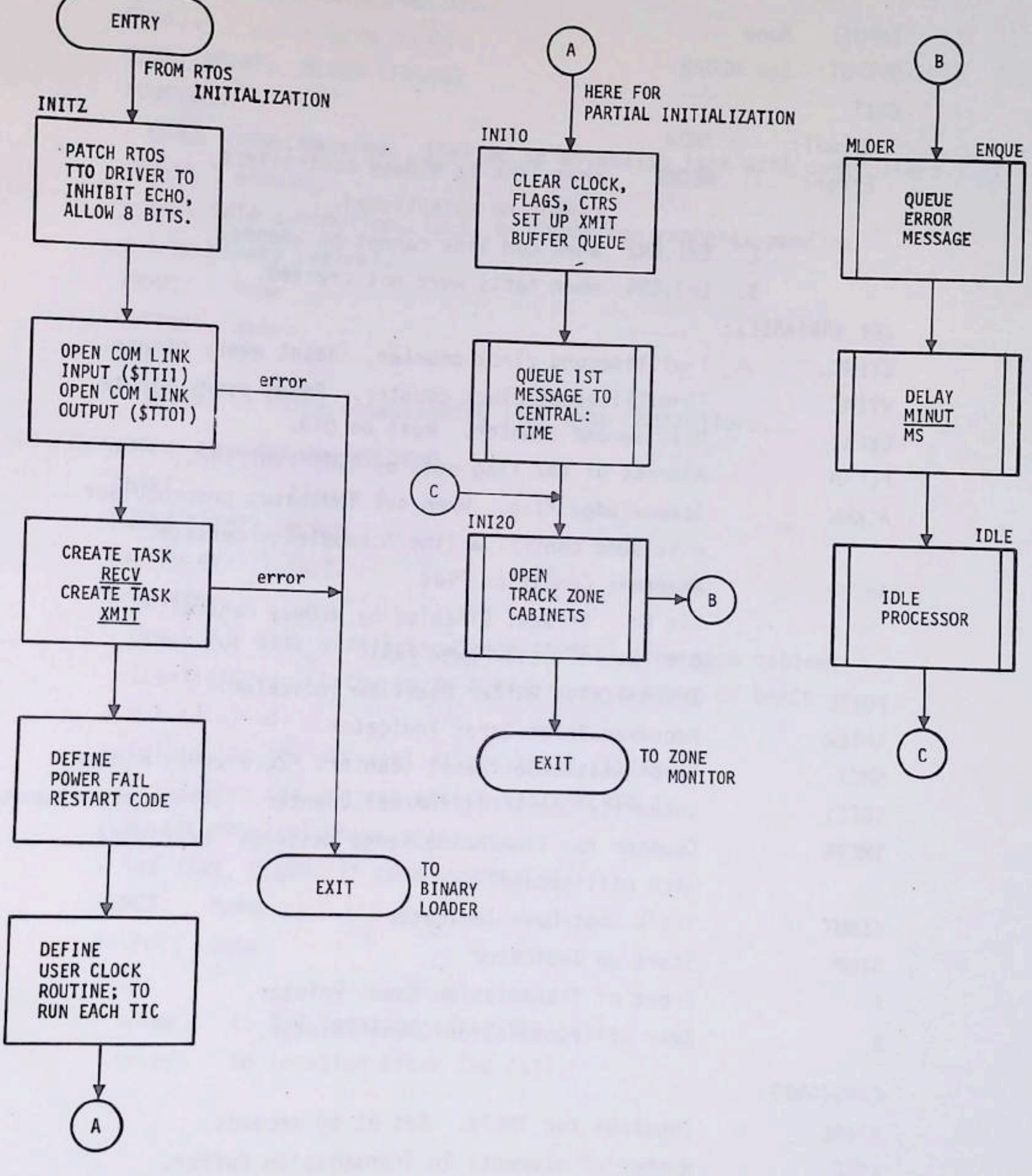


FIGURE 3
INITIALIZATION MODULE

INPUT: None

OUTPUT: See MLOPN

EXIT:

Normal: ZMON

Error:
1. MLOER when link to WEDway controllers cannot be established.
2. ER1,ER2 when com link cannot be opened.
3. ER3,ER4 when tasks were not created.

KEY VARIABLES:

CTIME	1-millisecond clock counter. Reset every minute.
HTIME	10-millisecond clock counter. Reset every minute.
CKEXT	Millisecond counter. Must be 0-9.
FLGAD	Address of the flag used by RTOS .XMT/.REC.
ACKNW	Acknowledge Flag. When set indicates preprocessor must send central a Time/Acknowledge message.
ABEND	Abnormal Condition Flag Bit 0: if set, Disabled by WEDway central. Bit 15: if set, Power Fail.
POVFL	Transmission Buffer Overflow Indicator.
IPTER	Receiver Input Error Indicator.
SMCT	Error Status Set/Reset Counter. Zero every minute.
ICECT	Integrity Check Fail/Normal Counter. Zero every minute.
TMCTR	Counter for Time/Acknowledge Message. Decrement each millisecond.
TSHUT	Track Shut-Down Indicator
STUP	Start Up Indicator
F	Front of Transmission Queue Pointer.
R	Rear of Transmission Queue Pointer.

CONSTANTS:

NTVAL	Constant for TMCTR. Set at 50 seconds.
XSZE	Number of elements in Transmission Buffer. Set at 100.

4-1-2 Controller Open Error Routine (MLOER)

CHART: Figure 3, B

ENTRY POINT: MLOER (ER100)

FUNCTION:

- Queue error message. (Failed to establish link with controllers.)
- Wait 1 minute.
- Call idle subroutine, IDLE, to check for requests pending from WEDway central.

INPUT: None

OUTPUT: None

EXIT:

INI20 to retry establishing link with controllers.

4-1-3 Open Motor Logic Cabniets (MLOPN)

CHART: Figure 4

ENTRY POINT: MLOPN

CALLED BY: INITZ

FUNCTION:

- Check for data path acknowledge (DPACK) from each cabinet (controller). Retry up to 5 times per cabinet if DPACK not received.
- Initialize the physical status table (STTAB).
- Initialize the logical status table (LGTBL).
- Do 1st physical input scan.
- Set flag, MLOSW, if open successful.

INPUT: None

OUTPUT: None

EXIT:

Normal: to 2nd location after the call.

Error: to location after the call.

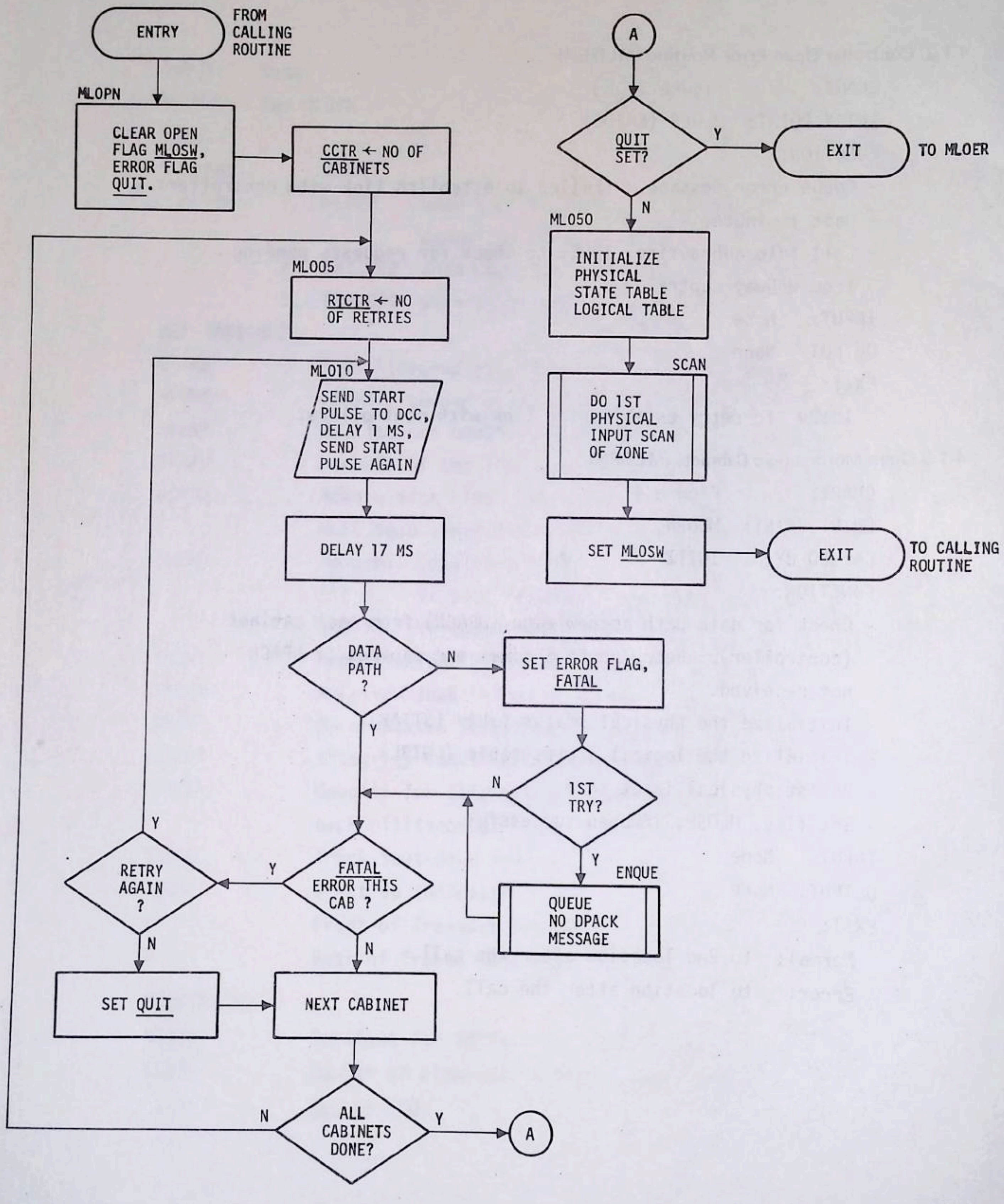


FIGURE 4
MOTOR CABINETS OPEN SUBROUTINES

METHOD OF OPERATION:

1. DPACK

   - Output start pulse to data coupler card.
   - Delay 1 millisecond.
   - Output start pulse to data coupler card.
   - Delay 17 milliseconds.
   - Test for DPACK signal.

The above sequence is retried up to 5 times.

2. Physical Status Table

   - Initial status is '001000'. (See Data Area Formats).
   - Initial status of special motor address for monitor points is '000000'.

3. Logical Status Table

   - Initial Logical Status is '000000'.
   - Initial Transition Time is -1. (See Data Area Formats).

DATA AREAS ACCESSED: STTAB, LGTBL, NCAB

FATAL Error indicator. Set each time DPACK not received. Reset or retry.

QUIT Error indicator. Set when all retries for a single cabinet fail.

KEY CONSTANTS:

RETRY Number of retries per cabinet. Set at 5.

