



An Electrical/Electronics Company

MANUAL PART NO.
2107-802XXX-0XU

**GOULD 2200S RECORDERS
INK WRITING MODELS
OPERATORS AND SERVICE MANUAL**

The information contained herein is the exclusive property of Gould Inc., except as otherwise indicated and shall not be reproduced in whole or in part without explicit written authorization from the company. The distribution of this material outside the company may occur only as authorized by the company in writing.

All information contained in this manual is the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

PRINTED SEPT., 1981
COPYRIGHT 1980

Gould Inc., Instruments Division
3631 Perkins Avenue, Cleveland, Ohio 44114

PRELIMINARY MANUAL
PRINTED IN U.S.A.

WARRANTY

CURRENT EQUIPMENT:

The Gould Instruments Division's products as shown in the Current Equipment Catalog are warranted for a period of one year from date of shipment to original purchaser. They are warranted to conform to the applicable published specifications in effect at the time of shipment, and to be free from any defects in material or manufacture when used with recommended Gould associated equipment and Gould chart paper. LIABILITY OF THE GOULD INSTRUMENTS DIVISION UNDER SUCH WARRANTY IS LIMITED TO SERVICING OR REPLACING DEFECTIVE PARTS EXCEPT PENS, STYLI, FUSES AND BATTERIES AND DOES NOT INCLUDE CALIBRATION AND MINOR MAINTENANCE AS OUTLINED IN GOULD OPERATING MANUALS. (Exception: The thermal pen in the 110 Strip Chart Recorder is guaranteed for life.) IN NO EVENT SHALL THE GOULD INSTRUMENTS DIVISION BE LIABLE UNDER ANY CIRCUMSTANCES, FOR ANY LOSS OF PROFITS OR OTHER CONTINGENT, CONSEQUENTIAL OR SPECIAL DAMAGES. Units are to be returned transportation prepaid by the buyer. The Gould Instruments Division will have the right of final determination of the cause and existence of a defect under this warranty. This warranty shall not apply to any products which have been subjected to misuse, improper installation, repair, alteration, neglect, accident, inundation, fire or operation outside their published maximum ratings. THE FOREGOING WARRANTY IS EXCLUSIVE AND EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS AND OF ANY OTHER OBLIGATION AND SHALL CONSTITUTE THE SOLE REMEDY OF THE BUYER AND SOLE LIABILITY OF THE SELLER.

REPLACEMENT PARTS: Same as above — except ninety (90) days from date of shipment.

If a defect occurs:

1. Notify your nearest ID Service Center (see below), giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data or shipping authorization and instructions will be forwarded to you.
2. On receipt of the shipping authorization, forward the instrument prepaid to location indicated on shipping authorization.

Compliance with the above procedure will assure the earliest repair and return of your equipment.

SERVICE CENTERS

BOSTON
INSTRUMENTS DIVISION
129 Middlesex Turnpike
Burlington, Massachusetts 01803
Phone: (617) 272-0750

BAY AREA (CA)
INSTRUMENTS DIVISION
25936 Eden Landing Road
Hayward, CA 94545
Phone: (415) 887-1300

CHICAGO
INSTRUMENTS DIVISION
1001 Oakton Street
Elk Grove Village, Illinois 60007
Phone: (312) 640-4380

CLEVELAND
INSTRUMENTS DIVISION
3631 Perkins Avenue
Cleveland, Ohio 44114
Phone: (216) 361-3315

DAYTON
INSTRUMENTS DIVISION
4668 Gateway Circle
Kettering, Ohio 45440
Phone: (513) 433-9586

DENVER
INSTRUMENTS DIVISION
730 West Hampden Avenue
Englewood, Colorado 80110
Phone: (303) 761-7021

DETROIT
INSTRUMENTS DIVISION
23775 Northwestern
Southfield, Michigan 48075
Phone: (313) 355-0900

COLUMBIA, SC
INSTRUMENTS DIVISION
c/o W.A. Brown Instruments Inc.
1201 St. Andrews Road
Columbia, SC 29210
Phone: (803) 798-8070

HOUSTON
INSTRUMENTS DIVISION
10500 Northwest Freeway
Houston, Texas 77092
Phone: (713) 680-1121

HUNTSVILLE, AL
INSTRUMENTS DIVISION
c/o W.A. Brown Instruments Inc.
7917-C Charlotte Drive
Huntsville, Alabama 35802
Phone: (205) 883-8660

LANHAM, MD
INSTRUMENTS DIVISION
5900 Princess Garden Parkway
Lanham, Maryland 20801
Phone: (301) 459-7350

LOS ANGELES
INSTRUMENTS DIVISION
2525 Campus Drive
Irvine, California 92715
Phone: (213) 639-7301

ORLANDO
INSTRUMENTS DIVISION
c/o W.A. Brown Instruments Inc.
222 Weber Avenue
Orlando, Florida 32803
Phone: (305) 425-5505

PHILADELPHIA
INSTRUMENTS DIVISION
GSB Building
Belmont & City Line Avenue
Bala Cynwyd, Pennsylvania 19004
Phone: (215) 839-7066

PITTSBURGH
INSTRUMENTS DIVISION
Campbells Run Road
Parkway West
Pittsburgh, Pennsylvania 15205
Phone: (412) 923-2160

SADDLEBROOK
INSTRUMENTS DIVISION
74 Kenney Place
Saddle Brook, New Jersey 07662
Phone: (201) 846-0220

SEATTLE
INSTRUMENTS DIVISION
The Commons Bldg, Suite C-155
1200 112th Avenue NE
Bellevue, Washington 98004
Phone: (206) 463-8100

TORONTO
ALLAN CRAWFORD ASSOC., LTD
6503 Northam Drive
Mississauga, Ontario, Canada
Phone: 678-1500

EUROPE

GOULD ALLCO S.A.
67 rue St. Sauveur 91180
Ballainvilliers, France
Phone: 908-10-67

GOULD ADVANCE
Rosbeck Road
Hainault, Essex, England
Phone: 01-500-1000

TABLE OF CONTENTS

SECTION	TITLE	PAGE
I	GENERAL INFORMATION	
1.1	SCOPE OF MANUAL	1.1
1.2	DESCRIPTION	1.1
1.3	MODEL NUMBERING SYSTEM	1.1
1.4	SPECIFICATIONS	1.2
1.4.1	General	1.2
1.4.2	Electrical	1.2
1.4.3	Physical	1.4
1.5	SUPPLIES AND ACCESSORIES	1.4
1.5.1	Supplies	1.4
1.5.2	Accessories	1.4
II	INSTALLATION	
2.1	GENERAL	2.1
2.2	SERVICE UPON RECEIPT	2.1
2.3	LINE VOLTAGE REQUIREMENTS	2.1
2.4	ANALOG SIGNAL CONNECTIONS	2.1
2.4.1	Without Preamplifiers	2.1
2.4.2	With Preamplifiers	2.2
2.5	EVENT MARKER INPUTS	2.2
2.5.1	Standard Event Markers	2.2
2.5.2	Optional Event Marker	2.2
2.6	REMOTE CHART DRIVE	2.2
2.7	CHART TAKE-UP INSTALLATION	2.3
2.8	RACK MOUNTING KITS	2.3
2.9	A.C. JUMPER BOARD	2.4
III	OPERATION	
3.1	GENERAL	3.1
3.2	FRONT PANEL CONTROLS & INDICATORS	3.1
3.3	REAR PANEL	3.3
3.4	TIMER SETTING	3.4
3.5	RIGHT EVENT TIMER ACTUATION	3.4
3.6	SET-UP AND OPERATION	3.4
3.7	REMOTE CONTROL OPERATION	3.5
3.8	ELECTRICAL APPLICATIONS	3.5
IV	THEORY OF OPERATION	
4.1	GENERAL	4.1
4.2	MAINFRAME	4.1
4.3	ANALOG RECORDING CHANNELS	4.3
4.4	STEPPER CHART DRIVE	4.3
4.5	SYSTEM DESCRIPTION	4.5
4.6	BLOCK DIAGRAM	4.5
4.7	PROCESSOR BOARD	4.5
4.7.1	Step Clock System	4.7
4.7.2	Step Clock Period Counter	4.7

IV THEORY OF OPERATION - Continued

4.7.3	Speed Selector	4.7
4.7.4	Motor Drive Outputs	4.8
4.7.5	Chart Motion Detector	4.8
4.7.6	Power On/Failsafe Reset	4.8
4.7.7	Switching Amplifier	4.8
4.7.8	Sawtooth Generator	4.9
4.7.9	Pulse Width Modulator and Error Amp	4.9
4.8	POWER SECTION	4.9
4.8.1	Control/Timer Board	4.9
4.8.2	Power Supply Board	4.10
4.8.3	Optical Sensor Board	4.10
4.8.4	Speed Selector Board	4.10
4.8.5	Thermal Writing	4.11
4.8.6	Software	4.11
4.8.7	Speed Select/Decode	4.11
4.8.8	Speed Loops	4.11
4.8.9	Frequency Adjust Routine	4.12

V MAINTENANCE

5.1	INTRODUCTION	5.1
5.2	OPERATIVE MAINTENANCE	5.1
5.2.1	Chart Paper Replacement	5.1
5.2.2	Ink Cartridge Replacement	5.1
5.2.3	Pen Replacement	5.4
5.2.4	Fuse Replacement	5.5
5.3	PREVENTIVE MAINTENANCE	5.7
5.3.1	Recorder Cleaning	5.7
5.3.2	Pen Cleaning	5.7
5.3.3	Pen Pressure Measurement	5.8
5.3.4	Pen Lapping	5.9
5.3.5	Manifold Bleeding Procedure	5.10
5.3.6	Case Removal	5.10
5.4	CALIBRATION	5.11
5.4.1	General	5.11
5.4.2	Test Equipment Required	5.11
5.4.3	Preliminary Set-Up	5.11
5.4.4	Calibration Procedure	5.11
5.4.5	Span Adjustment	5.11
5.4.6	Limit Adjustment	5.11
5.4.7	Damping Adjustment	5.11
5.4.8	Frequency Compensation Adjustment	5.12
5.4.9	Main Frame Tests	5.12
5.4.10	Remote Control	5.12
5.4.11	Standard Event Markers	5.13
5.4.12	Optional Event Markers	5.13
5.4.13	2200S Chart Drive Calibration	5.14
5.5	TROUBLESHOOTING	5.16
5.5.1	General	5.16
5.5.2	Electrical Power Malfunctions	5.16
5.5.3	Chart Drive Malfunctions	5.16

V MAINTENANCE - Continued

5.5.4	Writing System Malfunctions	5.17
5.5.5	Signal Malfunctions	5.18
5.5.6	Processor Board Troubleshooting	5.19
5.5.7	Preliminary	5.19
5.5.8	Test Procedure	5.20
5.5.9	Switching Amp Board Troubleshooting	5.23
5.6	SUBASSEMBLY REPLACEMENT	5.26
5.6.1	Ink Cartridge Replacement	5.26
5.6.2	Solenoid Valve Assembly Replacement	5.27
5.6.3	Manifold Assembly Replacement	5.27
5.6.4	Table Assembly Replacement	5.28
5.6.5	Stepper Motor Replacement	5.28
5.6.6	Control Transformer Replacement	5.28
5.6.7	Power Transformer Replacement	5.29
5.6.8	Pen Motor Replacement	5.29
5.6.9	Pen Motor Drive Band Replacement	5.29

VI PARTS IDENTIFICATION

6.1	GENERAL	6.1
6.2	PARTS USED ON OTHER MODELS	6.1

APPENDIX	SCHEMATIC DRAWINGS	A1
----------	------------------------------	----

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1-1	GOULD 2200S PORTABLE INK RECORDER	1.1
1-2	OUTLINE DIMENSIONS - 2200S PORTABLE RECORDER W/O PREAMPS	1.6
1-3	OUTLINE DIMENSIONS - 2200S PORTABLE RECORDER W/PREAMPS	1.7
1-4	OUTLINE DIMENSIONS - 2200S RACK MOUNT	1.8
2-1	SIGNAL INPUT CONNECTIONS	2.1
2-2	REAR PANEL TERMINAL CONNECTIONS	2.2
2-3	CHART TAKE-UP INSTALLATION	2.3
2-4	A.C. JUMPER BOARD	2.4
3-1	FRONT PANEL CONTROLS & INDICATORS	3.1
3-2	REAR PANEL	3.3
3-3	EXTERNAL PULSE REQUIREMENTS	3.5
4-1	BLOCK DIAGRAM (OVERALL SYSTEM)	4.2
4-2	ANALOG CHANNEL BLOCK DIAGRAM	4.4
4-3	FULL STEPPING	4.5
4-4	MICROSTEPPING	4.5A
4-5	NORMALIZED PHASE CURRENT	4.5A
4-6	BLOCK DIAGRAM (OVERALL SYSTEM)	4.5A
4-7	SPEED FLOW CHART	4.13
4-8	DECODE ROUTINE FLOW CHART	4.14
4-9	GENERAL SPEED LOOP FLOW CHART	4.15
4-10	FREQUENCY ADJUST ROUTINE FLOW CHART	4.16

LIST OF ILLUSTRATIONS - Continued

5-1	PAPER ROLL REMOVAL	5.1
5-2	CHANGING CHART PAPER	5.1
5-3	PAPER THREADING DIAGRAM	5.2
5-4	RECORDER TOP VIEW	5.3
5-5	INK CARTRIDGE ASSEMBLY	5.4
5-6	PEN REPLACEMENT	5.5
5-7	RECORDER REAR VIEW	5.6
5-8	HYPODERMIC NEEDLE	5.7
5-9	PEN PRESSURE MEASUREMENT	5.8
5-10	PEN PRESSURE ADJUSTMENT	5.8
5-11	PEN LAPPING	5.9
5-12	BLEEDING INKING SYSTEM	5.10
5-13	CALIBRATION CONTROLS	5.12
5-14	PROCESSOR BOARD CALIBRATION	5.14
5-15	S401 POSITIONS	5.15
5-16	SINE OUTPUT SIGNAL	5.19
5-17	COSINE OUTPUT SIGNAL	5.19
5-18	SINE/COSINE GATING SIGNAL	5.20
5-19	6502 PIN PACKAGE	5.20
5-20	ERROR AMPLIFIER	5.23
5-21	STEPPER MOTOR COILS	5.24
5-22	SWITCHING AMP STAR DIAGRAM	5.25
5-23	INK CARTRIDGE REPLACEMENT	5.26
5-24	INK TURN ON AND TURN OFF	5.26
5-25	INK CARTRIDGE ASSEMBLY	5.26
5-26	PENMOTOR DRIVE BAND REPLACEMENT	5.30
6-1	2200S SERIES RECORDER, PORTABLE	6.3
6-2	2200S SERIES RECORDER, RACK MOUNTED	6.5
6-3	2200S RECORDER ASSY	6.13
6-4	2200S RECORDER ASSY	6.14
6-5	SPEED SELECT BOARD ASSY	6.18
6-6	PLATE ASSY, L.H.	6.20
6-7	CONNECTOR ASSY	6.23
6-8	CONTROL TIMER BD ASSY	6.25
6-9	DRIVE AMP BD ASSY	6.29
6-10	INTERCHANNEL EVENT MARKER	6.31
6-11	PEN MOTOR BAR ASSY	6.33
6-12	BRAKE ASSY	6.35
6-13	R.H. PLATE ASSY	6.38
6-14	SENSOR ASSY	6.39
6-15	WRITING TABLE ASSY	6.41
6-16	CASE ASSY	6.43
6-17	CAGE ASSY	6.45
6-18	CHART TAKE-UP ASSY	6.47
6-19	DAMPER ASSY	6.49
6-20	PROCESSOR BD ASSY	6.53
6-21	SWITCHING AMP BD ASSY	6.57
6-22	POWER SUPPLY BOARD	6.59
6-23	RECORDER RACK MOUNT INSTALLATION	6.61
6-24	RECORDER W/PREAMPS RACK MOUNT INSTALLATION	6.63

LIST OF TABLES

TABLE	TITLE	PAGE
1-1	2200S RECORDER MODEL NUMBERING SYSTEM	1.5
3-1	TIMER REPETITION SWITCH SETTINGS	3.4
3-2	SIGNAL INPUTS FOR REMOTE OPERATION	3.6
3-3	REMOTE CONTROL PIN SPEED ASSIGNMENTS	3.6
4-1	FUSE VS CIRCUIT PROTECTED	4.3
4-2	CHART DRIVE SPEED CODES	4.9
4-3	TIMER SWITCH SETTINGS	4.10
4-4	REMOTE SPEED CODES	4.10
5-1	FUSE TABLE	5.6
6-1	FUSE TABLE	6.12

SECTION I

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual is provided for operators of Gould 2200S Direct Writing Ink Recorders. The manual contains Recorder Description, Specifications, and a Supplies and Accessories list. In addition this manual also contains detail service and repair information including Theory of Operation, Installation Procedures, Operator's instructions, Routine Maintenance, and Illustrated Parts Break-down (IPB). Instructions for preamplifiers which may be used with these recorders are contained in their own applicable manuals.

WARNING: IN PATIENT CARE APPLICATION, ISOLATION TRANSFORMER (GOULD P/N 882895-3 (115V), -4 (230V) OR EQUAL) MUST BE CONNECTED BETWEEN POWER SOURCE AND RECORDER.

1.2 DESCRIPTION

The Gould 2200S Direct Writing Recorder (Figure 1-1) features a high performance stepper motor and a microprocessor (digital) control. The recorder is self-contained in a 130mm mainframe chassis and contains either one 100mm channel or two 50mm channels. The recorder may be housed in a portable case (Figure 1-1) or rack-mounted in a standard RETMA rack. (See Model Numbering Table for specific configuration.)

Incremental chart drive is a standard feature of the recorder. Its stepper motor and microprocessor (digital) control allows for quiet operation and chart speeds from 0.05mm/sec. to 200mm/sec. in 12 steps via front-panel pushbuttons or remote TTL inputs. The chart speed can also be varied continuously between steps with a front panel variable speed control or remote TTL pulse input.

The Gould 2200S Recorder employs a pressurized fluid writing system. The system uses fast drying ink which is applied to specially coated chart paper. The ink is contained in disposable plastic cartridges which can be replaced in minutes. Standard on all recorders are 2 event markers with pens and 1 (or 2) penmotor(s) and pen(s).

1.3 MODEL NUMBERING SYSTEM

The model number of the 2200S Direct Writing Recorder designates the number of recording channels, type of mounting, preamp cage as required, and operating voltages. Table 1-1 on page 1.5 describes the various models. Appropriate outline dimensional drawings follow the model numbering table.

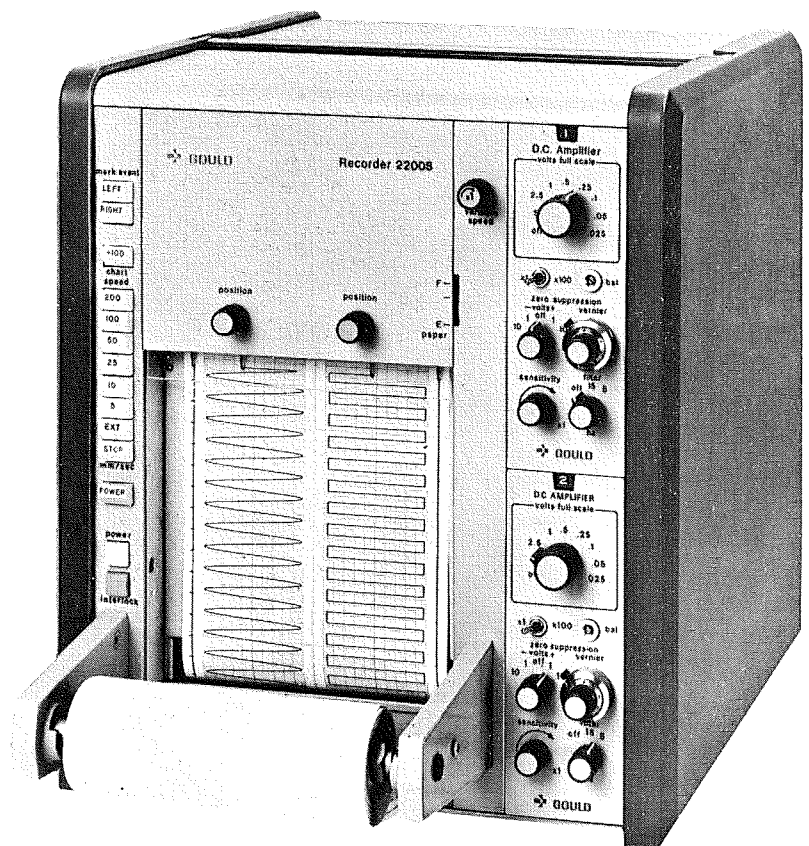


FIGURE 1-1 GOULD 2200S PORTABLE INK RECORDER

1.4 SPECIFICATIONS

1.4.1 General

Number of Analog Channels	Two 50mm or one 100mm.
Number of Event Marker Channels	Two. Left and right margin.
Channel Span	
2-Channel Recorder	50mm.
1-Channel recorder	100mm.
Trace Presentation	Rectilinear.
Trace Width	0.01 nominal.
Marking Method	Pressurized fluid (ink).
Marking Fluid Capacity	One-ounce replaceable, throw away cartridge.
Chart Speeds	5, 10, 25, 50, 100 and 200mm/sec. and divide-by-100. Selectable via front-panel pushbuttons or remotely via TTL or contact closure. Continuously variable via front-panel control or external pulse input.
Chart Speed Accuracy	± 0.25 @ 25°C $\pm 10^{\circ}\text{C}$.
Chart Length	275ft (84 mtrs) Kromecote. 400ft (122 mtrs) Reproducible (2 ch. only).
Chart Width	130mm (5.12 inches).
Divisions per Channel	50 Divisions on 50mm channels. 100 Divisions on 100mm channels.
Time Lines	One-mm by one-mm accentuated every 5-mm and 100mm.
Chart Travel Direction	Top to Bottom.
Paper Discharge	Front.
Chart Wander	$\pm 0.25\text{mm}$.
Operating Temperature Range	0°C to $+50^{\circ}$ ($+32^{\circ}\text{F}$ to $+122^{\circ}\text{F}$).
Storage Temperature Range	-40°C to $+70^{\circ}\text{C}$ (-40°F to $+158^{\circ}\text{F}$).
Humidity	95% @ 32°C ($+90^{\circ}\text{F}$); Non-Condensing.

1.4.2 Electrical

Input Circuit	Single ended, floating. (Isolated from ground up to 500Vdc.)
Input Impedance	100Kohm $\pm 1\%$. (Recorder without preamps.)

External Pulse Speed Control Chart speed is continuously variable via TTL pulse train.
 Frequencies of 0 to 20KHz corresponds to chart speeds of 0 to 250mm/sec in a linear relationship.

External Pulse Input 3TTL Loads, Min. 10 μ sec. Negative pulse width, 0-20KHz.
 Stepping occurs on negative transition 79.8 pulses/mm.

Variable Speed Control Continuously variable over a range of 2.5: 1 down to next lower speed.

1.4.3 Physical

Principle Dimensions. Refer to outline dimensional drawings following model numbering table.

Weight. Recorder 28.0 lb (12.7Kg) Portable Case 10.0 lb. (4.5 Kg)
 Portable case w/preamp cage 4.0 lb (1.8 kg). Preamps 3.5 lb (1.6 Kg) each average.

Finish Light and Dark Parchment.

1.5 SUPPLIES AND ACCESSORIES

1.5.1 Supplies

Chart Paper (All Models)

High Contrast, Kromekote (275 feet) 1mm time line

- 1-100 mm channel. 11-2913-30
- 2-50 mm channels. 11-2923-35
- 2-50 mm channels (400 ft. long - reproducible). 11-2923-46

Analog Pen
 (includes ink tube, lapping paper, and pen pressure adjustment wrench.) 11-2823-42

Analog Pen, Long Life
 (Includes ink tube, lapping paper, and pen pressure adjustment wrench.) 11-2823-422608

Event Marker Pen 267884-5

Ink Tube (Event Marker Pen) 667447-1

Ink Cartridge (1 oz. Blue Ink) 11-2730-01

Gram Gage 240601-910

Plug, Signal Input, P-201 (shipped loose with recorder) 114816-15

Plug, Monitor, P-202 (shipped loose with recorder). 289046

Connector, P-102 (shipped loose with recorder) 245537

1.5.2 Accessories

Starter Kits

Starter kits include 12 rolls of high contrast chart paper, gram gage, one analog pen, lapping paper and pen pressure adjustment wrench. Below are starter kit model numbers.

- 2-50mm channels 11-6250-13
- 1-100mm channel 11-6250-14

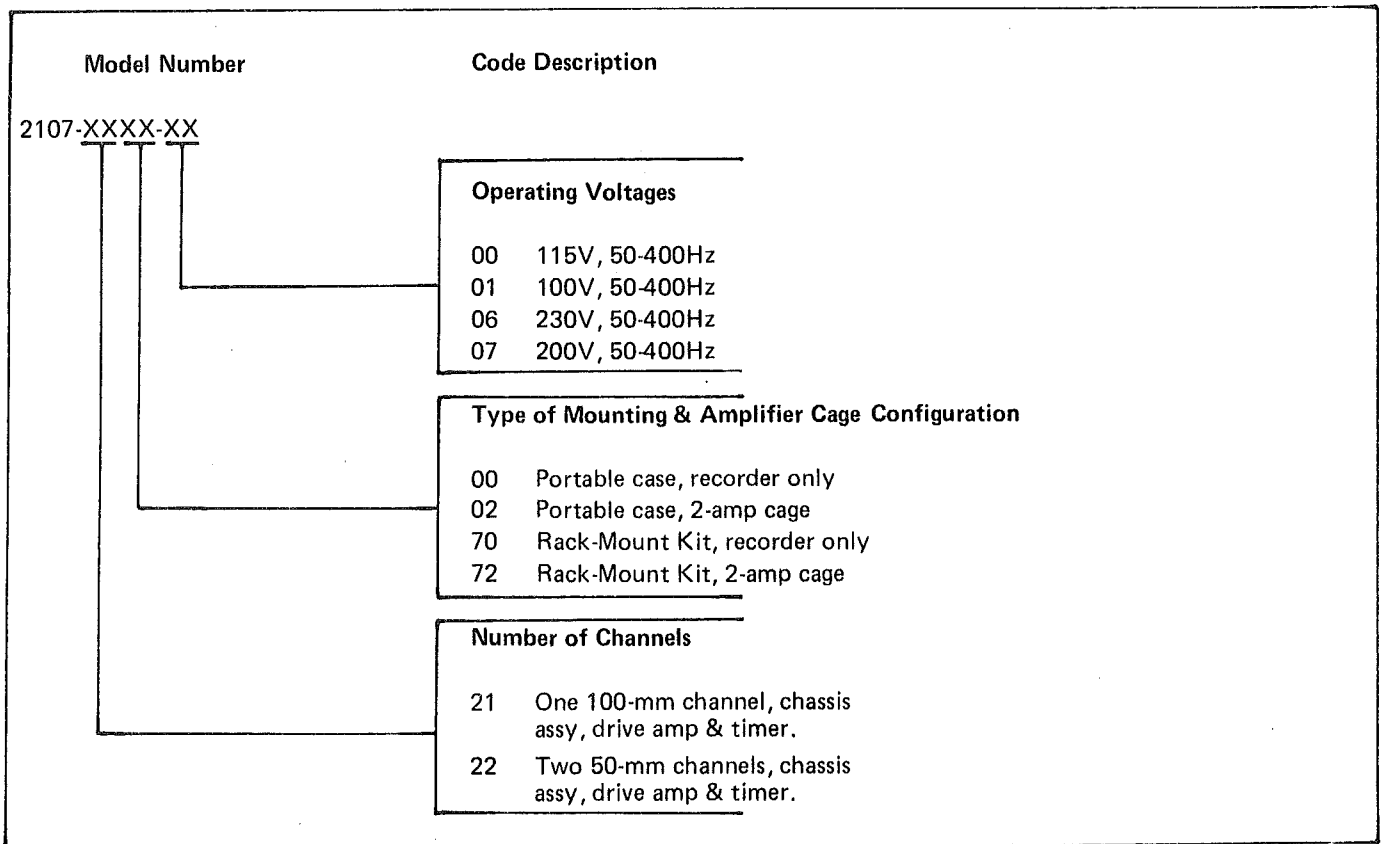
Blank Amplifier Module 13-4615-09

Blank Amplifier Panel 887005

Fuse Kits

115V, 50-400Hz	694458-00
100V, 50-400Hz	694458-01
230V, 50-400Hz	694458-06
200V, 50-400Hz	694458-07
Drive Amplifier Extender Card .....	.887526
Pen Pressure Adjustment-Wrench	1-120922-18
Band, Penmotor .....	.684999
Ink Tube Replacement Tool .....	.267528
Rack Mounting Kits (For Conversion of Portable Units)	
2200S Recorder with Preamp Cage	11-1202-16
2200S Recorder without Preamp Cage	11-1202-17
Mobile Carts	11-6405-02
Chart Take-up	11-6405-13
Interchannel Event Marker (includes pen when ordered with recorder) .....	.887181
500 Watt Portable Isolation Transformer (for patient care applications)	882895-3 (115Vac) 882895-4 (230 Vac)

TABLE 1-1 2200S RECORDER MODEL NUMBERING SYSTEM



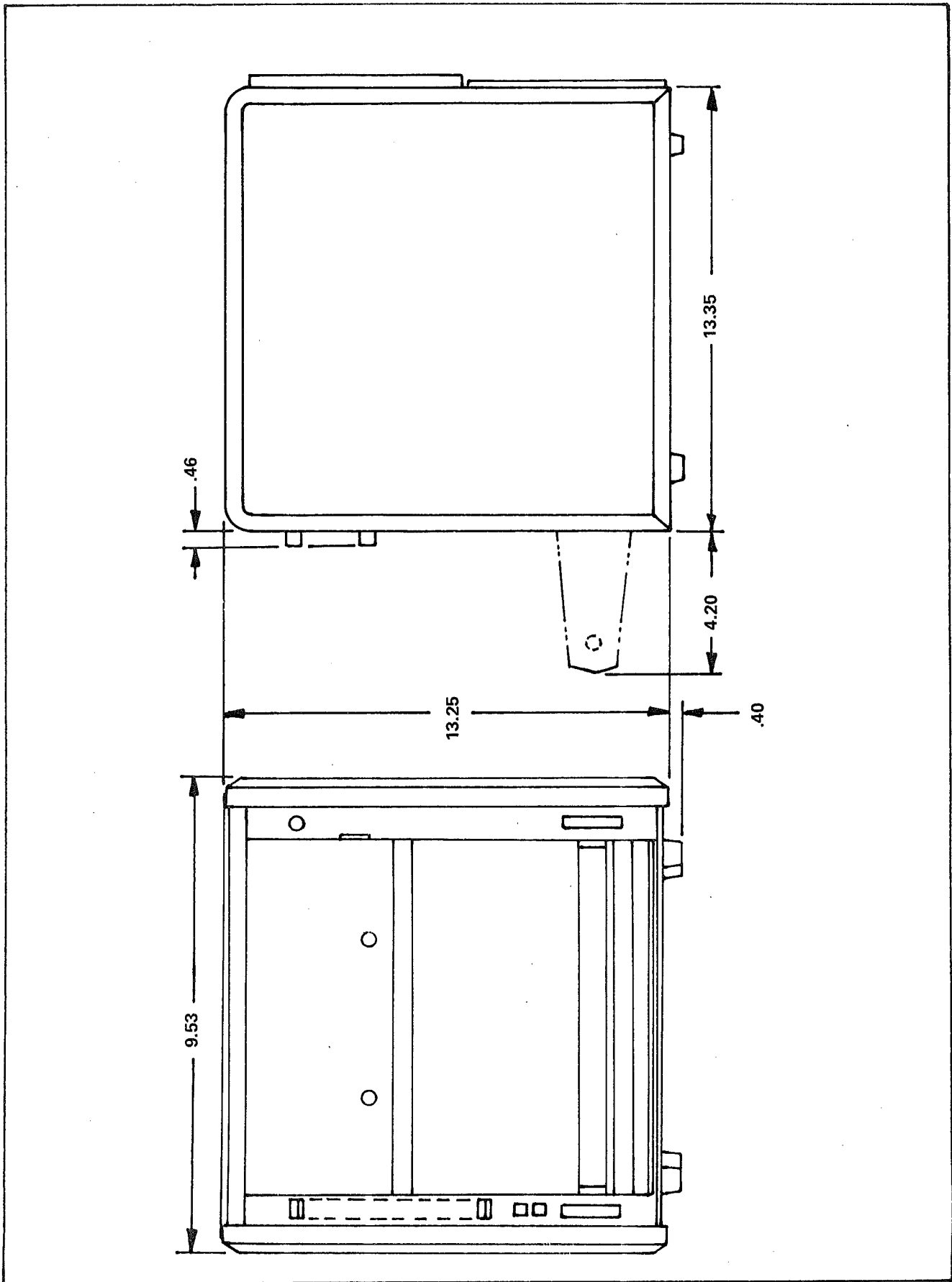


FIGURE 1-2 OUTLINE DIMENSIONS - 2200S PORTABLE RECORDER W/O PREAMPS

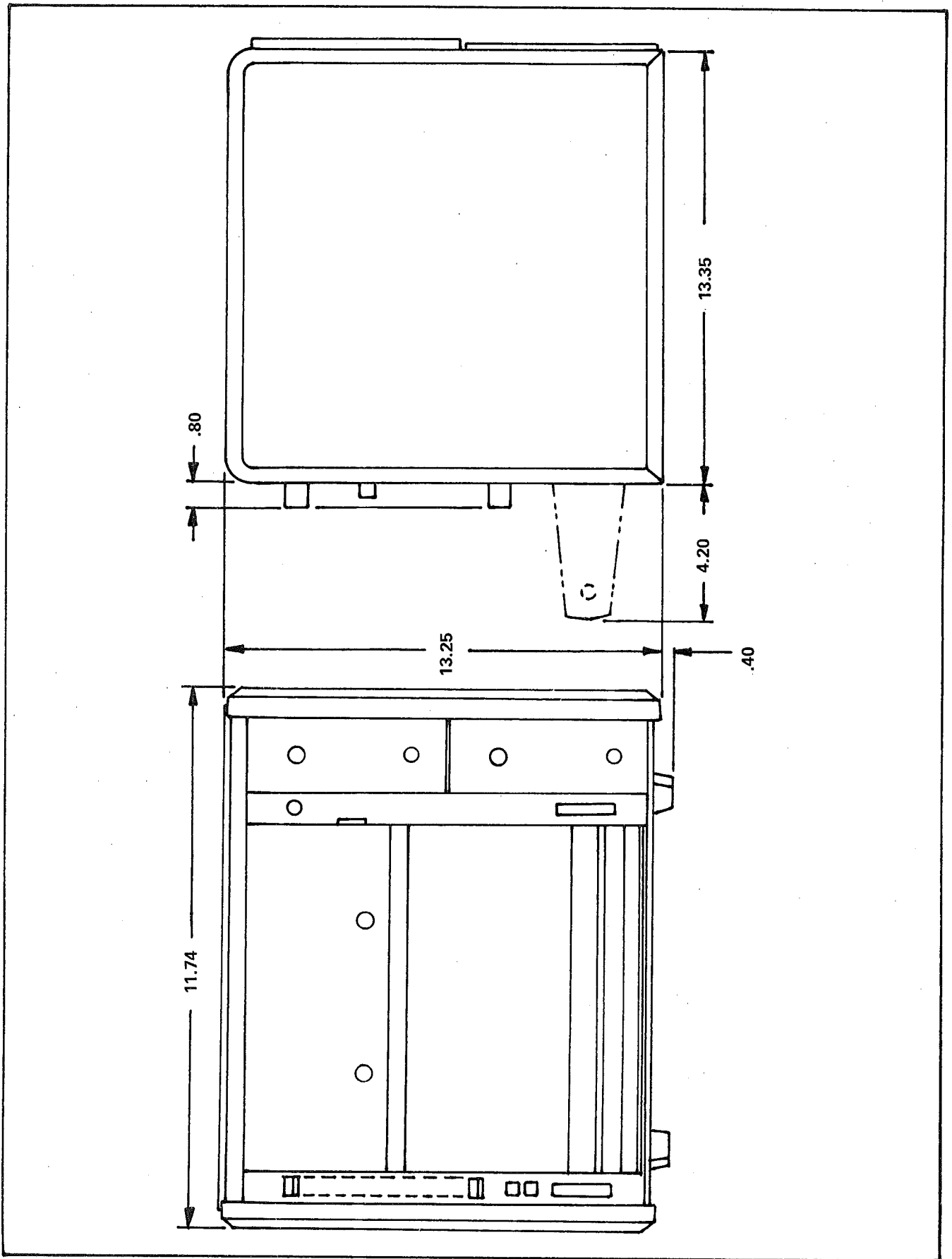


FIGURE 1-3 OUTLINE DIMENSIONS - 2200S PORTABLE RECORDER W/ PREAMPS

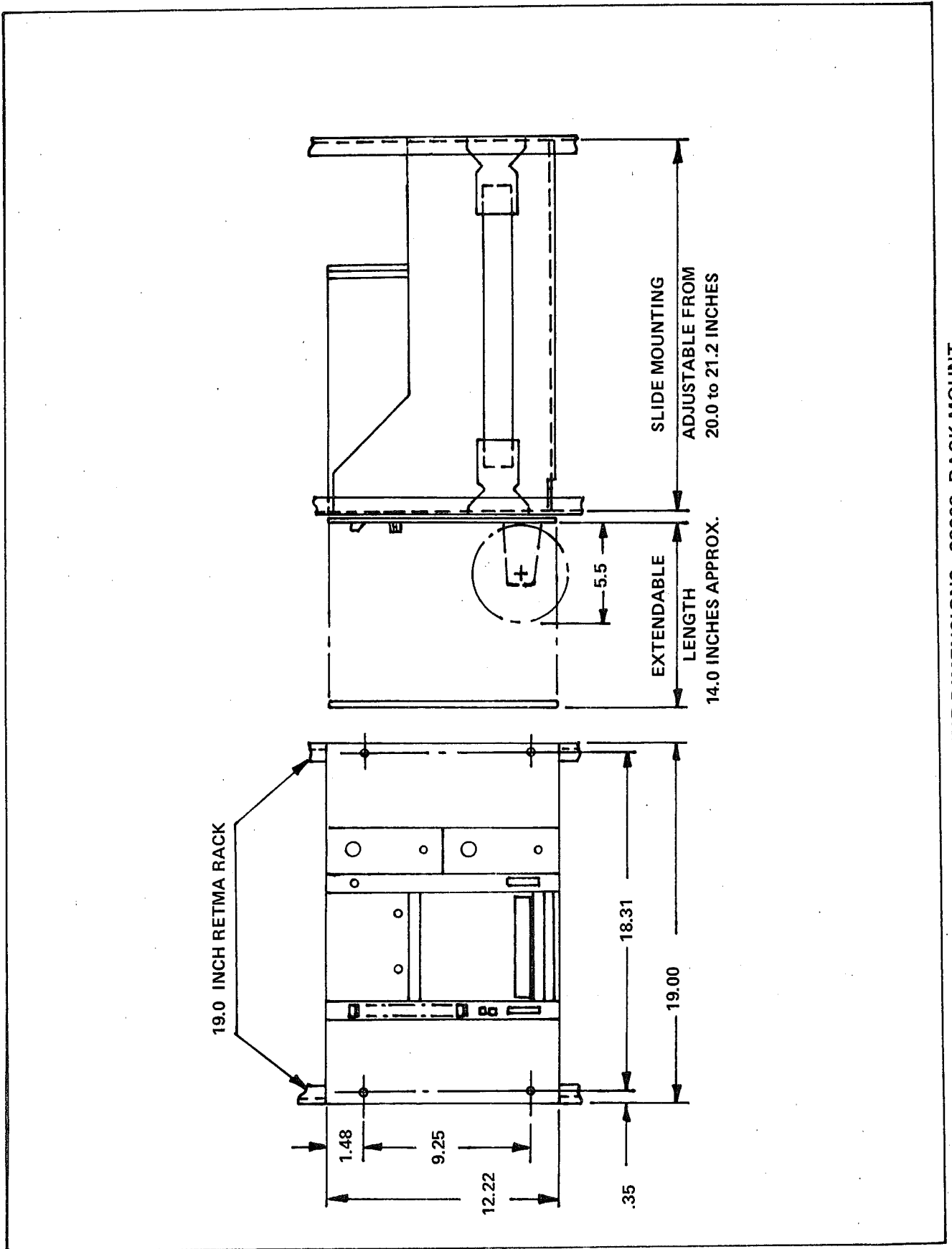


FIGURE 1-4 OUTLINE DIMENSIONS - 2200S RACK MOUNT

SECTION II INSTALLATION

2.1 GENERAL

This section contains information necessary to put the recorder into service, including installation of optional equipment.

2.2 SERVICE UPON RECEIPT

CAUTION: POWER MUST BE OFF DURING THE FOLLOWING SEQUENCE.

Before making signal connections and applying power to the recorder, the following service must be performed:

1. Remove sheet of chart paper from under pens and load roll of chart paper as described in Section V.
2. Slide all manual ink valves with tubing attached to ON position. (Follow direction of arrows on manifold bar.) Valves are located on top of recorder. Remove the recorder top front cover to gain access to valves. Slide cover forward and lift out. (If recorder is rack mounted, slide recorder out of rack.)
3. Ink cartridge and ink solenoid valve is turned on prior to shipment from factory.

NOTE: Ink cartridge should be near full.

4. Place cover back in position (or slide recorder back into rack and secure).

2.3 LINE VOLTAGE REQUIREMENTS

The last digit of the model number designates line voltage. Frequency range for all models is 50-400Hz. Listed below is last digit of model number and required line voltage.

DIGIT	LINE VOLTAGE	
0	115 Vac	CAUTION: MAKE SURE A.C. JUMPER BOARD IS IN CORRECT POSITION. (PARA. 2.9).
1	100 Vac	
6	230 Vac	
7	200 Vac	

2.4 ANALOG SIGNAL CONNECTIONS

2.4.1 Without Preamplifiers

On recorders not supplied with preamplifiers, signal input connections are made directly to pen drive amplifiers. Two phone jacks are provided on each drive amplifier. They are located on the rear of the recorder (Figure 2-1). Use shielded cable (Belden 8422 or equal) with mating phone plugs provided. Tips are high; rings are low; barrels are common.

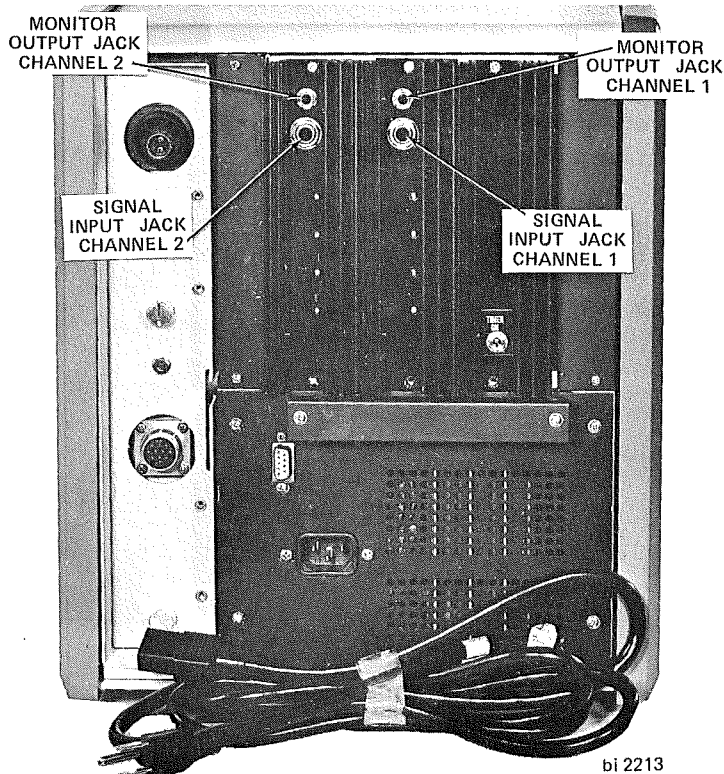


FIGURE 2-1 SIGNAL INPUT CONNECTIONS

2.4.2 With Preamplifiers

On recorders supplied with preamplifiers, signal input connections are made via a connector located in the preamplifier cage. Refer to applicable preamplifier manual for their signal input connections.

2.5 EVENT MARKER INPUTS

2.5.1 Standard Event Markers

Left and right markers are standard. Actuation is made by momentary switches on front panel or externally via the terminal strip located on recorder rear panel. External actuation may be

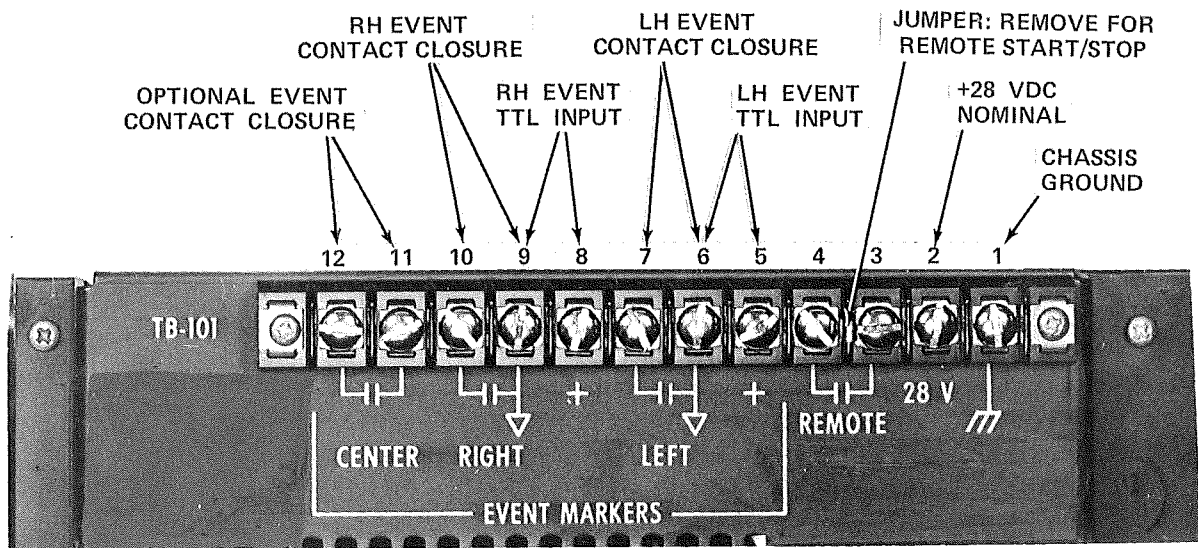
made by contact closure or TTL signal input. Refer to Figure 2-2 for connections.

2.5.2 Optional Event Marker

Interchannel optional event marker is actuated by a contact closure via the rear panel terminal strip. Refer to Figure 2-2 for connections.

2.6 REMOTE CHART DRIVE (Stop/Start)

For remote chart drive operation, remove jumper between pins 3 and 4 on rear panel terminal strip. Front Panel speeds are disabled during remote operation. A contact closure across these pins will "remote enable" chart drive motor. Refer to Figure 2-2. Chart SPEED must be pre-selected. Remote Start/Stop operation is covered in para. 3.6. Can also be operated via J-102 covered in para. 3.7.



NOTE: "L" SHAPED SHIELD, STANDARD, (not shown) PROTECTS TERMINAL BOARD.

bi 2035

NOTE:

WHEN USING OPTIONAL EVENT MARKERS, PLEASE USE CHASSIS GROUND INSTEAD OF EVENT CONTACT CLOSURE COMMON LOCATED ON BACK PANEL.

FIGURE 2-2 REAR PANEL TERMINAL CONNECTIONS

2.7 CHART TAKE-UP INSTALLATION

Refer to Figure 2-3, and install the optional chart take-up as follows:

1. Disconnect recorder from power source.
2. Remove case from recorder as described in para. 5.3.6 (or slide recorder about 6 inches out of rack).
3. Remove plastic caps covering slots in front panel.
4. Position chart take-up on front panel with

drive belt on left side. Secure with screws and lockwashers.

5. Slide pulley onto drive roll shaft, and secure with cotter pin.
6. Position drive belt over pulley.
7. Reinstall case.

2.8 RACK MOUNTING KITS

Rack mounting kit for recorder without preamps is Model 11-1202-17; for recorder with 2 channel preamp cage use Model 11-1202-16. Installation instructions are included with each kit.

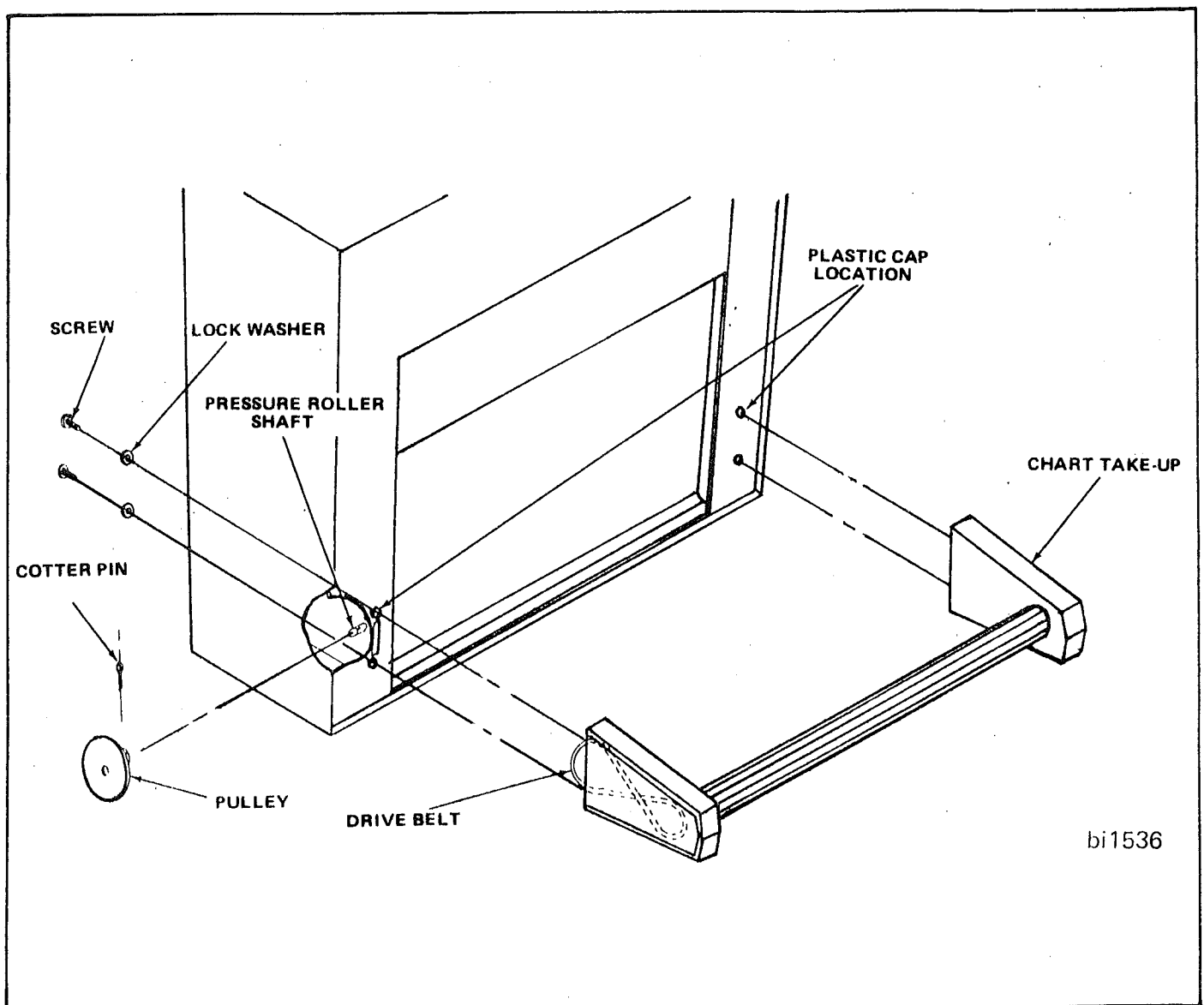


FIGURE 2-3 CHART TAKE-UP INSTALLATION

2.9 A.C. JUMPER BOARD

WARNING: REMOVE POWER SOURCE.

If it becomes desirable to operate the recorder at some voltage other than the specified one, the A.C. Jumper Board (Figure 2-4) must be repositioned, and the fuses replaced.

The A.C. Jumper Board is located behind the writing table. To gain access to the board, open the table and remove the chart paper roll (para. 5.3.6). The board will immediately become visible when looking into the recorder. The voltage the unit is set to operate at appears on the left side of the board.

The procedure that follows describes repositioning the A.C. Jumper Board.

1. Carefully place screwdriver blade between "EAR" of board and "CONNECTOR" and pry board upward from connector, first from one "EAR", then the other (See Fig. 2-4.)
2. Remove board from recorder once loosened. Select desired voltage, reading voltage number on left side of board (facing reader).
3. Place board back into connector making sure it is seated correctly.
4. Install appropriate fuses on Control Timer board. Refer to Table 4-1 for options.
5. Replace chart paper roll and close writing table. Refer to Section III, Operation, before attempting to operate recorder.

