RECOMP II

INPUT-OUTPUT SERVICE MANUAL

Autonetics Industrial Products

A DIVISION OF NORTH AMERICAN AVIATION, INC 3584 WILSHIRE BOULEVARD, LOS ANGELES 5, CALIFORNIA

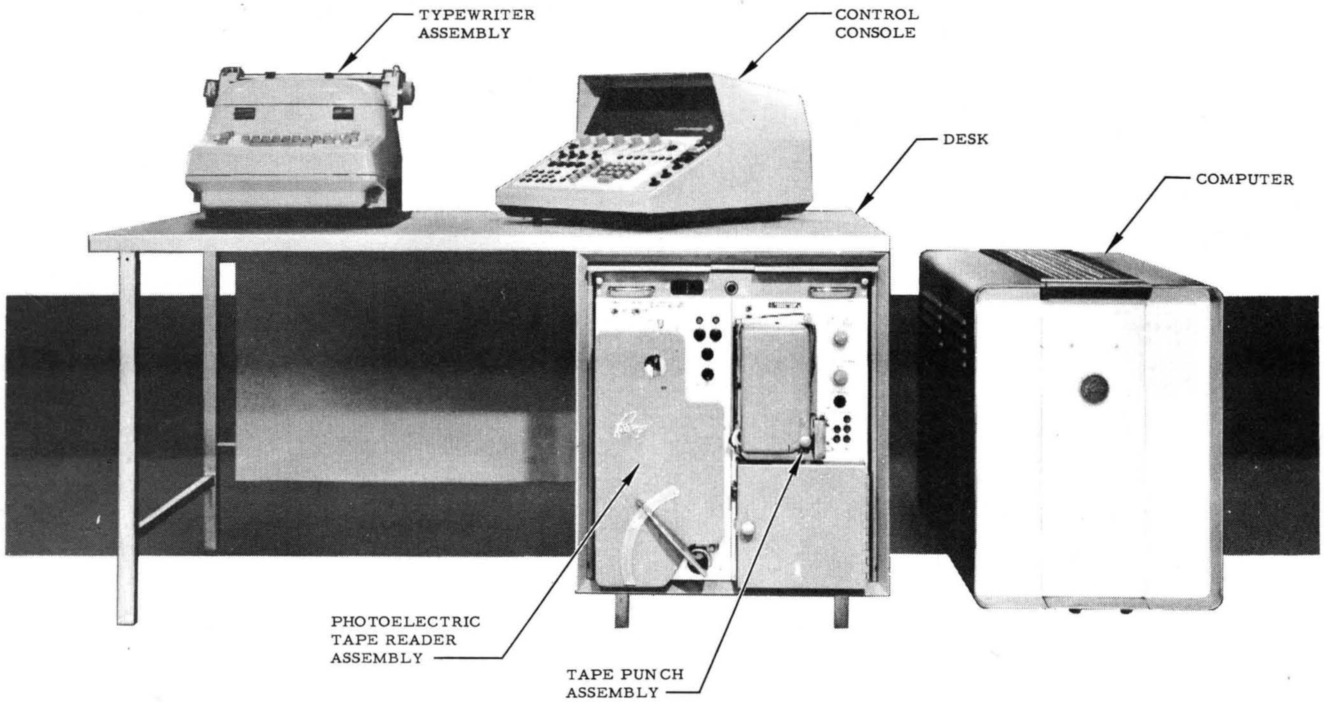
RECOMP II

INPUT-OUTPUT SERVICE MANUAL

20 August 1959

Publication 508-T-8

Autonetics Industrial Products
A DIVISION OF NORTH AMERICAN AVIATION, INC. 3584 WILSHIRE BOULEVARD, LOS ANGELES 5, CALIFORNIA



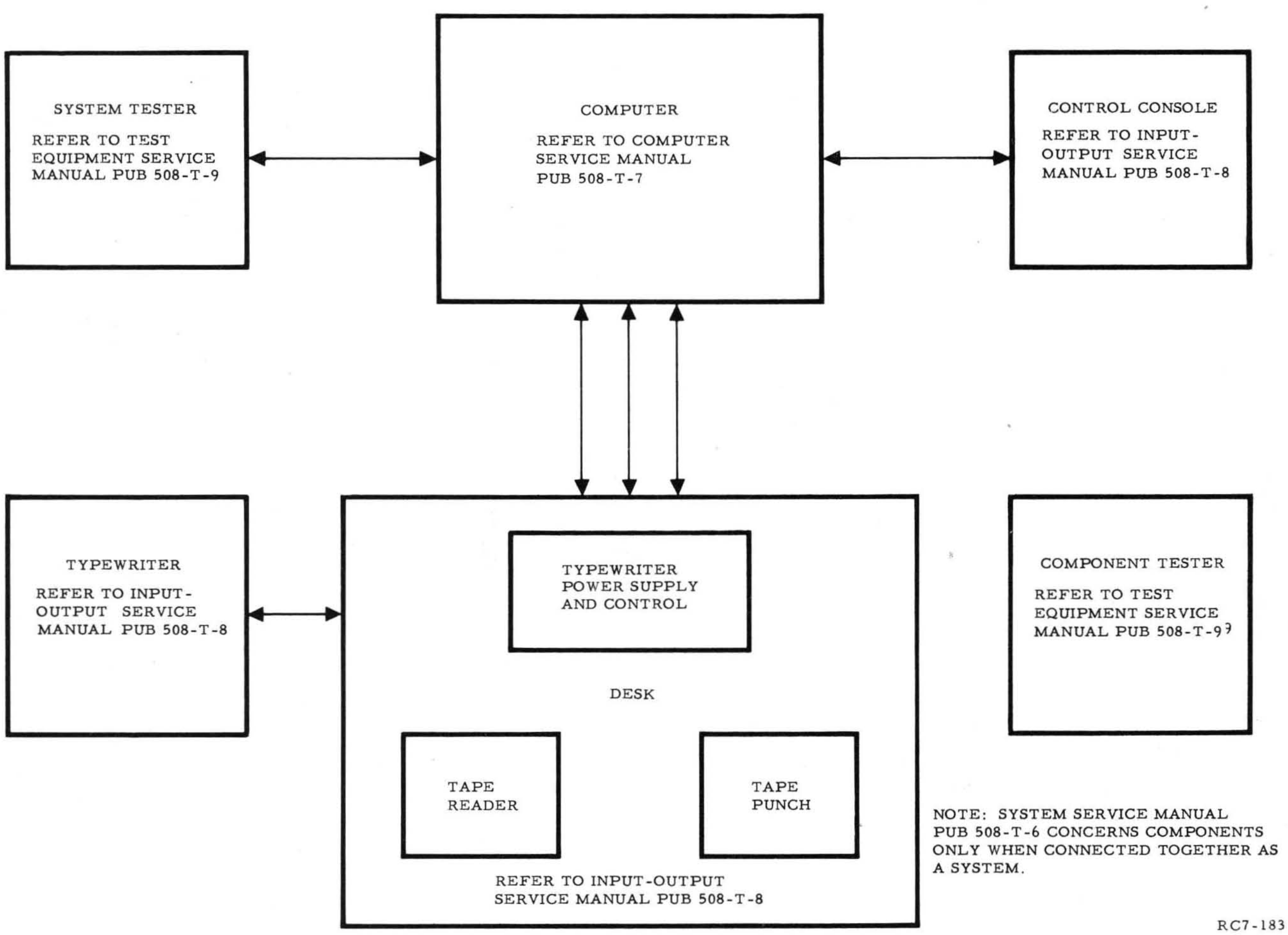


Figure 1. RECOMP II System Block Diagram

PREFACE

This manual is 1 of a set of 5 published by Autonetics to provide maintenance information on the RECOMP II computer system.

System Service Manual: Publication No. 508-T-6
Computer Service Manual: Publication No. 508-T-7
Input-Output Service Manual: Publication No. 508-T-8
Test Equipment Service Manual: Publication No. 508-T-9
System Reference Schematics: Publication No. 508-T-11

The block diagram of figure 1 illustrates each system component and shows its applicable service manual. In brief, the scope of each RECOMP II service manual is as follows:

System Service Manual: This manual describes the general concept of RECOMP II maintenance and provides operating instructions for check-out of the computer system using the system tester and both manual and automatic test routines. The goal of these system test procedures is to isolate malfunctions to a specific operational area or system component.

Computer Service Manual: This manual describes the operational components located in the computer assembly, including memory unit, power circuits, and signal circuits. It also provides maintenance instructions and adjustments for computer components, and gives a detailed set of test procedures for computer circuit boards using the component tester.

Input-Output Service Manual: This manual describes the operational characteristics of RECOMP II input-output equipment (control console, typewriter, tape reader, and tape punch). It also provides maintenance and test instructions for these input-output devices and the associated desk assembly.

Test Equipment Service Manual: This manual describes the functional characteristics of the system tester and component tester. It also provides maintenance and test instructions for these two RECOMP II test equipments.

System Reference Schematics: This publication provides a set of schematics, assembly drawings, wiring charts, and signal charts for each system component; i. e., computer, desk, control console, tape reader, typewriter, and tape punch.

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Continued)

TABLES

INTRODUCTION

RECOMP II input-output equipment consists of the desk, the photoelectric tape reader, the tape punch, the electric typewriter, and the control console. These assemblies are grouped with the computer, when the computer is set up for operation (see figure 1). They are interconnected as shown in the computer cabling diagram (figure 2). This service manual provides a description of each of the assemblies including their respective power circuits and signal circuits. It also provides maintenance and repair instructions for these assemblies, including detailed test procedures for their respective etched circuit boards.

The desk assembly houses the photoelectric tape reader and tape punch assemblies, and the power and control subassemblies for the typewriter. In addition, the desk supports the typewriter and control console during operation.

The computer control console provides the major controls and switches for operation of the computer system and also provides a visual readout display of computer information. By operating the appropriate controls, the contents of any storage location in memory or the contents of certain registers may be displayed or modified.

The electric typewriter is a combination input-output device for printing out data from the computer by electronic control, and for transmitting information to the computer or tape punch by means of manual keyboard key entries.

The photoelectric tape reader is an input device that converts information contained on punched paper tape to computer format for storage in the magnetic memory of the computer.

The tape punch receives information either from the computer or the typewriter in electrical pulses and records the information by punching it on paper tape.

Other types of input-output equipment can be adapted. For example, an external plotter may be plugged into a spare receptacle in the rear of the desk to record information from the computer. The information would be received from the tape punch external outlet.

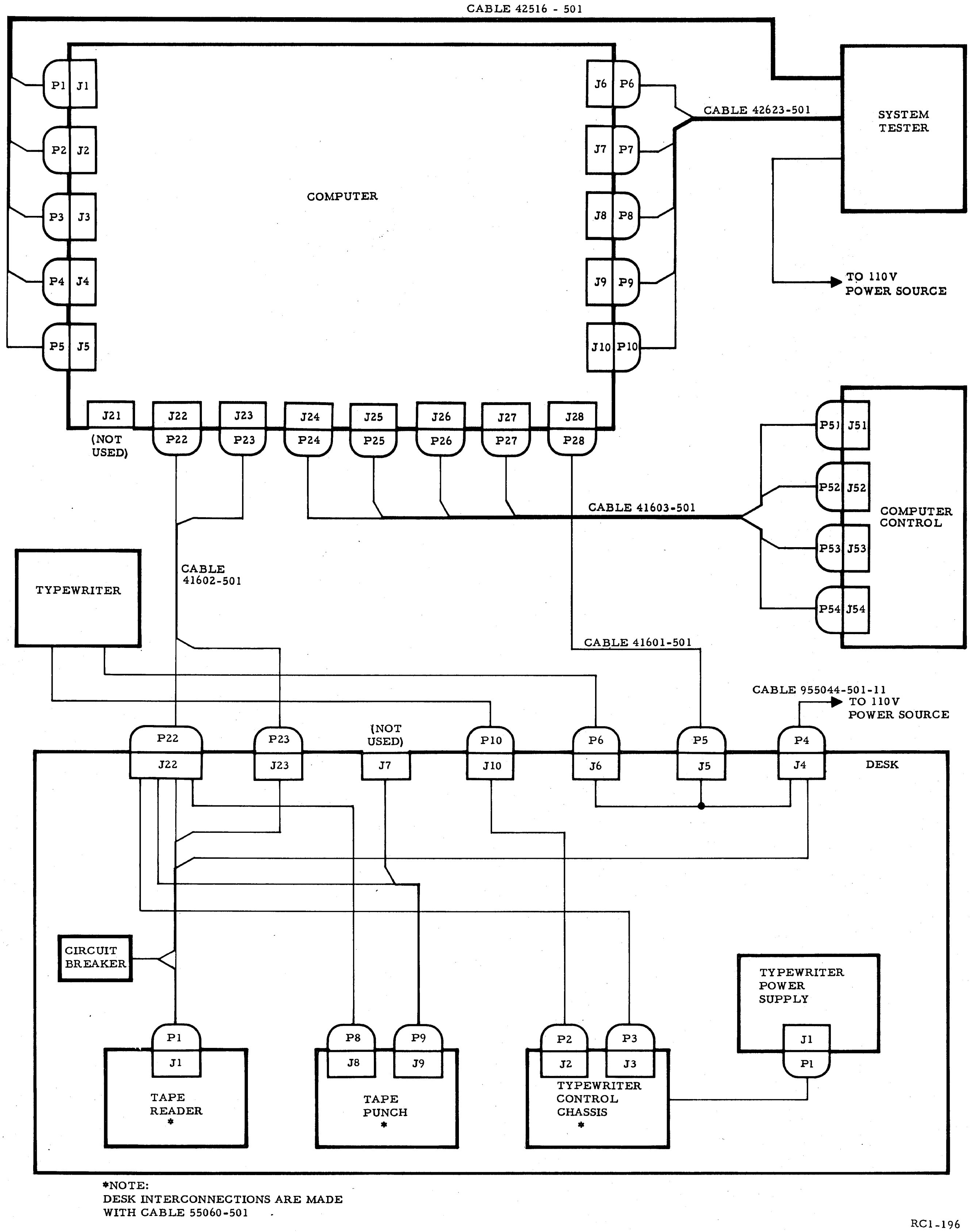


Figure 2. Computer Cabling Diagram

DESK

The desk is a metal structure with a formica top and contains a single major compartment having a lift-up disappearing door on the front and a swing door on the rear (see figure 3). The power supply chassis and the control chassis for the typewriter assembly are mounted to the desk framework inside the compartment. Signal connections are made between the typewriter, tape punch, and photoelectric tape reader assemblies and the computer through connectors in the desk. The desk also contains the interconnecting cables between these assemblies. In addition, main power connectors for the RECOMP II system are located in the desk (see figure 3, rear view). The desk provides housing for the photoelectric tape reader and tape punch assemblies. These assemblies are mounted side by side in the front end of the desk compartment to provide a compact arrangement for easy accessibility during operation. The typewriter and control console are positioned on the desk top within easy reach of the operator.

Desk specifications are as follows:

Size:	27 inches wide by 56 inches long by 28 inches high
Weight:	150 pounds
Structure:	Welded aluminum and steel
Maximum weight load:	100 pounds

CONTROL CONSOLE

The control console permits the operator to monitor and control computer operations (see figure 4). It is enclosed in an aluminum structure with hinged front and rear panels. Two upright members mounted on a base plate support the front and rear panels and the readout indicator assembly. Control switches and indicators are installed on the front panel, and seventeen circuit boards are mounted at the rear of the base plate. Fifteen of the sixteen readout indicators consist of a neon tube for decimal points and a nixie tube for decimal numeral indications. The other consists of five neons for indicating arithmetic signs and octal, decimal, or command format. A voltmeter and its selector switch, a running time meter, external receptacles, test terminals, and a blower are mounted on the rear panel. Like the typewriter, the control console is operated from the top of the desk assembly. Control console power and signal connections are made directly with the computer by means of a cable running from the rear of the control console chassis to the rear of the computer.

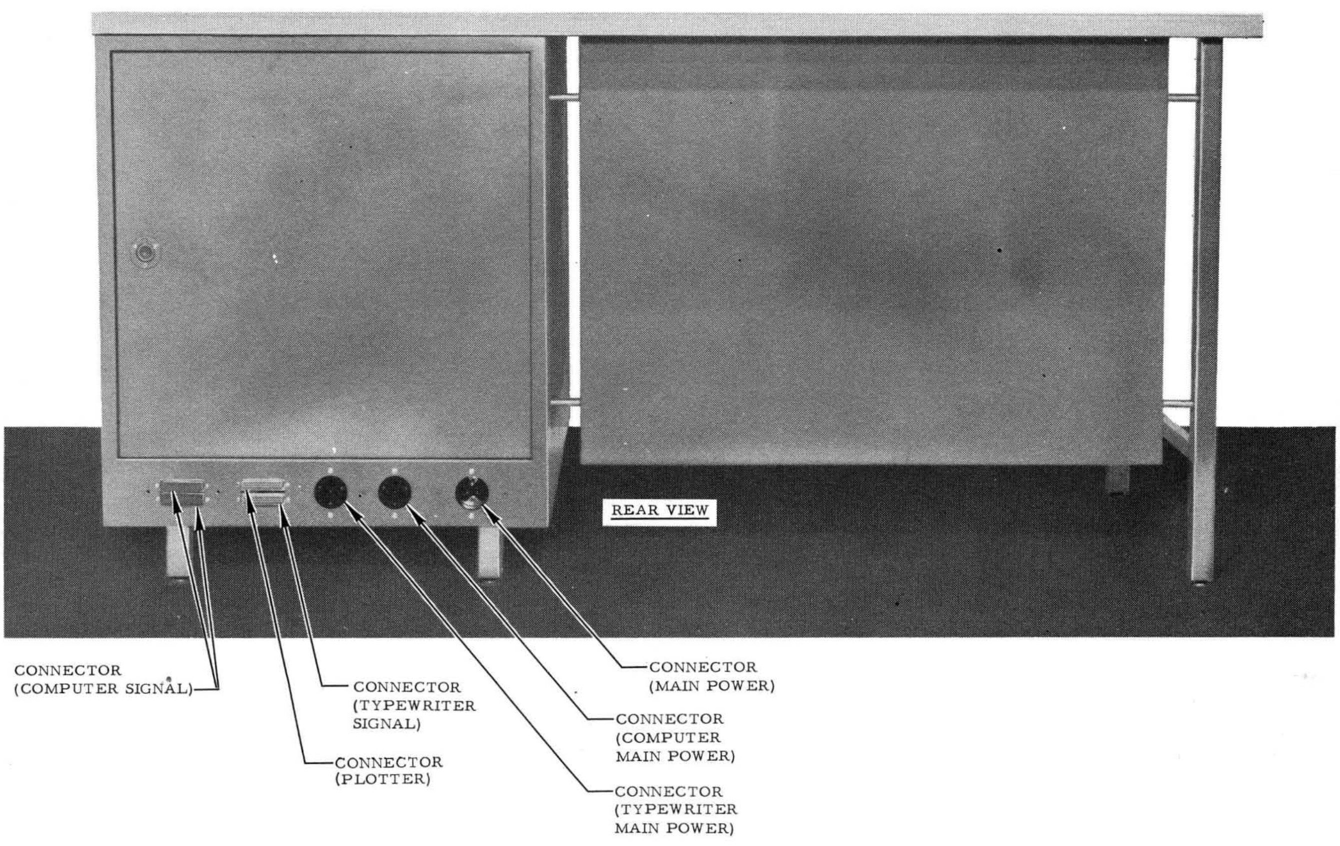
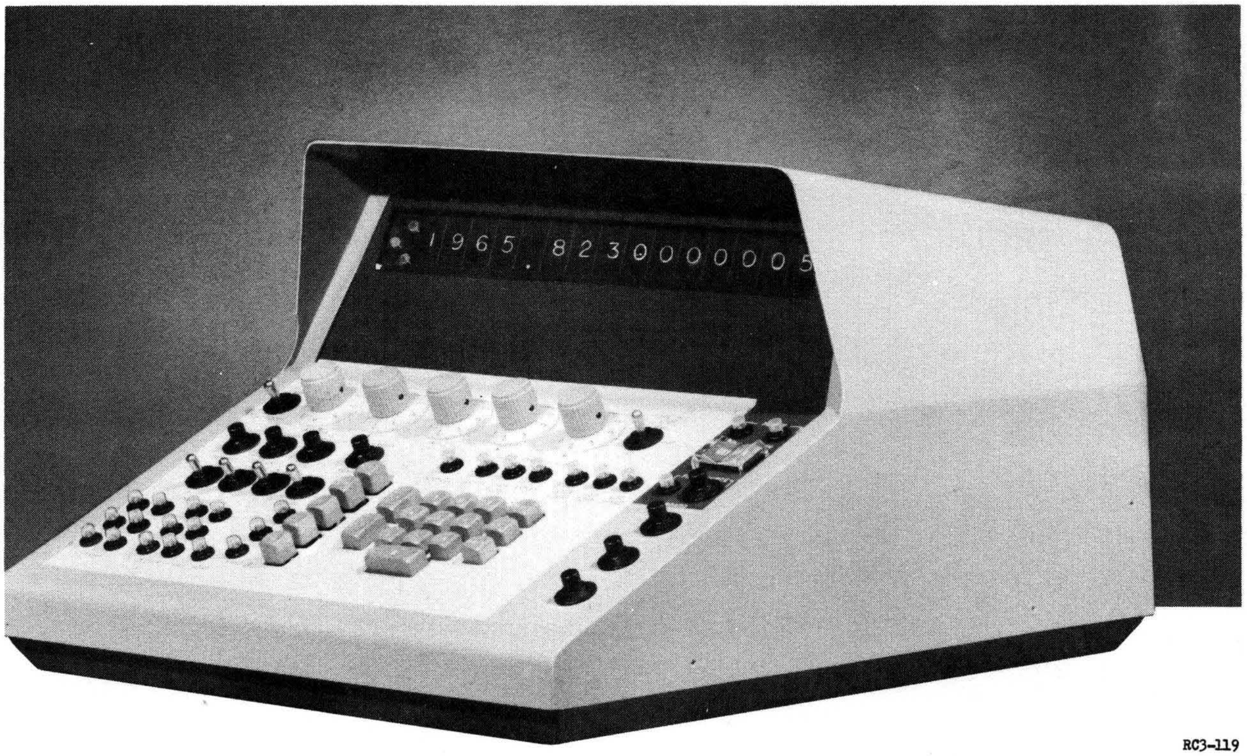


Figure 3. Desk Assembly



RC3-119

Figure 4. Control Console

Control console specifications are as follows:

Size: 19.5 inches long by 16 inches wide by 11 inches high
Weight: 30 pounds

TYPEWRITER

The typewriter assembly (figure 5) is a standard electrical unit equipped with a coder-decoder attachment. The electrical unit has the usual typewriter keyboard. The coder-decoder attachment functions as a conversion unit for information between the computer and the typewriter. When a typewriter key is depressed, the coder converts the character of the key into coded pulses that can be handled by the computer. Conversely, the decoder converts computer information into the printed characters when the computer addresses the typewriter. The speed of operation is a nominal 10 characters per second.

RC3-117

Figure 5. Typewriter Assembly

Typewriter specifications are as follows:

Power requirements

Electrical unit:	28 keys, 115 volts, 60 cps
Attachment:	115 volts, single-phase, 60 cps. Decoder solenoids are 24-volt dc with current consumption of 1 to 2 amperes. Decoder power is received from typewriter power supply in desk
Weight:	Approximately 50 pounds excluding units in desk assembly

PHOTOELECTRIC TAPE READER

The photoelectric tape reader uses photodiodes for reading information from a 5-channel teletype-coded paper tape 11/16 inch in width. The tape is fed through the reader at a nominal speed of 40 inches per second and the punched codes are converted into electrical signals, thereby permitting 400 lines per second to be read by the computer. The tape reader can be used to store information in any memory location of the computer.

The tape reader assembly (figure 6), consists of a tape canister and a panel assembly mounted on one section of a drawer-type chassis which slides into the single compartment of the RECOMP II desk. The canister contains a tape magazine and running slides. The panel assembly is bolted to mounting strips within the chassis. The front portion of the panel assembly contains the power and control switches, indicator lights, reader head, canister support, and locking handle. The rear portion mounts the capstan motor, control chassis, and power supply.

The control chassis contains three circuit boards in addition to other signal elements. Eight identical read amplifiers and one clock amplifier are mounted on one board. Flip-flop and logic circuits are contained on the second board, and bias control circuitry is contained on the third board.

The power supply consists of power elements mounted on a power supply chassis and one plug-in circuit board.

Photoelectric tape reader specifications are as follows:

Size:	9.5 inches wide by 19.5 inches high by 9.5 inches deep
Weight:	Approximately 36 pounds
Structure:	Aluminum
Power:	115-volt ac, 60 cps, single-phase

TAPE PUNCH

The tape punch assembly is capable of translating numerical, alphabetical, or alphanumerical information from the computer or the typewriter into information punched on paper tape. Both the punch and the typewriter may receive information from the computer simultaneously under programed control.

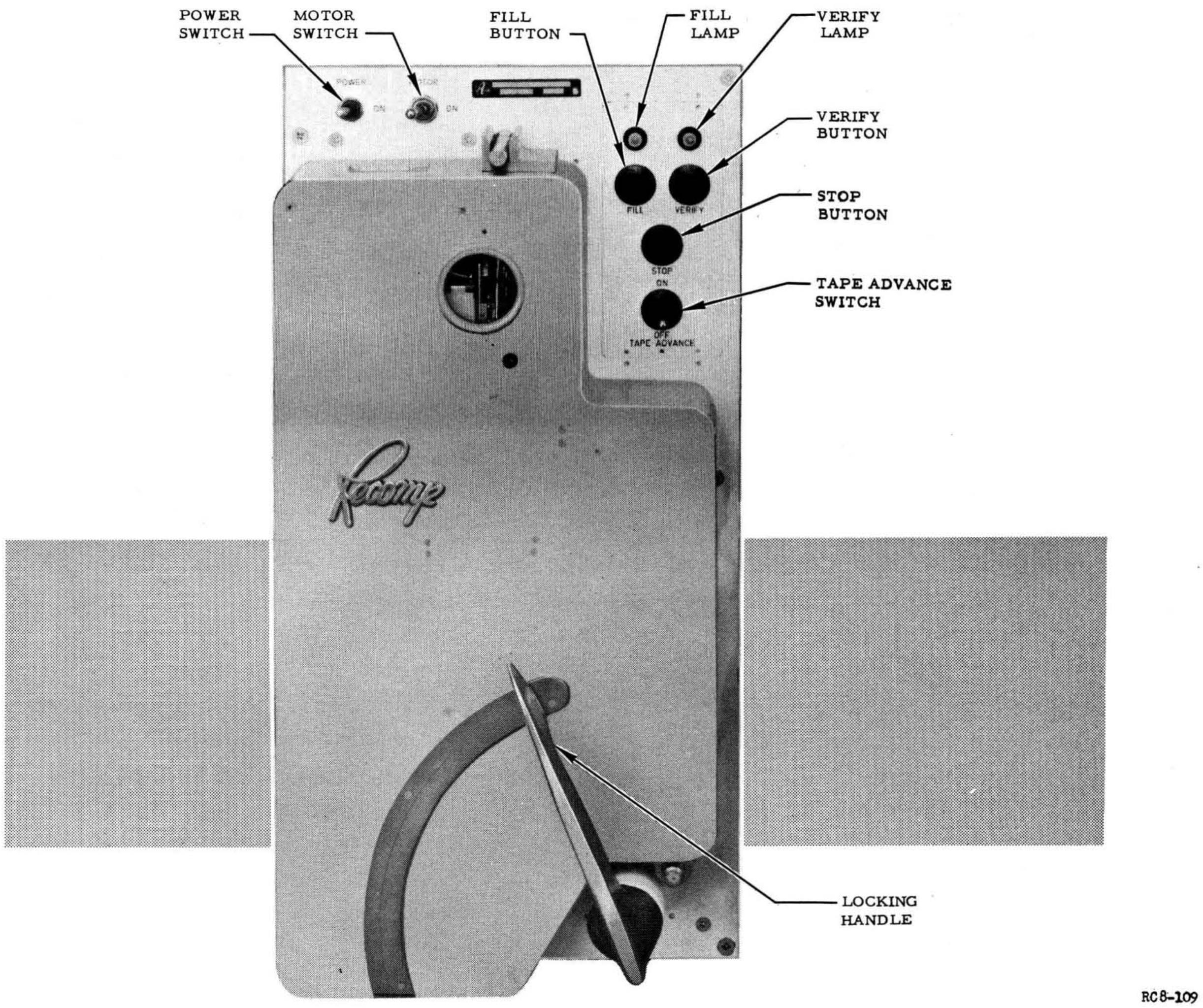


Figure 6. Photoelectric Tape Reader Assembly

The tape punch assembly (figure 7) consists of a 2-compartment tape magazine and a panel assembly mounted next to the photoelectric tape reader in the drawer-type chassis of the RECOMP II desk. One compartment of the tape magazine holds the supply of blank tape and the other collects the tape as it runs through the punch mechanism. The panel assembly is bolted to mounting strips within the chassis. The mechanical punch, magazine, and punch control panel are mounted on the front portion of the panel assembly; the motor drive unit, power supply, and control chassis are mounted on the rear portion.

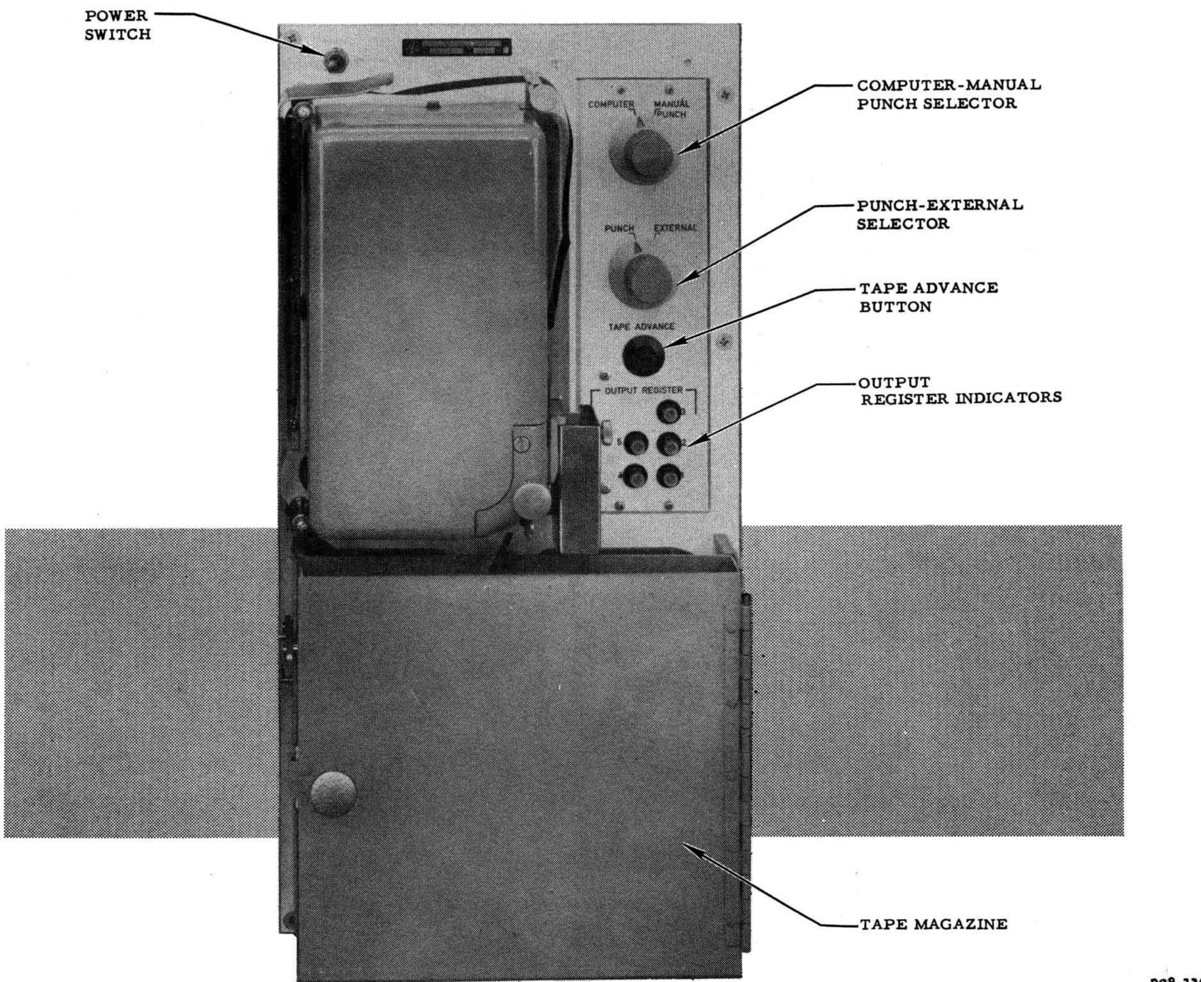


Figure 7. Tape Punch Assembly

Tape punch specifications are as follows:

Size:	9-15/32 inches wide by 19-9/32 inches high by 10 inches deep
Weight:	Approximately 32 pounds
Structure:	Aluminum
Power:	115-volt ac, 60 cps, single-phase, 100 watts

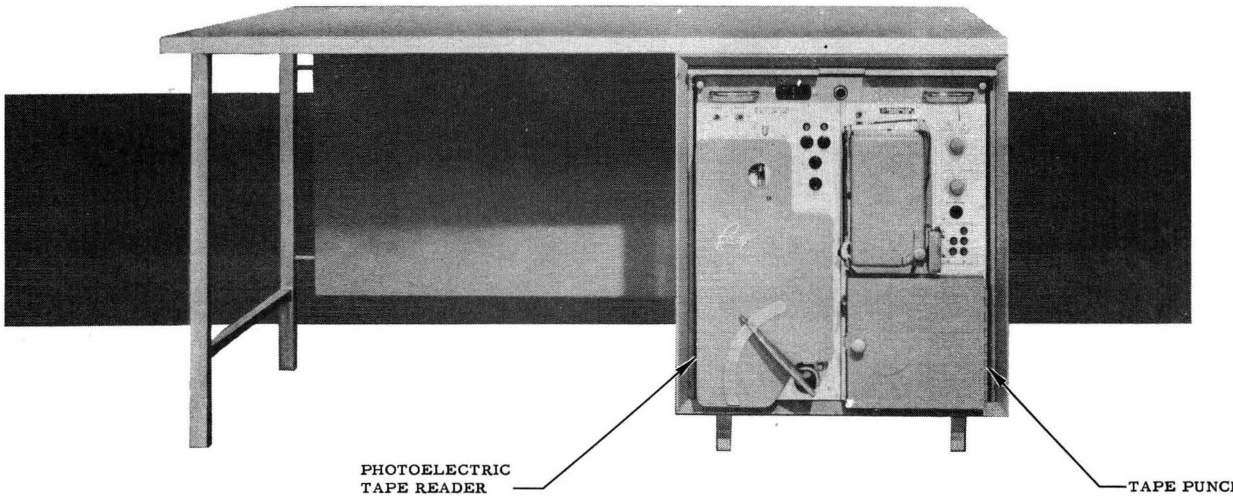
DESK

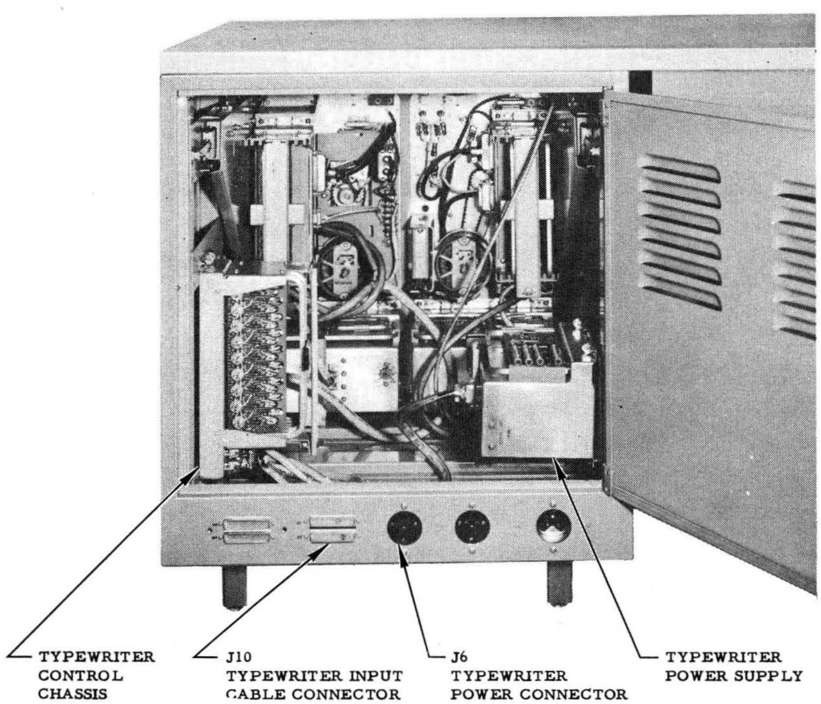
The desk assembly functions primarily as a housing and support unit for the RECOMP II input-output equipment. Two of the four input-output assemblies are mounted in the desk compartment (photoelectric tape reader and tape punch), and two assemblies (control console and typewriter) rest on the desk top. The desk assembly provides the primary power and signal connections between components of the RECOMP II system. In addition, the desk provides the housing for the typewriter power supply and control circuits which are mounted on two chassis in the rear of the desk compartment (see figure 8).

FUNCTIONAL DESCRIPTION

When reading the following description, see the desk interconnection block diagram (figure 9). Cable 955044-501 plugs into the main power connector at the rear of the desk at J4. This connection makes 110-volt primary power available to the entire RECOMP II system. Parallel connection is made through J4 with desk interconnecting cable 55060-501 to the photoelectric reader and tape punch power supplies. J4 is also in series with J5 and J6. Cable 41601-501 plugs into the desk at J5. This connection makes 110-volt primary power available to the computer power supply when the POWER ON button on the control console is depressed. J6 makes main power available to the typewriter through typewriter cable connections. Main power energizes the typewriter power roll, then returns through the typewriter cable connection to J10 at the rear of the desk. Desk interconnecting cable 55060-501 carries primary power to the typewriter control chassis at J2. The typewriter control chassis and power supply are interconnected and primary power is applied to the power supply transformer at power supply J1. Secondary voltage levels from the typewriter power supply are sent back to the control chassis on the same cable. Desk connector J7 makes computer signals available to an external device such as a plotter. When the PUNCH-EXTERNAL switch on the punch control panel is set at EXTERNAL, computer information is directed through the tape punch to the external device.

Cable 41602-501 connects the computer signal circuits to the photoelectric reader, tape punch, and typewriter signal circuits at desk connectors J22 and J23. Computer signals to the typewriter are transmitted through J22 to the control chassis of the typewriter and are carried from the control chassis to the typewriter through desk connector





RC3-114

Figure 8. Desk and Installations

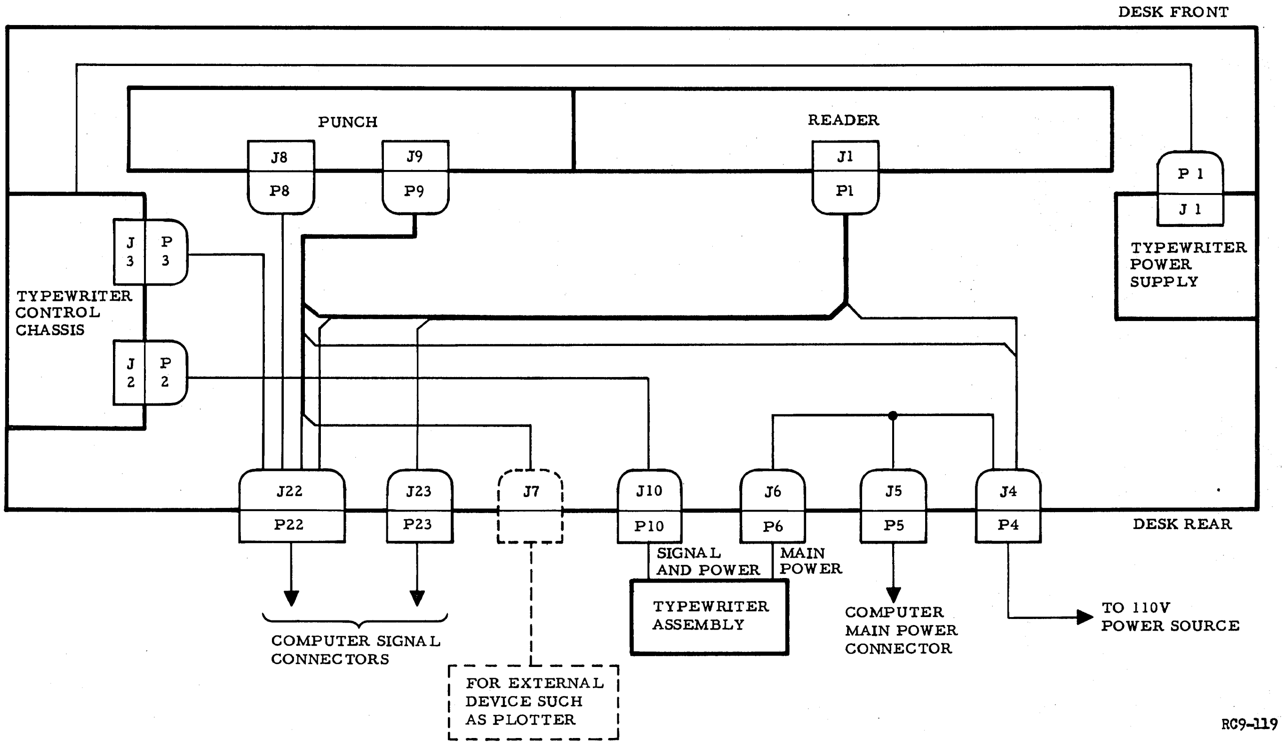


Figure 9. Desk Interconnection Block Diagram

J10. Computer signals are sent to the photoelectric tape reader through desk connector J22 and are received from the photoelectric tape reader through desk connector J23. Tape punch-computer signals are received and sent through J22. Connections between tape punch, photoelectric tape reader, and typewriter signal circuits, and J22 and J23 are made with desk interconnecting cable 55060-501.