4-2 TRACK ZONE MONITOR MODULE

4-2-1 Track Zone Monitor (ZMON)

CHART: Figure 5

ENTRY POINT: ZMON

FUNCTION:

Basic monitoring loop for the preprocessing system.

- Calls the idle processor, IDLE, to determine whether there are requests pending from WEDway central.
- Calls the physical input scan routine, SCAN.
- Calls the subroutine, TRANSIT, to check for motor crossing time-outs.

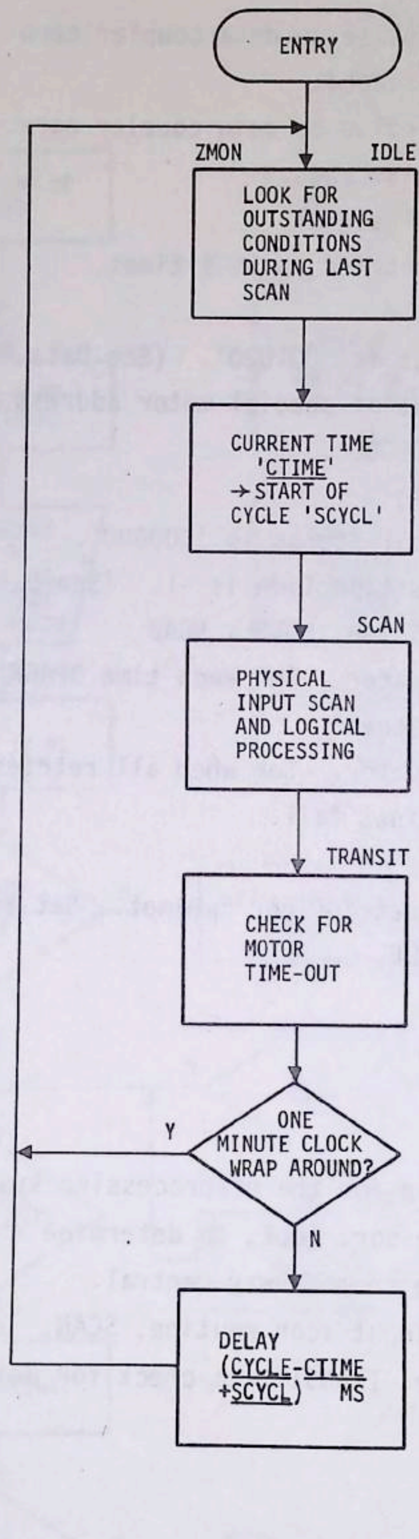


FIGURE 5
TRACK ZONE MONITOR MODULE

INPUT: None

OUTPUT: None

EXIT: (See IDLE, SCAN)

METHOD OF OPERATION:

The basic loop will require at least 8 milliseconds to complete because of a built-in delay.

KEY VARIABLES:

CTIME	1-millisecond clock counter. Reset every minute.
SCYCL	Value of CTIME at the start of a basic loop.

KEY CONSTANTS:

CYCLE	Number of milliseconds maximum for basic loop Set at 14.

4-2-2 Idle Processor (IDLE)

CHART: Figure 6

ENTRY POINT: IDLE

CALLED BY: MLOER, ZMON

FUNCTION:

- Test for outstanding requests pending from WEDway central that occurred when the preprocessor was active (eg. last scan).
- Test for receiver input errors and report.

INPUT: None

OUTPUT: None

EXIT:

Normal:	to calling routine.	
Error:	Binary Loader	if SHUT DOWN requested by WEDway central.
	STOP	if Power Fail Restart or DISABLE requested by WEDway central.

KEY VARIABLES:

ABEND	Abnormal error condition. Set by Power Fail restart or 'DISABLE' from WEDway central.
ABORT	Set by 'SHUT DOWN' request from WEDway central.
ACKNW	Time Acknowledge flag. Set every 50 seconds.
IPTER	Receiver Input Error Flag.

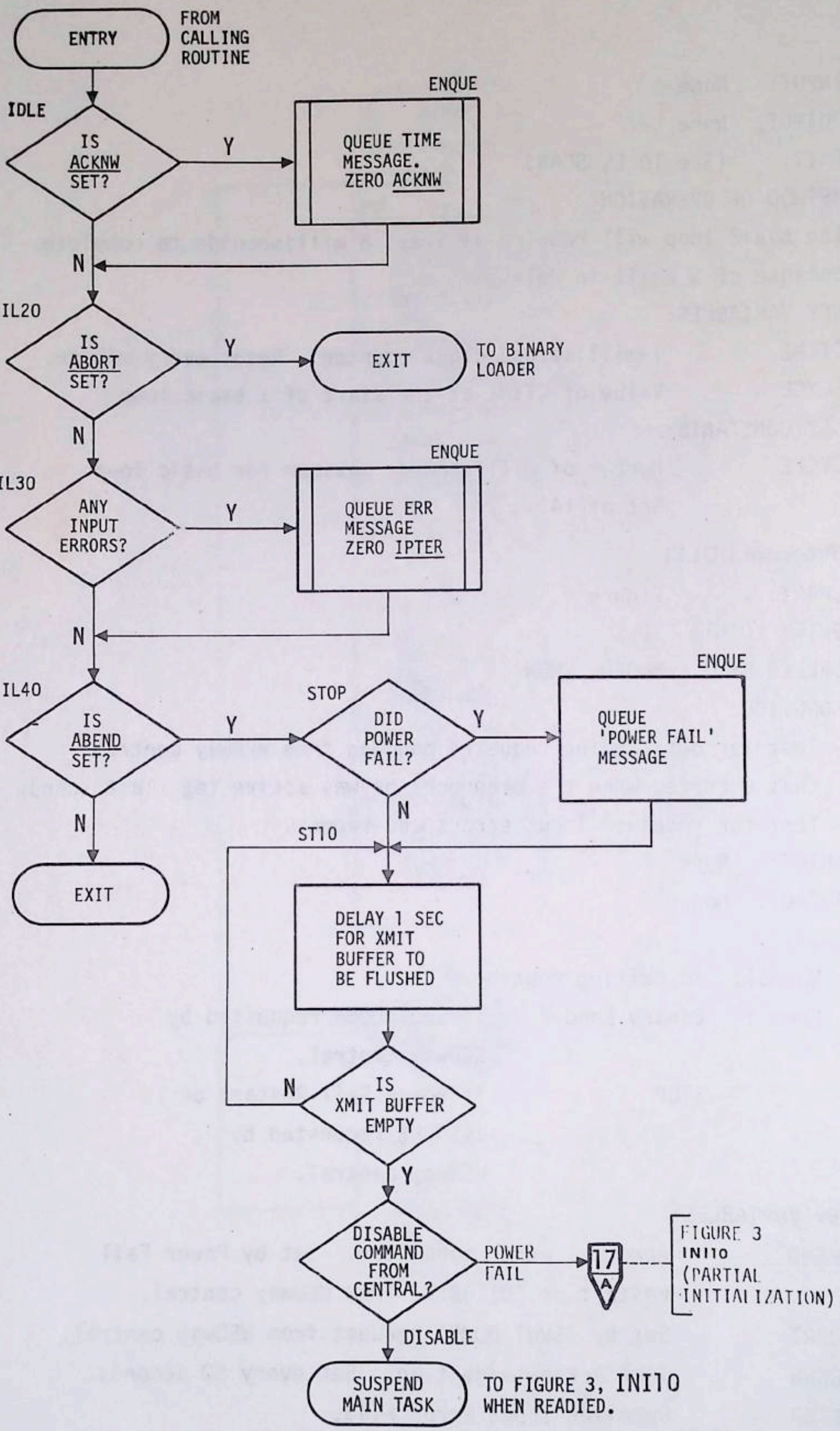


FIGURE 6
TRACK IDLE PROCESSOR

4-2-3 Abnormal Condition Processing (STOP)

CHART: Figure 6

ENTRY POINT: STOP

CALLED BY: Control passed from IDLE when ABEND flag set

FUNCTION:

- Flushes the transmission buffer before system goes to partial initialization.

INPUT: AC0 contains the ABEND flag

OUTPUT: Transmission Buffer is exhausted

EXIT:

On Power Fail	INI10
On 'DISABLE' request	MAIN task suspended by .SUSP proceeds to INI10 when awakened.

KEY VARIABLES:

ABEND	Abnormal Condition Flag
	Bit 0 if set, disabled by WEDway central
	Bit 15 if set, Power Fail

KEY CONSTANTS:

TKID	Task ID for the XMIT task. Set to 2.
BIT3	Value of status word returned by system call .IDST when a task is suspended by a .REC call.

4-2-4 Physical Input Scan Subroutine (SCAN)

CHART: Figure 7

ENTRY POINT: SCAN

CALLED BY: MLOPN, ZMON

FUNCTION:

- Perform 2 integrity card loop tests on each cabinet (controller).
- Input status from all motors.
- Determine change of status for special monitor point motor addresses.
- Determine any change of status and pass control to the Logical Processing Module (LOGIC) when it occurs.