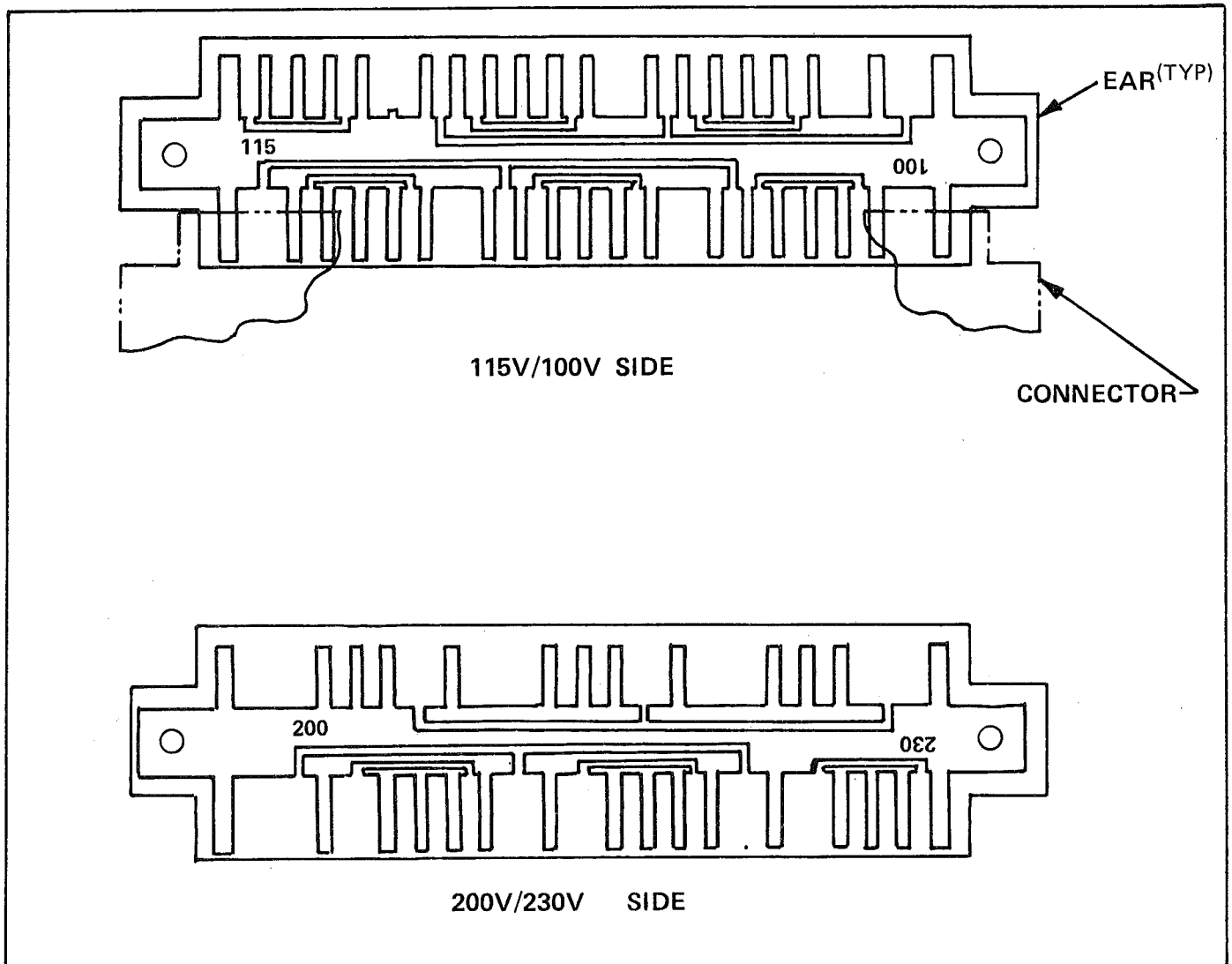


FIGURE 2-4 A. C. JUMPER BOARD

SECTION III

OPERATION

3.1 GENERAL

This section provides complete instructions for operation of the recorder. Functional descriptions of the controls and indicators are provided. If the recorder is equipped with preamplifiers, refer to their applicable instruction manuals for operating instructions.

CAUTION: NEVER APPLY POWER TO RECORDER WITH POWER BUTTON IN "ON" POSITION.

3.2 FRONT PANEL CONTROLS & INDICATORS

Figure 3-1 illustrates the front panel controls and indicators. The list that follows on page 3.2 corresponds to the items called out on Figure 3-1.

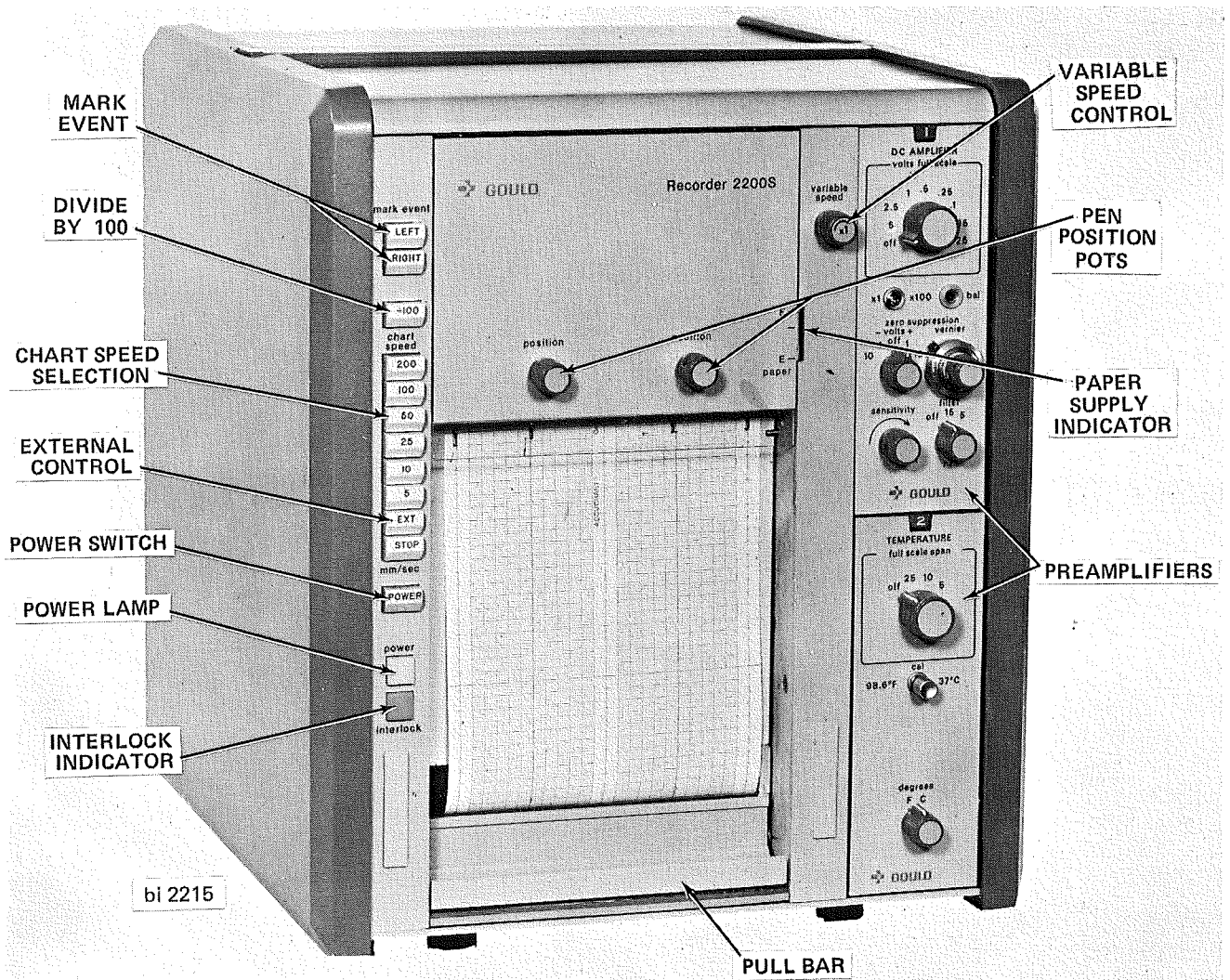


FIGURE 3-1 FRONT PANEL CONTROLS & INDICATORS

CONTROLS

DESCRIPTION

POWER SWITCH/POWER LAMP	Controls AC to recorder. Depress to turn recorder ON or OFF. POWER lamp is lighted when recorder is ON.
CHART SPEED SELECTION	Permits selection of six calibrated chart speeds of 5, 10, 25, 50, 100 and 200mm/second and STOP. When in STOP position chart drive is off, and pens will not respond to input signals. Depressing any chart speed button will activate the chart drive at the selected speed. Chart speeds may be changed while chart drive is running. However, during remote operation all front panel controls are disabled except for power On/Off pushbutton.
DIVIDE BY 100	When depressed, chart speeds become 0.05, 0.10, 0.25, 0.50, 1.0 and 2.0 mm/second.
*VARIABLE SPEED CONTROL	Single turn potentiometer with 270° rotation. Provides continuously variable speeds between calibrated selected chart speed, and overlapping next lower calibrated speed. When control is at full CW (calibrated detent) position (x1), chart speed matches selected speed. As control is rotated CCW chart speed is reduced. When at full CCW position chart speed is slower than next lower calibrated speed.
MARK EVENT	Two momentary switches permit manual marking of an event. When left MARK EVENT button is depressed the left event marker pen will deflect to the left. When the right MARK EVENT button is depressed the right event marker pen will deflect to the left. NOTE: The EVENT MARKER pens will remain deflected until the mark event button is released. Event marker will override timer event marker.
*PEN POSITION POTS	Permits pen positioning anywhere within the channel.
PULL BAR	Pull to gain access to chart paper supply roll.
INTERLOCK INDICATOR	Lamp lights when writing table is not completely closed or paper supply is exhausted.
POWER INDICATOR	Lamp lights when POWER switch is depressed.
PAPER SUPPLY INDICATOR	Gauge to indicate quantity of chart paper remaining.
EXTERNAL CONTROL	Used in conjunction with J-102, remote control connector. Switches chart drive from internal speed to external pulse input. (See Table 3-2 and 3-3).
PREAMPLIFIERS	Refer to applicable preamplifier manuals for operating instructions.

* VARIABLE SPEED CONTROL AND PEN POSITION POTS CONTAIN LOCKING KNOBS.

3.3 REAR PANEL

Figure 3-2 illustrates the recorder rear panel. The list that follows corresponds to the items called out on Figure 3-2.

CONTROLS	DESCRIPTION
PREAMP CAGE	Houses preamplifiers if part of the recorder system.
SIGNAL INPUT	Jacks for signal input direct to drive amplifiers. (overrides preamplifiers).
TERMINAL STRIP (TB-101)	Refer to para. 2.5 for description.
TIMER	ON/OFF toggle switch for timed left hand event marker activation. See section 3.4.
MONITOR JACK	Monitors output of preamplifier (regardless of chart display). For use on Scope, Meter, Output panel, etc.
REMOTE CONTROL CONNECTOR (J-102)	Allows for recorder to be operated from remote location. When proper inputs are made to J-102. See Section 3.7.
POWER INPUT CONNECTOR (J-101)	Connector accepts external power, i.e., 115/230V, 50-400Hz.

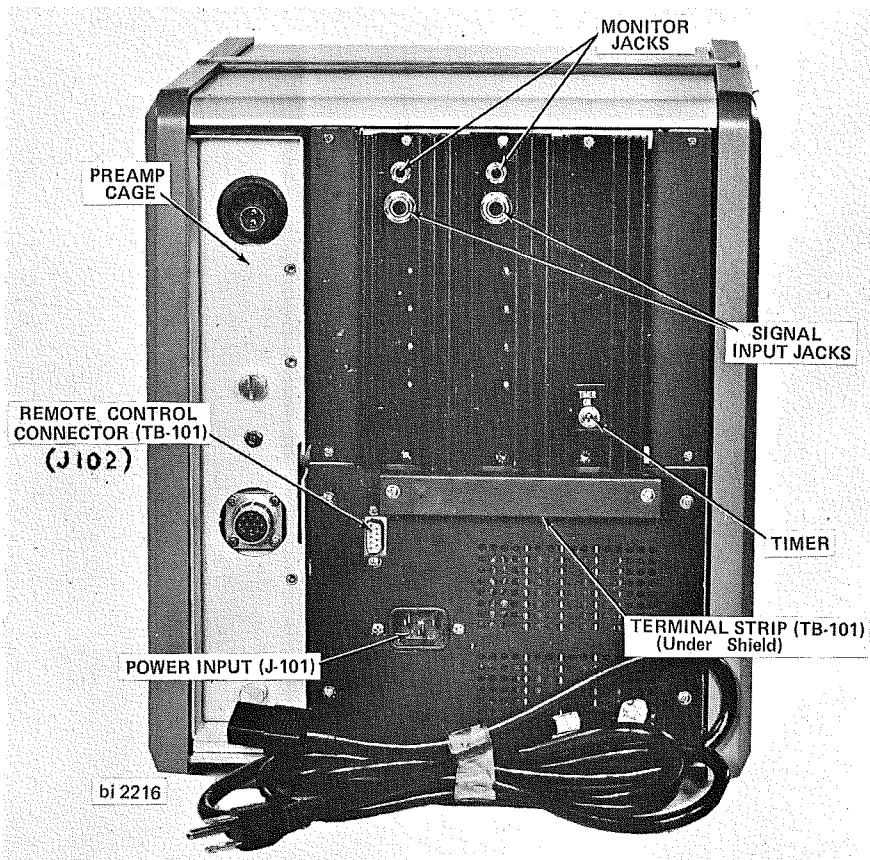


FIGURE 3-2 REAR PANEL

3.4 TIMER SETTING

The timer actuates left event markers at a programmed repetition rate. Selection of repetition rates is made via switch S-702 on the control board.

Set rate as follows:

NOTE: If the customer wishes timer to be actuate right event marker see para. 3.5.

1. Turn recorder power OFF.
2. Loosen the two screws which secure Control/Timer board and pull board out of recorder. (See Fig. 3-2).
3. Set switch positions for desired repetition rate per Table 3-1.
4. Replace control timer board and secure with screws.
5. Turn recorder power ON.
6. Turn TIMER switch ON. Timer ready for operation.

TABLE 3-1 SWITCH SETTINGS VS. TIMER REPETITION RATE

REPETITION RATE	SETTINGS	
	SW ON	SW OFF
0.1 SECOND	1, 3	2, 4, 5, 6, 7, 8
1.0 SECOND	1, 4	2, 3, 5, 6, 7, 8
10.0 SECONDS	1, 5	2, 3, 4, 6, 7, 8
100.0 SECONDS	1, 6	2, 3, 4, 5, 7, 8
0.01 MINUTE	2, 3	1, 4, 5, 6, 7, 8
0.10 MINUTE	2, 4	1, 3, 5, 6, 7, 8
1.00 MINUTE	2, 5	1, 3, 4, 6, 7, 8
10.00 MINUTES	2, 6	1, 3, 4, 5, 7, 8

3.5 RIGHT EVENT TIMER ACTUATION

By the removal of one resistor and the addition of another on the control/timer board, the timer will actuate the right hand event marker.

Procedure for right event timing marks are as follows:

1. Turn recorder power OFF and disconnect AC power.
2. Remove the two screws which secure control/timer board and pull board out of recorder.

3. Locate resistor R708 on the control/timer board and remove it.
4. Add resistor R709 to control/timer board, 3.3K ohm $\pm 5\%$ ¼ watt carbon resistor part number 5-241111-332.
5. Replace control/timer board and secure with screws.
6. Turn recorder power on.
7. Turn TIMER switch on. Right hand event marker should be responding to programmed repetition rate.

3.6 SET-UP AND OPERATION

Prepare recorder for operation as follows:

CAUTION: MAKE SURE ALL PROCEDURES DESCRIBED IN SECTION II, INSTALLATION HAVE BEEN PERFORMED.

1. Connect power source to recorder via power cable.
2. Check chart paper supply level. Make sure and adequate supply is present for length of time recorder is to be operated and that paper is properly threaded.
3. Check that chart STOP pushbutton is depressed (in).
4. Depress POWER pushbutton. POWER lamp will illuminate.
5. Set variable speed control full clockwise. to detent.
6. Depress 5mm/sec calibrated chart speed pushbutton. Allow chart to travel about one foot. Press STOP button. Vertical traces from analog pen(s) down the center of the chart and vertical traces with timed marks (per para. 3.4) from the event marker pens on the chart edges will appear.
7. Depress 5mm/sec chart speed pushbutton. Rotate pen position control(s) allowing analog pen travel to show full scale deflection within chart limits. Center pen(s) on chart with pen position control(s). Press STOP button.
8. Apply input signal(s) to recorder.

9. Depress calibrated chart speed pushbutton to that chart speed which best displays signal. Speed may be fractionally reduced as low as next slower calibrated speed by rotating variable speed control counterclockwise. Lock control in place when desired speed is attained.
10. When recorded data is completed, remove input signal(s), depress STOP button, and rotate variable speed control full clockwise unless setting is desired for recording future data.
11. Remove power by releasing POWER push-button.

3.2 and 3.3. Page 1 of schematic diagram 294232 located at the rear manual may be used as an aid. Signals S1 thru S4, STOP, ENABLE, and x100 are pulled to a logic 1 internally. The stop signal pin number 1 of J-102 will override front panel speed selection if connected to a logic 0.

3.8 ELECTRICAL APPLICATIONS

The 2200S uses the 74LSXX Series, which is low power Schottky. The power consumption is 2mW/Gate, and the speed is 18nsec. The Schottky diode prevents the transistor from saturating, allowing it to switch faster.

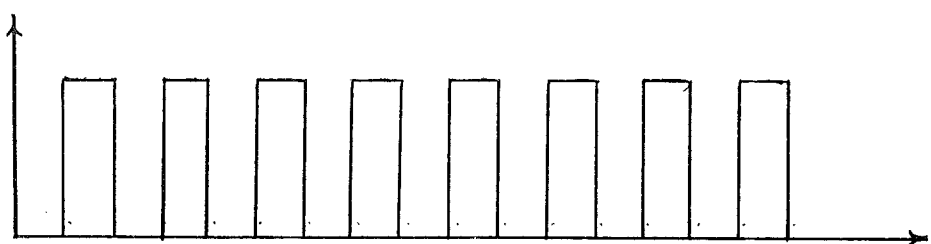
Typical TTL electrical characteristics:

Supply Voltage	5V
Minimum High Voltage	2.4V
Maximum Low Voltage	0.4V
Fan Out	10
Power Consumption	9mW/Gate
Noise Immunity	20%
Speed	15nSec.

3.7 REMOTE CONTROL OPERATION

The recorder may be operated remotely thru remote control connector J-102 located on the rear panel of the recorder. To attain this, mating connector P-102 (shipped loose with recorder) must be wired and signals provided per Tables

Ext. Pulse Input – 3TTL loads, minimum of 10 μ sec. positive pulse width from 0-20KHz. Stepping occurs on negative transition of pulse. 79.8 pulses/mm.



2200S can synchronize up to 4 cascaded units. Each cable should be shielded, and should not exceed 2 feet in length.

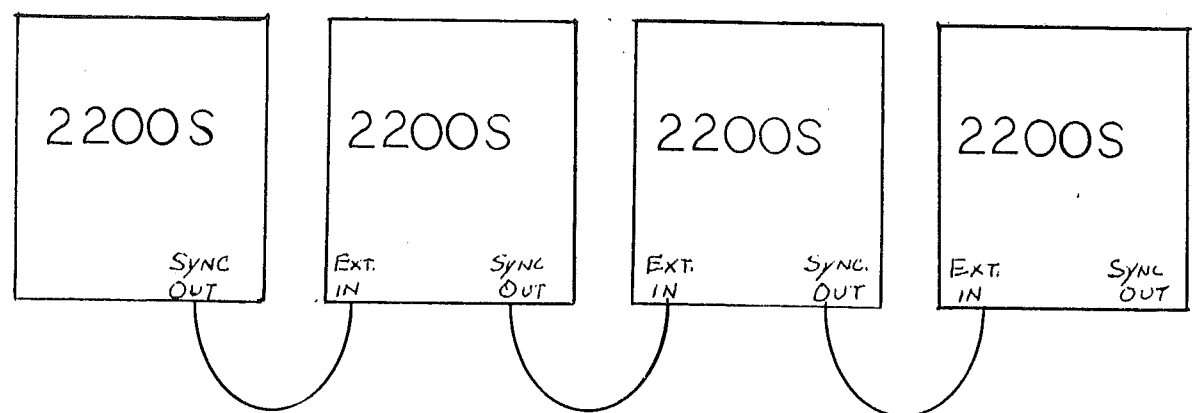


FIGURE 3-3 EXTERNAL PULSE REQUIREMENTS

TABLE 3-2 SIGNAL INPUTS FOR REMOTE OPERATION

PIN NO	SIGNAL NAME	DESCRIPTION
1	$\overline{\text{STOP}}$	0 = Stop, 1 = Go. Same function as remote start/stop link on TB-101, terminals 3 & 4.
2	$\overline{\text{S3}}$	See Table 3-3 for Remote. Speed Select Bits speed assignments
3	$\overline{\text{S2}}$	
4	$\overline{\text{S1}}$	
5	$\overline{\text{S4}}$	
6	$\overline{\text{ENABLE}}$	0 = Remote, 1 = Local. Enables remote speed select bits, pins 2 thru 5. 0 = TTL voltage of ground or 0V, and 1 = TTL voltage of 5V.
7	REMOTE SYNC	Output pulse with each motor step. Used to slave another recorder to Master.
8	COMMON	Logic 0
9	$\overline{\text{EXT}}$	External pulse for step per pulse operation. (See Fig. 3-3)
10	X100	Defeats ÷ 100 button on front panel active only in local mode.

TABLE 3-3 REMOTE CONTROL PIN SPEED ASSIGNMENTS

SIGNAL NAME				SPEED
S1	S2	S3	S4	
0	0	0	0	200mm/sec
0	0	0	1	100mm/sec
0	0	1	0	50mm/sec
0	0	1	1	25mm/sec
0	1	0	0	External Pulse
0	1	0	1	10mm/sec
0	1	1	0	5mm/sec
0	1	1	1	STOP - Stops all speeds
1	0	0	0	2mm/sec
1	0	0	1	1mm/sec
1	0	1	0	.5mm/sec
1	0	1	1	.25mm/sec
1	1	0	0	External Pulse
1	1	0	1	.1mm/sec
1	1	1	0	.05mm/sec
1	1	1	1	STOP

NOTE: Remote Control Operation, overrides all Front Panel Controls except for the power ON/OFF pushbutton.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL

The 2200S Series Recorder is a modular-constructed unit consisting of a 130mm (total chart width) mainframe and 1-100mm or 2-50mm analog recording channels. Each channel is electrically identical. Figure 4-1 illustrates a block diagram of the basic recorder.

Preamplifiers are optional and are discussed in their respective instruction manuals.

4.2 MAINFRAME

The mainframe contains a Speed Select Board, Control Timer Board, Control Transformer, Chart Drive Motor, Event Markers, Switching Amp Board, Sensor Board, Variable Speed Board, and an A.C. Distribution Board.

a. Speed Select Board

The Speed Select Board is mounted on the left side of the front panel. It contains the operator control switches for POWER ON/OFF, CHART SPEED selection, and EVENT Marker actuation; and indicators for POWER ON and INTERLOCK.

The POWER switch is a set-reset pushbutton which interrupts both phase and neutral sides of the ac power line.

Chart speed selection is made by depressing one of six SPEED, a DIVIDE, or STOP pushbutton. The SPEED and STOP pushbuttons are mechanically interlocked to reset a previously selected pushbutton. The DIVIDE is a set/reset pushbutton. A combination of four binary outputs are activated by the SPEED pushbuttons to obtain the desired chart speed.

Each chart speed may be divided by 60 or 100 (depending upon model number) by depressing the DIVIDE pushbutton. The STOP pushbutton interrupts power to the motor via relay K-701 and resets the SPEED pushbuttons.

When the LEFT or RIGHT MARK EVENT push-buttons are depressed, solenoids L108 and L109 respectively, are energized activating the left or right event markers. These are momentary push-buttons, and are reset when released.

b. Control Timer Board

The Control Timer Board is mounted in the card cage in the rear of the recorder. Contained in the control timer board are the branch fuses, start/stop relay K-701, the +5Vdc and +28Vdc power supplies, and timer.

Fuses are provided to protect each power branch. Table 4-1 shows fuse and circuit protected.

DPDT relay K-701 controls power to the ink solenoids, standard event markers, and optical couplers located in the pen drive amplifiers. It is energized when the chart STOP pushbutton is released. When energized, one set of contacts supplies power to the ink solenoids thru fuse F711 and activates the ink manifold solenoid. When de-energized, the other set of contacts inhibit the event markers and optical couplers in the pen drive amplifier(s).

The control board contains two dc power supplies: +28V and +5V. The +28Vdc power source is obtained from bridge rectifier CR702 and control transformer T109. The unfiltered section of this section of the supply provides power to relay K701, optional event marker solenoids, and the indicator lamps. The filtered section of this supply provides power to the standard event markers to insure accuracy when precise time events are required. The +5Vdc power source is obtained from the power supply board. This supply is filtered and regulated to provide power for the pen drive amplifier optical couplers and timer.

Pulsating dc voltage is provided from bridge rectifier CR701 to operate the ink supply solenoids.

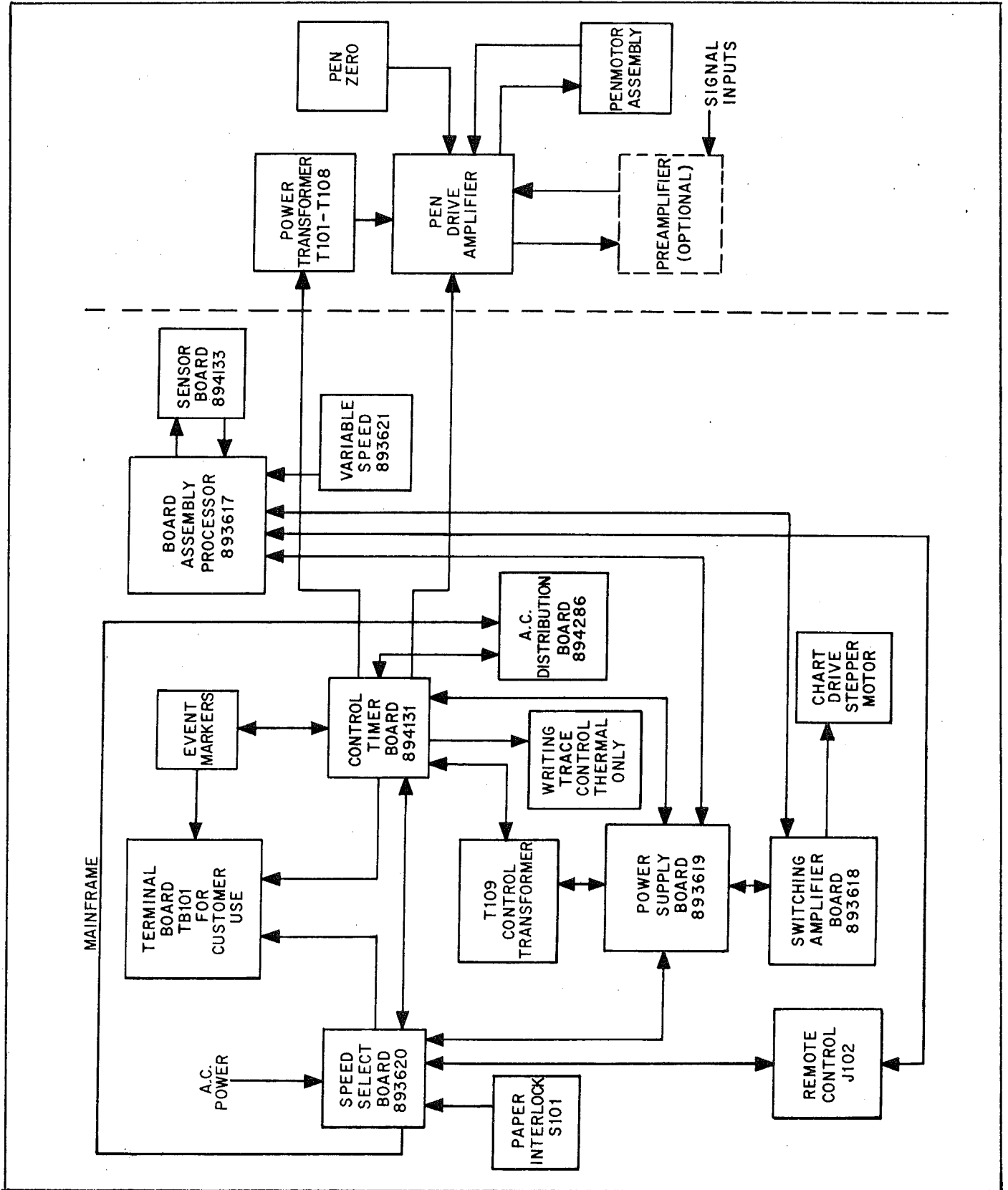


FIGURE 4-1 BLOCK DIAGRAM (OVERALL SYSTEM)

4.3 ANALOG RECORDING CHANNELS

a. General

Each analog recording channel consists of a power transformer, pen drive amplifier, and penmotor. The channels are isolated from one another by using separate transformer power supplies and optical couplers. The optical coupler disables the pen drive amplifier whenever relay K-701 on the control board is de-energized from depressing chart STOP pushbutton or upon loss of ac power.

Each power transformer has two primary and three secondary windings. The primary windings can be wired in parallel for 115Vac operation or in series for 230Vac operation. Two of the secondary windings (± 35 and ± 15 volts) provide power for the pen drive amplifier. The third (13Vac — may be used in preamplifiers requiring isolated power supplies for bridge excitation or suppression.

Figure 4-2 shows a block diagram of an analog channel. The penmotor drive amplifier is a complete servo system and uses a linear voltage displacement transformer (Metrisite*) in the penmotor to develop position, and a velocity transducer for velocity. These signals are summed with the input signal in a dc error amplifier which, after amplification, drive the penmotor.

b. Signal Limiter

The input signal enters the signal limiter and is summed with the pen zero signal. The summed signal is fed to a diode bridge circuit. Output from the bridge is limited to ± 2.6 volts.

* Registered Trademark of Gould Inc.

c. Frequency Compensation Network

Output from the signal limiter is fed to a frequency compensation network. Here, the signal's frequency response is adjusted to be flat within 2% from dc to 65Hz pen deflection and from dc to 125Hz for 10 division pen deflection. The frequency compensated signal is then fed to summing network where it is combined with error and velocity signals.

d. Oscillator and Demodulator

Position feedback is obtained from the Metrisite. Excitation for the Metrisite is obtained from a 20KHz Wein Bridge Oscillator. A demodulator attenuates the 20KHz carrier. Output from the demodulator is the position feedback signals.

e. Servo Control Amplifier

The compensated input signal, position feedback, and velocity are summed at the input of the servo amplifier. The output of this stage drives a Class B amplifier, which drives the pen to the proper position on the chart. This occurs when the summed signal is reduced to zero.

4.4 STEPPER CHART DRIVE

The 2200S Series Chart Drive Recorder is implemented using a stepper motor as the motion producer. The stepper motor is run in the microstepping mode rather than in the classical full or half stepping mode.

TABLE 4-1 FUSE VS CIRCUIT PROTECTED

FUSE	CIRCUIT PROTECTED
F701, F702	Analog channel power transformers T101 (and T102)
F709	Control transformer T109 which supplies power for the +5V and +28Vdc power supplies.
F111	Ink solenoid

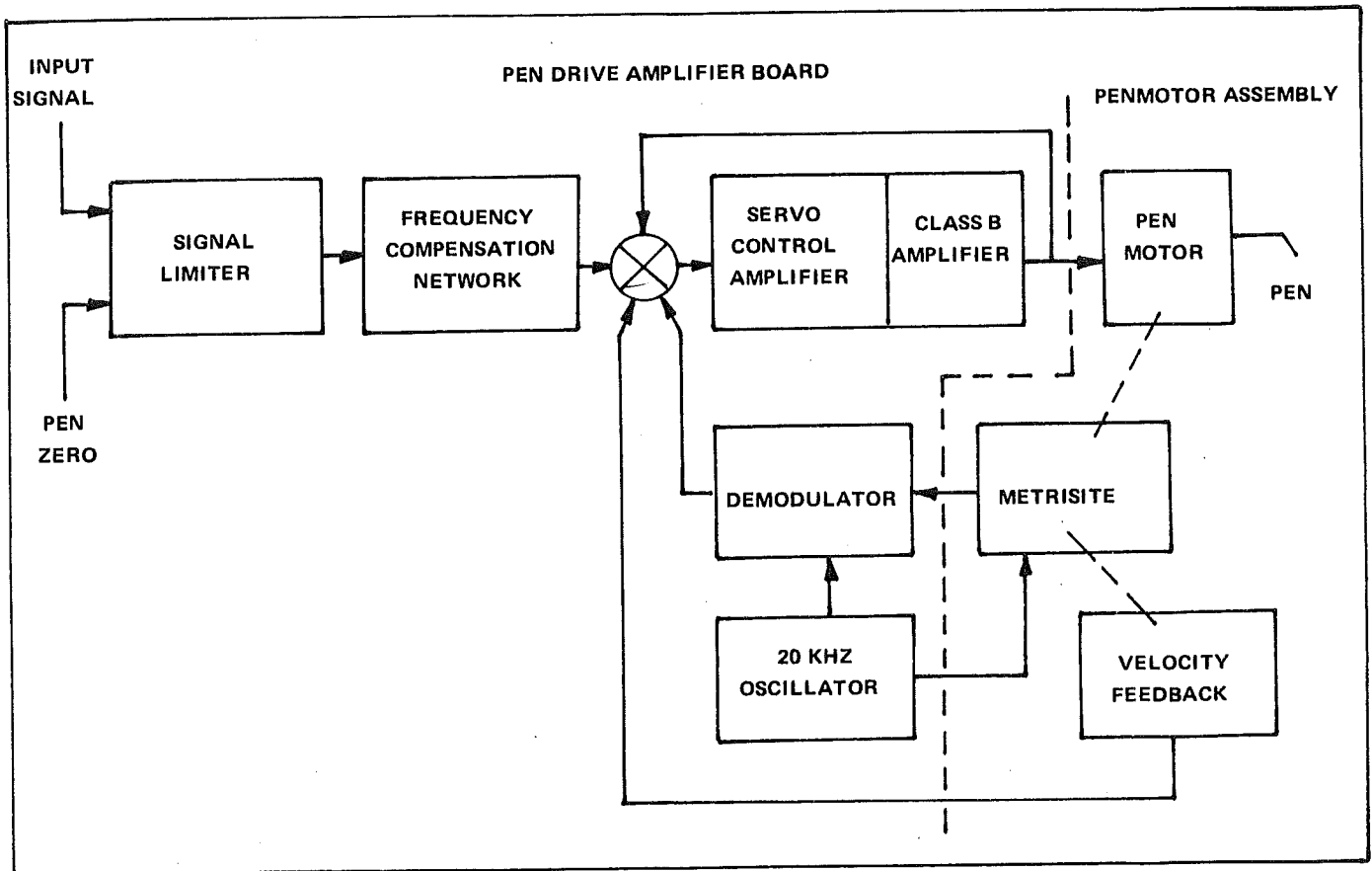


FIGURE 4-2 ANALOG CHANNEL BLOCK DIAGRAM

Microstepping is a method of achieving much smaller steps electrically. No gear trains are needed. The concept of microstepping is not new; however, the advent of microprocessors, inexpensive memory, and sophisticated analog integrated circuits have only recently made it a practical and viable alternative.

Classical full stepping of a four-phase stepper motor is accomplished by driving the four phases with four switches each 90° apart electrically. This is demonstrated graphically in Figure 4-3.

The vertical axis represents motor current in each of the four windings, and the horizontal axis represents time. A step occurs at each transition of any coil. The current waveforms are four symmetrical, unipolar square waves in a full quadrature relationship to one another. For a standard 1.8° motor of the type used in the 2000, each step represents 1.8° of angular motion, giving 200 steps per motor revolution.

To achieve microstepping, each of the current waveforms is changed to half-wave rectified sines maintaining the quadrature relationship as shown in Figure 4-4.

If the sine waves are truly continuous, no stepping occurs at all. The motor moves like a 200-pole synchronous motor. Achieving continuous sine waves which maintain an exact quadrature relationship independent of frequency is not practical. However, it is practical to generate sine waves digitally using a digital to analog converter and a ROM based look-up table. This will divide the sine waves into small discrete steps. The motor will then step, but the steps will be much smaller than normal full steps. In fact, the microsteps will be equal to one full step divided by the number of increments in each quarter cycle of the sine wave, and they will be of equal size.

The 2200S uses this technique. Each quarter cycle is divided into 16 increments, giving 16 equal microsteps per normal full-step, or $200 \times 16 = 3200$ microsteps per revolution. Each microstep then will give a rotation of approximately $.11^\circ$ instead of the normal 1.8° . The waveforms of motor current will be as in Figure 4-5.

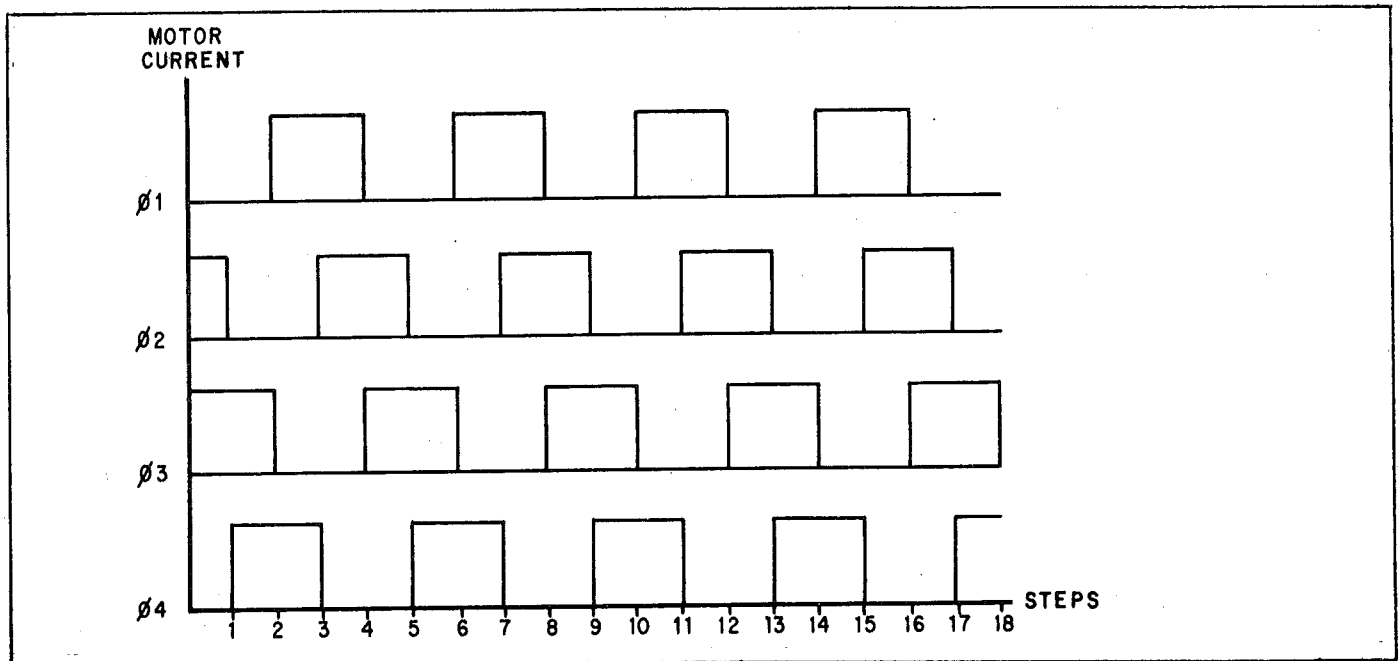


FIGURE 4-3 FULL STEPPING

4.5 STEPPER SYSTEM DESCRIPTION

The microstepping chart drive is implemented with an MPS 6502 microprocessor. The electronics resides on 6 printed circuit boards:

1. **Processor Board** - contains the processor system and the majority of the control electronics.
2. **Switching Amplifier Board** - contains the pulse width modulated power amplifier which actually drives the motor.
3. **Control/Timer Board 2000 Series Control Board** - contains event marker circuits, fuses and event marker timer.
4. **Power Supply Board** - contains system power supply voltages.
5. **Encoder Board** - contains optical sensor to verify chart motion.
6. **Speed Selector Board** - contains speed switches and remote interface.
7. **Software** - although the software resides on the chart control board, it will be treated as a functional block itself.

4.6 BLOCK DIAGRAM (STEPPER SYSTEM)

Refer to Figure 4-6.

System functions are determined by the processor system (1). The chart speeds are selected by the speed selector board (2), or the remote interface if enabled (3). The speed selector board puts out a 4 bit code which is read by the processor. The processor then monitors the step clock (4) to determine when a step should be taken. When it is time for a step, the processor updates the output to the amplifier (5) which drives the motor (8). If the speed selected was 200mm/sec., the processor will also monitor the motion detector (7) to insure that the chart is actually moving. A 10Hz signal is outputted to the event marker timer (6). This is derived from the master clock crystal (4MHz).

4.7 PROCESSOR BOARD (Refer to Schematic 293617)

The circuitry on the processor board is partitioned into several functional blocks. Each block can be discussed independently.

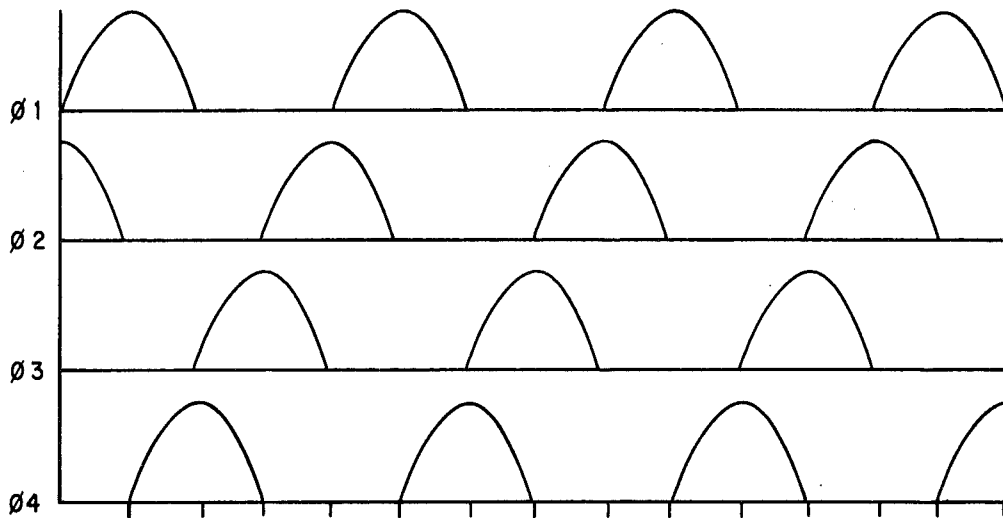


FIGURE 4-4 MICROSTEPPING

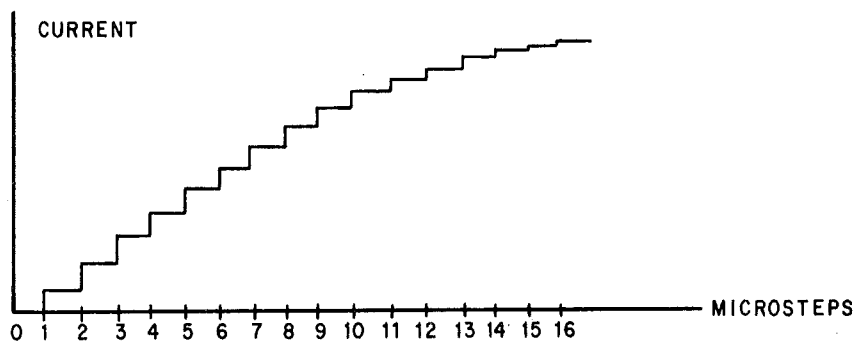


FIGURE 4-5 NORMALIZED PHASE CURRENT - 16 MICROSTEPS

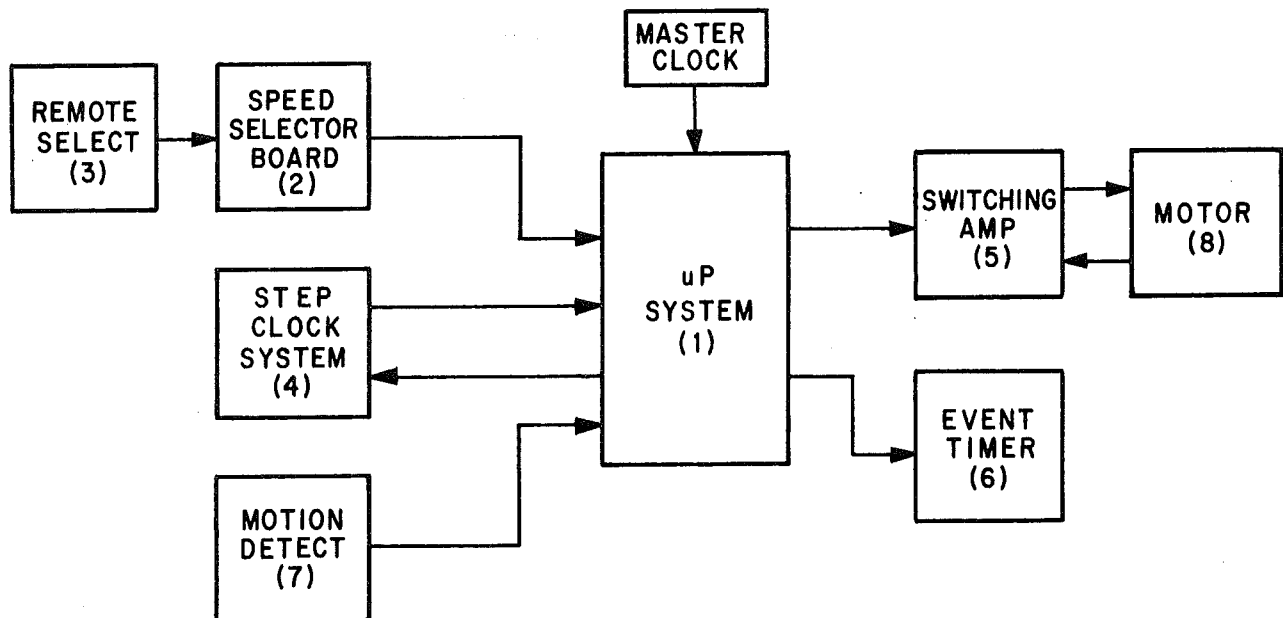


FIGURE 4-6 BLOCK DIAGRAM (OVERALL SYSTEM)

Processor System - the processor system consists of the microprocessor chip itself (U427), the scratch pad RAM (U429), the prom (U430), and the address decoders (U420, U415). The processor is the MPS 6502. U420 decodes the addresses for the RAM, ROM and I/O ports. Some I/O addresses are further decoded by U415. The enable pins on U420 (Pins 2 and 14) are driven by the ϕ_2 clock. In this way, all address strobes are properly synchronized for read/write operations without the need for further gating.

All addresses referred to are assumed to be hexadecimal for the purposes of this discussion. Hexadecimal numbers will be preceded with '\$'.

The RAM (U429) is divided into two independent halves. Addresses \$0000 thru \$003F are scratch pad locations used by the program. Locations \$0140 thru \$017F are the system stack. The two are separated by ignoring address bits A6 and A7, and using address bit A8 instead.

The prom (U430) is decoded at address \$7000-\$73FF. Since address bit 15 is ignored, addresses \$F000-\$FFFF will also select the prom, allowing the processor to fetch its vectors for reset, NMI, and IRQ. (See 6502 Processor manual for details).

The main I/O address decoder (U415) is divided into two halves. The high order select lines (pins 1 and 15) are wired to the R/W line. The two low order select lines (pins 3, 13) are wired to bits A0 and A1. The enables (pins 2, 14) are wired to address \$1000 (U420 pin 10). This chip decodes 8 port addresses, 4 of which are read only and 4 of which are write only. The exact port addresses and their functions are listed below:

ADR	U415 Pin No.	Function
\$1000R	7	D0-Stop Switch D6-External Pulse D7-Step Clock
\$1000W	9	Sine Data to Motor-D0-D6 D7-Sin Gate to Motor
\$1001R	6	D7-2X Step Clock D0-D6 Not Used
\$1001W	10	Cosine Data to Motor D0-D6 D7 COS Gate to Motor
\$1002R	5	D7-NMI Bit D0-D6 - Not Used
\$1002W	11	D0-D3 - Output Speed Select Code (See 3.1.4) D4-D7 Not Used
\$1003R	4	D0-D7 - Step Clock Period Counter to LO BYTE (See 3.1.3)
\$1003W	12	D0-D7 - Output to Step Clock Adjust DAC (U423)

I/O Functions decoded by U420 are as follows:

ADR	U420 Pin NO	Function
\$2000	11	D0, D1-HI - BYTE of step clock period counter. (See 3.1.3)
\$3000	12	D0-D7 Freq. Ref. Input Switch
\$4000	7	D7-Cal Switch D0-D6 Not Used
\$5000	6	Strobe used only; D0-D7 Not Used. Accelerates step clock.
\$6000	5	Available on socket XU430 for diagnostics

NOTE: All of the above except address \$6000 are read - only locations. The detailed operation of the processor will be explained in the following sections.

4.7.1 Step Clock System

The Step Clock is used to synchronize the chart speeds. The clock runs at the maximum stepping frequency (approx. 16KHz). All speeds are generated by counting step clocks.

The step clock system consists of U404, U409, U423 and half of U424, and associated discrete components. The clock is generated by U404, an LM331 voltage to frequency converter. Pin 7 of U404 is the input voltage control signal. U409 pin 6 is the summing point which builds this voltage. The reference voltage comes thru R406 from the variable speed pot and the 5V power supply. In addition, the processor is able to adjust this voltage, and therefore the clock frequency by writing data to U423, a digital to analog converter. This adjusting voltage appears at TP-1, and is scaled by R420, R416, and R414 so that a 1 LSB change on U423 gives no more than a 1 LSB change in frequency. The mechanics of this exchange will be explained in greater detail in the software section.

4.7.2 Step Clock Period Counter

This is actually part of the step clock system. The step clock period counter allows the processor to measure the step clock period using the 4MHz crystal as a reference. Then, if the period is incorrect due to time or temperature drift, the processor can adjust it using U423.

The counter consists of U411, U412, and U421. The processor reads the counter using U422 and U416 period latches to read the 10 bits of data.

The step clock appears on U411.3 and is divided by 2 by U411. The 4MHz oscillator is gated into the counter at U412.1. When U412.2 goes high, counting begins. U421 accumulates 4MHz clocks and overflows into U411.11. When U412.2 falls, counting stops, and the final count is latched into U422 and U416 by U411.6. One half step clock cycle later, U412.8 clears counters U421 and U411.13, and one half step clock cycle after that the process begins again. The processor reads the period by enabling address \$1003R. This strobes U422.1 low, enabling the tri-state buffers in the latch. The processor then reads address \$2000 to read the two hi order bits of the counter from U416.5 and U416.9 thru tri-state buffers U417.3 and U417.6, respectively.

Using this process, the data in the latches is always valid, and it is not necessary to check any status bits to determine when it is safe to read the counter.

At each transition of the step clock/2 signal, the processor determines whether or not to take a step. If it decides not to step, it then reads the step clock period, as above. If the step clock period is low, indicating the frequency is too high, the processor decrements U423 to bring it back down. If the period is high, U423 is incremented to bring the frequency up.

The correct period is determined by the processor and the step clock cal. reference switch (U238, S401). When the stop button is pressed, the processor reads the switch, and adds its value to hex \$0170 to build the reference period. This gives a range of \$0170 to \$026F giving a period of 46 to 77.8 USEC. The nominal period (switch setting \$80) is 62 usec. In this manner, the chart speeds can be trimmed to compensate for mechanical errors.

4.7.3 Speed Selector

The Speed Selector consists of U419 and U414. U419 is a 74LS95 shift register used as a quad latch output port. U414 is a 74LS85 quad magnitude comparator. The chart speed select codes come from the switch board and appear on U414 pins 1, 14, 11, and 9. If the code on the output port is different from that on the switches, the A=B output (pin 6) of U414 will go low. This pin is connected directly to the non-maskable interrupt (NMI) line of the processor U427 pin 6. A high to low transition on this pin causes an interrupt to the processor. The processor then abandons whatever it is doing and searches for the proper code to make $\overline{\text{NMI}}$ go high (it can read $\overline{\text{NMI}}$ thru U410.3). When it finds the code, it decodes it into a speed and then executes the new speed. See Table 4-2 for speed codes. The enable input (U414 pins 3, 4, 5) must be high or $\overline{\text{NMI}}$ cannot go high. This signal is brought low for either stop or interlock conditions. The strobe signal (J403-6) is used by the pen heat control circuit on the thermal unit to determine chart speed and set the proper pen heat.

CHART DRIVE SPEED CODES

TABLE 4-2

L101 (D3)	L102 (D2)	L103 (D1)	L104 (D0)	SPEED (MM/SEC)
0	0	0	0	STOP
0	0	0	1	.05
0	0	1	0	.1
0	0	1	1	EXT.
0	1	0	0	.25
0	1	0	1	.5
0	1	1	0	1
0	1	1	1	2
1	0	0	0	STOP
1	0	0	1	5
1	0	1	0	10
1	0	1	1	EXT.
1	1	0	0	25
1	1	0	1	50
1	1	1	0	100
1	1	1	1	200

4.7.4 Motor Drive Outputs

The motor drive outputs come from U418, U425, and U426. U425 and U426 are DAC's which the processor uses to generate the sin and COS signals for the switching amplifier. The code is 7 bit binary. Bit 0 (LSB) of the DAC is grounded (logical 0). The 8th bit is latched by the two halves of U418 to provide the sin gate and COS gate. The sin and COS signals are full wave rectified. The two gate signals direct the sin and COS to the proper motor coil. All 4 signals come from a look-up table in the ROM.

4.7.5 Chart Motion Detection

This section consists of U408 and U403. An optical detector (U402) is set up to give 8 pulses per motor revolution. These pulses are synchronized to step clock by U403. U403 is an NE555 timer wired in the retriggerable mode. The time constant is about 150msec. as long as encoder pulses arrive at a sufficient rate to keep the timer triggered, the output on U403-3 will be high. If pulses stop arriving, the 555 times out and U403-3 drops low causing an $\overline{\text{TRQ}}$ interrupt to the processor. This interrupt is masked by the software so that it is ignored by the processor for any speed except 200mm/sec. At this speed, however, the chart must be accelerated gradually. If the chart should stop for any reason, the $\overline{\text{TRQ}}$ informs the processor to re-accelerate. It does this by shorting C404, which then charges again exponentially, causing the control voltage on the VCO to do the same. The signal that shorts C404 also retriggers U403, allowing 150msec for the chart to build up enough speed to keep $\overline{\text{TRQ}}$ high.