A circuit breaker is mounted on the front of the desk structure across the desk interconnecting primary power wires. The circuit breaker will cut off primary power to the tape reader, tape punch, and typewriter when an overload occurs.

MAINTENANCE

Very little desk maintenance is required other than normal care and preservation. Trouble analysis, adjustments, preventive maintenance, and removal and replacement of the tape reader, tape punch assemblies and the typewriter control and power supply chassis are described in detail for each major assembly in corresponding sections.

The desk connectors and the interconnecting cabling should be checked periodically to determine that the connectors and especially the connector pins are not damaged and that the cables are not defective. Prior to RECOMP II system operation, all desk internal and external connections should be visually inspected to make certain all cables are plugged in and to make certain proper contacts are being made. Care should be taken of the external cables between components of the RECOMP II system when not in use. Connectors, cabling, or wiring which becomes defective should be replaced.

CONTROL CONSOLE

The RECOMP II control console (figure 10) provides the switches and controls for operating the computer system. Contents of the computer main memory or the computer registers may be examined or modified by operation of the controls on the front panel. The entire computer system program is controlled and monitored from the control console, which also provides a visual readout display of computer information. Electronic circuitry necessary to operate the control console is mounted on transistorized, plug-in, printed circuit boards and forms an integral part of the control console assembly.

FUNCTIONAL DESCRIPTION

FUNCTION OF CONTROLS

Operating controls are located on the front panel of the control console. They consist of a keyboard, switches, indicators, and a display register. Each control or indicator and its function is described individually in the RECOMP II operating manual.

NORMAL OPERATION

The computer and the control console are connected to the primary power source through J5 in the desk assembly. Power is applied to the computer and the control console when the POWER switch on the control console is depressed. Power is first applied through circuit breakers CB1 and CB2 in the computer to the POWER ON indicator, the blower, and running time meter in the control console, and to the computer memory. When the memory air bearing is functioning properly, the control console is also ready for operation. The control console contains indicators which indicate the condition of control, power, and signal circuits in the computer at any instant during computer operation. The console also controls the source of operation and contains indicators for this purpose.

Information is entered from the keyboard of the control console when the FILL SOURCE switch has been depressed. The keyboard unit converts the mechanical motion of key depression into coded pulse groups which are sent to the computer. Information is either entered or extracted from the computer memory by specifying the location on

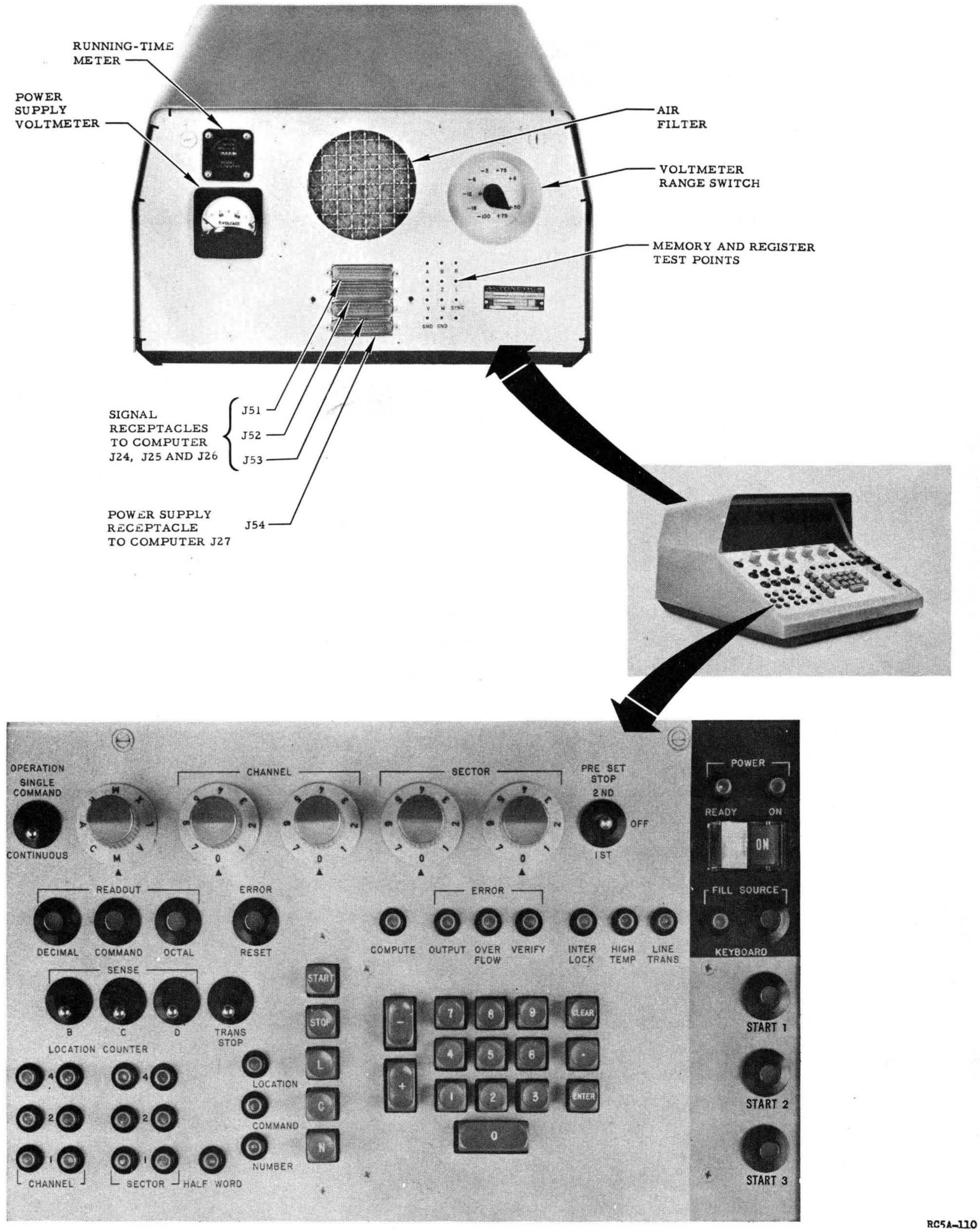


Figure 10. Control Console, Front and Rear Views

the location counter. Indicators displaying existing conditions must be observed and switches and control knobs must be set prior to entering data into or extracting data from the computer. A readout indicator assembly displays the number or command present in the location counter on the display register before entering or after readout.

DECIMAL KEYBOARD

The keyboard unit converts the mechanical motion of key depression into 5-binary-digit pulse code for the computer. Key symbols include decimal digits, plus sign, minus sign, decimal point, ENTER, and CLEAR. (See figure 11.)

When a key is depressed, the actuator moves into coded slots on the spring-loaded bars, thereby locking all bars except those pertaining to the selected code. At the same time, the actuator displaces the hinged bail which closes bail switches S1 and S2. (See figure 12.)

The bail switches apply -100-volt power to the keyboard rotary solenoid through normally closed contacts of antirepeat relay K1. The rotary solenoid requires a duration of 10 milliseconds to become completely energized after power is applied; during this time the following operations occur in the order listed:

1. The entire keyboard is locked from further operation, and the selected key button remains depressed.
2. The restoring bail is retracted, permitting unlocked code bars to move forward under spring tension.
3. The code bars engage corresponding coding contacts which apply -12-volt coding pulses to computer input flip-flop circuits. Decimal-to-binary conversion occurs for the particular key button depressed in accordance with the following code:

Character	Binary Code	Character	Binary Code
0	10000	8	11000
1	10001	9	11001
2	10010	+	11011
3	10011	-	11010
4	10100	.	11100
5	10101	ENTER	11110
6	10110	CLEAR	11101
7	10111		

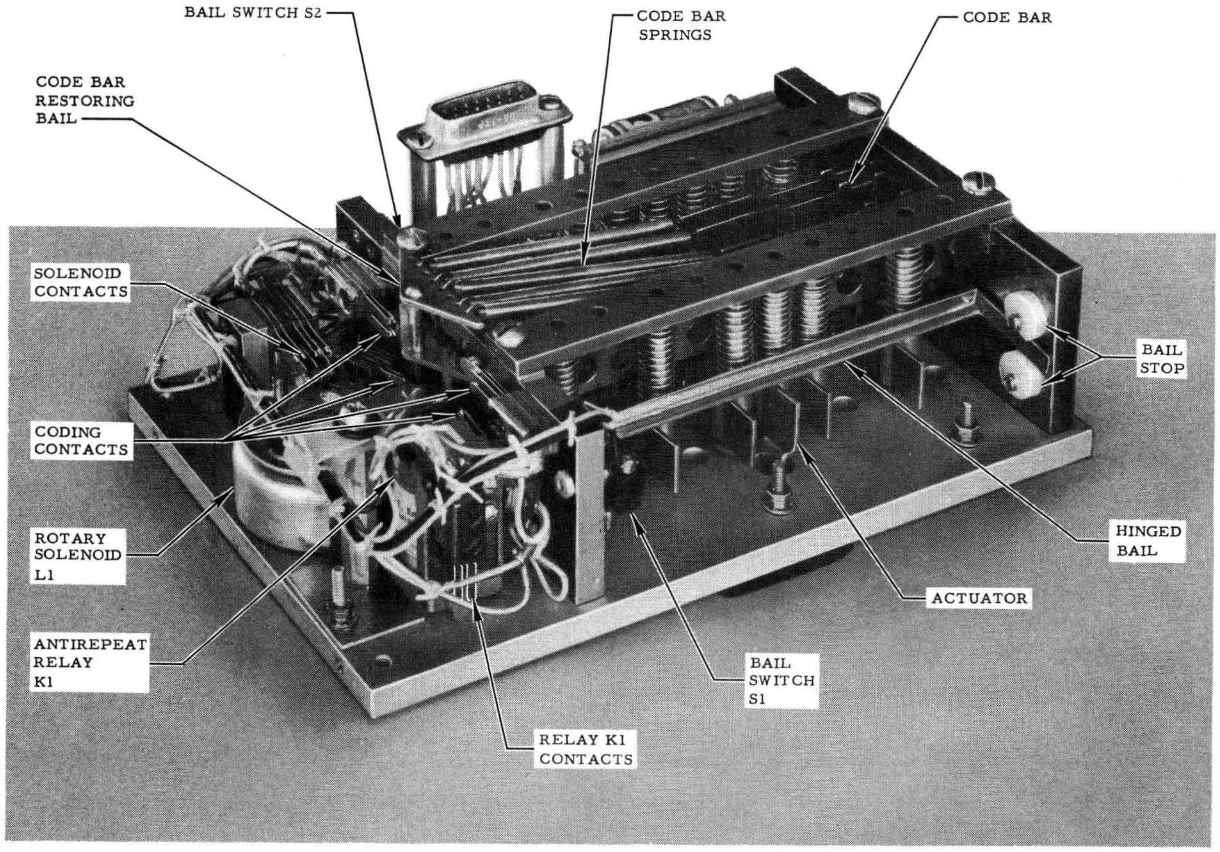
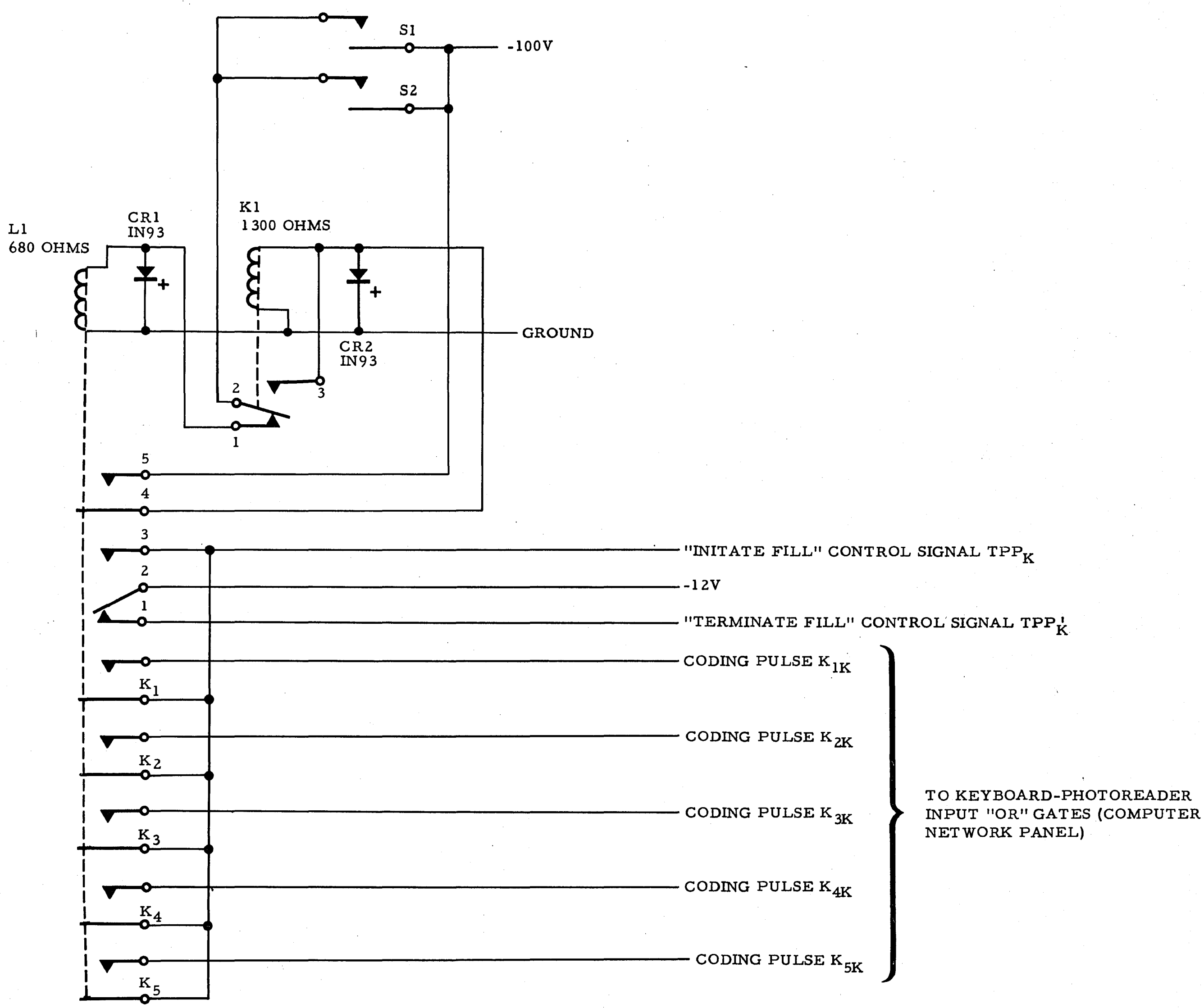


Figure 11. Control Panel Keyboard, Bottom View

Note that except for the most significant digit (1), the decimal numbers convert to exact binary-coded-decimal representation. Plus and minus convert to codes 11 and 10 respectively, decimal point to 12, clear to 13, and enter to 14. When the solenoid is completely energized, it closes a set of contacts that applies power to antirepeat relay K1. (This relay also has an energizing time of about 10 milliseconds). Energizing of relay K1 opens its normally closed contacts that apply power to the rotary solenoid. The solenoid is de-energized, allowing all displaced parts to return to normal orientation. As long as the actuated key is held down, the bail switch contacts (S1 or S2) will be closed to maintain relay K1 in an energized state. This prevents the rotary solenoid from being energized again until the key is released, thereby providing antirepeat action.



Note:

1. During period of solenoid energizing, contacts K_1 to K_5 close first; contact 1 opens, and contact 3 closes; contact 4 then closes
2. During period of solenoid deenergizing, contact 3 opens and contact 1 closes before opening of K contacts

RC2-100

Figure 12. Control Panel Keyboard Circuit Schematic

READOUT INDICATOR ASSEMBLY

The readout assembly of the control console consists of sixteen indicators which display the number or the command present in the memory location specified by the location counter. The sign and format indicator consist of the following five neon indicator displays: +, -, C (command), D (decimal) and O (octal). Each of the fifteen other indicators contains a decimal display tube (nixie tube) for indication of the digits 0 through 9 and a neon bulb for indication of the decimal point.

Sixteen identical etched circuit boards (termed "decade drivers") in the control console provide drive circuits for the indicators. Each drive circuit consists of a set of four flip-flops (bistable multivibrators) triggered by indicator selector signals and number signals, and an output decoding matrix which selects the numbers to be displayed and the particular indicators to display these numbers.

INDICATOR SELECTION

Sixteen possible combinations of binary-coded signals from the computer readout indicator flip-flops H_4, H_3, H_2, H_1 (figure 13) and an "activate readout" signal from computer flip-flop R_{C3} are applied to each driver board. Only one combination is true at any instant. It triggers its corresponding drive circuit and thus its indicator. The triggered indicator remains in a selected state until reset. The code for selection of indicators is listed as follows:

Binary-Coded Signals H_4	H_3	H_2	H_1	Indicator	Binary-Coded Signals H_4	H_3	H_2	H_1	Indicator
0	0	0	0	Sign and format	1	0	0	0	Decade 8
0	0	0	1	Decade 1	1	0	0	1	Decade 9
0	0	1	0	Decade 2	1	0	1	0	Decade 10
0	0	1	1	Decade 3	1	0	1	1	Decade 11
0	1	0	0	Decade 4	1	1	0	0	Decade 12
0	1	0	1	Decade 5	1	1	0	1	Decade 13
0	1	1	0	Decade 6	1	1	1	0	Decade 14
1	1	1	1	Decade 7	1	1	1	1	Decade 15

NUMBER SELECTION

Twelve possible combinations of binary-coded-decimal number selection signals from flip-flops F_1, F_2, F_3, and F_4 in the computer output register are also applied to each decade driver circuit board.

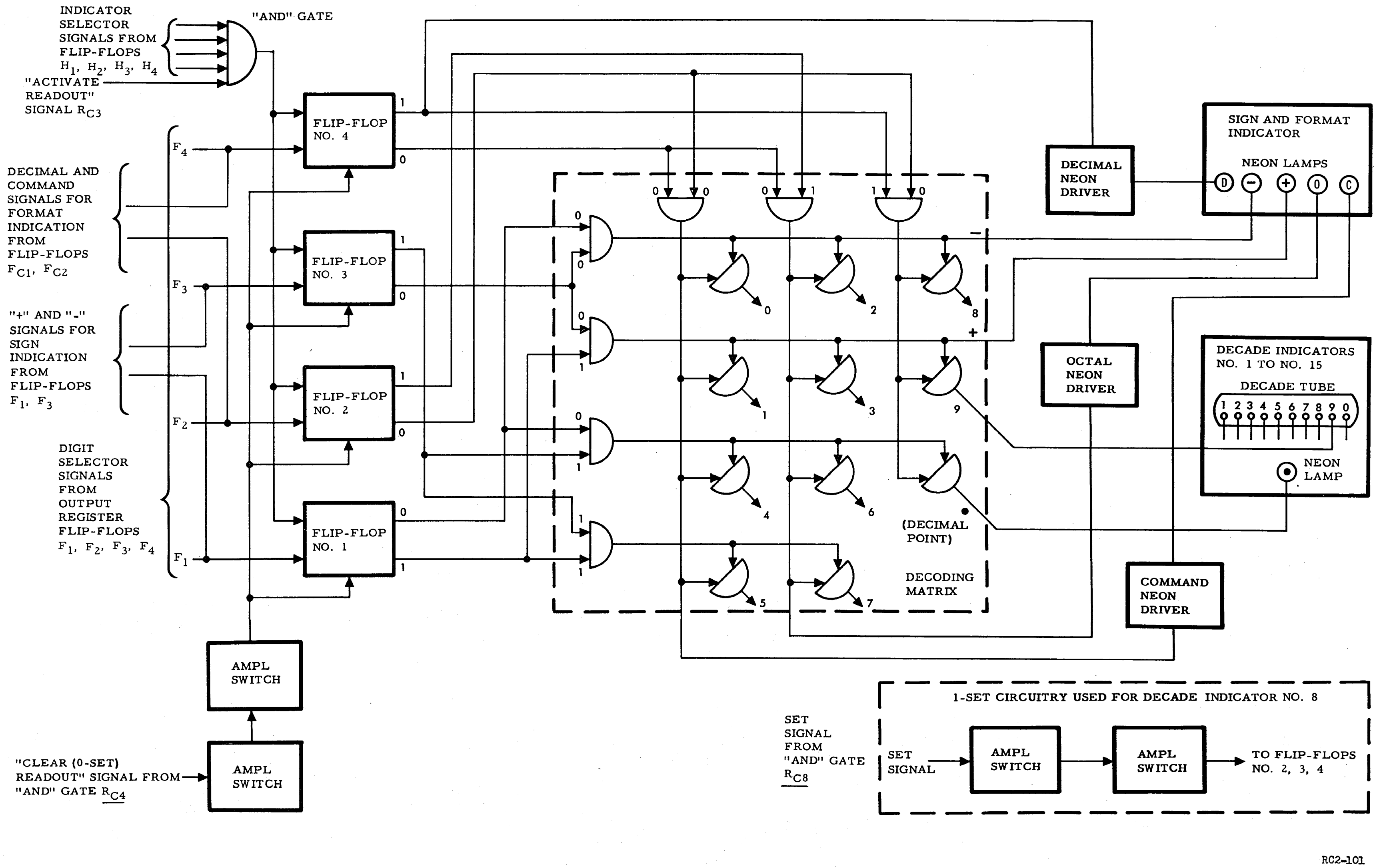


Figure 13. Readout Circuit Block Diagram

The twelve combinations correspond respectively to digits 0 through 9, decimal point, and reset, as follows:

Binary-Coded-Decimal Signals F_4 F_3 F_2 F_1	Decimal Display	Binary-Coded-Decimal Signals F_4 F_3 F_2 F_1	Decimal Display
0 0 0 0	0	0 1 1 1	7
0 0 0 1	1	1 0 0 0	8
0 0 1 0	2	1 0 0 1	9
0 0 1 1	3	1 0 1 0	. (decimal point)
0 1 0 0	4	1 1 0 1	(blank)
0 1 0 1	5	1 1 1 1	(blank, reset)
0 1 1 0	6		

The process for selecting a particular number or digit of an indicator is as follows:

At any instant, a flip-flop is either in the 1-state or 0-state. The outputs of each flip-flop are applied to the decoding matrix which consists of a particular arrangement of coincident networks ("and" gates). An "and" gate is a network that has a true output only if all inputs are true. For example, in order to light the 7 digit of the decade tube, the signal code required is $F_4 = 0$, $F_3 = 1$, $F_2 = 1$, and $F_1 = 1$. Assuming the proper combination of input signals H_1, H_2, H_3, H_4, and R_{C3} to one of the drive circuits, flip-flop 4 is triggered to the 0-state, flip-flop 3 to the 1-state, flip-flop 2 to the 1-state, and flip-flop 1 to the 1-state. Therefore, flip-flop 4 has a 0 output, and flip-flops 3, 2, and 1 have a 1 output. If these outputs are traced to the decoding matrix, it will be observed that only the top middle input "and" gate and the bottom input "and" gate have two true inputs. The outputs of these two "and" gates are applied through gate 7 to the 7-digit element of the decade tube (see figure 13).

Combinations of signals from the output register flip-flops F_3 and F_1 determine the selection of "+" or "-" in the sign indicator, as follows:

Binary-Coded Signals F_3 F_1	Display
0 1	+
0 0	-
1 0	(Blank)
1 1	(Blank)

For example, if the indicator selector signal combination selects the sign indicator, and digit selector signals $F_3 = 0$ and $F_1 = 1$, then flip-flop 3 is triggered to the 0-state and flip-flop 1 is triggered to the 1-state. It is observed that the 0 output of flip-flop 3 and the 1 output of flip-flop 1 are applied to the second vertical input "and" gate. The two signals being in coincidence, an output is applied over the "+" line to the "+" neon lamp in the sign indicator.

The sign indicator, combinations of signals from computer flip-flops F_{C1} and F_{C2}, determines selection of "command" or "decimal" neon lamps, as follows:

Binary-Coded Signals		Display
F_{C1}	F_{C2}	
0	0	C (command)
0	1	O (octal)
1	0	D (decimal)

For example, if indicator 1 is selected, and signals F_{C1} and F_{C2} are 0, flip-flops 4 and 2 are triggered to 0 state. It is observed that the 0 outputs of flip-flops 4 and 2 are applied to the top left input "and" gate. The "and" gate, having two signals in coincidence, supplies an output to the command neon driver circuit which, in turn, triggers the C neon lamp.

In readout of commands, decade indicator 8 specifies the sign (1 for plus, 0 for minus) of the second command of a word. A 1-set signal from computer "and" gate R_{C8} causes the computer to distinguish between 1 or 0 indications of numerical quantities and 1 or 0 indications of sign. This signal triggers flip-flops 2, 3, and 4 to the 0-state. Flip-flop 1, however, is either at 0-state or 1-state, depending upon its F_1 input. If F_1 is 0, flip-flop 1 has a 0 output. All four flip-flops then have a 0 output, which energizes the 0-digit of decade indicator 8. If F_1 is 1, flip-flop 1 has a 1 output, which, together with the 0 output of the other three flip-flops, energizes the 1-digit of decade indicator 8.

To clear all indicators, a reset (1-set) signal from computer "and" gate R_{C4} is applied to the four flip-flops. This signal sets the flip-flops to the 1-state. With only 1 output from the flip-flops, only the bottom input "and" gate can conduct. However, because each of the digit "and" gates of the matrix require two true inputs, neither gates 5 nor 7 can conduct. Consequently, all indicator elements are cleared.

LINE-VOLTAGE-TRANSIENT TRIGGER

The trigger circuit (figure 14) includes low- and high-voltage trigger stages, an inverter for the high-voltage section, and a flip-flop.

During computer warmup, a -12-volt (true) signal from the time delay circuit holds the transient indicator inoperative. Normally, a -0.5-volt (false level) signal from the time delay maintains the output of the transient indicator flip-flop at -0.5 volt. This level of output causes the transient indicator drive circuit to turn the neon indicator off. The lamp remains out as long as no transients occur. Occurrence of a low-voltage transient in the unregulated -18-volt line causes cutoff of the trigger stage with consequent triggering of the flip-flop to the 1-state. In this state, the output of the flip-flop is -12 volts (true level) which causes the neon drive circuit to flash the light. When the transient disappears, the flip-flop will continue to indicate an error until the ERROR RESET button is pushed, thereby returning all stages to their normal state.

Occurrence of a high-voltage (greater than -27 volts) transient triggers the high-voltage circuit and the neon light flashes.

MAINTENANCE

Maintenance of the control console consists of tests for locating faulty electrical circuits or elements, and of performing electrical and mechanical adjustments and preventive maintenance. In addition,

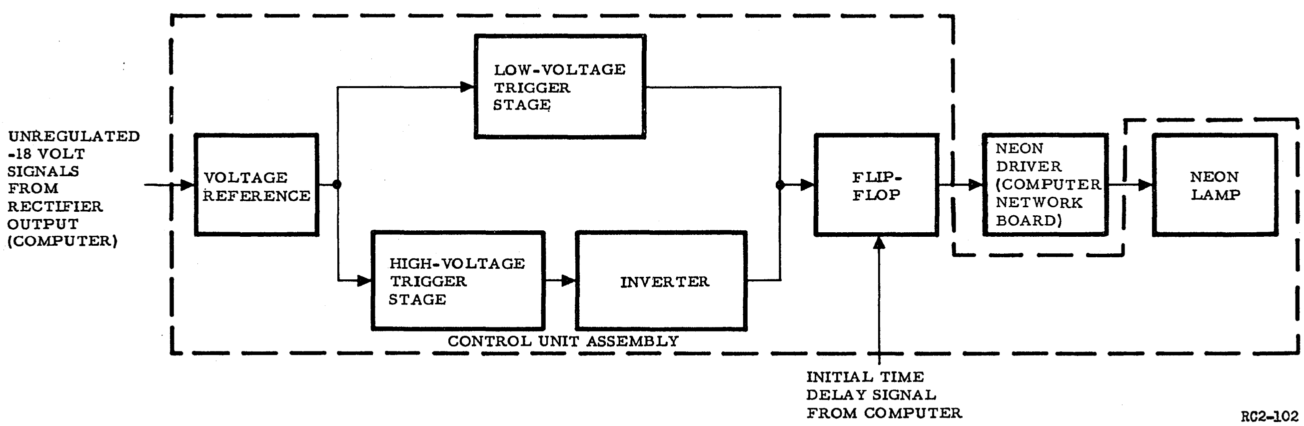


Figure 14. Voltage Transient Trigger Diagram

procedures for the replacement of parts are provided. Procedures for the Soroban mechanical keyboard are described under a separate heading. The component tester is used to test the control console circuit boards. Figure 15 shows the location of components with the control console chassis disassembled.

MECHANICAL KEYBOARD

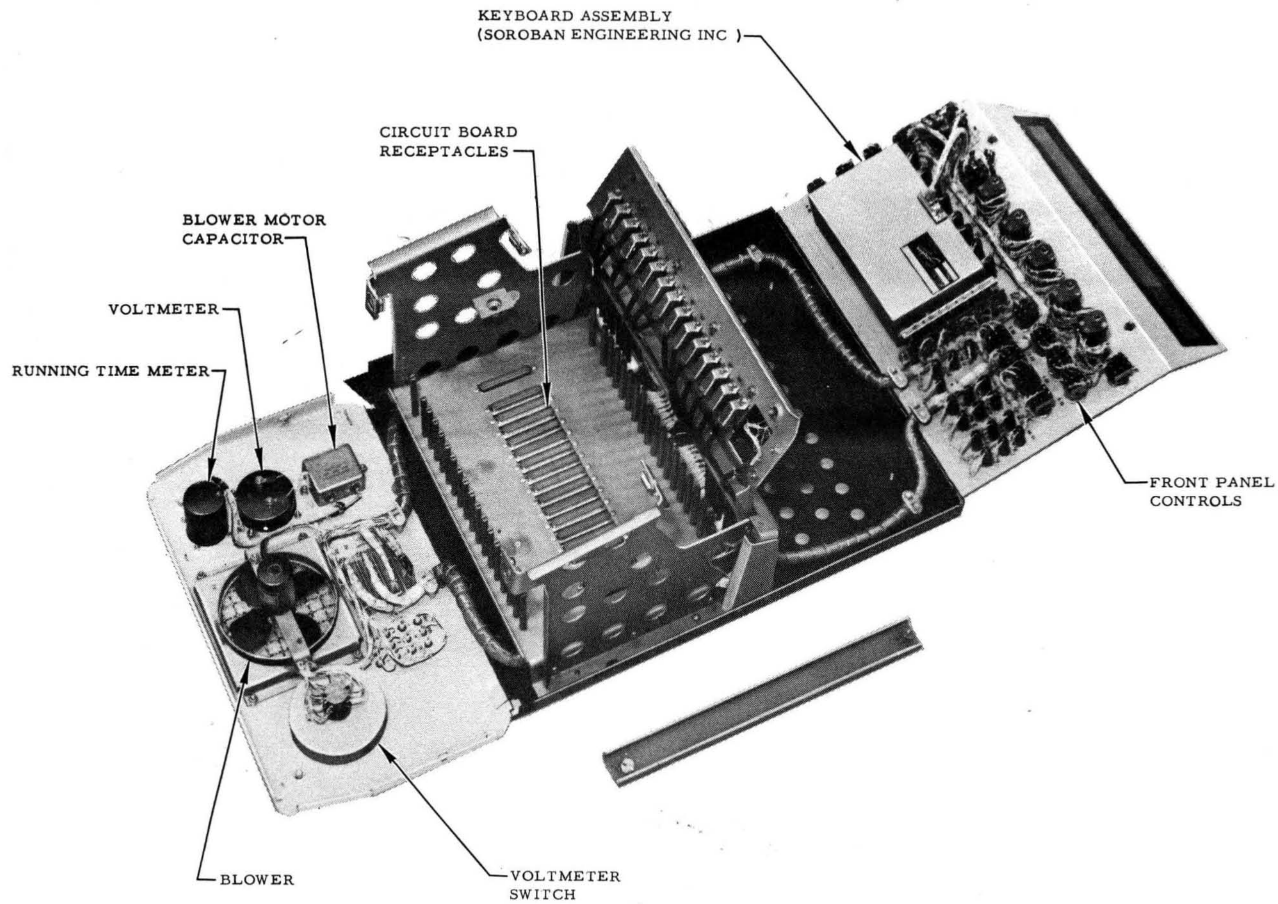
Keyboard failure, probable causes, and remedies are listed in table 1.

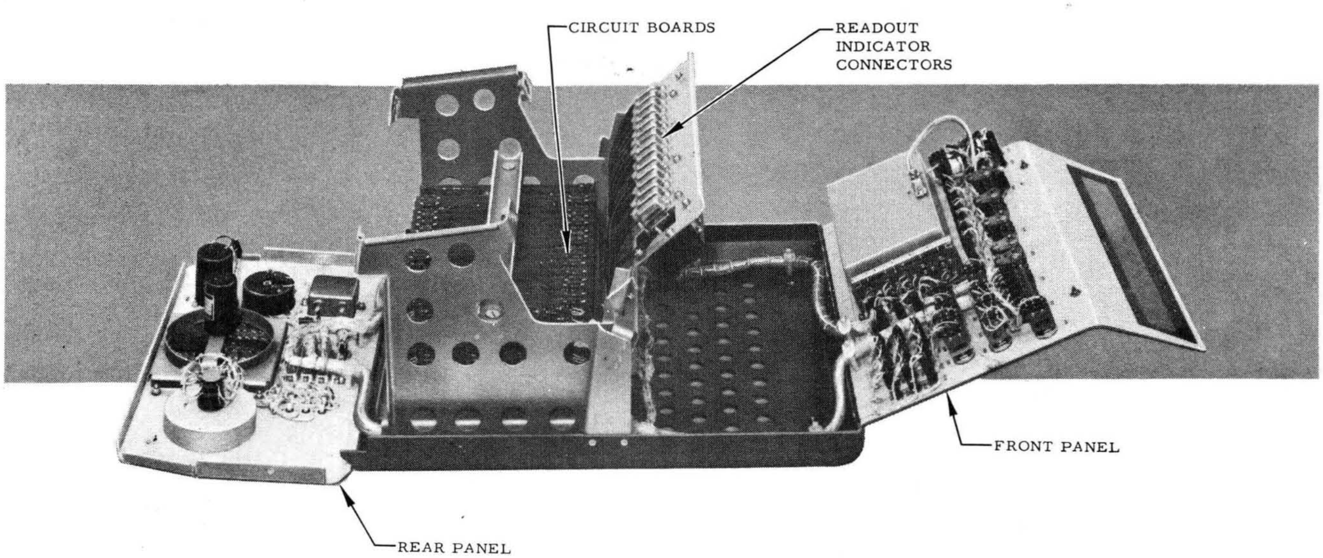
Table 1. Keyboard Trouble Analysis

Trouble	Probable Cause	Remedy
Nothing happens when given key is depressed	Failure of bail switch	Replace switch
Approximately half of keys operate normally and other half fail to operate	Failure of one bail switch	Adjust switch or replace
Characteristic click not observed when key is depressed with power off	Failure of bail switch	Adjust switch or replace
Some keys fail to operate, or operate intermittently	(1) Bail switch mounted too far from bail (2) Improper positioning of lower nylon bail stop	(1) Adjust switch (2) Adjust bail stop
Excessive over-travel with accompanying decreased bail switch life	Improper positioning of bail switch	Adjust switch
Incorrect code is generated	Code generating contacts are improperly adjusted	Adjust code generating contacts

NETWORK CIRCUIT BOARD

The network circuit board is tested with the use of the controls on the 6-NET CONTROL section of the component tester. These tests are performed on the decade drivers, the decoupling networks, multiplier resistors, and trigger network.





RC2-112

Figure 15. Control Console Disassembled

Preparation

Before performing the various tests, the component tester should be prepared as follows:

1. Set MASTER SELECTOR switch to 6.
2. Place POWER switch at "on."
3. Monitor +6-, -6-, -3-, -100-, +75-, -18-, -12-, and +50-volt d-c levels at test points.
4. Place POWER switch at "off."
5. Plug board into NETWORK CONTROL test jack at top of tester.
6. Place POWER switch at "on."

Decoupling Network Test

To test the decoupling network circuits, proceed as follows:

1. Perform preparation procedure (above).
2. Set TRIGGER switch to "off."
3. Connect a voltmeter between EXTERNAL TEST POINT 6-15 and GRD.
4. Set NET SEL switch to 1 and monitor voltage with a voltmeter. The voltage should be -12 ± 2-volt dc.
5. Set NET SEL switch to positions shown below and read the voltage indicated for each switch position:

NET SEL Position	D-C Voltage (Volts)
1	-12 ± 4.0
2	-6 ± 2.0
3	-0.7 ± 0.2
4	2.5 ± 1.0
5	-100 ± 15.0
6	-50 ± 8.0
7	-50 ± 8.0
8	+6 ± 2.0
9	+50 ± 8.0

Decade Driver Network

To check the decade driver network, proceed as follows:

1. Perform foregoing preparation procedure.
2. Place TRIGGER at "off."

3. Set NET SEL to 10.

4. Connect voltmeter between EXTERNAL TEST POINT 6-16 and GRD.

5. Depress SET switch and monitor voltage on voltmeter. The voltage should be between 0- and -0.3-volt dc.

6. Release SET switch and monitor voltage on voltmeter. The voltage should be more negative than -17-volt dc.

7. Connect voltmeter between EXTERNAL TEST POINT 6-14 and GRD.

8. Repeat steps 4 and 5 and monitor voltages. The readings should not exceed 11.5-volt dc.

Padder Resistors

To test the padder resistors, proceed as follows:

1. Perform foregoing preparation procedure.
2. Place TRIGGER switch to "off."
3. Set NET SEL to 1.
4. Depress PAD button and monitor voltage on test panel voltmeter. The voltage should be adjusted to value shown in Step 5.
5. Repeat Step 4 for NET SEL switch positions 2 through 9. The resistors and associated symbols checked at each position are as follows:

NET SEL Position	Resistors	D-C Value
1	R24, R34	0.45
2	R45, R47	0.32
3	R25, R35	0.75
4	R36	0.85
5	R26, R37	1.86
6	R38	1.30
7	R27, R39	0.65
8	Blank	----
9	R22, R28, R40	0.28

Trigger Network Test

To test the trigger network, proceed as follows:

1. Perform foregoing preparation procedure.
2. Place TRIGGER switch at "TRIGGER."
3. Set input voltage to -22.0-volt dc and monitor at pin 25 of circuit board by using test point on extender panel.
4. Adjust voltage level using resistor R1 on front of tester panel.

5. Connect voltmeter between EXTERNAL TEST POINT 6-17 and GRD.

6. Turn resistor R42 on circuit board fully counterclockwise.

7. Turn resistor R33 on circuit board fully clockwise.

8. Press RESET button and monitor voltage level. Voltage should be less than -3-volt dc.

9. Release RESET button and monitor voltage level. Voltage should be less than -3-volt dc.

10. Turn resistor R42 clockwise until voltage changes abruptly and reads more negative than -11.0-volt dc.

11. Monitor pin 25 on etched board by using extender panel, and adjust voltage to -30.0-volt dc using trimpot R1 on front panel of tester.

12. Reconnect voltmeter to EXTERNAL TEST POINT 6-17 and GRD.

13. Press RESET button and monitor voltage level. Voltage should be less than -3.0-volt dc.

14. Release RESET button and monitor voltage level. Voltage should remain at -3.0-volt dc.

15. Turn resistor R33 counterclockwise until voltage change is abrupt and reads more negative than -11.0-volt dc.

To complete the test procedures, place POWER switch at "off," and remove circuit board from tester.

DECADE CIRCUIT BOARD

The 7-DECADE section of the component tester is used to test the readout circuits of the control console.

Preparation

The following preparation of the component tester should be completed before beginning the test procedures:

1. Set MASTER SELECTOR switch to 7.
2. Place POWER switch at "on."
3. Monitor +50-, -100-, -0.7-, +6-, -3-, and -18-volt d-c levels at INTERNAL TEST POINTS.
4. Place POWER switch at "off."
5. Plug decade assembly into DECADE DRIVER test jack at top of tester.
6. Place POWER switch at "on."

Input Diode Test

The five input diodes CR5 through CR9 are checked for forward current characteristics by performing the following test:

1. Perform the preceding preparation procedure.
2. Set DIODE SELECTOR to 1.
3. Set NUMERAL SELECTOR to 1.
4. Depress SET, RESET, and TRIGGER buttons in the order indicated. The nixie tube numeral 1 should light.