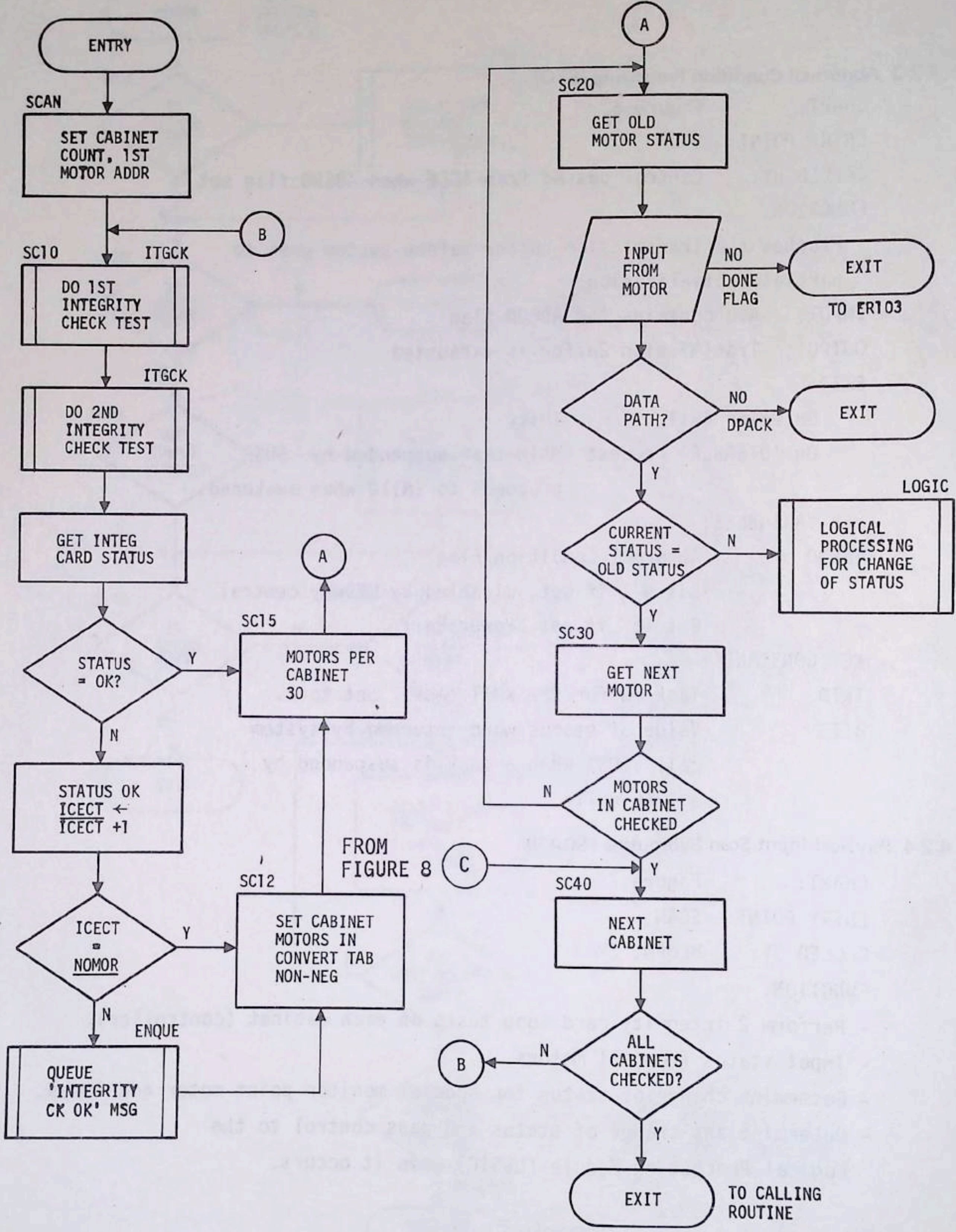


FIGURE 7
PHYSICAL INPUT SCAN SUBROUTINE

INPUT: Status words from the motor logic cards and integrity cards.

OUTPUT: None

EXIT:

Normal - return to calling routine

Error - ER101 NO DPACK

ER103 Done Flag at the Nova interface has timed out

DATA AREAS ACCESSED: PLCTB, STTAB

KEY VARIABLES:

MOTOR	Value of cabinet address during integrity card loop test.
TPTRN	Test pattern being transmitted to integrity card for loop test.
ICECT	Integrity check fail/normal counter. Reset each minute.

KEY CONSTANTS:

INTEG	Address relative to start of cabinet of the integrity card. Set at 31.
DONCNT	Number of retries in the done flag timeout loop. Set at 4.
K30	Number of motor logic cards per cabinet. Set at 30 (one less than actual number).
CSMSK	Mask of status bits on which change of state may occur.
NCAB	Number of cabinets for this preprocessor.

4-2-5 Integrity Card Check Subroutine (ITGCK)

CHART: Figure 8

ENTRY POINT: ITGCK

CALLED BY: SCAN

FUNCTION:

- Transmit a test pattern to the integrity card then read it back and compare.

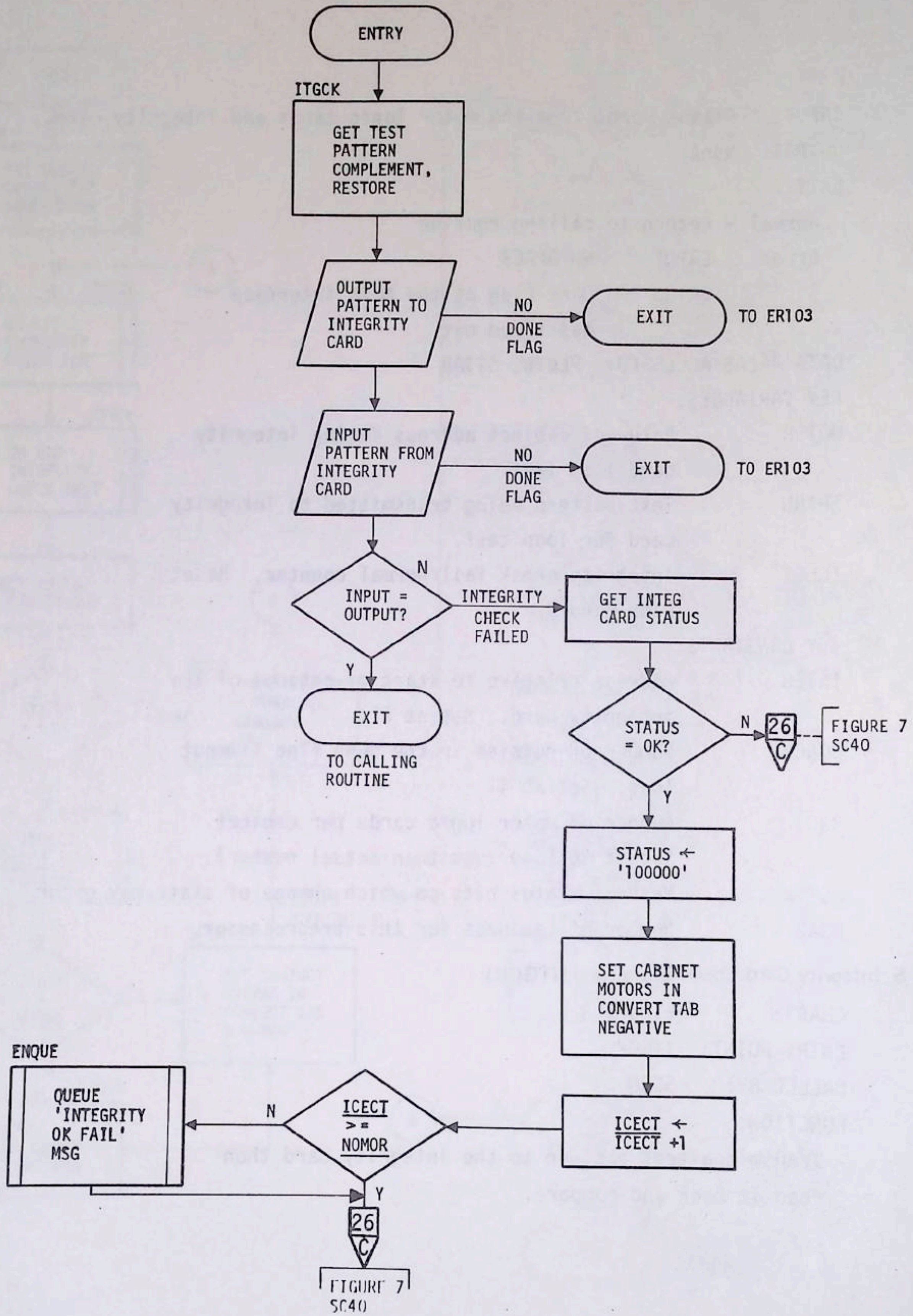


FIGURE 8
INTEGRITY CARD CHECK SUBROUTINE

INPUT: AC2 contains address of cabinet.

Input status from integrity card.

OUTPUT: Test pattern to integrity card.

EXIT:

Normal - return to calling routine.

Error - SC40.

4-2-6 Logical Processing Section (LOGIC)

CHART: Figure 9

ENTRY POINT: LOGIC

CALLED BY: SCAN

FUNCTION:

- Compare current scan status bits 4-7 (error bits) with previous scan status bits 4-7. If there is a change in status, isolate the bit(s) and send error message.
- Convert physical status to logical status.
- Determine and evaluate change of state for the speed and proximity sensors. In particular, analyze motor crossings.

INPUT: AC0 contains current physical status

AC2 contains the motor address

OUTPUT: Updated logical status table

EXIT: To SC30 in the SCAN subroutine

METHOD OF OPERATION:

The evaluation of the sensor change of state is described below.

The program examines 2 bits from the physical status:

BIT 0 PROXIMITY (PROX)

BIT 3 READ SPEED (RDSP)

Physical status is first converted to an internal logical status as follows:

Logical Status	Physical Status
0	PROX off, RDSP off
1	PROX off, RDSP on
2	PROX on, RDSP off
3	PROX on, RDSP on