4.7.6 Power On/Failsafe Reset

This circuit consists of U401A. The power-on reset is generated by CR405, R402, and C403 thru pin 4 of U401A. The failsafe reset is triggered by address bit 15 at U401A-12. If for any reason (line noise particularly) the processor should "bomb", its characteristic mode of failure is to go to address \$FFFF and halt. This causes A15 to be high. If this occurs for more than one step clock period (62 μ sec.) step clock will set U401A-9. On the next positive transition of step clock, U401A-6 will go low causing a failsafe reset which will re-start the processor. The effect on the chart is a momentary interruption, or 'Hiccup', however, no catastrophic failure will occur (i.e. chart will not stop for good).

4.7.7 Switching Amplifier Board (Refer to schematic 293618)

The switching amplifier board delivers the analog sine waves to the motor to make it move. This is a unipolar pulsewidth modulated amplifier with four outputs - one for each coil. This board consists of four sections - the sawtooth generator, the error amplifier, the pulse width modulator, and the power section.

The basic theory is to modulate the current in the motor coil by driving it with pulses of constant amplitude and frequency and varying pulse width or duty cycle. This allows an analog current waveform in the motor without the heat generated by an analog power amplifier.

4.7.8 Sawtooth Generator

This section consists of current source U501 pins 1, 2 and 3, Q509 and R503; and voltage comparator U502 pins 9, 8 and 14, Q510, and Q511. The current source develops a constant current at the collector of Q509 of approximately 1.88ma causing C503 to charge in a linear fashion. When the voltage across C503 reaches the reference voltage of the current source (approx. 10V) U502-14 will switch high causing Q510 to short out C503 bringing the voltage toward zero. U502-14 also turns on Q511 causing the voltage at U502-8 to drop to 0V + 1 diode drop. When C503 gets lower than U502-8, U502-14 switches low again allowing C503 to recharge. The net result is a linear sawtooth signal at about 10V peak and about a 20KHz rate. This sawtooth is the reference for the pulse width modulator.

4.7.9 Pulse Width Modulator and Error Amplifier

There are two pulse width modulators and two error amplifiers — one for coils $\emptyset 1$ and $\emptyset 3$ and one for coils $\emptyset 2$ and $\emptyset 4$. The error amplifiers compute the difference between the input voltage and the output current as sensed at R558 and R531, and send the error signals to U502-11 and U502-5, respectively. U502 is a quad voltage comparator. The reference signal appears at U502-10 and U502-4 respectively. Since the operation of both circuits is identical, only one will be described.

When the sawtooth reference drops to 0 volts, the input at pin 11 of U502 is greater than pin 10, and the output at U502-13 goes high, turning on the output transistor Q501 or Q503. This situation continues until the ramp reaches the voltage at U502-11. U502-13 then goes low, turning the output off again. Since the ramp is linear, the amount of time the output is on will be proportional to the size of the error signal, thus giving the pulsewidth modulation.

4.8 POWER SECTION

The power section is constructed in two halves — one half drives coils $\emptyset 1$ and $\emptyset 3$, and the other drives $\emptyset 2$ and $\emptyset 4$. Since both halves are identical only $\emptyset 1$ and $\emptyset 3$ will be discussed.

The pulse width modulated input is that of a full-wave rectified sine, and the cycles alternate between $\emptyset 1$ and $\emptyset 3$. The sin gate determines which phase is driven on a given cycle. If sin gate is high U503.7 is low turning off U506.1, and allowing the PWM signal to drive U505.1 and, ultimately Q501 or $\emptyset 1$. U503.14 will be off turning on U506.14 and shorting PWM to U505.14 turning Q3 and $\emptyset 3$ off. Furthermore, U504.1 will be on turning U505.7 on which turns Q502 on and puts catch diode D505 in the circuit. This diode swallows the inductive transients from the motor winding and must be present when the coil is driven. However, coils $\emptyset 1$ and $\emptyset 3$ form A 1:1 transformer so the catch diode must be disconnected when the coil is not driven or a current path exists for induced current causing heating and loss of power in the motor. This is the function of Q502 and Q504.

Operation of the circuit is swapped when sin gate is low, i.e. Q503 and Q504 are on and Q501 and 502 are off.

4.8.1 Control/Timer Board (Refer to schematic 294131)

This board provides fusing for the system. It is also responsible for turning the ink solenoid, the drive amplifiers, and the event markers on and off. This is accomplished thru relay K701. The relay common is interrupted if the stop button is depressed, or if the interlock lamp is on (paper out). This opens the relay, and pins 7, 8 open the event marker ground. This ground is also used by the optoisolators on the drive amplifiers to enable the output stages. Pins 4 and 5 of K701 interrupt ac to the ink solenoid.

The event marker timer is formed by U101, U102, U103, U104 and S101. This circuit is simply a counter chain giving various repetition rates depending on which of the six switches in S101 is closed. The settings are as in Table 4-3.

TABLE 4-3

REPETITION RATE	SETTINGS	
	SW ON	SW OFF
.1 SECOND	1, 3	2, 4, 5, 6
1 SECOND	1, 4	2, 3, 5, 6
10 SECOND	1, 5	2, 3, 4, 6
100 SECOND	1, 6	2, 3, 4, 5
.01 MINUTE	2, 3	1, 4, 5, 6
.1 MINUTE	2, 4	1, 3, 5, 6
1 MINUTE	2, 5	1, 3, 4, 6
10 MINUTE	2, 6	1, 3, 4, 5

4.8.2 Power Supply Board (Refer to schematic 293619)

The power supply board generates the voltages used by the chart drive system. The voltages are:

1. +22V unregulated @ 8a
2. +5V regulated @ 600ma
3. -5V regulated @ 20ma
4. +12V regulated @ 20ma
5. +15V regulated @ 70ma
6. -15V regulated @ 80ma

There is also a relay to interrupt the +5V and +22V if a paper out condition occurs. (K301)

4.8.3 Optical Sensor Board (Refer to schematic 294133)

The optical sensor board provides gross motion detection to the processor. The motor damper has eight non-reflective lines on it. The optical sensor monitors these lines, and outputs a pulse from its buffer transistor each time one is detected. If they arrive at too low a rate, the logic on the chart control board will interrupt the processor. This interrupt is ignored unless the selected chart speed is 200mm/sec.

4.8.4 Speed Selector (Refer to schematic 293620)

The switchboard contains the speed selection logic. The two multiplexers on the board (74LS157) select either the front panel switches, or the rear panel remote connector.

The select line for the mux is high for local and low for remote, and is driven from the rear panel. The four signals L101, L102, L103, L104 are the chart speed code. The code is listed in Table 4-4.

TABLE 4-4 REMOTE SPEED CODES
LOGICAL 0 = 0V LOGICAL 1 = 5V

L102	L102	L103	L104	SPEED
0	0	0	0	STOP
0	0	0	1	.05MM/SEC.
0	0	1	0	.1MM/SEC.
0	0	1	1	EXT. PULSE (See Note 1)
0	1	0	0	.25MM/SEC.
0	1	0	1	.5MM/SEC.
0	1	1	0	1MM/SEC.
0	1	1	1	2MM/SEC.
1	0	0	0	STOP
1	0	0	1	5MM/SEC.
1	0	1	0	10MM/SEC.
1	0	1	1	EXT. PULSE
1	1	0	0	25MM/SEC.
1	1	0	1	500MM/SEC.
1	1	1	0	100MM/SEC.
1	1	1	1	200MM/SEC.

NOTE 1: Code 0011 corresponds to ext. ÷ 100. This code could possibly be given special functions on an NSP basis.

The stop signal (pin 19) is used by the chart control board to generate a reset to the processor. In local mode, it comes from the stop switch thru U604 pin 3. In remote it comes from U601-6 when the proper code for stop is present on $\overline{S2}$, $\overline{S3}$ and $\overline{S4}$. The relay signal (pin 14) turns on relay K701 on the control board. If Q602 is off, the relay is off, interrupting the event marker ground and turning off the drive amplifiers and ink solenoid. Thus Q602 is turned off by either a stop condition, paper out condition, removal of the remote link, or grounding the stop pin (pin C). In local mode, the stop condition is sensed thru U604-13 from the stop switch. In remote, it is thru U601-8 in conjunction with U601-6. The enable signal (pin 5) controls the magnitude comparator on the chart control board. If a paper out condition occurs, K701 on the control timer board opens, interrupting the event marker ground (pin 6) and allowing Q601 to turn on and ground enable. The processor then is unable to find a speed, and the chart stops.

4.8.5 Thermal Writing

The thermal writing recorders also have a pen heat control circuit. The purpose of this circuit is to heat the pens proportionally with chart speed, giving more even trace density.

The strobe out signal (U607-3) is integrated by R634 and C606. Since this signal is a pulse of constant width and varying frequency, the dc voltage at C606 will be proportional to the frequency of strobe out and therefore to chart speed.

The ac ref. signals (pins y and z) are rectified by CR607. The comparator U606 will give a negative pulse out whenever the rectified ac ref. approaches ov. The result is a 120Hz pulse train synchronized to the ac line. When this pulse is low Q605 turns on shorting C605 to +15V. When the pulse goes back high C605 begins to charge toward -15V at a rate determined by R631, generating a negative-going ramp. When the value of this ramp as seen at comparator U606-10 is less than the integrated chart speed voltage at U606-11, U606-13 will go high. The leading edge of this pulse is passed to Q607 by C607 turning on opto-isolator U605. This in turn turns on Q604 causing gate current to flow in triac Q606. Q606 turns ov, causing ac current to flow in the pen heat transformers.

4.8.6 Software

The system software is broken up into three basic modules:

Speed decode/select, speed generation and step clock frequency tracking. The latter two modules are active concurrently and the former is active only when a speed change occurs or when the recorder is stopped.

The starting address of the software is \$7000. (Refer to flow charts)

4.8.7 Speed Select/Decode

All the chart speeds are selected by counting the step clock/2 signal. The speed decode software reads the speed code, and converts it into an index. It then reads from ROM the number of step clocks to ignore before taking a step using the index as a pointer to a look up table. These values are stored in two locations of scratch pad RAM for use by the speed generation routines (locations fact1 and consth, constl). Refer to Figure 4-7 flow chart for operation of this module.

Whenever the speed is changed, the hardware generates an interrupt. (NMI on Figure 4-7). The processor outputs a 0000 to U419 and checks the NMI to see if that is the right code. If it is, it goes to the decode routine flow chart, Fig. 4-8). If it is not, it increments the code on U419 and checks again. This process repeats until the correct code is found, or until all possibilities are exhausted. In the latter case, the processor returns to the stop routine (point (A) Figure 4-7). Here, the frequency is checked. If NMI is still true the processor returns to the switch decode routine, and repeats the entire process. This will happen if the enable line is 0, which occurs for stop, remote link out, remote stop true, or interlock.

The speed decoder (Figure 4-8 point (B)), uses the switch setting established by U419 to generate the correct speed. The speed code is put in the index register. This number is decremented and multiplied by 2 to give a compact, efficient structure to the speed look up table. The index register is now the pointer to this table. The processor fetches the correct speed constants from the table using an indexed load, and stores them twice in RAM. Each constant is two BYTES and represents the number of step clocks to count before stepping. One constant is decremented to zero by the speed routine and the second restores the first.

Certain speeds are handled as special cases, and these are shown at the end of Figure 4-8.

At this point, the constants have already been loaded, so the index register has been incremented once from its original number. If it contains a \$5 or \$15, this indicates that the external step mode is to be enabled. If it contains a \$18, the speed is 100mm/sec, which is a special loop. If it contains a \$10, the speed is 200mm/sec. which is a special loop. If it contains a number greater than \$10, the code is invalid, and we return to the stop routine, and eventually attempt to re-decode it. If none of the above is true, the speed is between .05 and 50mm/sec and we go to the general speed loop (Figure 4-9, point (F)).

4.8.8 Speed Loops

1. General Speed Loop (Flow Chart, Figure 4-9)

For this loop, the Y index register holds the lo-order BYTE of the speed constant, and the hi-order BYTE is in memory. The processor waits for step clock to go low. When it does,

the Y register is decremented and compared to zero. If it is not zero, the processor goes to the frequency check subroutine (point G, Figure 4-9), and then returns to wait for step clock to go high again.

If Y was zero, the processor decrements the order BYTE of speed constant and compares it to zero. If it is not zero, as above we check the frequency and repeat.

If hi-BYTE is zero, then the processor steps the motor, and restores hi and lo BYTE constants.

To take a step, the processor must update the sin and cos signals on U425 and U426 respectively. The sin and cos lookup tables are interleaved in a 256 BYTE section of memory. Using the index register x as a pointer, the processor fetches the data with an indexed load.

2. 100mm/sec Speed Loop

This loop operates like the general loop except that a step is taken on each hi to lo transition of step clock. This eliminates the requirement for counting clocks and comparing counts, giving the processor sufficient time to adjust frequency at every step.

3. 200mm/sec Loop

This loop is as above, except that at every hi to lo transition the processor advances two entries through the sin/cos look up table, reducing the micro steps to 8 and effectively doubling the motor speed.

4. External Loop

This loop steps the motor at each hi to lo transition of the external input. Frequency is not checked or adjusted.

4.8.9 Frequency Adjust Routine (flow chart Figure 4-10)

The frequency adjust routine allows the processor to monitor the step clock frequency and adjust it to eliminate time or temperature drift. This routine uses the period counter and the freq. adjust dac (U423). The lop also effectively averages readings to compensate for noise and to prevent oscillations about the center frequency.

First, the processor checks the switch on the variable speed pot. If this is open, the recorder is in variable speed mode and nothing else is done; the processor returns.

If the switch is closed, the frequency is adjusted. The adjustment dac is 8 bits wide, however the processor maintains a 16 bit number to control it. Only the 8 most significant bits actually go out to the dac. The low order 8 bits are initialized to \$80.

The processor then reads the period counter's hi BYTE and compares it with the hi BYTE of the period reference established the last time the stop button was hit. If the two are equal, then the period counter's lo BYTE is read and compared to the period reference lo BYTE. In either case if an inequality occur the direction of inequality is established. If the frequency is hi, the DAC must be decremented. If it is lo, the DAC must be incremented.

Both the increment and decrement routines work the same way, so only the increment routine will be discussed.

First, the low BYTE of DAC is incremented. If this generates a carry (i.e. the register overflowed from \$FF to \$00), then the hi BYTE is incremented and output to the DAC. Also the low BYTE is re-initialized to \$80. This way, the frequency must be in error 128 (\$80) readings in a row in the same direction before the DAC actually changes. This gives a filtering effect which insures that the VCO is able to settle to its final value before it is changed again.

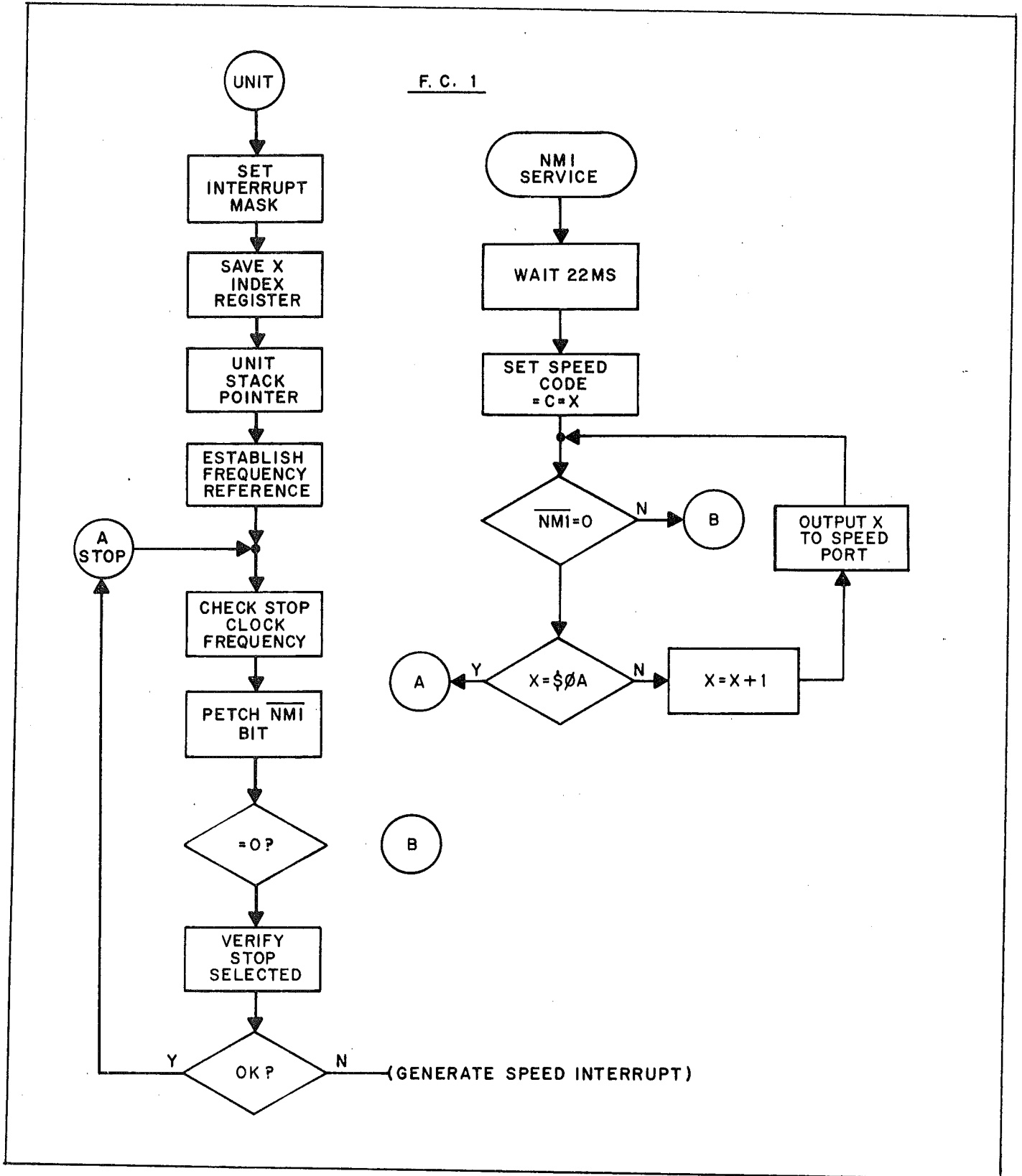


FIGURE 4-7 SPEED FLOW CHART

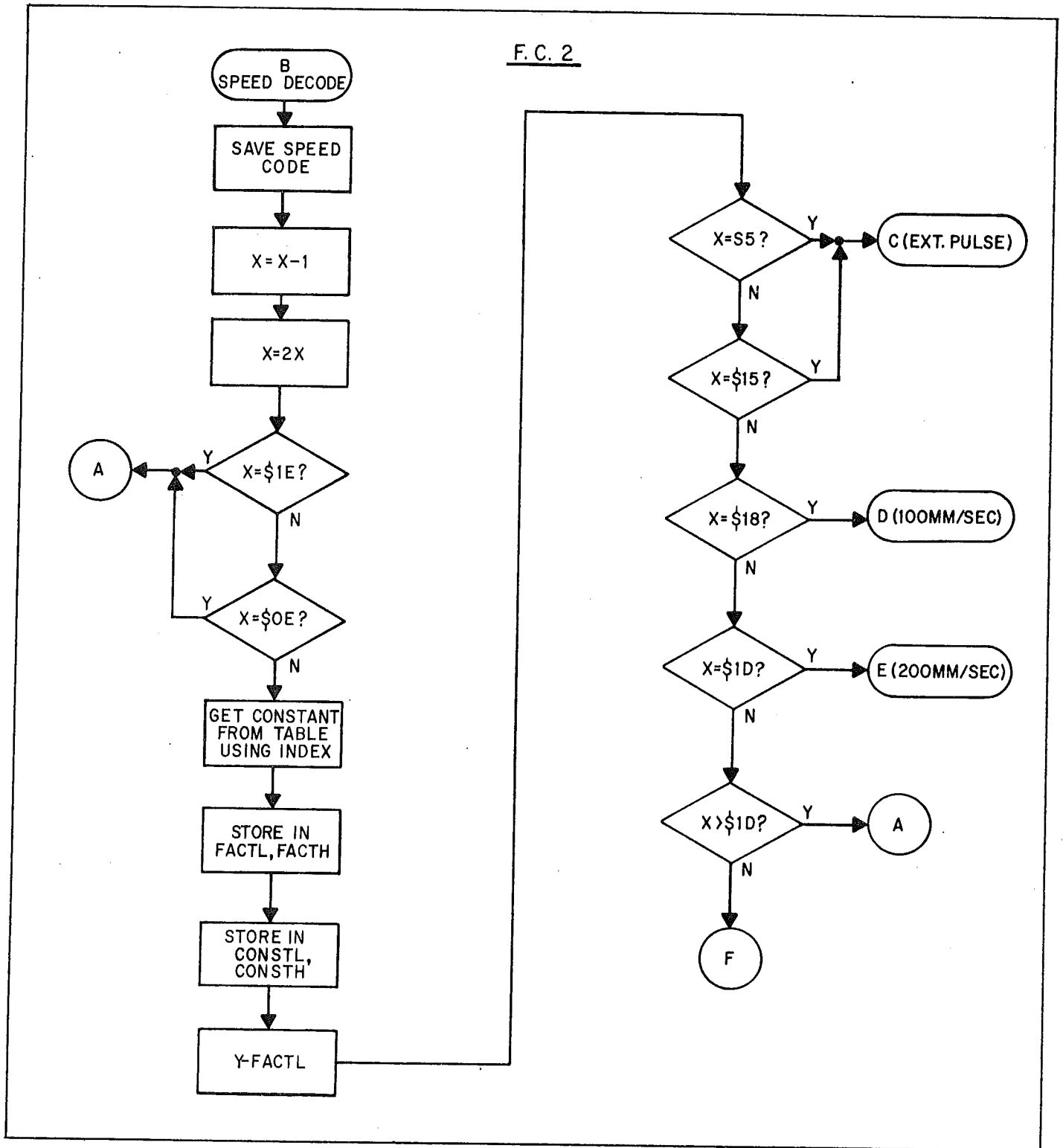


FIGURE 4-8 FLOW CHART DECODE ROUTINE

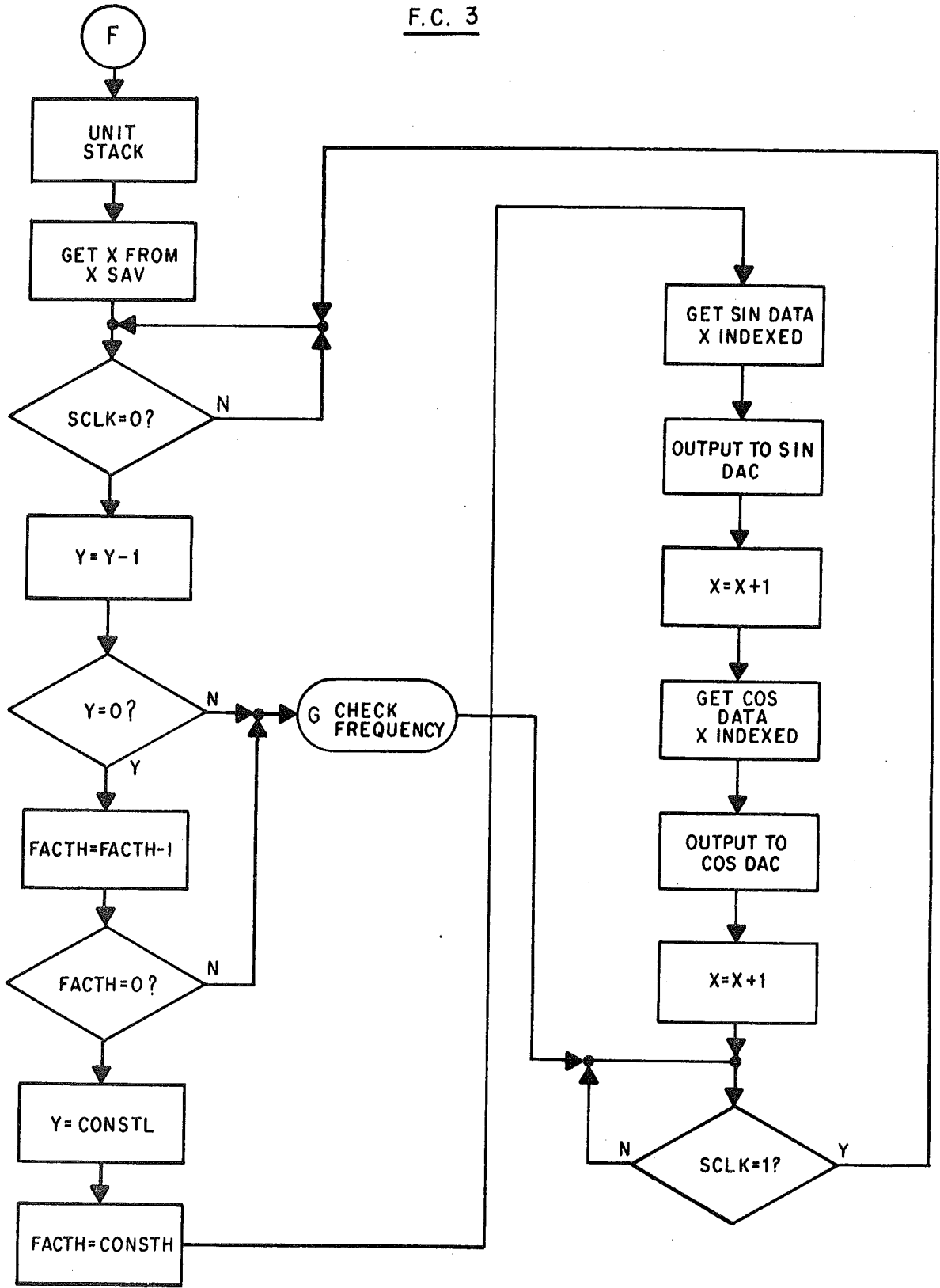


FIGURE 4-9 FLOW CHART GENERAL SPEED LOOP

FLOW CHART NO.4 FREQUENCY ADJUST

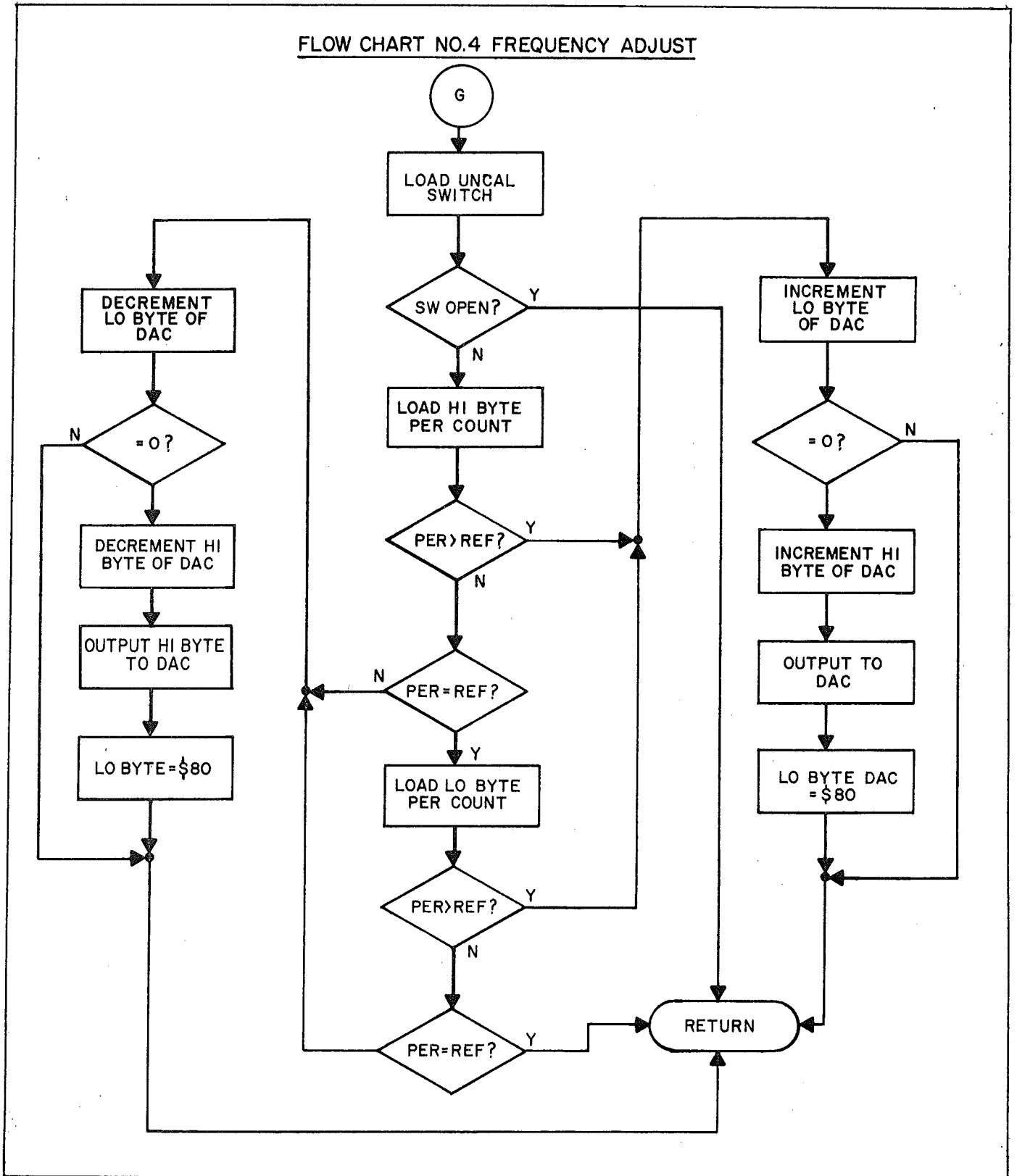


FIGURE 4-10 FLOW CHART FREQUENCY ADJUST ROUTINE

SECTION V MAINTENANCE

5.1 INTRODUCTION

This section contains paragraphs describing operation maintenance, preventative maintenance, calibration, troubleshooting, and subassembly replacement. Operative maintenance generally refers to maintaining materials regularly consumed in operation, i.e., paper and ink. Preventative maintenance consists of cleaning, lubrication, and periodic inspection.

5.2 OPERATIVE MAINTENANCE

5.2.1 Chart Paper Replacement

WARNING: BEFORE ATTEMPTING TO REPLACE CHART PAPER TURN POWER OFF AND DISCONNECT RECORDER FROM POWER SOURCE.

1. Grasp pull bar (Figure 5-1) and open writing table.

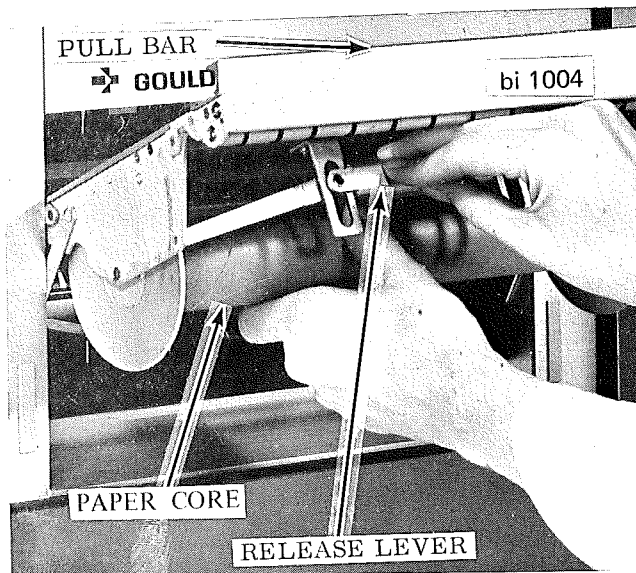


FIGURE 5-1 PAPER ROLL REMOVAL

2. Hold paper supply roll and pull down on paper supply release lever. Remove paper supply roll.
3. Unscrew right flange from paper supply roll. Remove and discard core (Figure 5-2).
4. Slide new paper roll onto supply shaft. Make sure notches in paper core align with guide pins on left flange and paper edge is facing forward and down.

5. Screw right flange onto supply shaft until it is snug against paper edge.
6. Insert paper roll into writing table assembly. Push release lever up to lock into position.

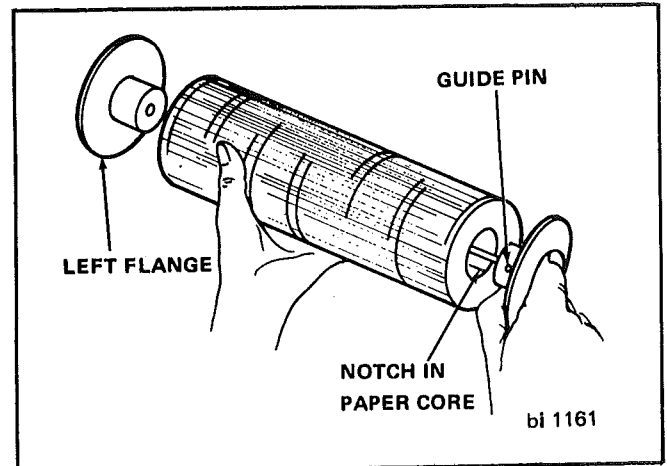


FIGURE 5-2 CHANGING CHART PAPER

CAUTION: MAKE SURE SHAFT IS SEATED PROPERLY AND ROTATES FREELY. USE CARE WHEN THREADING PAPER SO NOT TO DAMAGE PENS.

7. Refer to Figure 5-3. Feed paper over writing bar, down through slot between pull bar and drive roll, around pressure roll, and out to front of writing table assembly.
8. Slowly close writing table while gently pulling on chart paper. When friction resists rotation of paper roll, pull paper taut and center, and close writing table assembly. Make sure table is completely closed.
9. Turn recorder on and run out about two feet of chart paper at 100mm/sec to align on writing table.

5.2.2 Ink Cartridge Replacement

The ink supply, dependent on use, should be sufficient for about one year. When ink cartridge replacement becomes necessary, recorder must first be removed from its case in portable models or slid out of cabinet in rack mount models. To slide unit out of cabinet, remove 4 screws from panels along left and right front sides of recorder. Recorder will slide out of cabinet.

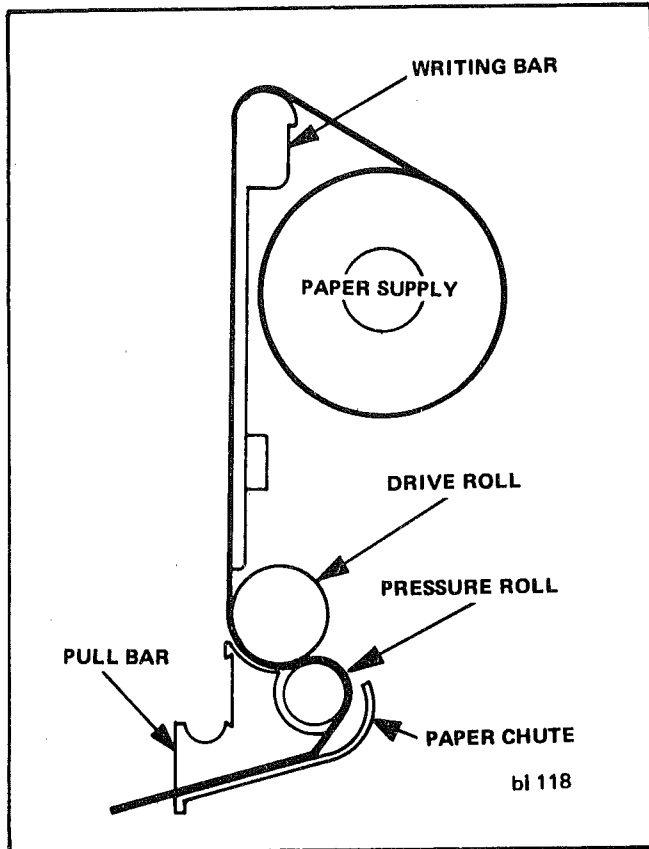


FIGURE 5-3 PAPER THREADING DIAGRAM

To remove recorder from case (portable models) and change the ink cartridge (portable or rack mount models) use the procedure that follows.

CAUTION: EXERCISE CARE WHEN REMOVING RECORDER FROM CASE SO AS NOT TO DAMAGE PRINTED CIRCUIT BOARDS MOUNTED ON BOTH SIDEPLATES.

1. Remove front and rear slide covers from top of case by sliding front cover toward front of recorder and rear cover toward rear of recorder.
2. If recorder is equipped with preamplifiers disconnect preamp cage connector from recorder connector. (See Figure 5-4 for location.)
3. Pull case handle up. Remove 2 screws directly over recorder.
4. Turn case on one side or back. Remove 5 screws from bottom of case directly under recorder.
5. Turn case upright. Slide recorder out from FRONT of case. Push from rear and/or pull

from side plates. Do not pull from top front of recorder or chart take-up.

6. Ink cartridge is attached to ink plunger assembly located on top of recorder (See Figure 5-4).
7. Observe large hole or slot. Activating screw is located under hole. Turn screw clockwise until spring in ink plunger is drawn up tight.
8. Turn ink off at solenoid valve and slide bar on manifold. Follow direction of arrows.
9. Remove hardware holding ink plunger assembly to top bracket assembly (Figure 5-4). Carefully pull ink plunger assembly (with ink cartridge) straight up and out of recorder. Retain hardware.
10. Place paper towel under ink tubing where it is connected to bottom of ink cartridge. Carefully pull ink tubing off ink cartridge.

CAUTION: DO NOT USE TOOLS WHICH COULD GOUGE OR CUT THE INK TUBING.

11. Unscrew ink cartridge from plunger assembly and discard (Figure 5-5).
12. Remove piston retainer from replacement cartridge and discard (Figure 5-5).
13. Screw new ink cartridge onto ink plunger assembly and tighten firmly.
14. Remove shipping cap from ink cartridge and discard (Figure 5-5).
15. Install ink tube on ink cartridge.
16. Attach ink plunger assembly (with ink cartridge) to top bracket assembly with exiting hardware.
17. Turn activating screw counterclockwise until snug to pressurize ink systems. Turn ink on at solenoid valve and slide valve on manifold following directions of arrows. Check system for leaks.
18. Install recorder back into case or cabinet in reverse order of disassembly.

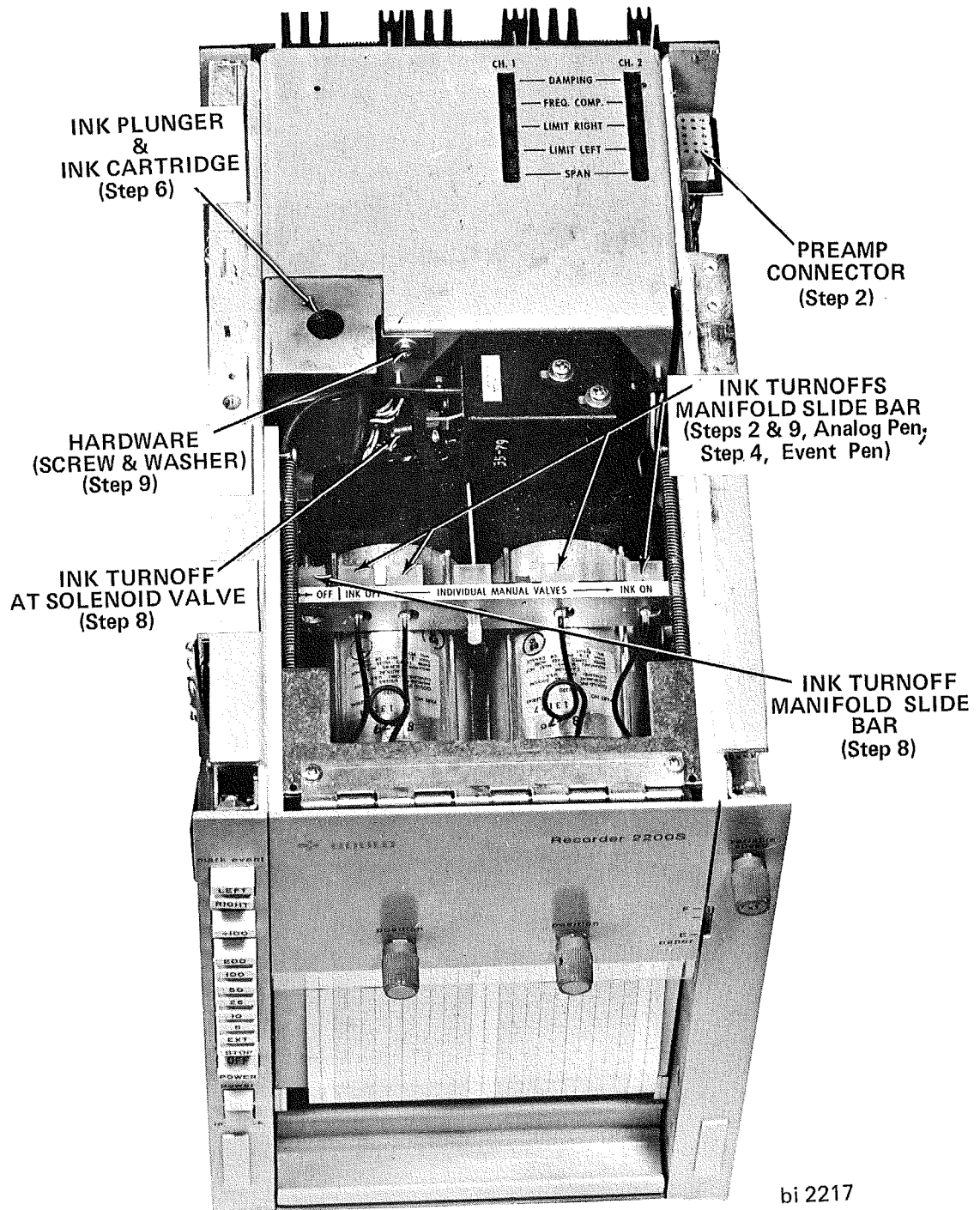


FIGURE 5-4 RECORDER, TOP VIEW

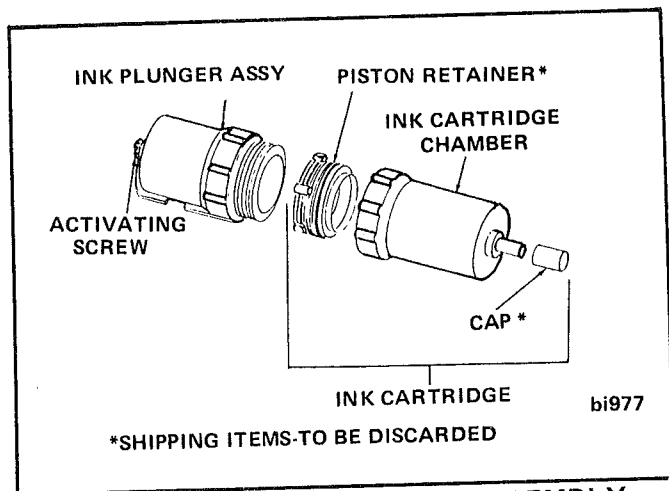


FIGURE 5-5 INK CARTRIDGE ASSEMBLY

5.2.3 Pen Replacement

Pens should only be replaced when excessively worn or broken. Replacement should be performed only by personnel who are familiar with the recorder. Replace and adjust one pen at a time.

CAUTION: POWER IS TURNED OFF.

a. Analog Pen

NOTE: Analog Pen part number is Model 11-2823-42. Ink tubing is included with pen.

1. Remove top front cover from recorder. (Slide cover forward and lift out.) This gains access to individual manual valves.
2. Slide ink valve of pen to be changed to "OFF" position. Follow direction of arrows on manifold bar. (See Figure 5-4).

CAUTION: DO NOT PERMIT INK TO SPILL ON RECORDER COMPONENTS. PLACE PAPER TOWELS AROUND AREA.

3. Carefully remove ink tube from manifold valve nipple. Wipe excess ink from nipple.
4. Raise pen access cover by pulling out on bottom and sliding back into recorder. Cover will be parallel with top of recorder.
5. Raise front of cover with one hand and carefully remove ink tube from pen with other hand. Discard ink tube.
6. Loosen two screws (do not remove) which secure pen to drive arm and carefully slide pen off in downward motion. (Figure 5-6).

NOTE: If pen does not readily slide off, it may be necessary to loosen pen pressure adjustment screw also.

7. Carefully slide new pen onto drive arm. Snug the two screws to secure pen. (Pen should be perpendicular to writing surface.)
8. Install new ink tubing between valve nipple and pen.
9. Slide ink valve to "ON" position. Follow direction of arrows on manifold bar.
10. Turn recorder ON and run at a chart speed of 5mm/sec.
11. Carefully lift pen slightly and allow ink to bleed through pen tip.
12. Shut down recorder.
13. Gently grasp pen near top and move it across entire channel. If trace is not parallel to a horizontal line and/or pen is not on same line as other pens, turn pen in screw slots and slide pen vertically. Tighten screws.
14. Lap pen per paragraph 5.3.4 if necessary.
15. Measure pen pressure per paragraph 5.3.3.

b. Event Marker Pen

NOTES:

1. Use steps 1 thru 5 from paragraph 5.2.3a, Analog Pen, for changing Event Marker Pen.
2. Event marker Pen number is 267884-5; ink tubing P/N is 667447-1.
1. Loosen two screws (do not remove) which secure pen to bracket assembly and carefully slide pen off in downward motion (Figure 5-6).

NOTE: If pen does not readily slide off, it may be necessary to loosen pen pressure adjustment screw also.

2. Carefully slide new pen between pen pressure bracket and bracket assembly. Snug the two screws to secure pen. (Pen should be perpendicular to writing surface.)
3. Install new ink tubing between valve nipple and pen.

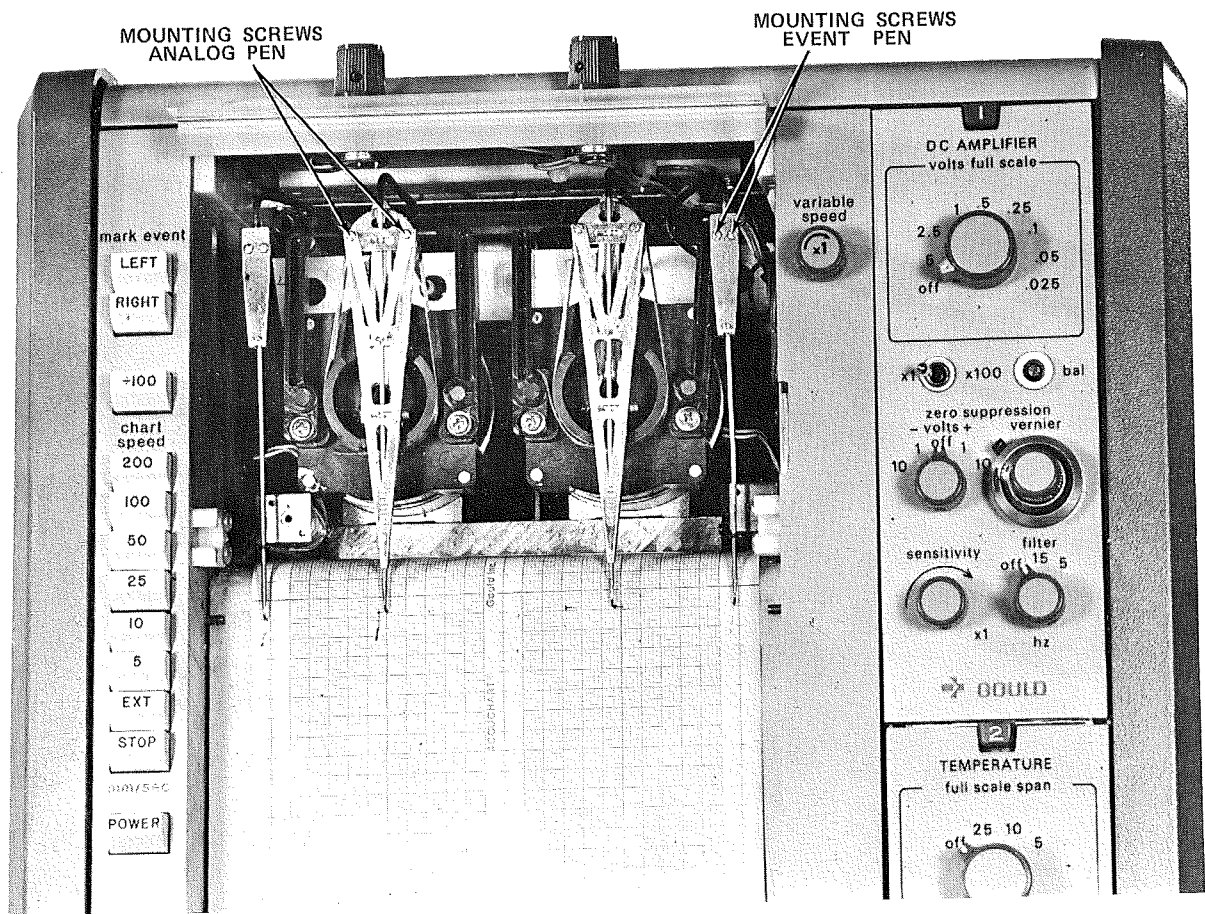


FIGURE 5-6 PEN REPLACEMENT

bi 2218

4. Slide ink valve to "ON" position.
5. Turn recorder ON and run at a chart speed of 5mm/sec. Adjust pen ZERO to set pen on event gridline.
6. Carefully lift pen slightly and allow ink to bleed through pen tip.
7. Shut down recorder.
8. If pen tip is not on same line as other pens, loosen screws and slide pen vertically. Tighten screws.
9. Lap pen per paragraph 5.3.4 if necessary.
10. Measure pen pressure per paragraph 5.3.3.

5.2.4 Fuse Replacement

WARNING: BEFORE ATTEMPTING TO REPLACE FUSES TURN POWER OFF AND DISCONNECT RECORDER FROM POWER SOURCE.

All fuses are located on the Control/Timer Board Assembly. The board is a plug-in module accessible from the rear panel. (See Figure 5-7.) The Control Board is easily distinguished from the other boards because a timer switch is mounted on its heat sink. Remove the top and bottom screws which secure the board to the recorder and remove the board by grasping the heat sink and pulling it out and away from the recorder. All fuses are located near the top of the Control Board. Table 5-1, which follows, defines usage of all fuses.

TABLE 5-1 FUSE TABLE

FUSE SYMBOL	* MODEL, AMP-RATING & PART NUMBER				CIRCUIT PROTECTED
	-00 (115V)	-01 (100V)	-06 (230V)	-07 (200V)	
F-701-F-708	3/4 Amp 116198-9	1 1/2 Amp 116198-11	3/4 Amp 116198-9	3/4 Amp 116198-9	Pen-Drive
F-709	1 Amp 116198-10	1 1/2 Amp 116198-11	1/2 Amp 116198-8	3/4 Amp 116198-9	Chart-Drive
F-711	1/4 Amp 116198-6	1/4 Amp 116198-6	1/8 Amp 116198-4	1/8 Amp 116198-4	Ink Solenoid

* Frequency for all models is 50/400Hz.

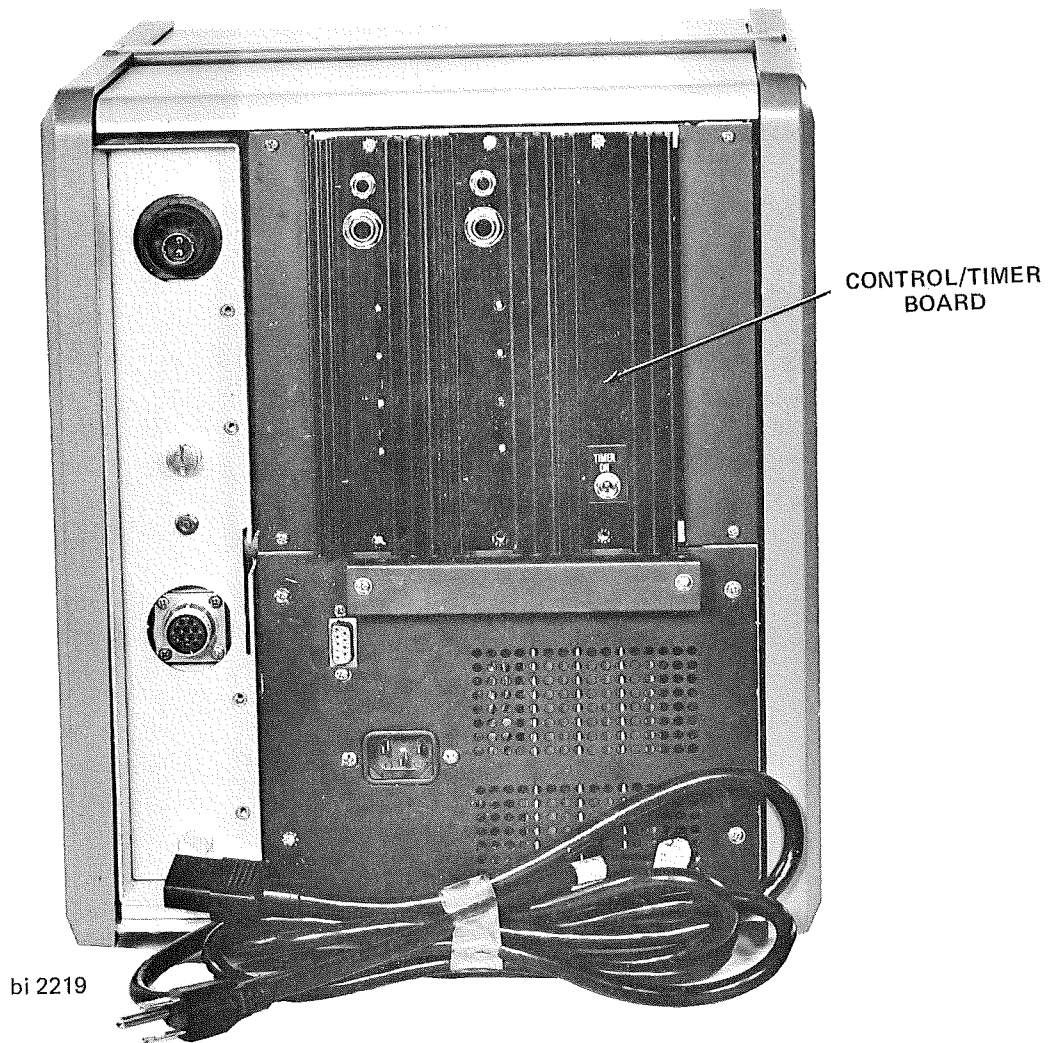


FIGURE 5-7 RECORDER, REAR VIEW

5.3 PREVENTATIVE MAINTENANCE

5.3.1 Recorder Cleaning

a. General Cleaning

CAUTION: AVOID USE OF CHEMICAL CLEANING AGENTS WHICH MIGHT DAMAGE PLASTIC OR PAINTED SURFACES. DO NOT USE CHEMICALS WHICH CONTAIN TOLUENE, ACETONE, OR SIMILAR SOLVENTS.