NOTE

> Any position of the NUMERAL SELECTOR will serve to test the input diodes; however, the numeral selected will indicate in the nixie tube instead of the one suggested.

5. Repeat Steps 3 and 4 for each position of the DIODE SELECTOR. The nixie tube numeral 1 should light for each position of the DIODE SELECTOR.

Nixie Tube Circuit Test

The NUMERAL SELECTOR switch of the component tester is connected to the four 16-kilohm clock resistors on flip-flops F_1', F_2', F_3', and F_4'. For a different switch position, these resistors are either grounded or switched to -12-volt dc. Each position selects the preset logic for the correct flip-flop. After the NUMERAL SELECTOR is turned to a position, all flip-flops are then reset with the RESET switch. To finally trigger the nixie tube, the TRIGGER switch should be depressed. The flip-flop inputs are then grounded, which causes a pulse to trigger all flip-flops having a -12-volt d-c potential on the clock resistor. By using the diode logic, enough potential is applied across either the nixie tube or the neon readout to cause it to light. To perform the test, proceed as follows:

1. Perform preceding preparation procedure.
2. Set NUMERAL SELECTOR to 1.
3. Set DIODE SELECTOR to any diode position that has previously checked out correctly.
4. Depress the SET, RESET, and TRIGGER buttons in the order indicated. After the TRIGGER switch has been depressed, the nixie tube numeral 1 should light.

5. Repeat steps 2 and 3 for each of the positions on the NUMERAL SELECTOR. The selected numeral should light on the nixie tube, or the decimal (.), plus (+), and minus (-) neon indicator should light for the last three positions of the NUMERAL SELECTOR.

Neon Driver Test

To test the neon driver circuit proceed as follows:

1. Perform preceding preparation procedure.
2. Depress the NEON TEST button. The N neon indicator should glow while button is depressed, and go out when button is released.

After the test procedures have been completed, the following procedure should be performed:

1. Set POWER switch to "off."
2. Remove decade driver board from tester.

NIXIE TUBES

The control console nixie tubes (decade tubes) are tested with the controls located on the 2-NIXIE section of the component tester. The tubes are tested by applying 150 volts dc to each element within the tube to determine if each element lights. The neon indicator at the bottom of the nixie assembly is tested through an internal neon driver circuit which is actuated by a tester switch.

Preparation

The following preparation of the component tester should be completed before beginning the test procedure:

1. Set MASTER SELECTOR switch to 2.
2. Place POWER switch at "on."
3. Monitor -12-, -100-, and +50-volt d-c levels at INTERNAL TEST POINTS. Tolerances should be as follows:

-12±1 volts
-100±15 volts
+50±3 volts

If the tolerances do not agree with the above, make the following adjustments:

-12 volts: Adjust R27 on the -12-, +75-volt power supply board.
-100 volts: No adjustment
+50 volts: Adjust R12 on the -200-, +50-, -1-, -0.7-volt power supply board.

4. Place POWER switch at "off."
5. Verify that NEON switch on 2-NIXIE panel is at "off."
6. Plug nixie assembly into NIXIE test jack on vertical front panel.
7. Place POWER switch at "on."

Element Check

To check the individual nixie elements, proceed as follows:

1. Perform preceding preparation procedure.
2. Set NEON ON-OFF to "on."
3. Set SELECTOR to desired element (positions 1 through 10), and verify that each element lights for individual positions selected.
4. Set NEON ON-OFF switch to "off," and verify that none of the nixie elements light at any position selected. If any element fails the test, replace nixie assembly.

Neon Indicator Check

To test the neon indicator, proceed as follows:

1. Perform preceding preparation procedure.
2. Depress NEON button and verify that neon indicator glows. Replace indicator if it fails to glow.

To complete the test, place POWER switch at "off" and remove nixie assembly.

PREVENTIVE MAINTENANCE AND LUBRICATION

Component malfunctions are held to a minimum by preventive maintenance performed at regular intervals. Such maintenance includes a periodic maintenance schedule for the control console assembly and lubrication instructions for the mechanical keyboard. Periodic servicing of the control console should be performed as listed in Table 2.

Table 2

Control Console Preventive Maintenance Schedule

Component	Two Months	Three Months	Twelve Months	Type of Maintenance
All circuit boards and nixie tube assembly		X		Perform individual checks as described on preceding pages.
Keyboard			X	Lubricate when bail switch is replaced, or once a year, whichever occurs more often.
Blower			X	Check lubrication of bearings. Bearings are the sealed-type and cannot be repacked; therefore, they should be replaced.
Filter	X			When the filter becomes congested, remove and clean as follows: a. Immerse filter in cool, clear water. If foreign matter remains, a detergent should be used, followed by a rinse. CAUTION Do not subject filter to temperatures above 212 F. b. If impossible to immerse filter, accumulation should be washed out by using a fine spray of water passed through the filter in a direction opposite to that of the airflow arrows. (Direct waterflow from the clean side to the dirty side of the filter and wash accumulation off filter.)

Component	Two Months	Three Months	Twelve Months	Type of Maintenance
				CAUTION Do not direct a high-velocity stream of water against the filter. c. Gently shake water out of filter and replace filter in unit with airflow arrows indicating direction of air circulation. CAUTION Do not disturb the normal distribution of shredded material in filter.

NOTE

Table 2 does not include storage time. A complete check should be performed on the control console after the unit has been in storage for 90 days or more.

The keyboard is lubricated during final factory test and adjustments. However, because of normal wear and evaporation of lubricating oils, the keyboard should be relubricated periodically with each momentary switch replacement, or once each year, whichever occurs more often. The use of light machine oil such as SAE 20 or Soroban keyboard oil (SAE 20) or Soroban keyboard grease (mixture of Molylube and Plastilube) or Soroban keyboard lubricant (a mixture of the three). (See Table 3.)

NOTE

Only mineral oil lubricants should be used. Fish or vegetable oils will not permit satisfactory service. (For specific points of lubrication for the keyboard elements, see figures 11 and 16.)

Table 3. Lubrication Chart

Keyboard Element	Type of Lubrication
Actuator guides	One drop per glide of keyboard oil
Interlocking balls	One drop per ball of keyboard oil
Actuator locking bar gliding surfaces (front and rear plate)	Keyboard grease
Switch bail and pivots	Keyboard grease
Code bar restoring bails (front and rear plate caps)	Keyboard grease
Rotary Ledex solenoid	Keyboard grease (one dab on plates and balls)

DISASSEMBLY AND ASSEMBLY

Procedures in the following paragraphs explain component and part removal. Replacement, in most cases, is the same as removal except in reverse order.

CONTROL CONSOLE CHASSIS

To disassembly the control console chassis see figure 15 and proceed as follows:

1. Remove three flatheaded screws on the right and left sides of cover, and lift cover upward and forward to remove.
2. Turn two fasteners 1/4-turn counterclockwise and lift sloping front panel forward.
3. Turn two fasteners on back cover panel 1/4-turn counterclockwise and lower rear cover panel.
4. Turn two fasteners (above decade tubes) 1/4-turn counterclockwise and pull decade tube assembly away from inner chassis.

NOTE

> This completes the necessary disassembly of control console for normal maintenance requirements. Further disassembly is necessary only for more detailed maintenance procedures.

CIRCUIT BOARDS

To remove the boards, proceed as follows:

1. Disassemble control console.
2. Remove circuit board with circuit board extractor.

DECADE INDICATORS (NIXIE TUBES)

The decade indicators are removed as follows:

1. Disassembly control console.
2. Loosen Phillips-head screw at top of selected indicator.
3. Manipulate indicator up and down while pulling outward to remove from socket. Complete indicator assembly should release from socket.

NEON INDICATORS

To remove the neon command indicators (+, -, N, C, and 0), proceed as follows:

1. Unsolder leads on back of indicators.
2. Remove retaining ring on front mounting panel.
3. Remove and replace complete indicator assembly through rear of mounting panel.

FILTER

To remove the filter, proceed as follows:

1. Remove top cover of control console (refer to paragraph on removal of control console chassis).
2. Remove four flatheaded screws on back cover and remove blower and filter assembly unit.
3. Remove filter from blower bracket and clean. (Refer to table 2.)

KEYBOARD

To remove the mechanical keyboard, see figures 11 and 16 and proceed as follows:

1. Disconnect cannon connector from back of keyboard case.
2. Remove four flatheaded screws from front sloping panel, and the four spacers between unit and sloping panel.

CAUTION

> Hold keyboard unit in hand while removing screws from panel to prevent any possible damage.

Remove keyboard from inside of panel.

NOTE

> Further access to the keyboard mechanism is attained by removal of four No. 10 screws on the sides of the keyboard case. In general, this provides adequate access for scheduled lubrication, replacement of momentary switches, and occasional adjustments.

REMOVAL OF BAIL MOMENTARY SWITCHES

Bail switch failures require a major portion of the keyboard service, hence when one switch fails, it is likely that the companion switch is approaching the end of its useful life. For this reason, failure of one switch should be followed by replacement of both. To replace a defective switch, proceed as follows:

1. Remove bottom cover of keyboard.
2. Unsolder two switch leads from momentary switch, being careful not to damage the insulation.
3. Carefully remove the two spacers and single nut with each of two flatheaded screws mounting the switch to the frame.
4. Remove momentary switch.

INSTALLATION OF BAIL MOMENTARY SWITCHES

Care must be exercised in replacing the momentary switch to avoid distortion of the momentary switch bail. Proper operation of the momentary switch is dependent upon satisfactory operation of the switch bail as well as proper positioning of the switch and its associated bail stops. The switch bail should hit all actuators evenly and should ride free on its pivots with a slight amount of end play (0.005 inch) to permit the switch spring to return the bail to its neutral position. To install and position the new momentary switch, proceed as follows:

1. Place the two flatheaded retaining screws in switch and carefully aline spacers before tightening.
2. Position switch by depressing a key button and manually engaging the rotary solenoid so that keyboard locking mechanism retains key in the depressed position.
3. Adjust the switch for minimum overtravel consistent with reliable operation of switch from any button. This adjustment is made with key restrained solely by locking mechanism.

CAUTION

It is extremely important that the preceding adjustments be made only when the keys are locked in the depressed position by the keyboard locking mechanism, not by full manual depression.

TESTS DURING ASSEMBLY

The keyboard installed in the control console is a mechanical device (Soroban Series FK-104X). Under normal operating conditions, adjustments other than those made by the manufacturer should not be required during the life of the instrument. A visual and physical check of the keyboard should be made to assure proper key button alinement and free key button operation. In addition to unrestricted key motion, all keys should exhibit full return to neutral when pressure is removed from all buttons. If inspection reveals damage during shipment, no adjustment should be attempted until the factory has been notified. However, if at any time the keyboard is disassembled beyond removal of the panel from its cast aluminum case, the following tests should be made during re-installation:

1. All actuators should enter the slots freely in the interlock cage. If binding action is noted, depress the actuator and bend or twist it until play exists between the actuator and its guiding slot.

2. The code bars should travel freely in their respective slots after the caps and retaining bars have been tightened. The ends of the code bars are notched for identification and installation (see figure 16).

3. The interlocking balls in the cage should shift back and forth freely and the interlock bar should be secured.

4. With the code bar springs in place, a weight of 50±5 grams should be sufficient to pull the code bar away from the restoring bail.

5. Following assembly, the retaining bars should be moved toward the code bars until all keys have vertical play when the solenoid is energized.

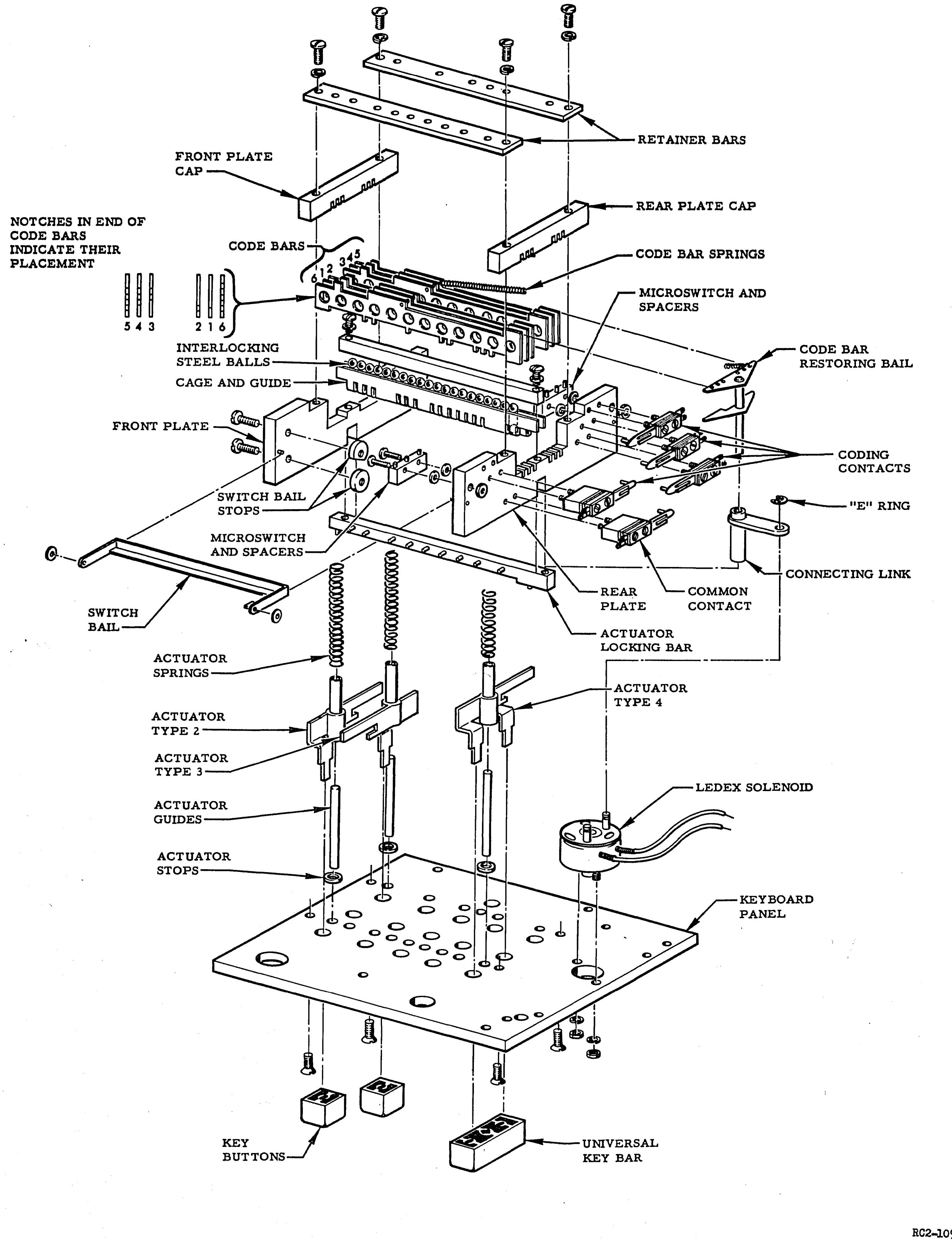


Figure 16. Control Console Keyboard, Exploded View

ELECTRIC TYPEWRITER

The electric typewriter is an input-output device which converts binary electrical code from the computer into characters on the typewriter keyboard. The keys automatically print their information on paper. When information is entered from the typewriter keyboard, the key characters are converted into coded information which may be transmitted either to the computer or to the tape punch. The typewriter is a standard electrical unit equipped with a computewriter attachment. Conversion of information is performed by the computewriter. Electronic circuitry necessary to operate the typewriter is mounted on etched circuit plug-in boards located in the desk assembly.

FUNCTIONAL DESCRIPTION

FUNCTION OF CONTROLS

Typewriter controls and their functions apply to the manually operated devices on the typewriter proper (see figures 17 and 18).

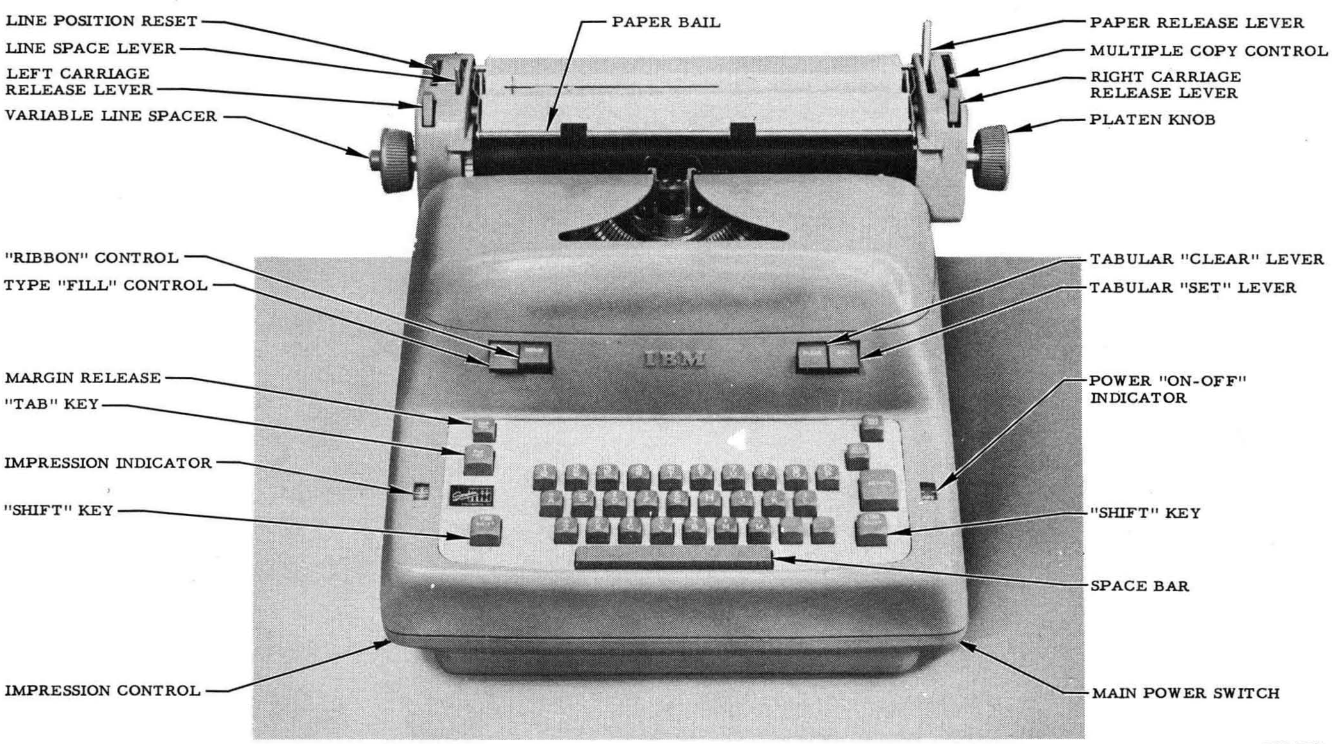


Figure 17. Typewriter Exterior Controls

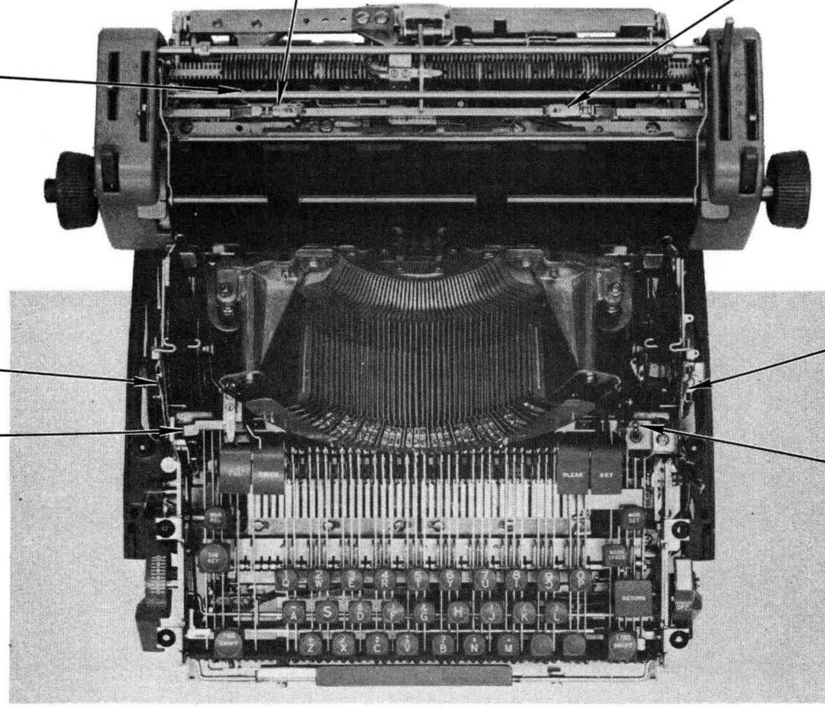


Figure 18. Typewriter (Cover Removed)

RC3-104

CONTROL	FUNCTION
Main power switch	Applies a-c power to the power roll, thereby unlocking the printing keys.
Power ON-OFF indicator	Indicates state of main power switch.
Impression control	Adjusts the print impression.
Impression indicator	Indicates the print impression. Force of impression varies directly with the number of copies (low setting for stencil, higher setting for multiple copies).
RIBBON control	Controls printing to lower edge, center, or top edge of ribbon, or to stencil position.
TAB SET lever	Sets tabular stop.
Type FILL lever	Sets typewriter to receive teletype code.

CONTROL	FUNCTION
Tabular CLEAR lever	Clears tabular stop.
Front paper scale	Indicates position of carriage, permitting setting for margins and tabulations.
Rear paper scale	Consists of two scales: lower scale is equivalent to front paper scale; upper is 10-inch scale.
Variable line spacer	When pressed, it locks out standard spacing, permitting platen to move freely backward or forward. Sets paper to any position not attainable by line space lever.
Left carriage release lever	Releases carriage for manual adjustment.
Right carriage release lever	Releases carriage for manual adjustment.
Platen knob	Steps platen a single space at a time.
Line position reset	Releases platen for free movement, as with variable line spacer. However, the reset restores platen to original position when typing above or below a line.
Line space lever	Selects single, double, or triple line spacing.
Adjustable paper guide	Guides paper for easy insertion and acts as marker for obtaining uniform margins.
Paper release lever	Frees paper for positioning and removal.
Multiple copy control	Adjusts platen to compensate for thickness of copy. Position "A" used for one to four copies. Lever advanced one position for every three extra copies.

CONTROL	FUNCTION
Ribbon manual reverse lever	With automatic rewind lever in unlocked position, depression of this lever reverses direction of ribbon.
Ribbon automatic rewind lever	In locked position, causes ribbon to rewind automatically.
Left margin stop	Sets left margin.
Right margin stop	Sets right margin.
Tabular override switch	Carriage returns regardless of shift position.

NORMAL OPERATION

Primary power is applied to the typewriter power roll through the desk circuit breaker when the main power switch is placed at ON as indicated by the power ON-OFF indicator. When power is turned on, the printing keys are unlocked and printing or typing action may be performed. Printing action begins when a specific combination of teletype-coded pulses (corresponding to the character selected) from the computer output register drives the typewriter decoding magnets. The magnets actuate the desired key indirectly, thereby printing a character. Typing action begins with the manual depression of a key which produces a specific set of teletype-coded pulses in the coder assembly. These pulses are fed into the computer input register or the tape punch assembly. Typewriter code is shown in table 8.

CONTROL CIRCUITS

The typewriter control circuits (figure 19) consist of (1) computewriter attachment, (2) amplifying circuits (typewriter driver board), and (3) echo check circuits (control network board). The computewriter components are attached to the rear of the typewriter chassis. The driver and control network boards are mounted in the typewriter control chassis located in the desk assembly (see figure 8).

The computewriter attachment consists of a decoder assembly, coder assembly, and mechanical power unit (see figure 20). The decoder assembly translates computer output electrical pulses into mechanical coding for key operation. The coder assembly translates the mechanical

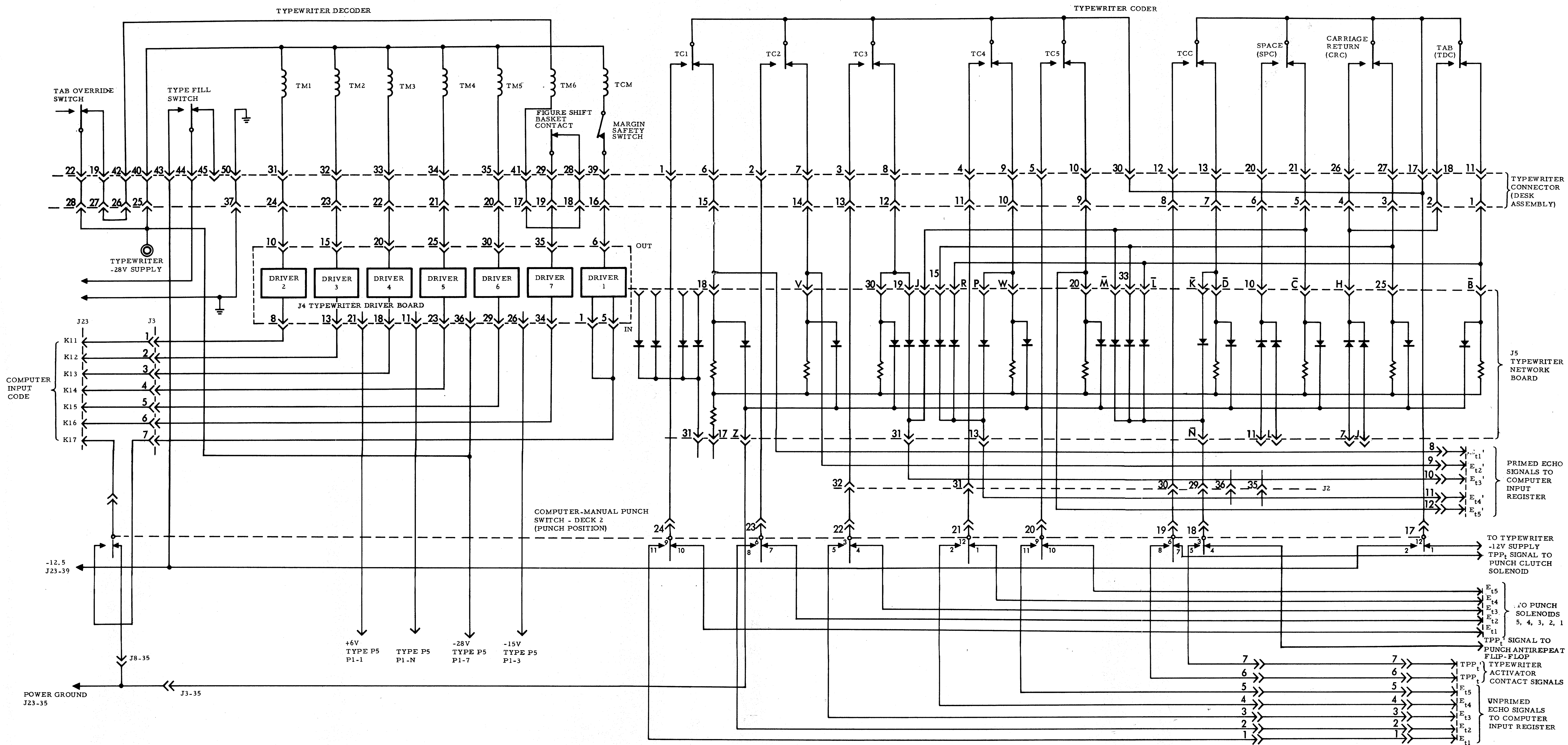


Figure 19. Typewriter Input-Output Schematic

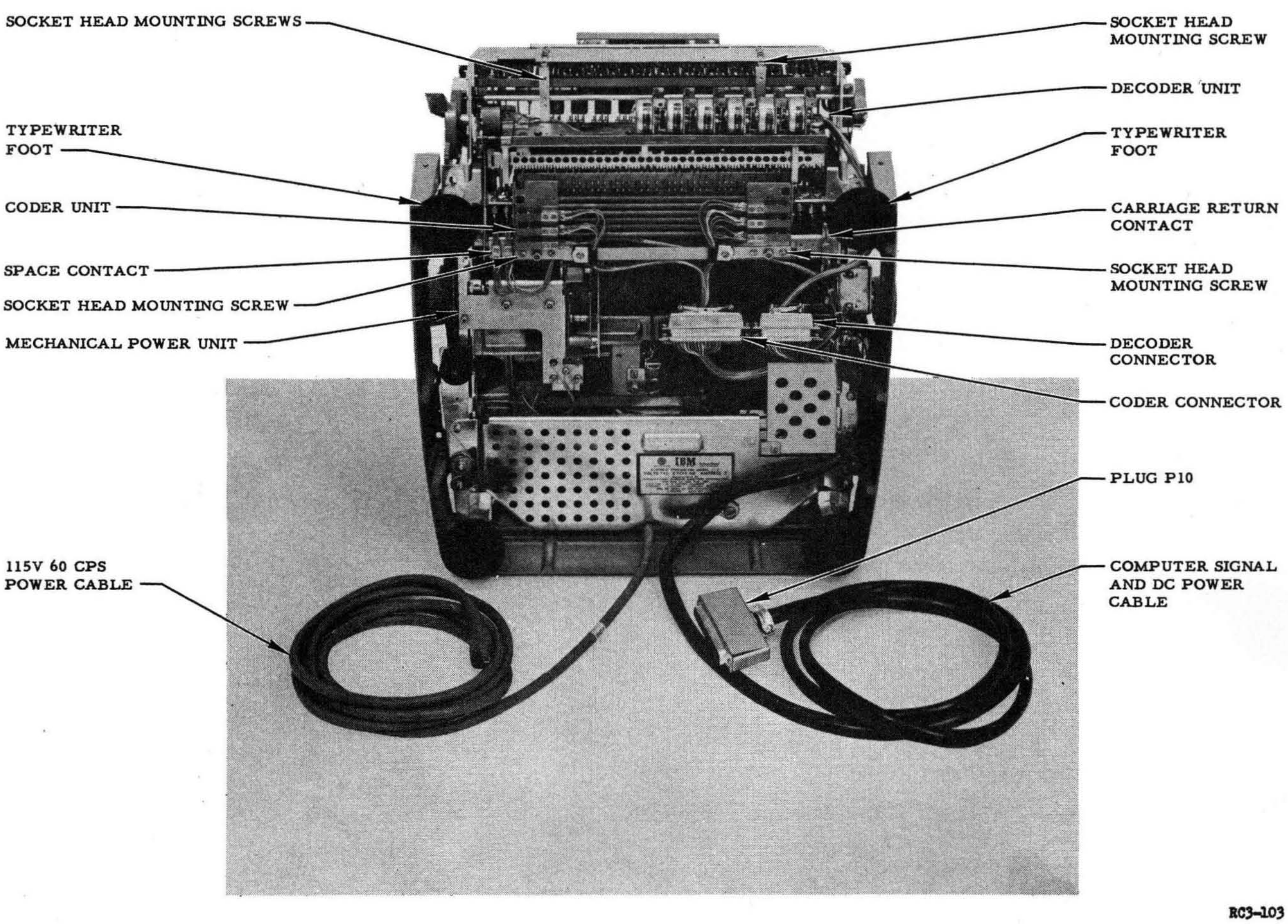
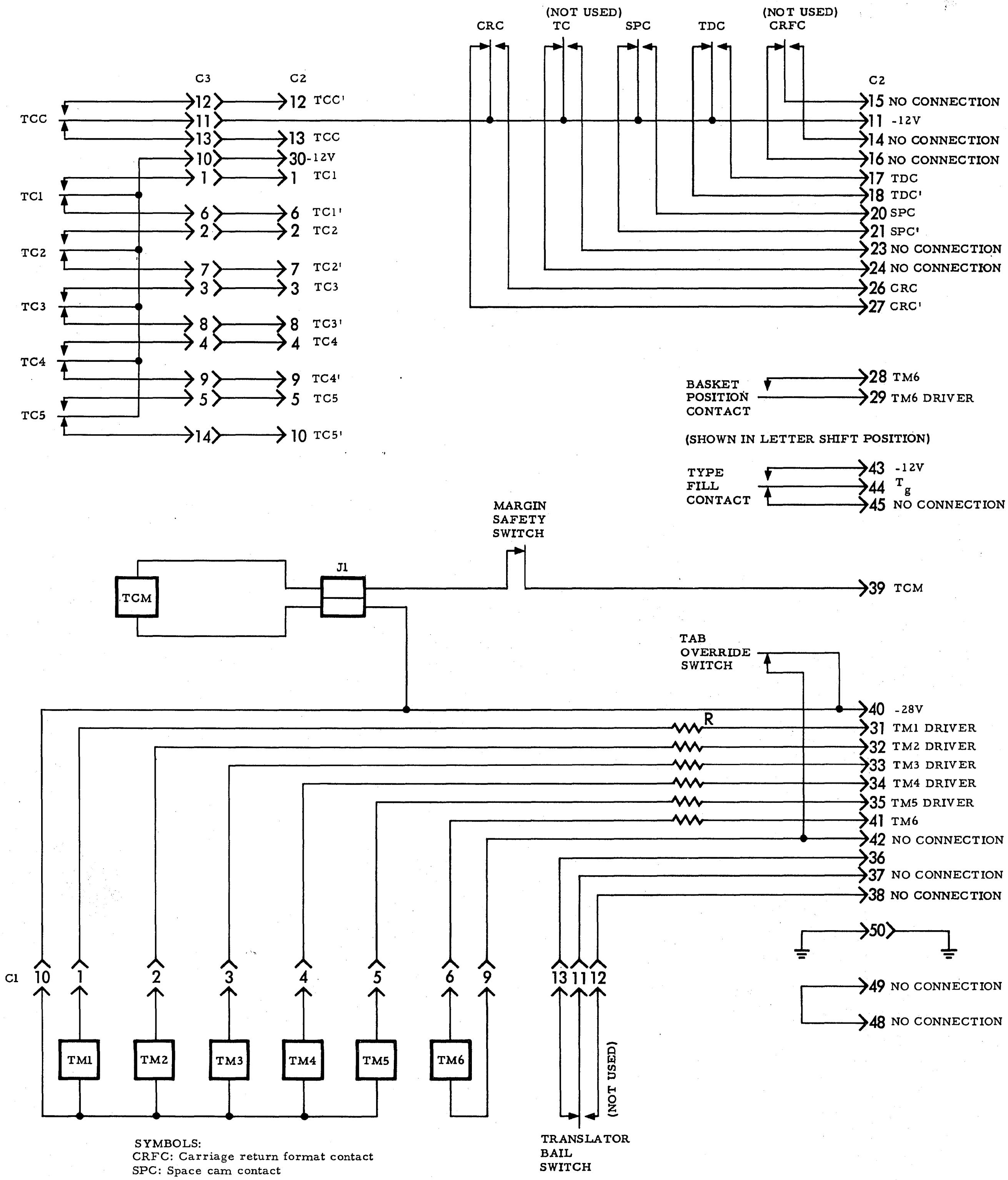


Figure 20. Typewriter, Bottom View



SYMBOLS:
CRFC: Carriage return format contact
SPC: Space cam contact
CRC: Carriage return cam contact
TC: Tab cam contact
TDC: Tab delay contact (at rear of typewriter)
TC1 to TC5: Typewriter coder contacts
TCC: Typewriter coder common contact

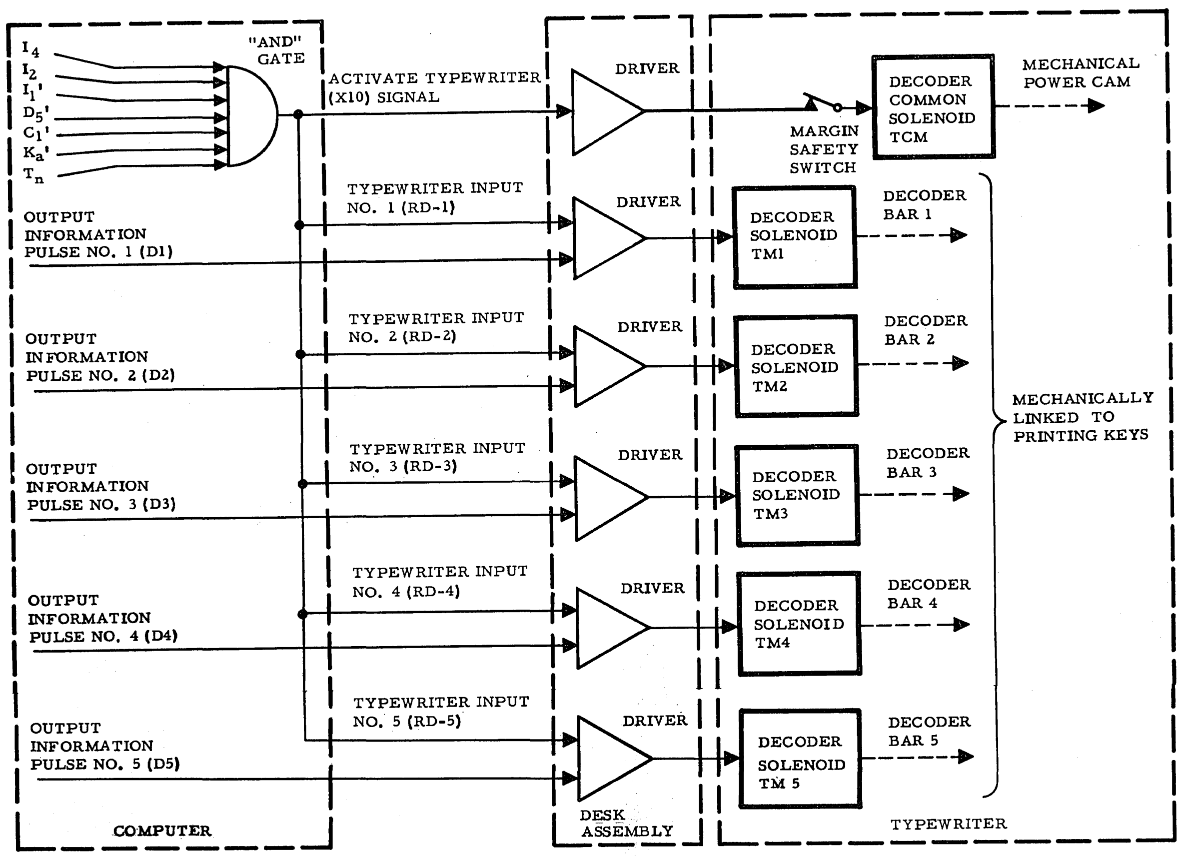
Note:
1. Resistor values are 25 ohms, rated 25 watts
2. TM1 to TM6 and TCM are 24-volt d-c solenoids
3. Ribbon shift lever is split to provide for type fill contact
4. Contact timing: TC1 to TC5 must transfer before TCC

Figure 21. Computewriter Assembly, Schematic

motion of key depression into electrical pulses for entering data into the computer, terminates each printing action, and verifies the printed output (termed "echo checking"). The mechanical power assembly supplies mechanical drive to the decoder and coder (see figure 21).

Mechanical Power Assembly

The mechanical power assembly contains a solenoid-controlled half-revolution cam mounted below the typewriter power roll. When the solenoid (TCM) is energized by an activate typewriter $(X_{10}M_7)$ pulse from the computer, (figure 22), the cam is permitted to engage the typewriter power roll. Because the power roll rotates continuously as a result of normal typewriter power, it causes the cam to rotate until the cam stop pin encounters the trip arm (a 1/2-revolution rotation). The pull rod, which connects the cam shaft and decoder drive shaft, is displaced to the rear of the typewriter and returned to normal position by the cam movement. Mechanical interlocks prevent more than one pull on the rod with each energized cycle of the solenoid.



RC3-100A

Figure 22. Typewriter-Decoding Block Diagram

Decoder Assembly

Teletype-coded electrical current pulses from the computer output register are amplified in the typewriter driver circuits and applied to five typewriter solenoids (TM1 through TM5) (see figure 22). Each solenoid positions a corresponding spring-loaded decoder bar. The decoder bars are notched so that for any specific combination of solenoid actuation, only one continuous slot can exist across all five bars. A corresponding key seeker is allowed to drop into the slot by the spring-loaded drive from the mechanical power unit. Because the upper end of each seeker hooks over a pin on the side of each typewriter key, the key is depressed which results in typewriter action.