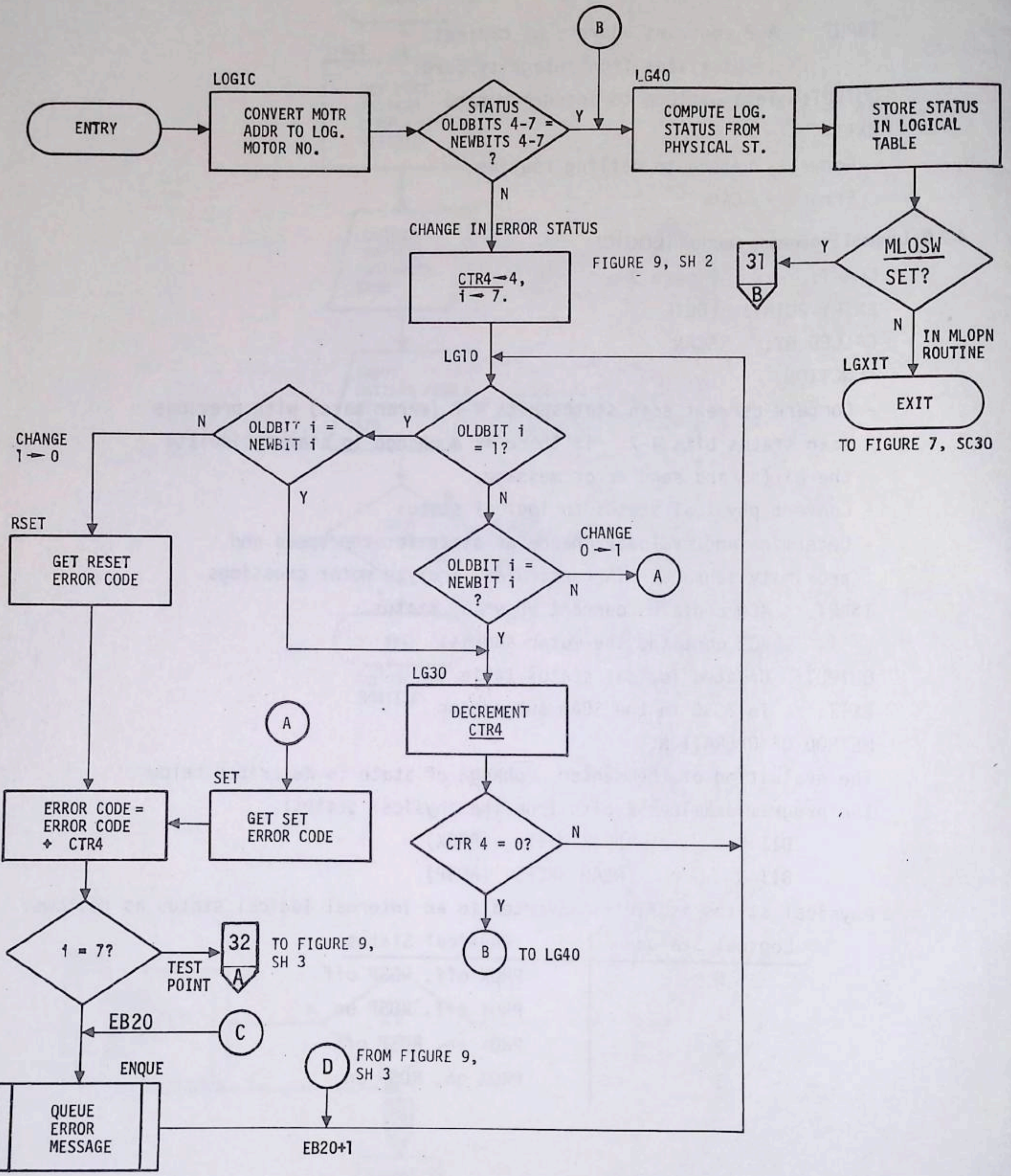


FIGURE 9
LOGICAL PROCESSING MODULE
SHEET 1 OF 3

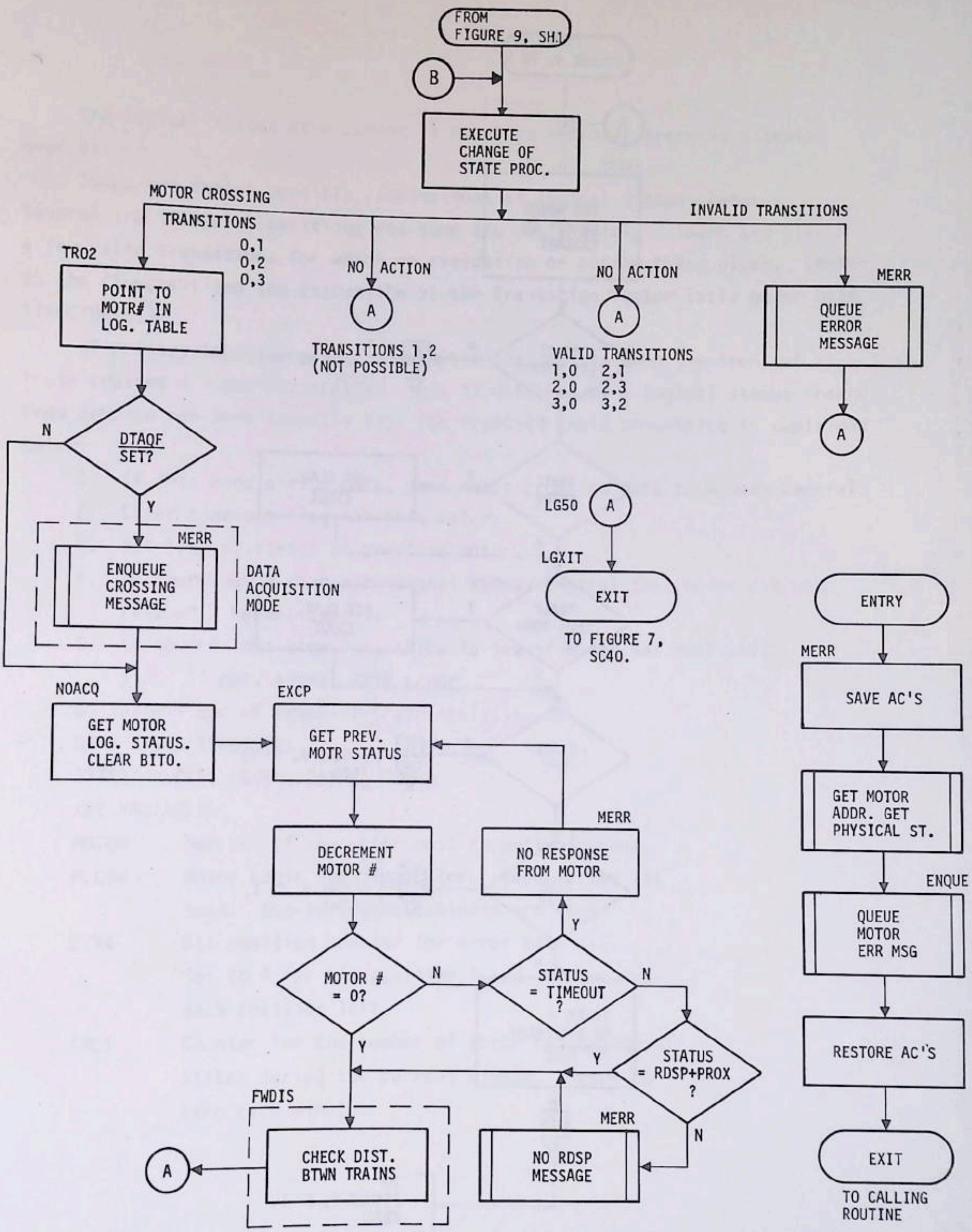


FIGURE 9
LOGICAL PROCESSING MODULE
SHEET 2 OF 3

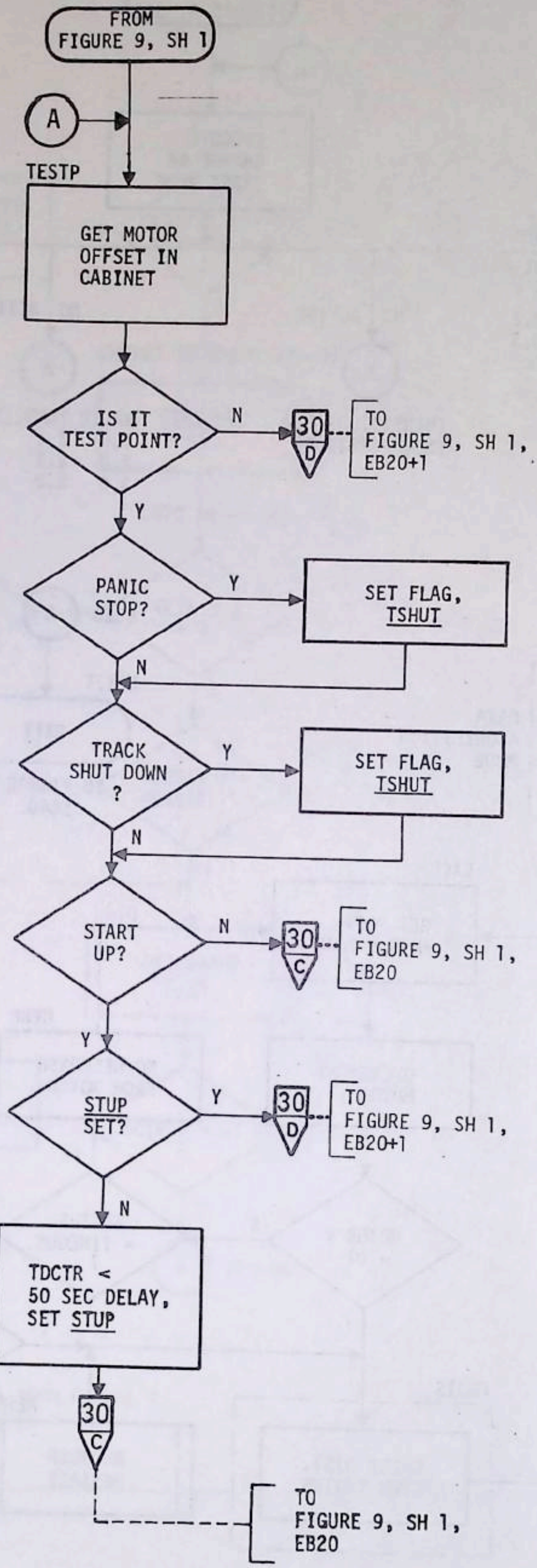


FIGURE 9
LOGICAL PROCESSING MODULE
SHEET 3 OF 3

The logical status at a sensor is non-zero whenever there is a train over it.

There are twelve possible combinations of logical status change. Several are illegal transitions and some are not possible. There are also a few valid transitions for which no evaluation or action takes place. (Refer to the flowchart and the discussion of the Transition Vector Table under DATA STRUCTURES.)

Of primary importance is the analysis that occurs when the front of a train crosses a specific sensor. This is detected by a logical status change from zero to non-zero (usually 2). The front-of-train processing is explained below:

1. If data acquisition mode, send motor crossing data to WEDway central.
2. Clear time-out flag for this motor.
3. Set logical status of previous motor.
4. If there was a time-out, signal WEDway central that motor did not respond. Repeat step 3.
5. If no previous time-out, check to see if motor has RDSP state yet. If not, signal RDSP error.
6. Exit - end of front-of-train analysis.

DATA AREAS ACCESSED:

STTAB, PLCTB, LGTBL, DATAQ, SCTBL

KEY VARIABLES:

MOTOR	Address of the motor most recently scanned.
MLOSW	Motor Logic Open Indicator. Zero during 1st scan. Non-zero when cabinets are open.
CTR4	Bit position counter for error bits 4-7. Set to 4 for bit position 7 and decremented each position left.
SMCT	Counter for the number of error bit change of states during the current minute. Reset to zero each minute.

DATAQ Motor Crossing (Data Acquisition) Mode flag. When set, motor crossing data is transmitted to WEDway central.

TSHUT Track Shut Down Indicator. No sensor messages are transmitted when this indicator is set.

KEY CONSTANTS:

TENSC Time delay after start-up (in milliseconds) required before sensor-related error messages are transmitted. Set at 50000.

CUTOF Maximum number of error status messages(4-7) allowed per minute. Set at 50.

TPMAX Maximum number of monitor points per cabinet. Set at 9.

4-2-7 Transit Subroutine (TRANSIT)

CHART: Figure 10

ENTRY POINT: TRANSIT

CALLED BY: ZMON

FUNCTION:

- Determine which motors have timed out, that is, the elapsed time between them and the previous motor exceeds a prescribed maximum.

INPUT: None

OUTPUT: Time-out flag set in Logical Status Word (CSTAT) of Logical Table for motors that time out. Also reset when train has passed.

EXIT: To calling routine.

METHOD OF OPERATION:

1. From the Logical Status Table determine where the front of each train is.
2. The time-out test is <u>not made</u> if maximum Motor Crossing Time is 0 or the transition time (i.e. time at which front of train crosses motor) is -1. This is true at initialization time.