EXTERIOR: Remove loose dust with a soft cloth or small paint brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

INTERIOR: Dust in recorder interior should be removed occasionally due to its electrical conductivity under high-humidity conditions. Blow off accumulated dust with dry, low-pressure air. Remove any dirt which remains with a soft paint brush or a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or printed circuit boards.

b. Ink Removal

NOTE: The recommended ink remover is ANCHOR HAND CREAM, No. 25 obtainable from Anchor Office Supply Company of Cleveland, Ohio.

1. Blot up any excess ink with a tissue or paper towel.
2. Apply ink remover to the inked area ONLY. DO NOT attempt a general cleaning.
3. Gently rub the area with a soft cloth until the ink spot is removed.
4. Wipe the area thoroughly with a damp cloth.
5. Allow cleaned area to dry at least ten minutes before using recorder.

5.3.2 Pen Cleaning

Intermittent, missing, or faint traces may be indications of a clogged pen. The following cleaning procedure is intended as a guide, but may not always prove effective. Access to individual manual valves is required.

1. Turn recorder OFF.
2. Slide ink valve of pen to be cleaned to "OFF" position. Follow arrows.
3. Remove ink tubing from manifold valve nipple.
4. Remove pen (Paragraph 5.2.3a or 5.2.3b).
5. Modify No. 18 hypodermic needle per Figure 5-8.
6. Attach modified needle onto 2cc hypodermic syringe.
7. With syringe plunger depressed, insert needle in pen tubing.
8. Immerse pen tip in cleaning agent (Isopropyl Alcohol, Cell-O-Solve or equivalent.)
9. Back-flush by slowly withdrawing syringe plunger.

NOTE: It may be necessary to allow the pen to remain for a brief period in the cleaning agent to dissolve dried ink at pen tip.

10. Install pen (para. 5.2.3a or 5.2.3b).

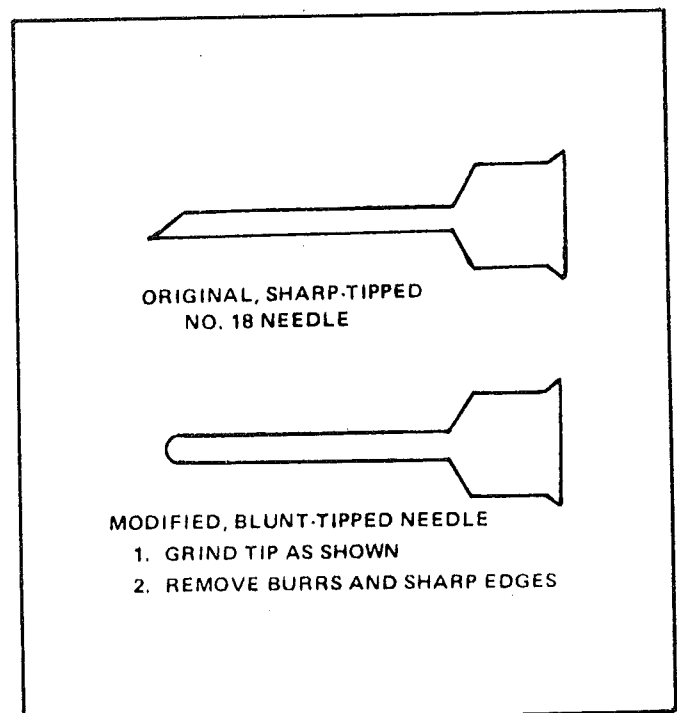


FIGURE 5-8 HYPODERMIC NEEDLE MODIFICATION

5.3.3 Pen Pressure Measurement

Analog or event marker pen pressure should be checked after replacement, if the ink trace is excessively wide (bleeding), indicating low pen pressure or if pen gouges the chart paper, indicating excessive pen pressure.

NOTE: Wide trace may also indicate an improperly lapped pen. Refer to Paragraph 5.3.4 for pen lapping procedures.

The gram gage (part number 240601-910) is used to measure the pressure of the analog and event marker pens as follows:

1. Raise pen access cover by pulling out on bottom and sliding back into recorder.
2. Turn ON recorder and set chart SPEED at 5mm/sec.
3. Place gram gage hook under pen as close as possible to top. Form a right angle to pen shaft with hook (Figure 5-9).
4. Pull pen from chart as shown in Figure 5-9 and take reading on gage the moment excessive ink starts to flow from pen.
5. Proper pressure for analog pens is 30 ± 2 grams, for event marker pen 25 ± 2 grams.
6. If pen pressure is not within specified limits,

adjust pressure using special pen adjustment wrench (Gould part number 1-120922-18). Refer to Figure 5-10. Turn screw clockwise to increase pressure, counterclockwise to decrease pressure.

7. Recheck pen pressure per steps 3, 4 and 5.

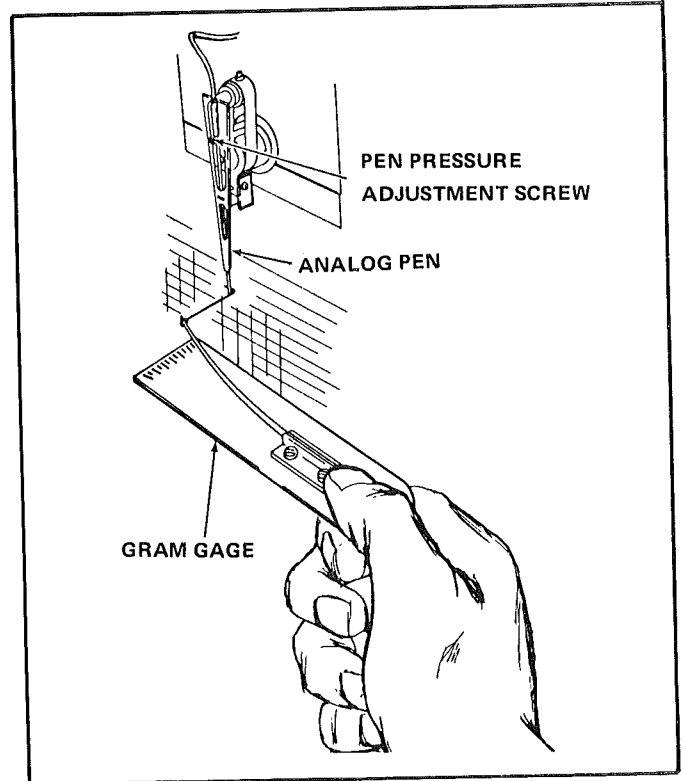


FIGURE 5-9 PEN PRESSURE MEASUREMENT

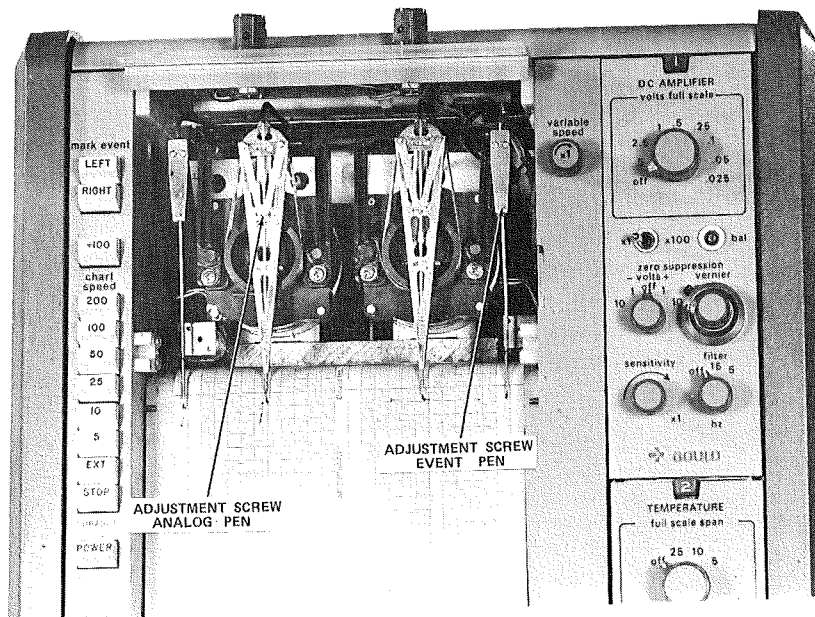


FIGURE 5-10 PEN PRESSURE ADJUSTMENT

5.3.4 Pen Lapping

a. General

This paragraph describes and illustrates the proper procedures for lapping the analog and event pens. Intermittent or "wet" ink trace are indications that pen pressure is incorrect or that pen requires lapping. Check for "wet" writing by operating the recorder (no signal applied). Check pen trace by wiping index finger, with moderate pressure, across trace approximately one inch below pen tip. If ink does not smear, pen is properly lapped. If trace smears, check and adjust pen pressure (Para. 5.3.3). Repeat test, and if trace continues to smear, lapping is required.

b. Lapping Procedures

CAUTION: LAPPING SHOULD ONLY BE DONE WHEN ABSOLUTELY NECESSARY. EXCESSIVE LAPPING WILL SHORTEN PEN LIFE.

1. Turn OFF recorder.
2. Raise pen access cover by pulling out on bottom and sliding it back into recorder.
3. Carefully raise pen tip just enough to slide a small strip of lapping paper (Gould P/N 669234, Silicon Carbide, M-600 grit) under pen tip.

4. Refer to Figure 5-11. Hold lapping paper flat against writing table and move it in a circular motion several times while gently pressing pen tip with finger.
5. Remove lapping paper and clean debris from pen tip. Operate recorder at 5mm/sec chart SPEED.
6. Check pen trace by wiping index finger, with moderate pressure, across trace about one inch below pen tip. If ink does not smear, pen is properly lapped. If ink smears, check pen pressure per paragraph 5.3.3.

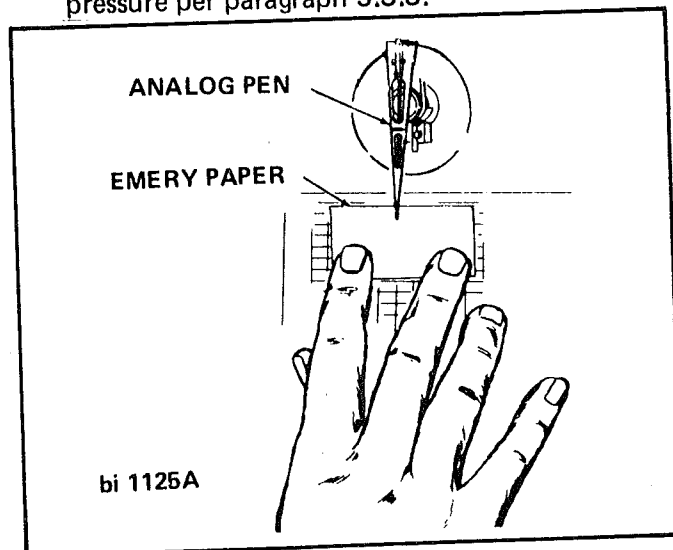


FIGURE 5-11 PEN LAPPING

5.3.5 Manifold Bleeding Procedure

a. General

After changing or replacing the manifold assembly, it is imperative that the inking system is bled before operating the recorder. This is necessary so that any air trapped in the system is removed to guarantee uninterrupted writing. It may be desirable to bleed the system when changing the ink cartridge and solenoid valve assembly also.

b. Bleeding Procedure

1. Use Figure 5-12 as an aid with the procedure that follows.
2. Slide all manual ink valves (6) to OFF position. Follow arrows on manifold bar.
3. Turn ink solenoid valve OFF. Use screwdriver thru hole in left hand plate assy.
4. Disconnect all pen tubing only from manifold valve nipples. Replace with ink outlet caps (P/N 249360). All 5 valve nipples on pen side of manifold must be capped.
5. If inking system is not under pressure turn activating screw on ink plunger assembly counterclockwise until ink fills tubing linking ink cartridge with solenoid valve.
6. Turn ink solenoid valve ON. Push hinged valve closed with finger. (Figure 5-12.) Solenoid plunger will close, opening diaphragm in valve assembly. Hold closed. Ink should fill tubing linking solenoid valve with manifold supply valve.
7. Open manifold supply valve. Slide to "ON" position. Manifold should fill with ink.
8. Place paper towels under 5 capped manifold valve nipples.
9. Remove cap from valve nipple farthest from manifold supply valve.
10. Allow a few drops of ink to drip from the nipple by sliding the valve directly behind it in the direction of the arrow to "INK ON".
11. Turn the ink off by sliding the valve in the direction of the arrow to "INK OFF". Wipe the nipple free of excess ink and replace the outlet cap.
12. Repeat steps 9 thru 11 for the next closest nipple to the supply valve and so on until all 5 nipples are bled.

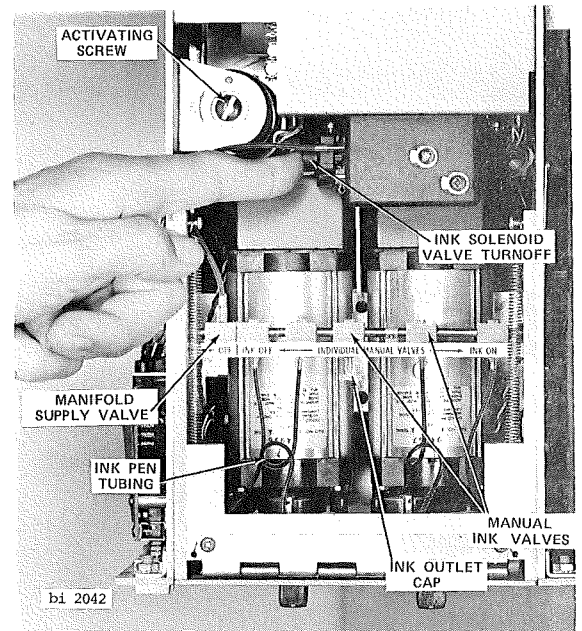


FIGURE 5-12 BLEEDING THE INKING SYSTEM

13. Replace ink outlet caps with pin tubing where removed in step 4.

5.3.6 Case Removal (Portable Models)

When removing the case, be careful not to damage gears or switchboard on recorder assembly.

1. Remove front slide covers from top of recorder case.
2. Remove the three screws located on top of recorder.
3. If recorder is equipped with preamplifiers, remove retainer. (Hardware linking preamp cage with recorder, at top of recorder.)
4. If recorder is equipped with preamplifiers, disconnect preamp cage connector (P203) at top of recorder just behind where retainer was.
5. Remove 6 large machine screws from bottom of case.
6. Slide recorder out from FRONT of case. Push from rear and/or pull from side plates. Do not pull from top front of recorder or chart take-up.

SECTION 5.4

CALIBRATION

5.4.1 General

The Gould 2200S Series Recorder has been factory calibrated. Under normal conditions, it will not be required. However, calibration may be required when parts are replaced. This section describes the procedures necessary to calibrate the 2200S Series Recorder. Calibration should only be performed by qualified individuals.

5.4.2 Test Equipment Required

Proper test equipment is essential. Use the equipment specified below or its equal.

- a. Voltmeter - Triplet Model 630 APL or equivalent.
- b. D.C. Calibration Source - Digitek Model 3110 or equivalent.
- c. Function Generator - Wavetek Model 164 or equivalent.
- d. DVM - Data Precision Model 3500 or equivalent.
- e. Oscilloscope - Gould OS 245 or equivalent.
- f. PT-3783 Remote Control.

5.4.3 Preliminary Set-Up

- a. If the recorder contains preamplifiers, remove each preamplifier from its cage prior to calibrating the channel.
- b. Depress recorder STOP button.
- c. Plug ac line cord into the proper ac voltage source.
- d. Turn ON the recorder.

5.4.4 Calibration Procedure

Calibration is required on pen drive amplifiers (one per channel) and preamplifiers (if recorder is so equipped). Only pen drive amplifier and stepper drive calibration is discussed in this manual. Refer to the applicable preamplifier manual for its calibration.

Calibration controls and procedures are identical for all channels. Refer to Figure 5-13 and calibrate each pen drive amplifier as follows:

5.4.5 Span Adjustment

1. Remove the Recorder top rear cover to gain access. Slide cover back and lift out.
2. Connect a D.C. calibration source thru the large telephone jack, J-201, to amp input. Run the chart at 5mm/sec. Set the input to zero. Using the pen position on the front panel set the pen on the channel zero line on the chart.
3. Apply a $+2.5 \pm .25\text{mV}$ signal to the input to deflect the pen to the left. Adjust the span control, R201, for a $50\% \pm 0.1\%$ of full channel width deflection.

5.4.6 Limit Adjustment

1. Set the input to zero and turn the pen position fully counterclockwise. Adjust the left limit, R202, for $1.5 \pm .25\text{mm}$ deflection beyond the left channel margin.
2. Turn the pen position fully clockwise and adjust the right limit, R203, in a similar manner. Center the pen on chart.

5.4.7 Damping Adjustment

1. Connect a function generator to the input and apply a 4 volt peak to peak square wave with a 1Hz rep rate.
2. Turn the damping control, R204, clockwise to obtain an overshoot on the pen trace, then turn it counterclockwise to reduce the overshoot to zero. Check the overshoot at 20 and 100% pen deflection. There should be zero overshoot in either case; readjust if necessary.

5.4.8 Frequency Compensation Adjustment

1. Set the function generator for a 5Hz sine wave and the chart speed at 25mm/sec. Adjust the input amplitude to obtain a 40mm pen deflection on the chart.
2. Step change the input frequency from 5 to 50Hz. Adjust the freq. comp., R205, so that the 50Hz amplitude is within .1mm of the 5Hz amplitude.

5.4.9 Main Frame Tests

Chart Speed Accuracy - 90% of Line Voltage

1. Set variable speed control to detent. Connect a one second, line synchronous, time base generator to the left event marker terminals on TB101-6 and 7 run the chart at 100mm/sec at low line voltage, for at least 20 seconds. Measure the distance between the second and the 11th timer mark. It should be 1000 \pm 2.5mm. Insure that all chart speed buttons function.

2. With variable speed control set to detent, run chart at 25mm/sec. Set variable speed control to full CCW position and verify that chart speed is less than 10mm/sec. Return to detent.

5.4.10 Remote Control

1. Set chart to stop. Remove the remote link on TB101-3 and -4. Install a SPST switch, run the recorder at 5mm/sec. Operate the remote link switch. The chart should start and stop depending on the switch position. Stop chart and replace the remote link.
2. Plug PT-3783 into the remote connector J102. Put remote enable switch in 'local' position. Put 'stop' switch in 'go' position. Select a speed of .05mm/sec. On switches S1 thru S4 of PT-3783 select the chart speed code for .05mm/sec. (See Table 3-3).
3. Put remote enable switch to 'remote'. Verify no change in operation.

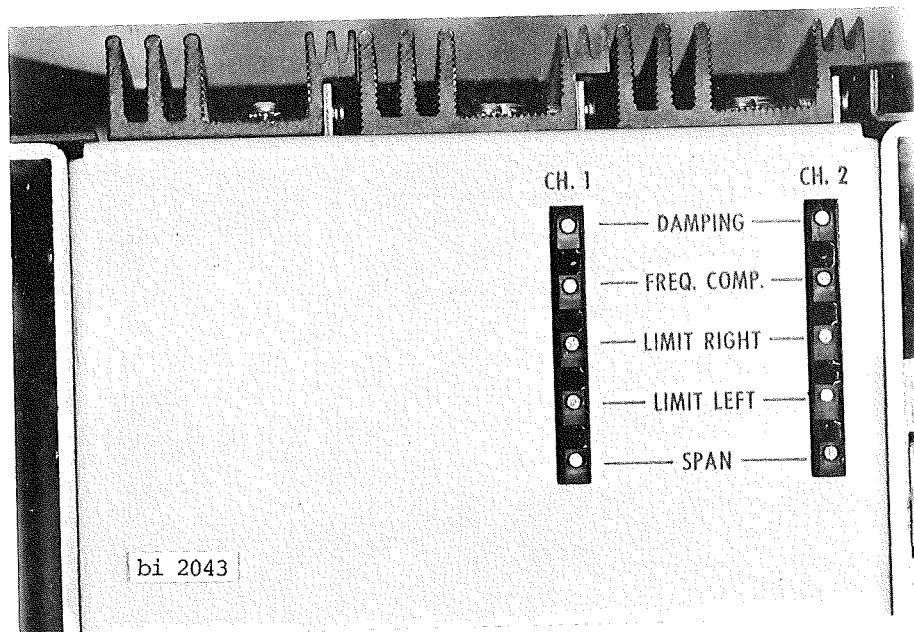


FIGURE 5-13 CALIBRATION CONTROLS

4. Leaving remote enable in remote, select another speed on the recorder front panel. Verify no change in operation.
5. Repeat steps 1 thru 4 for the other speeds.
6. With remote enable in remote position and the code for 5mm/sec on S1-S4, operate 'stop' switch. Verify that chart stops.
7. Repeat 3-6 with remote enable in 'local' position, and a speed of 5mm/sec selected on front panel.
8. With enable in 'local' position, connect a TTL compatible pulse train to J102 pin 9. Select 'ext' on the front panel. Verify that the chart moves proportionally with the frequency of the pulse train up to 20KHz. Start at 10KHz and gradually accelerate to 20KHz. 20KHz will give a chart speed of approximately 250mm/sec.

5.4.11 Standard Event Markers

1. Run the recorder at 5mm/sec and alternately short and unshort TB101-6 and -7. The left event marker should deflect to the left when the terminals are shorted. Repeat for the right event marker shorting TB101-9 and -10.

2. Apply a $+2.4 \pm .1$ VDC signal to TB101-6 and -5. The left event marker should operate. Use TB101-9 and -8 to operate the right event marker. TB101-6 and -9 are common GND.
3. Push the chart drive stop and repeat the above tests. The event markers should not operate when the recorder is in the stop mode.

5.4.12 Optional Event Markers

1. Run the recorder at 5mm/sec and alternately short and unshort terminals TB101-11 and -12. The first optional marker should operate. Optional event markers use pairs of terminals where the odd terminal is grounded. The second optional event marker is connected to TB101-13 and -14. Check out all event markers.
2. With the recorder in the stop mode, optional event markers should not operate.

5.4.13 2200S CHART DRIVE PROCESSOR BOARD ASS'Y (#893617) CALIBRATION

The purpose of this calibration procedure is to synchronize the selected speeds with the chart speed.

1. Set R432 (Processor Board) to mid-range and the variable speed control full clockwise to detent. (Refer to Figure 5-14).

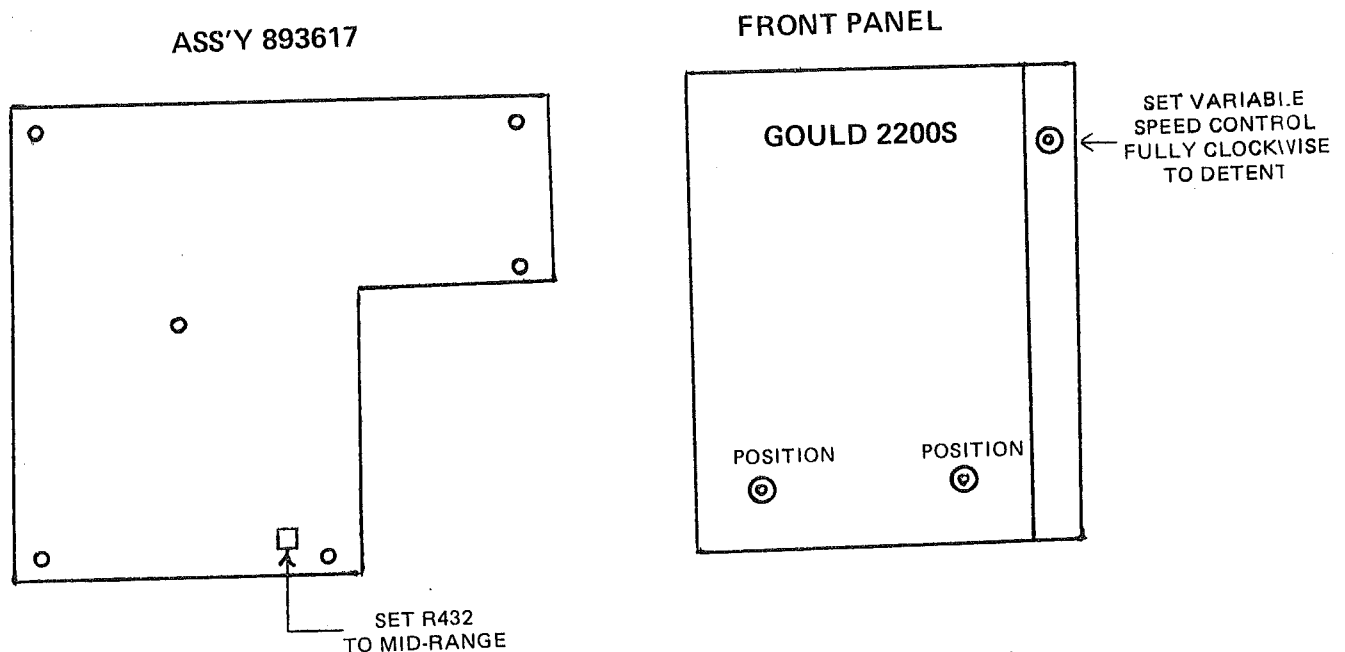


FIGURE 5-14 PROCESSOR BOARD CALIBRATION

2. Set Dip Switch S401 to hexadecimal 80 (See Figure 5-15).
3. Monitor TP1 with channel 2 of oscilloscope and TP2 with channel 1. Use pin 6 of J406 as common.
4. Adjust R432 to obtain a stable $0v \pm 500mv$ at TP1. TP1 may be "hunting", i.e. either a positive going or negative going level. The correct adjustment of R432 will eliminate this.
5. Connect a 1 second timer to the right event marker.
6. Select a chart speed of 25mm/sec and run out 1 meter of chart paper. Measure event tics with meter stick. This distance between 41 consecutive tics should be 1 meter $\pm 2.5mm$.
7. If the distance in step 6 was too great, the chart is fast. Increment the number on S401 (See Figure 5-15).

NOTE: Whenever S401 is changed to a new value, make sure you depress the stop button before proceeding with calibration. Depressing the stop button allows the processor to read the new speed.

8. If the distance measured in step 6 was too small, decrement the number on S401 (See Figure 5-15).
9. Select any speed, and then select stop.
10. Repeat steps 6 thru 9 until the distance measured is 1 meter ± 2.5 mm.
11. Adjust R432 for 0V ± 100 Mv at TP1 using a DVM with chart running at 25mm/sec.
12. Check speed at 100, 50, 10, and 5mm/sec. using the event timer and meter stick.

INCREASE									DECREASE								
Hex No.	1	2	3	4	5	6	7	8	Hex No.	1	2	3	4	5	6	7	8
80	On	On	On	On	On	On	On	Off	80	On	On	On	On	On	On	On	Off
81	Off	On	On	On	On	On	On	Off	7F	Off	Off	Off	Off	Off	Off	Off	On
82	On	Off	On	On	On	On	On	Off	7E	On	Off	Off	Off	Off	Off	Off	On
83	Off	Off	On	On	On	On	On	Off	7D	Off	On	Off	Off	Off	Off	Off	On
84	On	On	Off	On	On	On	On	Off	7C	On	On	Off	Off	Off	Off	Off	On
85	Off	On	Off	On	On	On	On	Off	7B	Off	Off	On	Off	Off	Off	Off	On
86	On	Off	Off	On	On	On	On	Off	7A	On	Off	On	Off	Off	Off	Off	On
87	Off	Off	Off	On	On	On	On	Off	79	Off	On	On	Off	Off	Off	Off	On
88	On	On	On	Off	On	On	On	Off	78	On	On	On	Off	Off	Off	Off	On
89	Off	On	On	Off	On	On	On	Off	77	Off	Off	Off	On	Off	Off	Off	On
8A	On	Off	On	Off	On	On	On	Off	76	On	Off	Off	On	Off	Off	Off	On
8B	Off	Off	On	Off	On	On	On	Off	75	Off	On	Off	On	Off	Off	Off	On
8C	On	On	Off	Off	On	On	On	Off	74	On	On	Off	On	Off	Off	Off	On
8D	Off	On	Off	Off	On	On	On	Off	73	Off	Off	On	On	Off	Off	Off	On
8E	On	Off	Off	Off	On	On	On	Off	72	On	Off	On	On	Off	Off	Off	On
8F	Off	Off	Off	Off	On	On	On	Off	71	Off	On	On	On	Off	Off	Off	On
90	On	On	On	On	Off	On	On	Off	70	On	On	On	On	Off	Off	Off	On
91	Off	On	On	On	Off	On	On	Off	6F	Off	Off	Off	Off	On	Off	Off	On



OFF = 1
ON = 0

1 COUNT = .125MM/1000MM

FIGURE 5-15 S401 POSITIONS

SECTION 5.5
TROUBLESHOOTING

5.5.1 General

This section provides troubleshooting hints to assist the operator and/or serviceman in locating malfunctions that are the possible causes and remedy. If a problem exists which is not identified in this section, contact the factory for assistance.

5.5.2 Electrical Power Malfunctions

MALFUNCTION	CAUSE	REMEDY
1. Recorder inoperative (Power ON and INTER-LOCK Lamps are extinguished with POWER ON switch depressed.	a. Recorder not connected to power source.	a. Connect to power source.
	b. Fuse F709 blown	b. Replace fuse.
	c. POWER ON switch defective.	c. Replace switch.
2. Recorder Inoperative (POWER ON and INTER-LOCK Lamps are illuminated.	a. Chart Paper torn or supply is depleted	a. Rethread or replace chart paper.
	b. INTERLOCK switch defective.	b. Replace switch

5.5.3 Chart Drive Malfunctions

MALFUNCTION	CAUSE	REMEDY
1. Inoperative	a. Desired Chart SPEED button not depressed	a. Depress desired chart speed button.
	b. Drive belt worn or broken.	b. Replace drive belt.
	c. Jumper between pins 3 & 4 of TB101 missing.	c. Replace Jumper.
	d. Fuses F709 blown.	d. Replace Fuse.
	e. Motor defective.	e. Replace motor.
	f. Chart speed switch defective.	f. Replace switch board assy.
	g. Relay K701 defective.	g. Replace relay.
	h. Defective Power Supplies	h. Troubleshoot Power Supplies.
	i. Bad Switching Amp Board	i. Refer to Section 5.5.9

5.5.3 Chart Drive Malfunctions - Continued

MALFUNCTION	CAUSE	REMEDY
2. Inoperative on divide by 100 speed.	a. Broken wire b. Switch defective	a. Replace wire. b. Replace switch.
3. Chart runs intermittently only at 200mm/sec speed	a. Sensor Board Assembly	a. Replace
4. Chart speed not accurate or is erratic.	a. Drive roll worn excessively. b. Processor Board Bad	a. Clean or replace drive roll. b. Refer to Section 5.4.13

5.5.4 Writing System Malfunctions

MALFUNCTION	CAUSE	REMEDY
1. Trace missing or faint.	a. Ink supply exhausted.	a. Replace ink cartridge.
	b. Screw on ink cartridge not fully counterclockwise.	b. Turn screw fully counterclockwise.
	c. Ink manifold valves not in full ON position.	c. Rotate to full ON position.
	d. Pens clogged.	d. Clean or replace pens.
	e. Ink manifold solenoid defective.	e. Replace solenoid.
	f. Ink manifold solenoid de-energized.	f. Fuse 711 blown: replace fuse.
	g. Air in System.	g. Bleed System.
2. Trace heavy or wet; pen gouges paper.	a. Pen excessively worn.	a. Replace pen.
	b. Pen not properly lapped.	b. Lap pen.
	c. Improper pen pressure.	c. Adjust pen pressure.
3. All pens not on same time line.	a. Pen(s) out of alignment.	a. Align Pen(s).
4. Pen fails to return to same position each time.	a. Loose pen.	a. Align and tighten pen.
	b. Loose penmotor linkage.	b. Replace penmotor.

5.5.5 Signal Malfunctions

MALFUNCTION	CAUSE	REMEDY
1. Trace unusually wide.	a. Noise appearing at the pen tip.	a. Check input signal and connections. Defective drive amplifier or pre-amplifier boards; repair or replace.
2. No signal on any or all channels.	a. Drive amplifier or pre-amplifier defective.	a. Replace drive amplifier or preamplifier.
	b. Drive amp fuse(s) blown.	b. Replace fuse(s) after correcting malfunction.
	c. Chart speed stop switch defective.	c. Replace switch.
3. Pens limp or biased to either side.	a. Drive amplifier or preamplifier defective.	a. Repair or replace drive amplifier or preamplifier.
	b. Recorder requires calibration.	b. Calibrate recorder.
	c. Pen loose.	c. Align and tighten pen.
	d. Defective pen position pot.	d. Replace pen position pot.

5.5.6 6502 Processor Board Ass'y (#893617) Troubleshooting

The purpose of this troubleshooting procedure is to allow the serviceman the capability of identifying a failure within the processor board, to a specific component or area on the processor board. This can be achieved by comparing known "Good" signatures of a working unit, to those signatures of a bad unit.

Test Equipment Needed

1. 5004A Signature Analyzer (Hewlett Packard)
2. 6502 Free-Running Test Adapter can be obtained from Gould Service Department.
3. 1-40 Pin Dip Clip
4. 2-16 Pin Dip Clips
5. Jumper Leads
6. A Universal Frequency Counter
7. Oscilloscope (Tektronix 465 or 466) or Gould 4000A Oscilloscope

5.5.7 Preliminary

All waveforms were taken with a chart speed of 5mm/sec.

1. The first place to check on the Processor Board 893617 is for the sine and cosine waveforms and gating signals.
2. This can be achieved by connecting an oscilloscope to J402 pins 2 or 1 for the sine and cosine outputs, and J402 pins 4 or 5 for their respective gating signals. Refer to Figures 5-16, 5-17, and 5-18.

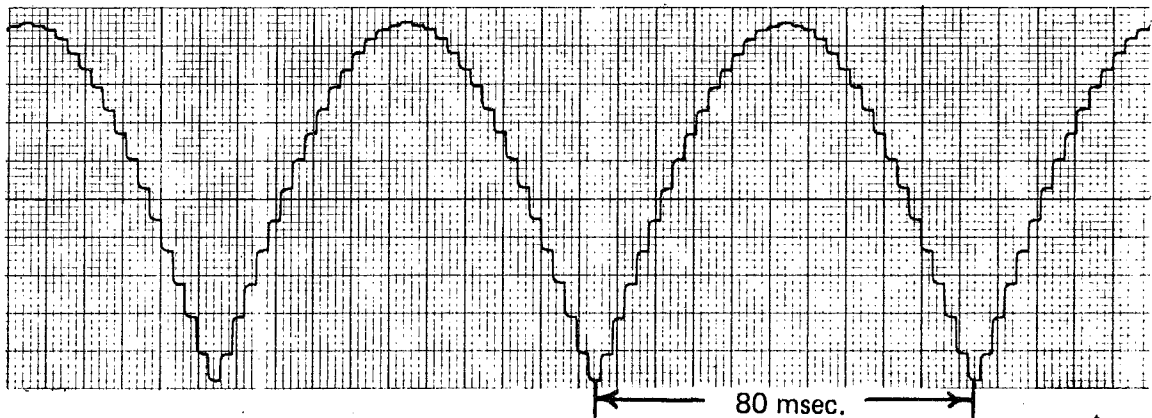


FIGURE 5-16 OUTPUT SIGNAL 5V PEAK U424-1 OR J402-2 SINE

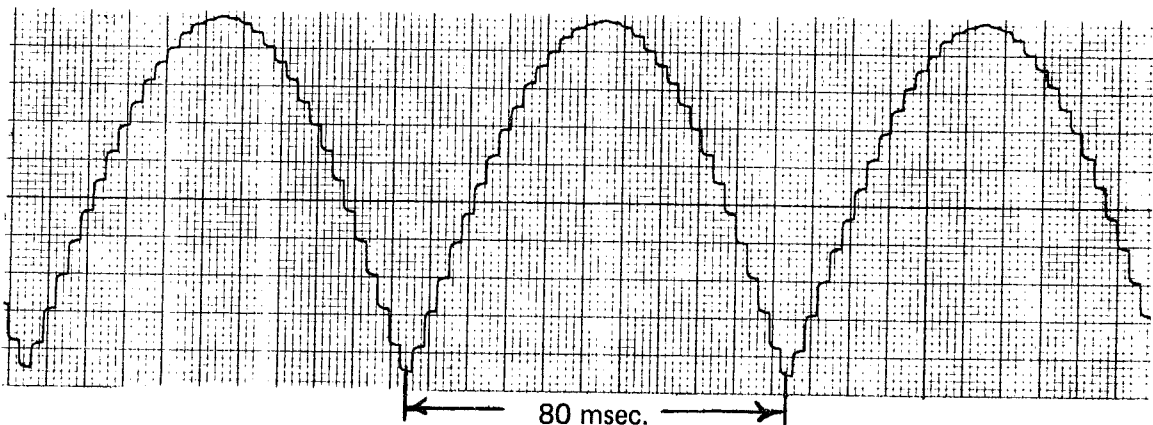


FIGURE 5-17 OUTPUT SIGNAL 5V PEAK U424-7 OR J402-1 COSINE



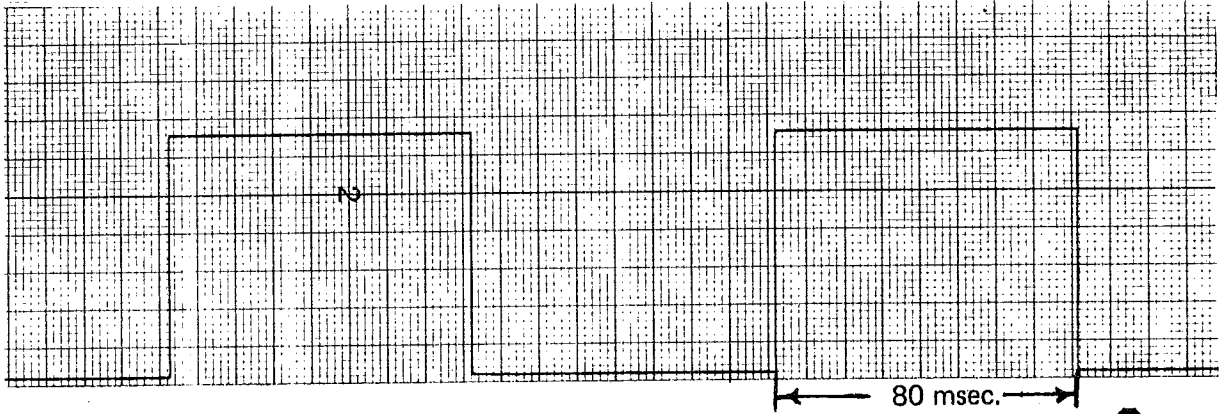


FIGURE 5-18 AND 4 GATING SIGNAL 3.8V PEAK J402-4 OR J402-5

3

3. If the waveforms shown in 5-16, 5-17, and 5-18 agree with your waveforms, the Processor Board is functioning properly. However, if the waveforms are missing or do not agree, proceed with the troubleshooting procedure for the 6502 Processor Board.

NOTE:

The information contained in the following troubleshooting procedure is intended to aid the Service Engineer in isolating problems within the Processor Board #893617. The troubleshooting procedure should be used as a guide.

5.5.8 Test Procedure

1. Disconnect plug J502 from switching amplifier board. This removes stepper motor from circuit.
2. Unplug 6502 microprocessor from its socket, on the processor board. Insert 6502 Free-Running Test Adapter into 6502 socket on board.

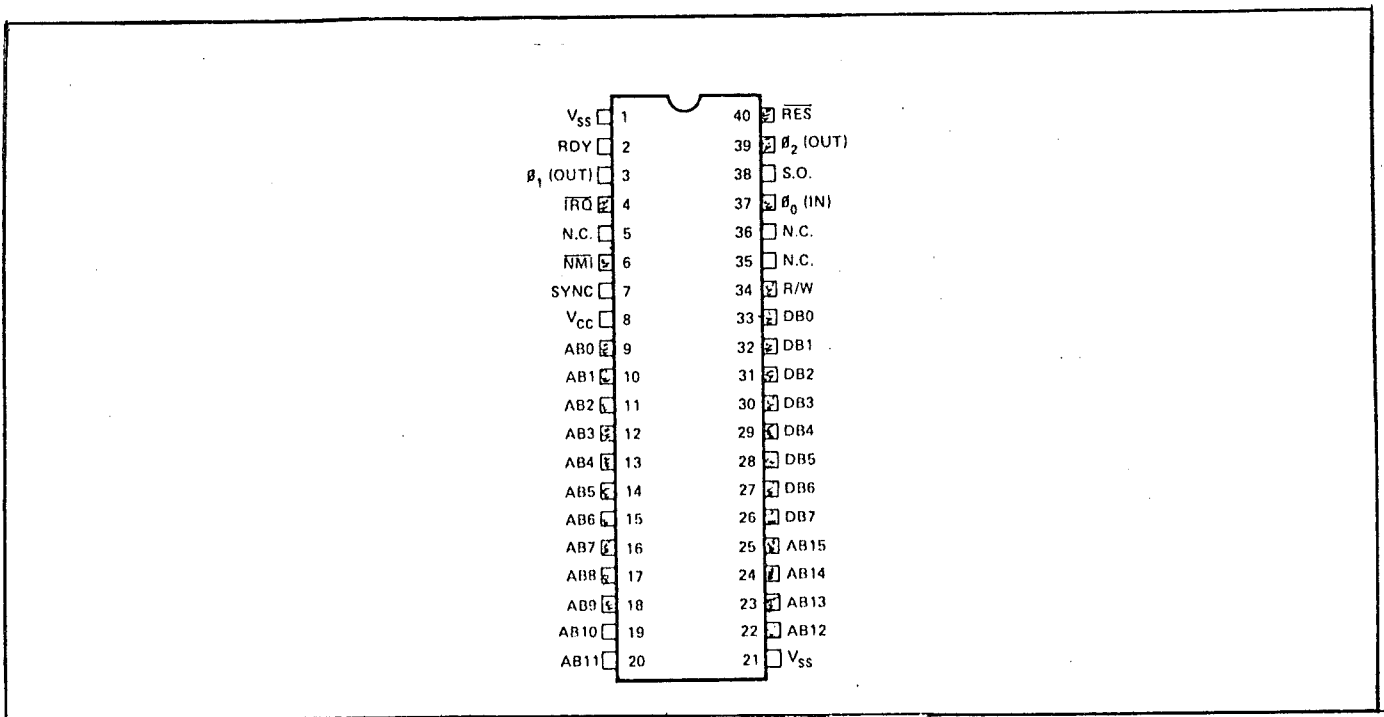


FIGURE 5-19 SY6502 – 40 PIN PACKAGE

3. Connect Signature Analyzer (S.A.) leads to the following locations. (Refer to Figure 5-19).
 - a. GND - To logic ground J406 Pin 6
 - b. Clock - To 6502 Pin 39
 - c. Stop - To 6502 Pin 25
 - d. Start - To 6502 Pin 25
4. Set all S.A. pushbuttons to the "OUT" position except the clock pushbutton. Set this pushbutton to the negative going slope or "IN" position.
5. Turn on 2200S and S.A., and select 5mm/sec. chart speed.
6. Verify that the "GATE" LED on S.A. is pulsing.
7. Using the S.A. Data Probe, check for the following stable signatures.

6502 ADDRESS BUS PINS

PIN #	SIGNATURES
9	UUUU
10	FFFF
11 .....	.8484
12 .....	.P763
13	1U5P
14	Ø356
15	U759
16	6F9A
17 .....	.7791
18 .....	.6321
19	37C5
20	6U28
22	4FCA
23 .....	.4868
24	9UP1

8. Push start button to the "IN" position.
9. Check pin 7 of 6502 for stable signature UUUU.
10. Push the start button to the "OUT" position.
11. Check pin 34 of 6502, by verifying that the red probe tip light gets brighter, and ignore display.

NOTE: All the above signatures must be present before continuing on to any further tests. If an error is observed, the μp signal at the respective pin is faulty. Turn off power and replace the 6502 with a known new operational unit. Re-apply power, and re-check all signatures. If the error is still present, the problem is external to the 6502.

Probable causes for errors include:

- a. Defective input circuit inside an I.C. at the pin connected to the bad signal.
- b. Foreign matter introduced on the circuit board (loose hardware, debris, etc.)
- c. Defective I.C. sockets.

12. Using the S.A. probe, check U420 pins 4 thru 12 for following signatures:

PIN #	SIGNATURES	PIN #	SIGNATURES
4	.....26UU	9	.....H21U
5	.....147P	10	.....3714
6	.....1ACA	11	.....3H02
7	.....C7HA	12	.....47PC

13. Using the S.A. probe, check U415 for the following signatures:

PIN #	SIGNATURES
4	.....967P
5	.....59U7
6	.....67H0
7	.....9U4P

- a. Verify that the red probe tip light gets brighter when applied to U415 pins 9, 10, 11 and 12.
- b. Connect a clip lead from U415-1 to U415-8 to short pin 1 to ground.
- c. Verify the probe light gets brighter when applied to U415 pins 4, 5, 6, and 7.
- d. Check for the following signatures:

PIN #	SIGNATURES
9	.....9U4P
10	.....67H0
11	.....59U7
12	.....967P

- e. Remove the clip lead from U415 pins 1 and 8.

14. Using a frequency counter, verify the following frequencies.

- a. Check pin 8 of U401 for a frequency of 4MHz \pm .01Hz.
- b. Check pin 1 of U412 and verify a frequency of 4MHz \pm .01Hz.

NOTE: The preceding two checks verify that the 4MHz crystal oscillator is working.

- c. Check pin 39 of U427 and verify a frequency of 1MHz \pm .01Hz.
- d. Check pin 7 of U407 and verify a frequency of 100KHz \pm .01Hz.
- e. Check pin 7 of U406 and verify a frequency of 100Hz \pm .01Hz.
- f. Check pin 9 of U405 and verify a frequency of 10Hz \pm .01Hz.
- g. Check TP2 and verify a frequency of about 16KHz, with the variable speed knob fully clockwise in the detent position. This check will insure that the step clock system is functioning correctly.

5.5.9 2200S Switching Amplifier Board Troubleshooting Assy 893618

1. Disconnect the Stepper Motor by removing the J503 plug.
2. Connect two 47K ohm $\frac{1}{4}$ watt resistors in parallel with the 2.2 mega ohm feedback resistors of the error amplifier U501. (Refer to Figure 5-20).
3. Connect 4-1K ohm $\frac{1}{4}$ watt load resistors to J503 pins 8 and 2, 7 and 1, 6 and 4, 5 and 3, to substitute the disconnect motor coils. (Refer to Figure 5-21).
4. Turn the recorder on and select a speed of 5mm/sec.
5. Referring to the Switching Amplifier Star diagram (Figure 5-22), verify that the amplitudes of waveforms and respective frequencies are correct.