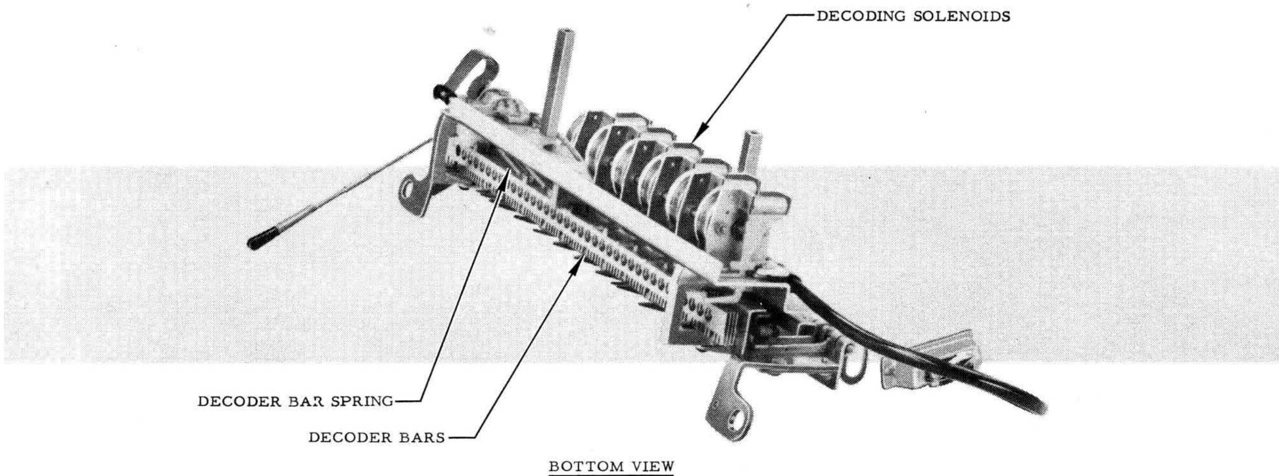
Initially, the force of the decoder drive crank spring causes the crank to push a pivoted actuator rod to the rear. The actuator rod positions the seeker bail so that all seekers are lifted free of the coding bars. When the decoder bars have been positioned by solenoid actuation, a pull action supplied by the pull rod and the mechanical power assembly draws the seeker bail forward. The spring-loaded seekers attempt to follow the bail motion; all but the selected seeker are restrained by the code bars. The selected seeker enters the selecting slot, is caught by the bail, and pushed against the pin on the key lever. Movement of the lever causes the key typeface to strike the paper. At the end of the power cam stroke, the pull action on the pull rod is released, and displaced parts return to initial positions (see figure 23).

Coder Assembly

The coder assembly is used to supply signals for filling the computer, for verifying the typewritten output, and for terminating the typing action. The coder assembly consists of code bars for the keys, contact deflecting plates, and five sets of contacts (TC1 through TC4, TCC, common) which are mechanically coupled to the keys (see figure 24).

When the selected seeker displaces the corresponding key during the decoding action, it simultaneously displaces a corresponding code bar. The coding projections on the bar strike deflecting plates which, in turn, cause the corresponding coder contact arms to transfer to the normally open contacts.

Coding contacts for the SPACE, TAB, and RETURN key are not actuated as part of the coder assembly, but are actuated directly by these keys. Figure 18 shows the location of the tab delay switch which contains the tab delay contacts. Figure 20 shows the location of the



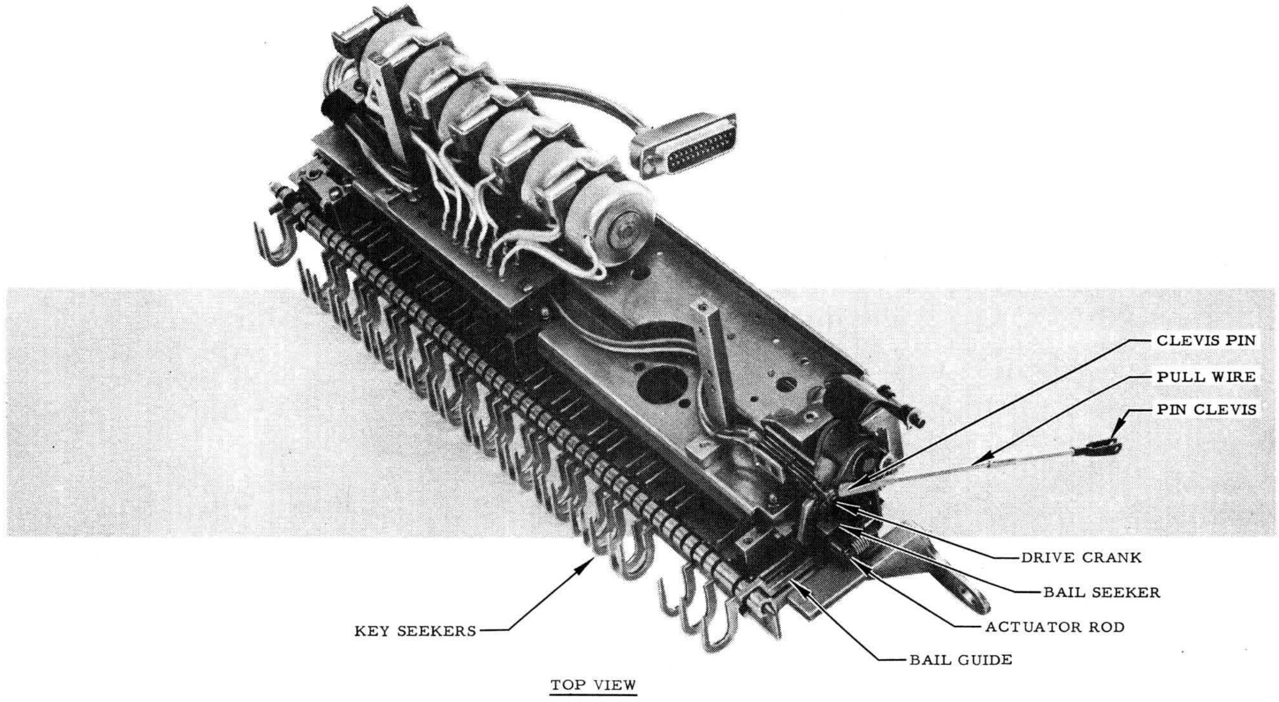


Figure 23. Decoder Assembly

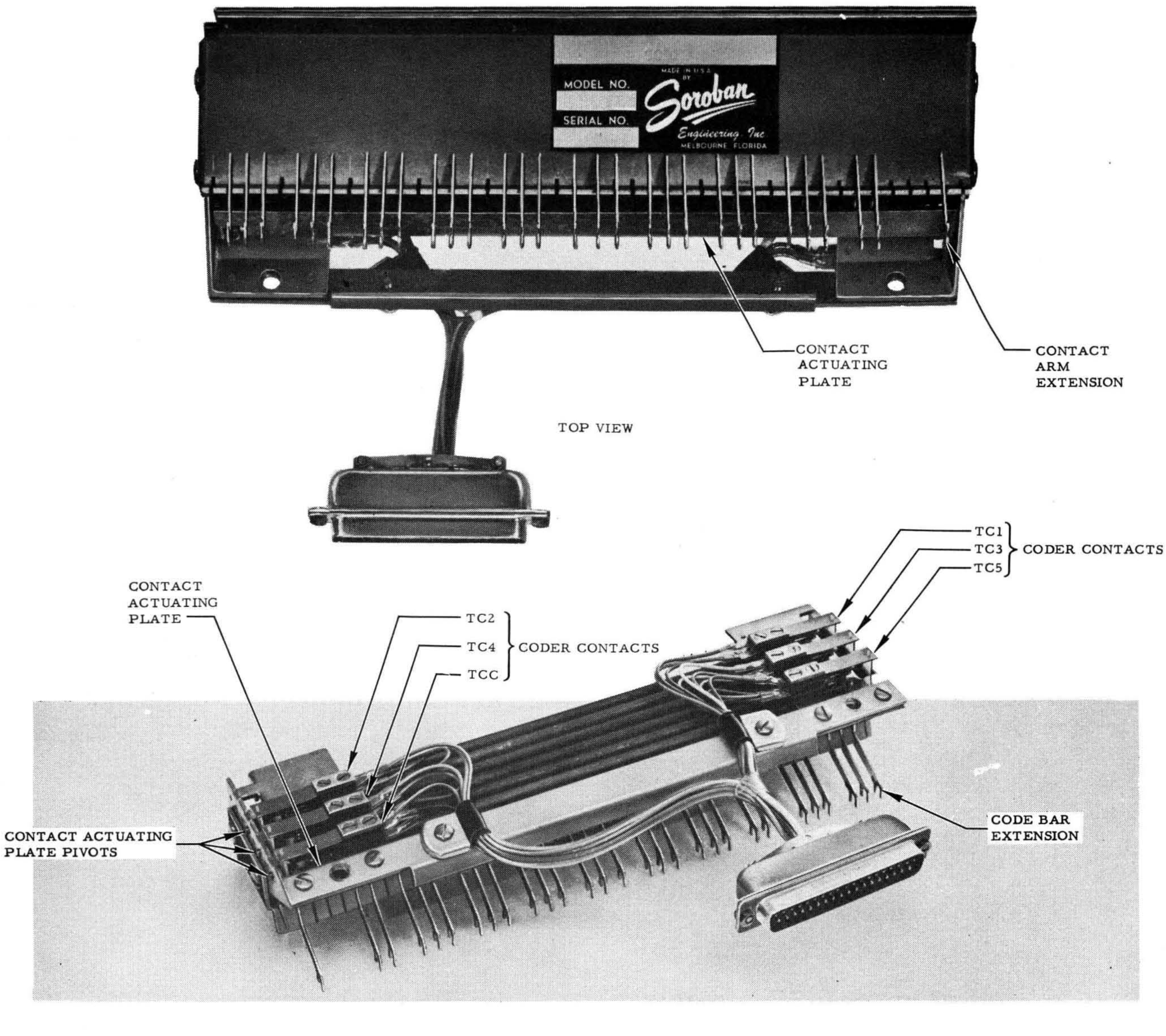


Figure 24. Coder Assembly

space and carriage return contacts. When one of the typewriter keys is automatically operated by a command from the computer, the corresponding verify contacts are actuated in accordance with the teletype code shown on figure 33. For example, if the number 7 is typed, a 0 digit is required in channels 4 and 5, and 1-digits required in channels 3, 2, and 1. Closing of contacts TC3, TC2, and TC1 generates pulses of current, K_{3k}, K_{2k}, and K_{1k}, respectively, which simulate the 1 digits. The 0 digits in channels 4 and 5 are simulated by the TC5 and TC4 contacts which remain closed, thereby sending a pulse of current to the 0 digit "and" gates on lines E_{t5}, and E_{t4}. (An "and" gate has the property of supplying a true output only if all its input signals are true. (In figure 25 a current from the -12-volt supply is a true signal.)

If a nonprinting operation, i.e., carriage return, space, or tabulation, is established, a similar procedure occurs. For example, if the SPACE key is actuated, a 1 digit is required in channel 3, and 0 digits are required in channels 5, 4, 2, and 1. Closing of contact SPC generates a pulse of current that flows through the space diode to line K3K. (The diodes prevent interaction between lines.) Lines K5K, K4K, K2K, and K1K do not receive current. Also, because the SPC' contact at this time is open, no current flows on the SPC' lines to the 0 digit "and" gate E_{t3}'. However, because "and" gates E_{t5}', E_{t4}', E_{t2}', and E_{t1}' do not have an SPC' line, a current flows on these lines, thereby establishing the required 0 digits (figure 25).

The antirepeat function of the coding units terminates each printing action and resets the computer. Contacts producing this function are the TCC set, which is mechanically common to each key and the normally closed contacts of the carriage return, space, and tabular delay keys (figure 25). When the TCC arm transfers, a 12-volt "initiate termination" signal TPP_t is applied to the computer. This signal causes the "activate printer" signal (X_{10} M_7) to be removed from the decoder common solenoid (TCM). When the TCC arm returns to normal, all lines to the TPP_t' "and" gate are again supplied with current. The resulting TPP' signal resets the computer, allowing it to proceed with the computation or send out another output signal.

Tab Override Switch

When the typewriter is in the figure shift position and the computer sends out code for carriage return, the typewriter will tabulate. When the typewriter type basket is in the letter shift position and the computer sends out code for carriage return, the typewriter will return. When the tabular override switch (figure 18) is moved to the override position, and the computer sends out code for carriage return, the typewriter will return regardless of the shift position.

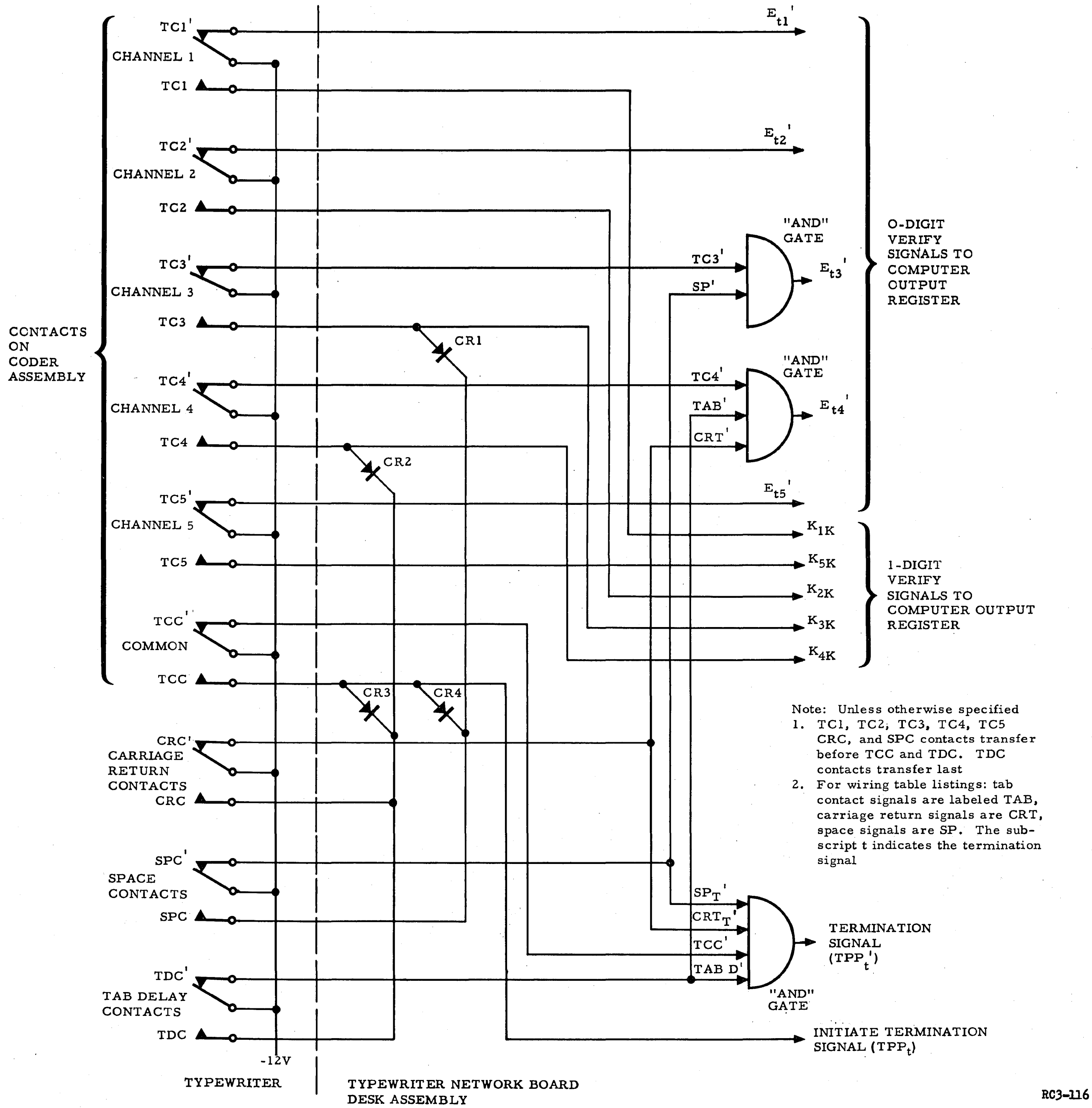


Figure 25. Typewriter Coding, Simplified Diagram

Typewriter Driver Board

The driver board, which plugs into the typewriter control chassis (figure 26), contains nine identical driver amplifiers, of which six are used to amplify the coded input signals originating in the computer. The amplified signals are applied to the five typewriter solenoids (TM1 through TM5) and to the typewriter actuation solenoid (TCM) for use in the typewriter decoding operation.

Typewriter Control Network Board

The control network board in the control chassis contains the space diodes and "and" gates required to select the signal combinations transmitted by the echo check contacts in the coder assembly. When a typewriter key is depressed, the character is converted into electrical pulses by the actuation of echo check contacts corresponding to the key character. The signals generated by the contacts are then recoded in the network board into output pulse groups the computer can receive as information. (See figure 25.)

TYPEWRITER POWER SUPPLY CIRCUITS

The typewriter power supply chassis (figure 27) is a separate package, mounted in the desk assembly, and providing four levels of secondary d-c voltage to the typewriter circuits. The power supply incorporates the use of transistors and etched circuitry on a plug-in board in addition to the transformer, choke, and other power units mounted on the chassis. Primary power at 115 volts, 60 cps is applied through the circuit breaker and the POWER ON-OFF switch to the power transformer. Power at d-c voltages of unregulated -28 volts, and regulated -15, -12.5, and +6 volts are supplied to the typewriter circuits. The source of these voltages is 30-volt ac stepped down from the primary voltage. The secondary ac is rectified in a full-wave bridge rectifier consisting of four diodes and located on the power supply chassis. Rectifier output is full-wave unregulated -28 volts with respect to ground. Unregulated -28-volt power is supplied to the typewriter solenoids located in the decoder unit. Choke-input filters are used to filter the -12.5-, -15-, and +6-volt power supplies.

-15- and -12.5-Volt Power Supplies

The -15- and -12.5-volt power supplies are regulated by a control amplifier located on the power supply board and a power amplifier located on the power supply chassis (see figure 28). The power amplifier carries the majority of the load current. The filtered output from the transformer

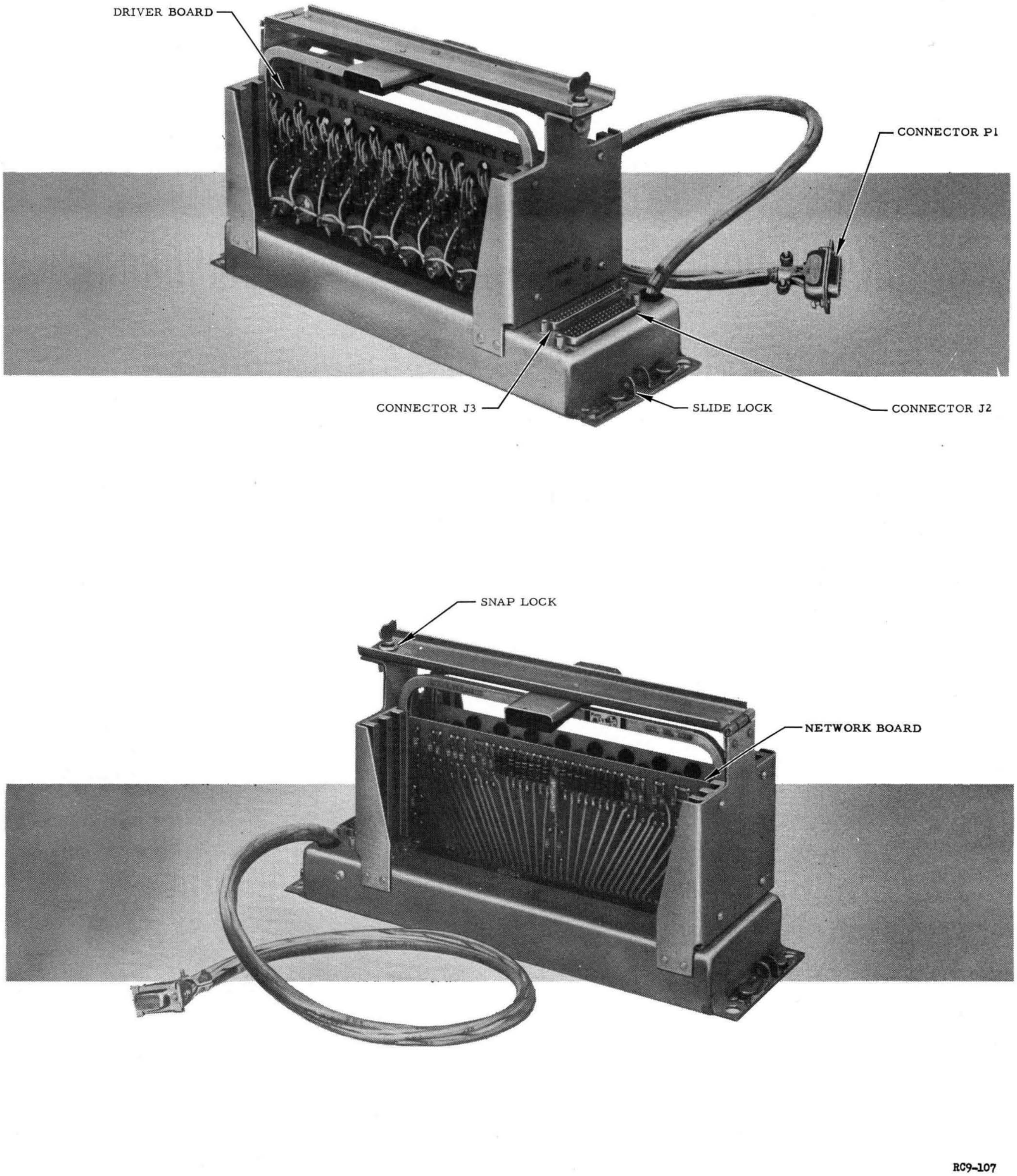


Figure 26. Control Chassis

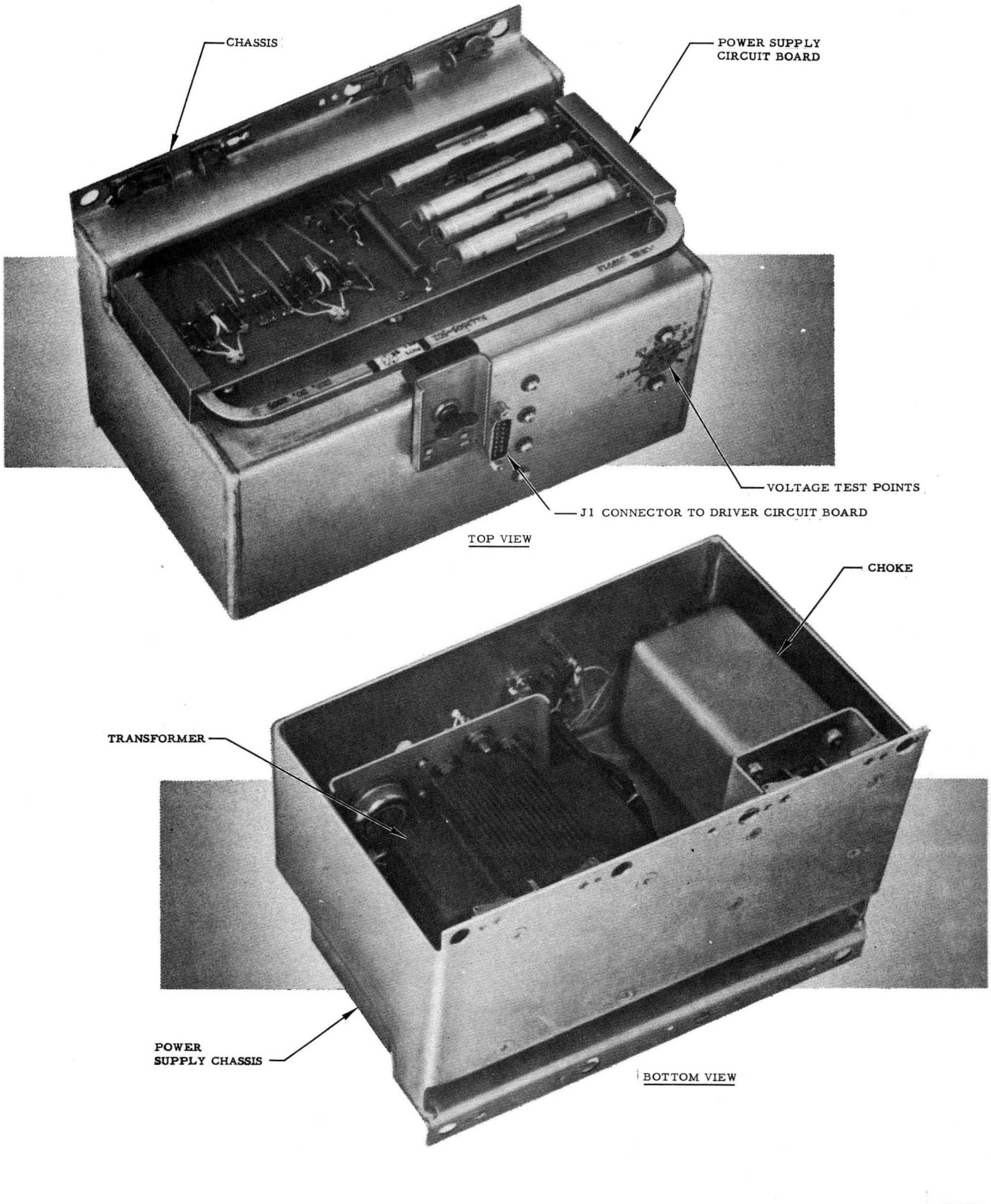


Figure 27. Typewriter Power Supply

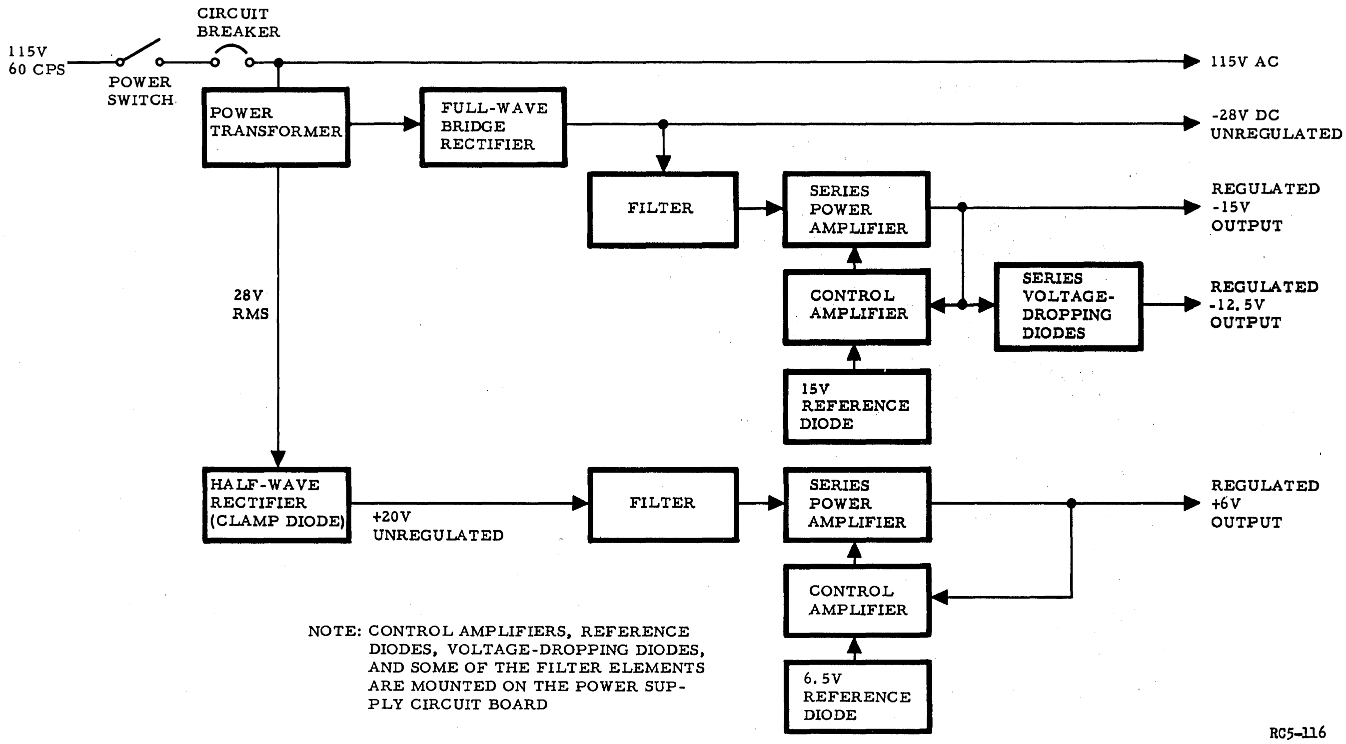


Figure 28. Typewriter Power Supply, Block Diagram

is applied across a Zener diode. The diode has a fixed voltage drop of -15 volts which serves as a fixed potential on the control amplifier. This fixed potential holds the control amplifier current output steady. Since the control amplifier is little affected by load current changes, its current output regulates the power amplifier. Because of control amplifier regulation and because its output impedance is low, the power amplifier is relatively independent of supply voltage changes. The power amplifier output is a regulated -15 volts. A second output of -12.5 volts is produced by connecting three diodes in series with the output. These diodes are back-biased to produce the more positive -12.5-volt level. The diodes have a voltage drop of approximately 0.8 volt each.

+6-Volt Power Supply

The +6-volt power supply is also regulated by a control amplifier located on the power supply board and a power amplifier located on the power supply chassis (see figure 28). The series power amplifier carries the majority of the load current. The regulation, however, is 1/2-wave operated. That is, the negative half-cycle of ac is clamped to ground. The positive half is coupled through a capacitor to the filter supplying the input to the +6-volt regulator and then to ground. From ground, the return is to the filter supplying the input to the -12.5- and -15-volt regulator and then to the transformer return. The output voltage of the power amplifier is controlled by negative feedback. A Zener diode acts as the reference for the output with a fixed 6.5-volt drop. If the output voltage across a bleeder resistor tends to decrease, the difference between it and the 6.5-volt reference is applied to the control amplifier as a negative change. This negative change on the control amplifier causes the power amplifier to become more positive, increasing the load current. The output voltage, therefore, is increased sufficiently to offset the original tentative decrease.

MAINTENANCE

Maintenance of the electric typewriter consists of testing for faulty electrical circuits or elements, and of performing electrical and mechanical adjustments and preventive maintenance. In addition, procedures for the replacement of parts are provided. In analyzing troubles or determining the need for adjustments of the typewriter itself, reference should be made to International Business Machine Manual 1261089. Prior to performing electrical checks or adjustments of signal circuitry, the typewriter power supply should be checked to determine that the appropriate power levels are being applied. Test equipment, recommended for use in performing checks, is listed as follows:

Item	Model or Type
Voltohmmeter	Model 630-A, Triplett
Oscilloscope	
Variable auto-transformer	Range: 0 to 115 volts

Power Supply Tests

The typewriter power supply is mounted in the rear of the desk compartment. Power supply chassis and circuit board checks include insulation resistance, transformer primary and secondary checks, and secondary load, no-load checks.

Insulation Resistance

Verify that the power cord is not connected to the power source. With the megohmmeter, measure the resistance between the chassis and the body of the 2N443 transistors, and between the chassis and body of the 1N253 diodes. All resistances should be infinite. If they are not, check the insulation for defects, and especially the mica washers.

Transformer Primary Check

With the circuit board removed, apply exactly 115 volts to the primary of the typewriter power supply transformer. With the secondary open, the output voltage should be 32.0 ± 1.5 volts.

Secondary D-C Voltage Level Checks

Plug the circuit board into the chassis. Energize the power supply through the connection of an autotransformer originally set to zero. Increase the autotransformer voltage slowly to 115 volts and check the voltage levels at the +6-, -28-, and -15-volt output terminals. If there are any signs of overheating, or if the output voltage decreases when the input voltage increases, reduce the input voltage immediately and repeat the test. If the malfunction continues, reduce the input voltage to zero and discontinue test procedures until the element causing the malfunction has been located and replaced.

Load Test

Apply the loads to the appropriate test points indicated, with the power supply deenergized. (Refer to table 5, load column.)

No-Load Test

Energize the power supply. With no load, measure the power supply voltage as shown in table 4.

Table 4. Power Supply Voltage Measurement

Voltage Level (Volts)	Test Point	Voltage Limit (Volts)
+6	1	+6.3 ± 0.5
-12.5	7	-12.5 to -13.1
-15	3	-15.5 ± 1.5
-28	4	-29 ± 3

Table 5. Power Supply Load Test

Supply Voltage (Volts)	Test Point	Maximum Voltage (Volts)	Maximum Ripple (Millivolts, Peak-to-Peak)	Load
+6	Pin 1	+6 ± 0.5	50	200 ohms
-12.5	Pin 7	-12.5	75	160 ohms
-15	Pin 3	-15 ± 1.5	75	150 ohms
-28	Pin 4	-28 + 3	200	100 ohms
-24.5 (Lamp Supply)	Pin 2	-24.5 ± 1.5*	200	46 ohms
Ground	Pin 8	0	0	12 watts

* Lamp Supply is Not Used in Typewriter

NOTE

With rated load of 160 ohms, the output at pin 7 should be less negative than the -15-volt supply by 1.5 to 3 volts dc.

1. With the power supply energized, the output voltages should be as shown in table 5.
2. With the power supply energized and the loads connected, use the oscilloscope to read the allowable ripple as listed in table 5.

SIGNAL CIRCUIT BOARD CHECKS

Signal circuit boards consist of the control network and driver boards which plug into the typewriter control chassis. The control chassis is mounted in the rear of the desk compartment. The two boards should be removed from the control chassis prior to applying the appropriate voltage levels to the respective boards. The typewriter power supply, previously tested, is used as the power source in the following checks.

Control Network Board

1. When checking the thirteen clamping circuits, apply +6 volts to terminal 17, and connect terminal Z to ground. The voltage on each of the clamp terminals should not exceed 1 volt.

2. With the +6-volt power supply energized, apply -12 volts in turn to each of the clamp output terminals and measure the terminal current. The current should not exceed 4 milliamperes in clamps 1 through 7, 7.6 milliamperes in clamps 8 through 10, and 11.4 milliamperes in clamps 11 through 13.

3. When checking the eleven diode input-output circuits, ground the output terminal. Apply -12 volts through a 1.1-kilohm resistor to each of the input terminals in turn, and measure the voltage drop across the diode. This voltage drop should not exceed 1 volt.

4. Ground the input terminals in turn and apply -18 volts to the output terminal. The output terminal current should not exceed 18 milliamperes.

5. Repeat the procedure in steps 2 and 3 for each of the eleven diode circuits.

Driver Circuit Board Check

Checks are performed on the driver amplifiers, tape advance, antirepeat, and PCM functions to determine that signal output levels are within appropriate values and tolerances, and to isolate possible defective elements on the board. In addition to the typewriter power supply output levels, a -12-volt external power source is required in the following procedures.

Driver Voltage Levers. Connect the power supply output levels (-28-, -15-, and +6-volt dc) to the appropriate input terminals on the board.

1. Apply all normal power to the board.

2. Connect a 150-ohm, 10-watt resistor between output 1 (pin 6) and -28-volt dc (pin 36).

3. Connect input 1 (pin 5) to ground.

4. Connect the multimeter between pin 6 (output 1) and pin 36 (-28-volt dc) to measure the voltage drop across the resistor.

5. The voltage should be less then 0.1-volt dc.

6. Connect the 150-ohm, -10-watt resistor between outputs 2 through 9 individually and -28-volt dc (pin 36) while connecting inputs 2 through 9 individually to ground. (Refer to table 6-4 for pin number designations.)

7. Connect the multimeter between outputs 2 through 9 individually and pin 36 (-28-volt dc) to measure the voltage drop across the resistor.

8. The voltage should be less then 0.1-volt dc in each case.

9. Remove the ground from the board inputs.

10. Apply -12 volts from an external power supply to input 1 (pin 5) with the load connected as in step 3.

11. Connect the multimeter between output 1 (pin 6) and ground.

12. The voltage should read no more negative then -0.25-volt dc.

13. Repeat step 10 for inputs 2 through 9; measure the voltage between outputs 2 through 9 individually and ground. The voltage should be no more negative then -0.25-volt dc. (Refer to table 6 for input and output terminal designation.)

Table 6

Input and Output Terminals

Input	Pin	Output	Pin
1	5	1	6
2	8	2	10
3	13	3	15
4	18	4	20
5	23	5	25
6	29	6	30
7	34	7	35
8	39	8	41
9	42	9	43

Tape Advance and Code Delete Check. The resistance of the tape advance and code delete functions are checked as follows:

1. Remove all power from the board.

2. Connect an ohmmeter between pin 3 (tape advance) and the input side of resistor R20.

3. The resistance should read 22 kilohms.

4. Connect the ohmmeter between pin 16 (code delete) and the input side of resistor R20.

5. The resistance should read 22 kilohms.

6. Repeat step 4 from pin 16 (code delete) to the input side of resistors through R28 individually.

7. The resistance should read 22 kilohms in each case.

PCM End and Antirepeat Check. To perform the tests on the PCM and antirepeat functions, proceed as follows:

1. Removal all meters from the board.
2. Connect pin 1 (PCM), and pin C (antirepeat) to ground.
3. Connect a 150-ohm, 10-watt resistor between pin 6 (output No. 1) and pin 36 (-28-volt dc).
4. Apply all normal power (-28, -15, +6) to the board.
5. Connect the multimeter between pin 6 (output 1) and pin 36 to measure the voltage across the 150-ohm resistor.
6. The voltage should read less then 0.1-volt dc.
7. Repeat steps 2 through 5 for outputs 2 through 9. (Refer to table 6 for output terminal designations.)
8. Remove the ground from pin 1 and pin C and apply -12-volt dc to pin 1 and pin C successively.
9. Measure the voltage drop across the 150-ohm resistor connected between pin 36 (-28-volt dc) and outputs 1 through 9 individually. (Refer to table 6 for output terminal designations.)
10. The voltage should be no more negative then -0.25-volt dc.

Typewriter Functional Tests

The typewriter is functionally tested by applying static inputs to the typewriter driver amplifiers to simulate commands from the computer. Coded signals are checked against the printed character to determine correct key selection by the decoder. Echo signal checks are performed also to make certain that the computer truly receives a correct echo of the coded pulse group previously sent to the typewriter. Functionally tested typewriter power supply, control network, and driver circuitry should be used in the following checks. The power supply and control chassis need not be removed from the desk.

Decoder Check

Code designations and the respective pin numbers for typewriter driver inputs are shown (table 7).

Table 7. Typewriter Driver Inputs

Code Column (Left to Right)	*Input Cable Pin	Designation
5	5	K 15
4	4	K 14
3	3	K 13
2	2	K 12
1	1	K 11
6	6	K 16

*The input cable connector is J10, located on the back of the desk. (See figure 3.)

Table 8 shows the coding of the typewriter. In the right column, a "1" represents an applied voltage of -12 ± 1 volt, and a "0" represents a voltage of 0 ± 1 volt, or an absence of voltage. In the first column (character or operation), an "L" preceding the character indicates that the typewriter has been placed in letter shift and the input codes applied to the drivers should cause a key to print the corresponding character. An "F" preceding the character indicates that the typewriter has been placed in figure shift and input codes should cause a key to print the corresponding figure.

1. With the typewriter assembly energized, and the FIG SHIFT key depressed, apply -12 volts to the driver inputs (table 7) in the combinations indicated. (Refer to table 8.)
2. After each combination is set up, apply -12 volts (X10) to pin 7 (K17) to actuate the computewriter and typewriter. The character or operation printed should be in accordance with the combinations indicated. (Refer to table 8.)

With the LTR SHIFT key on the typewriter depressed, repeat steps 1 and 2 for all combinations indicated. (Refer to table 8.)

Echo Check (Coder)

To check the signals sent back to the computer for echo check, the various keys of the typewriter are depressed, and the outputs to the computer are monitored. Each of the echo output points are grounded through a 10-kilohm resistor and the outputs are monitored by an oscilloscope, set as follows:

1. SQUARE WAVE CALIBRATOR set to 10 volts
2. VERTICAL DEFLECTION set to 1 volt per centimeter

3. TIME per centimeter set to 10 milliseconds

4. The oscilloscope is triggered by placing EXTERNAL TRIGGER to pin 7 (K17).

The pins corresponding to the various echo outputs are shown. (Refer to table 9.)

Table 8

Typewriter Character or Operation	Input Code
	5;4,3;2,1
Blank	0 0 0 0 0
L-E, F-3	0 0 0 0 1
Line Feed	0 0 0 1 0
L-A, F-Minus	0 0 0 1 1
Space	0 0 1 0 0
L-S	0 0 1 0 1
L-I, F-8	0 0 1 1 0
L-U, F-7	0 0 1 1 1
L-Carriage Return, F-Tabulation	0 1 0 0 0
L-D, 1	0 1 0 0 1
L-R, F-4	0 1 0 1 0
L-J	0 1 0 1 1
L-N	0 1 1 0 0
L-F	0 1 1 0 1
L-C	0 1 1 1 0
L-K	0 1 1 1 1
L-T, F-5	1 0 0 0 0
L-Z, F-Plus	1 0 0 0 1
L-L	1 0 0 1 0
L-W, F-2	1 0 0 1 1
L-H	1 0 1 0 0
L-Y, F-6	1 0 1 0 1
L-P, F-0	1 0 1 1 0
L-Q, F-1	1 0 1 1 1
L-O, F-9	1 1 0 0 0
L-B	1 1 0 0 1
L-G	1 1 0 1 0
L-FIG	1 1 0 1 1
L-M, F-Period	1 1 1 0 0
L-X	1 1 1 0 1
L-V	1 1 1 1 0
L-LTR	1 1 1 1 1

Table 9. Echo Output Points

Output	Pin	Designation
ET1	1	K1K
ET2	2	K2K
ET3	3	K3K
ET4	4	K4K
ET5	5	K5K
	6	TPP_t
	7	TPP_t
ET1'	8	
ET2'	9	
ET3'	10	
ET4'	11	
ET5'	12	

1. As the character is typed, or the command executed, the various outputs (ET1, ET1, etc) should indicate -12 volts, as shown (table 10). All outputs not listed are zero.