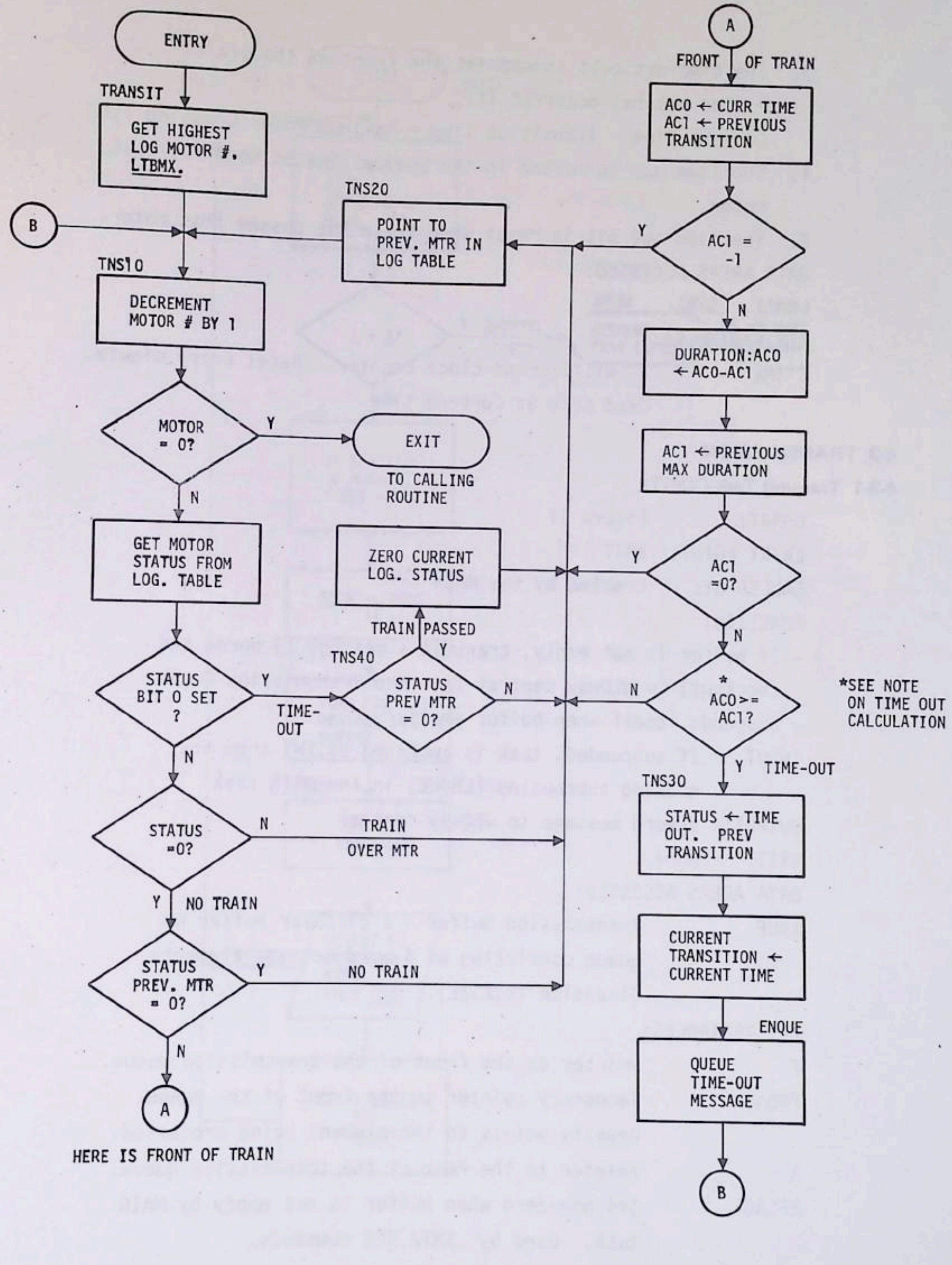


FIGURE 10
TRANSIT SUBROUTINE

3. The time-out test is made at the front of the train.
   A time out has occurred if:
   Current Time - Transition Time = Maximum Motor Crossing Time
4. The time out is marked in the Logical Status Word for that motor.
5. The time out bit is reset when train has passed that motor.

DATA AREAS ACCESSED:

LGMAX, LGTBL

KEY VARIABLES:

CTIME	1- millisecond clock counter. Reset every minute. Used here as current time.

4-3 TRANSMISSION

4-3-1 Transmit Task (XMIT)

CHART: Figure 11

ENTRY POINT: XMIT

CALLED BY: Created by the MAIN task

FUNCTION:

- If buffer is not empty, transmit a message (4 words and checksum) to WEDway central from the Transmission Queue.
- Suspends itself when buffer empty.

INPUT: If suspended, task is awakened by.XMT from the queuing subroutine (ENQUE) in the MAIN task.

OUTPUT: 5-word message to WEDway central.

EXIT: None

DATA AREAS ACCESSED:

XBUF	Transmission Buffer - a circular buffer or queue consisting of 4-word message elements. Dimension (4,XSZE).

KEY VARIABLES:

F	Pointer to the front of the transmission queue.
FRONT	Temporary pointer to the front of the queue. Usually points to the element being processed.
R	Pointer to the rear of the transmission queue.
XFLAG	Set non-zero when buffer is not empty by MAIN task. Used by .XMT/.REC commands.

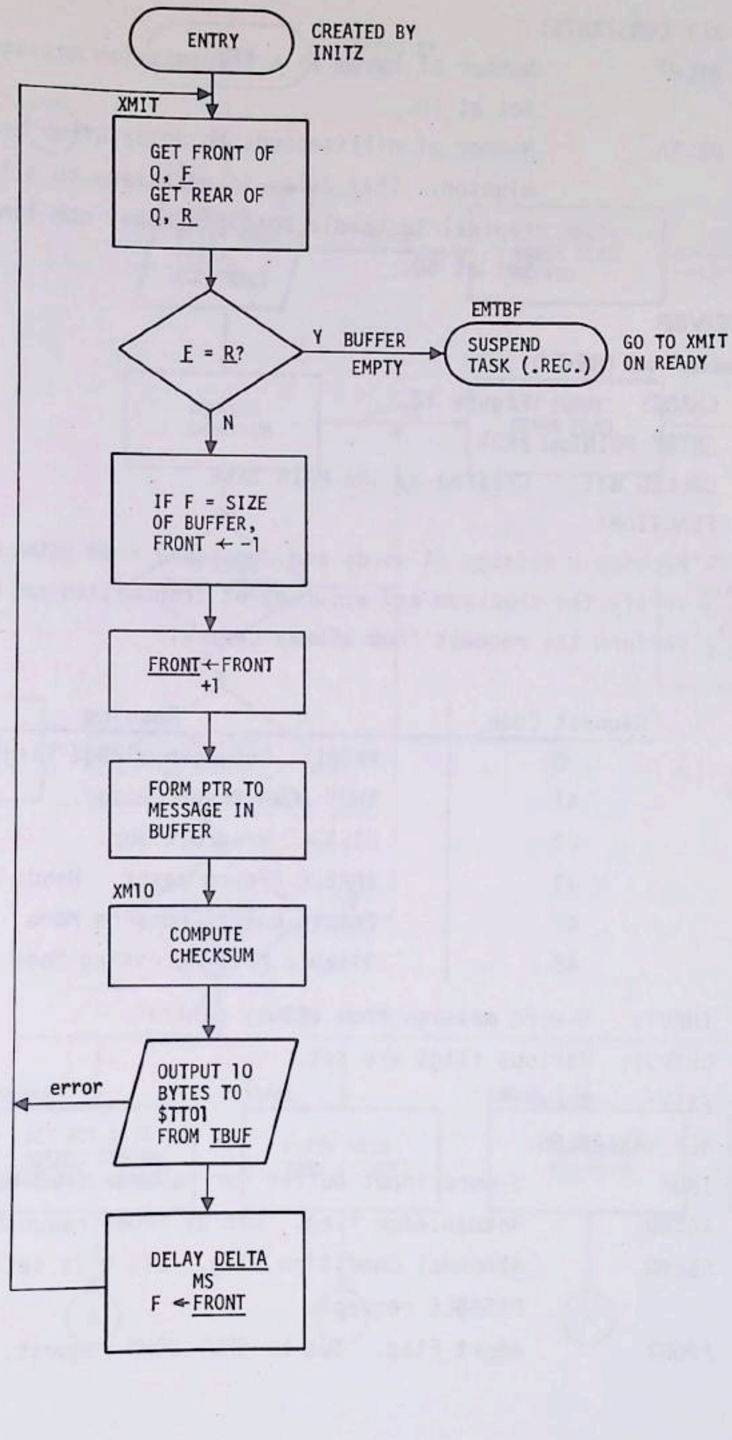


FIGURE 11
TRANSMIT TASK

KEY CONSTANTS:

BYCNT — Number of bytes in a transmission message. Set at 10.

DELTA — Number of milliseconds to delay after transmission. This delay is necessary to allow WEDway central to handle possible heavy com link traffic. Set at 50.

4-4 RECEIVER

4-4-1 Receive Task (RECV)

CHART: Figure 12

ENTRY POINT: RECV

CALLED BY: Created by the MAIN task

FUNCTION:

- Receive a message (4 words and checksum) from WEDway central.
- Verify the checksum and accuracy of transmitted message.
- Perform the request from WEDway central.

Request Code	Meaning
0	PROBE. Set Acknowledge Flag
41	SHUT DOWN Preprocessor.
42	DISABLE Preprocessor.
43	ENABLE Preprocessor. Ready MAIN task.
47	Enable Motor Crossing Mode
48	Disable Motor Crossing Mode

INPUT: 5-word message from WEDway central.

OUTPUT: Various flags are set.

EXIT: None

KEY VARIABLES:

IBUF — 5-word input buffer for message from WEDway central.

ACKNW — Acknowledge flag. Set by PROBE request.

ABEND — Abnormal Condition Flag. Bit 0 is set by the DISABLE request.

ABORT — Abort Flag. Set by SHUT DOWN request.