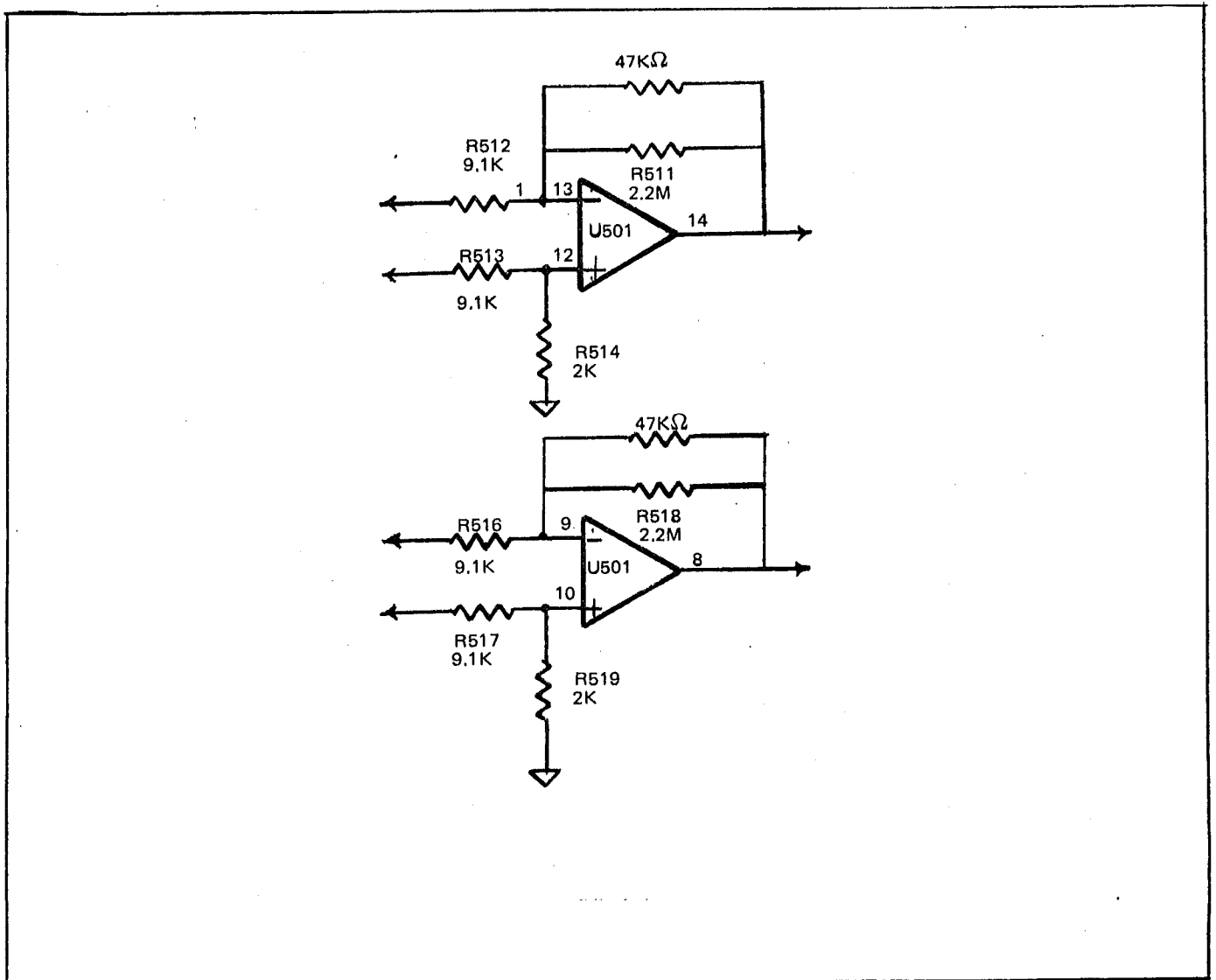


FIGURE 5-20 ERROR AMPLIFIER U501

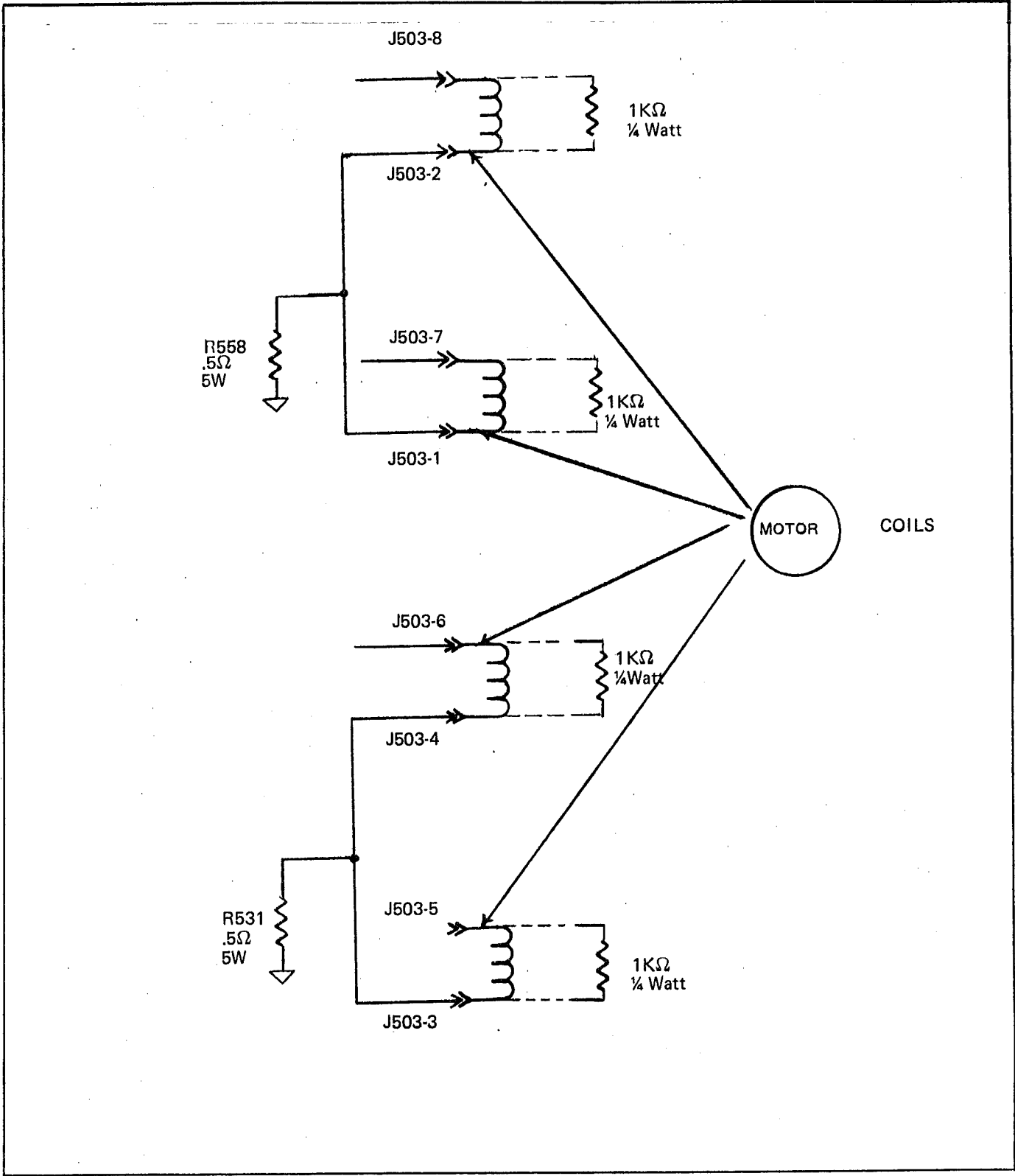


FIGURE 5-21 STEPPER MOTOR COILS

2200S SWITCHING AMPLIFIER STAR DIAGRAM

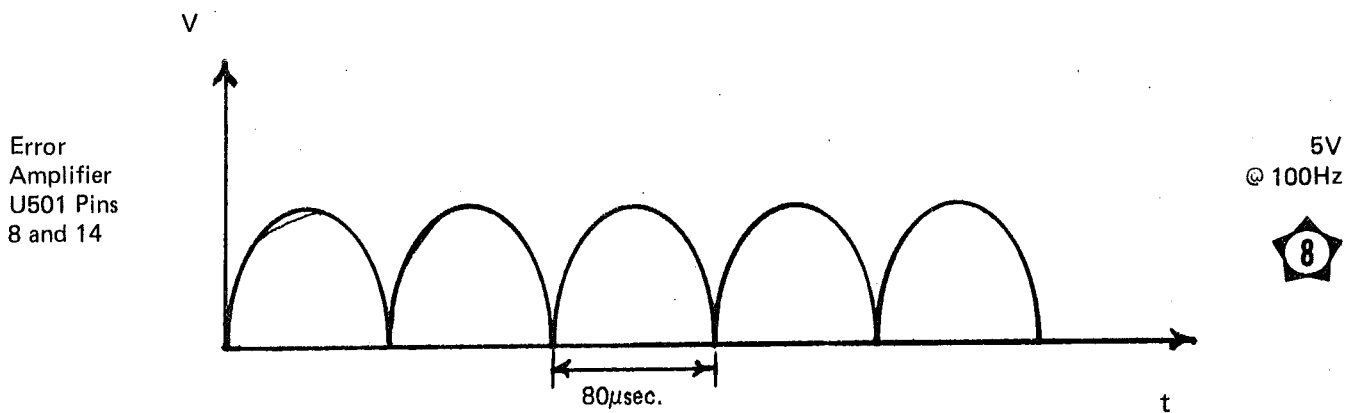
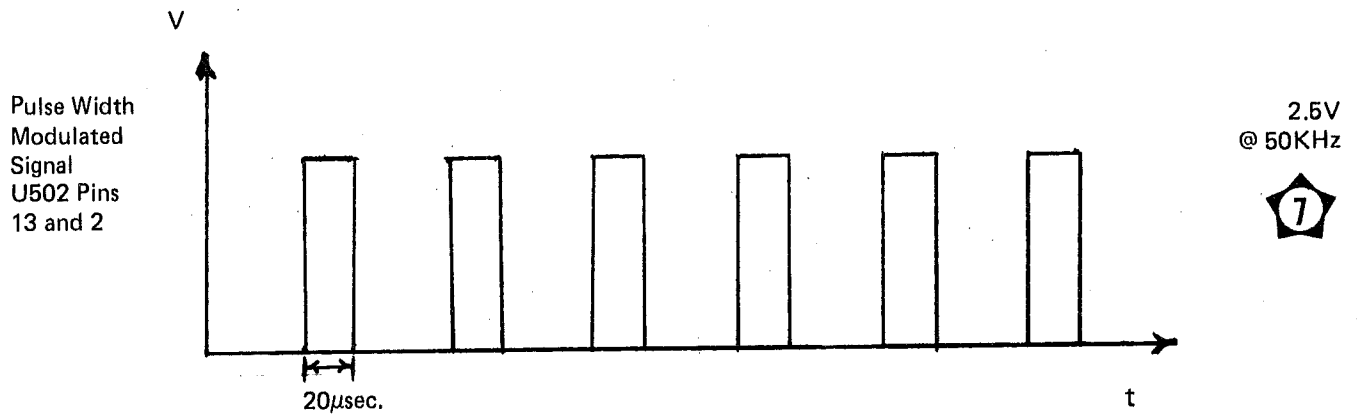
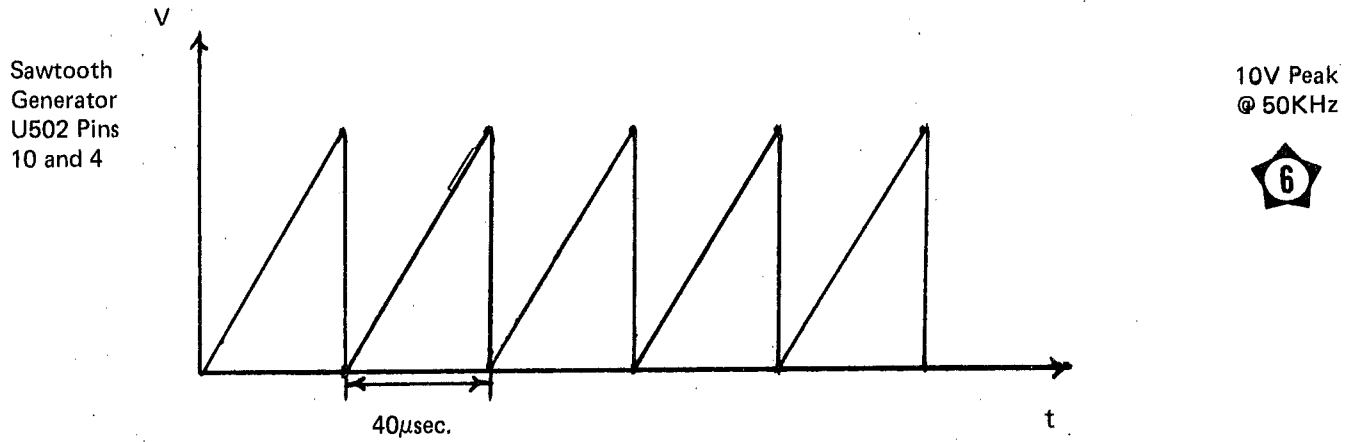
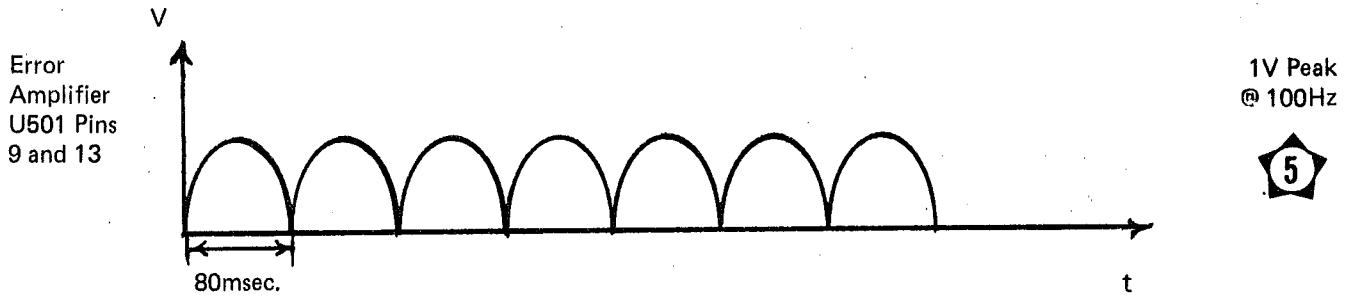


FIGURE 5-22 2200 S SWITCHING AMPLIFIER STAR DIAGRAM

5.6 SUBASSEMBLY REPLACEMENT

5.6.1 Ink Cartridge Replacement

Ink supply should be sufficient for one year under normal conditions. Cartridge is located behind left hand plate assembly, and visible thru hole in same plate assembly. See Figure 5-23. Procedure follows:

WARNING: MAKE SURE POWER IS OFF AND RECORDER IS DISCONNECTED FROM POWER SOURCE.

1. Remove recorder from case per paragraph 5.3.6. (If recorder is rack mounted, slide recorder a little more than halfway out of rack.)
2. Observe activating screw, (Figure 5-24). Turn screw clockwise until spring in ink plunger is drawn up tight.

CAUTION: DO NOT PERMIT INK TO SPILL ON RECORDER COMPONENTS. PLACE PAPER TOWELS UNDER INK SYSTEM.

3. Carefully pull ink tubing off of ink cartridge.

CAUTION: DO NOT USE TOOLS WHICH MAY GOUGE OR CUT THE INK TUBING.

4. Unscrew ink cartridge from plunger assembly and discard. (Figure 5-23).
5. Remove piston retainer from replacement cartridge and discard. (Figure 5-25).
6. Install cartridge in plunger assembly and tighten firmly. (Figure 5-23).
7. Remove shipping cap from ink cartridge and discard.

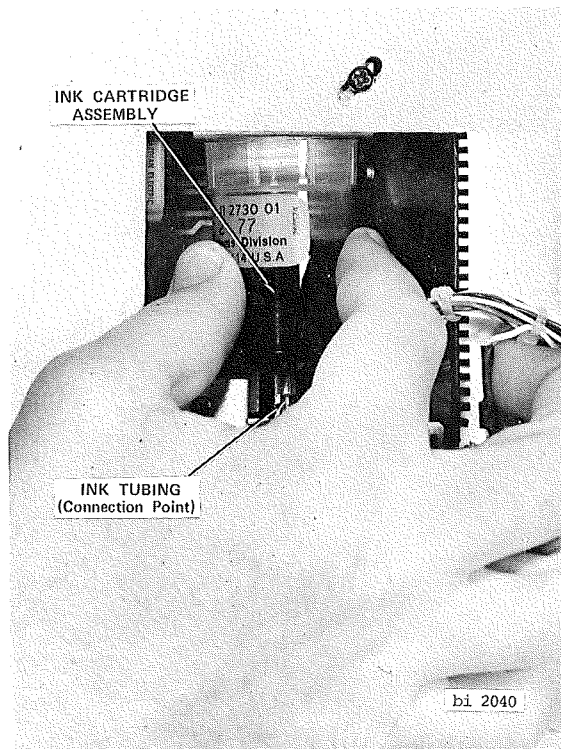


FIGURE 5-23 INK CARTRIDGE REPLACEMENT

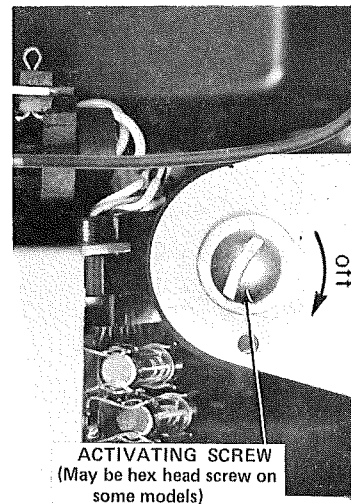


FIGURE 5-24 INK TURN OFF AND TURN ON

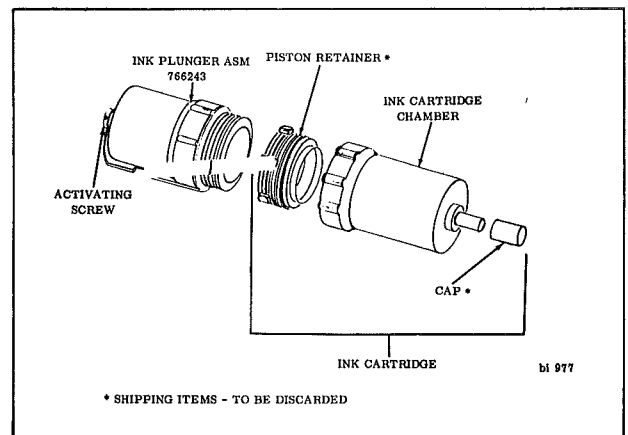


FIGURE 5-25 INK CARTRIDGE ASSEMBLY

8. Install ink tube on ink cartridge.
9. Turn activating screw counterclockwise (Figure 5-24) until snug to pressurize ink system. Check for leaks.
10. It may be desirable to bleed the inking system at this point. Refer to paragraph 5.3.5 for procedure.
11. Install recorder in case or slide recorder into rack and secure.

5.6.2 Solenoid Valve Assembly Replacement

NOTE: Refer to illustrated parts breakdown of recorder assembly in Section VIII.

WARNING: MAKE SURE POWER IS TURNED OFF AND RECORDER IS DISCONNECTED FROM POWER SOURCE.

Replace solenoid valve assembly (item 9) as follows:

1. Remove recorder from case per paragraph 5.3.6 (If recorder is rack mounted, slide recorder completely out of rack.)
 2. Turn OFF ink cartridge. (Activating Screw, Figure 5-24).
- NOTE: If solenoid only is to be replaced, turning ink off is not required.**
3. Remove Drive Amp board(s) and/or panel filler (for 1 channel recorders) from rear of recorder.
 4. In cavity left by Drive Amp board remove and retain 2 screws and washers in area of Drive Amp board connectors. Solenoid Valve Assembly will fall away from opposite side of bracket wall.
 5. Place paper towels around area underneath solenoid valve assembly.
 6. If entire assembly is to be replaced perform the following:
 - a. Disconnect yellow and orange leads from solenoid terminals. Tag leads.

- b. Pull ink tubing from both valve nipples.
 - c. Make connections to new solenoid valve assembly in reverse order of "a" and "b" above. Attach assembly to brakcket wall.
 - d. It may be desirable to bleed the inking system at this point. Refer to paragraph 5.3.5 for procedure.
7. If solenoid and diode only are to be replaced perform the following:
 - a. Disconnect yellow and orange leads from solenoid terminals. Tag leads.
 - b. Remove and retain cotter pin connecting solenoid plunger and valve link.
 - c. Remove and retain 2 screws and washers from solenoid housing. Solenoid diode assembly will fall away from housing.
 - d. Install new solenoid/diode assembly and make connections in reverse order of "a", "b" and "c" above. Attach solenoid valve assembly to bracket wall.
 8. Install Drive Amp board(s) and/or panel filler.
 9. Install recorder in case (or rack).

5.6.3 Manifold Assembly Replacement

NOTE: Refer to illustrated parts breakdown of recorder assembly in Section VI.

Replace manifold assembly (item 34) as follows:

1. Remove recorder from case per paragraph 5.3.6 (If recorder is rack mounted, slide recorder a little more than halfway out of rack.)
2. Turn OFF ink cartridge and solenoid ink valve.
3. Place paper towels around area underneath manifold assembly.
4. Pull off ink tubing from manifold to pens and manifold to ink cartridge.

5. Remove four machine screws which secure manifold assembly to side plates. Lift out manifold assembly.
6. Install new or repaired manifold assembly.
7. Replace ink tubing to manifold assembly.
8. Turn ON ink cartridge and solenoid ink valve. Check for leaks.
9. Bleed the inking system per paragraph 5.3.5.
10. Install recorder in case or slide recorder into rack and secure.

5.6.4 Table Assembly Replacement

NOTE: Refer to illustrated parts breakdown of Recorder assembly and Writing Table assembly in Section VI.

1. Remove recorder from case per paragraph 5.3.6 (If recorder is rack mounted, slide recorder a little more than halfway out of rack.)
2. Remove paper supply roll per paragraph 5.2.1.
3. Remove timing belt and pulley assembly from R.H. Plate Assy.
4. Remove retaining rings from table arms and carefully pry arms out of plate assemblies. Do not bend arms.
5. Tilt table slightly and pull out of recorder removing right and left hand lever assemblies.
6. Mount new or repaired table assembly on lever assemblies. Slide table into recorder and snap arms into side plate holes. Replace retaining rings, pulley assy and timing belt.
7. Replace paper supply roll and install recorder in case (or rack).

5.6.5 Stepper Motor Replacement.

NOTE: Refer to illustrated parts breakdown of Recorder Assembly, Section VI.

WARNING: MAKE SURE POWER IS TURNED OFF AND RECORDER IS DISCONNECTED FROM POWER SOURCE.

Remove the Motor (M109) as follows:

1. Remove recorder from case per paragraph 5.3.6. (If recorder is rack mounted, slide recorder completely out of rack.)
2. Remove rear cover assembly. (Contains AC power cord and TB101.) Move cover away from rear of recorder. (If it becomes necessary to disconnect any leads, make sure they are tagged.)
3. Remove the power supply board, by removing the four screws located at the bottom of recorder.
4. Remove timing belt from small (9 tooth) pulley.
5. Remove the four motor mounting nuts located on side of recorder, and remove the motor.
6. Remove and retain 9 tooth pulley (gear) from motor shaft.
7. Install 9-tooth pulley (gear) on shaft of new motor.
8. Install new motor in reverse order of the above procedure.

5.6.6 Chart Drive or Control Transformer Replacement (T109)

WARNING: MAKE SURE POWER IS TURNED OFF AND RECORDER IS DISCONNECTED FROM POWER SOURCE.

1. Remove recorder from case per paragraph 5.3.6 (If recorder is rack mounted, slide recorder a little more than halfway out of rack.)
2. Remove rear cover assembly. (Contains AC power cord and TB101.) Move cover away from rear of recorder. (If it becomes necessary to disconnect any leads, make sure they are tagged.)

3. Remove power supply board per para. 5.6.5. Steps 1, 2, and 3.
4. Remove drive amplifier board.
5. Remove two screws holding transformer in place.
6. Install new transformer in reverse order of steps 3, 4, and 5.

5.6.7 Power Transformer Replacement T101, T102.

NOTE: Refer to illustrated parts breakdown of chassis assembly in Section VIII.

WARNING: MAKE SURE POWER IS TURNED OFF AND RECORDER IS DISCONNECTED FROM POWER SOURCE.

Replace power transformer(s) (item 51 as follows:

1. Remove recorder from case per paragraph 5.3.6. (If recorder is rack mounted, slide recorder a little more than halfway out of rack.)
2. Remove paper supply roll per paragraph 5.2.1.
3. Remove 2 screws securing transformer to chassis.
4. Note terminal/color code lead connections while disconnecting lugs and before transformer removal.

NOTE: Twelve connections per transformer as follows:

- 1) Eight lugs on top of transformer.
- 2) Four leads at bottom of transformer which terminate at J1001.
5. Remove defective transformer thru hole in front of recorder.
6. Install new transformer in reverse order of steps 3, 4 & 5.
7. Install paper supply roll.
8. Install recorder in case (or rack).

5.6.8 Penmotor Replacement

NOTE: Refer to illustrated parts breakdown of recorder assembly and penmotor bar assembly.

WARNING: MAKE SURE POWER IS TURNED OFF AND RECORDER IS DISCONNECTED FROM POWER SOURCE.

Remove penmotor as follows:

1. Remove recorder from case per paragraph 5.3.6. (If recorder is rack mounted, slide recorder completely out of rack).
2. Remove paper supply roll per paragraph 5.2.1.

NOTE: To make room for penmotor to be removed from recorder assembly the manifold and valve solenoid assemblies must first be removed. Refer to paragraphs 5.6.2 and 5.6.3.

3. Remove pen assembly by loosening 2 screws which secure it to drive arm. Slide pen down and away from penmotor. Refer to Figure 5-6.
4. Remove 2 socket head screws which mount penmotor to penmotor bar. Disconnect connector and remove penmotor from recorder.
5. Install new penmotor in reverse order of procedure above.
6. Install recorder in case (or in rack).
7. Perform calibration on penmotor drive amp after completing installation.

5.6.9 Replacing Penmotor Drive Band (684999)

CAUTION: IT IS RECOMMENDED THAT THE DRIVE BAND BE REPLACED AT THE FACTORY SO THAT PROPER BAND TENSION IS MAINTAINED. SHOULD FIELD REPLACEMENT BECOME NECESSARY, PERFORM THE FOLLOWING STEPS.

NOTE: Refer to Figure 5-26 for location of parts in capital letters.

a. **Band Removal**

1. Remove Analog Pen Assembly.
2. Loosen (but do NOT remove) screws securing FRONT and REAR BAND CLAMPS.
3. Remove DRIVE BAND by sliding FREE END in counterclockwise direction from between REAR CLAMP and ANCHOR, then from between FRONT CLAMP and PULLEY.
4. Conclude removal by gently unhooking band from BAND ANCHOR.

b. **Band Replacement**

1. Place hooked (or bent) end of DRIVE BAND over ANCHOR as shown, and reinstall in clockwise direction between FRONT CLAMP and PULLEY, then between REAR CLAMP and ANCHOR.

2. Apply 5.5 to 6.5 pounds tenion to FREE END OF BAND with a spring clamp and spring tension scale or equivalent.

NOTE: Be sure that tension is applied directly in line with band i.e., does not pull band forward or back.

3. Maintaining tension, fully tighten all screws and apply a drop of Red Glyptal or equal at screwheads and mating surfaces.
4. Remove spring scale and spring clamp.
5. Reinstall Analog Pen.
6. Check frequency response for compliance with specifications given in Section I.

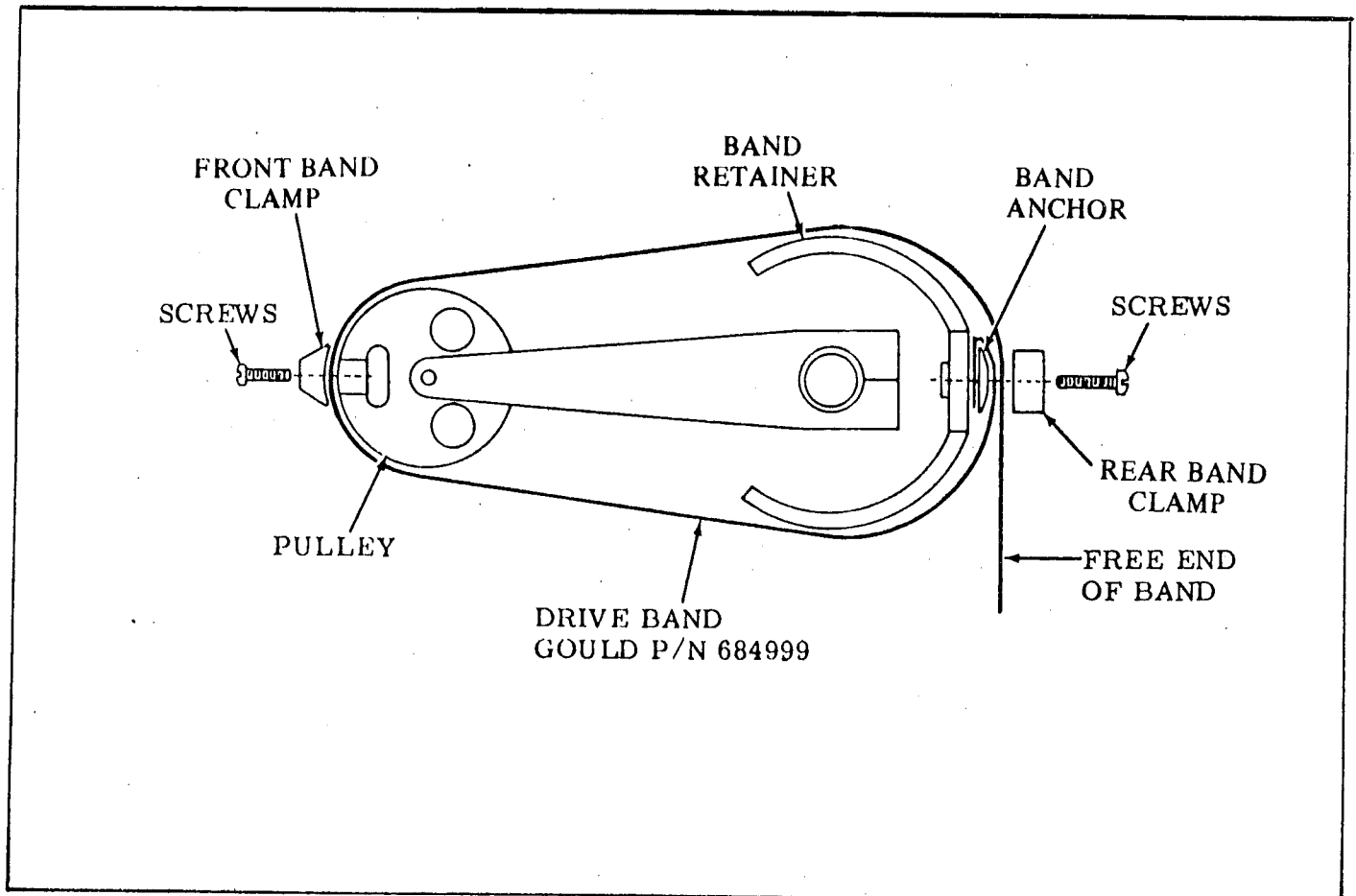


FIGURE 5-26 PENMOTOR DRIVE BAND REPLACEMENT

SECTION VI

PARTS IDENTIFICATION

6.1 GENERAL

This Gould 2200S Series Recorder has been accurately calibrated and adjusted before shipment from the factory, and should give long trouble free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the recorder.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the recorder. For replacement parts, refer to the appropriate Figure and Parts List that follow. The items listed do not necessarily imply they are procurable. If an item is marked with an asterisk (*), it is not procurable.

To assure prompt and satisfactory delivery of replacement parts, include the following information with your purchase order:

1. Name and model number of the instrument.
2. Description of part as listed in this manual.
3. Gould part number.

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

6.2 PARTS USED ON OTHER MODELS

The USED ON column identifies the recorder on which the part is used. If on code is not present, part is common to all models. Below are the codes and explanations:

CODE	EXPLANATION
130-1	130mm chassis, 1 channel
130-2	130mm chassis, 2 channel
130-XP	130mm chassis, (X) channel with preamps.

2200S INK WRITING SERIES – All Portable Models
FIGURE 6-1

ITEM NUMBER	PART NUMBER	DESCRIPTION	USED ON
1	2107-210X-XX 2107-220X-XX 887336	2200S Recorder, 1 Channel 2200S Recorder, 2 Channel Case Assembly, Recorder - W/O preamps (See Figure 6-16)	130-2
1	887334	Case Assembly, Recorder W/preamps (See Figure 6-17)	130-2P
2	2107-210X-XX 2107-220X-XX 31-119918-0212 1-118195-309 1-216741-430 8-249616-0205	Recorder Assembly (Figure 6-3 & 6-4) Recorder Assembly (Figure 6-3 & 6-4) (A-P) Screw, Mach, Pan Hd. Washer, Plain Lockwasher, Spring Screw, Mach, Pan Hd. - Painted -----*	
3	11-6402-13 266046 236865-3 31-119918-8208 1-216741-425	Chart Take-Up Assembly - Per Customer Order (See Figure 6-18) (A-P) Pulley Pin, Cotter Screw, Mach, Pan Hd. Lockwasher, Spring -----*	
4	894547 31-119918-8205 10-120053-103 31-119918-6210 1-118195-305 1-216741-420 8-249616-0205 1-216141-438	Cage Assembly, Preamp (See Figure 6-17) (A-P) Screw, Mach, Pan Hd. Lockwasher, Spring Screw, Mach, Pan Hd. Washer, Plain Lockwasher, Spring Screw, Mach, Pan Hd. - Painted Spring -----*	130-2P
5	292818 12-119918-8205 1-216741-425	Spacer (A-P) Screw, Mach, Pan Hd. Lockwasher, Spring -----*	130-2P
6	292819 13-262715-4004	Shim (A-P) Screw, Self Tapping -----*	
7	887005	Panel Assy, Blank Preamp	130-2P

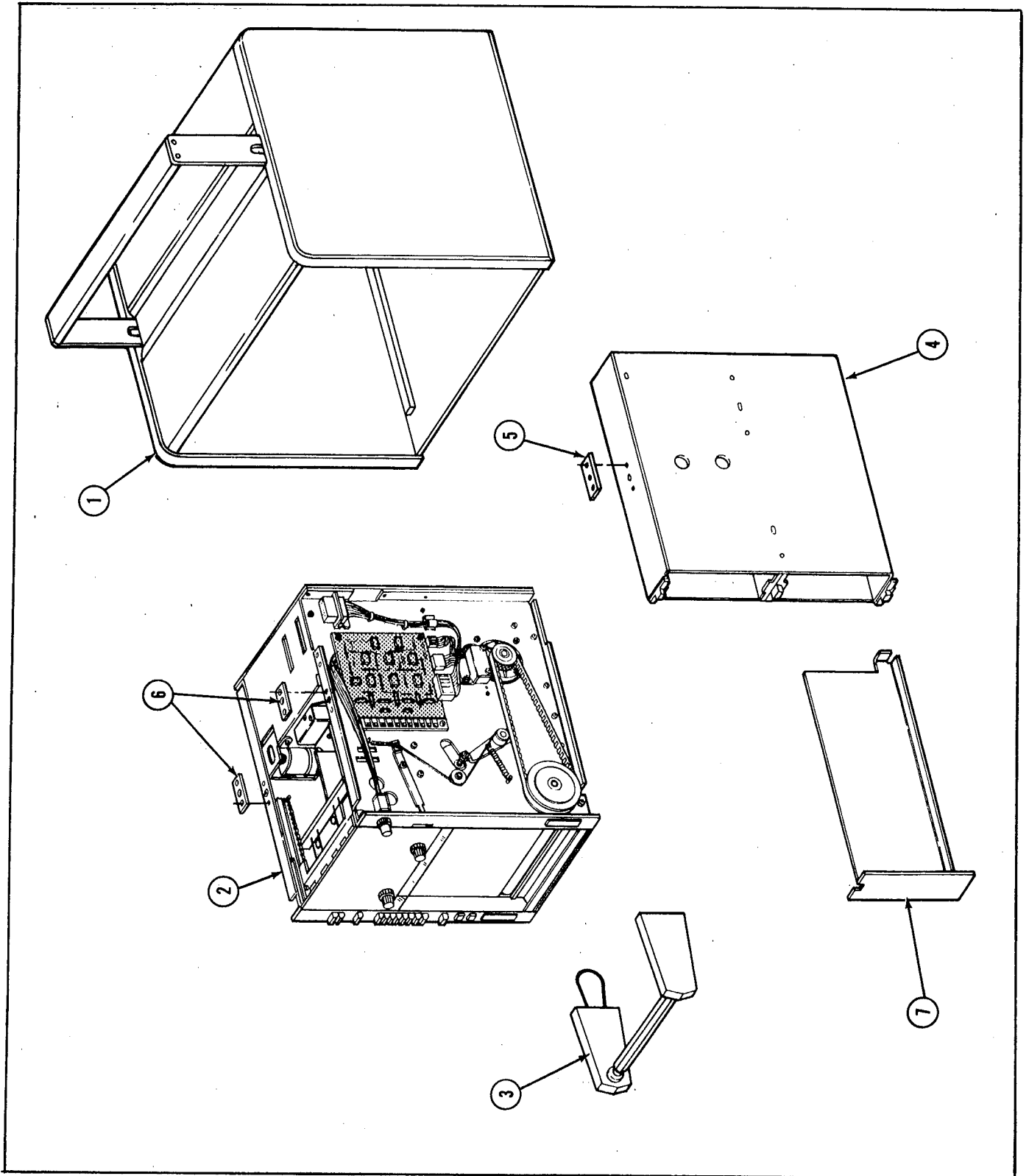


FIGURE 6-1 2200S SERIES RECORDER, PORTABLE

**2200S INK WRITING RECORDER – RACK MOUNT MODELS
FIGURE 6-2**

ITEM NUMBER	PART NUMBER	DESCRIPTION	USED ON
	2107-21XX-XX	2200S Recorder, 1 Channel	
	2107-22XX-XX	2200S Recorder, 2 Channel	
1	2107-2190-XX	Recorder Assembly (See Figure 6-3 & 6-4)	130-1
1	2107-2290-XX	Recorder Assembly (See Figure 6-3 & 6-4)	130-2
2	467037	Frame, Shipping (Per Customer Order)	
3	11-1154-61	Cabinet Assembly (Per Customer Order)	
4	11-6402-13	Chart Take-Up Assembly - Per Customer Order (See Figure 6-18) (A-P)	
	266046	Pulley	
	236865-3	Pin, Cotter	
	31-119918-8208	Screw, Mach. Pan Hd.	
	1-216741-425	Lockwasher, Spring	
		-----*	
5	894547	Cage Assembly, Preamp (See Figure 6-17)	130-XP
6	887005	Panel Assy, Blank Preamp	130-1P
Not Shown	**688007	Rack Mount Kit Assembly, Model 11-1202-17 (See Figure 6-23) (Rack Mount Installation Instructions, Recorder only.	
Not Shown			
Not Shown	**688008	Rack Mount Kit Assembly, Model 11-1202-18 (See Figure 6-24) (Rack Mount Installation Instructions, Recorder and Preamp Cage)	

** Use Kit Model number for ordering purposes.

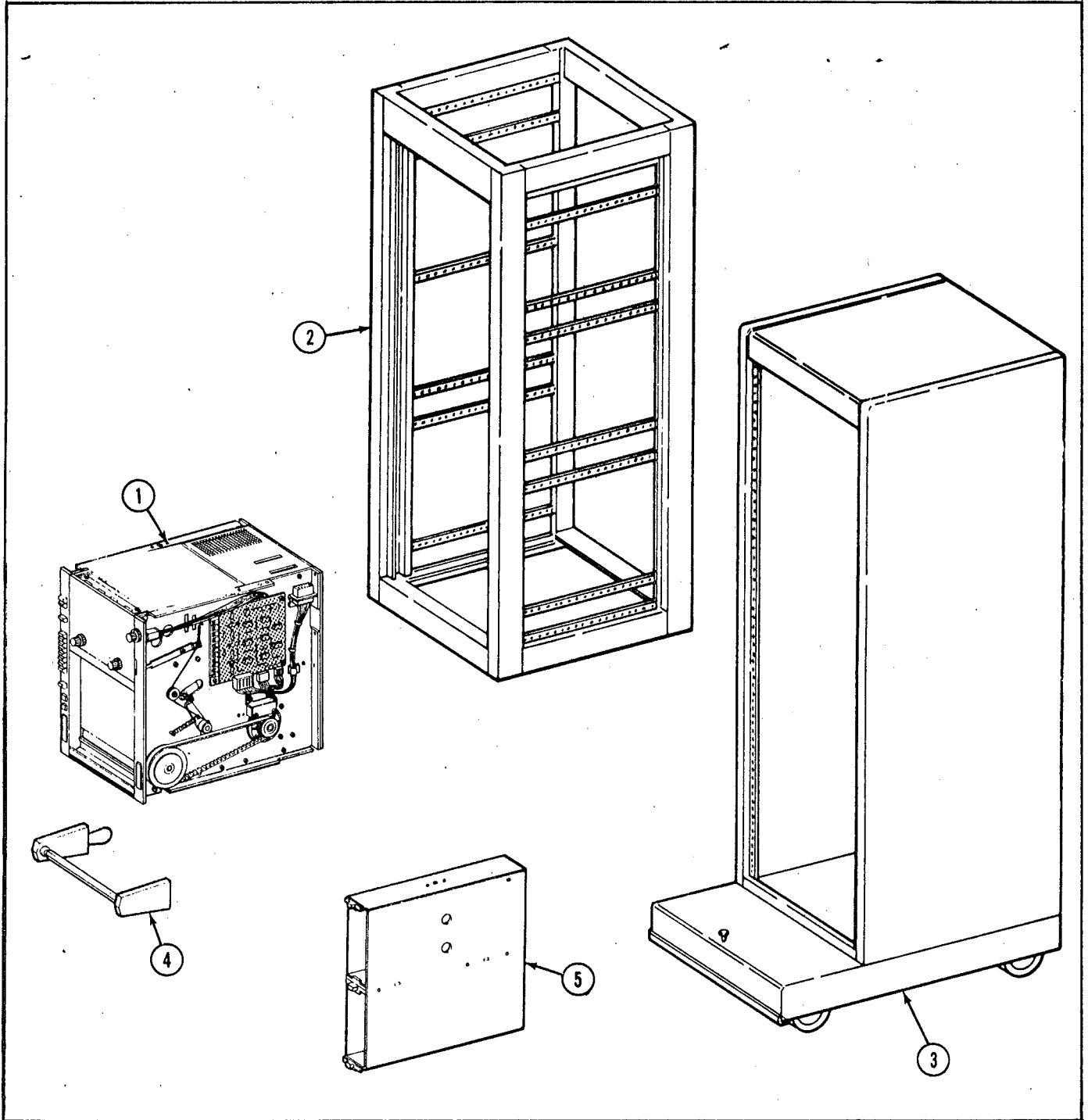


FIGURE 6-2 2200S SERIES RECORDER, RACK MOUNTED MODELS

**EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER – ALL MODELS
 RECORDER ASSEMBLY – 1300MM CHASSIS – 2107-2X90-XX
 FIGURES 6-3 and 6-4**

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
1	2107-2290-XX 893620-1	Recorder Assy, Ink Board Assy, Speed Select (See Figure 6-5) (A-P)		
	1-118195-304 31-119918-4004	Washer Screw		
2	294518	Insulator, Speed Select		
3	2-240731-10	Ring, Retaining, Ext.		
4	127271	Washer		
5	265741-1	Bearing, Ball		
6	265745-1	Washer, Mylar		
7	1-227070-9	Ring, Ret.		
8	242461-45	Nut		
9	248169-2	Spacer		
10	294545	Insulator, Processor		
11	694371-3	Cable Assy, Flat		
12	694371-2	Cable Assy, Flat		
13	694371-1	Cable Assy, Flat		
14	694371-7	Cable Assy, Flat		
15	893617 31-119918-6206	Board Assy, Processor (See Figure 6-20) (A-P) Screw		
16	667447-1	Tube Assy		
17	687477-1	Tube, Ink		
18	666582-2	Tube, Ink		
19	787391 10-120053-202 31-119918-6205	Manifold Assy (A-P) Lockwasher, Ext. Screw		
20	285711	Spring		
21	291067	Cable Assy Power	P-101	
22	287599 13-262716-4004 1-120052-203	Cover, Rear (A-P) Screw Lockwasher, Int. Tooth		
23	289046	Plug	P-202	
24	114816-15	Plug	P-201	
25	1-280875-8	Spacer, Threaded		
26	289225-1	Shield		
27	129699	Jumper		

EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER — ALL MODELS
 RECORDER ASSEMBLY — 1300MM CHASSIS — 2107-2X90-XX
 FIGURE 6-3 and 6-4 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
28	1-286155-12	Board, Terminal (A-P)	TB-101	
	31-119918-4004	Screw		
	1-120052-203	Lockwasher, Int. Tooth *-----		
29	794115	Cover Assy, Rear (A-P)		
	13-262716-4004	Screw		
	1-120052-203	Lockwasher, Int. Tooth		
30	894474	Connector Assy, (See Fig. 6-7) (A-P)		
	13-262716-4008	Screw		
	31-119918-4004	Screw		
	1-120053-201	Lockwasher, Ext.		
	243898-82	Nut *-----		
31	281584	Receptacle (A-P)		
		Screw		
		Lockwasher, Ext.		
		Nut *-----		
32	265840-1	Terminal Lug		
33	294546	Insulator, Sw Amp		
34	893618	Board Assy Sw Amp. (See Figure 6-21) (A-P)		
	31-119918-6205	Screw *-----		
35	694371-8	Cable Assy, Flat		
36	294161	Insulator, Heat Sink		
37	894133	Board Assy, Sensor (A-P)		
	31-119918-4004	Screw		
	1-120052-203	Lockwasher *-----		
	290439	Sensor		
	5-241111-243	Resistor ¼W 5%	R801	
	5-241111-512	Resistor ¼W 5%	R802	
	5-241111-910	Resistor 91 ohm ¼ W 5%	R803	
	294310-4	Connector	J801	
38	694293	Brake Assy, (See Figure 6-12) (A-P)		
	31-119923-0204	Screw, Set *-----		
39	243457	Spring		
40	286531	Spring		
41	270903-11	Clamp		
42	243542-13	Belt, Timing		

EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER – ALL MODELS
 RECORDER ASSEMBLY – 1300MM CHASSIS – 2107-2X90-XX
 FIGURE 6-3 and 6-4 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
43	694520	Pulley, Modified (A-P)		
	31-119923-6203	Screw, Set -----*		
44	123913	Washer, Spacer		
45	787467	Shaft Assy., Supply		
46	785718	Flange Assy, Supply		
47	887393-1	Table Assy, Writing (See Figure 6-15)		
48	685196-1	Lampholder Assy		
49	285764-4	Lens		
50	285764-1	Lens		
51	285765-4	Lamp		
52	685196-2	Lampholder Assy	DS-101, 102	
53	286770	Cover, Panel		
54	793171	Panel Assy, Ft. L.H. (A-P)		
	243898-02	Nut Assy -----*		
55	894284	Plate Assy, L.H. (See Figure 6-6)		
56	285357-3	Shaft		
57	232997-23	Strap, Retaining		
58	783590	Sensor Assy (See Figure 6-14) (A-P)		
	31-119923-0204	Screw, Set -----*		
59	287595	Cover, Rear (A-P)		
	13-262716-4004	Screw		
	1-120052-203	Lockwasher, Int. Tooth -----*		
60	494285	Board, P.C. AC Dist.		
61	894286	Board Assy, AC Distr (A-P)		
	31-119918-4004	Screw -----*		
	1-284199-144	Connector	J1001	
	9-270159-56	Connector	J1002; J1004;	
	281711-4	Connector	J1005	
	9-270159-2	Connector	J1003	
			J1006	
62	793682	Shield Assy (A-P)		
	13-262716-4004	Screw -----*		

EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER — ALL MODELS
 RECORDER ASSEMBLY — 1300MM CHASSIS — 2107-2X90-XX
 FIGURE 6-3 and 6-4 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
63	893619	Board Assy, Power Supply (See Figure 6-22) (A-P)		
	31-119918-4006	Screw		
	243898-82	Nut		
		-----*-----		
64	285651-3	Knob		
65	694245	Knob Assy, Locking		
66	786977-4	Door Assy (A-P)		
	13-262716-6204	Screw		
		-----*-----		
67	286971	Slide		
68	243225-4	Clamp, Loop (A-P)		
	13-262716-4004	Screw		
	1-118195-304	Washer		
	1-120052-203	Lockwasher, Int. Tooth		
		-----*-----		
69	691288	Jumper Assy		
70	204519	Insulator, Ink Cartridge		
72	11-2730-01	Ink Cartridge Assy		
73	887425-2	Valve Assy, Solenoid (A-P)		
	1-216741-425	Lockwasher, Spring		
	31-119918-8206	Screw		
	1-118195-307	Washer		
		-----*-----		
74	794173	Bracket Assy, Top (A-P)		
	13-262716-4006	Screw		
		-----*-----		
75	894131	Board Assy, Control (See Fig. 8-8)		
76	886220	Board Assy, Dr. Amp See Fig. 6-9) (A-P)		
	31-119918-4006	Screw		
	1-120053-201	Lockwasher, Ext.		
		-----*-----		
	794153	Transformer Assy, Control (A-P)	T109	
	31-119918-8206	Screw		
	243898-82	Nut		
		-----*-----		
77	9-281501-6	Connector		
78	281502-1	Contact		
79	1-232997-23	Strap, Retaining		
80	9-270158-56	Connector		
81	270153-1	Contact		

EXPLODED VIEW PARTS LIST
2200S INK SERIES RECORDER – ALL MODELS
RECORDER ASSEMBLY – 130MM CHASSIS – 2107-2X90-XX
FIGURE 6-3 and 6-4 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
82	294073	Transformer, Control	T109	
83	694166	Damper Assy (See Fig. 6-19)		
84	894287	Plate Assy, R.H. (See Fig. 8-13)		
85	265814-6	Terminal Board (A-P)	TB102	
	31-119918-4008	Screw		
	243898-40	Nut -----*		
86	241026-2	Terminal Lug		
87	241513-206	Capacitor	C108	
88	265840-2	Terminal Lug		
89	794096	Bracket Assy, Bottom (A-P)		
	13-262716-4006	Screw -----*		
90	270160-1	Terminal, Lug		
91	294065-1	Filter, RFI Power Line (A-P)		
	31-119918-4004	Screw		
	243989-40	Nut -----*		
92	794174	Panel Assy, Ft. R.H. (A-P)		
	243898-02	Nut Assy -----*		
93	785701-3	Chute, Paper (A-P)		
	13-262716-8206	Screw -----*		
94	267426-3	Paper Defector		
95	686966	Roll, Drive		
96	236460-1	Mount, Shock (A-P)		
		-----*		
97	694405	Stepper Motor Assy	M109	
98	694552	Motor, Stepper		
99	9-281501-8	Connector		
100	281502-1	Contact		
	1-232997-23	Strap, Retaining		
101	893621	Board Assy, Vari-Speed		
	293271	Resistor, Variable 10K	R901	
	294310-6	Connector	J901	
102	285651-16	Knob		
103	494129	Chassis, Bottom (A-P)		
	13-262716-8206	Screw -----*		

EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER – ALL MODELS
 RECORDER ASSEMBLY – 130MM CHASSIS – 2107-2X90-XX
 FIGURE 6-3 and 6-4 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
104	245244-02 694512	Nut Transformer Assy, Power (A-P)	T101; T102	
105	31-119918-0208 294305	Screw Transformer, Power	T101; T102	
106	232997-23	Strap, Retaining		
107	270153-1	Contact		
108	9-270158-56	Connector		
109	887181	Event Marker Assy (See Fig. 6-10) (A-P)		
110	787394	Bar Assy, Pen Motor 2 Ch (See Fig. 6-11) (A-P)		
	20-119922-8206 1-216741-425	Screw, Cap Lockwasher, Spring -----*		
111	11-2823-42	Pen Assy		
112	116198-6	Fuse ¼ Amp F-711 (For -00 & -01)		
	116198-10	Fuse 1 Amp F-701, 702 (For -01) F-709 (For -00)		
	116198-11	Fuse 1½ Amp F-709 (For -01)		
	116198-8	Fuse 3/8 Amp F-701; F-702 (For -06)		
	116198-4	Fuse 1/8 Amp F-711 (For -06 & -07)		
	116198-7	Fuse ½ Amp F-701; F-702) For -07) F-709 (For -06)		
	116198-9	Fuse 3/4 Amp F-709 (For 2107-2290-07) F-701 & F-702 (For -00)		

2200S INK WRITING RECORDER

TABLE 6-1 FUSE TABLE (ITEM 112)

RECORDER FUSE TABLE				
Fuse Symbol	For-00	For-01	For-06	For-07
F701 thru F708	3/4A 250V	1A 250V	3/8A 250V	½A 250V
F709	1A 250V	1½A 250V	½A 250V	3/4A 250V
F711/W2 Ink Solenoids	¼A 250V	¼A 250V	¼A 250V	¼A 250V
F711 W/1 Ink Solenoid	1/8A 250V	1/8A 250V	1/8A 250V	1/8A 250V

LINE VOLTAGE

00 = 115V

01 = 100V

06 = 230V

07 = 200V

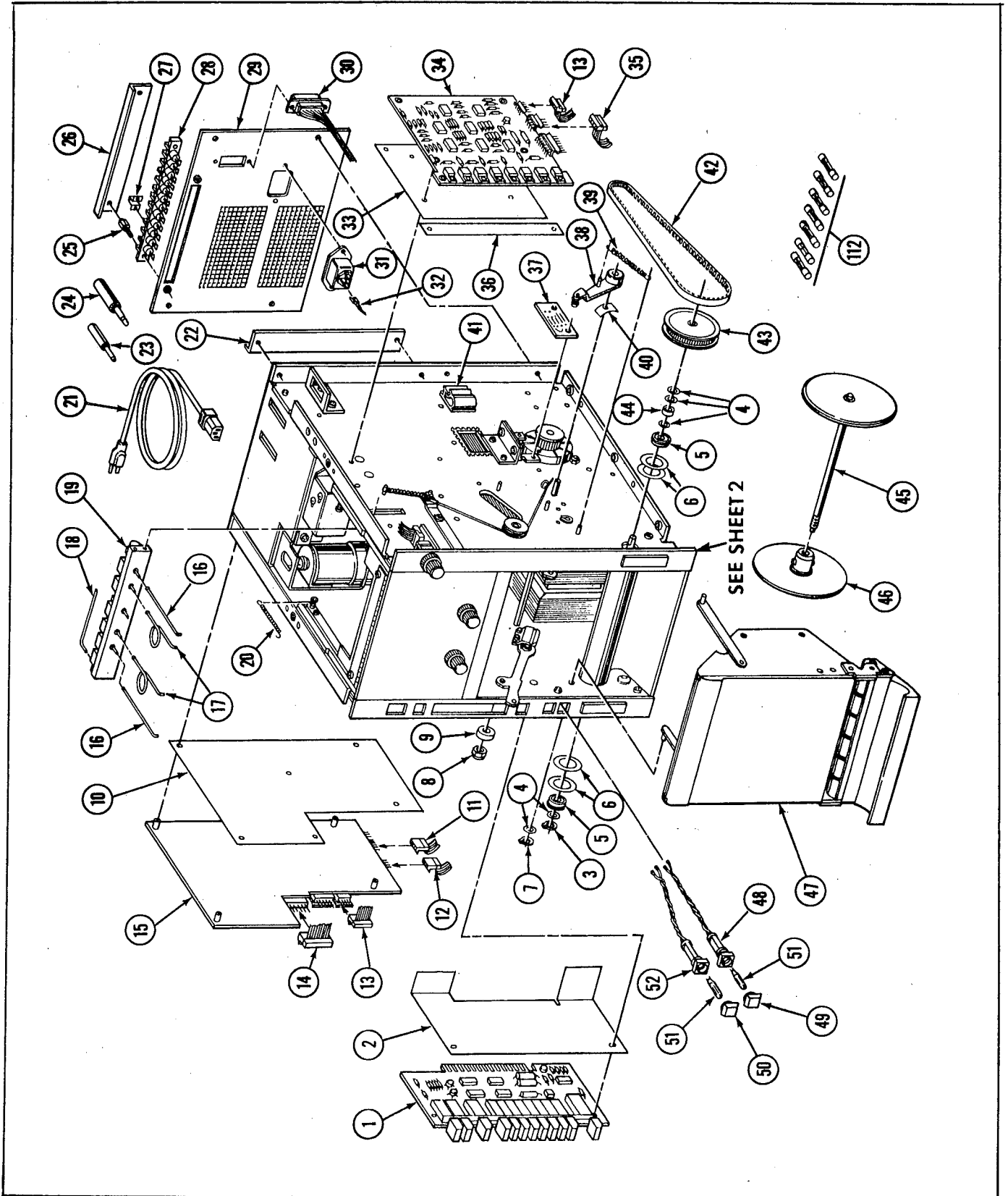


FIGURE 6-3 2200S RECORDER ASSY

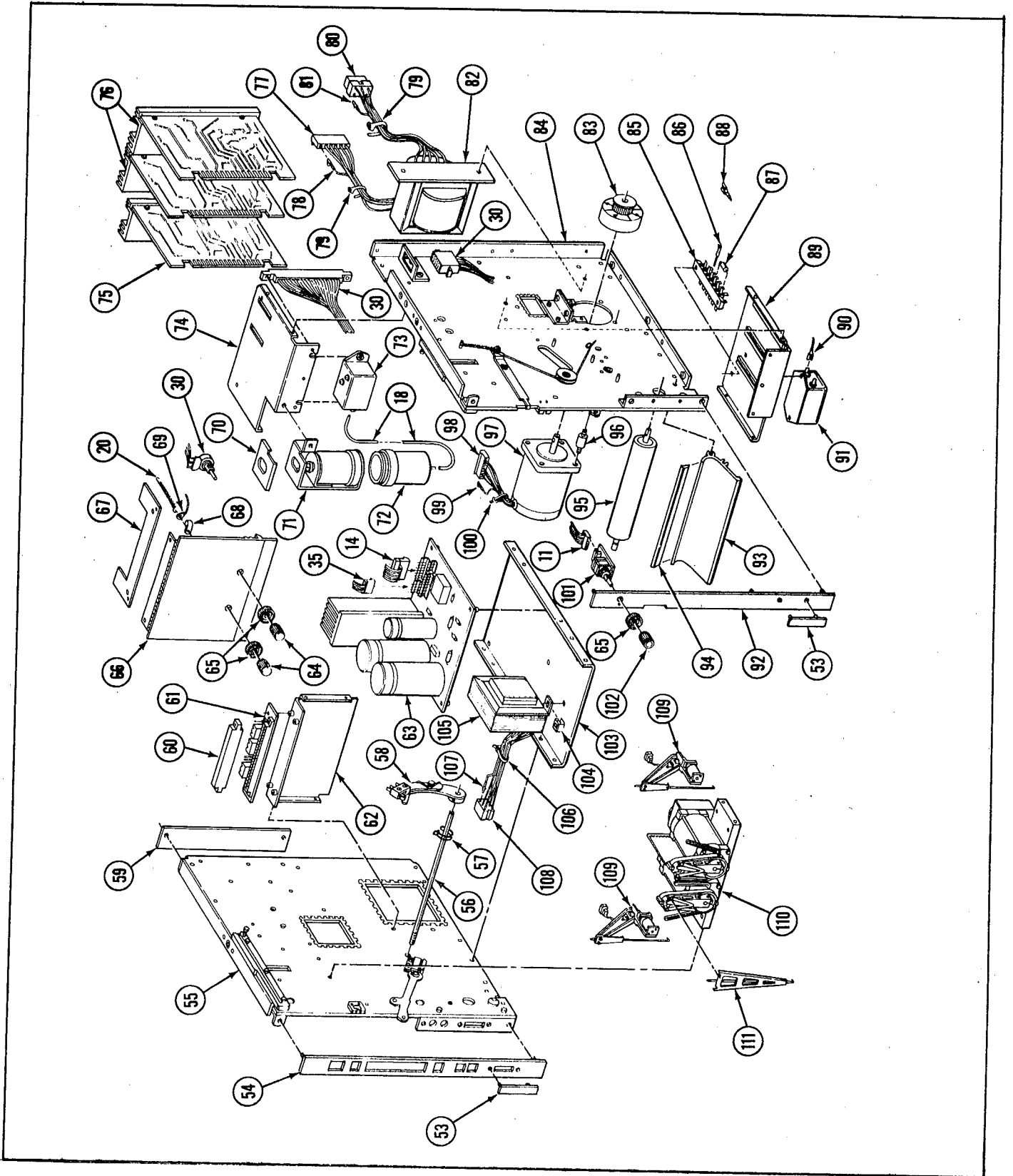


FIGURE 6-4 2200S RECORDER ASSY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER – ALL MODELS
 BOARD ASSY SPEED SELECT – 893620
 FIGURE 6-5

ITEM NUMBER	PART NUMBER	DESCRIPTION	USED ON
1	786080-10	Left Event Button	
2	786080-11	Right Event Button	
3	786080-9	Button Divide by 100	÷100
4	786080-8	Button 200	
5	786080-7	Button 100	
6	786080-6	Button 50	
7	786080-5	Button 25	
8	786080-4	Button 10	
9	786080-3	Button 5	
10	786080-41	Button Ext.	
11	786080-2	Button Stop	
12	786080-1	Button Power	

EXPLODED VIEW PARTS LIST CONT'D
 2200S SERIES RECORDER – ALL MODELS
 BOARD ASSY SPEED SELECT – 893620
 FIGURE 6-5

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C601	20-290244-107	Capacitor 100 μ fd @ 10V
C602	10-125904-472	Capacitor 0047 μ fd @ 100V
C603, 605	288755-104	Capacitor .1 μ fd @ 50V
C604	128020-256	Capacitor 25 μ fd @ 50V
C606	10-290244-475	Capacitor 4.7 μ fd @ 10V
C607	288755-473	Capacitor .047 μ fd @ 50V
C608	240352-101	Capacitor 100 μ fd @ 1KV
CR601-606	280440	Diode IN4148
CR609, 610	280440	Diode IN4148
CR607	282295-8	Bridge Rect. VE 18X
CR608	269256-7	Diode IN4148
Q601-603	286141	Transistor 2N3904
Q607, 608	286141	Transistor 2N3904
Q604, 605	286143	Transistor 2N3906
Q606	291230	Triac 2N6155
R601-613	5-241111-102	Resistor 1K ohm
R618-638	5-241111-102	Resistor 1K ohm
R641	5-241111-102	Resistor 1K ohm
R614, 615	5-241111-512	Resistor 5.1K ohm
R617, 625	5-241111-512	Resistor 5.1K ohm
R616	5-241111-273	Resistor 27K ohm
R620	5-241111-153	Resistor 15K ohm
R621	5-241111-111	Resistor 110K ohm
R622	5-241111-132	Resistor 1.3K ohm
R619, 634	5-241111-103	Resistor 10K ohm
R636	5-241111-103	Resistor 10K ohm
R624	5-241111-332	Resistor 3.3K ohm

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER - ALL MODELS
 BOARD ASSY SPEED SELECT - 893620 (CONT'D)
 FIGURE 6-5

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R627	5-241111-221	Resistor 220 ohm
R623	5-241111-753	Resistor 75K ohm
R628	5-241111-622	Resistor 6.2K ohm
R626	5-241111-912	Resistor 9.1K ohm
R629, 630	5-242300-512	Resistor 5.1K ohm
R632	5-241111-824	Resistor 820K ohm
R633	5-241111-823	Resistor 82K ohm
R635	5-241111-203	Resistor 20K ohm
R637	5-241111-272	Resistor 2.7K ohm
R639	5-241111-271	Resistor 270 ohm
S601 E1-E4	292898 265763-2	Switch Assy Pushbutton Contact
U601	290169-10	Integ. Ckt. 74LS10
U602, 604	290169-157	Integ. Ckt. 74LS157
U603	290169-04	Integ. Ckt. 74LS04
U606	286146	Integ. Ckt. LM339
U605	285589	Isolator, LED 4N28
U607	287613 493620	Integ. Ckt. NE555 Board P.C.