Table 10. Echo Checks, FIG SHIFT Depressed

Character or Command	-12 Volts
0	ET5, ET3, ET2
1	ET5, ET3, ET2, ET1
2	ET5, ET2, ET1
3	ET1
4	ET4, ET2
5	ET5,
6	ET5, ET3, ET2
7	ET3, ET2
8	ET3, ET2
9	ET5, ET4
+	ET5, ET1
-	ET2, ET1
.	ET5, ET4, ET3
TAB	ET4

2. With the LTR SHIFT key on the typewriter depressed, repeat the process of step 1 for all combinations listed. (Table 11).

Table 11. Echo Checks for LTR SHIFT Depressed

Character or Command	-12 Volts
P	ET5, ET3, ET2
Q	ET5, ET3, ET2, ET1
W	ET5, ET2, ET1
E	ET1
R	ET4, ET2
T	ET5
Y	ET5, ET3, ET1
J	ET3, ET2, ET1
I	ET3, ET2
O	ET5, ET4
Z	ET5, ET1
A	ET2, ET1
M	ET5, ET4, ET3
Carriage Return	ET4
X	ET5, ET4, ET3, ET1
L	ET5, ET2
C	ET4, ET3, ET2
N	ET4, ET3
H	ET3, ET1
D	ET5, ET3
F	ET4, ET1
G	ET4, ET3, ET1
K	ET5, ET4, ET2
FIG.	ET4, ET3, ET2, ET1
V	ET5, ET4, ET3, ET2
B	ET5, ET4, ET1
LTR.	ET5, ET4, ET3, ET2, ET1
Space	ET3
J	ET4, ET2, ET1

3. With the typewriter energized, but not printing, ET1', ET2', ET3', ET4' and ET5' should indicate -12 volts.

4. During each printing process TPP_t should indicate -12 volts and TPP_t' should indicate 0 volts.

5. When the machine is not printing, TPP_t' should indicate -12 volts, and TPP_t should indicate 0 volts.

MAINTENANCE AND REPAIR

This section provides preventive maintenance instructions and procedures for the removal and replacement of parts. Repair of RECOMP II input-output equipment other than etched circuit boards, consists solely of replacement of defective components.

Preventive Maintenance

Preventive maintenance is limited to lubrication of the Soroban computewriter attachment. Correct lubricants are applied in proper amounts during planned intervals. Special lubrication instructions for the attachment are listed (table 12), and lubrication points are shown (figures 29 and 30).

CAUTION

Lubricants used in excess may flow onto the typewriter power cam and power roll, causing malfunction of the cam and permanent damage to the power roll.

Table 12. Lubrication Instructions

Callout	Name	Instructions
1	Magnet arm shaft	Use lubricant (Lubriplate No. 2 or equivalent)
2	Permutation bar guides	Use lubricant (Lubriplate No. 2 or equivalent) on bearing surfaces and bearing surface of center spacer not shown in figure 29
3	Permutation bar return spring	Use lubricant (Lubriplate No. 2 or equivalent)
4	Clevis pin	Use lubricant (Molub-Alloy No. 3 or equivalent) to pack bearings
5	Magnet arm and permutation bar	Use lubricant (Molub-Alloy No. 3) or equivalent between arm and permutation bar

Callout	Name	Instructions
6	Flange bushing	Use lubricant (Lubriplate No. 2 or equivalent)
7	Bail roller	Use lubricant (Lubriplate No. 2 or equivalent) on each end of decoder
8	Bail guides	Use lubricant (Lubriplate No. 2 or equivalent) on each end of decoder
9	Seeker and seeker guide cap	Use lubricant (Lubriplate No. 2 or equivalent)
10	Bail spring loops	Use lubricant (Molub-Alloy No. 3 or equivalent) each end of decoder
11	Cam trip arm and sleeve and accelerator arm and sleeve	Use lubricant (Lubricate No. 2 or equivalent)
12	Cam magnet arm and cam magnet bracket	Use lubricant (Lubricate No. 2 or equivalent)
13	Clevis pin	Use lubricant (Molub-Alloy No. 3 or equivalent) to pack bearings
14	Stop pins	Use lubricant (Molub-Alloy No. 3 or equivalent)
15	Accelerator pins	Use lubricant (Molub-Alloy No. 3 or equivalent)
16	Accelerator arm	Use lubricant (Molub-Alloy No. 3 or equivalent)
17	Trip arm lugs	Use lubricant (Molub-Alloy No. 3 or equivalent)
18	Cam roller	Use lubricant (Lubriplate No. 2 or equivalent)
19	TCM armature shaft	Use lubricant (Lubriplate No. 2 or equivalent)

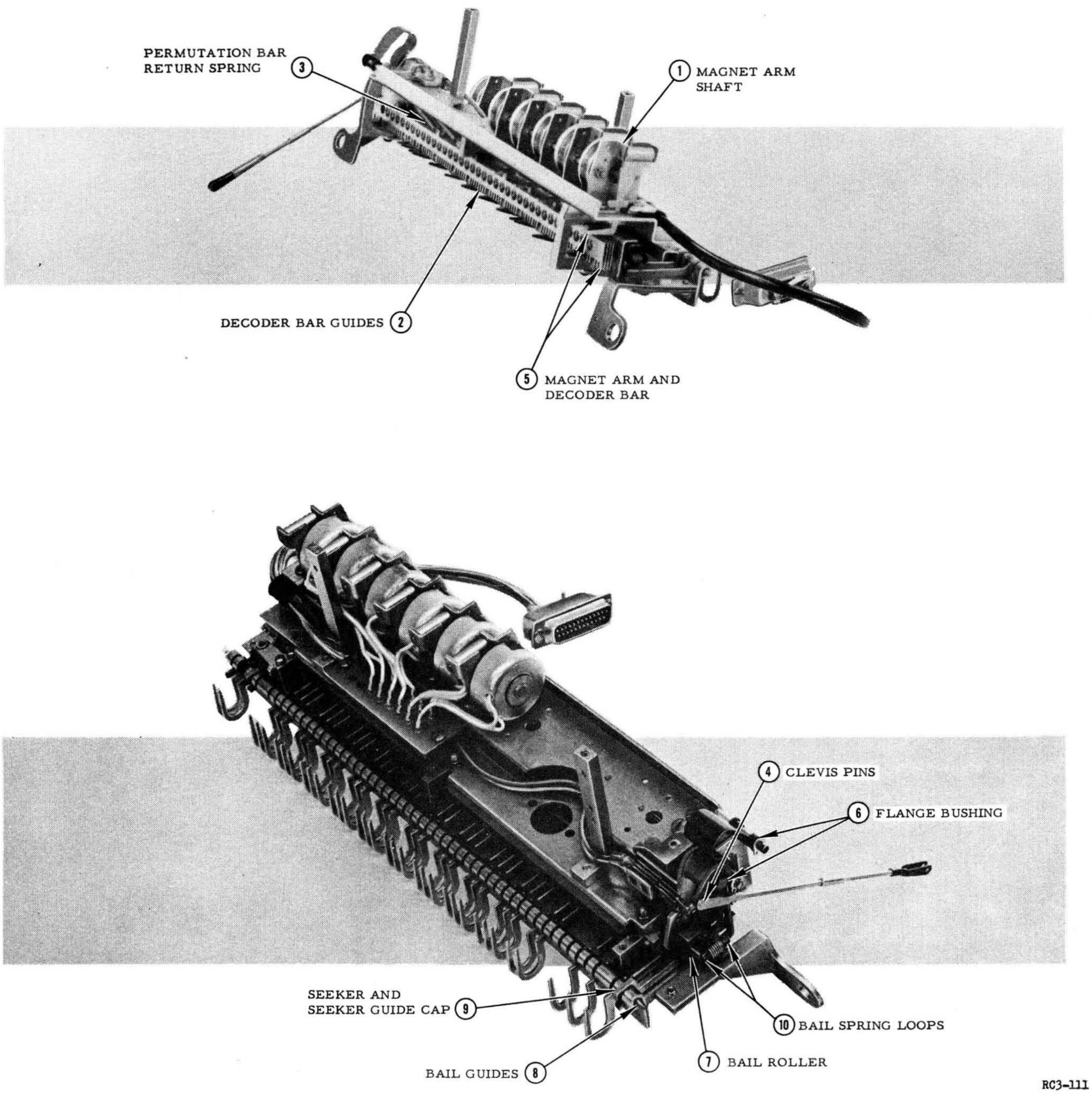
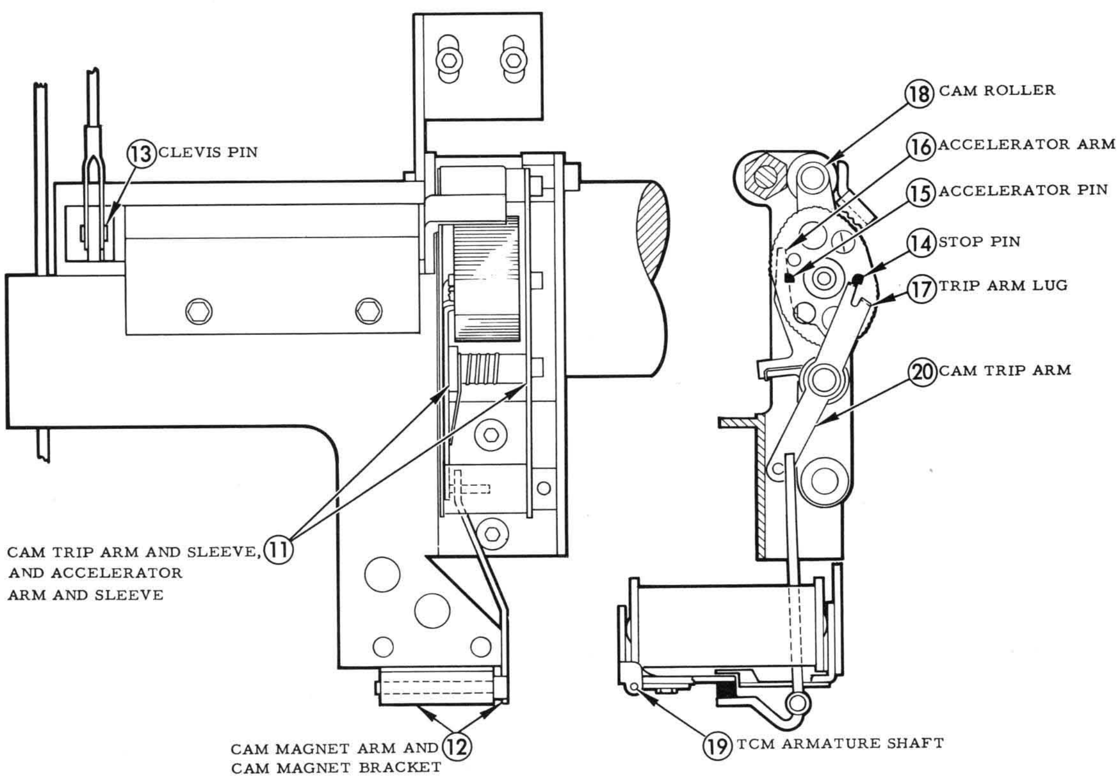


Figure 29. Decoder Lubrication Points



RC3-109

Figure 30. Coder and Power Unit Lubrication Points

Callout	Name	Instructions
20	Cam trip arm pin	Use lubricant (Molub-Alloy No. 3 or equivalent)
21	Magnet arm	Use lubricant (Lubriplate No. 3 or equivalent)
22	Code bars	Use lubricant (Lubriplate No. 2 or equivalent) between code bars and code bar guides

Assembly and Disassembly

The subsequent procedures describe the removal and replacement of the decoder, power unit, coder, control chassis, and power supply. To remove or install the components of the computewriter attachment properly, specific instructions must be followed.

Decoder Removal

To remove the decoder unit from the typewriter, see figure 31 and proceed as follows:

1. Raise front of typewriter until machine is resting on its back cover.
2. Disconnect pull wire from power unit assembly by spreading adjustable pin clevis at the fulcrum until the ball bearing is disengaged.
3. Disconnect electrical receptacle below right end of decoder assembly.
4. Remove both front feet from typewriter.
5. Remove socket head screws attaching strut hangars of decoder unit to front frame of typewriter.
6. Grasp decoder and rotate slightly about the left and right supports so that the seekers rise slightly and move towards the back of the typewriter. This motion disengages the seekers from the pin in the typewriter key levers, permitting the decoder to be withdrawn.

Decoder Installation

To install the decoder, proceed as follows:

1. Insert decoder in typewriter and check to make sure each seeker is over its respective key lever pin.
2. Insert screws through strut hangar into the decoder mounting strut.

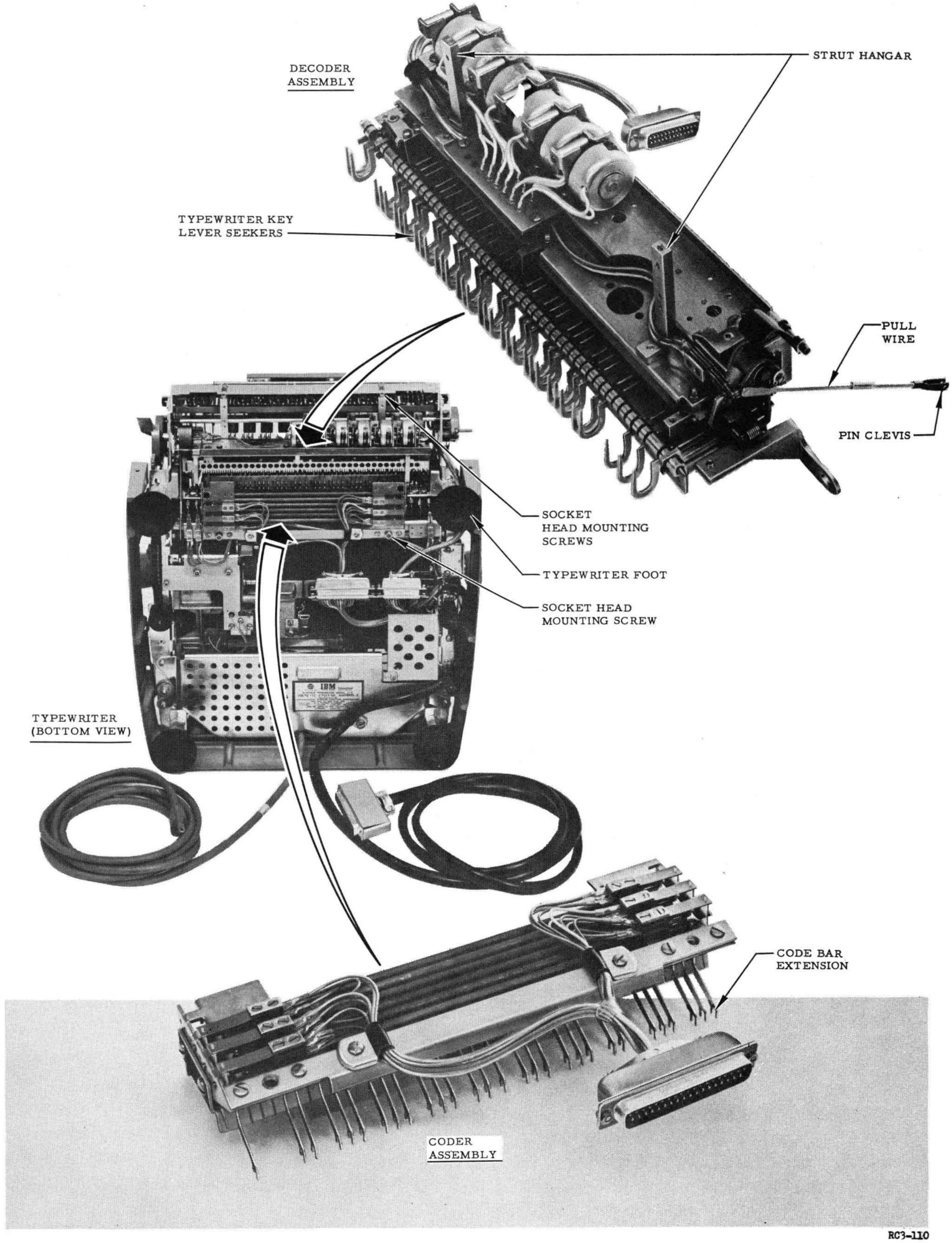


Figure 31. Coder and Decoder Assembly and Removal

3. Attach typewriter front feet through left and right decoder supports.

4. Set position of decoder so that the tip of each seeker overlaps its key lever pin by 0.094 inch.

NOTE

> Shifting of decoder to this position is accomplished by adding or removing shims between both strut hangers and the typewriter main frame, and between the left and right supports of the decoder and the seeker guide plate.

5. Adjust position of left and right supports on decoder so that when the typewriter feet are tightened, there is a 0.012- to 0.015-inch clearance between the actuating surface of each seeker and its key lever pin. Too little clearance may prevent typewriter cams from resetting.

6. Set lateral positioning of decoder so that the average clearance of each seeker to its key lever is 0.031 inch. If lateral shifting is necessary, loosen front feet of typewriter, and screws attaching both strut hangers to typewriter front frame. Shift as necessary and retighten. Do not loosen screws through strut hangers into mounting strut of decoder for this operation.

7. Tighten all attaching screws firmly and tighten typewriter feet. After positioning adjustments of decoder have been made, the decoder may be removed at any time and re-installed without shifting its position in the machine, provided the following precautions are taken into consideration: When removing decoder, loosen only typewriter front feet and screws through strut hangers into mounting struts of decoder. After re-installing decoder, always tighten screws through strut hangers into decoding mounting struts before tightening typewriter front feet.

8. Attach adjustable pin clevis to power unit by lengthening or shortening the pull rod assembly. To accomplish this, turn the adjustable pin clevis until maximum clearance is obtained between seekers and permutation bars on the decoder. To position drive shaft actuator rod and main connecting link shafts in a straight line, check that the pull wire is the proper length. A half turn of the adjustable pin clevis in either direction will reduce the clearance between the seekers and the permutation bars.

9. Mechanically trip TCM (typewriter power off) and turn the typewriter power roll by hand until the power cam is at its point of maximum lift. At this point, the decoder bail should just touch the coroprene stops located on the bottom inside surface of the seeker guide plate. If the bail

stroke is not correct, the cam drive tube assembly of the power unit must be adjusted. To increase the bail stroke, loosen the mounting screws holding the cam drive tube assembly to the power unit and slide towards the decoder slightly. Check to make certain the center line of this assembly is parallel to the power roll and then retighten. To decrease the bail stroke, move the cam drive tube away from the decoder. Readjust the adjustable pin clevis so that clearance between seekers and permutation bars is correct, and recheck the stroke of the bail.

Power Unit Removal and Installation

The power unit installation is essentially the same as removal only in reverse order. See figure 20 and proceed as follows:

1. Disconnect electrical receptacle below left side of power unit assembly.
2. Disconnect pull wire by spreading adjustable pin clevis at the fulcrum until it disengages the ball bearing.
3. Remove three mounting screws.
4. Move power unit to right slightly to disengage cam support bracket and remove from typewriter.

Coder Removal

When removing the coder unit from the typewriter, disconnect the electrical receptacle and remove two socket head mounting screws. Rotate the coder unit while removing it. (See figure 31.)

Coder Installation

The coder is installed in the typewriter in the following manner:

1. Hook the code bar extension onto the key lever linkage.
2. Aline the coder mounting holes with the tapped holes in the typewriter frame. Fasten with two mounting screws.
3. Assemble the connector.

Control Chassis Removal and Installation

Control chassis installation is essentially the same as removal only in reverse order.

1. Disconnect the typewriter from the desk at J10 (41576-501). Disconnect control chassis cables at P2 and P3. Disconnect the control chassis cable at P1. Release the chassis snap slides and remove the control chassis from the desk.

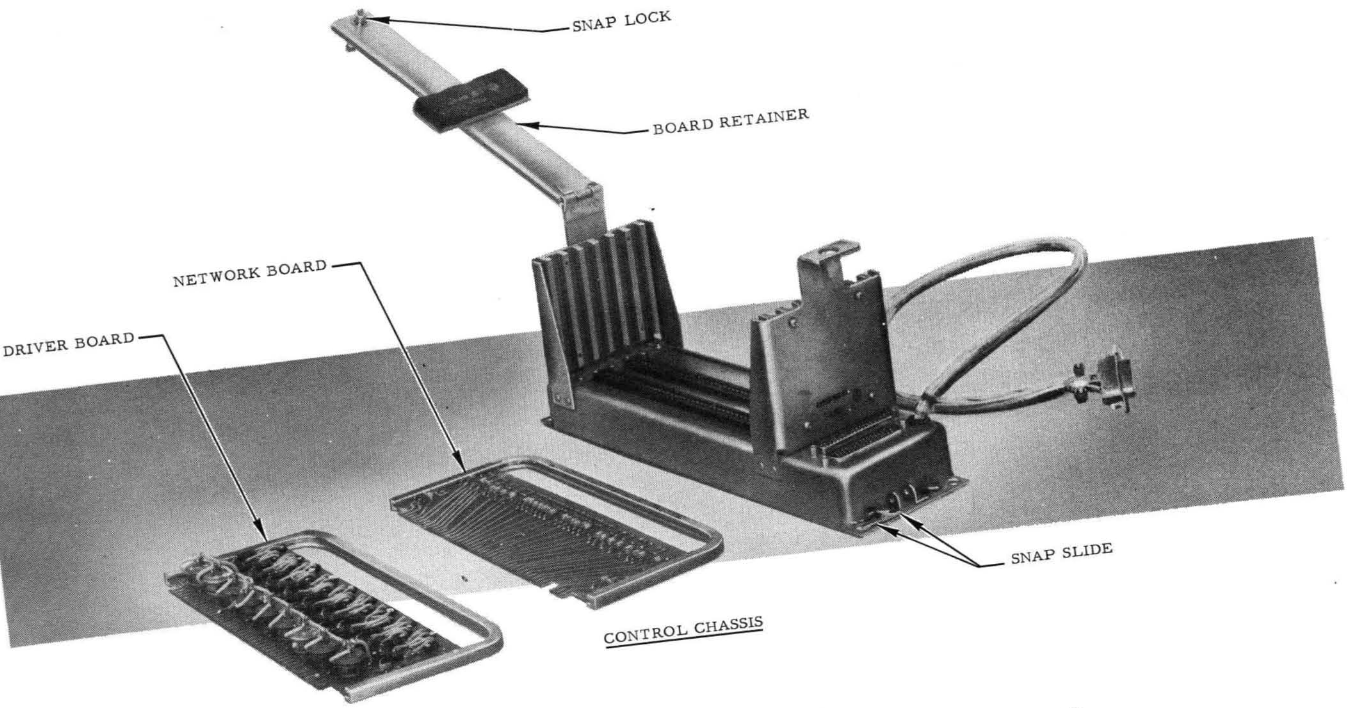
2. With the control chassis removed from the desk, release the snap lock on the board retainer and remove driver and network boards. (See figure 32.)

Power Supply Chassis Removal and Installation

Power supply installation is accomplished in reverse order to removal.

1. Disconnect the control chassis cable from the power supply at P1. Release the chassis snap slides and remove the power supply from the desk.

2. With the power supply removed from the desk, release the snap lock on the board retainer and remove the etched board. (See figure 32.)



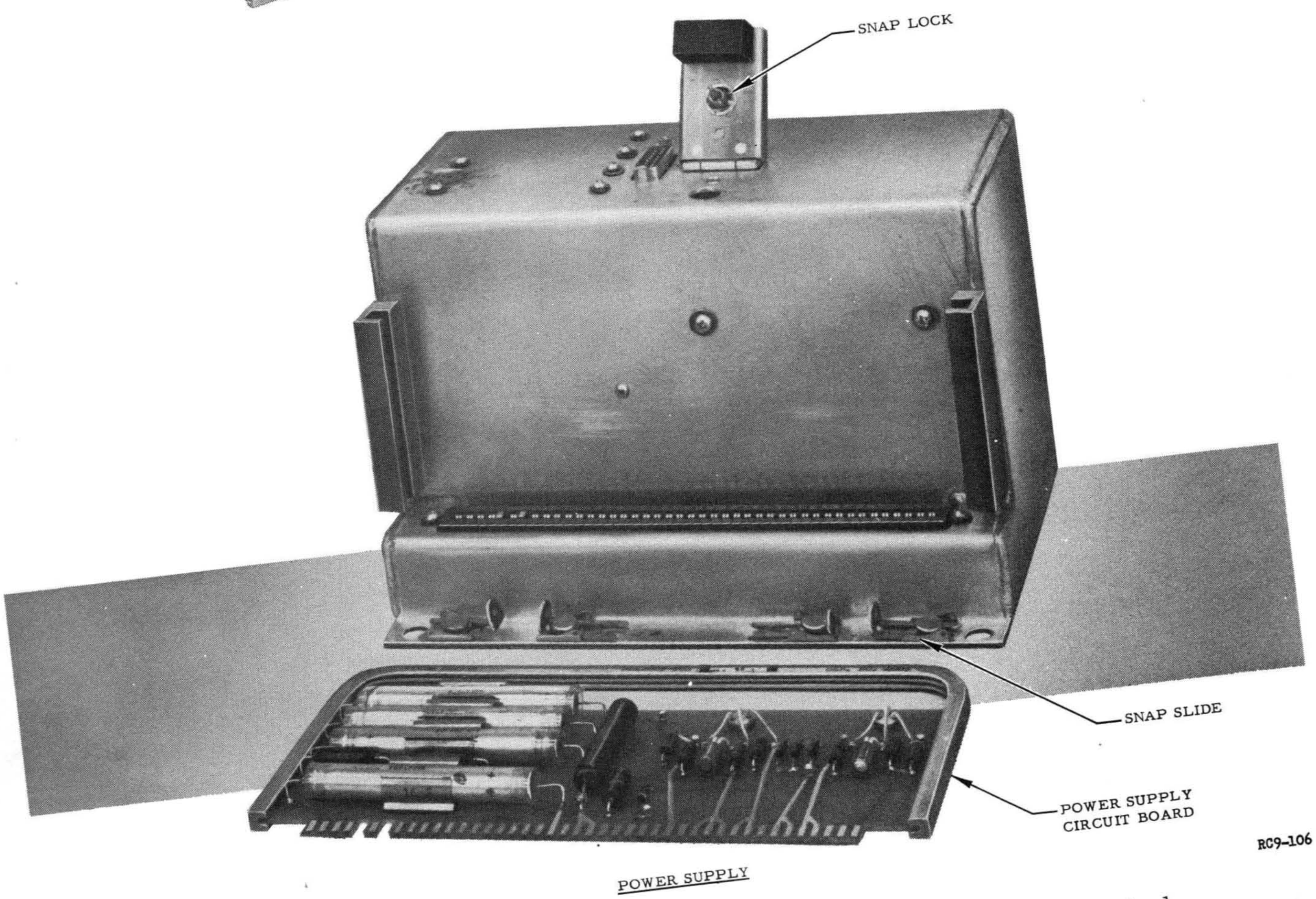


Figure 32. Control Chassis and Power Supply Disassembled

508-T-8

PHOTOELECTRIC TAPE READER

The RECOMP II photoelectric tape reader converts coded information punched on paper tape into a binary electrical code, which is then stored in the computer memory. Light-sensitive photodiodes monitor the five channels and the sprocket hole of the black, fan-folded tape and generate an electrical pulse whenever a hole appears. All electronic circuitry necessary to operate and control the reader is mounted on transistorized, plug-in, printed circuit boards and forms an integral part of the reader assembly.

FUNCTIONAL DESCRIPTION

FUNCTION OF CONTROLS

The tape reader controls are grouped on the front section of the tape reader assembly (see figure 6). Tape reader controls and their functions are described as follows:

Control	Function
POWER circuit breaker (toggle)	Controls 60-cps 115-volt primary power to tape reader and power supply circuits
MOTOR switch (toggle)	Controls power to tape reader motor only
FILL switch (momentary)	When depressed and then released, permits tape fill mode of computer; computer returns a signal which starts tape movement
VERIFY switch (momentary)	When depressed and then released, establishes verify mode of computer wherein information previously stored in computer is compared to tape information. Computer returns a signal which starts tape movement

Control	Function
STOP switch (momentary)	When depressed, stops tape movement regardless of computer signal
TAPE ADVANCE switch (toggle)	Advances an endless tape to the starting point from any point in the program, simultaneously preventing the reading of tape information. When the switch is placed at "on," a simulated start signal is generated which causes power to be applied to the solenoid. Simultaneously the reading circuits are disabled. The tape advances until the electronic switch in the homing sensor network is triggered by the slit in the tape at the starting point, thereby stopping the tape
FILL lamp (located above FILL switch)	Indicates when a fill start signal is supplied by the computer
VERIFY lamp (located above VERIFY switch)	Indicates when a verify start signal is supplied by the computer

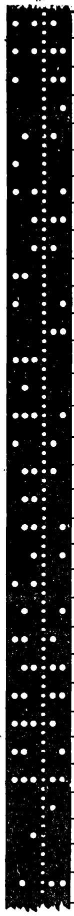
TAPE CONFIGURATION

The coding format used in the punched paper tape is standard 5-channel, Baudot teletype code. Numerical, decimal, or command information format for input is converted automatically by RECOMP to the proper binary form for internal use. For alphanumeric entries, a special code signifies that a word to follow is to enter the computer in a format conforming to the configuration in the paper tape. The complete code for all RECOMP II input-output equipment is listed with explanatory notes in figure 33.

TAPE READING MODES

Information may be read from the punched paper tape and entered into the computer in any of four modes: (1) alphanumeric, (2) decimal, (3) command, and (4) control code.

TELETYPE (BAUDOT) CODE
For Numeric, Alphabetic, and Alphanumeric Input-Output with Typewriter, Tape Reader, and Tape Punch



Teletype Code Tape	Figures[1] Shift Characters[2]	Letters Shift Characters[2]	Octal Represen-tation	Internal[3] Binary Represen-tation	Decimal Represen-tation	CONSOLE CONTROLS[4] Figure[1] or Operation	BINARY CODED DECIMAL[4] Figure[1]	Code
	ϕ	P	26	10110	22	ϕ	ϕ	0000
	1	Q	27	10111	23	1	1	0001
	2	W	23	10011	19	2	2	0010
	3	E	01	00001	01	3	3	0011
	4	R	12	01010	10	4	4	0100
	5	T	20	10000	16	5	5	0101
	6	Y	25	10101	21	6	6	0110
	7	U	07	00111	07	7	7	0111
	8	I	06	00110	06	8	8	1000
	9	O	30	11000	24	9	9	1001
	+	Z	21	10001	17	+		
	-	A	03	00011	03	-		
	.	M	34	11100	28	.		1100[6]
	Tab/CR[5]	Car. Ret	10	01000	08	Enter	Car. Ret	
	/	X	35	11101	29	Clear		
	)	L	22	10010	18	Location		
	:	C	16	01110	14	Command		
	,	N	14	01100	12	Number		
	!	F	15	01101	13			
	s	S	05	00101	05	Start Compute		
	H	H	24	10100	20	Stop Compute		
	$	D	11	01001	09			
	&	G	32	11010	26			
	(	K	17	01111	15			
	Fig. Shift	Fig. Shift	33	11011	27			
	;	V	36	11110	30			
	?	B	31	11001	25			
	Ltr Shift	Ltr Shift	37	11111	31			
	Line Feed	Line Feed	02	00010	02			
	Space	Space	04	00100	04		Space	
	Blank[7]	Blank[7]	00	00000	00		Terminate	1111[6]
		J	13	01011	11			

1. The numerals 0 through 9 are represented internally in true binary form and value. Manual entry from typewriter and console keyboard is accomplished by depressing the key for the character desired (no code is necessary).
2. The following nonalphanumeric characters read from tape or received from the typewriter initiate these respective computer actions: Carriage Return, Enter; X, Clear; L, Locations; C, Commands; N, Numbers; S, Start Compute.
3. Used only for internal representation of alphanumeric information operated on.
4. The console controls and binary coded decimal columns have no relationship to the teletype code. However, the BCD figure is recorded on tape or paper in the corresponding teletype code. The console controls are used for decimal, octal, and binary input with the console keyboard; binary coded decimal is used for word output with the typewriter, visual readout, and tape punch. The + and - are used for input of binary 1's and 0's, respectively in the Command mode. On the visual readout BCD codes 1010, 1011, and 1101 are nonterminating blanks; 1100 is decimal point, and 1110 and 1111 are terminating blanks.
5. In Figures Shift switch on typewriter permits selection of tab or carriage return operation.
6. Decimal Point code 1100 and Terminate code 1111 are preferred; however, the computer also recognizes 1101 for Decimal Point and 1110 for Terminate. Terminate codes are neither typed nor punched.
7. The blank does not represent nor cause any action.

RC3-118

Figure 33. Input-Output Codes

Alphanumeric

When characters present some unique symbolic configuration such as a name or serial number, rather than expressing the concept of quantity, the alphanumeric mode may be used. When this mode is used, each lateral section representing one character is entered into the computer unaltered; i.e., with the internal binary configuration corresponding to the holes punched on the tape. No conversion to a binary quantity is involved.

Decimal

In decimal mode, each decimal number is converted automatically to its equivalent in the binary number system (both fractions and integers).

Command

In command format, each character from tape (1 lateral section) represents one character of an instruction.

Control Codes

During control codes, special one-character commands are interpreted immediately upon detection by the reader. Examples of these codes are the S (start) and H (halt) commands as well as the format codes C (command), L (location), N (decimal number), and F (alphanumeric) which specify the type of conversion which the computer is to perform on succeeding information.

NORMAL OPERATION

Primary power is applied to the tape reader motor through the circuit breaker on the desk assembly when the POWER and MOTOR switches on the reader front panel are placed at "on". When power is applied, motor rotation causes a capstan to rotate. The tape reader solenoid causes the idler roller to press the tape against the rotating capstan (figure 34).

Solenoid power is applied through control and amplifying circuits. These circuits are triggered either automatically by command from the computer or manually by switches on the tape reader control panel. The tape is drawn from the tape canister into the reader head. Once it passes the head, the tape restacks in the canister. The canister contains a tape magazine and running slides (figure 35). It fits into place on the

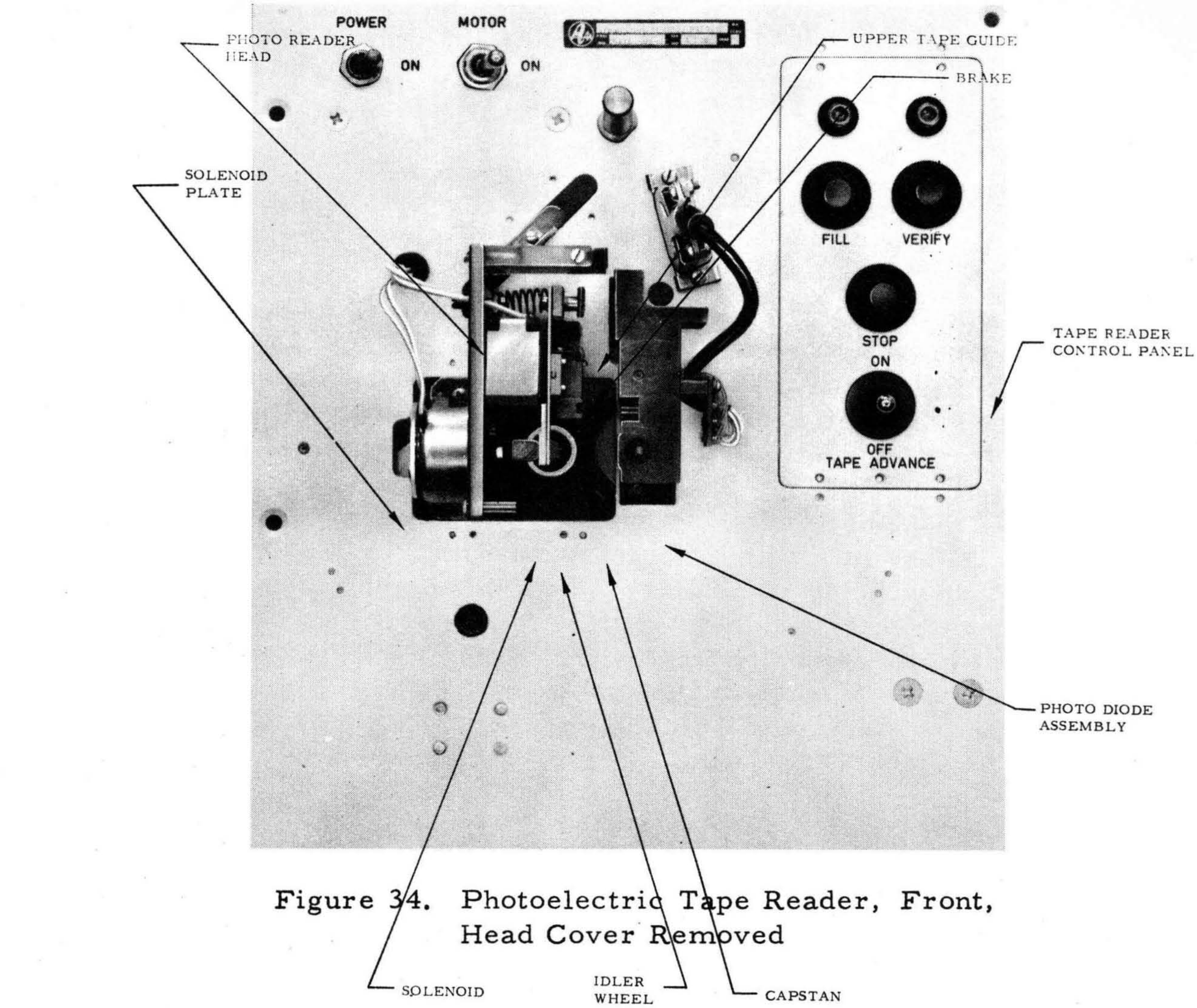


Figure 34. Photoelectric Tape Reader, Front, Head Cover Removed

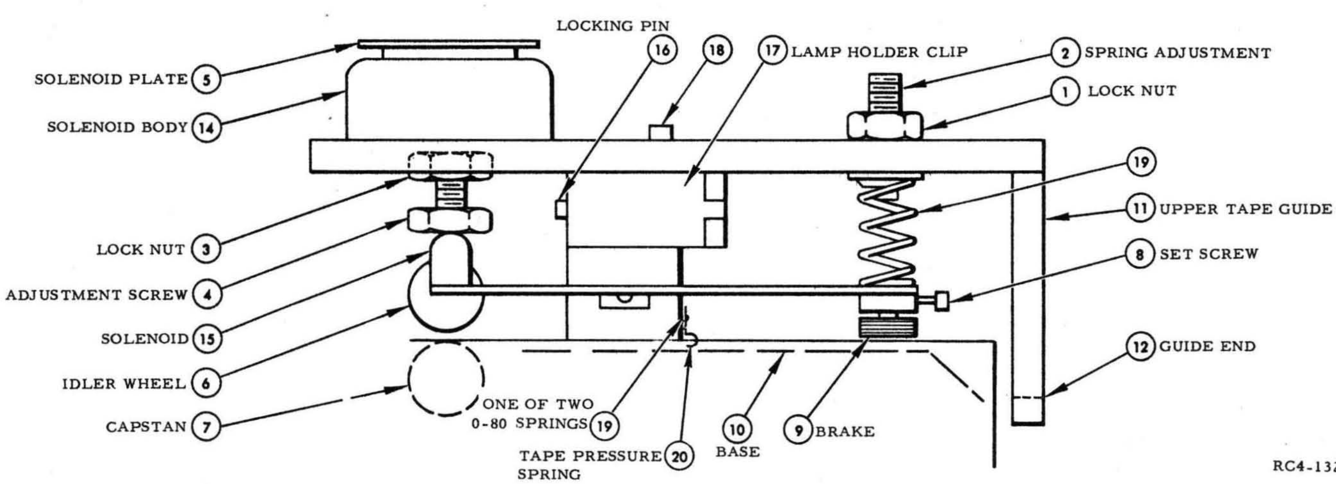


Figure 35. Photoelectric Tape Reader, Canister, Cover Removed

photoreader front panel over two dowel pins. When the canister is mounted, a 90-degree manual turn of the locking handle locks the canister in place, releases the tape from magazine clips, and secures it in the reader head (see figure 6).

Tape movement through the head may be interrupted by removing power from the motor. Power is removed when the MOTOR switch on the front panel is placed at "off." Although capstan rotation ceases, control and amplifying circuits are not affected. This feature is included for checkout in which manual control of the tape is required.

Standard teletype code is used for representing information on the tape (figure 33). The small hole in the tape (sprocket) is used to generate a clock pulse for sequencing tape information to the computer input circuits. The pulse is generated when tape runs between the exciter lamp and a photodiode (clock channel), both of which are located in the reader head. When a sprocket hole appears, light from the exciter lamp strikes the photodiode, creating a pulse of current. The pulse is amplified and inverted for use as a clock pulse.

CONTROL CIRCUITS

The tape reader control circuits are composed of (1) tape drive control circuits for mechanical operation of the tape reader (electronic control amplifier board), (2) circuits for conversion of punched-tape code into electrical information for application to the computer memory (photodiode amplifier board), and (3) special electronic control circuits which adjust current values during operation (AGC electronic control amplifier board). These three boards are mounted in the circuit board chassis (figure 36). Their functions are illustrated in the photoelectric tape reader block diagram (figure 37).