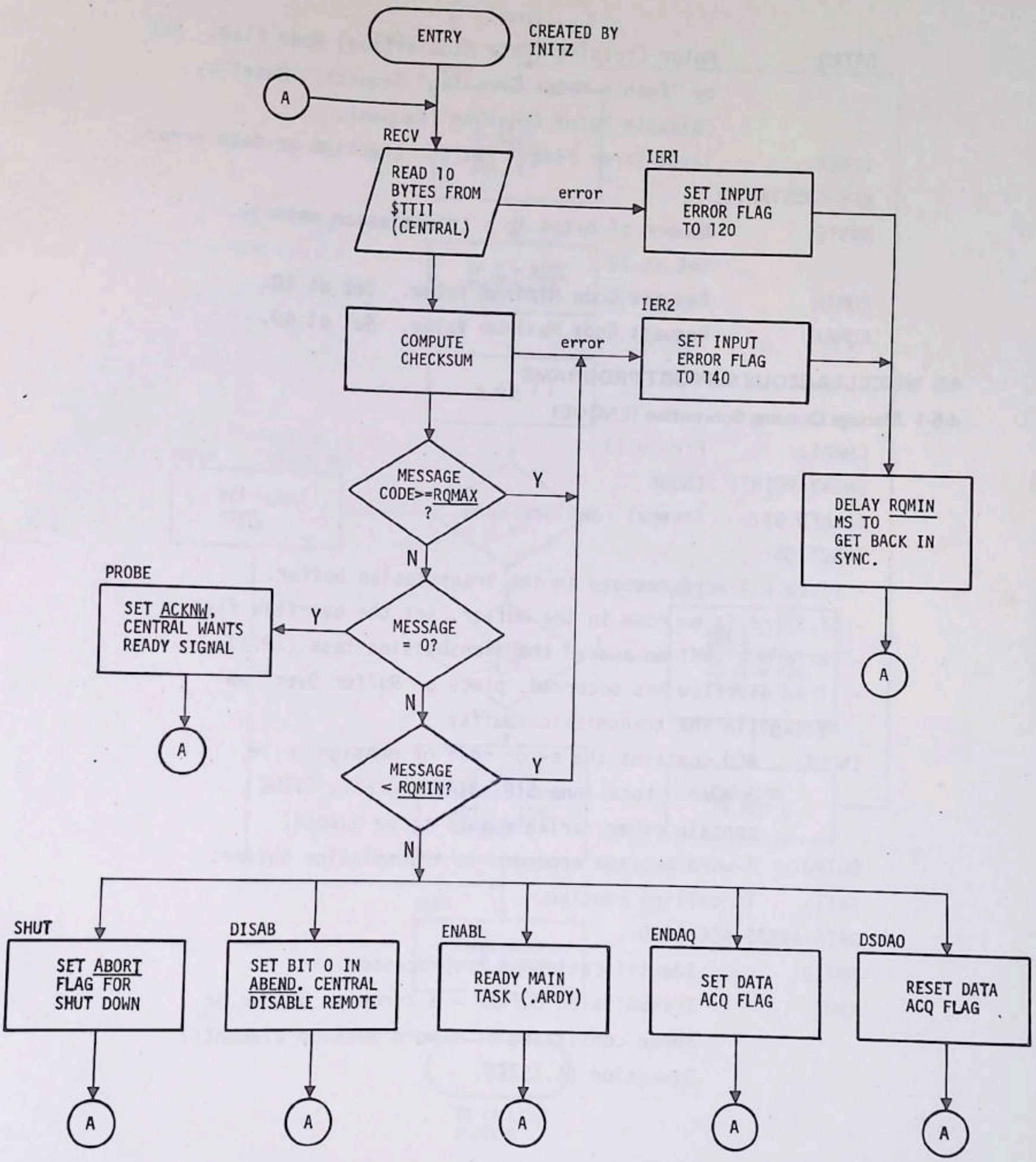


FIGURE 12
RECEIVE TASK

DATAQ Motor Crossing (Data Acquisition) Mode Flag. Set by "Enable Motor Crossing" Request. Reset by "Disable Motor Crossing" Request.

IPTER Input Error Flag. Set for checksum or data error.

KEY CONSTANTS:

NBYTE Number of bytes in a transmission message. Set at 10.

RQMIN Request Code Minimum Value. Set at 40.

RQMAX Request Code Maximum Value. Set at 49.

4-5 MISCELLANEOUS SUPPORT PROGRAMS

4-5-1 Message Queuing Subroutine (ENQUE)

CHART: Figure 13

ENTRY POINT: ENQUE

CALLED BY: Several routines

FUNCTION:

- Place a 4-word message in the transmission buffer.
- If there is no room in the buffer, set the overflow flag.
- Perform a .XMT to awaken the transmission task (XMIT).
- If an overflow has occurred, place a 'Buffer Overflow' message in the transmission buffer.

INPUT: AC0 contains the error code of message to be queued. Locations SID, STATU, CKEXT, CTIME contain other variable data to be queued.

OUTPUT: 4-word message appended to transmission buffer.

EXIT: To calling routine.

DATA AREAS ACCESSED:

RMTID Identification of Preprocessor.

XBUF Transmission Buffer - a circular buffer or queue consisting of 4-word message elements. Dimension (4,XSZE).

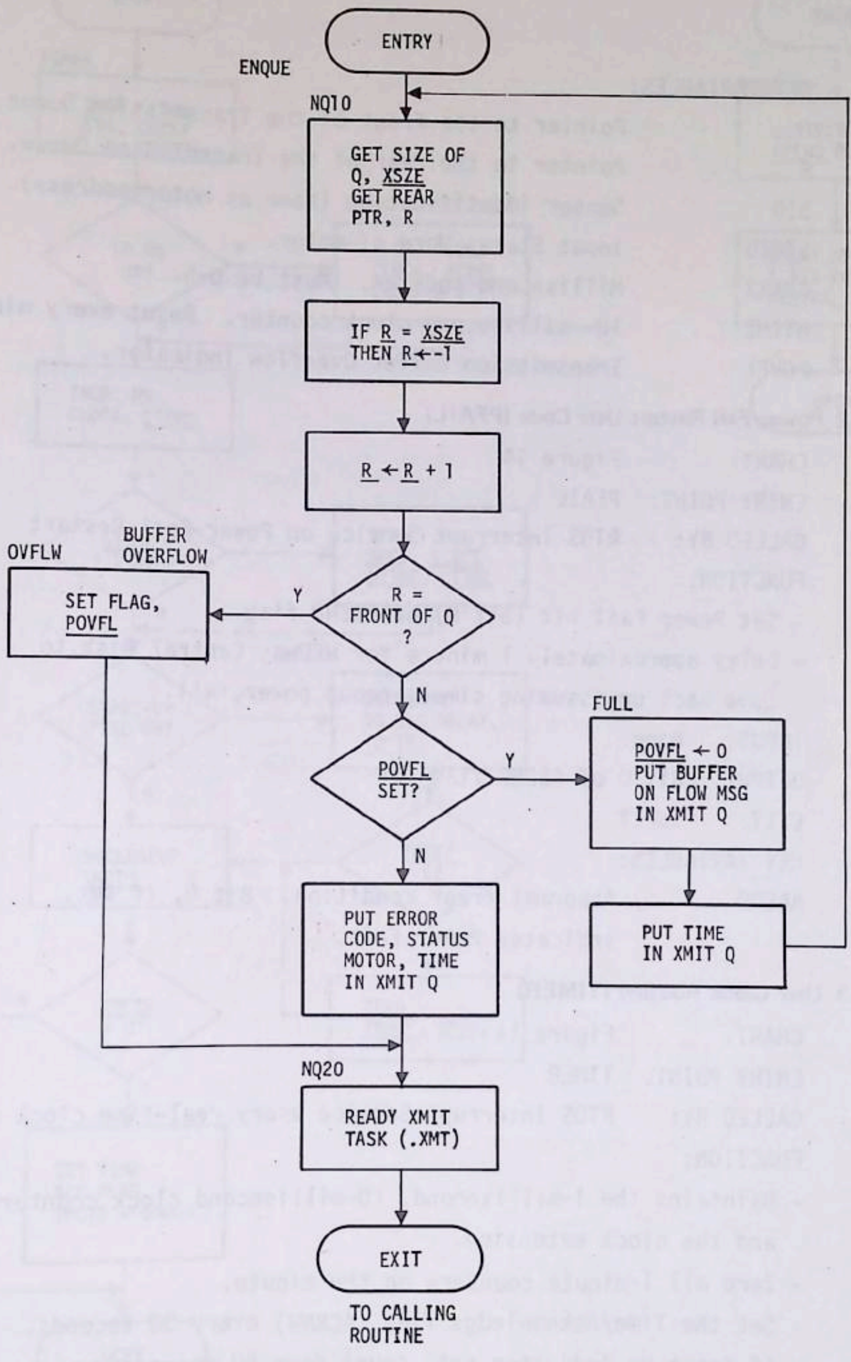


FIGURE 13
MESSAGE QUEUING SUBROUTINE

KEY VARIABLES:

F	Pointer to the front of the Transmission Queue.
R	Pointer to the rear of the Transmission Queue.
SID	Sensor identification (same as motor address).
STATU	Input Status Word of motor.
CKEXT	Millisecond counter. Must be 0-9.
HTIME	10- millisecond clock counter. Reset every minute.
POVFL	Transmission Buffer Overflow Indicator.

4-5-2 Power Fail Restart User Code (PFAIL)

CHART: Figure 14

ENTRY POINT: PFAIL

CALLED BY: RTOS Interrupt Service on Power Fail Restart

FUNCTION:

- Set Power Fail bit (bit 0) of ABEND flag.
- Delay approximately 1 minute for WEDway Central Disk to come back up assuming simultaneous power fail.

INPUT: None

OUTPUT: Bit 0 of ABEND flag set

EXIT: .UPEX

KEY VARIABLES:

ABEND	Abnormal error condition. Bit 0, if set, indicates Power Fail.

4-5-3 User Clock Routine (TIMER)

CHART: Figure 14

ENTRY POINT: TIMER

CALLED BY: RTOS Interrupt Service every real-time clock pulse.

FUNCTION:

- Maintains the 1-millisecond, 10-millisecond clock counters and the clock extension.
- Zero all 1-minute counters on the minute.
- Set the Time/Acknowledge flag (ACKNW) every 50 seconds.
- If Start-Up Indicator set, count down 50 seconds.