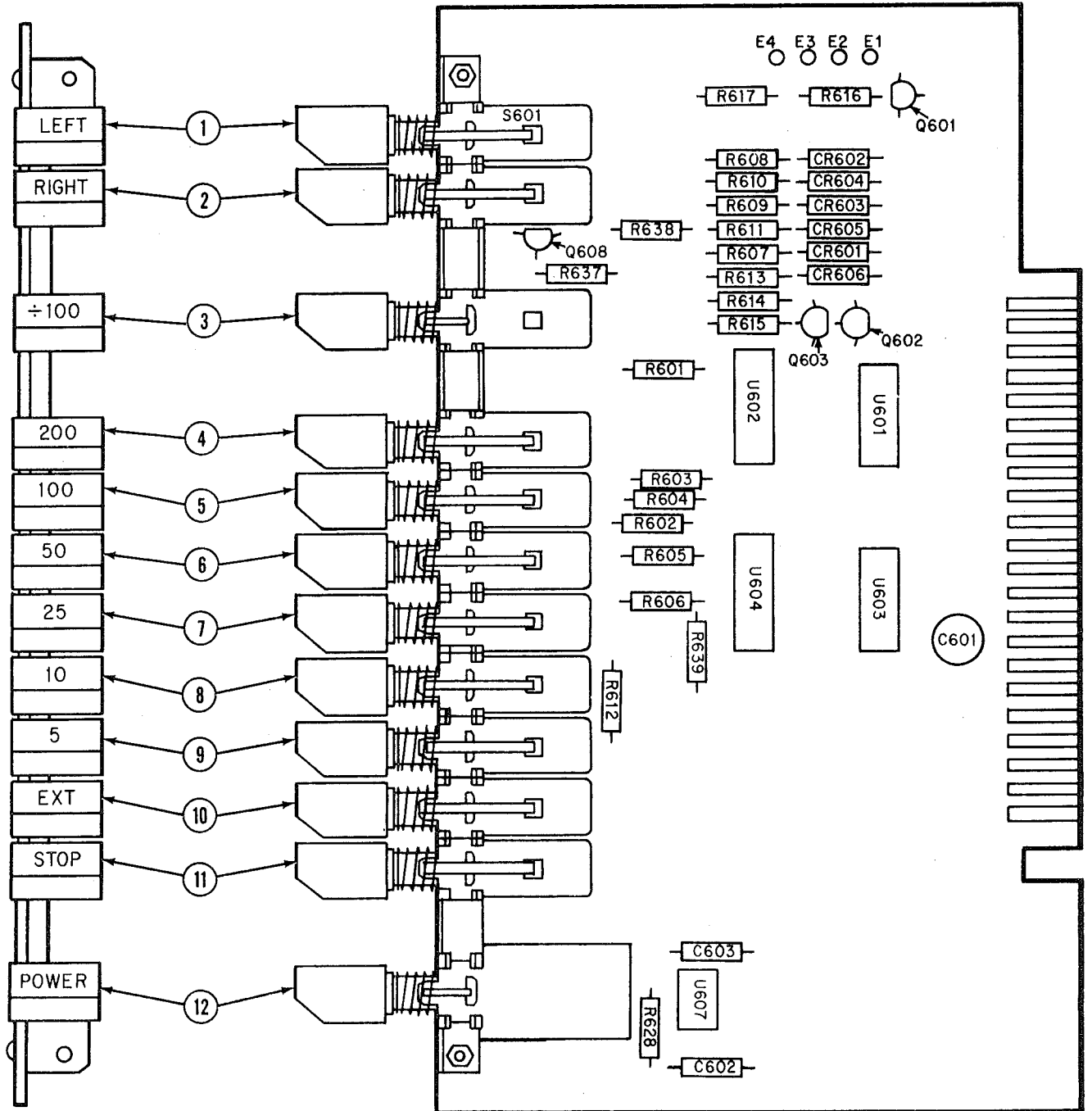


FIGURE 6-5 SPEED SELECT BOARD ASSY

2200S INK WRITING RECORDER — ALL MODELS
L.H. PLATE ASSEMBLY — 894284
FIGURE 6-6

ITEM NUMBER	PART NUMBER	DESCRIPTION
1	394345	Bracket, Conn. (A-P)
	13-262716-4004	Screw -----*-----
2	1-265849-4	Bracket (A-P)
	31-119920-6204	Screw -----*-----
3	385543-2	Guide (A-P)
	31-126906-405	Screw -----*-----
4	13-262716-4006	Screw
5	2-128693-3	Grommet
6	243623	Spring
7	243622	Pad, Friction (A-P)
	13-262716-6204	Screw -----*-----
8	243611-910	Lever Assy (A-P)
	127271	Washer
	1-220070-9	Ring Retaining -----*-----
9	285929	Bracket, L.H. (A-P)
	31-119920-6204	Screw -----*-----
10	285599	Catch (A-P)
	13-262716-4006	Screw -----*-----
11	894132	Plate, Subassy
	1-123253-1401	Spacer
12	294254	Rivet
13	3-129275-105	Nut, Clinch
14	240161-310	Pin
15	243440	Bumper
16	243507-2	Button, Detent (A-P)
	1-127657-5	Ring, Retaining
	128348	Washer -----*-----
17	2-129275-102	Nut, Clinch
18	494130	Plate, Side L.H.

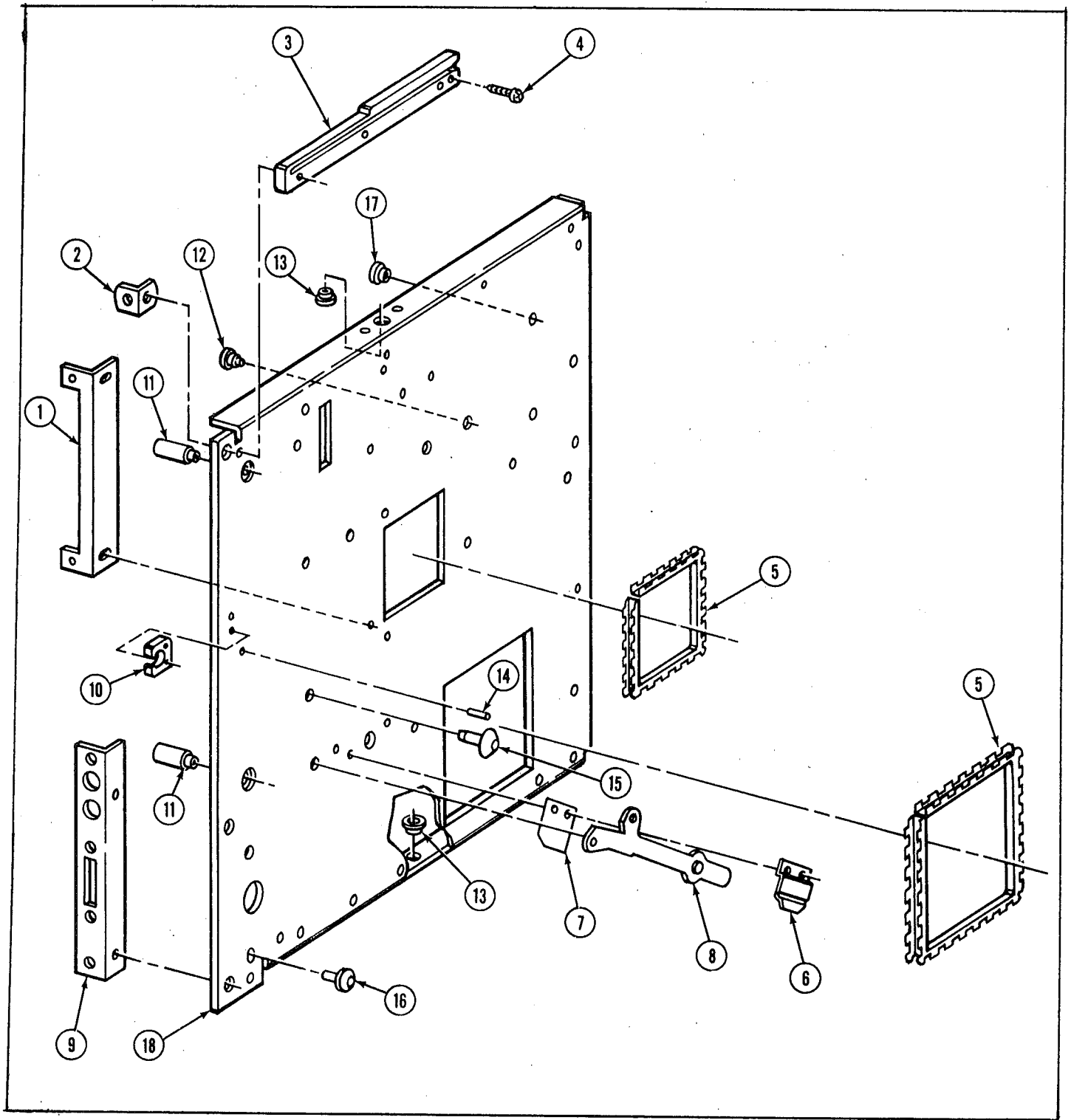


FIGURE 6-6 PLATE ASSY, L.H.

EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER – ALL MODELS
 CONNECTOR ASS'Y 894474 – 130MM
 FIGURE 6-7

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
	894474	Connector Assy		
	694479	Cable Assy		
1	694371-10	Cable Assy, Flat		
2	1-283408-1	Contact		
3	265840-1	Term. Lug		
4	1-283408-2	Contact, Elec.		
	894590	Harness Assy		
5	283420-44	Connector		
6	1-283408-2	Contact, Elec.		
7	284700	Key, Polarizing		
8	270153-1	Pin		
9	9-270158-2	Connector		
10	9-281501-4	Connector		
11	265915-1	Term Lug		
12	265840-1	Term. Lug		
13	281502-1	Pin		
	785087	Harness Assy, Penmotor		
14	1-283836-2	Contact, Elec.		
15	232997-23	Strap, Retaining		
16	281506-3	Contact, Elec.		
17	9-281501-82	Connector XM101-XM108		
	785089	Harness Assy, Power Transformer		
18	1-283408-2	Contact, Elec.		
19	232997-23	Strap, Retaining		
20	265840-1	Terminal Lug		
	788091	Harness Assy, Pen Position		
21	1-283408-1	Contact, Elec.		
22	10-286044-103	Resistor, Vari	R101	
	787424	Harness Assy, Pen Position		
23	1-283408-1	Contact, Elec.		
24	10-286044-103	Resistor, Vari.	R101, R102	
	894465	Harness Assy		
25	270154-1	Contact, Elec.		
26	9-270159-15	Connector	J303	
27	265915-1	Term. Lug		
28	286594-1	Term. Lug		
29	265840-1	Term. Lug		
30	9-270159-2	Connector	P105, P107	

EXPLODED VIEW PARTS LIST
 2200S INK SERIES RECORDER – ALL MODELS
 CONNECTOR ASS'Y 894474 – 130MM
 FIGURE 6-7 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
31	1-283408-1	Contact, Elec.		
32	283420-44	Connector	XA101, 102	
33	286598	Commoning Spring		
34	284700	Key, Polarizing		
35	232997-23	Strap, Retaining		
	694501	Cable Assy		
36	1-283408-1	Contact		
37	694371-4	Cable Assy, Flat	J403	
	694480	Cable Assy		
38	1-283408-1	Contact		
39	694371-9	Cable Assy		
	694478	Cable Assy		
40	245538	Remote Control Conn	J102	
41	694371-5	Cable Assy, Flat	J102	
42	1-253408-1	Contact		

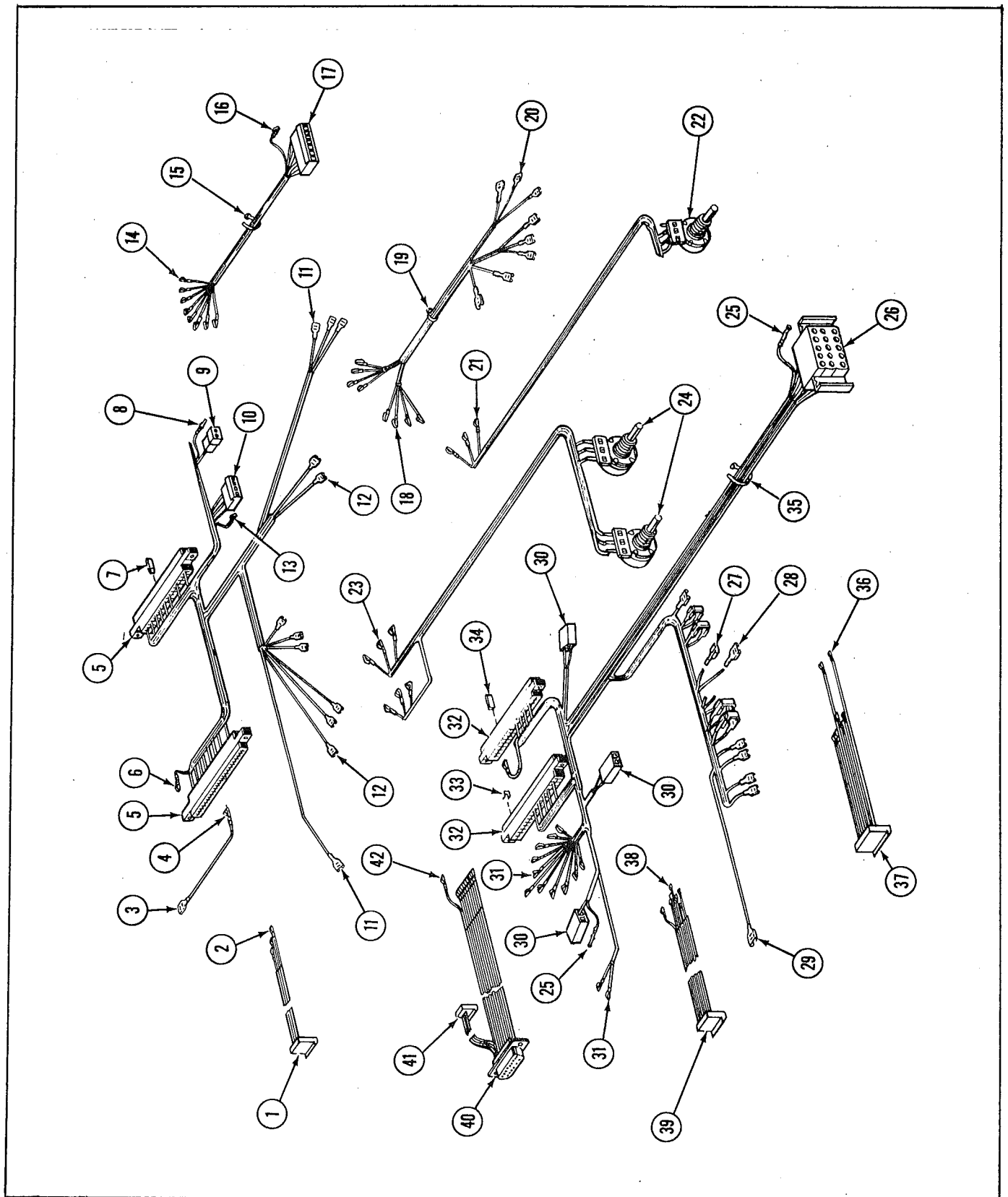


FIGURE 6-7 CONNECTOR ASSY

2200S INK WRITING RECORDER – All Models
CONTROL-TIMER BOARD ASSEMBLY – 894131 (Schematic 294131)
FIGURE 6-8

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C701	243037-257	Capacitor, 250 μ fd
C702	20-290244-107	Capacitor, 100 μ fd
C703, C704	288755-104	Capacitor, .1 μ fd
C705	262585-475	Capacitor, 4.7 μ fd
C706	288755-104	Capacitor, .1 μ fd
C707	243037-257	Capacitor, 250 μ fd
CR701	286018-2	Diode, KBP04
CR702	286018-1	Diode, KBP02
CR703	269256-7	Diode, IN4007
CR704	280440	Diode, IN4148
CR705	269256-7	Diode, IN4007
K701	291310-24	Relay
Q701	286143	Transistor, 2N3906
Q702	292538-2	Transistor, 2N6427
Q703	286143	Transistor, 2N3906
Q704	292538-2	Transistor, 2N6427
R701, R702	5-241111-332	Resistor, 3.3K ohm
R703, R704	5-241111-472	Resistor, 4.7K ohm
R705	5-241111-102	Resistor 1K ohm
R706	5-241111-472	Resistor, 4.7K ohm
R707	5-241111-103	Resistor, 10K ohm
R708, R709	5-241111-332	Resistor, 3.3K ohm
R710	5-241111-472	Resistor, 4.7K ohm
R711	5-241111-102	Resistor, 1K ohm
R712	5-241111-472	Resistor, 4.7K ohm
S701	268923	Switch (Attaching Parts included)
SP	285179	Switchplate
S702	286142-8	Dipswitch
U701	290169-92	Integrated Circuit, 74LS92
U702	290169-90	Integrated Circuit, 74LS90
U703	290169-390	Integrated Circuit, 74LS390
U704	286016	Integrated Circuit, 74121
HS	686397	Heatsink (A-P)
	31-119918-4004	Screw
	1-118195-304	Washer, Plain
	1-216741-411	Lockwasher
		-----*
*FC	285577	Fuse Clip
Jumper	267235	Jumper Circuit
E1 thru E4	265763-3	Contact

* Note: See Table 6-1, Fuse Table, for fuse ratings.

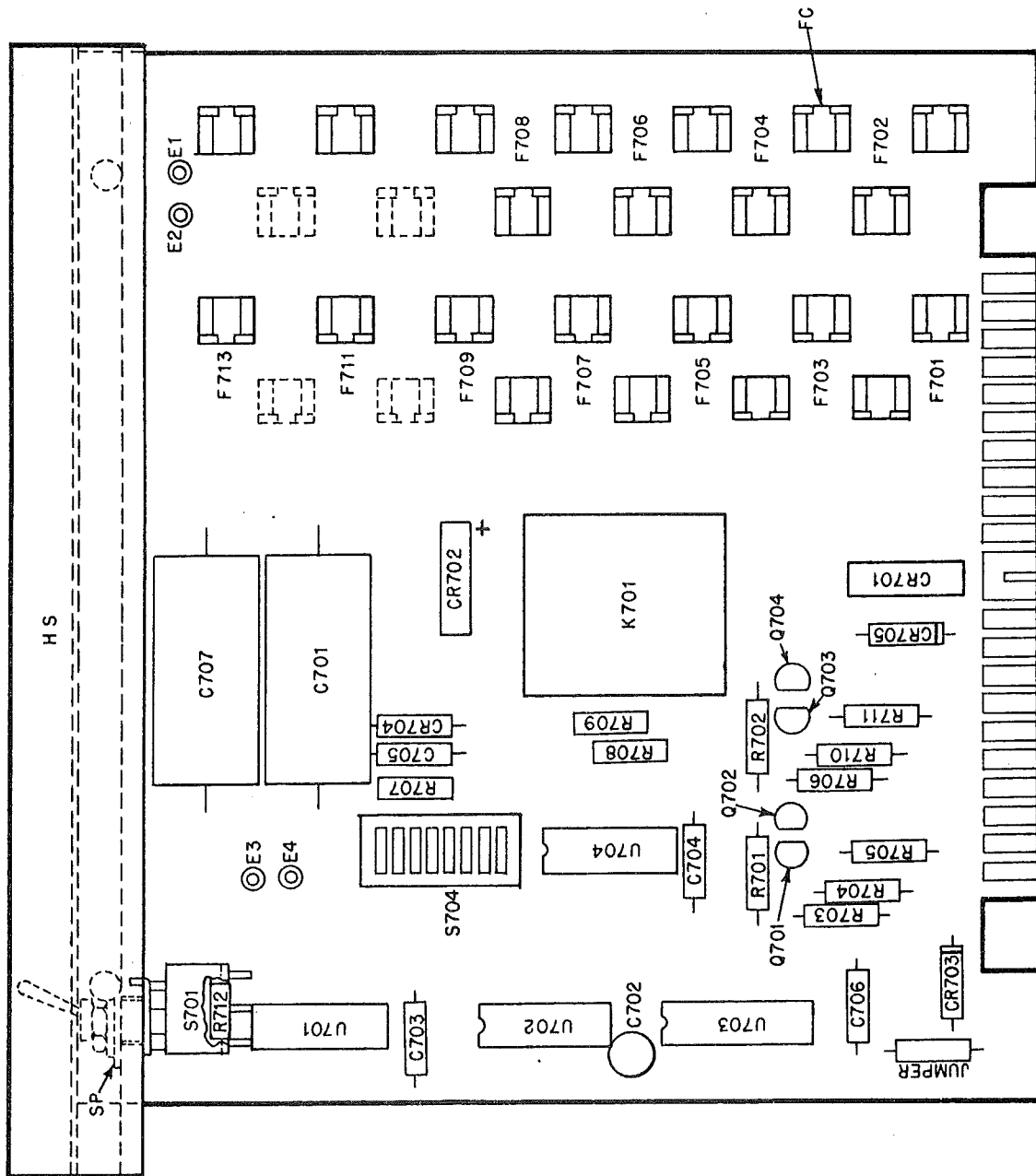


FIGURE 6-8 CONTROL TIMER BOARD ASSY

2200S SERIES RECORDER – INK WRITING MODELS
 BOARD ASSEMBLY, DRIVE AMPLIFIER – 886220 (Schematic 292273)
 FIGURE 6-9

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C201	10-125904-223	Capacitor
C202	10-247116-102	Capacitor
C203, 204	10-247116-102	Capacitor
C205	240352-501	Capacitor
C206	10-247116-103	Capacitor
C207	240352-501	Capacitor
C208	262585-106	Capacitor
C209	10-247116-103	Capacitor
C210, 211	10-247116-102	Capacitor
C212	240352-202	Capacitor
C213	10-125904-503	Capacitor
C214	10-125904-223	Capacitor
C215	281509-507	Capacitor
C216	262585-106	Capacitor
C217	281509-507	Capacitor
C218	262585-106	Capacitor
C219-222	286010-108	Capacitor
*C223	288755-104	Capacitor
CR201, 202	263727	Diode, 1N961B
CR203-208	270508	Diode, 1N4454
CR209, 210	286018-1	Diode, MDA-101
CR211	269256-7	Diode, 1N4007
CR212	270508	Diode, 1N4454
Q201	281703-2	Transistor, 2N4403
Q202	281702-2	Transistor, 2N4401
Q203-205	286141	Transistor, 2N3904
Q206	1-230057-3	Transistor, 2N4923
Q207	1-286145-1	Transistor, 2N5982 (A-P)
	12-119918-4006	Screw -----*
Q208	1-230058-3	Transistor, 2N4920
Q209	1-286147-1	Transistor, 2N5985 (A-P)
	12-119918-4006	Screw -----*
Q210	281857-2	Transistor, 2N5033
R201	1-281851-30002	Resistor
R202	1-281851-1002	Resistor
R203	1-281851-43201	Resistor
R204	1-281851-10002	Resistor

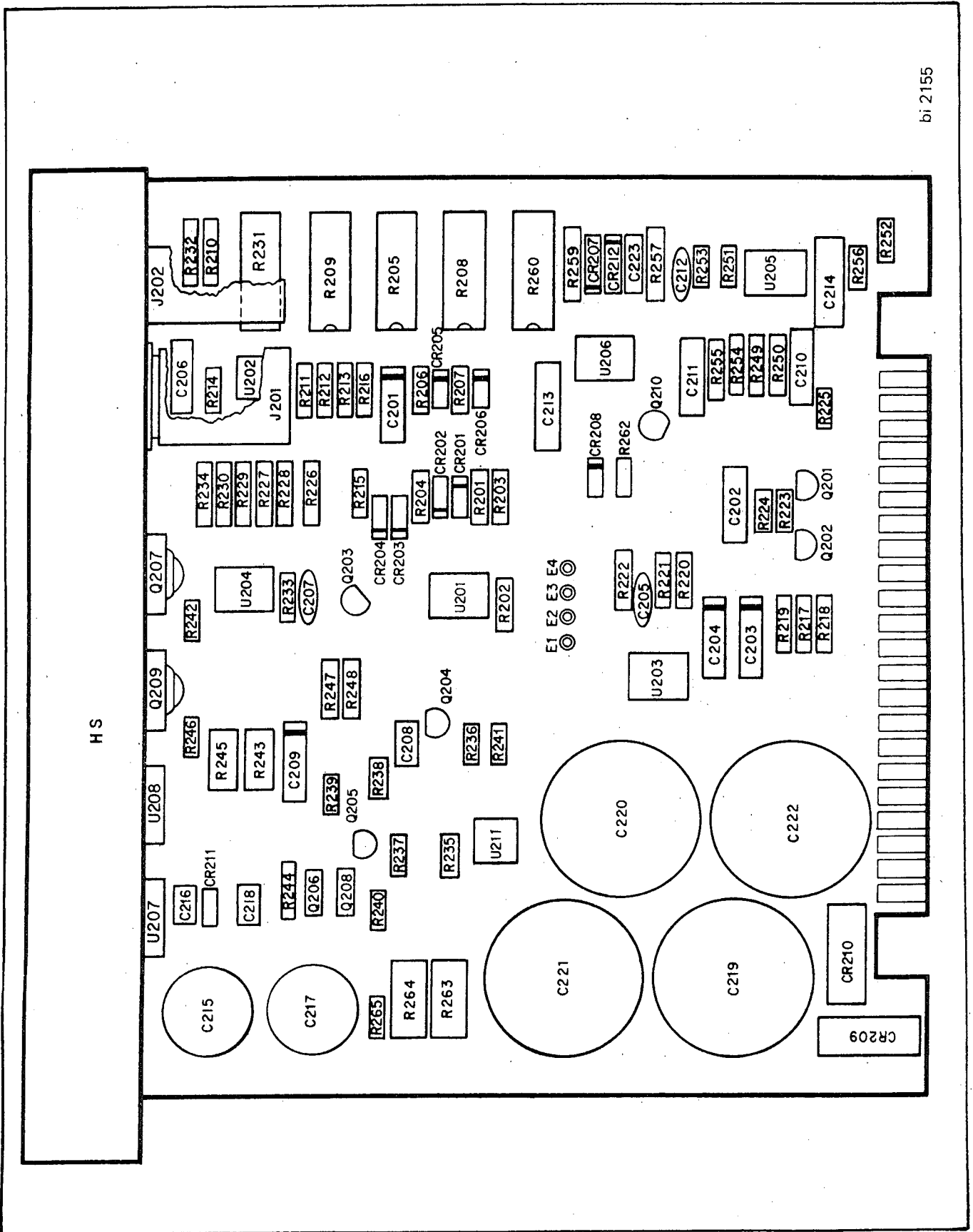
* Used only in 80mm applications.

2200S SERIES RECORDER — Ink Writing Models
 BOARD ASSEMBLY, DRIVE AMPLIFIER — 886220 (Schematic 292273)
 FIGURE 6-9

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R205	282299-103	Resistor
R206, 207	1-281851-69000	Resistor
R208	282299-103	Resistor
R209	282299-202	Resistor
R210	1-281851-200R0	Resistor
R211	1-281851-10002	Resistor
R212, 213	1-281851-10001	Resistor
R214	1-281851-16601	Resistor
R215, 216	1-281851-10000	Resistor
R217, 218	1-281851-80000	Resistor
R219	1-281851-72001	Resistor
R220	1-281851-40000	Resistor
R221	1-281851-80001	Resistor
R222	1-281851-40001	Resistor
R223, 224	5-241111-622	Resistor
R225	5-241111-392	Resistor
R226, 227	1-281851-50001	Resistor
R228	1-281851-10002	Resistor
R229	1-281851-60001	Resistor
R230	1-281851-60000	Resistor
R231	282299-502	Resistor
R232	1-281851-500R0	Resistor
R233	1-281851-10003	Resistor
R234	1-281851-26501	Resistor
R235	5-241111-104	Resistor
R236	5-241111-203	Resistor
R237	5-241111-822	Resistor
R238	5-241111-102	Resistor
R239, 240	5-241111-202	Resistor
R241	5-241111-391	Resistor
R242	5-241111-102	Resistor
R243	5-286587-181	Resistor
R244	5-283654-220	Resistor
R245	5-286587-181	Resistor
R246	5-241111-102	Resistor
R247	1-281851-20001	Resistor
R248	1-281851-500R0	Resistor
R249, 250	1-281851-80000	Resistor
R251	5-241111-104	Resistor
R252, 253	5-241111-103	Resistor

2200S SERIES RECORDER — Ink Writing Models
 BOARD ASSEMBLY, DRIVE AMPLIFIER — 886220 (Schematic 292273)
 FIGURE 6-9 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R254	1-281851-16001	Resistor
R255	1-281851-50000	Resistor
R256	5-241111-101	Resistor
R257	1-281851-20001	Resistor
R258	Not Used	
R259	1-281851-40001	Resistor
R260	282299-103	Resistor
R261	Not Used	
R262	5-241111-104	Resistor
R263, 264	5-130340-2R0	Resistor
R265	5-241111-822	Resistor
U201-204	280863-3	Integrated Circuit, 741C
U205	269941-2	Integrated Circuit, 1439P1
U206	280863-3	Integrated Circuit, 741C
U207	285461	Voltage Reg., MC 7815 (A-P)
	12-119918-4005	Screw -----*
U208	285778	Voltage Reg., MC 7915 (A-P)
	12-119918-4005	Screw -----*
U209, 210	Not Used	
U211	285589	Isolator, LED, 4N28
HS	686391	Heatsink (A-P)
	31-119918-4005	Screw
	1-118195-304	Washer
	1-216741-411	Lockwasher -----*
-----	685187	Jack Assembly
J201	285315	Jack
J202	289045	Jack (A-P)
	1-120052-211	Lockwasher -----*
E1 thru E4	265763-3	Contact



bi 2155

FIGURE 6-9 DRIVE AMPLIFIER BOARD ASSEMBLY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER – All Models
 INTERCHANNEL EVENT MARKER – 887181
 FIGURE 6-10

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER	USED ON
1	887181	Interchannel Event Marker Assy		
2	286619	Nut, Plate		
3	Not Used			
4	786658	Bracket Assy		
5	270153-1	Contact		
	9-270158-2	Connector, Plug	J-105 thru J-107	
6				
7	269256-7	Diode	CR-114 thru CR-120	
8	3-227070-2	Ring, Retaining		
9	385930	Pivot, Pen		
10	286416	Spring, Helical		
	249249-14	Pin		
11				
12	260742-1	Washer, Flat		
13	286415	Solenoid	L-108 thru L-114	
14	267884-5	Tube, Pen		
15	241073-0803	Screw, Set		
	285166	Bracket, Pen Pressure		

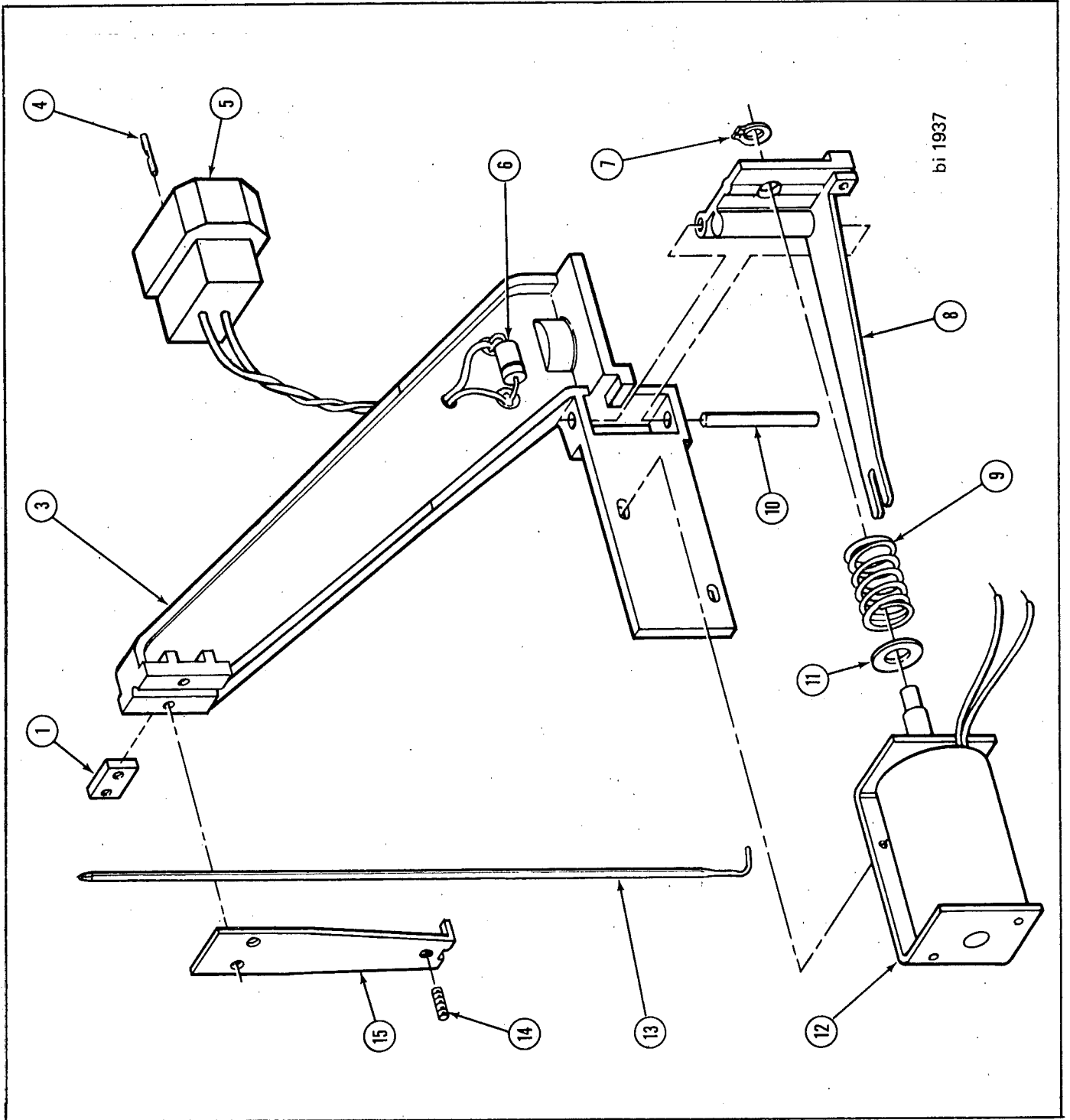
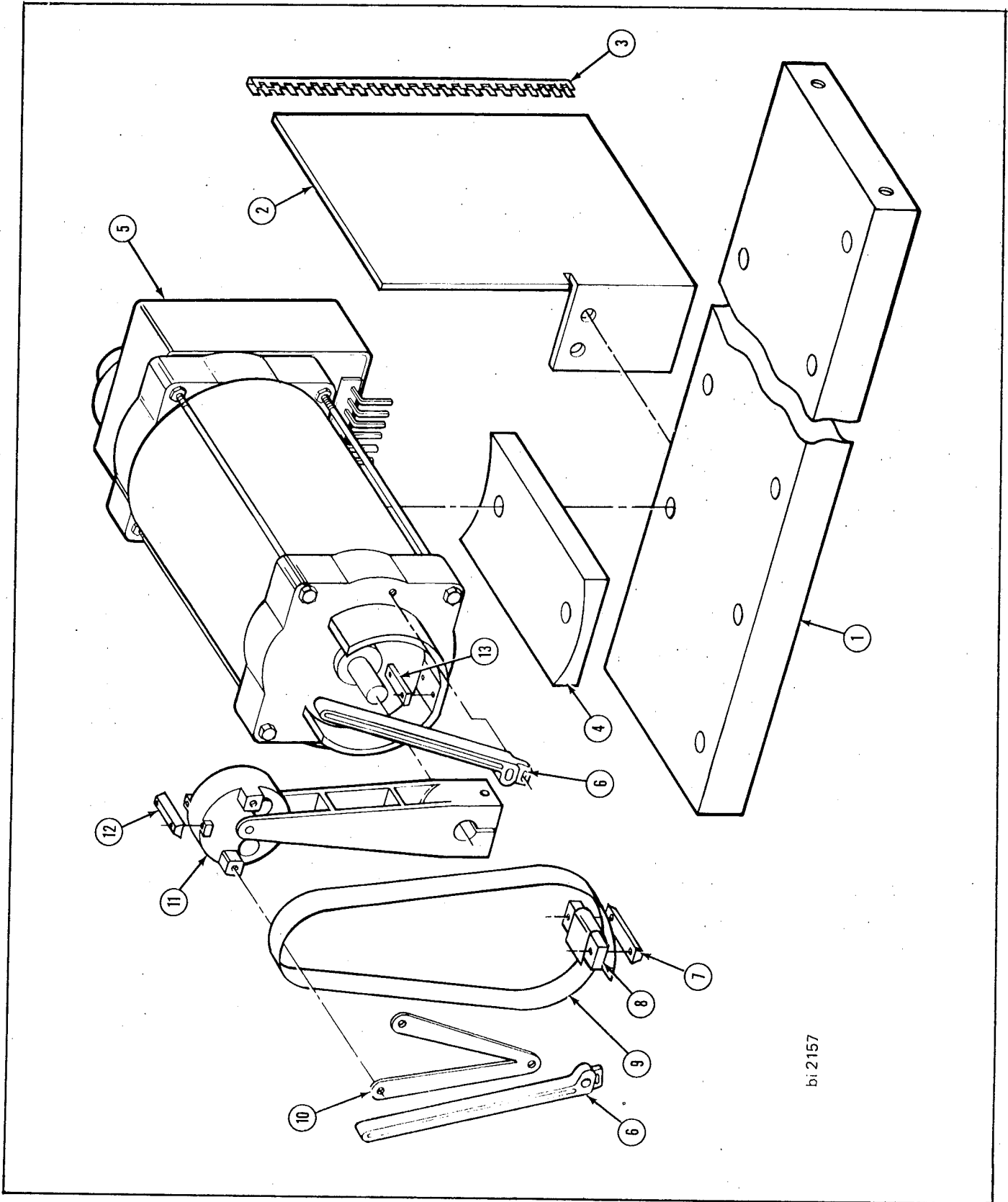


FIGURE 6-10 INTERCHANNEL EVENT MARKER

2200S SERIES RECORDER – All Models
 PENMOTOR BAR ASSEMBLY – 130mm Mainframe
 FIGURE 6-11

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
1	†787392	Bar Assy, Penmotor - 1 Ch.	M-101,M-102
	†787394	Bar Assy, Penmotor - 2 Ch.	
	884320	Penmotor Assy (A-P)	
2	1-216741-425	Lockwasher	
	31-119922-8210	Screw ----- *	
	287184	Shield (A-P)	
3	13-262716-4004	Screw, Self-Tap ----- *	
	2-128693-1	Grommet	
	286972	Bar, Mtg.	
4	684853	Saddle, Penmotor	
	384597	Stop (Part of Item 1) (A-P)	
	31-119918-4008	Screw	
5	1-118195-304	Washer ----- *	
	784583	Drive Arm Assy (Part of Item 1) (A-P)	
	31-119998-26	Nut, Hex	
6	31-119922-2608	Screw ----- *	
	284925-2	Clamp, Band Rear (Part of Item 1) (A-P)	
	284924	Plate, Nut	
7	1-265424-09010	Screw ----- *	
	285273	Anchor, Band (Part of Item 1)	
	284993	Bracket, Pen (A-P)	
8	31-119914-0004	Screw ----- *	
	684999	Band, Drive (Part of Item 1)	
	684896	Extrusion, Modified (Part of Item 1) (A-P)	
9	265424-09008	Screw ----- *	
	284924	Plate, Nut (Part of item 1)	
	13		

† Penmotor Bar Assembly not procurable. Use items 1 thru 13 and attaching parts (A-P).



bi 2157

FIGURE 6-11 PEN MOTOR BAR ASSY

EXPLODED VIEW PARTS LIST
2200S INK WRITING SERIES RECORDER – All Models
BRAKE ASS'Y, 694293
FIGURE 6-12

ITEM NUMBER	PART NUMBER	DESCRIPTION
1	685127	Disk Assy
2	0-108400-15	Insulation, Flex Sleeve
3	269291	Spring
4	794054	Arm Sub Assy
5	1-118195-304	Washer
6	0-240731-2	

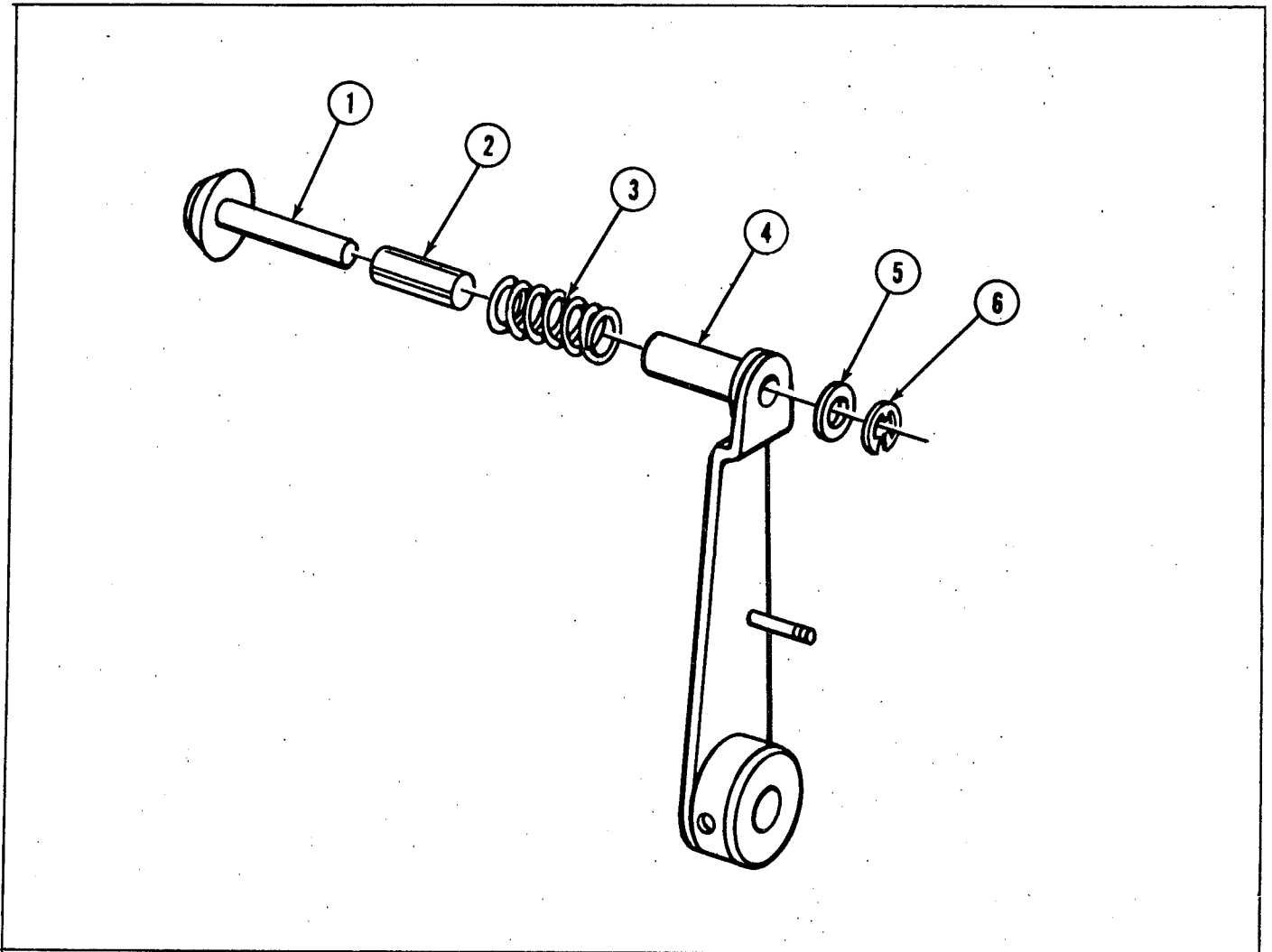


FIGURE 6-12 BRAKE ASSY

2200S INK WRITING RECORDER — All Models
R.H. PLATE ASSEMBLY — 894287
FIGURE 6-13

ITEM NUMBER	PART NUMBER	DESCRIPTION
1	385543-1 31-126906-405	Guide (A-P) Screw -----*
2	13-262716-4006 294213	Screw Bracket, Conn (A-P)
3	31-119918-6204	Screw -----*
4	1-240031-12	Spring
5	2-128693-3	Grommet
6	294342 31-119918-6204	Bracket, Sensor Adj (A-P) Screw -----*
7	11-125110-1104 1-227070-3	Rivet (A-P) Ring, Retaining -----*
8	694056 11-125110-1104 1-227070-3	Indicator Assy (A-P) Rivet Ring, Retaining -----*
9 10	694294 294341 31-119918-4003 1-118195-304	Cable Assy Bracket, Sensor Mtg (A-P) Screw Washer, Plain -----*
11	294343	Bushing
12	267257 31-119918-6216 1-216741-420 1-118195-305	Pulley (A-P) Screw Lockwasher, Spring Washer, Plain -----*
13	285712 31-119920-6204	Bracket, R.H. (A-P) Screw -----*
14	243622	Pad Friction
15	243623 13-262716-6204	Spring (A-P) Screw -----*
16	665789 1-227070-9 127271	Lever Assy (A-P) Ring, Retaining Washer -----*

2200S INK WRITING RECORDER – All Models
R.H. PLATE ASSEMBLY – 894287 (Cont'd)
FIGURE 6-13

ITEM NUMBER	PART NUMBER	DESCRIPTION
17	285599	Catch (A-P)
	13-262716-4008	Screw -----*
18	1-265849-4	Bracket (A-P)
	31-119920-6204	Screw -----*
19	894138 3-129275-105	Plate Subassy Nut, Clinch
20	265874-1	Pin
21	4-112468-7	Pin, Roll
22	265874-3	Pin
23	128348	Washer
24	243507-2	Button, Detent (A-P)
	1-127657-5	Ring, Retaining -----*
25	240161-310	Pin
26	494090	Plate, Side, R.H.
27	31-119918-4003	Screw (Not included with side plate assy. order separately)