Electronic Control Amplifier Board

The tape drive control circuitry consists of a control flip-flop and two amplifiers which control the solenoid-operated clutch-brake mechanism in the reader head. This circuitry is contained on the electronic control amplifier board. Start and stop pulses are initiated by three button switches (FILL, VERIFY, and STOP) on the tape reader panel.

"Start" and "stop" trigger amplifiers are a-c coupled to the inputs of the solenoid control flip-flop and set the flip-flop to either the tape drive or tape stop states. An interlock transistor switch connected to the collector of a driver amplifier saturates when either the FILL or VERIFY switch is

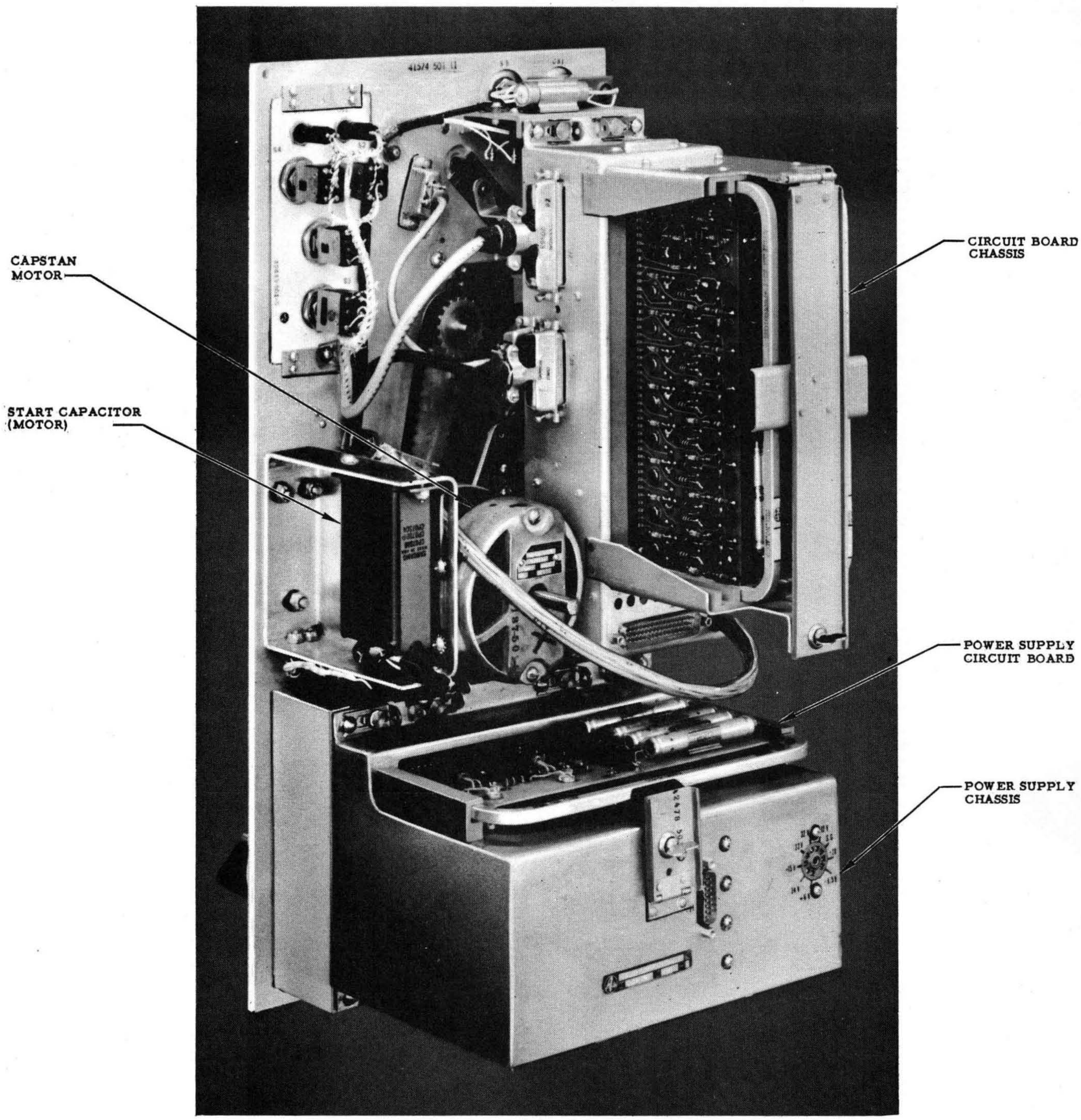


Figure 36. Photoelectric Tape Reader, Rear

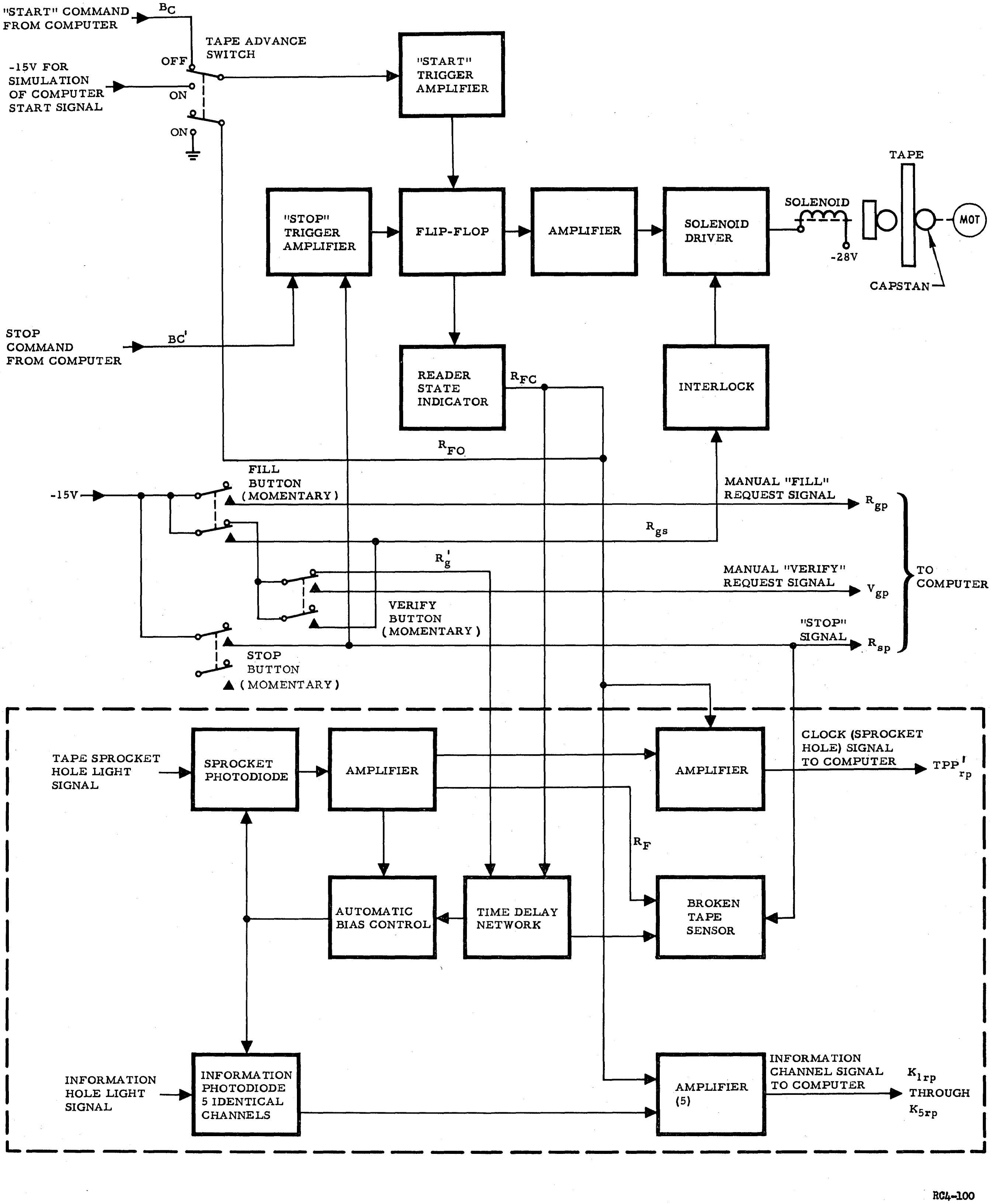


Figure 37. Photoelectric Tape Reader, Block Diagram

depressed, thus preventing the solenoid power transistor from being turned on until either the FILL or VERIFY switch is released. The subsequent discussion describes the resultant effects of signals applied from the tape reader control panel by the operator.

Solenoid Control Flip-Flop

When the FILL and VERIFY switches are in the normally open position and either switch is depressed, a computer connection is made. Momentary depression of the FILL switch causes a -15-volt pulse (R_{gp}) to be sent to the computer. If the computer is in the noncompute mode, the pulse causes the computer to set automatically to the tape fill mode. A start signal is sent by the computer to the read side of the flip-flop through the "start" trigger amplifier. The computer may send a programed start command automatically and then set automatically to the fill mode. A start signal or start command from the computer permits amplified power to energize the solenoid, thereby starting tape movement. Momentary depression of the VERIFY switch causes a -15-volt pulse (V_{gp}) to be sent to the computer. This pulse causes the computer to set automatically to the tape verify mode. A start signal is sent by the computer to the read side of the flip-flop which permits amplified power to energize the solenoid. Momentary depression of the STOP switch causes a stop signal to be sent directly to the no-read side of the flip-flop through the stop trigger amplifier. This signal cuts off solenoid power regardless of computer command, because of direct connection with the "stop" trigger amplifier. The same signal, a -15-volt pulse (R_{sp}), is sent to the computer, which in turn sends a stop signal to the "stop" trigger amplifier. A programed stop command also may be sent automatically by the computer to the stop side of the flip-flop. A stop signal or stop command removes power from the solenoid, thereby stopping tape movement (figure 37).

The reader state indicator amplifier detects the state of the flip-flop (on or off) (see figure 37). Ground potential indicates the off state and -12.5-volt output indicates the on state. When the tape advance switch is "on", no information is being read into the computer even though the tape is running. The computer at this time must "think" that the tape is not running. During tape advance, a flip-flop off condition is simulated by clamping the indicator output to ground.

Photodiode Amplifier Board

The photodiode amplifier board contains the amplifier circuits required to amplify the clock channel (sprocket hole) and the five information channel photodiode currents. The tape sprocket-hole (small hole) circuit generates an initiate fill signal and applies it to the computer. Active elements of the circuit are the sprocket hole photodiode amplifier board and three transistor amplifiers on the photodiode amplifier board. The five large holes punched along the width of the tape correspond to the 5-channel teletype-coded information to be entered into the computer memory. Each channel has its own photodiode that converts the hole information into an electrical pulse. The signal undergoes three stages of amplification. Therefore a total of fifteen transistor amplifiers are used on the photodiode amplifier board for information channel amplification.

AGC Electronic Control Amplifier Board

The AGC electronic control amplifier board is composed of an automatic bias circuit and a homing sensor network. These circuits perform special functions on which both the mechanical operation of the tape reader and the conversion of information depend. Color or density variations of a particular tape will normally cause variations in the photodiode currents. These variations are compensated for by the automatic bias adjust circuit which senses the duty cycle of the clock waveform and automatically adjusts the photodiode bias to hold the duty cycle constant. The bias of the information channel photodiodes is supplied from the same source; thus, the effects of tape variation on all channels are removed. If the reader has been stopped by the removal of sprocket holes (on an endless tape) and then restarted, sprocket pulses will not be available immediately because of the time constant of the solenoid. Therefore, the automatic bias adjust circuit is held inoperative and clamped to a nominal voltage (approximately 1 second after starting) to prevent bias changes before sprocket pulses are available for monitoring. When using tapes requiring bias adjustments, several hundred milliseconds of sprocket leader should be used before information is read from the information channels of the tape.

The homing sensor network (broken tape sensor) consists of an integrating circuit, and an electronic switch that monitors the signal from the sprocket channel photodiode. When the clock pulse has been amplified and inverted, it is applied to the homing sensor network. When there is no tape in the canister, or when the tape breaks, the absence of the clock pulses will trigger the electronic switch. The switch transmits a signal directly to the stop side of the flip-flop, thereby deactivating the solenoid and stopping the tape. The switch will transmit a similar signal to the stop side of the flip-flop when a short slit, cutting out at least seven sprocket holes, is placed at the beginning of a program on an endless tape. A minimum number of six holes must be removed from the tape before the switch is activated by the integrating circuit. To ensure that the reader will start after having stopped on a slit or sprocket hole, the integrating circuit is disabled for 100 milliseconds by a time delay network after either the FILL or VERIFY switch has been released. During the 100-millisecond interval, no stop pulse can be generated.

POWER SUPPLY CIRCUITS

The tape reader power supply provides five levels of secondary d-c voltage to the tape reader signal circuits. The power supply incorporates the use of transistors and etched circuitry on a plug-in board, in addition to the transformer, choke, and other power units mounted on the chassis (see figure 13). Primary power at 115 volts, 60 cps is applied through the POWER ON-OFF switch and circuit breaker to the tape reader motor and the power transformer. Power at d-c voltages of unregulated -28 volts and regulated -15, -12.5, and +6 volts is supplied to the circuits. The source of these voltages is 30-volt ac produced by stepdown of primary voltage. The secondary ac is rectified in a full-wave bridge rectifier consisting of four diodes and located on the power supply chassis. Rectifier output is full-wave unregulated -28 volts with respect to ground. Unregulated -28-volt power is supplied to the reader solenoid. Choke-input filters are used to filter the -12.5-, -15-, and +6-volt power supplies, and the exciter lamp power (-24.5 volts).

-15- and -12.5-Volt Power Supplies

The -15- and -12.5-volt power supplies are regulated by a control amplifier located on the power supply board and a series power amplifier located on the power supply chassis. The power amplifier carries the majority of the load current. The filtered output from the transformer is applied across a Zener diode. The diode has a fixed voltage drop of -15 volts which serves as a fixed potential on the control amplifier. This fixed potential holds the control amplifier current output steady. Since the control amplifier is little affected by load current changes, its current output regulates the series power amplifier. Because of control amplifier regulation and because its output impedance is low, the power amplifier is relatively independent of supply voltage changes. The series power amplifier output is a regulated -15 volts. A second output of -12.5 volts is produced by connecting three diodes in series with the output. These diodes are back-biased to produce the more positive -12.5-volt level. The diodes have a voltage drop of approximately 0.8 volt each.

+6-Volt Power Supply

The +6-volt power supply is also regulated by a control amplifier located on the power supply board and a series power amplifier located on the power supply chassis (see figure 7). The series power amplifier carries the majority of the load current. The regulation, however, is half-wave operated, that is, the negative half-cycle of ac is clamped to ground. The positive half is coupled through a capacitor to the filter supplying the input to the 6-volt regulator and then to ground. From ground, the return is to the filter supplying the input to the -12.5- and -15-volt regulator and then to the transformer return. The output voltage of the power amplifier is controlled by negative feedback. A Zener diode acts as the reference for the output with a fixed 6.5-volt drop. If the output voltage across a bleeder resistor tends to decrease, the difference between it and the 6.5-volt reference is applied to the control amplifier as a negative change. This negative change on the control amplifier causes the power amplifier to become more positive, increasing the load current. The output voltage, therefore, is increased sufficiently to offset the original tentative decrease.

MAINTENANCE

Maintenance of the photoelectric tape reader consists of tests for locating faulty electrical circuits or elements, and of performing electrical and mechanical adjustments and preventive maintenance. In addition, procedures for the replacement of parts is provided. Prior to performing electrical checks or adjustments of signal circuitry, the tape reader power supply should be checked to determine that the appropriate power levels are being applied. Test equipment, recommended for use in performing checks, is listed as follows:

Item	Model or Type	Manufacturer
Oscilloscope		
Multimeter (20 kilohms per volt)	Model 630-A	Triplett
Autotransformer	Range: 0 to 115 volts	
Microammeter	Range: 0 to 500 microamperes	

POWER SUPPLY TESTS

The tape reader power supply checks of the chassis and circuit board include insulation resistance, transformer primary and secondary output, load, and no-load tests.

Insulation Resistance

Check the resistance between the chassis and the body of all transistors, and the resistance between the chassis and the body of all diodes. Both resistances should indicate infinity on the highest ohmmeter resistance range. If the resistances are not as required, check the installation of the parts, and particularly, check the mica washers used for insulation.

Transformer Primary Check

With the circuit board removed, apply exactly 115 volts to the primary of the tape reader power supply transformer. With the secondary open, the output voltage should be 32.0±1.5 volts.

Secondary D-C Voltage Level Checks

Plug the circuit board into the chassis. Energize the power supply through the connection of an autotransformer originally set to zero. Increase the autotransformer voltage slowly to 115 volts and check the voltage levels at the +6-, -28-, and -15-volt output terminals. If there are any signs of overheating, or if the output voltage decreases when the input voltage increases, reduce the input voltage immediately and repeat the test. If the malfunction continues, reduce the input voltage to zero and discontinue test procedures until the element causing the malfunction has been located and replaced.

Load Test

Apply the loads (Load column, Table 13) to the appropriate test points indicated, with the power supply deenergized.

1. With the power supply energized, the output voltages should be as shown in table 13.
2. With the power supply energized, and the loads connected, use the oscilloscope to read the allowable ripple as listed in table 13.

Table 13. Power Supply Load Test

Supply Voltage (Volts)	Test Point	Maximum Voltage (Volts)	Maximum Ripple (Millivolts Peak-to-Peak)	Load
+6	Pin 1	+6.0±0.5	50	200 ohms
-12.5	Pin 2	-12.5	75	160 ohms
-15	Pin 3	-15±1.5	75	150 ohms
-28	Pin 7	-28±3	200	100 ohms
-24.5 (Lamp Supply)	Pin 5	-24.5±1.5	200	46 ohms
Ground	Pin 5	0	0	12 watts

No-Load Test

To perform the no-load tests, remove the loads as specified in table 13 and measure the secondary d-c levels. The voltage limits of each level should be as shown in table 14.

Table 14. No-Load Voltage Levels

Voltage Level	Test Point	Voltage Limits (Volts)
+6	Pin 1	+6.3±0.5
-12.5	Pin 2	-12.5 to -13.1
-15	Pin 3	-15.5±1.5
-28	Pin 7	-29.0±3.0
-24.5	Pin 5	-24.5±3.0

PHOTODIODE SENSITIVITY CHECK

A sensitivity check is performed on the photodiodes to determine that the appropriate currents are generated when diodes are exposed to light. To perform the check, proceed as follows:

1. Connect a 12.0-kilohm, 0.5-watt resistor, a 60.0-volt dry cell battery and the microammeter in a series test circuit, in the order mentioned.

2. Move the canister locking handle to the operate position and remove photodiode assembly cable connector P5 from the tape reader panel.

3. Attach the test circuit lead nearest the resistor to pin 11 of the photodiode assembly cable connector. Attach the lead nearest the meter to pin 1 of connector P5 and turn on the POWER switch.

4. Measure and record the photodiode current which should be not less than 160 microamperes.

5. Repeat steps 3 and 4 with the test circuit load nearest the meter connected to pins 2 through 5, and lead nearest resistor to pin 9 to determine the sensitivity of channels 2 through 5 and clock, respectively (see figure 15).

6. If all channels exhibit low values of photodiode current (less than 160 microamperes) check exciter lamps for excessive blackening, low exciter lamp supply voltage, or dirty or damaged exciter lamp system.

7. Photodiode sensitivity should be checked approximately once every 90 days.

PHOTODIODE POTENTIOMETER ADJUSTMENTS

Photodiode potentiometers should be adjusted to those resistance values necessary to produce the required timing between the true levels of the clock and information channel waveforms, and the false levels of the clock and information channel wave forms, and to produce synchronization between the clock and information channel waveforms. Included is a stop signal check of the tape advance function controlled by the AGC board.

A specially prepared tape is used to adjust the potentiometers. One foot of the tape should be punched with repeating LTR SHIFT codes (all channels punched) and followed by approximately one foot of sprocket holes only. The two ends of the tape should be spliced together to make a short endless loop of tape (see figure 38).

NOTE

> The slit in the tape should not be made until so directed in the procedure.

Clock and Information Channel Timing Check

Observe that all photoreader interconnecting cables are in their respective connectors and both the POWER and MOTOR switches are placed at OFF. Proceed as follows:

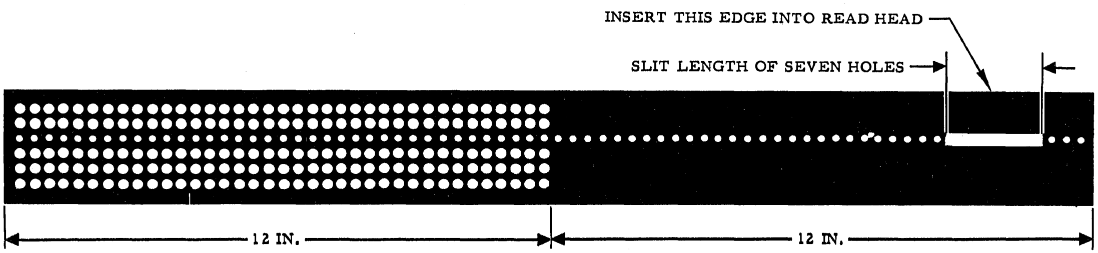


Figure 38. Photoelectric Tape Reader Test Tape

1. Install jumper wires from pin 13 to pin 21, from pin 22 to pin 25, and from pin 8 to pin 17 on test point connector J11 on the circuit board chassis.

2. Turn the POWER switch on.

3. Depress and release the FILL pushbutton. The solenoid coil (15, figure 40) should energize when the FILL pushbutton is released. Depress the STOP pushbutton. The solenoid should release.

4. Insert the test tape in the read head. Place the MOTOR switch at on; then depress and release the START switch. The tape should advance through the read head.

5. Connect a 10-kilohm, 0.5-watt resistor between pins 9 and 24 of connector J11. Monitor the clock channel at pin 9 with the oscilloscope, using d-c coupling, internal sweep, and internal synchronization on channel A. The clock channel output should be false (0.0 volts) for 40±10 percent of the time period, and true (-15 volts) for the remainder of the period. For a typical waveform, see the photoreader potentiometer diagram (figure 39a).

6. Connect a 10-kilohm, 0.5-watt resistor between pins 1 and 17 (ground) of connector J11. Monitor No. 1 information channel at pin 1 with the oscilloscope using channel B. The information channel output signal should be true (-12.5 volts) for 80±10 percent of the period and false (0.0 volts) for the remainder of the period. For a typical waveform, see the photoreader potentiometer diagram (figure 39b).

7. Repeat steps 5 and 6 while monitoring pins 2, 3, 4, and 5 respectively on connector J11.

8. Remove the jumper wire from pins 22 and 25.

9. Repeat step 5.

10. Repeat steps 6 and 7.

<u>Synchronization Check for Clock and Information Channels</u>

1. Compare the clock channel signal with each of the information channel signals if a dual-channel oscilloscope is available. The horizontal sweep of the oscilloscope should be synchronized with the clock channel signal. The waveform should be as shown in the photoreader

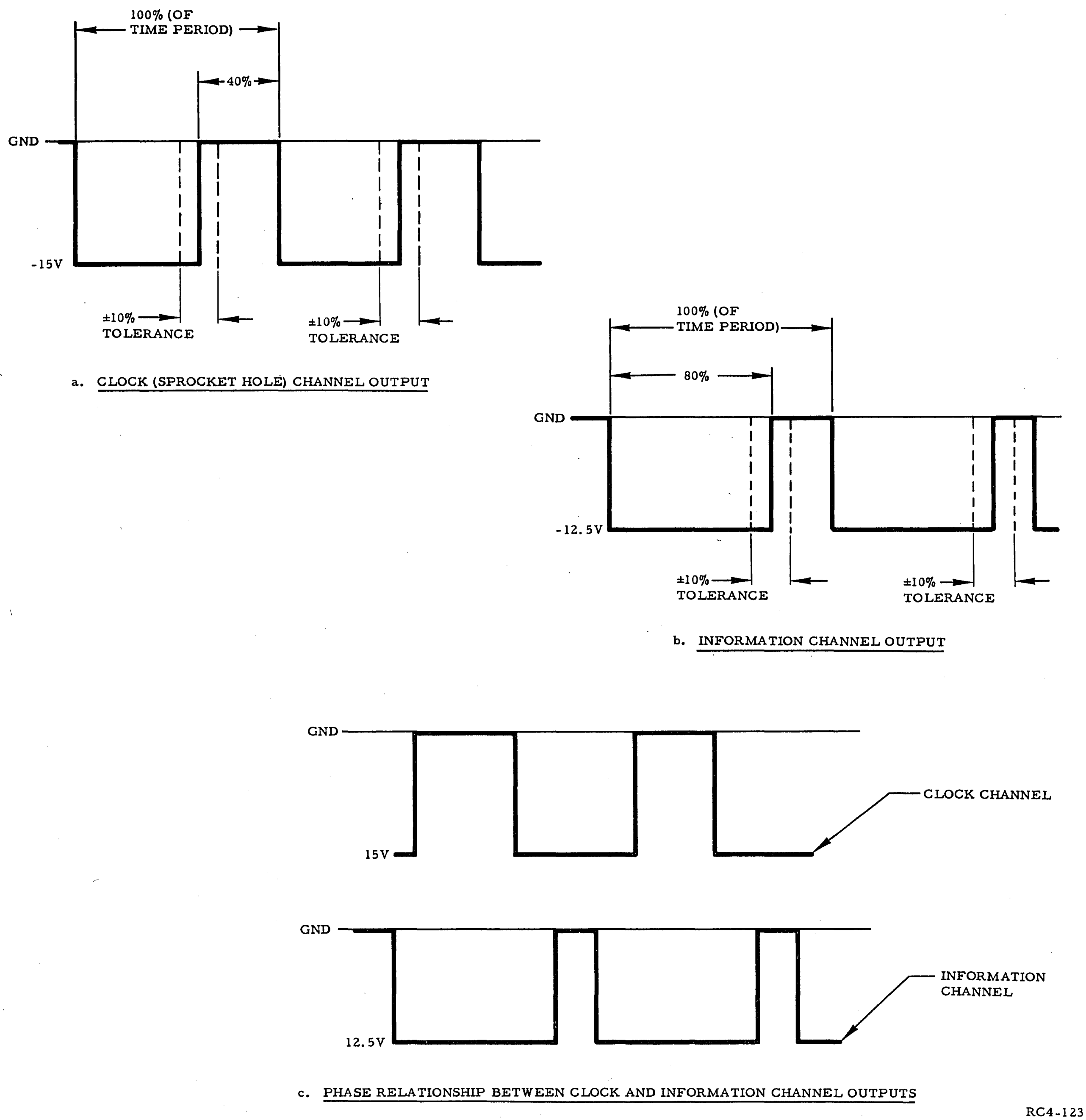


Figure 39. Photoelectric Tape Reader Potentiometer

potentiometer diagram (figure 39c) with the true portion of information channel No. 1 completely enclosing the false portion of the clock channel signal in respect to time.

2. The waveform for each information channel should be as shown in the photoreader potentiometer diagram (figure 39c).

3. None of the information channels should trigger on the blank (sprocket holes only) portion of the test tape.

Stop Signal Check

Remove six portions of paper separating seven consecutive holes in the test tape sprocket channel to make a slit in the sprocket channel seven holes long (see figure 38).

1. Remove the jumper wire from pins 8 and 17; then start the test tape. The tape should advance only until the slit in the tape sprocket channel reaches the read head. The stop signal generated by the slit in the tape should cause the solenoid to release after each revolution of the tape.

2. Remove all jumpers from the test point connector. Check to make sure all interconnecting cables are installed in their proper connectors and that the connectors are securely locked.

CONTROL CIRCUIT TESTS

Functional checks of the control circuit boards are made with simulated voltage signals applied at the appropriate inputs and measured at the outputs to determine required values and tolerances. The tape reader power supply output voltage levels should be checked at the test points shown in table 15 prior to these procedures.

NOTE

> Remove the AGC electronic control amplifier, photodiode amplifier, and electronic control amplifier boards from the control chassis before performing the subsequent checks.

AGC Electronic Control Amplifier Test

Energize the amplifier board with voltage listed in table 16 and proceed with the check.

Table 15. Power Supply Voltage Level

Voltage (Volts)		Test Point
+6±0.5		Pin 1
-12.5	(1.5 to 3 volts more negative than -15-volt level)	Pin 7
-15±1.5		Pin 3
-28±3		Pin 4
-24.5±1.5	(Lamp supply)	Pin 2
0 (ground)		Pin 8

Table 16. Applied D-C Voltages

Voltage (Volts)	Pin No.
+6±0.5	X
-12.5*	1
-15±1.5	H
0 ground	29

*Refer to -12.5 voltage level in table 15.

1. Set variable resistor R41 (Autonetics drawing 41988-50) to midrange. With no input signals applied to the board, varying the resistance of resistor R33 should cause the photodiode bias line (pin 18) to vary from more positive than 0.0 to more negative than -8.5 volts. Adjust resistance at resistor R33 to produce -4.5 volts on the bias line.

2. Ground pin 6. Connect a 330-ohm, 0.5-watt resistor from test point TP_2 to ground. Apply -15 volts to pin 16. Varying the resistance of resistor R41 should cause the bias line to vary from 0.0 to -8.5 volts again. Remove the 330-ohm resistor.

3. With pin 6 grounded, and -15 volts applied to pin 16, the voltage listed in table 17 should be obtained.

4. Ground pin B. The voltage across pin 2 and ground should be 0.0 to +1.8 volts. Remove the ground from pin B, and ground pin H. The voltage across test point TP6 and -15 volts should be 0.0 to +1.5 volts.

Table 17. Amplifier Voltages

Voltage (Volts)	Test Point
0.0 to 1.5	TP6 to -15 volts
0.0 to 1.5	TP7 to -15 volts
+1 to +2	TP4 to ground
0.0 to 0.9	Pin 2 to -12.3
0.0 to -0.3	TP8 to ground
-5.3 to -6.7	TP1 to ground
0.0 to -0.3	TP6 to ground
More negative than -8.5	Pin 18 to ground

5. Remove the ground from pin H and ground pin T. The voltages listed in table 18 should be obtained.

Table 18. Amplifier Voltages

Voltage (Volts)	Test Point
0.0 to 1.5	TP6 to -15 volts
0.0 to 1.5	TP8 to -15 volts
0.0 to -0.3	TP7 to ground
0.0 to -1.2	TP1 to ground
+3 to +6	TP4 to ground

6. Remove the ground and -15 volts applied to pins T and 16, respectively. The following voltages should be obtained:

0.0 to 1.5 volts across test point TP8 and -15 volts
0.0 to -0.3 volts across test point TP7 and ground

7. Ground pin 4 and reconnect -15 volts to pin 16. The delay between the time -15 volts is applied to pin 16 and the time -8 volts is applied to test point TP7 should be greater than 100 milliseconds.

8. Remove the ground from pin 6. Adjust resistor R41 for -6 volts at test point TP11. The voltage from pin 18 to ground should be more than 0.0 volts.

9. With -15 volts still applied to pin 16, ground pin 6. The delay before the voltage at test point TP4 is -12.5 volts should be 60 to 12 milliseconds. The width of the pulse produced at test point TP4 should be 15±10 milliseconds, measured at the -6-volt point.

10. Remove all power and test equipment from the board.

Photodiode Amplifier Test

Energize the amplifier with the voltages listed in table 19.

Table 19. Applied D-C Voltage

Voltage (Volts)	Pin No.
*-12.5	D
-15±1.5	P
0 (ground)	K
+6±0.5	6

*Refer to -12.5 voltage level in table 15.

1. To check amplifier 1, apply +3 volts to pin $\overline{X}$ through a 10-kilohm resistor. The amplifier output at pin 43 should be -12.5±1.0 volt.

2. Remove the source from pin $\overline{X}$ and apply a voltage of -3 volts to pin $\overline{X}$ through a 10-kilohm resistor. The output at pin 43 should be 0±1 volt.

3. When checking amplifiers 2 through 8, repeat steps 1 and 2 and refer to table 20.

Table 20. Amplifier Check

Amplifier No.	Input Pin	Output Pin
1	$\overline{X}$	43
2	$\overline{L}$	$\overline{M}$
3	Z	$\overline{A}$
4	S	13
5	$\overline{S}$	$\overline{T}$
6	$\overline{E}$	$\overline{F}$
7	X	W
8	L	9

4. To check the clock channel read amplifier, apply -3 volts to pin B through a 10-kilohm resistor. The output at pin 2 should be -12.5±1 volts.

5. Remove the input from pin B and apply a voltage of +3 volts, through a 10-kilohm resistor, to pin B. The output at pin 2 should be 0±1 volt.

6. To check the flip-flop indicator, apply a voltage of -12.5 volts to pin V. The voltage at pin 3 should be -12.5±1.0 volts and the voltage at pin F should be 0±1 volt.

7. Remove the input from pin V and ground it. The voltage at pin 3 should be 0±1 volt and the voltage at pin F should be -12.5±1.0 volts.

8. Remove all power and test equipment from the board.

Electronic Control Amplifier Test

Energize the amplifier with the voltage listed in table 21

Table 21. D-C Supply Voltages

Voltage (Volts)	Pin No.
-15.0±1.5	W
+6.0±0.5	$\overline{K}$
-28±3	C
0 (ground)	$\overline{D}$

1. Apply -12 volts to pin $\overline{M}$. This application sets the board to the run state; the output at pin 4 should be -15.0±1.5 volts.

2. Remove the -12 volts from pin $\overline{M}$ and apply -12 volts to pin $\overline{S}$. This application sets the flip-flop to the not-run state. The output at pin 4 should switch to 0±1 volt.

3. Remove the -12-volt source from pin $\overline{S}$ and apply it to pin 32. The output at pin 4 should reset to -15.0±1.5 volts.

4. Remove the -12-volt source from pin 32 and apply it to pin 42. The output should reset to 0±1 volt.

5. Remove the -12-volt source from pin 42 and apply it to pin 32 to reset the output to -12.0±1.5 volts. Remove the -12-volt source from pin 32 and apply it to pin $\overline{X}$. The output should reset to 0±1 volt.

6. Repeat steps 1 trhough 5 between the start and stop trigger, for pin 37 and pin $\overline{T}$.

7. During each of the previous operations when the board is in the run state (pin 32 actuated), the output of pin 10 should be 0±1 volt.

8. Remove the power and test equipment from the board.

ELECTRICAL ADJUSTMENTS

To adjust the AGC and the photodiode potentiometer, proceed as follows:

1. Adjust variable resistor R33 on the AGC board (Autonetics drawing 41988-501) to obtain the required voltage at pin 19 on test point connector J11.
2. Adjust potentiometer R9 on the circuit board chassis to obtain a false clock channel output signal.
3. Adjust potentiometer R1 on the circuit board chassis to obtain a true clock channel output signal.
4. Adjust potentiometer R41 on the circuit board chassis to regain the 40-percent duty cycle for the clock channel output.

MECHANICAL ADJUSTMENTS

Most of the following mechanical adjustments are made on reader head components. (For reader head adjustment points, see figure 40.)

Drive and Brake Adjustment

To adjust the drive and brake on the reader head, proceed as follows:

1. Remove upper tape guide (11).
2. Move the canister locking handle to OPERATE, i.e., rotate clockwise to travel limit stops. Loosen locknut (1) and unscrew spring adjustment (2) for minimum spring compression.

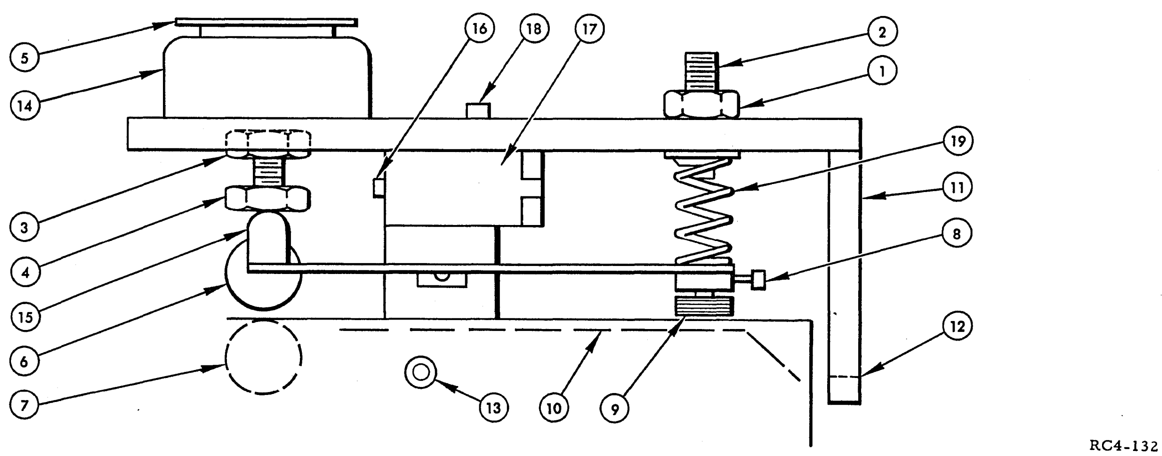


Figure 40. Reader Head Adjustment Points

3. Remove AGC electronic control amplifier from the circuit board chassis assembly.

4. Install jumper wires between pins 13 and 21, and pins 8 and 17 on test point connector J11 located on the circuit board chassis. The jumper wires are required for tape reader operation without tape in the read head.

5. Loosen locknut (3) and insert a 0.004-inch feeler gauge (thickness of paper tape) between the solenoid plate (5) and the solenoid body (14). Insert a piece of tape in the read head and move the canister locking handle to OPERATE.

6. Depress the START button on the knockout panel to energize the solenoid (15). Hold the solenoid plate (5) and turn adjustment screw (4) with a 1/4-inch end wrench until the idler wheel (6) contacts the tape and exerts a slight pull on the tape as it is pulled manually past the read head. Tighten the locknut (3), recheck the clearance, and remove the feeler gauge.

7. Loosen setscrew (8) and adjust the gap between the brake (9) and base (10) 0.015 to 0.020 inch. Tighten setscrew (8). Deenergize the solenoid by pressing the STOP button.

8. Turn spring adjuster (2) until solenoid releases when deenergized. Tighten locknut (1).

9. Depress the START and STOP buttons alternately a few times to make sure the solenoid energizes and deenergizes properly.

10. Remove the jumper wires and replace the AGC board.

11. Replace upper tape guide (11) and realine.

Motor Drive Belt Tension

1. Loosen the four bolts securing the motor to the motor base plate and raise or lower the motor until the drive belt has a sideplay of approximately three-eighths of an inch without stretching the belt.

2. Increased bearing life expectancy and quieter operation can be obtained if the belt tension is adjusted for minimum noise while the motor is running.

PREVENTIVE MAINTENANCE

Component malfunctions are held to a minimum by preventive maintenance performed at regular intervals. Preventive maintenance includes a periodic maintenance schedule and a functional check of mechanical parts and electrical circuits.

Schedule

Periodic servicing of the tape reader should be performed as listed (table 22).

Table 22. Service and Lubrication

Assembly	Inspection Interval	Type of Maintenance
Lamp bulbs	Daily	Replace when burned out or every 100 hours.
Idler roller	Weekly	Remove accumulation with cloth dampened in denatured alcohol. Replace when rubber sleeving or bearing shows wear.
Platen	Weekly	Lubricate
Upper tape clip release	Weekly	Lubricate
Detent plate for handle linkage	Weekly	Lubricate
All linkage junctions	Weekly	Lubricate
Tape tension gear rack	Weekly	Lubricate
Setscrews	Quarterly	Lubricate
Exciter lamp lens	Daily	Clean lens and window with soft, dry, lint-free cloth.

DISASSEMBLY AND ASSEMBLY

The procedures in the following paragraphs explain reader head, circuit board, and power supply chassis removal. Component replacement is essentially the same as removal except in reverse order.

Reader Head

Tape Pressure Roller - Remove two screws holding the lamp housing to the platen bracket. Pull out on the lamp housing assembly. Remove two screws mounting the yoke and roller shafts. Dismount yoke, roller, and shafts. Remove shafts from bearings only when necessary to replace bearings.

Photodiode Assembly - Disconnect connector P5. Loosen Allen-head setscrew on the base and remove the photodiode assembly. When replacing a photodiode, position the diode in the housing so that the diode lens is touching the inside surface of the diode assembly glass window.

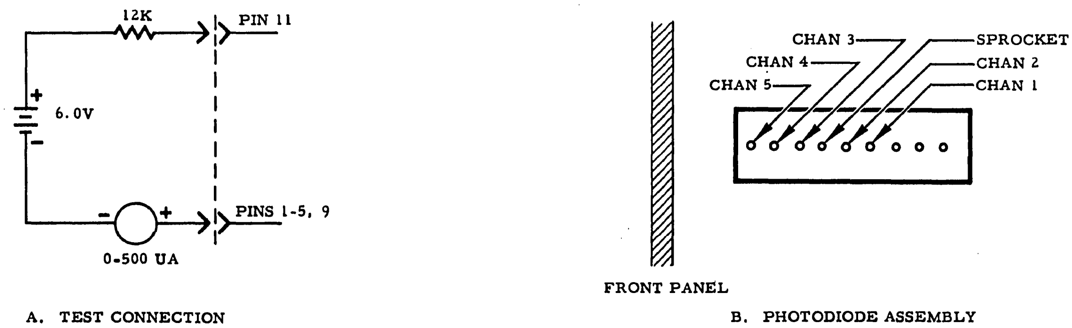
CAUTION

Do not exert excessive pressure when installing diode tip against glass window.