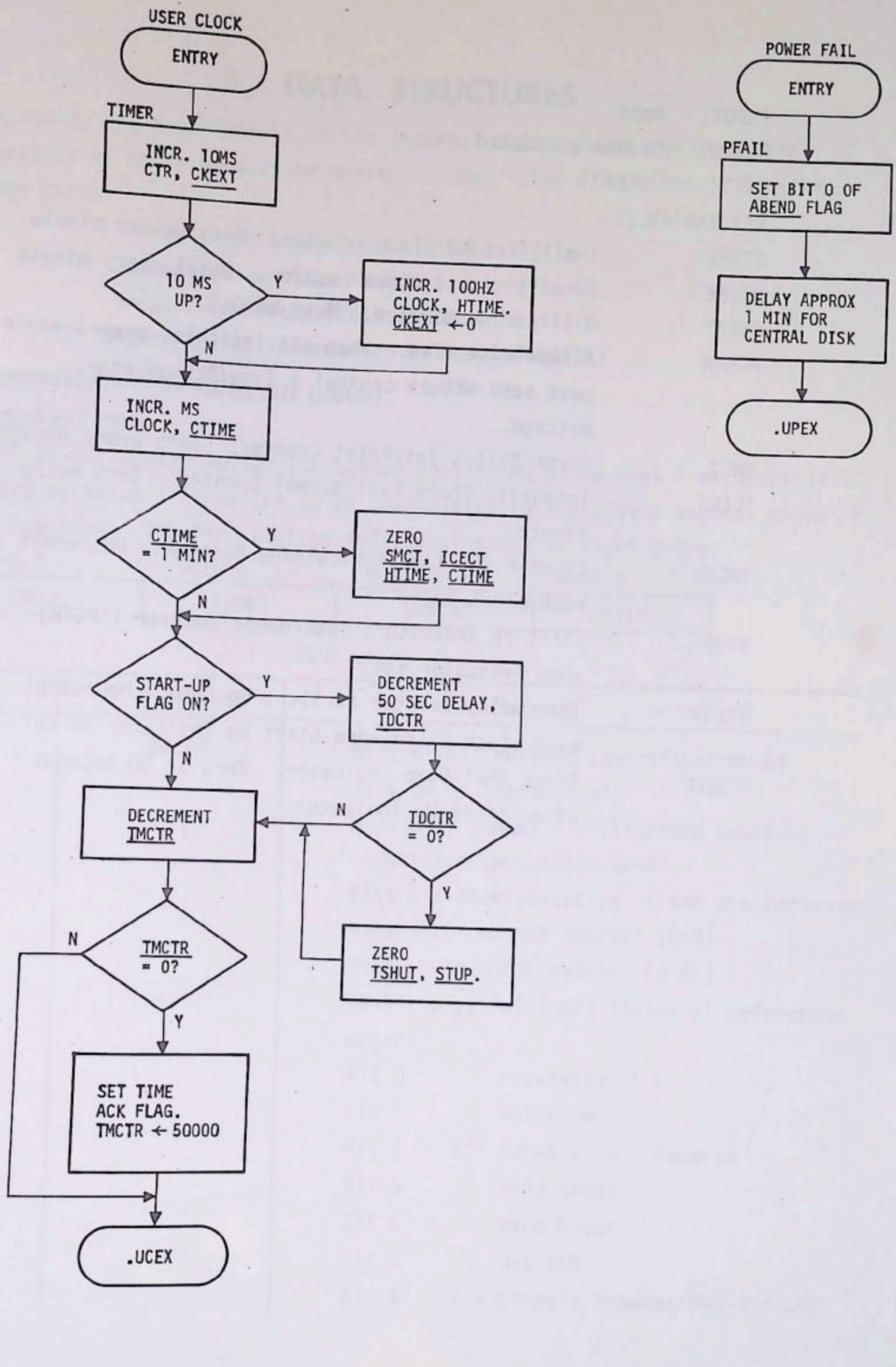


FIGURE 14
USER CLOCK AND POWER FAIL ROUTINES

INPUT: None

OUTPUT: Counters Updated

EXIT: .UCEX

KEY VARIABLES:

CTIME	1-millisecond clock counter. Reset every minute.
HTIME	10-millisecond clock counter. Reset every minute.
CKEXT	Millisecond counter. Must be 0-9.
ACKNW	Acknowledge Flag. When set indicates preprocessor must send WEDway central a Time/Acknowledge message.
SMCT	Error Status Set/Reset Counter. Zero every minute.
ICECT	Integrity Check Fail/Normal Counter. Zero every minute.
TMCTR	Counter for Time/Acknowledge Message. Decrement each clock pulse.
STUP	Start-Up Indicator: Decrement counter (TDCTR) when indicator set.
TDCTR	Time Delay Counter at Start Up time. Decrement each clock pulse when Start Up Indicator is set.
TSHUT	Track Shut-Down Indicator. Zero at 50 seconds after Start-Up Indicator.

5. DATA STRUCTURES

Following are descriptions of the internal data formats and structural relationships of the preprocessor monitor system. The discussion is divided into four parts:

Transmission Buffer/Queue (XBUF)
Communications Link Messages
Transition Vector Table (SCTBL)
Motor/Sensor Information Tables (DATABASE)

5-1 TRANSMISSION BUFFER/QUEUE (XBUF)

5-1-1 Data Area Format

XBUF is a circular buffer (or queue) consisting of several 4-word entries. Each entry contains information to be transmitted to the WEDway central computer via the **com** link. The format of an individual entry is shown below.

word 0	word 1	word 2	word 3
ERCOD	ERMOT	ERSTAT	ERTIM

XBUF entry

Offset	Fieldname	Meaning
0	ERCOD	Bits 8-15. Message identification of data to be transmitted.
1	ERMOT	Bits 0-3. CKEXT - millisecond counter containing tens digit (0-9). Bits 4-7 identification of the preprocessor Bits 9-10 cabinet address (0-3) Bits 11-15 motor address (0-31)
2	ERSTAT	16-bit physical input status of referenced motor. Bit 0 Proximity Bit 1 Motor On Bit 2 1 = Forward, 0 = Reverse Bit 3 Read Speed Bit 4 Warm Motor Bit 5 Hot SCR Bit 6 1 = Circuit Breaker On, 0 = Off

Offset	Fieldname	Meaning	
		Bit 7	Test Point
		Bits 8-15	Speed Count
		Initial value:	Bit 6 on, all others off
3	ERTIM	Contains value of 10-millisecond clock counter at time event occurred.	

The number of entries in XBUF is controlled by the constant, XSZE in page zero. This is presently set at 100.

5-1-2 Data Access

XBUF is accessed by the ENQUE subroutine and the XMIT task.

ENQUE fills the buffer by adding entries to the queue. XMIT removes entries from the queue and transmits the message to the WEDway central computer.

Pointers, F and R (Front and Rear of queue) facilitate additions and deletions.

5-2 COMMUNICATIONS LINK MESSAGES

5-2-1 Message Format

Transmission messages are similar to the XBUF entry. The format of the message is shown below.

word 0	word 1	word 2	word 3	word 4
ERCOD	ERMOT	ERSTAT	ERTIM	CHECKSUM

Transmission Message

Offset	Fieldname	Meaning
0	ERCOD	These items are completely defined in the preceeding XBUF data area format.
1	ERMOT	
2	ERSTAT	
3	ERTIM	
4	CHECKSUM	The checksum word is computed as follows: CHECKSUM + (ERCOD+ERMOT+ERSTAT+ERTIM) = 0 or CHECKSUM = two's complement (sum of 1st 4 words)

5-3 TRANSITION VECTOR TABLE (SCTBL)

Every motor in a track zone can attain one of four possible logical states. These are:

Logical State	Physical State
0	Proximity Off, Read Speed Off
1	Proximity Off, Read Speed On
2	Proximity On, Read Speed Off
3	Proximity On, Read Speed On

The Logical Processing Module interprets the position of trains in the zone whenever a motor changes its logical state.

5-3-1 Data Area Format

SCTBL is a 2-dimensional (4,4) array. Each entry in the array contains the address of a section of code to be performed when the transition occurs. A diagram of the array is illustrated below.

From State \ To State	0	1	2	3
0	No Change	Transition 0 to 1	Transition 0 to 2	Transition 0 to 3
1	Transition 1 to 0	No Change	Transition 1 to 2	Transition 1 to 3
2	Transition 2 to 0	Transition 2 to 1	No Change	Transition 2 to 3
3	Transition 3 to 0	Transition 3 to 1	Transition 3 to 2	No Change

5-4 MOTOR/SENSOR INFORMATION TABLES (DATABASE)

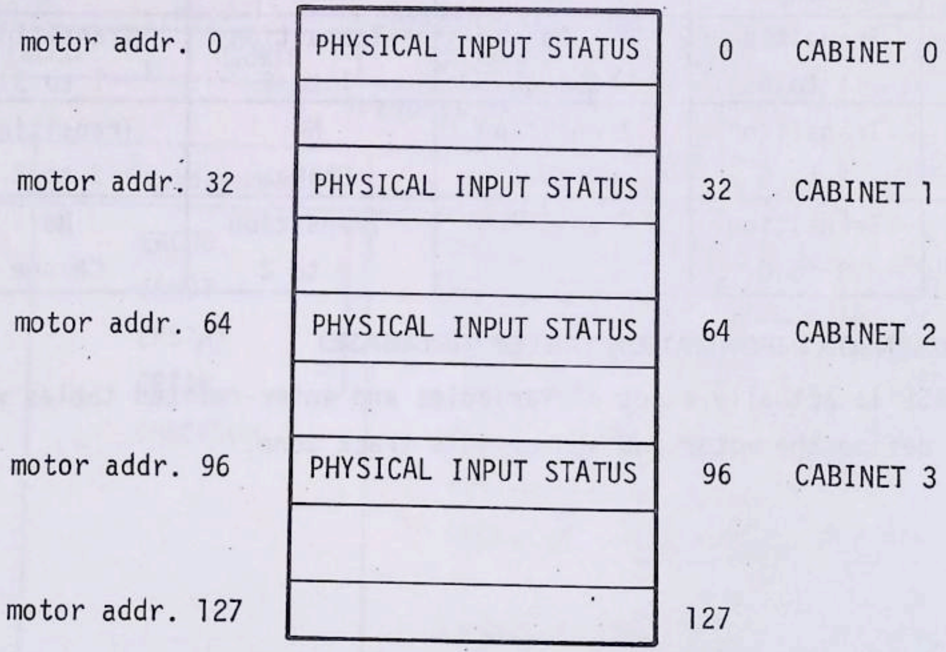
DATABASE is actually a set of variables and inter-related tables which completely define the motor and sensor in a track zone.

Name	Type	Description
RMTID	variable	identification number of the preprocessor
DATAQ	variable	data acquisition flag
LODER	variable	indirect jump instruction to the binary loader (indirect address = highest address in preprocessor memory)
NCAB	variable	number of cabinets (controllers) in the zone
STTAB	table	physical status table
PLCTB	table	physical to logical conversion table
LGMAX	variable	number of motors in a zone minus 1
LGTBL	table	logical motor table

5-5 PHYSICAL STATUS TABLE (STTAB)

5-5-1 Data Area Format

STTAB consists of 1-word entries each containing the input status of a motor address. The table contains 128 entries (one for each possible motor address in the track zone). These entries are arranged in motor address order from 0 to 127.



Format of STTAB

Physical Input Status Bits

Bit	Indication if Set
0	Proximity On
1	Motor On
2	Forward (Reverse if Reset)
3	Read Speed On
4	Warm Motor
5	Hot SCR
6	SCR Breaker On
7	Test Point
8	
9	
10	
11	
12	
13	
14	
15	

5-6 PHYSICAL-TO-LOGICAL CONVERSION TABLE (PLCTB)

5-6-1 Data Area Format

PLCTB is a conversion table which contains logical motor numbers corresponding to every physical motor address. The table contains 128 entries (one for each possible motor address). These entries are arranged in motor address order from 0 to 127. If a given motor address has no corresponding actual motor, its entry will contain -1.

motor addr. 0	0	0	CABINET 0
motor addr. 30	-1	30	
motor addr. 31	-1	31	
motor addr. 32	27	32	CABINET 1
motor addr. 64	57	64	CABINET 2
motor addr. 127	-1	127	

Format of PLCTB

When an integrity check test fails, all entries corresponding to that cabinet are made negative. They are restored to their original value when the integrity check test passes once more.

5-7 LOGICAL MOTOR TABLE (LGTBL)

5-7-1 Data Area Format

LGTBL is a table consisting of several 6-word entries. Each entry contains information pertinent to an actual motor in the zone. Hence there are N entries where N is the actual number of motors in the zone. These motors are numbered from 0 to N-1.

logical motor 0	6-word entry
logical motor 57	6-word entry
logical motor N-1	6-word entry

LGTBL Format

The format of an individual entry is shown below.

word 0	word 1	word 2	word 3	word 4	word 5
CSTAT	CTSIT	CTMAX	CPOS		CPHYS

LGTBL Entry

Offset	Fieldname	Meaning
0	CSTAT	Motor Logical Status 0 Proximity Off, Read Speed Off 1 Proximity Off, Read Speed On 2 Proximity On, Read Speed Off 3 Proximity On, Read Speed On Initial value 0
1	CTSIT	Time on the 1-millisecond counter when the last transition (0 to 1) took place Initial value -1
2	CTMAX	Max motor crossing time (between this motor and the next succeeding motor) in milliseconds
3	CPOS	Distance of motor from the starting point on the track (ft.)
4		Not used
5	CPHYS	Motor Address corresponding to this actual motor

6. BUILDING AND UPDATING THE DATABASE

Following is an explanation of the procedures for creating and maintaining the preprocessor Motor/Sensor Information Tables (DATABASE). These tables form a master file of punched cards and also reside on the WEDway disk cartridge.