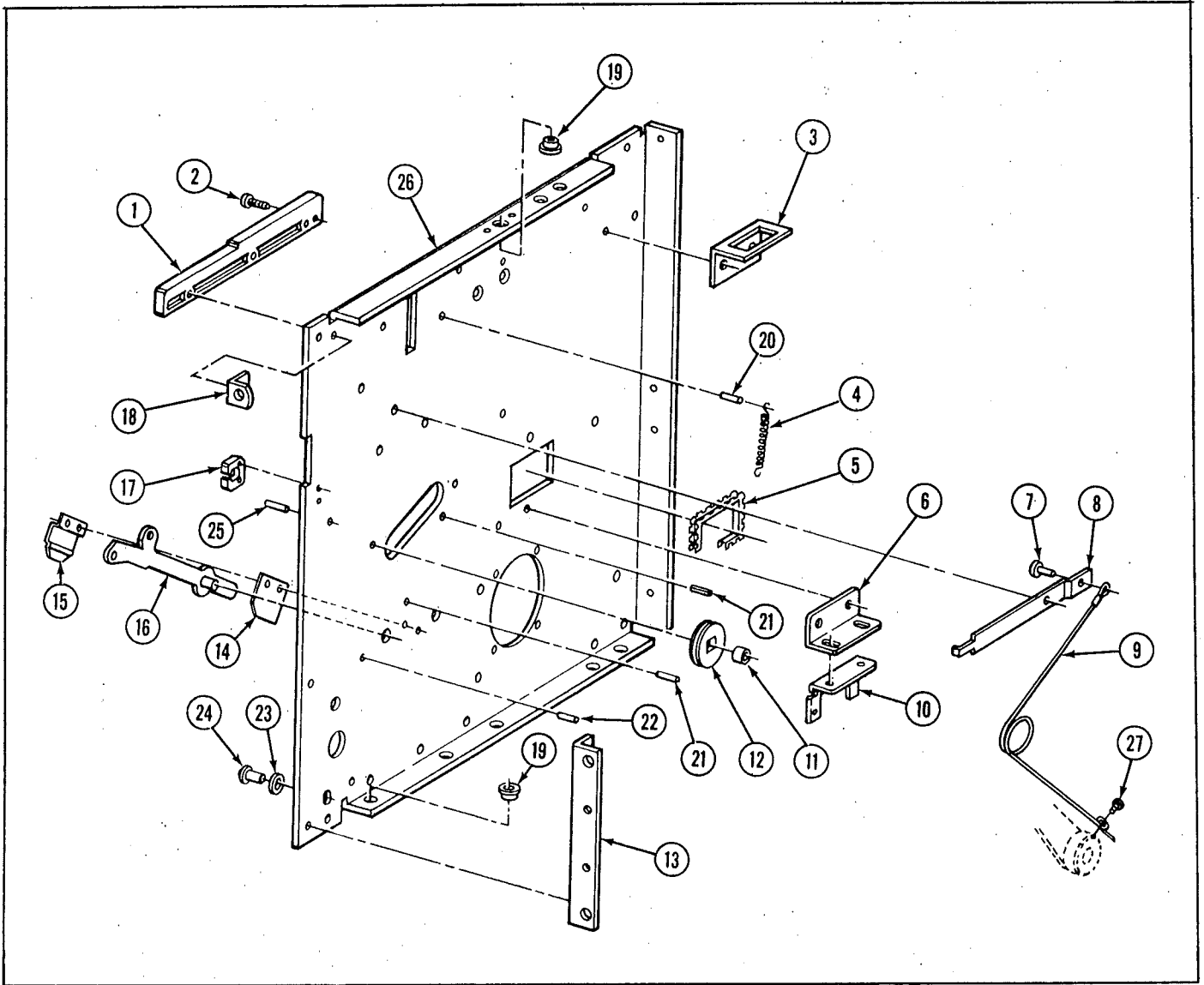
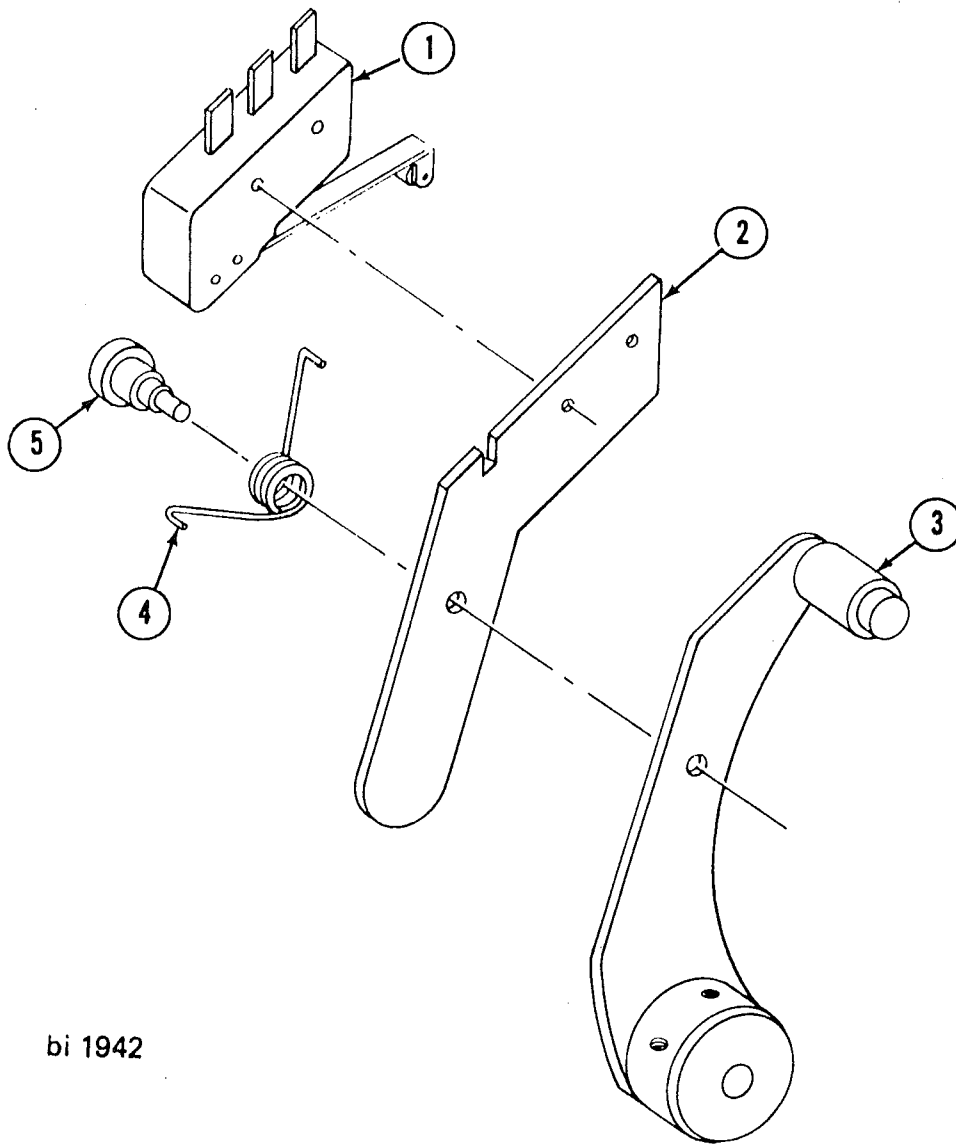


FIGURE 6-13 R.H. PLATE ASSEMBLY

EXPLODED VIEW PARTS LIST
2200S SERIES RECORDER — All Models
SENSOR ASSEMBLY
FIGURE 6-14

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
1	783590	Sensor Assembly	S-102
2	286154	Switch, Sensitive	
3	286386	Arm Switch	
4	743915	Arm Assy, Sensor	
5	286385	Spring, Torsion	
	286384	Pin	



bi 1942

FIGURE 6-14 SENSOR ASSEMBLY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER – All Models
 TABLE ASSEMBLY, WRITING
 FIGURE 6-15

ITEM NUMBER	PART NUMBER	DESCRIPTION
1	887393	Table Assy, Writing
2	787396	Bar Assy, Writing
3	687390	Paper Release Assy
4	343616-910	Support Assy, Right
5	4-112468-21	Roll Pin
6	1-210761-6	Bearing, Ball
7	286974	Roll, Pressure
8	685620-1	Bar Assy, Pull
9	243867-1	Packing, Preformed
10	343617-910	Support Assy, Left
	243855-1	Catch, Friction

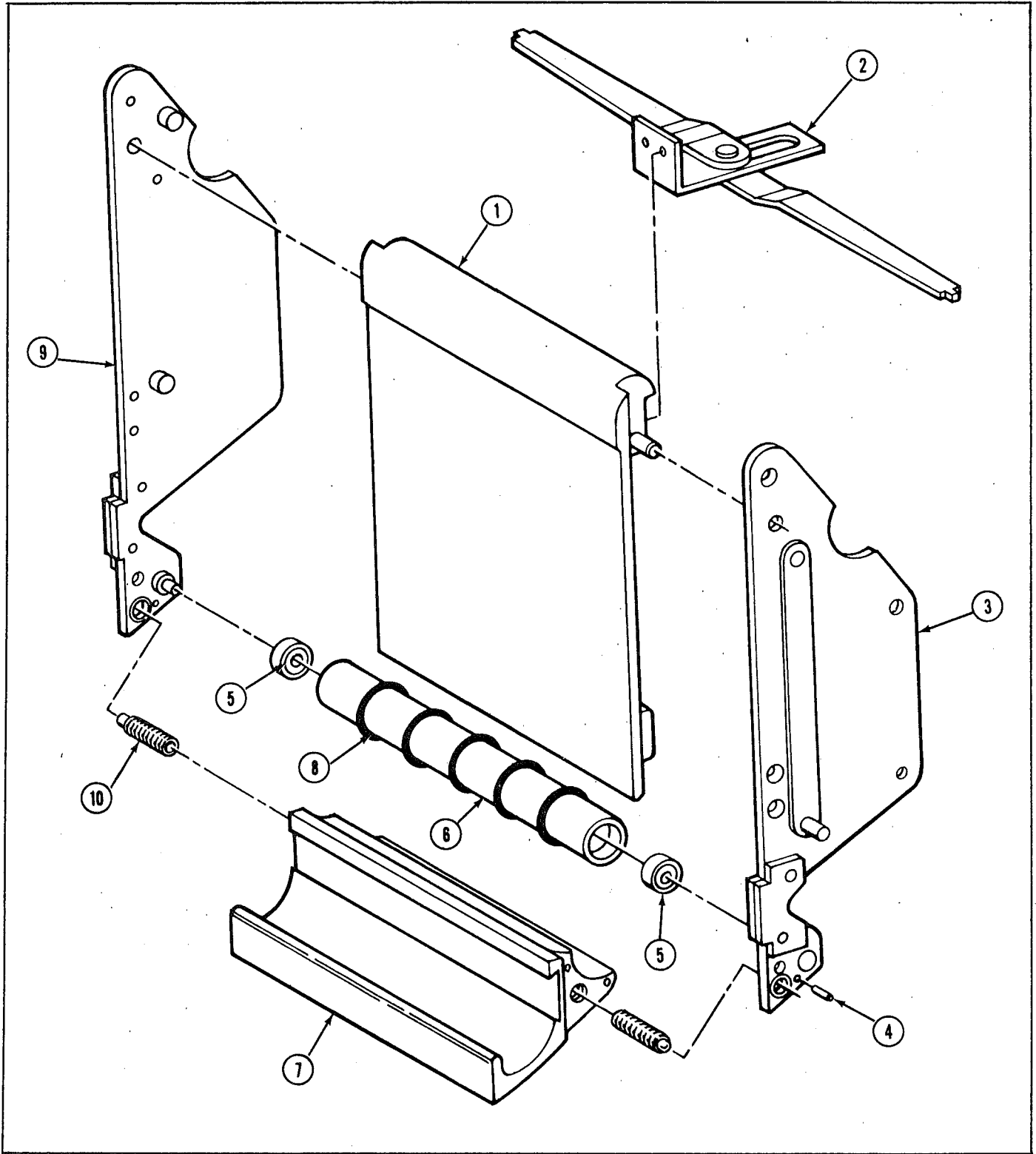


FIGURE 6-15 WRITING TABLE ASSY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER
 CASE ASSEMBLY
 FIGURE 6-16

ITEM NUMBER	PART NUMBER	DESCRIPTION	USED ON
	887336	Case Assembly	130-1 & 2
	887334	Case Assembly	130-XP
1	486081	Side Panel	
2	785099-7	Handle Assembly	130-1 & 2
	785099-6	Handle Assembly	130-XP
		consisting of:	
	286050	Slide, Handle	
	686074-7	Handle	130-1 & 2
	686074-6	Handle	130-XP
3	686049-7	Cover, Center	130-1 & 2
	686049-6	Cover, Center	130-XP
4	286048	Support, Handle	
5	486075-2	Guide, Left	
6	486075-1	Guide, Right	
7	686051-7	Cover, Front & Rear	130-1 & 2
	686051-6	Cover, Front & Rear	130-XP
8	1-232736-16	Tape, Teflon	
9	3-266107-5	Bail Assembly	
10	487326	Saddle Assembly	130-1 & 2
	887328	Saddle Assembly	130-XP
11	287185	Bar Support	

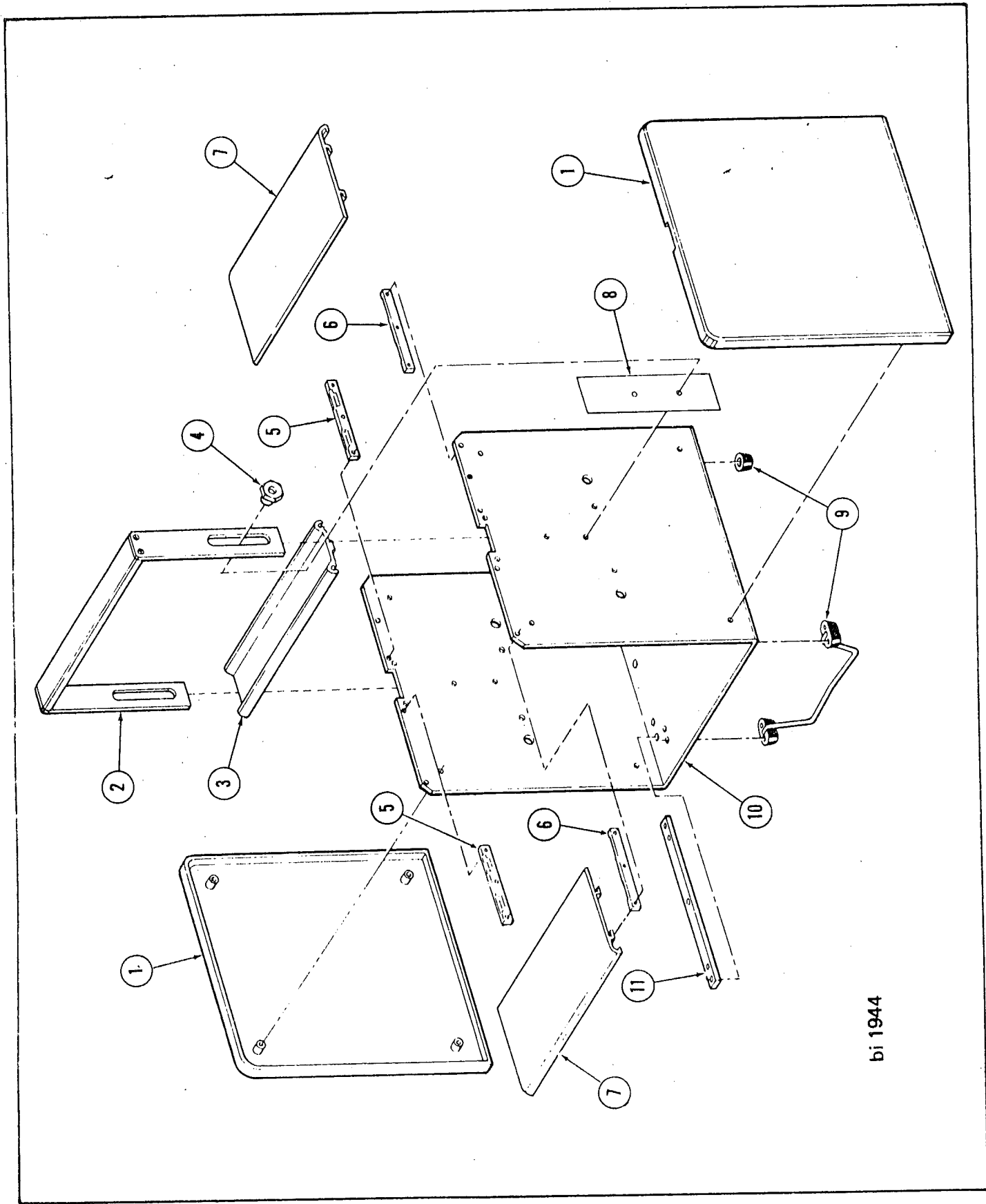


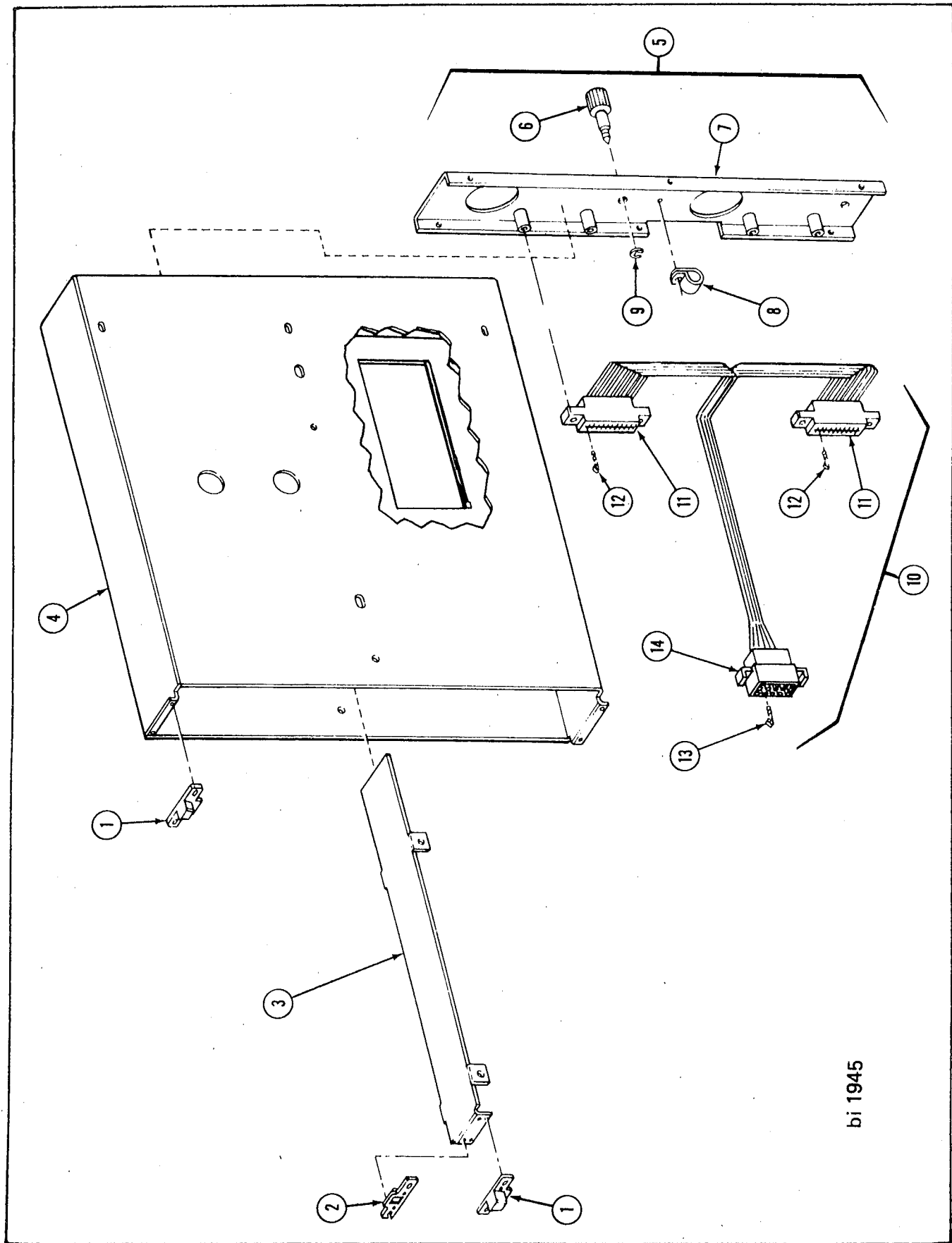
FIGURE 6-16 CASE ASSEMBLY

bi 1944

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER
 CAGE ASSEMBLY PREAMP
 FIGURE 6-17

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
1	888321 786056-1 786056-2	Cage Assembly, Preamp, 2 Channel Guide, Engraved "1" Guide, Engraved "2"	
2	386058-2	Guide, Preamp	
3	386476	Shelf	
4	486461	Enclosure, Preamp	
*5	788280	Cage Assembly, Rear consisting of:	
6	286052	Screw, Shoulder	
7	786475	Panel Assembly, Rear	
8	234623-6	Clamp, Loop	
9	3-240731-10	Ring, Retaining	
10	787422	Harness Assembly consisting of:	
11	286410-16	Connector	XA201,202
12	1-283408-2	Contact (for item 11)	
13	270153-1	Contact (for item 14)	
14	9-270158-15	Connector	P203

*Item 5, Cage Assembly—Rear, not procurable. Use indented items 6 thru 14 or Preamp Cage Assembly at top of list.



bi 1945

FIGURE 6-17 CAGE ASSEMBLY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER — All Models
 CHART TAKE-UP ASSEMBLY 11-6402-13
 FIGURE 6-18

ITEM NUMBER	PART NUMBER	DESCRIPTION
1	249617-4	Plate Cover - R
2	243867-12	"O" Ring
3	246651	Roller, Guide
4	246307	Block
5	236865-3	Cotter Pin
6	266046	Pulley
7	9-249640-8206	Screw, Flat Head
8	767254-5	Arm Assembly — L.H.
9	687668	Shaft Assembly
10	247523-117	Plate Ident. Model No.
11	767249-5	Arm Assembly - R.H.
12	249618-4	Plate Cover - L
13	267253	Spring, Compression
14	266184	Shaft, Shouldered
15	667251	Shaft Assembly, Shouldered
16	243696	Retainer, Bearing
17	267257	Pulley
18	31-119918-8208	Screw, Pan Head (Not Shown) For holding Chart Takeup Assy to Recorder

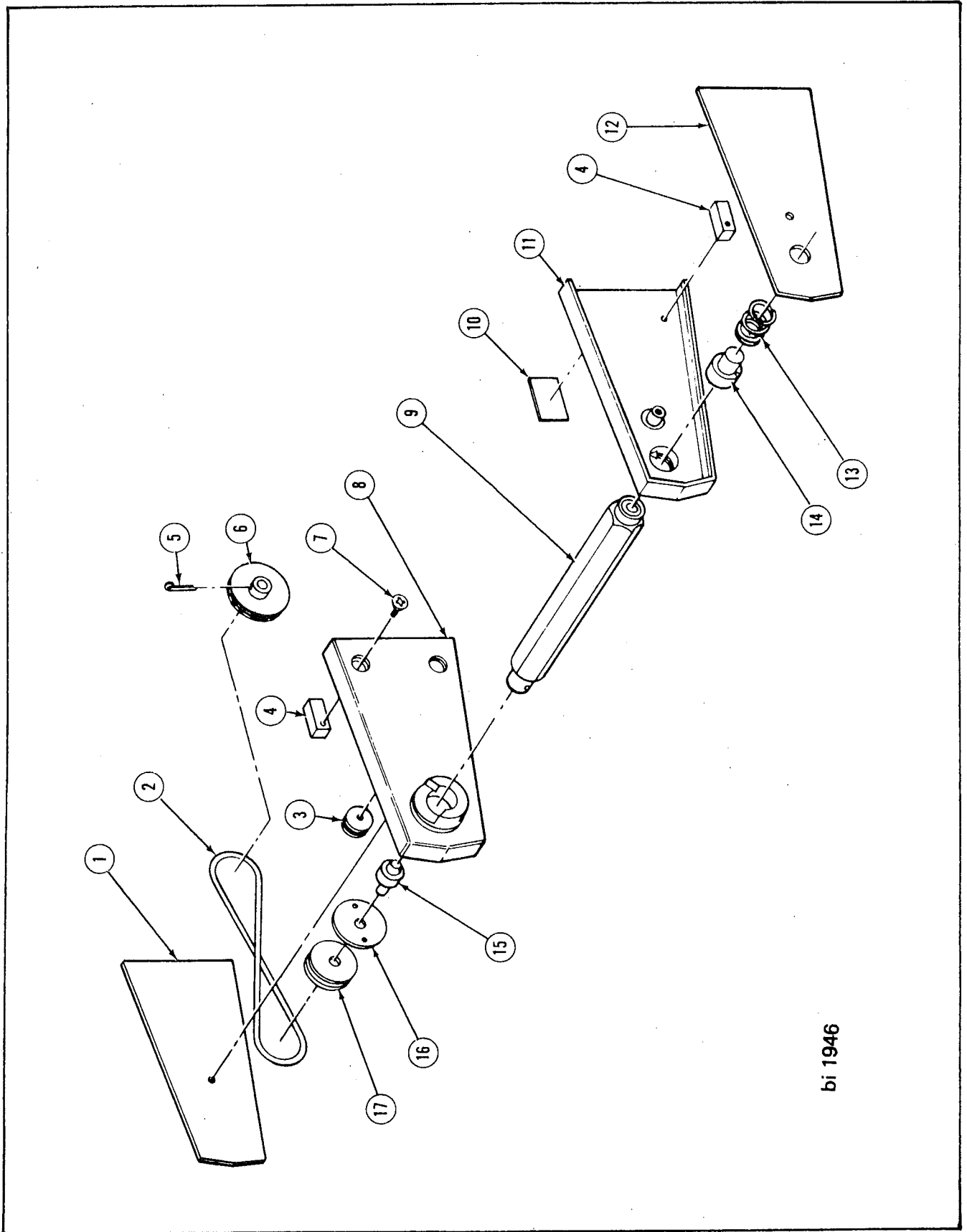


FIGURE 6-18 CHART TAKE-UP ASSEMBLY

bi 1946

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER – All Models
 DAMPER ASSY
 FIGURE 6-19

ITEM NUMBER	PART NUMBER	DESCRIPTION
	694166	Damper Assy
1	694165	Pulley Assy, Damper
2	240889-2	Bearing, Sleeve
3	294163	Link, Damper - Drive (A-P)
	31-119923-8206	Screw, Set -----*
4	294140	Pad, Damper
5	127711-6	Bearing, Sleeve
6	294162	Plate, Cover (A-P)
	31-119920-4006	Screw, Flat Hd. -----*

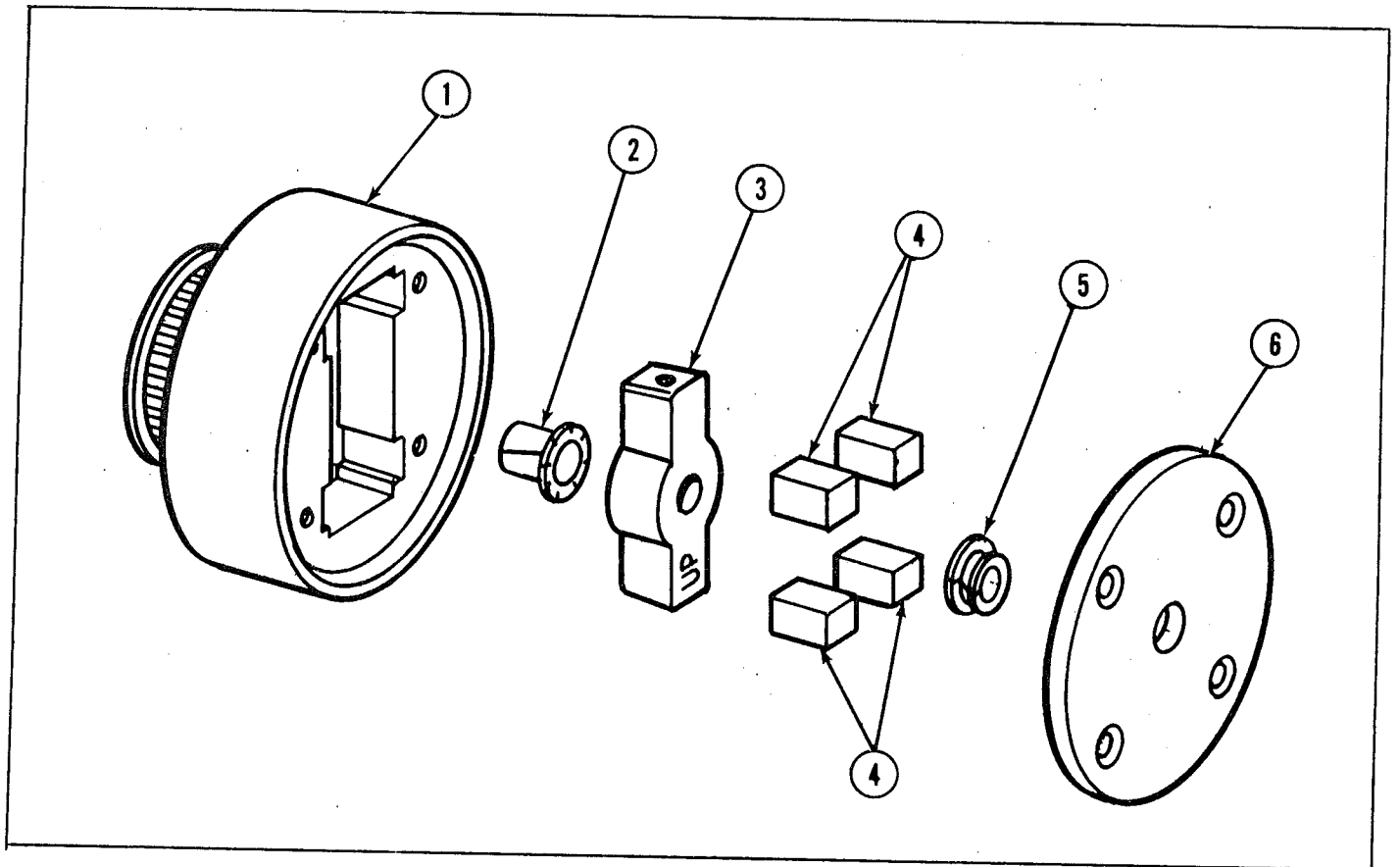


FIGURE 6-19 DAMPER ASSY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER – ALL MODELS
 BOARD ASSEMBLY PROCESSOR – 893617
 FIGURE 6-20

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C405, C410	288755-104	Capacitor .1 μ fd @ 50V
C413, C422	288755-104	Capacitor .1 μ fd @ 50V
C425, C427	288755-104	Capacitor .1 μ fd @ 50V
C430	288755-104	Capacitor .1 μ fd @ 50V
C403, C404	280865-156	Capacitor 15 μ fd @ 20V
C406, C417	280865-156	Capacitor 15 μ fd @ 20V
C420	280865-156	Capacitor 15 μ fd @ 50V
C407	20-285066-1	Capacitor 1 μ fd @ 50V
C408	282927-502	Capacitor .005 μ fd
C409	283943-476	Capacitor 47 μ fd @ 20V
C416, C426	20-290244-107	Capacitor 100 μ fd @ 10V
C428, C429	294069-104	Capacitor .1 μ fd @ 10V
C414, C415	294069-104	Capacitor .1 μ fd @ 10V
CR401, 405	280440	Diode IN4148
J401	294310-4	Connector
J402, J404	294310-6	Connector
J403	294310-9	Connector
J405	294310-3	Connector
J406	294063-7	Connector
Q401	286143	Transistor 2N3906

EXPLODED VIEW PARTS LIST CONT'D
 2200S SERIES RECORDER – ALL MODELS
 PROCESSOR 893617
 FIGURE 6-20

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R401, 416	5-241111-102	Resistor 1K ohm
R402	5-241111-103	Resistor 10K ohm
R403	1-281851-20001	Resistor 20K ohm
R404, 430	5-241111-103	Resistor 10K ohm
R405, 407	5-241111-512	Resistor 5.1K ohm
R408	5-241111-910	Resistor 91 ohm
R409	1-281851-12101	Resistor
R406	1-281851-43200	Resistor 12.1K ohm
R410	5-241111-470	Resistor 47 ohm
R411, 415	1-281851-10002	Resistor 100K ohm
R412, R428	1-281851-10001	Resistor 10K ohm
R413, 417	5-241111-472	Resistor 4.7K ohm
R414	5-241111-274	Resistor 270K ohm
R418	5-241111-433	Resistor 43K ohm
R419	5-241111-332	Resistor 3.3K ohm
R420	5-241111-912	Resistor 9.1K ohm
R425	5-241111-102	Resistor 1K ohm
R426	1-281851-43200	Resistor 4.32K ohm
R427	5-241111-104	Resistor 100K ohm
R429, 431	5-241111-102	Resistor 1K ohm
R433, 434	5-241111-512	Resistor 5.1K ohm
R437	5-241111-102	Resistor 1K ohm
R432	269085-502	Variable P.C. 5K ohm
R435	5-241111-222	Resistor 2.2K ohm
RN401	1-283274-102	Resistor Network 1K ohm
S-401	286142-8	Switch, Dip 206-8

EXPLODED VIEW PARTS LIST CONT'D
 2200S SERIES RECORDER – ALL MODELS
 PROCESSOR 893617
 FIGURE 6-20

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
U401	289243	Integ. Ckt. MC4024
U401, U408	290169-74	Integ. Ckt. 74LS74
U402	290169-04	Integ. Ckt. 74LS04
U403	287613	Integ. Ckt. NE555
U404	293086	Integ. Ckt. LM331
U405, U406	290169-390	Integ. Ckt. 74LS390
U407	290169-390	Integ. Ckt. 74LS390
U409	283948	Integ. Ckt. LM1458
U410, U417	284433-1	Integ. 74125
U411, U413	290169-74	Integ. 74125 74LS74
U412	290169-00	Integ. Ckt. 74LS00
U414	290169-85	Integ. Ckt. 74LS85
U415, U420	290169-155	Integ. Ckt. 74LS155
U416, U418	290169-74	Integ. Ckt. 74LS74
U419	290169-95	Integ. Ckt. 74LS95
U421	290169-393	Integ. Ckt. 74LS393
U422	290169-374	Integ. Ckt. 74LS74
U423, U425	293085	Integ. Ckt. AD7524
U426	293085	Integ. Ckt. AD7524
U424	287740	Integ. Ckt. LM324
U427	293090	Integ. Ckt. 6502
U428	290169-244	Integ. Ckt. 74LS244
U429	291587	Integ. Ckt. 6810
U430	695128-00	Integ. Ckt. Prog. B2708
Y-401	289053-4	Crystal

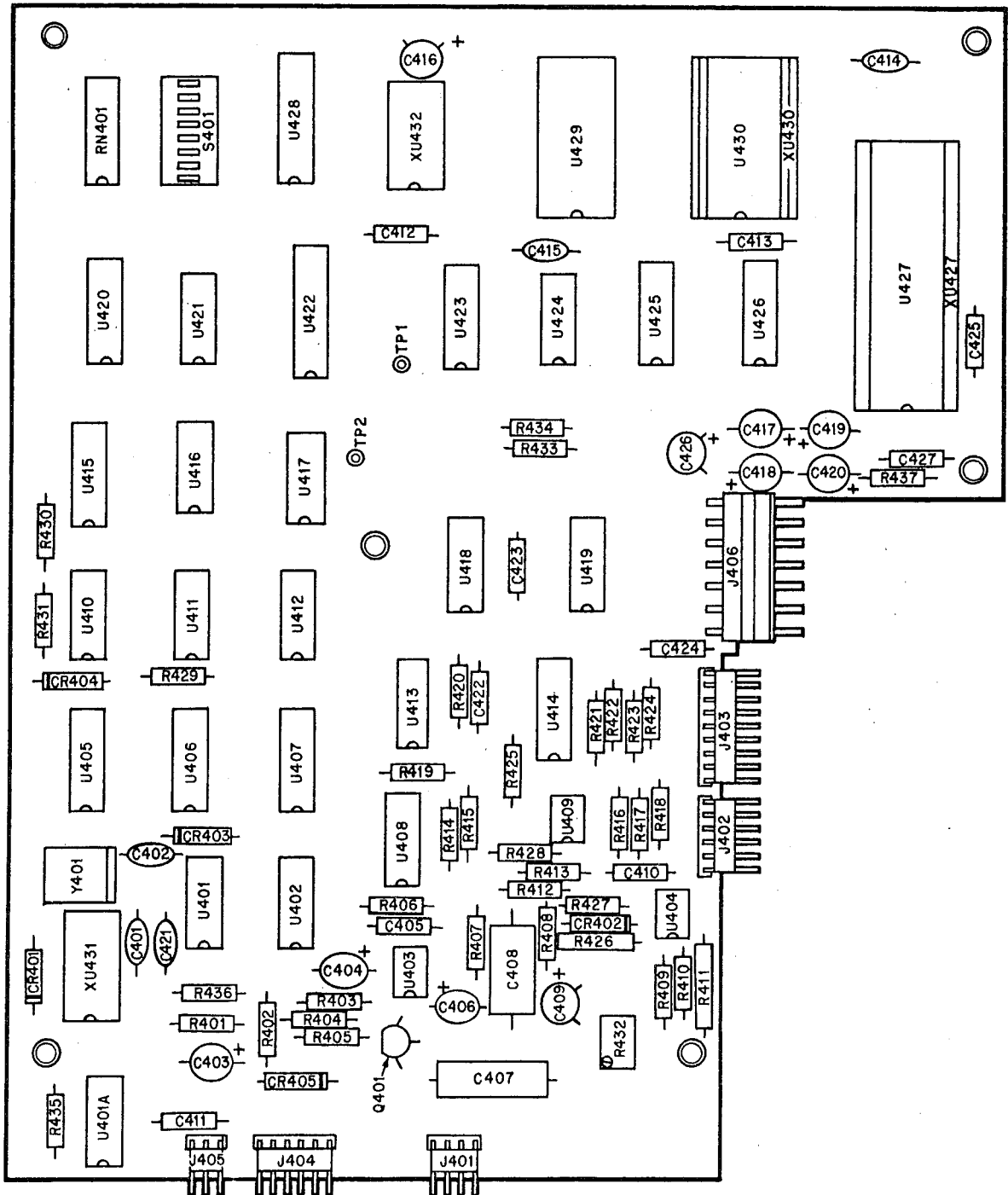


FIGURE 6-20 PROCESSOR BOARD ASSY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER – ALL MODELS
 BOARD ASSY SWITCHING AMP – 893618
 FIGURE 6-21

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C501, 502	283943-476	Capacitor 47 μ fd @ 20V
C503	10-125904-602	Capacitor .006 μ fd @ 25V
CR501, 502	289662	Diode IN914
CR503, 504	289662	Diode IN914
CR505, 507	284425-1	Diode IN5550
CR506, 508	289662	Diode IN914
CR509, 511	284425-1	Diode IN5550
CR510	289662	Diode IN914
J501	294310-6	Connector
J502	294063-8	Connector
J503	294063-4	Connector
Q501-Q508	294066-1	Transistor 2N611
Q509	286143	Transistor 2N3906
Q510, 511	286141	Transistor 2N3904
R501, 10	5-241111-512	Resistor 5.1K ohm
R502, 504	5-241111-103	Resistor 10K ohm
R503, 533	5-241111-272	Resistor 2.7K ohm
R505, 508	5-241111-102	Resistor 1K ohm
R506	5-241111-183	Resistor 18K ohm
R507	5-241111-274	Resistor 270K ohm
R509, 520	5-241111-123	Resistor 12K ohm
R511, 518	5-241111-225	Resistor 2.2M ohm
R512, 513	5-241111-912	Resistor 9.1K ohm
R514, 519	5-241111-202	Resistor 2K ohm
R521, 538	5-241111-152	Resistor 1.5K ohm
R515, 526	5-241111-512	Resistor 5.1K ohm
R516, 517	5-241111-912	Resistor 9.1K ohm
R522, 524	5-241111-123	Resistor 12K ohm

EXPLODED VIEW PARTS LIST CONT'D
 2200S SERIES RECORDER — ALL MODELS
 BOARD ASSY SWITCHING AMP — 893618
 FIGURE 6-21

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R523, 550	5-241111-102	Resistor 1K ohm
R525, R544	5-241111-103	Resistor 10K ohm
R527, R529	5-115558-331	Resistor 330 ohm
R528, 530	5-241111-471	Resistor 470 ohm
R531, 558	1-294064-00R5	Resistor .5 ohm
R532, 536	5-241111-512	Resistor 5.1K ohm
R534, 561	5-241111-182	Resistor 1.8K ohm
R535, 539	5-241111-123	Resistor 12K ohm
R537, 560	5-241111-272	Resistor 2.7K ohm
R540, 567	5-241111-122	Resistor 1.2K ohm
R541, 549	5-241111-123	Resistor 12K ohm
R542, 546	5-241111-331	Resistor 330 ohm
R543, 547	5-241111-471	Resistor 470 ohm
R548, 566	5-241111-152	Resistor 1.5K ohm
R545, 53	5-241111-512	Resistor 5.1K ohm
R551, 562	5-241111-123	Resistor 12K ohm
R552, 569	5-241111-103	Resistor 10K ohm
R555, 557	5-241111-471	Resistor 470 ohm
R554, R556	5-115558-331	Resistor 330 ohm
R559, 563	5-241111-512	Resistor 5.1K ohm
R564	5-241111-272	Resistor 2.7K ohm
R565, 568	5-241111-123	Resistor 12K ohm
R570	5-241111-512	Resistor 5.1K ohm
R571, 573	5-115558-331	Resistor 330 ohm
R572, 574	5-241111-471	Resistor 470 ohm

EXPLODED VIEW PARTS LIST CONT'D
 2200S SERIES RECORDER – ALL MODELS
 BOARD ASSY SWITCHING AMP – 893618
 FIGURE 6-21

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
U502	286146	Integ. Ckt. LM339
U503, 505	293093	Transistor MPQ3904
U504	293094	Transistor MPQ3906
U506, 507	293093	Transistor MPQ3904
	493618	Board P.C.
	294058	Plate

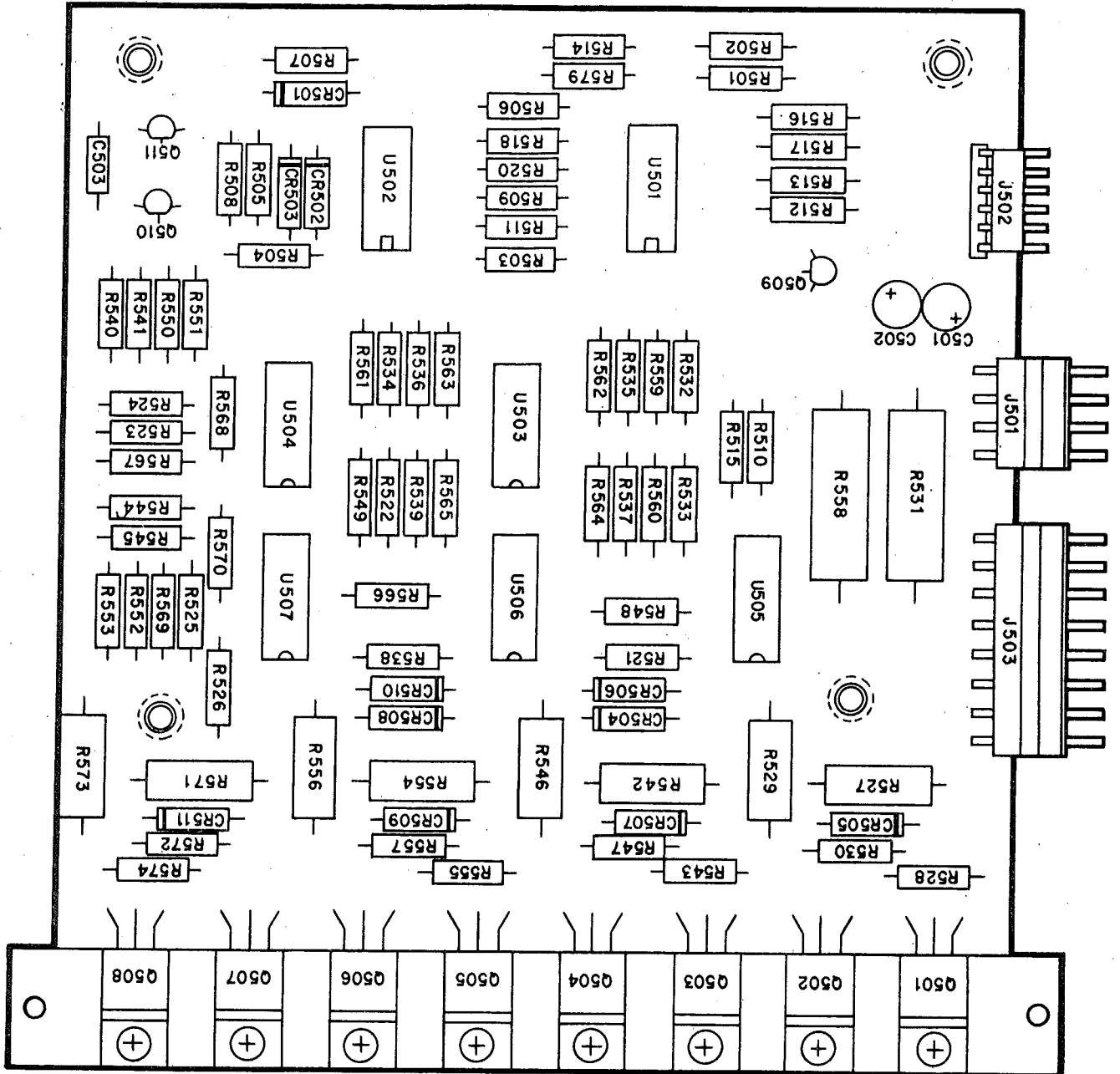


FIGURE 6-21 SWITCHING AMP BOARD ASSY

EXPLODED VIEW PARTS LIST
 2200S SERIES RECORDER — ALL MODELS
 BOARD ASSY POWER SUPPLY — 893619
 FIGURE 6-22

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C301	294302-588	Capacitor 5800 μ fd @ 40V
C302	286010-108	Capacitor 1000 μ fd @ 50V
C303	294301-908	Capacitor 9000 μ fd @ 25V
C304, C306	288755-474	Capacitor .47 μ fd @ 50V
C310, C311	288755-474	Capacitor .47 μ fd @ 50V
C307, 309	280865-156	Capacitor 15 μ fd @ 20V
C312, 313	280865-156	Capacitor 15 μ fd @ 20V
C314	20-290244-107	Capacitor 1000 μ fd @ 10V
CR301	283651-2	Diode MDA970-2
CR302, 303	286018-2	Rectifier KBP04
CR304	269256-7	Diode IN4007
J301	281711-6	Connector 6 Pins
J302	281711-8	Connector 8 Pins
J303	281711-7	Connector 7 Pins
J304	281711-4	Connector 4 Pins
J305	281711-3	Connector 3 Pins
K301	289048-24	Relay
U301	285461	Regulator 7815
U302	285778	Regulator 7915
U303	285317	Regulator 7805
U304	289387	Regulator 78L12
U305	289897	Regulator 79L05
	493619	Board P.C.
	694057	Heatsink
L301, 302	291224-1	Inductor 8.2 μ H.
L303	291224-1	Inductor 8.2 μ H.

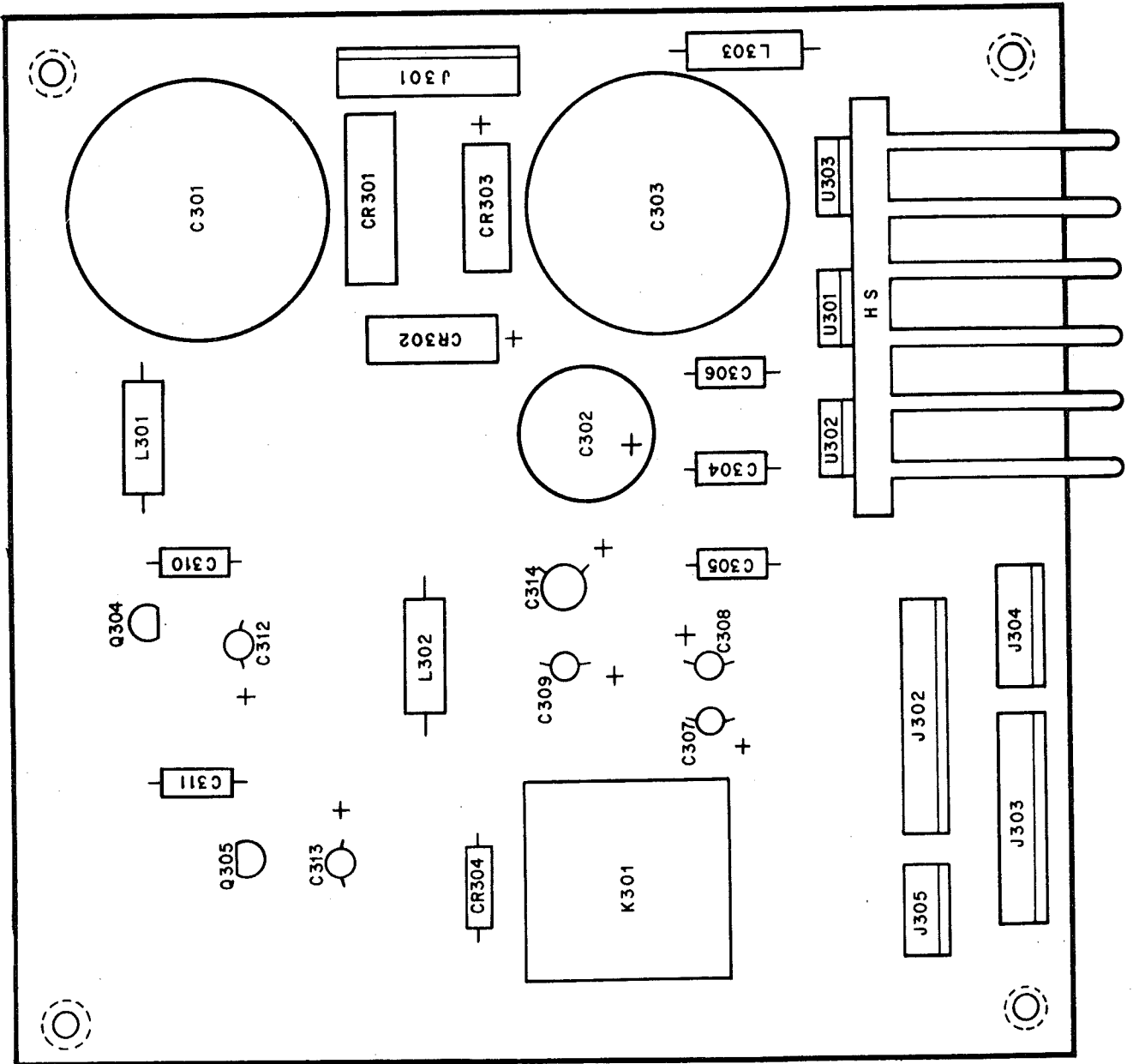


FIGURE 6-22 POWER SUPPLY BOARD ASSY

EXPLODED VIEW PARTS LIST 2200S SERIES RECORDERS
 RACK MOUNT INSTALLATION INSTRUCTIONS —
 RECORDER ONLY (688007) Kit Model 11-1202-17
 FIGURE 6-23

ITEM NUMBER	PART NUMBER	DESCRIPTION
1**	2007-2X90-XX	Recorder Assy
2	31-119998-02	Nut
3	1-216741-430	Lockwasher
4	287011	Bracket
5	31-119918-0208	Screw
6	31-119998-82	Nut
7	1-216741-425	Lockwasher
8	269569-1	Slides, Pair
9	287148	Nut Plate
10	31-119918-8206	Screw
11	287153	Spacer
12	31-119920-0208	Screw
13	487857	Saddle Assy Rack
14	13-262716-4004	Screw
15	387863	Bracket
16	787868	Panel Assy, Front
17	248352-0218	Screw
18	245244-02	Nut
19	Not Used	
20	287653	Spring, Rack Lock
	269569-2	* Front Bracket (Part of item 8)
	269569-3	* Rear Bracket (Part of item 8)
	269569-4	* Nut Bar (Part of item 8)

* Order separately from item 8.
 ** Not included with kit.

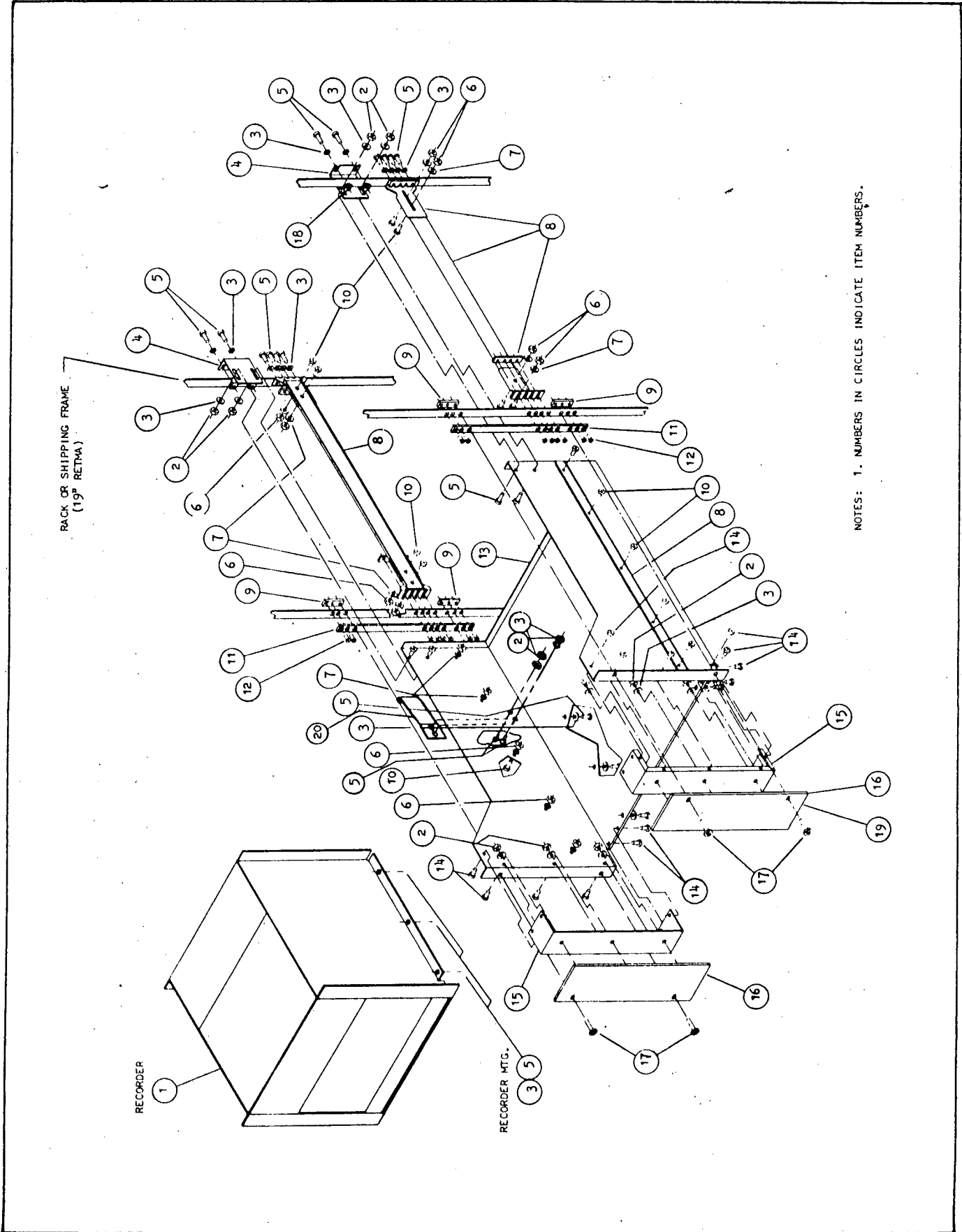
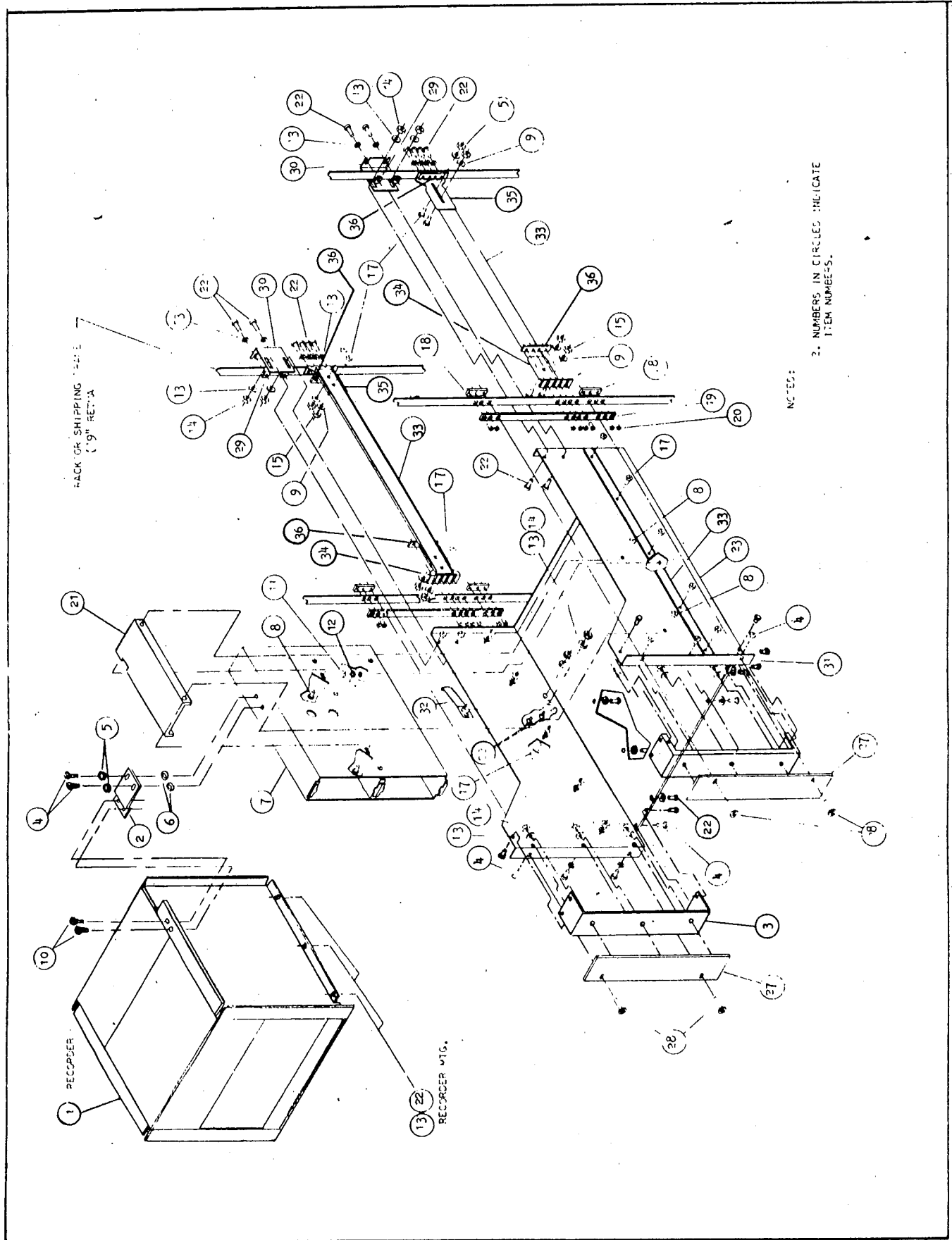


FIGURE 6-23 RACK MOUNT INSTALLATION, RECORDER ONLY

**EXPLODED VIEW PARTS LIST 2200 SERIES RECORDERS
RACK MOUNT INSTALLATION INSTRUCTIONS
Recorder with Preamp Cage (688008) Kit Model 11-1202-18
FIGURE 6-24**

ITEM NUMBER	PART NUMBER	DESCRIPTION
1**	2007-2X90-XX	Recorder Assy
2	293035	Bracket Support
3	387863	Bracket
4	13-262716-4004	Screw
5	10-120053-101	Lockwasher
6	1-118195-305	Washer, Plain
7**	886494	Cage Assy
8	13-262716-8204	Screw
9	1-216741-425	Lockwasher
10	13-262716-4004	Screw
11	13-262716-8204	Screw
12	10-120053-103	Lockwasher
13	1-216741-430	Lockwasher
14	31-119998-02	Nut
15	31-119998-82	Nut
16	13-262716-4006	Screw
17	31-119918-8206	Screw
18	287148	Nut Plate
19	287153	Spacer
20	31-119920-0208	Screw
21	287856	Bracket
22	31-119918-0208	Screw
23	487857	Saddle Assy, Rack
24	Not Used	
25	Not Used	
26	Not Used	
27	787870	Panel Assy, Front
28	248352-0218	Screw
29	245244-02	Nut
30	287011	Bracket
31	Not Used	
32	287653	Spring, Rack Lock
33	269569-1	Slides, Pair
34	269569-2	Front Bracket
35	269569-3	Rear Bracket
36	269569-4	Bar, Nut

** Not included with Kit.



NOTES:
 2. NUMBERS IN CIRCLED INDICATE ITEM NUMBERS.