Check that the wire nearest the red dot on the diode is connected to the common bus. (See figure 41.)

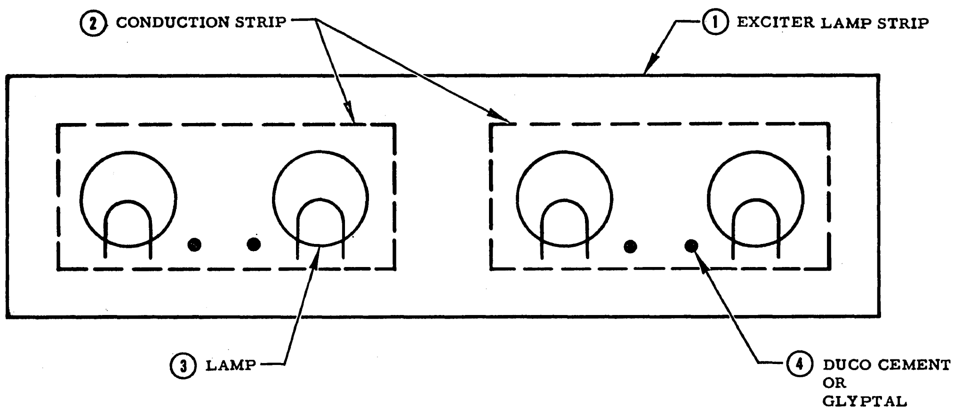
Exciter Lamps and Lamp Strip. In the subsequent procedure for removing and replacing exciter lamps and the exciter lamp strip, reference is made to the reader head adjustment points (figure 40) and to callouts on the exciter lamp strip (figure 42). To remove and replace exciter lamps and the exciter lamp strip, proceed as follows:

1. Press the lampholder clip (17, figure 40) towards the head adjustment screw (4, figure 40), until the clip just clears the locking-pin (16, figure 40) swing clip away from lamp housing exposing exciter lamp strip.
2. Remove the exciter lamp strip and replace defective lamps or lamps with excessive blackening of glass.
3. When replacing exciter lamps, orient lamp filaments (3, figure 42) and place a drop of glyptol or rubber cement on each lamp barrel (4, figure 42) to secure the lamp to the strip until the strip is reinstalled.
4. Reinsert exciter lamp strip (1, figure 42) in housing with end having the smallest distance between the conduction strip (2, figure 42) and the end of the lamp strip nearest the tape reader panel.
5. Swing clip into position and secure with locking pin (1, figure 40).



RC4-130

Figure 41. Photodiode Assembly



RC4-122

Figure 42. Photoreader Exciter Lamp Strip

Canister

Turn locking screw 1/2-turn counterclockwise to disengage the canister retaining plate.

Motor Belt

Remove four screws on the motor mount. Slip belt off the driver and driver pulleys.

Cricuit Board Chassis

1. Disconnect all cabling from the circuit board chassis. Release the chassis snap slides and remove circuit board chassis from the reader. (See figure 36.)

2. Once the chassis is removed, release the snap lock on the board retainer and remove the AGC electronic control amplifier, photodiode amplifier and electronic control amplifier boards. (See figure 43.)

Power Supply Chassis

1. Disconnect cabling from the power supply and release the chassis snap slides.

2. Remove the power supply from the reader. (See figure 36.)

3. Once the chassis is removed, release the snap lock on the board retainer and remove the power supply etched board. (See figure 43.)

TAPE REPAIR AND REPLACEMENT

The tape must be replaced or repaired if it becomes torn, creased, or pleated. A 12-inch "code delete" (all channels punched) leader should precede and follow the start and finish, respectively, of every program. These leaders may be punched as part of the computer program or spliced onto the program. Care should be used when splicing tape to prevent unnecessary buildup of the tape thickness. It is not uncommon for a splice to become jammed in the brake mechanism of the read head due to heavy splices. A splice with a large overlap will not be flexible enough to bend around the tape guide rollers in the canister and may cause the tape drive to slip. The following procedures describe the method used to repair tape:

1. Delete all information within 2 inches of splice using the "code delete" code.

2. Repunch deleted information on a new tape. Precede and follow this information with at least 2 inches of "code delete" code. Splice can be placed in the middle of a word without disturbing the computer program.

3. Insert new tape segment into tape, observing the instructions provided for splicing.

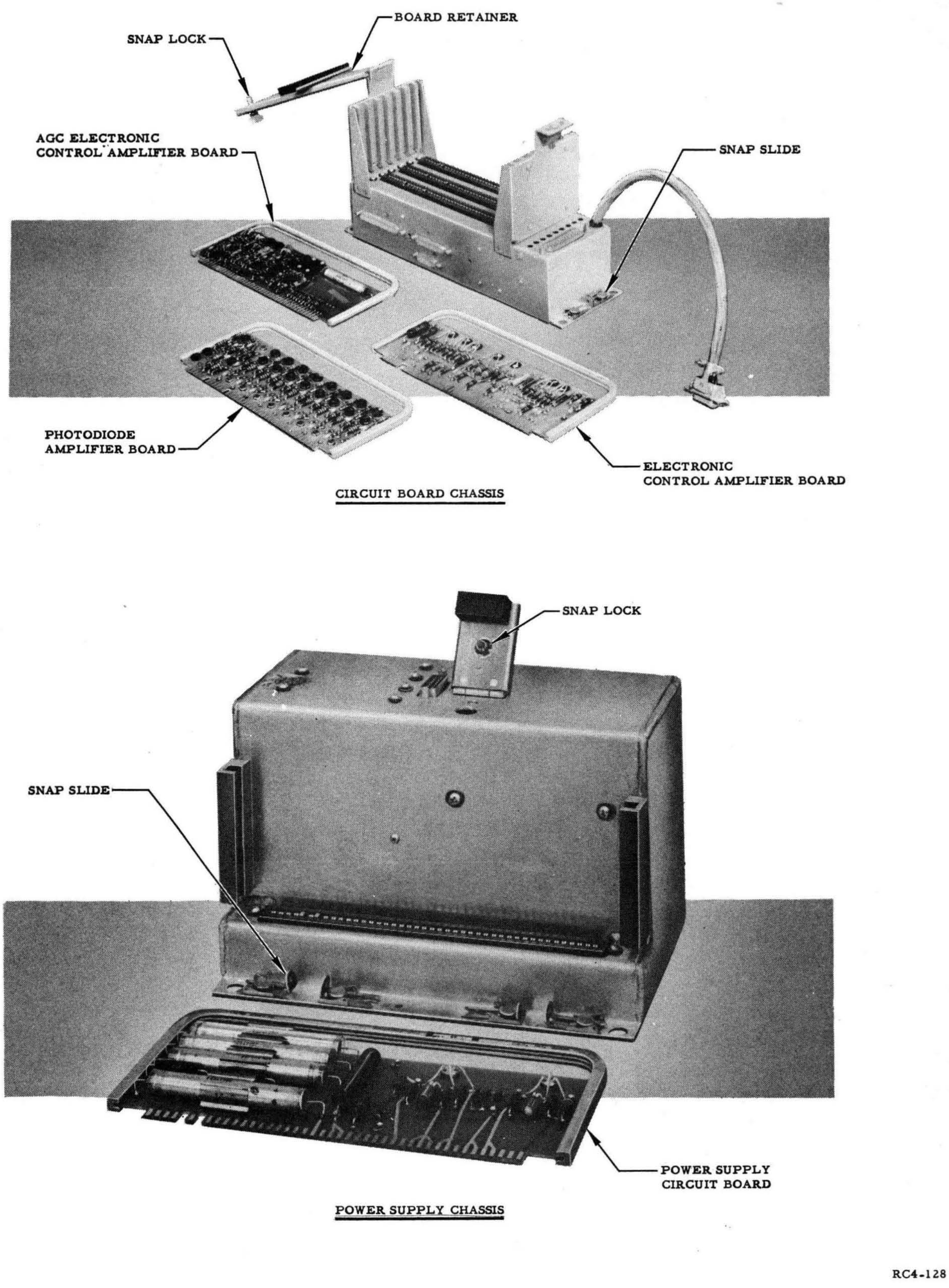


Figure 43. Power Supply and Control Chassis, Disassembled

Method of Splicing

The method for splicing is as follows:

1. Cut the top section of the tape between 2 and 6-1/2 inches from the last fold. The tape should be cut squarely through a sprocket hole rather than on a diagonal. Place the bottom section of the tape under the top section, maintaining 8-1/2 ± 1/32 inch between folds. Place a pencil mark on the bottom section of the tape using the top as a template. Cut the bottom section on a sprocket hole so that an overlap of two complete sprocket holes will be obtained when the splice is completed.

2. Clean the tape ends with acetone to remove excess oil and dirt.

3. Apply Duco household cement or plastic cement to both surfaces to be joined and press tightly together. Remove excess cement from the sprocket and information holes with a pointed instrument. The sprocket holes must coincide and the edges of the tape must be parallel.

4. Splice should be permitted to dry at least 10 minutes before using.

5. The thickness of the completed splice should not be greater than 0.010 of an inch at any point.

TAPE PUNCH

The RECOMP II tape punch converts binary electrical coded information from the computer or typewriter into information punched on black, fan-folded paper tape. Electrical pulses generated by the computer or typewriter, energize solenoids in the punch assembly which allow the electrical signals to be converted into information holes in the tape by action of the punch pins. All electronic circuitry necessary to operate and control the punch is mounted on transistorized plug-in circuit boards and forms a part of the tape punch assembly.

FUNCTIONAL DESCRIPTION

FUNCTION OF CONTROLS

The tape punch controls are grouped on the front section of the tape punch assembly (see figure 44). Tape punch controls and their functions are described as follows:

Control	Function
Power ON-OFF circuit breaker (toggle)	Applies 60-cps 115-volt primary power to tape punch motor and power supply
COMPUTER-MANUAL PUNCH rotary switch	When in COMPUTER position, the tape punch and typewriter are connected to computer and the punch responds to computer commands. When in MANUAL-PUNCH position, the punch is connected to the typewriter and the punch responds to teletype code from the typewriter
PUNCH-EXTERNAL rotary switch	When in PUNCH position, the information source (computer or typewriter) is connected to the punch. When in EXTERNAL position, information is directed from the computer to a plotter or some other external device

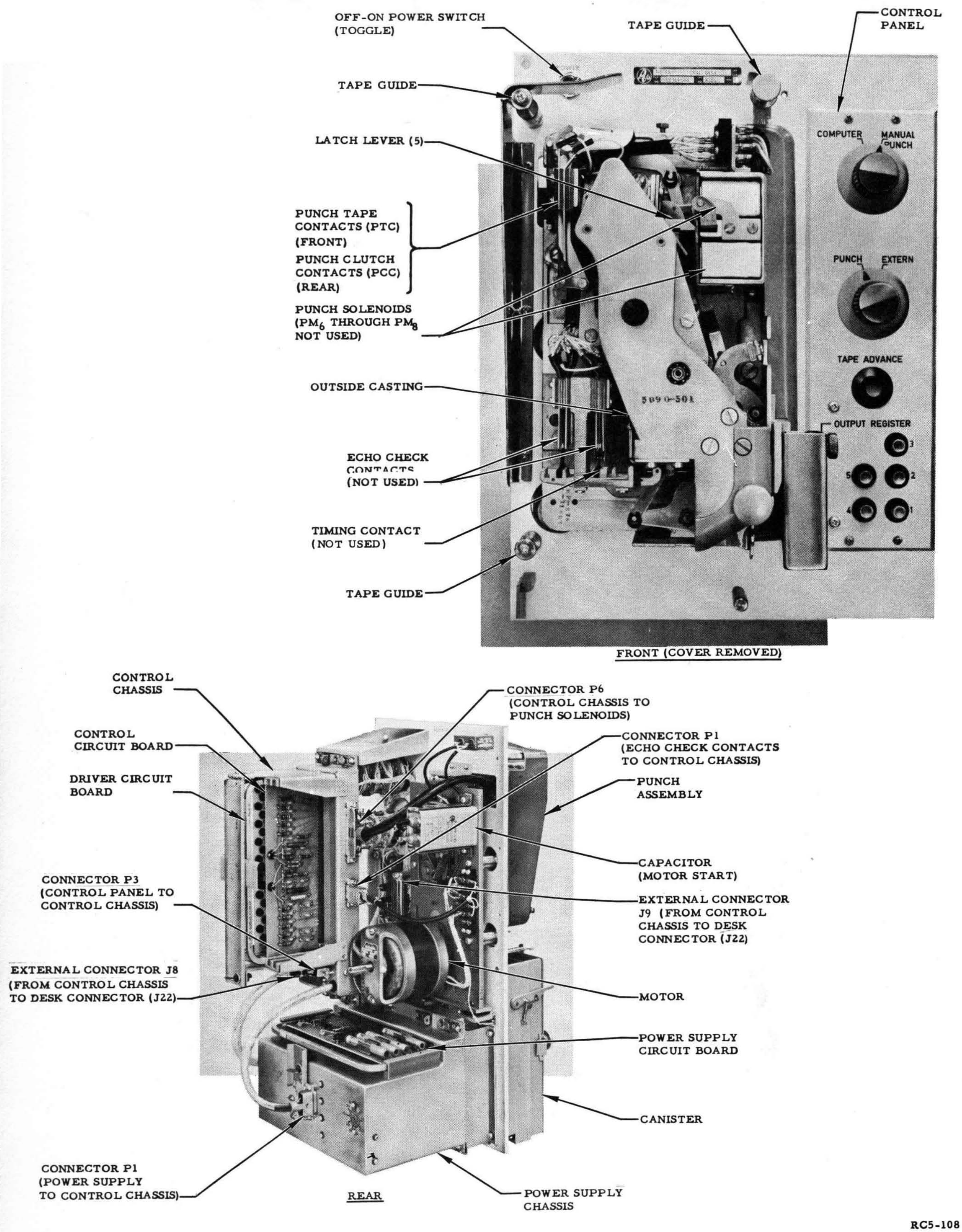
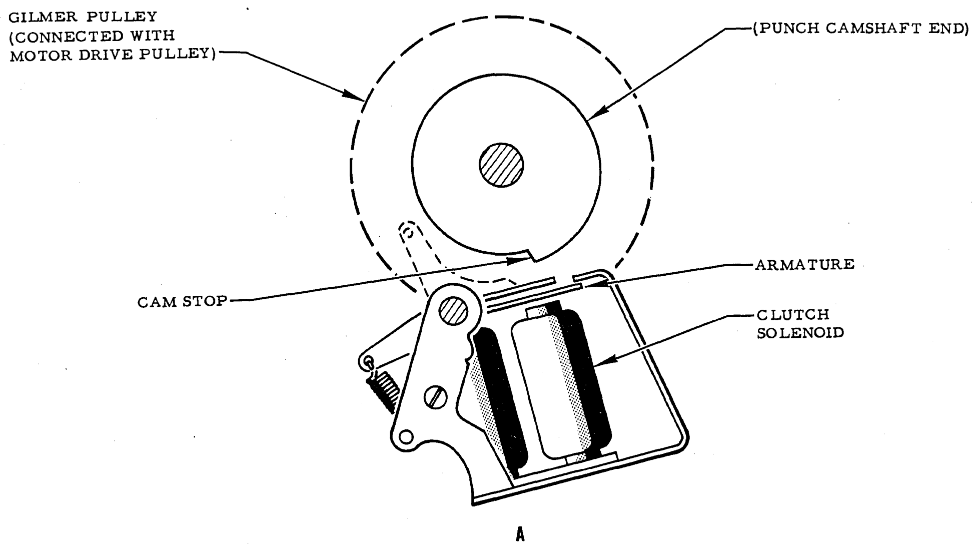


Figure 44. Tape Punch Recorder Interior View

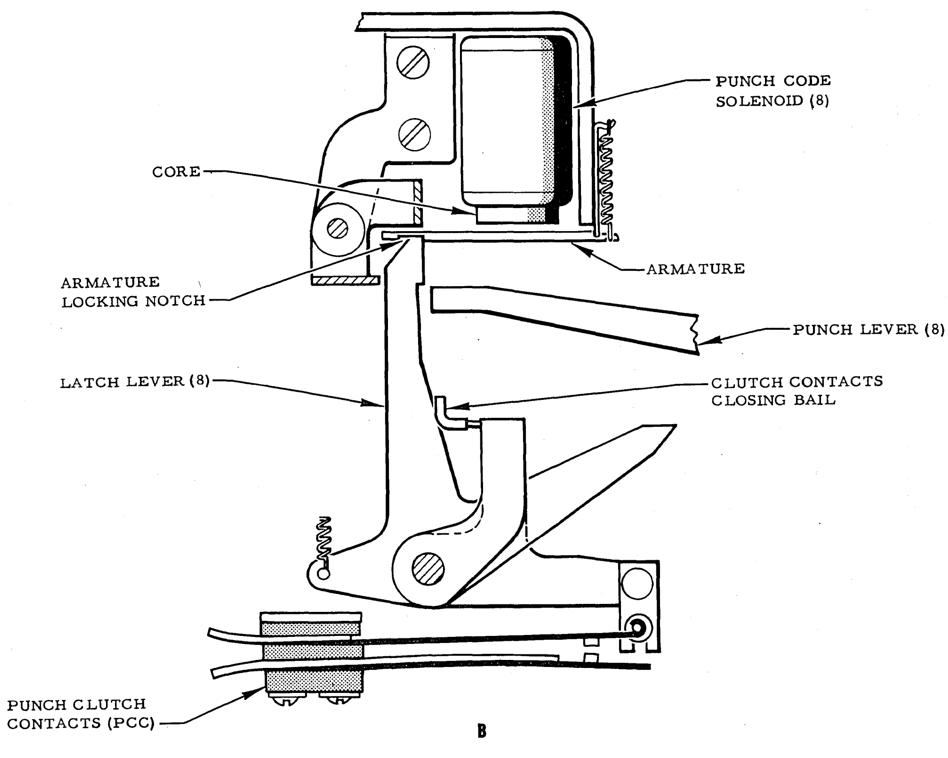
Control	Function
TAPE ADVANCE momentary switch	When depressed, actuates the clutch solenoid, which permits the clutch to engage the punch camshaft allowing the tape to advance through the punch
OUTPUT REGISTER DISPLAY (five neon lights)	When tape punch and computer are connected, displays the correct coded information transmitted from all sources through the computer output register during normal operation. When an error is made stopping the tape displays the correct code for those characters punched in error

NORMAL OPERATION

Primary power is applied to the tape punch motor through the circuit breaker on the desk assembly when the power ON-OFF circuit breaker switch is placed at ON. Motor rotation causes the motor drive pulley to rotate. The drive pulley is connected to the punch clutch. Tape movement begins when the clutch solenoid is actuated permitting the clutch to engage the punch camshaft. Rotation of the camshaft draws the tape through the punch. Information is punched on the tape when punch solenoids are actuated permitting cam action. Punch and clutch solenoid power is applied through control and amplifying circuits. These circuits are triggered either automatically by commands from the computer and manual operation of the typewriter, or by manual application of clutch solenoid power through the tape advance switch on the punch control panel. The punch control panel consists of two rotary switches, one toggle switch, one button switch, and an output register consisting of five neon lights. (See figure 44.) The neon lights provide a visual display of the coded pulses being sent out to the punch from the computer output register. The lights will continually flash during normal punch operation in sequence with each coded output, but when an error is made causing the punch to stop, a combination of lights remain on, indicating the correct code group punched in error. Coded information is converted from electrical signals to five large information holes in the paper tape by action of the mechanical punch unit. The sprocket hole in the tape (small hole) is generated by the rotation of a tape feed sprocket wheel in sequence with the information holes. The mechanical selection of the information holes is dependent on the



A. CAM SHAFT ACTUATION



B. CODE PUNCH ACTUATION

RC5-119

Figure 45. Clutch and Code Solenoid Actuation

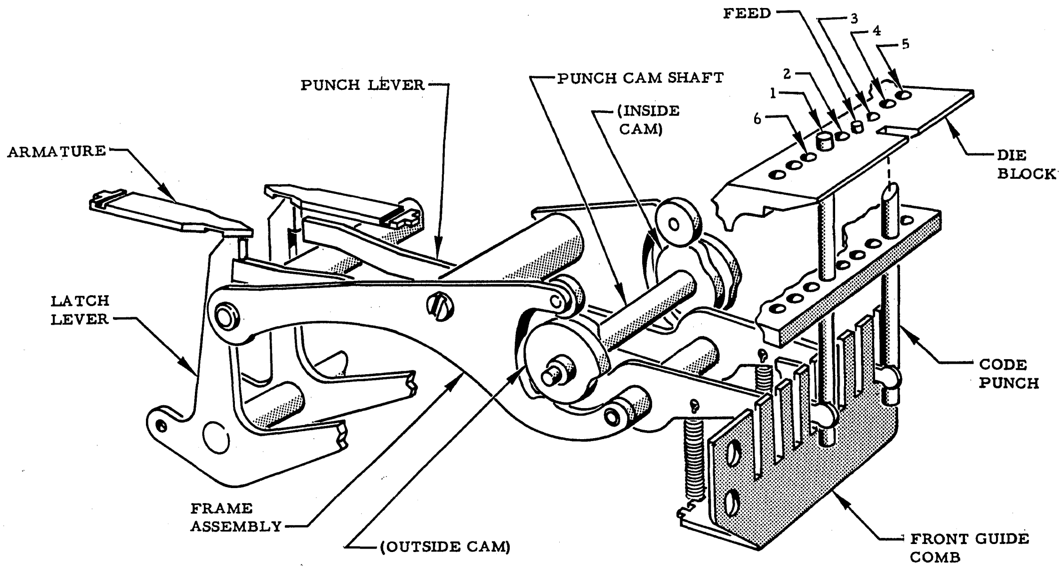
coded electrical selection of the appropriate punch solenoids. Synchronization of the sprocket hole with the information holes is the result of the timed actuation of an electrical contact (SC). A canister consisting of a double section is mounted on the front of the tape punch chassis. The back section contains the unpunched tape, which is fed through a system of guides to the tape feed mechanism on the punch. The coded tape drops down to the front section of the canister, where it is stored.

MECHANICAL PUNCH UNIT

When the punch clutch solenoid (PCM) is energized by an activate punch command or a start signal (TPP_t) from the typewriter, the punch clutch connected to the constantly running drive pulley on the motor is permitted to engage the punch camshaft. (See figure 45A.) Initial rotation of the camshaft closes a set of clutch contacts (PCC) through cam action. At the same time, the coded input pulses, which are transmitted with the start command or signal, energize one or more punch code solenoids (PM1 through PM 5). When any one punch solenoid is actuated, the armature, attracted to the core, pivots a latch lever and the latch lever engages its respective punch lever. (See figure 45B.)

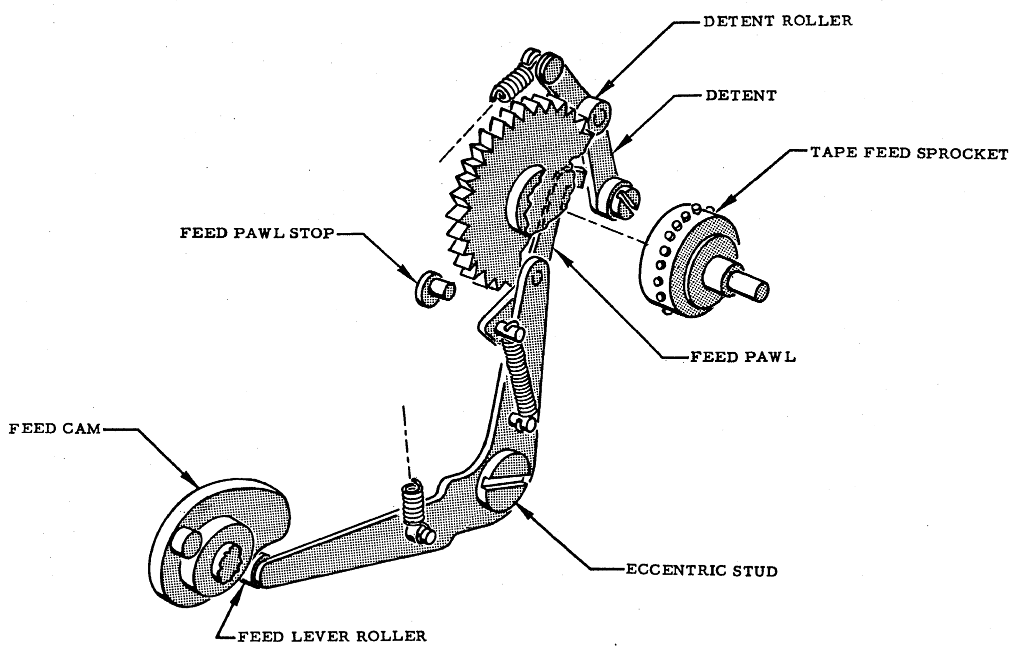
Rotation of the punch camshaft by the engagement of the clutch, initiates cam action which causes the punch lever and frame assembly to move forward. The rod on which the punch levers are pivoted is also moved forward. The latch levers determine which punch levers will be moved; those punch levers engaged by their respective latch levers will be moved forward while those not engaged will be held down by spring tension. The forward movement of the punch levers selected will force their respective code punches through the tape, perforating a code for those positions for which a punch solenoid has been energized. When the punches have extended to their maximum limit, further rotation of the shaft causes cam action moving the punch levers and frame assembly in the reverse direction and returning the punches from the die to the normal position. The camshaft completes one full revolution by restoring the latch levers to the notches of their respective punch solenoid armatures. (See figure 46A.)

During the latch-restoring operation, rotation of the shaft causes a cam to move a feed pawl arm into the teeth of a ratchet wheel. (See figure 46B.) The arm engages a tooth which indexes the wheel. The



A

MECHANICAL ASSEMBLY



B

FEED MECHANISM

RC5-120

Figure 46. Tape Punch Mechanical Assembly

action of the wheel rotates the tape feed sprocket, advancing the tape one-tenth of an inch. The hole punched by the feed sprocket is used later as the sprocket for clocking programing information to the computer.

If the tape runs out, binds, or if there is a malfunction in the tape feed, the tape contacts (PTC), which are in series with the clutch solenoid, are opened through cam action. The clutch solenoid is deenergized, releasing the clutch from the camshaft and stopping the punch.

MOTOR DRIVE UNIT

The motor drive unit consists of motor and drive pulley mounted by four bolts separately to the punch chassis. (See figure 44 rear). When power is applied to the tape punch by means of the power circuit breaker, motor rotation causes rotation of the drive pulley. Tape movement does not occur, however, until the punch clutch is allowed to engage the punch camshaft, by energizing the clutch solenoid (PCM). When the punch clutch and camshaft are connected, the rotation of the shaft draws the tape from the canister through the tape feed mechanism. The tape is not punched, however because the activate punch signal is not accompanied by the code pulses.

COMPUTER DRIVE CIRCUITS

Although the tape punch is capable of punching up to eight code holes (channels) in the tape, only five code holes are necessary as 5-channel tape is used in the computer. The punch contains a clutch solenoid and eight code solenoids of which only five are used. When the COMPUTER-MANUAL PUNCH switch is in the COMPUTER position, the computer and punch are connected. The activate punch command (X9) and the output information pulses (F1 through F5), are transmitted from computer output register flip-flops. (See figures 47 and 48.)

These signals (K18 through K23 after leaving computer) are amplified through the code and clutch solenoid drivers to the clutch solenoid (PCM) and the code solenoids (PM1 through PM5). Actuation of the clutch solenoid initiates camshaft rotation.

Cam action moves those punch levers forward which were initially activated when their latch levers were released by the code solenoid armatures. The punch levers force the punch pins through the tape resulting in coded perforations. (Refer to the last column of the table on page 122.)

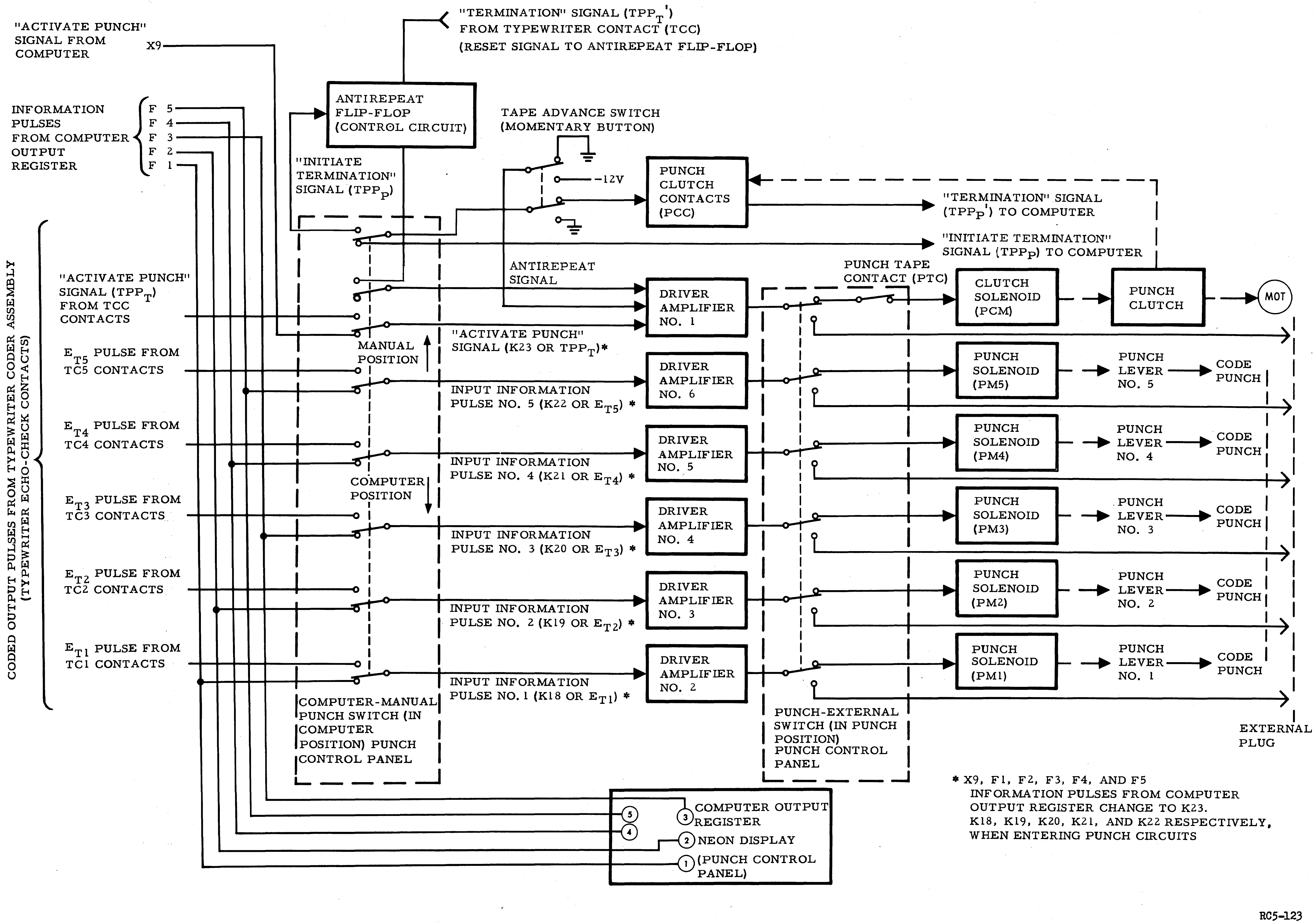


Figure 47. Tape Punch Activation Block Diagram

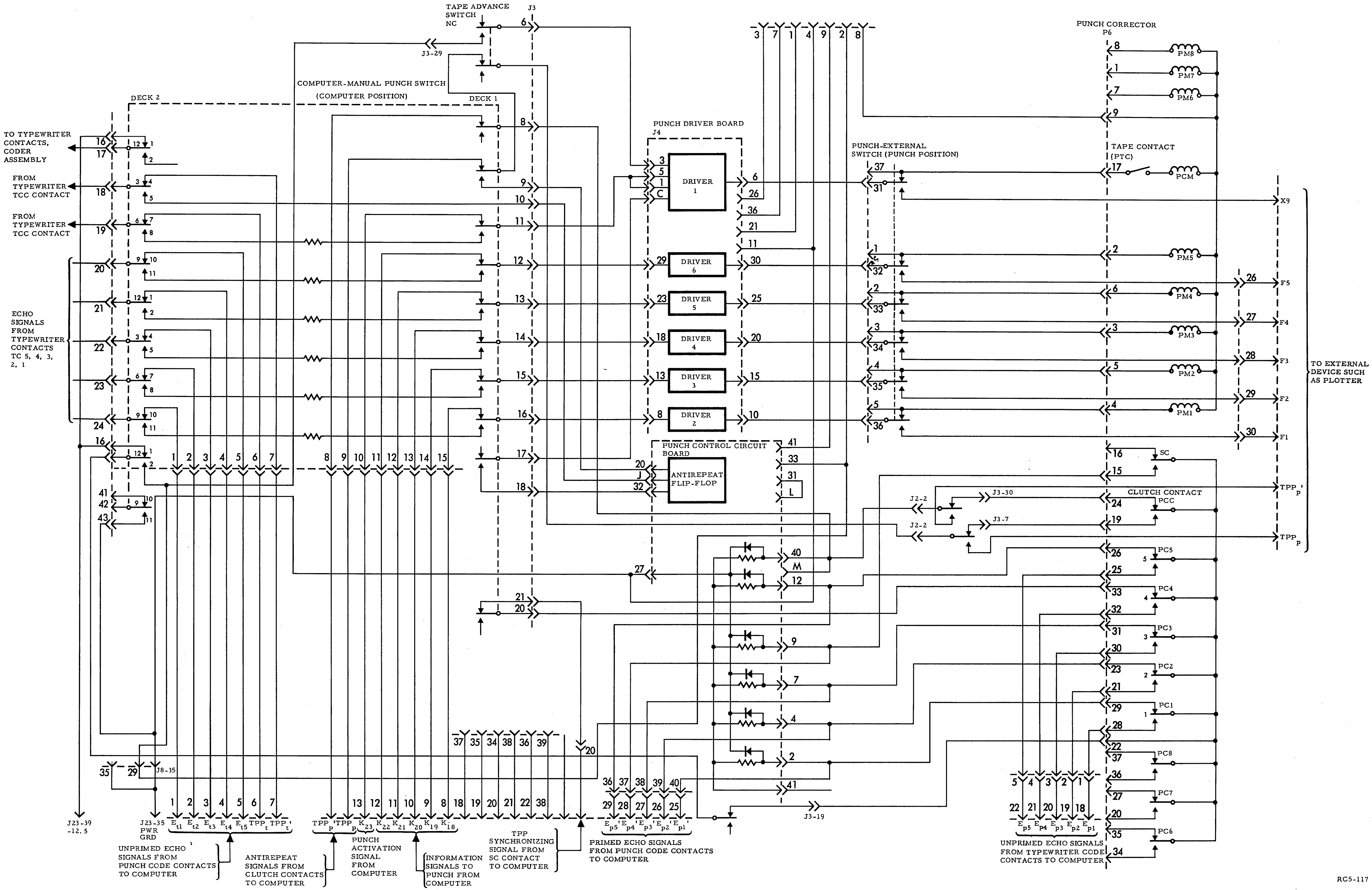


Figure 48. Punch Input-Output Schematic

Antirepeat Contacts

The antirepeat function of the coding units prevents the punch from double punching by terminating each punching operation. Contacts producing this function are the contact of the PCC set (figures 47 and 48). When the clutch solenoid is actuated by the start signal (X9), cam action closes the punch clutch contacts (PCC). When the clutch contacts close, an initiate termination signal (TPP_p) is sent to the computer. When the computer receives the initiate termination signal, the punch solenoid drivers are clamped to ground, removing the activate punch command (X9) from the clutch solenoid and the information pulses from the punch solenoids. The punch camshaft will complete one full revolution, however, before being held against the deactivated clutch solenoid armature by the cam on the shaft end. During the interval in which the shaft is completing the revolution, the PCC contact arm transfers, transmitting a termination signal (TPP_p') to the computer resulting in a reset signal (TPP'). This signal resets (zero-sets) the X9 flip-flop in the computer for the next start output signal.

Echo Checking Contacts

Echo checking contacts, once used to verify the punching operation, remain in the computer-punch circuits, but have no function.

Timing Contacts

The timing function synchronizes the coded echo check signals for each punching action. The contacts producing this function are the SC set. The SC contacts are common to the five sets of echo check contacts, PC1 through PC5 (figure 48). The SC contacts are mechanically coupled to the tape feed arm in order that the contacts close when the feed sprocket pin perforates the tape. (Refer to paragraph on Normal Operation.) When the contacts close, a -12-volt signal (TPP) is sent to the computer. This signal causes the echo check signals (E_{p1} through E_{p5}) to be compared with computer output signals at a time when all the selected punch levers have actuated their corresponding punch pins.

Character or Command	Input Code	Output Hole Configuration					
	5;4, 3;2, 1	5	4	3	o	2	1
B L A N K	0 0 0 0 0				o		
L-E, F-3	0 0 0 0 0				o		0
LINE FEED	0 0 0 0 0				o	0	
L-A, F-MINUS	0 0 0 0 0				o	0	0
SPACE	0 0 0 0 0			0	o		
L-S	0 0 0 0 0			0	o		0
L-I, F-8	0 0 0 0 0			0	o	0	
L-U, F-7	0 0 0 0 0			0	o	0	0
L-Carriage Return, F-Tab	0 1 0 0 0		0		o		
L-D, 1	0 1 0 0 1		0		o		0
L-R, F-4	0 1 0 1 0		0		o	0	
L-J	0 1 0 1 1		0		o	0	0
L-N	0 1 1 0 0		0	0	o		
L-F	0 1 1 0 1		0	0	o		0
L-C	0 1 1 1 0		0	0	o	0	
L-K	0 1 1 1 1		0	0	o	0	0
L-T, F-5	1 0 0 0 0	0			o		
L-Z, F-Plus	1 0 0 0 1	0			o		0
L-L	1 0 0 1 0	0			o	0	
L-W, F-2	1 0 0 1 1	0			o	0	0
L-H	1 0 1 0 0	0		0	o		
L-Y, F-6	1 0 1 0 1	0		0	o		0
L-P, F-Zero	1 0 1 1 0	0		0	o	0	
L-Q, F-1	1 0 1 1 1	0		0	o	0	0
L-O, F-9	1 1 0 0 0	0	0		o		
L-B	1 1 0 0 1	0	0		o		0
L-G	1 1 0 1 0	0	0		o	0	
F-F6R	1 1 0 1 0	0	0		o	0	0
L-M, F-Period	1 1 1 0 0	0	0	0	o		
L-X	1 1 1 0 1	0	0	0	o		0
L-V	1 1 1 1 0	0	0	0	o	0	
L-LTR	1 1 1 1 1	0	0	0	o	0	0

NOTE

A command operation from the computer may be a letter character or a figure character when the computer is the information source. An "L" preceding the character or command in the first column denotes that the coded pulse group is being sent as a figure. Whether the hole configurations represent letters or figures is determined by the computer program. When the LTR SHIFT or FGR SHIFT key on the typewriter is depressed manually, subsequent manual key depression corresponds to the "L" or "F" preceding the character.