6-1 CARD FORMAT

Each input record defines a specific cabinet and motor address. Hence there are 32 input records for each cabinet (one for each motor address). The card format for an input record is shown below:

	col.9	col.17	col.25	col.33
	.SENS	1100	3980	; CABINET #18

COLUMN	ITEM	ALIGNMENT	VALUE
9-16	Macro	left just.	.SENS if there is an actual motor at this address .NOSNS if there is no motor at this address (skip 2 items
17-24	Max Motor Crossing Time	left just.	In milliseconds 0 means undefined
25-32	Motor Position	left just.	In feet
33-72	Comments	left just.	";" followed by comments

6-2 CREATING THE MASTER FILE

1. For preprocessor #1, create input cards to define every address in the first cabinet (cabinet 0). There will be 32 cards.
2. Repeat step 1 for each existing cabinet.
3. Repeat steps 1 and 2 for each preprocessor.

6-3 UPDATING THE MASTER FILE

1. Adding a motor at address x.
   a. Find the input card defining the cabinet and motor address x from the master file deck.
   b. This card should be a .NOSNS card since there is no motor at that slot.
   c. Replace the .NOSNS card with the properly defined .SENS card.
2. Changing the attributes of a motor at address x.
   a. Search the master file to find the input card defining the cabinet and motor address x.
   b. Replace this card with one containing the correct attributes. For example, the position field must be changed if the physical position of the motor is changed.
3. Deleting a motor at address x.
   a. Search the master file to find the input card defining the cabinet and motor address x.
   b. Replace this card with a .NOSNS card. This removes the motor from the data base.

6-4 ASSEMBLING, LOADING, AND ESTABLISHING THE ABSOLUTE FILE

After the DATABASE has been created or updated, an absolute (core image) file must be produced for loading at the preprocessor. Use the following procedure to produce an absolute preprocessor file from the master card deck file:

1. Assuming the WEDway disk has been bootstrapped, type:

   @BATCH@

   on the console.
2. Place the REMOTE PROGRAM GENERATION card deck in the card reader. Make card reader ready.
3. When the message

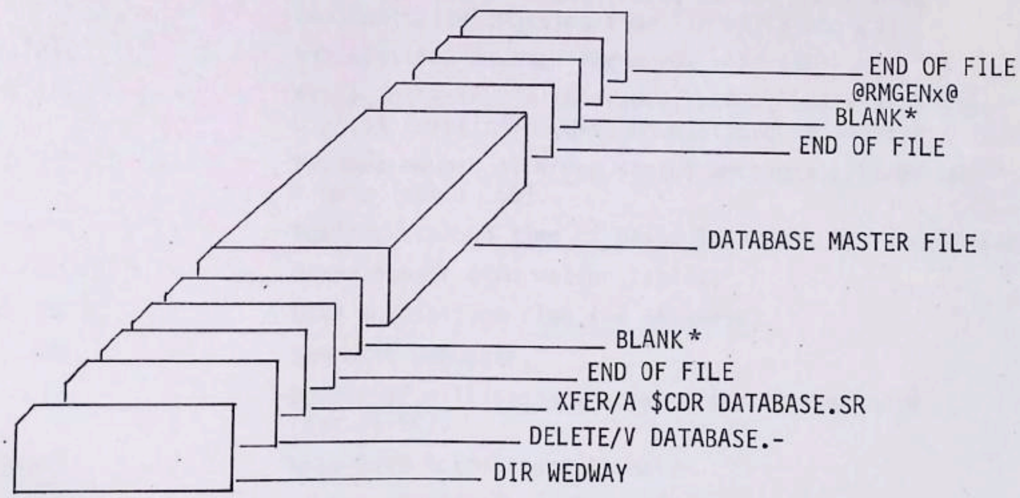
   LOAD $CDR, STRIKE ANY KEY

   occurs, hit the "space" bar several times. The cards will be read in until the hopper is empty. Read in the entire card deck this way.

4. An absolute preprocessor program will be generated.

The REMOTE PROGRAM GENERATION card deck is described in the following discussion. The deck consists of the following cards:.

1. DIR WEDWAY
2. DELETE/V DATABASE.-
3. XFER/A $CDR DATABASE.SR
4. END OF FILE CARD
5. BLANK CARD*
6. DATABASE MASTER FILE DECK
7. END OF FILE CARD
8. BLANK CARD*
9. @RMGENx@ (x is the preprocessor whose program is to be generated)
10. END OF FILE CARD



DECK SETUP FOR REMOTE PROGRAM GENERATION

*Blank card required after END OF FILE card in BATCH.

@RMGENx@ is a command file which contains the following RDOS command line interpreter instructions (x is the preprocessor to be loaded):

```
MAC PREx/S DATABASE DATABx/B LINEPRINTER/L
DELETE/V REMOx.AB
RLDR/C/D WWPMON DATABx RTSMOD RTOS.LB LINEPRINTER/L
MKABS/Z WWPMON REMOx.AB 40/S
```

Listings will be made on the listing device to which LINEPRINTER is linked.

GLOSSARY

Term		Definition
ABEND	-	Abnormal Condition flag indicating power failure or preprocessor disabled by central computer.
ABORT	-	Shut Down flag from central computer.
ACKNW	-	Acknowledge flag - when set, preprocessor must send central computer a Time/Acknowledge message.
BIT3	-	Value of status word returned by a .IDST when a task is suspended by a .REC.
CKEXT	-	Millisecond counter. Reset every 10 milliseconds.
CPHYS	-	Offset of entry in the table, LGTBL.
CPOS	-	Offset of entry in the table, LGTBL.
CSMSK	-	Mask of status bits on which a change of state may occur.
CSTAT	-	Offset of entry in the table, LGTBL, containing motor logical status word.
CTIME	-	1- millisecond clock counter. Reset every minute.
CTMAX	-	Offset of entry in the table, LGTBL, containing maximum motor crossing time (in milliseconds).
CTR4	-	Bit position counter for error bits 4-7.
CTSIT	-	Offset of entry in the table, LGTBL, containing time of last transition (0-1) on millisecond counter.
CUTOF	-	Maximum number of error status messages allowed per minute (set at 50).
CYCLE	-	Maximum elapsed time of basic loop (set at 14 milliseconds).
DATABASE	-	Motor/Sensor Information tables.
DATAQ	-	Data Acquisition flag (in DATABASE).
DEBUG	-	Symbolic Debugger.
DELTA	-	Number of milliseconds delay after transmission (set at 50).
DPACK	-	Data Path Acknowledge signal.
DONCNT	-	Number of retries in Done flag timeout loop (set at 4).
ENQUE	-	Message Queuing subroutine.
ERCOD	-	Message identification of data to be transmitted.
ERMOT	-	CKEXT entry (bits 0-3).

Term		Definition
ERSTAT	-	16-bit status of referenced motor.
ERTIM	-	HTIME entry.
EST-SST	-	Symbol tables for symbolic debugger.
F	-	Pointer to front of transmission queue.
FATAL	-	DPACK Not Received error indicator.
FLGAD	-	Address of flag used by RTOS .XMT/.REC.
FRONT	-	Temporary pointer to front of queue.
HTIME	-	10- millisecond clock counter (reset each minute).
IBUF	-	5-word input buffer for messages from central computer.
ICECT	-	Integrity Check Fail/Normal counter (reset every minute).
IDLE	-	Idle subroutine.
INITZ	-	Initialization program.
INI10	-	Partial Initialization code.
INI20	-	Code to establish links with controllers.
INTEG	-	Integrity card cabinet address (set at 31).
IPTER	-	Receiver Input Error indicator.
ITGCK	-	Integrity card check subroutine.
K30	-	Number of logic cards/cabinet (set at 30).
LGMAX	-	Number of motors in zone less 1 (in DATABASE).
LGTBL	-	Logical Status table (in DATABASE).
LODER	-	Binary Loader indirect jump instruction (in DATABASE).
LOGIC	-	Logical Processing module.
MLOER	-	Controller Open Error routine.
MLOPN	-	Open Motor Logic Cabinet Subroutine.
MLOSW	-	Motor Logic Open indicator.
MOTOR	-	Address of motor most recently scanned.
NBYTE	-	Number of bytes in a transmission message (set at 10).
NCAB	-	Number of logic cabinets in zone (in DATABASE).
NTVAL	-	Constant for TMCTR (set at 50 seconds).

GLOSSARY (CONT.)

Term		Definition
PFAIL	-	Power Fail restart user code.
PLCTB	-	Physical-to-Logical conversion table (in DATABASE).
POVFL	-	Transmission Buffer Overflow indicator.
PROX	-	Proximity Status.
QUIT	-	Error Indicator - set when all retries for one cabinet failed to obtain DPACK.
R	-	Pointer to rear of transmission queue.
RDSP	-	Read Speed status.
RECV	-	Receive task.
RETRY	-	Number of Retries per cabinet when DPACK not received (set at 5).
RMTID	-	Preprocessor identification.
RQMAX	-	Request Code Maximum value (set at 49).
RQMIN	-	Request Code Minimum value (set at 40).
RTOS	-	Operating System.
SCAN	-	Physical Input Scan routine.
SCTBL	-	Transition Vector Table.
SCYCL	-	Value of CTIME at start of basic loop.
SID	-	Sensor Identification (same as motor address).
SMCT	-	Counter for status changes per minute (reset every minute).
STATU	-	Input Status word of motor.
STOP	-	Code to process abnormal indication.
STTAB	-	Physical Status table.
STUP	-	Start Up indicator.
TDCTR	-	Time Delay at start-up time counter.
TENSC	-	Time Delay after start up (in milliseconds).
TIMER	-	User Real Time Clock routine.
TKID	-	Transmit task identification.
TMCTR	-	Time/Acknowledge message counter (decrements each millisecond).

Term		Definition
TPMAX	-	Maximum number of monitor points per cabinet (set at 9).
TPTRN	-	Test Pattern transmitted for integrity loop test.
TRANSIT	-	Transit subroutine.
TSHUT	-	Track Shut-Down indicator.
WWPMON	-	Monitor Program.
XBUF	-	Transmission Buffer.
XFLAG	-	Set non-zero when buffer is not empty.
XMIT	-	Transmit (to central computer) task.
XSZE	-	Number of elements in transmission buffer (set at 100).
ZMON	-	Track Zone Monitor.
$TTI1	-	Com Link Input device.
$TTO1	-	Com Link Output device.