FIGURE 6-24 RACK MOUNT INSTALLATION, RECORDER WITH PREAMP CAGE

**APPENDIX
SCHEMATIC DIAGRAMS**

Below is the list of schematic diagrams which apply to this recorder. The schematics follow this page in the order they are listed and include the assembly name and number which they apply to.

SCHEMATIC DIAGRAMS

SCHEMATIC NUMBER	ASSEMBLY NAME	ASSEMBLY NUMBER
294232	Recorder Assembly	2107-2290-XX
292273	Drive Amp Board	886220
293617	Processor Board	893617
293618	Switching Amp Board	893618
293619	Power Supply Board	893619
293620	Speed Select Board	893620
293621	Variable Speed Board	893621
294131	Control Timer Board	894131
294133	Sensor Board	894133
294286	A.C. Distribution Board	894286

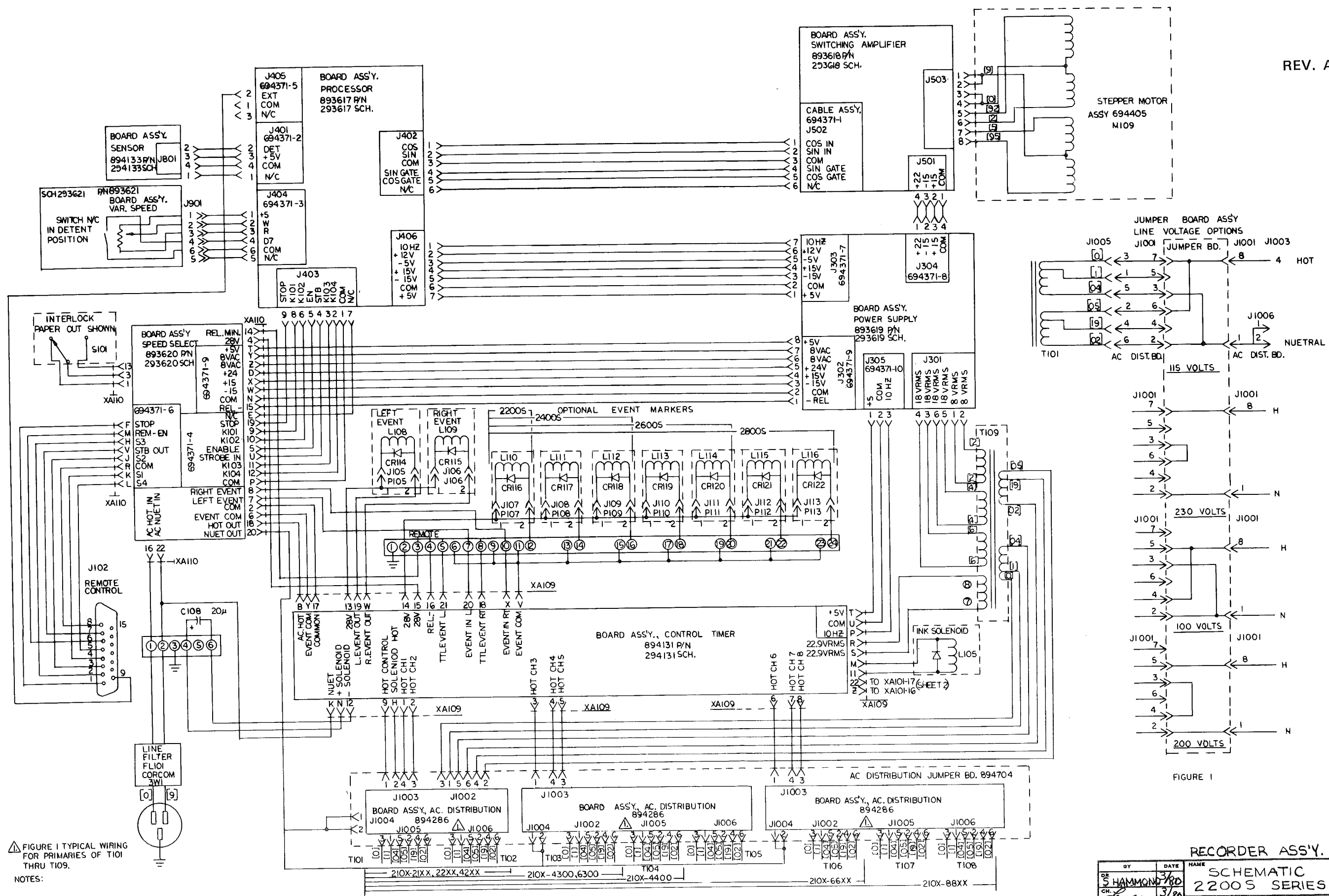


FIGURE 1

△ FIGURE 1 TYPICAL WIRING FOR PRIMARIES OF T101 THRU T109.

NOTES:

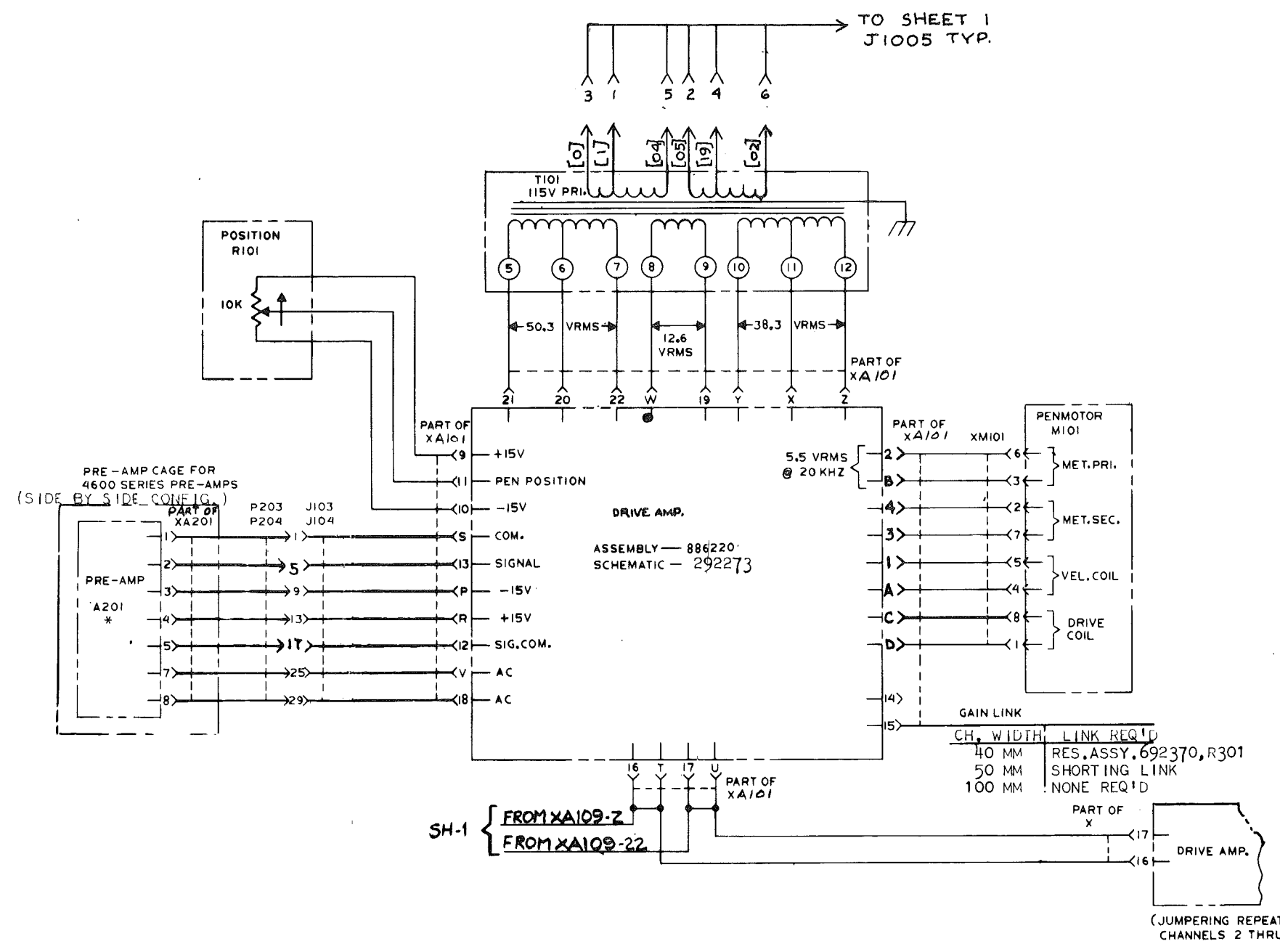
RECORDER ASS'Y. 2107-2290 -XX

BY S. HAMMOND	DATE 3/80	NAME SCHEMATIC	2200S SERIES	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A.
CH. Daniel	3/80	CODE IDENT.	ISSUE G	DWG. NO. 294232
APP Daniel	3/80	96795	CODE	SHT. 1 OF 2

REVISIONS			
BY	DESCRIPTION	DATE	APPROVAL

CH. 1 THRU 8 CONNECTION TABLE FOR 2400S, 2600S, 2800S RECORDERS

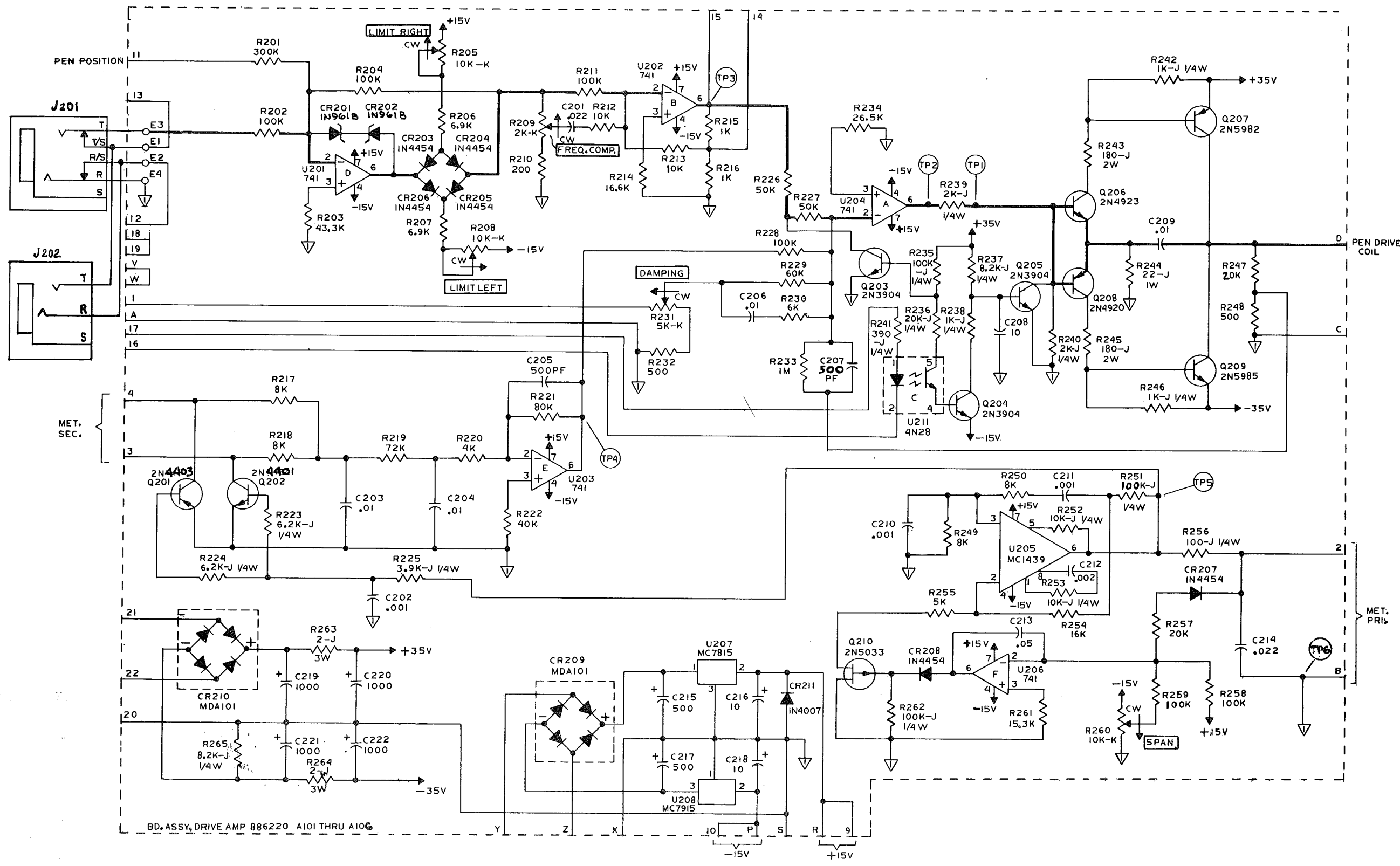
P203/J203 TERM USED							
1	1	5	9	13	17	25	29
2	2	6	10	14	18	26	30
3	3	7	11	15	19	27	31
4	4	8	12	16	20	28	32
P204/J204 TERM USED							
5	1	5	9	13	17	25	29
6	2	6	10	14	18	26	30
7	3	7	11	15	19	27	31
8	4	8	12	16	20	28	32
FOR 2200S RECORDERS							
CH.	P203/J203 TERM USED						
1	1	4	7	10	13	16	14
2	3	6	9	12	15	2	5



RECORDER ASS'Y. 2107-2290-XX

BY	DATE	NAME	S. HAMMOND	Gould Inc.
				Instrument Systems Division
				Cleveland, Ohio 44114 U.S.A.
				DWG. NO. 294232
				ISSUE 6
				PG. 2 OF 2

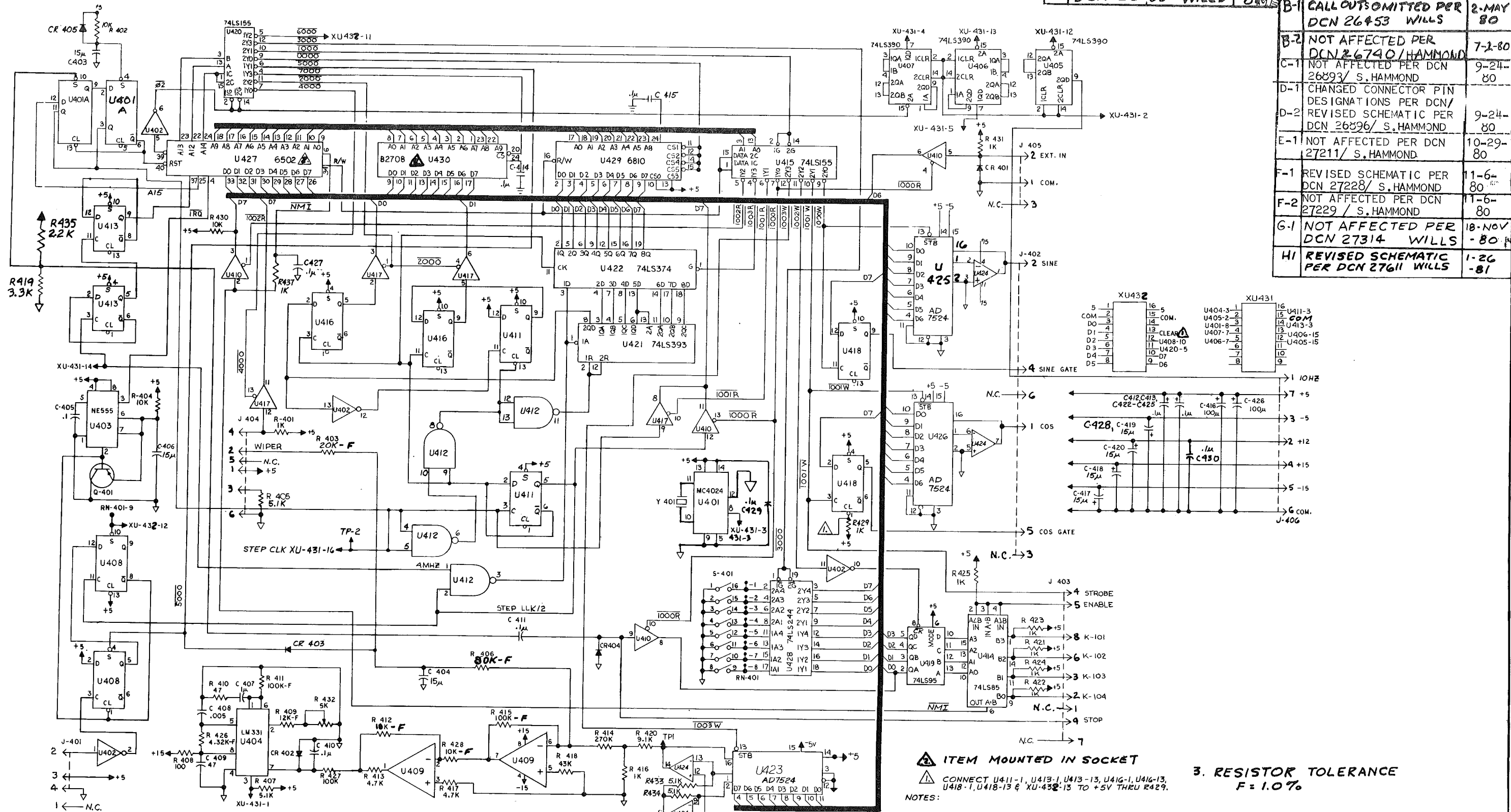
REVISIONS		
SYM.	DESCRIPTION	DATE



BD. ASSY, DRIVE AMP 886220 A101 THRU A106

BY R. CLARK	DATE 1/2/77	NAME SCHEMATIC	DRIVE AMP ASSY, 886220	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A.
CHG. R. CLARK	DATE 2/77	ISSUE 96795	CODE G	DWG NO. 292273

REV. NO.		DESCRIPTION	DATE
J-1	REV SCHEMATIC PER DCN 27651 WILLS	8 FEB 81	
K-1	NOT AFFECTED PER DCN 28135 WILLS	14 MAY 81	
A1	NOT AFFECTED PER DCN 26307/C. WILLS	4-1-80	
B-1	CALLOUTS OMITTED PER DCN 26453 WILLS	2-MAY 80	
B-2	NOT AFFECTED PER DCN 26740/HAMMOND	7-2-80	
C-1	NOT AFFECTED PER DCN 26893/S. HAMMOND	9-24-80	
D-1	CHANGED CONNECTOR PIN DESIGNATIONS PER DCN/REVISED SCHEMATIC PER DCN 26896/S. HAMMOND	9-24-80	
D-2			
E-1	NOT AFFECTED PER DCN 27211/S. HAMMOND	10-29-80	
F-1	REVISED SCHEMATIC PER DCN 27228/S. HAMMOND	11-6-80	
F-2	NOT AFFECTED PER DCN 27229/S. HAMMOND	11-6-80	
G-1	NOT AFFECTED PER DCN 27314 WILLS	18-NOV-80	
HI	REVISED SCHEMATIC PER DCN 27611 WILLS	1-26-81	



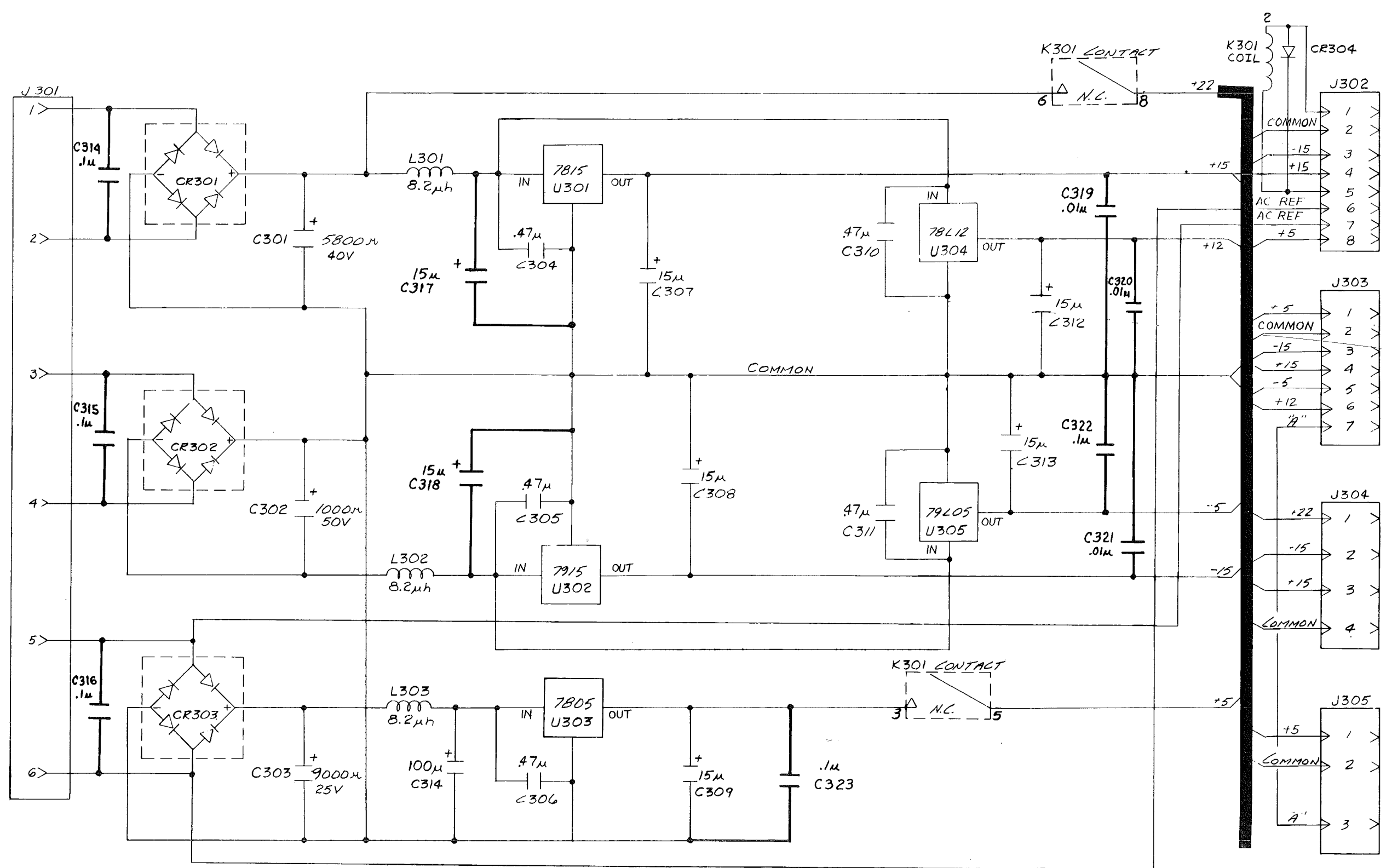
ITEM MOUNTED IN SOCKET
 CONNECT U411-1, U413-1, U413-13, U416-1, U416-13, U418-1, U418-13 & XU-432-13 TO +5V THRU R429.

3. RESISTOR TOLERANCE
 F = 1.0%

BD. ASS'Y,
 PROCESSOR 893617

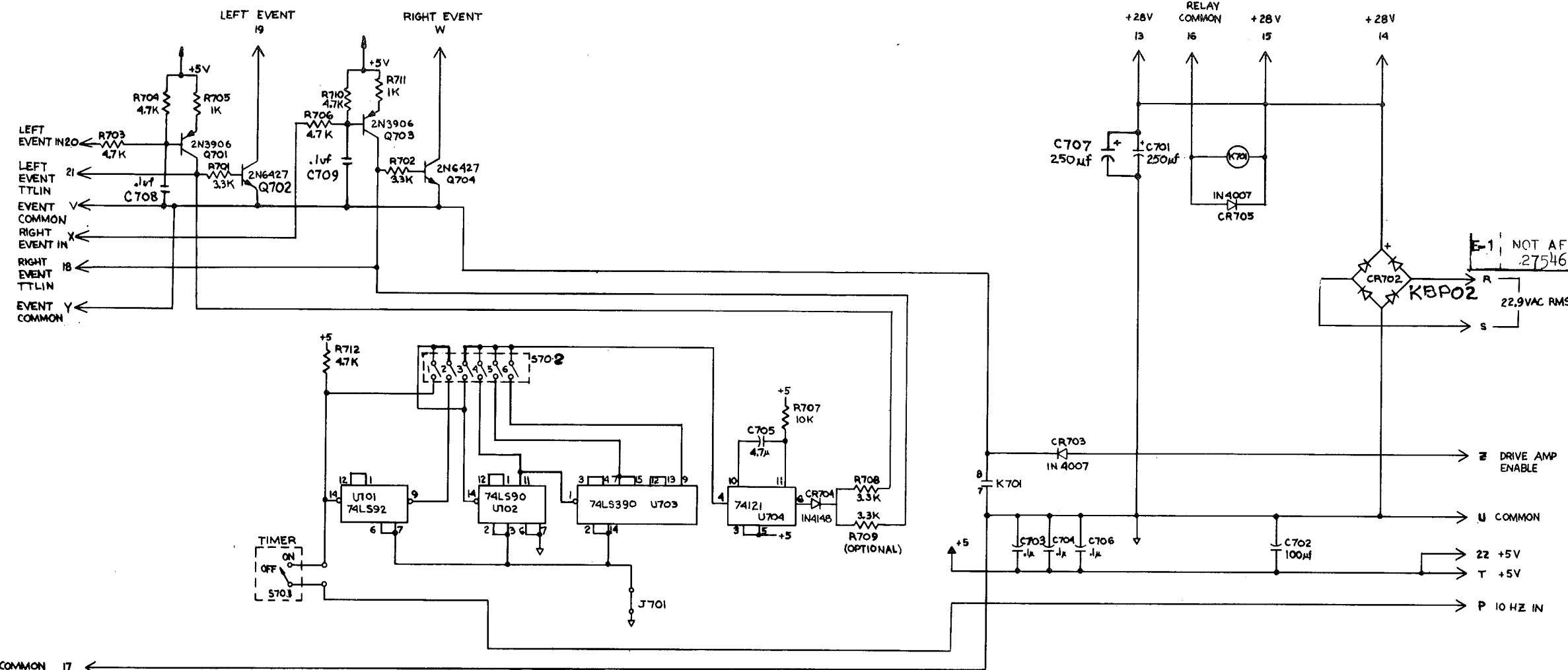
BY WILLS	DATE 3/80	NAME SCHEMATIC	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A. DWG. NO. 293617
CH. Hammond	3/80	CODE IDENT. 96795	ISSUE G
APP. Daniel	3/80		

REV. D-1

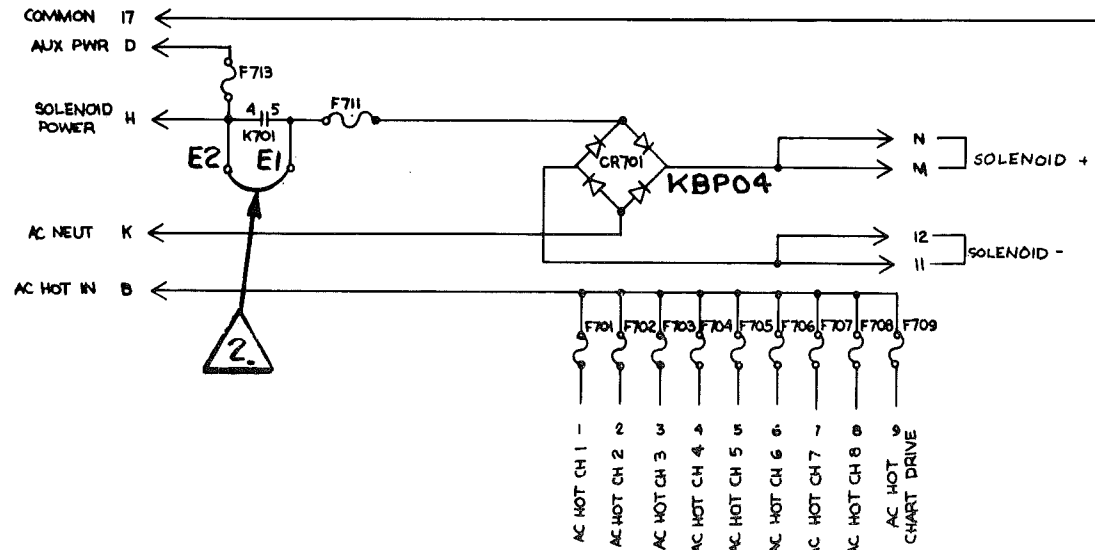


BD. ASS'Y.,
POWER SUPPLY 893619

BY	DATE	NAME	SCHEMATIC	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A. DWG. NO. 293619
WILLS	3/80			
CH			CODE IDENT.	ISSUE
Ben D	3/80		96795	6



E-1 NOT AFFECTED PER DCN 27546 / C.WILLS 1-15-81



REP RATE	SW ON	SW OFF
.1 SEC.	1,3	2,4,5,6
1 SEC.	1,4	2,3,5,6
10 SEC.	1,5	2,3,4,6
100 SEC.	1,6	2,3,4,5
.01 MIN.	2,3	1,4,5,6
.1 MIN.	2,4	1,3,5,6
1 MIN.	2,5	1,3,4,6
10 MIN.	2,6	1,3,4,5

	FOR-00	FOR-01	FOR-06	FOR-07
F701-F708	3/4 A. 250V	1 A. 250V	3/8 A. 250V	1/2 A. 250V
F709	1 A. 250V	1/2 A. 250V	1/2 A. 250V	3/4 A. 250V
F711 W/2 INK SOLENOIDS	1/2 A. 250V	1/2 A. 250V	1/4 A. 250V	1/4 A. 250V
F711 W/1 INK SOLENOID	1/4 A. 250V	1/4 A. 250V	1/8 A. 250V	1/8 A. 250V

-00=115V
 -01=100V
 -06=230V
 -07=200V

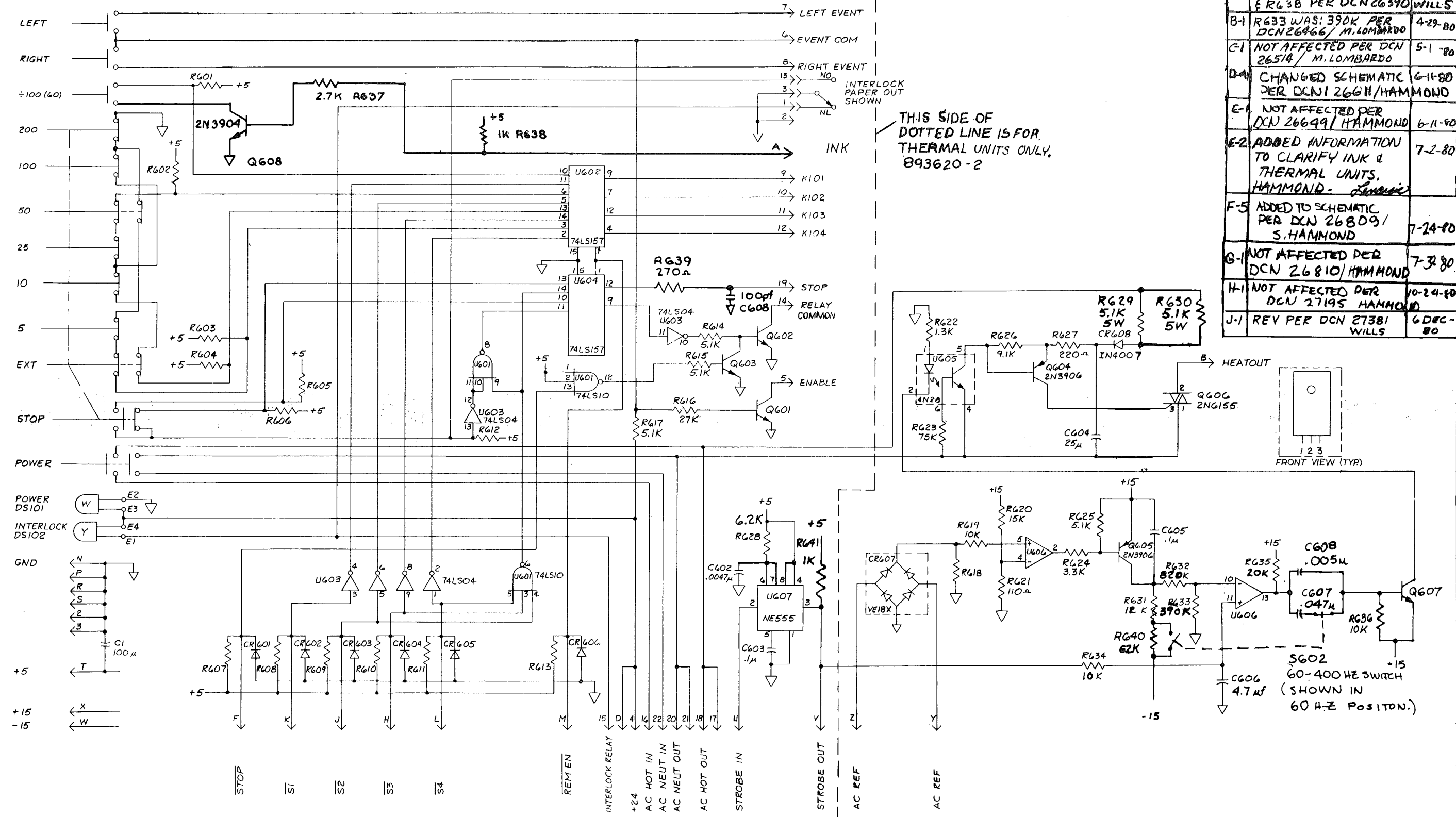
BD ASS'Y., CONTROL 894131

2. ADD JUMPER, FOR THERMAL USE ONLY
 1. ALL RESISTORS ARE 1/4 W, ±5%

NOTES:

BY DR. WILLS 3/80	DATE 3/80	NAME SCHEMATIC	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A. Dwg. No. 294131
CH. D. Wills	ISSUED 96795	REVIS G	

REVISIONS		
SYM	DESCRIPTION	DATE
A-1	ADDED Q608, R637 & R638 PER DCN 26390	4-24-80
B-1	R633 WAS: 390K PER DCN 26466 / M. LOMBARDO	4-29-80
C-1	NOT AFFECTED PER DCN 26514 / M. LOMBARDO	5-1-80
D-1	CHANGED SCHEMATIC PER DCN 26611 / HAMMOND	6-11-80
E-1	NOT AFFECTED PER DCN 26649 / HAMMOND	6-11-80
E-2	ADDED INFORMATION TO CLARIFY INK & THERMAL UNITS. HAMMOND - <i>S. Hammond</i>	7-2-80
F-5	ADDED TO SCHEMATIC PER DCN 26809 / S. HAMMOND	7-24-80
G-1	NOT AFFECTED PER DCN 26810 / HAMMOND	7-31-80
H-1	NOT AFFECTED PER DCN 27195 / HAMMOND	10-24-80
J-1	REV PER DCN 27381	6 DEC - 80



THIS SIDE OF DOTTED LINE IS FOR THERMAL UNITS ONLY. 893620-2

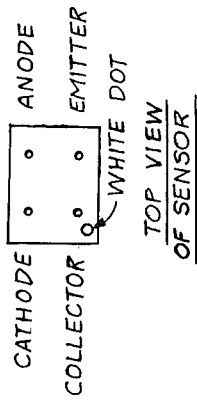
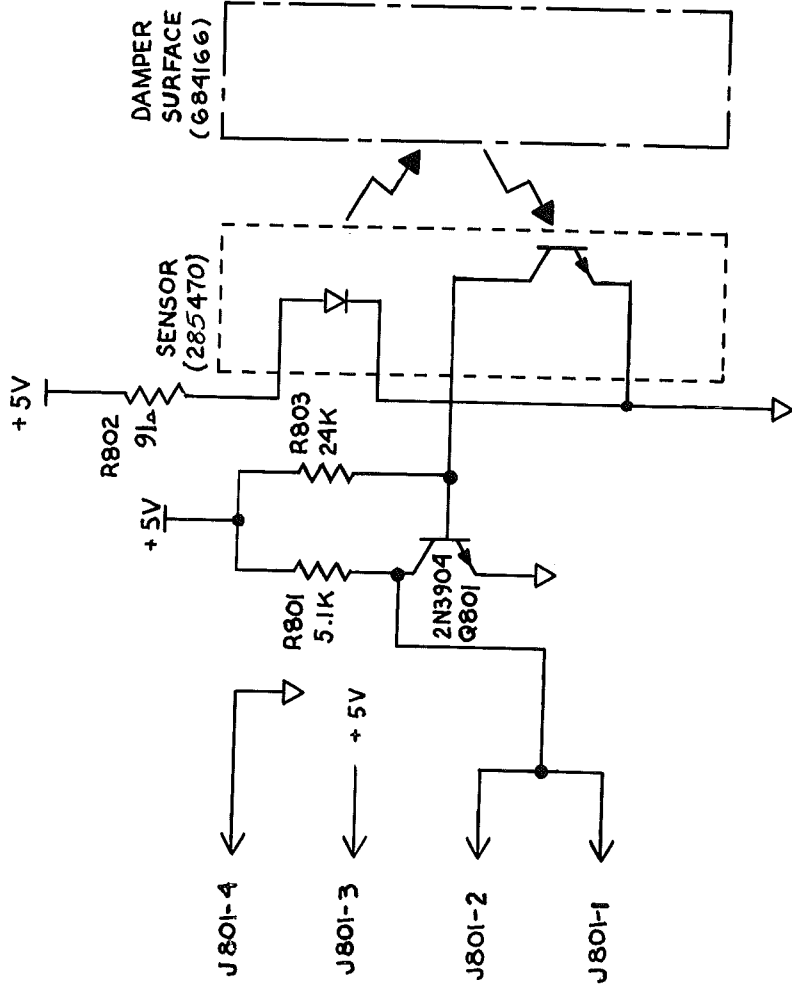
3. ALL TRANSISTORS ARE 2N3904.
 2. ALL DIODES ARE IN4148.
 1. ALL RESISTORS ARE 1K[±] 1/4W, 5%
 NOTES: UNLESS OTHERWISE SPECIFIED

INK UNITS ONLY.
 893620-1

BD. ASS'Y.,
 SPEED SELECT 893620-1#2

BY	DATE	NAME	SCHEMATIC	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A. Dwg. No. 293620
WILLS	5/10			
CH			ISSUE	
			96795	
			CODE	G

E-1 NOT AFFECTED PER DCN 27944/ S. JONES 74-7-81



BD. ASS'Y,
SENSOR 894133

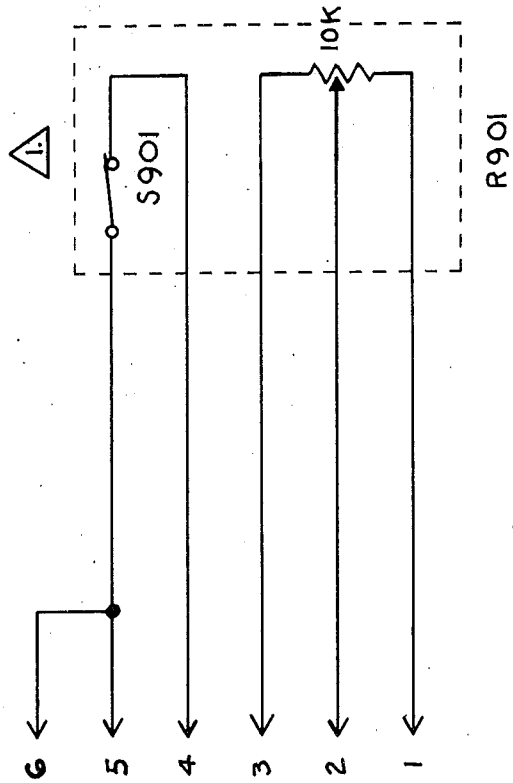
BY	DATE	NAME	CODE	TRIALZ	CODE	9
S. HARRISON	3/24/82	SCHEMATIC		96795		5
OF	BY	DATE	NAME	CODE	TRIALZ	CODE
SCHEMATIC	3/24/82					
Don L						

ALL RESISTORS ARE 1/4W, ± 5%
NOTES:

Grand Inc.
Instruments Division
Cleveland, Ohio 44114 U.S.A.
294133

REV	DESCRIPTION	DATE
A-	NOT AFFECTED PER ECN 26417/A, SOTEROS	1-23-80
B-1	NOT AFFECTED PER ECN 26500/S, HAMMOND	8-26-80
C-	CHANGED PIN NUMBERS PER DCN 26916/S, HAMMOND	9-23-80
C-2	NOT AFFECTED PER DCN 26925/S, HAMMOND	9-23-80

J901



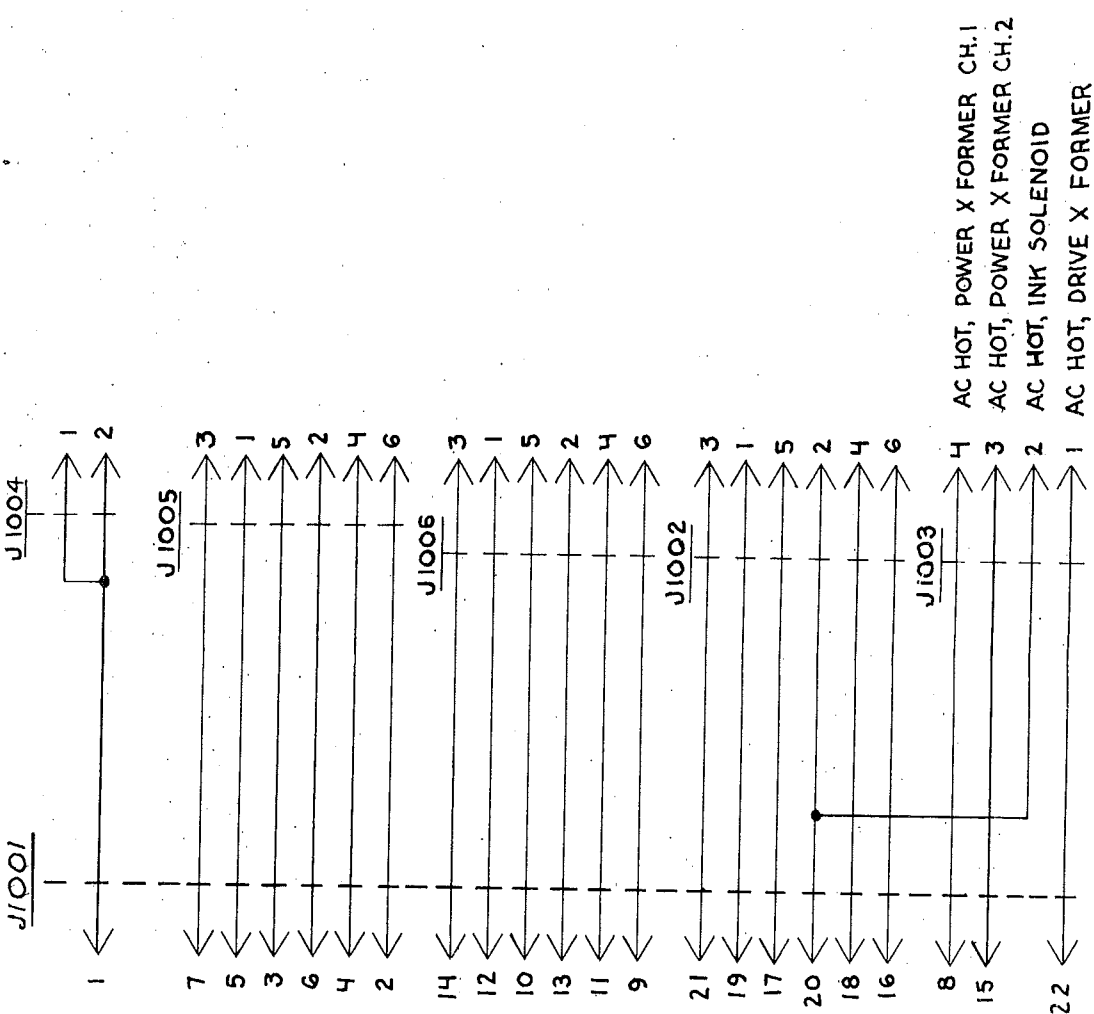
1. SWITCH SHOWN IN DETENT POSITION

NOTES:

BD ASSY,
VARIABLE SPEED 893621

REV	DATE	NAME	SCALE	SIZE
A	8-24-80	HAMMOND	SCHEMATIC	9.675"
293621 INSTRUMENTS DIVISION GOLD INC. 1000 W. 170th ST. GARDEN CITY, N.Y. 11530				

REV	REVISIONS	DATE
A1	CHANGED PICTORIAL PER DCN 268777-HAMMOND	8/20/80
B1	NOT AFFECTED PER DCN 27365 J. DAVIS	1-4-81
C1	NOT AFFECTED PER DCN 27885 WILLS	2/22/81



AC HOT, POWER X FORMER CH.1
 AC HOT, POWER X FORMER CH.2
 AC HOT, INK SOLENOID
 AC HOT, DRIVE X FORMER

80. ASSY.
 80. C. DISTRIBUTION

894286

SCHEMATIC

9/6785

294286

REV	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	REVISIONS
A1	NOT AFFECTED PER DCN 26920 S. HAMMOND	9-14-80							4-1-80
B1	CR501 THRU CR507 WERE DCN 26920 S. HAMMOND	12-4-80							5-9-80
C1	REVERSED PIN DESIGNATIONS PER DCN 26920 S. HAMMOND								
C2	CS03 WAS .01U								
C3	CR503, 07, 09, 11 WERE UTR40								

SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION
H-1	NOT AFFECTED PER RE-ISSUE OF DCN 27943 K. HAMILTON	5-21-81					
J-1	NOT AFFECTED PER DCN 28405 / S. JONES	8-12-81					
E-1	NOT AFFECTED PER DCN 27555 / C. WILLS	1-30-81					
F-1	NOT AFFECTED PER DCN 27943 / S. JONES	1-6-81					
G-1	NOT AFFECTED PER DCN 28084 C. WILLS	1-6-81					

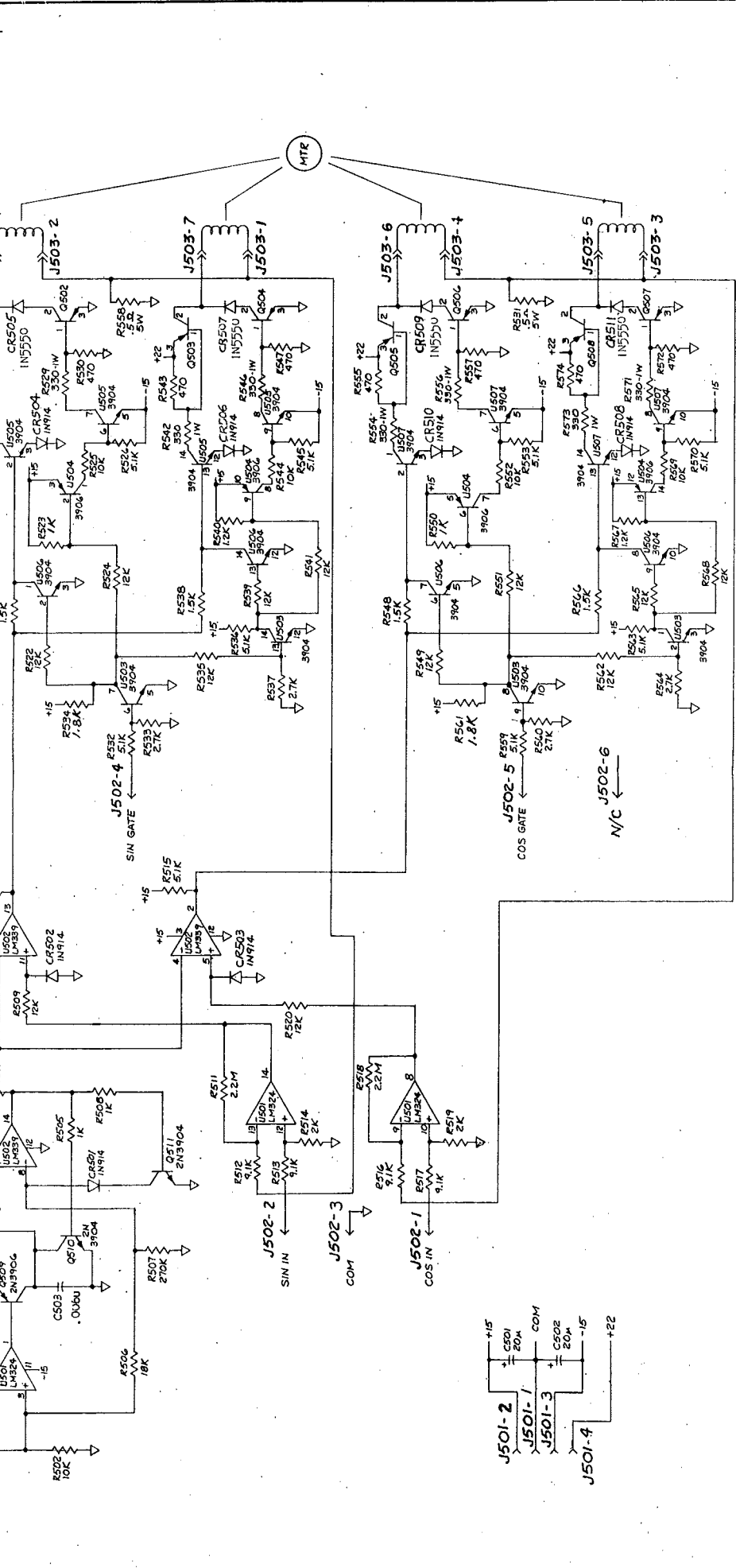
SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION

SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION

SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION

SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION

SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION



REV	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	REVISIONS

REV	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	REVISIONS

REV	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	REVISIONS

REV	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	REVISIONS

REV	DATE	SYN	DESCRIPTION	DATE	SYN	DESCRIPTION	DATE	REVISIONS

2. TRANS. Q501 THRU Q503 (2N4111) ARE HEATSINKED TO CHASSIS.
 1. ALL RESISTORS ARE 1/4 W 5 %.
 NOTES: UNLESS OTHERWISE SPECIFIED