TYPEWRITER DRIVE CIRCUITS

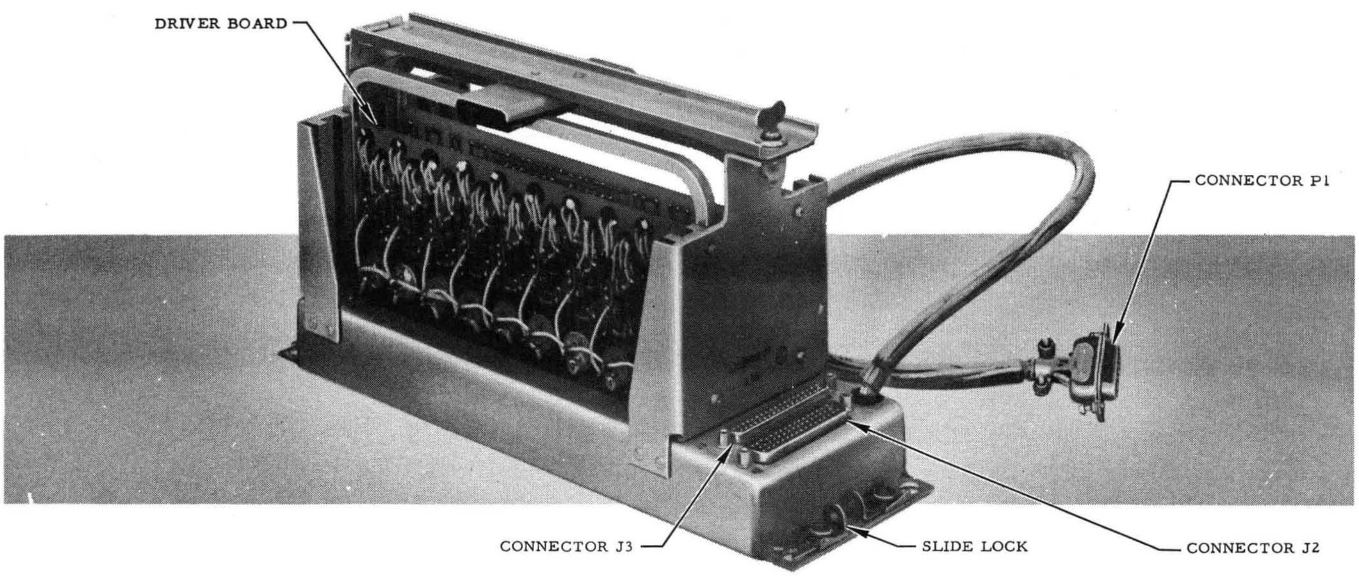
When the COMPUTER-MANUAL PUNCH switch is in the MANUAL PUNCH position, the typewriter is connected to the punch. (See figure 48.) Typewriter key depression will generate coded output pulses (E_{t1} through E_{t5}) to the punch solenoids and an activate punch signal (TPP_t) to the clutch solenoid. This is accomplished in the typewriter coder assembly, which contains the typewriter echo-checking contacts (TC1 through TC5) and the common contacts (TCC) normally used to verify the typing output and terminate the typing action when the computer drives the typewriter. The typewriter echo-checking contacts are shown in figure 19. When a key is depressed manually on the typewriter, a combination of these contacts is actuated, resulting in a coded pulse group. This pulse group would normally be sent to the computer as echo-checking signals to verify the typing out. Instead, they are sent to the punch circuits. The typewriter code pulses are identical to the tape punch code pulses (figure 33), and therefore are received by the punch circuits in the same manner as the computer output pulses. When a combination of these contacts is actuated by key depression, a punch start signal and information pulses are transmitted to the punch drivers, where they are amplified and sent to the clutch solenoid and the code solenoids. Since the punch accepts information at a greater acceleration than can be transmitted by the typewriter when manually operated, punch echo-checking contacts are not necessary to verify the punch output. The punch, however, is still capable of double-punching and each punching operation is terminated in a manner similar to that described (refer to paragraph on antirepeat contacts). The essential difference is that when the typewriter drives the punch and the PCC contacts close, the initiate termination signal is transmitted to the antirepeat flip-flop in the tape punch control circuit.

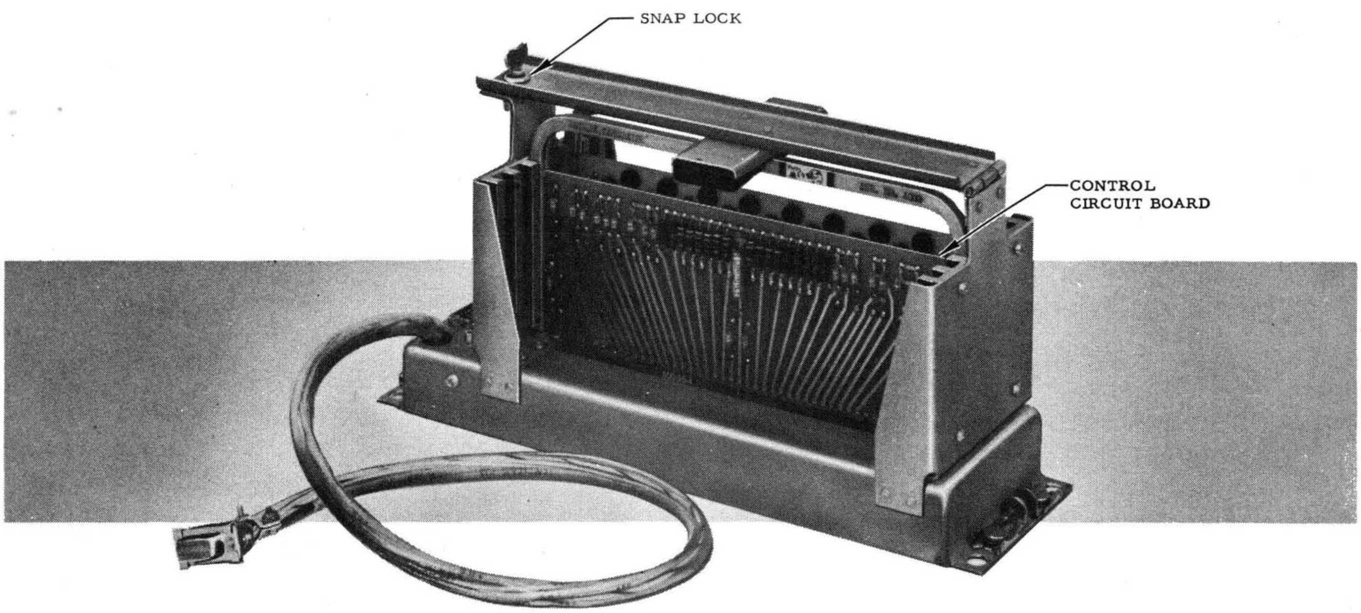
CONTROL CHASSIS

The control chassis contains the driver amplifier board and the control circuit board, both of which incorporate the use of transistors, diodes, and etched circuitry. (See figure 49.) The driver board contains nine identical driver amplifiers of which six are used to amplify the coded input signals originating in the computer or the typewriter. The coded pulses are amplified in the drivers and applied to the five punch solenoids and the clutch solenoid. When the activate punch signal to driver No. 1 is true, the driver conducts and actuates the clutch solenoid. When cutoff of this driver occurs, due to an "initiate termination" signal, drivers No. 2 through No. 6 (code solenoid drivers) are also clamped to ground.

The control circuit board contains 10 identical resistor-diode clamping circuits, of which 6 are used as part of the echo checking circuit tieing the computer to the punch. These clamps hold the signals to the "false" condition when their corresponding contacts are in the open position. In addition to the clamping circuits, the control circuit contains the antirepeat flip-flop. When the typewriter is driving the punch, the initiate termination signal (TPP_p), from the punch clutch contact (PCC) is transmitted to this flip-flop. The flip-flop is triggered, sending a -12-volt signal to the antirepeat line in the driver board. The line is common to all drivers, clamping them to ground and blocking the signals to the clutch solenoid and the code solenoids.

The drivers remain clamped to ground until the TCC contact in the typewriter, actuated by release of the key depressed, transmits a signal (TPP_t') to the flip-flop, resetting it to the opposite state. The clamp is then removed from the drivers, preparing them for the next group of input signals from the typewriter. The flip-flop remains in the opposite state until the next TPP_p signal is received from the punch clutch contacts.





RC5-121

Figure 49. Tape Punch Control Chassis

POWER SUPPLY

The power supply is a separate package providing four levels of secondary d-c voltage to the punch circuits. The power supply incorporates the use of transistors and etched circuitry on a plug-in board in addition to the transformer, choke, and other power units mounted on the chassis. (See figure 50.) Primary power at 115 volts, 60 cps is applied through the power ON-OFF switch (S-1) and circuit breaker (CB1) to the punch motor and to the power transformer. Power at d-c voltages of unregulated -28 volts and regulated -15, -12.5, and +6 volts are supplied to the circuits. The source of these voltages is 30-volt ac produced by step-down of primary voltage. The secondary ac is rectified in a fullwave bridge rectifier consisting of four diodes and located on the power supply chassis. Rectifier output is full-wave unregulated -28 volts with respect to ground. Unregulated -28-volt power is supplied to the punch solenoids and clutch solenoid located in the punch assembly. Choke-input filters are used to filter the -12.5, -15, and +6-volt power supplies.

-15-And -12.5-Volt Power Supplies

The -15-and -12.5-volt power supplies are regulated by a control amplifier located on the power supply board and a power amplifier located on the power supply chassis. (See figure 51.) The power amplifier carries the majority of the load current. The filtered output from the transformer is applied across a Zener diode. The diode has a fixed voltage drop of -15 volts which serves as a fixed potential on the control amplifier. This fixed potential holds the control amplifier current output steady. Since the control amplifier is little affected by load current changes, its current output regulates the power amplifier. Because of control amplifier regulation and because its output impedance is low, the power amplifier is relatively independent of supply voltage changes. The power amplifier output is a regulated -15 volts. A second output of -12.5 volts is produced by connecting three diodes in series with the output. These diodes are back-biased to produce the more positive -12.5-volt level. The diodes have a voltage drop of approximately 0.8 volt each.

+6-Volt Power Supply

The +6-volt power supply is also regulated by a control amplifier located on the power supply board and a power amplifier located on the power supply chassis. (See figure 51.) The series power amplifier

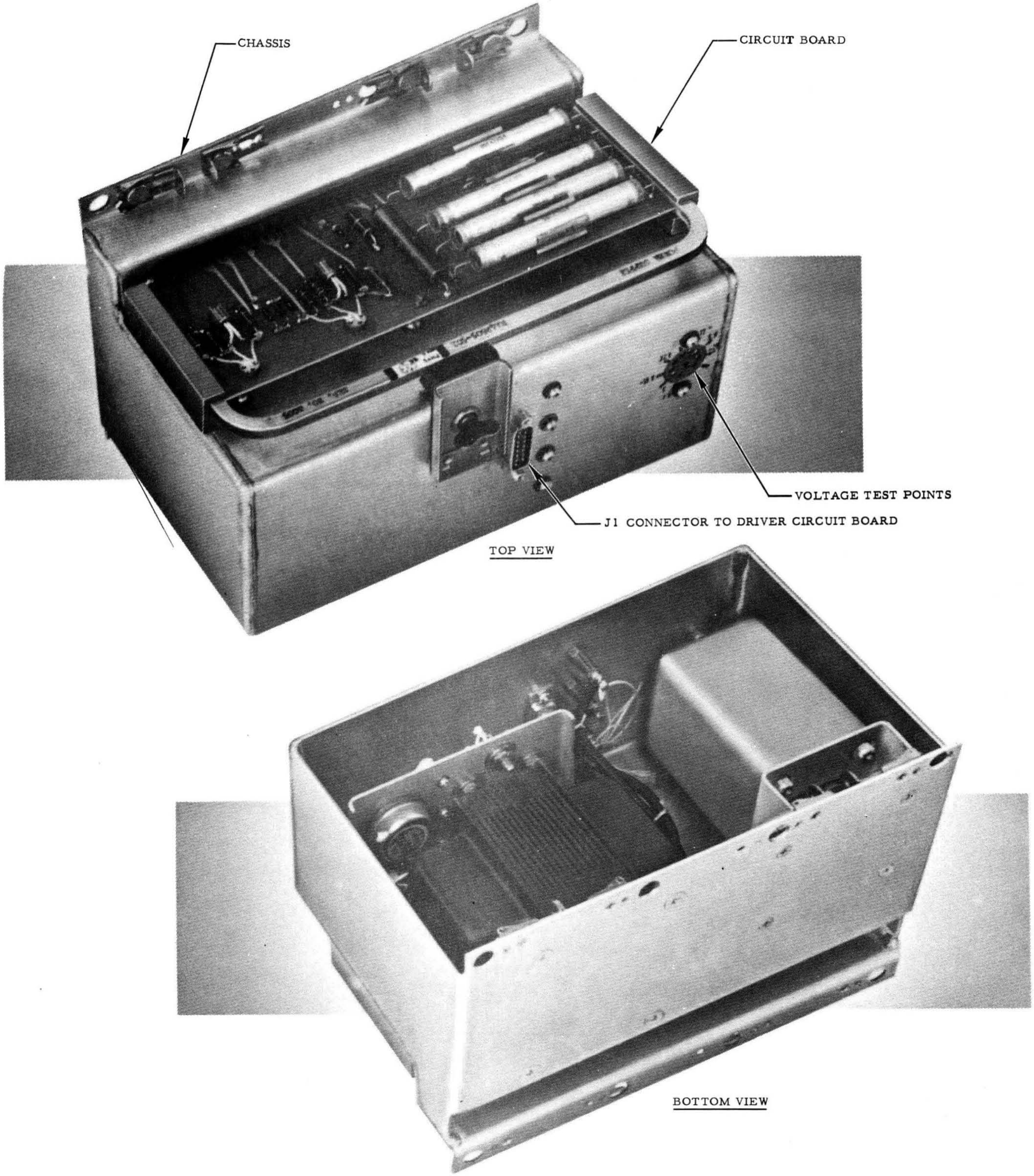


Figure 50. Tape Punch Power Supply

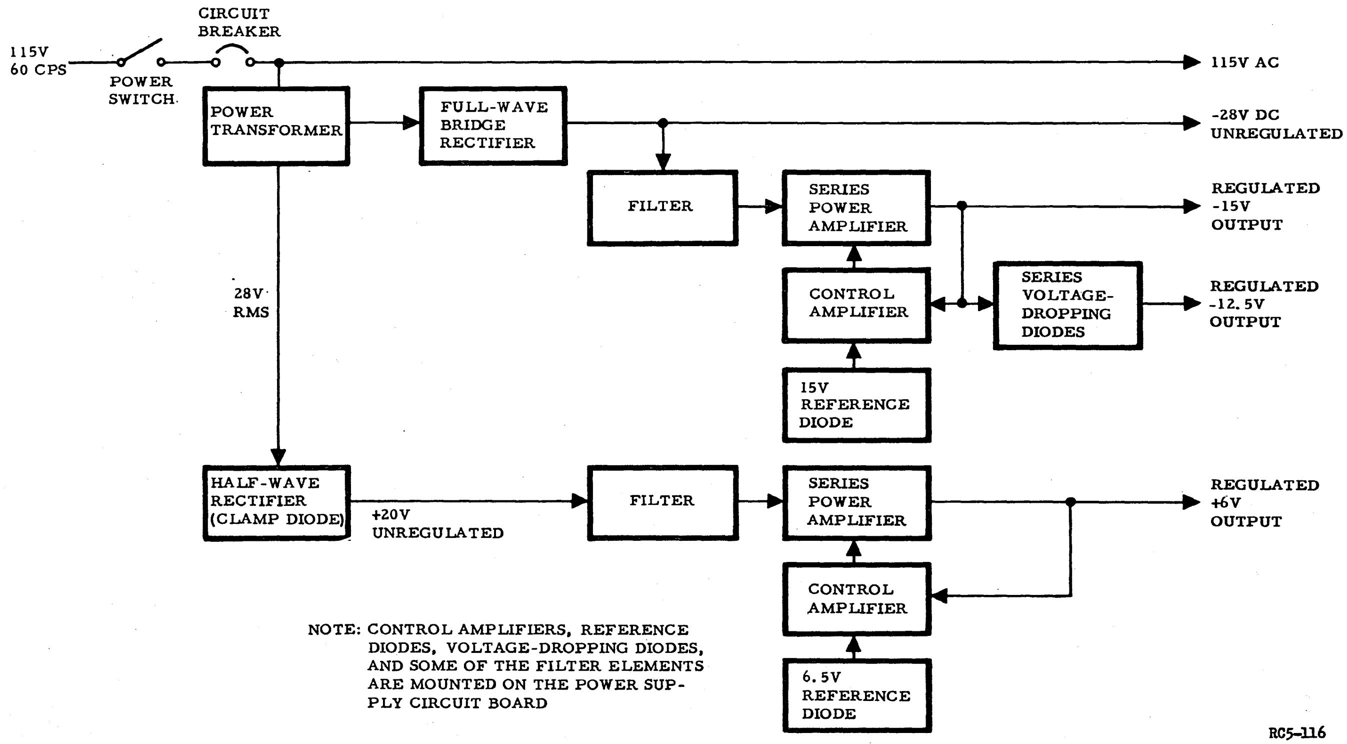


Figure 51. Tape Punch Power Supply (Block Diagram)

carries the majority of the load current. The regulation, however, is half-wave operated. That is, the negative half-cycle of ac is clamped to ground. The positive half is coupled through a capacitor to the filter supplying the input to the +6-volt regulator and then to ground. From ground, the return is to the filter supplying the input to the -12.5-and -15-volt regulator and then to the transformer return. The output voltage of the power amplifier is controlled by negative feedback. A Zener diode acts as the reference for the output with a fixed 6.5-volt drop. If the output voltage across a bleeder resistor tends to decrease, the difference between it and the 6.5-volt reference is applied to the control amplifier as a negative change. This negative change on the control amplifier causes the power amplifier to become more positive, increasing the load current. The output voltage therefore is increased sufficiently to offset the original tentative decrease.

MAINTENANCE

Maintenance of the Tape Punch consists of tests for locating faulty electrical circuits or elements, and of performing electrical and mechanical adjustments and preventive maintenance. In addition, procedures for the replacement of parts is provided. Prior to performing electrical checks or adjustments of signal circuitry, the tape punch power supply should be checked to determine that the appropriate power levels are being applied. Test equipment, recommended for use in performing checks, is listed as follows:

Item	Model or Type	Manufacturer
Oscilloscope		
Multimeter (20 kilohms per volt)	Model 630A	Triplett
Autotransformer	Range 0 to 115 volts	

POWER SUPPLY TESTS

The tape punch power supply checks of the chassis and circuit board include insulation resistance; transformer primary and secondary output; and load, no-load tests.

Insulation Resistance

Check the resistance between the chassis and the body of all transistors, and the resistance between the chassis and the body of all diodes. Both resistances should indicate infinity on the highest ohmmeter resistance range. If the resistances are not as required, check the installation of the parts. Particularly, check the mica washers used for insulation.

Transformer Primary Check

With the circuit board removed, apply exactly 115 volts to the primary of the tape reader power supply transformer. With the secondary open, the output voltage should be 32.0±1.5 volts.

Secondary D-C Voltage Level Checks

Plug the circuit board into the chassis. Energize the power supply through the connection of an autotransformer originally set to zero. Increase the autotransformer voltage slowly to 115 volts and check the voltage levels at the +6, -28, and -15-volt output terminals. If there are any signs of overheating, or if the output voltage decreases when the input voltage increases, reduce the input voltage immediately and repeat the test. If the malfunction continues, reduce the input voltage to zero and discontinue test procedures until the element causing the malfunction has been located and replaced.

Load Test

Apply the loads indicated (table 23) to the appropriate test points indicated, with the power supply deenergized.

Table 23. Power Supply Load Test

Supply Voltage (Volts)	Test Point	Maximum Voltage (Volts)	Maximum Ripple (Millivolts-Peak-to-Peak)	Load
+6	Pin 1	+6±0.5	50	200 ohms
-12.5	Pin 7	-12.5	75	160 ohms
-15	Pin 3	-15±1.5	75	150 ohms
-28	Pin 4	-28+3	200	100 ohms
-24.5 (Lamp Supply)	Pin 2	-24.5±1.5*	200	46 ohms
Ground	Pin 8	0	0	12 watts

* Lamp Supply is not used in Tape Punch

NOTE

With rated load of 160 ohms, the output at pin 7 should be less negative than the -15-volt supply by 1.5-to 3-volt dc.

1. With the power supply energized, the output voltages should be as shown (table 23).
2. With the power supply energized and the loads connected, use the oscilloscope to read the allowable ripple as listed (table 23).

No-Load Test

To perform the no-load tests, remove the loads as specified (table 23) and measure the secondary d-c levels. The voltage limits of each level should be as shown (table 24).

Table 24. No-Load Tests

Voltage Level	Test Point	Voltage Limits (Volts)
+6	1	+6.3±0.5
-12.5	7	-12.5 to -13.1
-15	3	-15.5±1.5
-28	4	-29±3
-24.5	2	-24.5±3

SIGNAL CIRCUIT BOARD CHECKS

Signal circuits consist of control and amplifying circuitry mounted on two etched circuit boards which plug into the tape punch control chassis.

The control circuit board contains the antirepeat flip-flop and 10 clamping circuits that tie the punch to the computer. The tape punch driver board contains the amplifiers designed to drive the tape punch solenoids. The two boards should be removed from the control chassis before applying the appropriate voltage levels to the respective boards. The tape punch power supply, previously tested, is used as the power source in the following tests.

Control Circuit Board Check

Checks are performed on the antirepeat flip-flop circuit and the clamping network to determine functional values, and isolation of possibly defective elements on the board.

Antirepeat Circuit. Connect the various power supply output levels to the appropriate input terminals on the board.

1. Apply all normal power to the board.
2. Connect a 2,200-ohm resistor between antirepeat output terminal (pin 32) and ground.
3. Apply -12 volts between TPP (pin 20) and TPP T' (pin 31).

4. Connect the multimeter between the antirepeat output terminal (pin 32) and ground to monitor the voltage.

5. The voltage output should be 0-volt dc.

6. Connect TPP (pin 20) to ground and apply -12 volts to antirepeat output terminal (pin 32)

7. Connect the multimeter between TPP T' (pin 31) and ground to monitor the voltage. This voltage should read -12 volt-dc.

8. Remove the power source and disconnect the meter.

Clamping Circuit. To perform the clamping circuit check, proceed as follows:

1. Apply +6-volt dc to pin 41 and connect pin 27 to ground.

2. Connect the multimeter between pin 2 and ground, to monitor the voltage at clamp 1.

3. The voltage should be no more then +1-volt dc.

4. Repeat step 2 for clamp 2 through 10. (Refer to table 25 for pin numbers checked at each clamp).

5. Remove the power source and meter from the board except for power ground (pin 27).

6. Apply -12 volts to pin 2. (clamp 1).

7. Insert the multimeter in series with pin 27 and the power supply ground.

8. The current should be no more than 4-milliamperes dc.

9. Repeat steps 6 and 7 for clamps 2 through 9. The current should be no more than 4-milliamperes dc. (Refer to table 25 for input terminals for clamps 1 through 10).

10. Repeat steps 6 and 7 for clamp 10. The current should be no more than 8.3-milliamperes dc.

Table 25

Input Terminals to Clamps 1 Through 10

Clamp No.	1	2	3	4	5	6	7	8	9	10
Pin No.	2	4	7	9	12	35	36	37	38	40

Driver Circuit Board Check

Checks are performed on the driver amplifiers; and tape advance, antirepeat, and PCM functions to determine that signal output levels are within appropriate values and tolerances, and to isolate possibly defective elements on the board. In addition to the tape punch power supply output levels, a -12-volt external power source is required in the subsequent procedures.

Driver Voltage Levels. Connect the power supply output levels (-28-, -15-, and +6-volt dc) to the appropriate input terminals on the board.

1. Apply all normal power to the board.
2. Connect a 150-ohm, 10-watt resistor between output 1 (pin 6) and -28-volt dc (pin 36).
3. Connect input 1 (pin 5) to ground.
4. Connect the multimeter between pin 6 (output 1) and pin 36 (-28-volt dc) to measure the voltage drop across the resistor.
5. The voltage should be less than 0. 1-volt dc.
6. Connect the 150-ohm, 10-watt resistor between outputs 2 through 9 individually and -28-volt dc (pin 36) while connecting inputs 2 through 9 individually to ground. (Refer to table 26 for pin number designations).
7. Connect the multimeter between outputs 2 through 9 individually and pin 36 (-28-volts dc) to measure the voltage drop across the resistor.
8. The voltage should be less than 0. 1-volt dc in each case.
9. Remove the ground from the board inputs.
10. Apply -12 volts from an external power supply to input 1 (pin 5) with the load connected as in step 3.
11. Connect the multimeter between output 1 (pin 6) and ground.
12. The voltage should read no more negative than -0. 25-volt dc.
13. Repeat step 10 for inputs 2 through 9 and measure the voltage between outputs 2 through 9 individually and ground. The voltage should be no more negative than -0. 25-volt dc. The following table shows input and output terminal designations.

Table 26.

Input and Output Terminals

Input No.	1	2	3	4	5	6	7	8	9
Pin No.	6	10	15	20	25	30	35	41	43
Output No.	1	2	3	4	5	6	7	8	9
Pin No.	5	8	13	18	23	29	34	39	42

Tape Advance and Code Delete Check. To check the resistance of the tape advance and code delete functions, proceed as follows:

1. Remove all power from the board.
2. Connect an ohmmeter between pin 3 (tape advance) and the input side of resistor R20.
3. The resistance should read 22 kilohms.
4. Connect the ohmmeter between pin 16 (code delete) and the input side of resistor R20.
5. The resistance should read 22 kilohms.
6. Repeat step 4 for resistors R21 through R28 individually. The resistance should read 22 kilohms in each case.

PCM and Antirepeat Check. To perform the tests on the PCM and antirepeat functions, proceed as follows:

1. Remove all meters from the board.
2. Connect pin 1 (PCM), and pin C (antirepeat) to ground.
3. Connect a 150-ohm, 10-watt resistor between pin 6 (output 1) and pin 36 (-28-volt dc).
4. Apply all normal power (-28, 15-+6) to the board.
5. Connect the multimeter between pin 6 (output 1) and pin 36 to measure the voltage across the 150-ohm resistor.
6. The voltage should read less than 0. 1-volt dc.
7. Repeat steps 2 through 5 for outputs 2 through 9. (Refer to table 26 for output terminal designations.)
8. Remove the ground from pin 1 and pin C and apply -12-volt dc to pin 1 and pin C successively.

9. Measure the voltage drop across the 150-ohm resistor connected between pin 36 (-28-volt dc) and outputs 1 through 9 individually. (Refer to table 26 for output terminal designations.)

10. The voltage should be no more negative than 0.25-volt dc.

TAPE PUNCH FUNCTIONAL CHECKS

The tape punch is functionally tested either with coded signals applied from the typewriter or by static signal inputs to the punch driver amplifiers to simulate commands from the computer. Coded signals, in both instances, are checked against coded configurations in the tape to determine correct punch operation. The tape punch power supply output voltage levels should be checked with driver and control boards removed, at the board pins listed in table 27, prior to performing functional checks:

Table 27.

Board and Pin Numbers

Voltage to Ground	Board No.	Pin No.
0 volt (ground)	42590-501	27
+6±1 volt	42590-501	41
-38±5 volts	42587-501	36
-16±3 volts	42587-501	26
+6±1 volt	42587-501	21
0 volt (ground)	42587-501	11
-16±3 volts	42590-501	33

Code designations and the respective pin numbers for tape punch inputs are shown (table 28).

Table 28.

Code Designations And Pin Numbers

Code Column	Inputs (Plug P-9)
5	20
4	21
3	22
2	23
1	24

Table 29 shows the coding of the punch. A "1" represents an applied voltage of -12±1 volts, and a "0" represents a voltage of 0±1 volt, or an absence of voltage. In the character or command column an "L" preceding the character or command indicates that the typewriter is in letter shift, and an "F" preceding the column indicates that the typewriter is in figure shift.

Table 29.

Coding

Character or Command	Input Code	Output Hole Configuration					
	5; 4, 3; 2, 1	5	4	3	o	2	1
B L A N K	0 0 0 0 0				o		
L-E, F-3	0 0 0 0 1				o		0
LINE FEED	0 0 0 1 0				o	0	
L-A, F- MINUS	0 0 0 1 1				o	0	0
SPACE	0 0 1 0 0			0	o		
L-S	0 0 1 0 1			0	o		
L-I, F-8	0 0 1 1 0			0	o	0	
L-U, F-7	0 0 1 1 1			0	o	0	0
L-Carriage Return, F-Tab	0 1 0 0 0		0		o		
L-D, 1	0 1 0 0 1		0		o		0
L-R, F-4	0 1 0 1 0		0		o	0	

Table 29. (Continued)

Character or Command	Input Code	Output Hole Configuration					
L-J	0 1 0 1 0		0		o	0	0
L-N	0 1 1 0 0		0	0	o		
L-F	0 1 1 0 1		0	0	o		0
L-C	0 1 1 1 0		0	0	o	0	
L-K	0 1 1 1 1		0	0	o	0	0
L-T, F-5	1 0 0 0 0	0			o		
L-Z, F-Plus	1 0 0 0 1	0			o		0
L-L,	1 0 0 1 0	0			o	0	
L-W, F-2	1 0 0 1 1	0			o	0	0
L-H,	1 0 1 0 0	0		0	o		
L-Y, F-6	1 0 1 0 1	0		0	o		0
L-P, F-Zero	1 0 1 1 0	0		0	o	0	
L-Q, F-1	1 0 1 1 1	0		0	o	0	0
L-O, F-9	1 1 0 0 0	0	0		o		
L-B	1 1 0 0 1	0	0		o		0
L-G	1 1 0 1 0	0	0		o	0	
L-Fig.	1 1 0 1 1	0	0		o	0	0
L-M, F-Period	1 1 1 0 0	0	0	0	o		
L-X	1 1 1 0 1	0	0	0	o		0
L-V	1 1 1 1 0	0	0	0	o	0	
L-LTR.	1 1 1 1 1	0	0	0	o	0	0

Typewriter Coding Input

A previously tested typewriter assembly should be used to enter the coding to the punch.

A cable connecting the typewriter assembly to the punch will be required in the following check:

1. With all boards in the typewriter and tape punch assemblies, and with the two assemblies connected, energize both assemblies and place the COMPUTER-MANUAL PUNCH switch at MANUAL PUNCH.
2. Place the PUNCH-EXTERNAL switch at PUNCH.
3. With the FIG SHIFT key on the typewriter depressed, the characters or commands (table 29) should be executed on the typewriter for figures.

4, The tape should be punched in accordance with the code indicated (table 29), with a hole in the tape indicating a "1" and absence of a hole indicating a "0".

5. With the LTR SHIFT key depressed, repeat the procedure in steps 3 and 4 for the characters under character and command column of Table 29.

Simulated Computer Inputs

Static input signals to the punch drivers corresponding to the code combinations (table 29) are applied to the punch input pins of plug 9 (shown in table 28) in the following procedures:

1. With the assembly energized, place the COMPUTER-MANUAL PUNCH switch in the MANUAL PUNCH position.
2. Apply successively the combinations shown (table 29) to the pins shown (table 28). After a particular combination is set, actuate the punch by applying a -12-volt signal to pin 10 of plug 9.
3. As each code combination is punched, the same code combination should appear on the tape.

TAPE PUNCH ADJUSTMENTS

Tape punch adjustments are made on the mechanical punch located on the front of the punch assembly chassis and consist of adjustments of tape punch contacts and of the clutch and tape feed mechanisms. These adjustments should be made only if necessary.

Tape Feed Mechanism

To insure that the feed hole (sprocket hole) is properly positioned along the width of the tape and that the tape is being fed evenly, thereby assuring proper registration (required distance between holes), it may be necessary to adjust the tape feed mechanism according to the following procedure:

1. Feed out a length of blank tape (approximately 1 foot long), and check the registration of the feed holes. Spacing between feed holes should be 0.100 inch or 60 feed holes in 6 inches. (See figure 52A.) If the tape feed does not meet this requirement, loosen the locknut and adjust the detent arm eccentric stud until the proper registration is obtained.

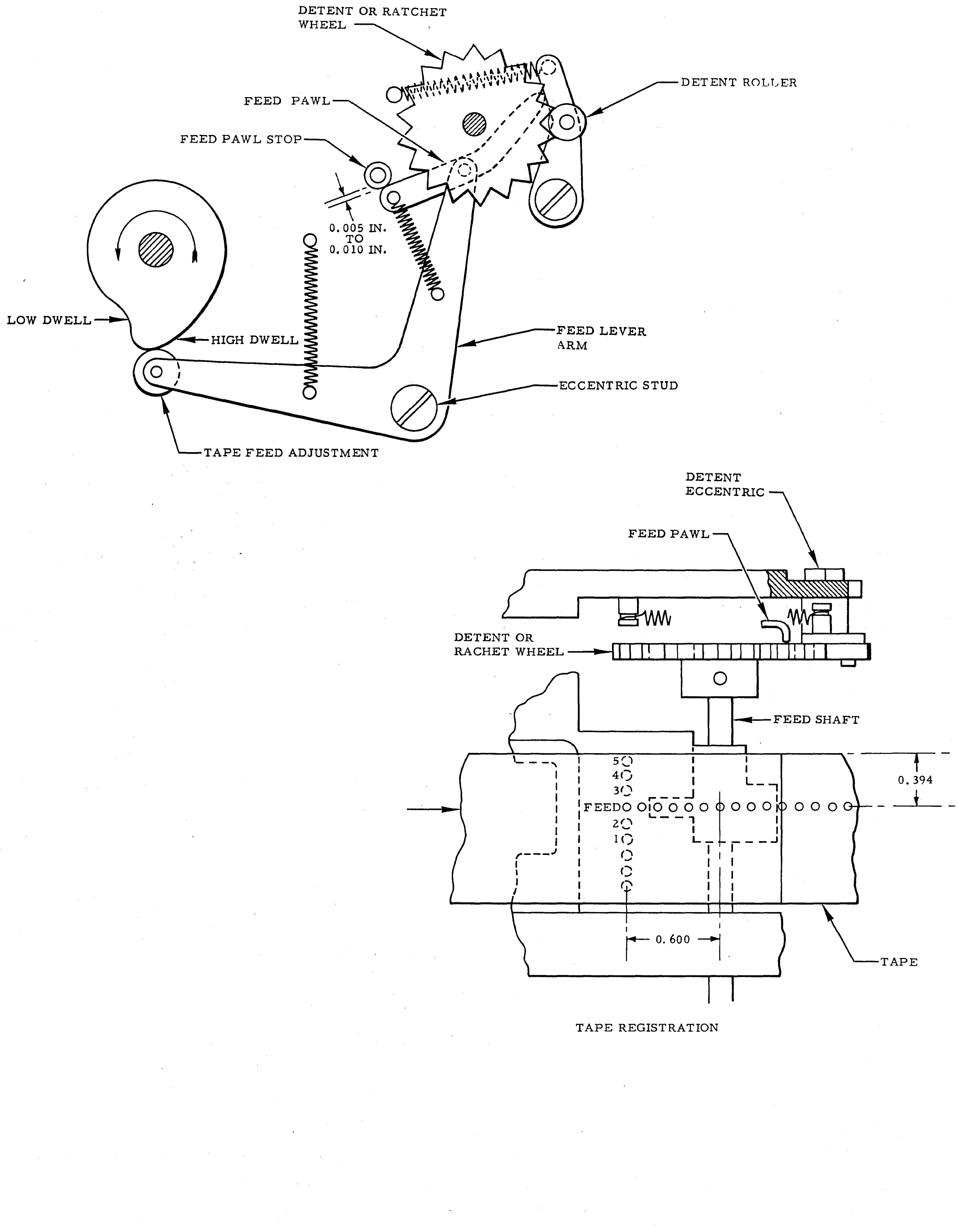


Figure 52. Tape Feed Adjustment Diagram

(See figure 47B.) The tape support plate should be adjusted so that the center line of the feed hole will be approximately 0.394 inch from the inside (or guide) edge of the tape (nearest No. 5 code hole). In addition, the outside tape guide (on tape runout arm) should be adjusted to insure even feed of the tape.

NOTE

If a detent adjustment is made, continue with steps 2 and 3.

2. Adjust the eccentric stud for the feed pawl lever so that the feed pawl moves the ratchet wheel (detent wheel) to within less than 0.010 inch of detented position. (See figure 52B.) The extent of feed motion should never be beyond the detented position.

3. With the feed roller (on feed lever) on the high point of the feed cam, adjust the feed pawl stop to stop the motion of the feed pawl, without chocking off, just as soon as the detent roller is fully seated between two teeth of the ratchet (detent) wheel. (See figure 52B.)

4. Adjust the tape stripper so that the curved portion is even with or below the surface of the pin wheel (tape feed sprocket wheel).

Clutch Mechanism

It may be necessary to adjust the clutch mechanism for appropriate tolerances so that the clutch engages and disengages smoothly, without play, when the clutch solenoid is energized or deenergized. To adjust the clutch mechanism, proceed as follows:

1. Set the clutch detent cam on the punch shaft to engage the detent arm (figure 53B) at the point where the feed lever roller has moved 15±1 degrees past the low dwell on the feed cam. (See figure 52B.)

NOTE

15 degrees equals one-eighths of an inch with a 0.010-inch tolerance.

2. Position the clutch magnet yoke on the casting so that the tip of the armature, when in attracted position, clears the high point of the clutch sleeve by 0.005-inch to 0.007-inch. (See figure 53A.)

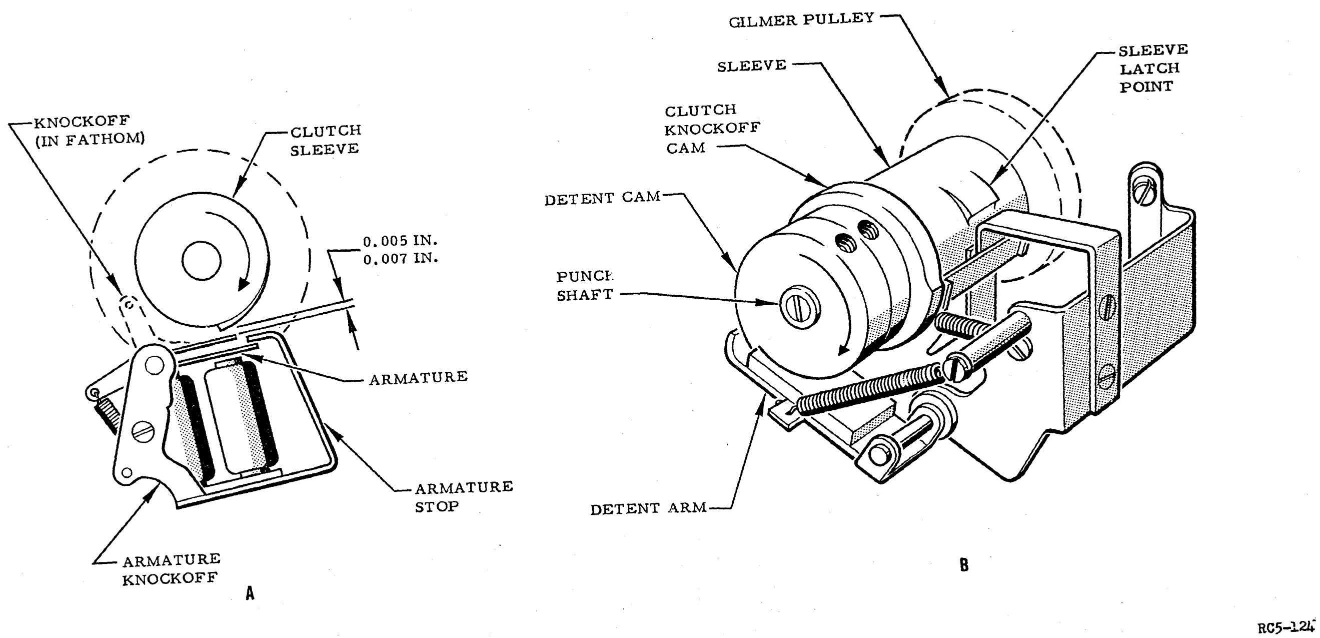


Figure 53. Clutch Adjustments

3. When the armature knockoff roller is on the high dwell of the cam, there should be 0.005-inch to 0.010-inch gap between the armature and the knockoff. Reform the knockoff to obtain this gap. (See figure 53A.)

4. Position the clutch collar on the clutch shaft so that when the latch point of the sleeve just engages the armature tip, the latch point of the detent cam is one-thirty-second of an inch short of latching onto the tip of the detent arm. When making this adjustment, and before tightening the setscrews, the clutch sleeve and its collar should have their normal free relationship to each other. (See figure 53B.)

5. Adjust the knockoff cam (radially on the shaft) so that the clutch will not overtravel more than 4-1/2 degrees. One degree from the latched position equals one-thirty-second of an inch to one-sixteenth of an inch of movement. (See figure 53A.)

Contacts

The clutch (PCC) and tape (PTC) contacts are adjusted for air gap when necessary. Double punching and tape malfunctions are prevented by these contacts, which are located in the upper left corner of the mechanical punch. (See figure 44, front view.)

1. The PCC contacts should be adjusted to have a minimum of 0.025-inch air gap with the latches in their normal position against the punch solenoid armatures. Also, the stationary strap should move an additional 0.002 inch away from its support stop after the contacts close. (Break before making adjustment.)

2. The outside break contacts (PTC) should be closed during all normal operations (tape properly conditioned). Observe that the stationary contact moves an additional 0.002 inch when the contacts close. There should be a 0.020- to 0.025-inch air gap when the contacts are open.

PREVENTIVE MAINTENANCE

Preventive maintenance of the tape punch assembly is limited to resoldering loose or corroded joints and lubrication of certain components of the mechanical punch. Reference should be made to the Friden Motorized Tape Punch Model 2 Service Manual for disassembly and assembly of the mechanical punch. Periodic lubrication of the mechanical punch should be performed as shown. (Table 30.)

Table 30.

Mechanical Punch Lubrication

Component	Lubricant	Lubricant Interval
Clutch mechanism	Retinax "T" (Shell)	100 hours
Other	Tellus No. 27 (Shell)	200 hours

NOTE

Apply lubricant by hand and wipe off excess, leaving only a light film.

DISASSEMBLY AND ASSEMBLY

The components of the tape punch assembly are shown. (See figure 44.) The procedures in this paragraph explain component removal. Component replacement is essentially the same as removal except in reverse order.

Mechanical Punch Unit

To disassemble the mechanical punch unit, disconnect the tape punch control chassis cable from the desk and from the knockout panel. Remove six panel mounting screws and remove the mechanical punch.

Control Chassis

To disassemble the control chassis, disconnect cables P2 and P3 at the control chassis. Disconnect cable P1 at the power supply. Release the chassis snap slides and remove the control chassis from the desk. Once the chassis is removed, release the snap lock on the board retainer and remove the driver and control network boards. (See figure 54.)