IBM Field Engineering

Maintenance Manual

1620 Data Processing System, Model 1

227-5500-3

IBM Field Engineering Maintenance Manual

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1620 Data Processing System, Model 1

This edition, Form 227-5500-3 is a major revision of Form 227-5500-2. This manual is written for E, F, G, and H level machines (1620-1, Serial 10701 and above) and incorporates Customer Engineering Maintenance Manual Supplement, Form 227-5620-1.

All maintenance material specifically for the IBM 1621 Paper Tape Unit has been removed from this manual and placed in a separate 1621 (Reader and Punch) CE Maintenance Manual (see Bibliography).

Service aids and information contained in 1620 CEMs through 174 is included.

Copies of this and other IBM publications can be obtained through IBM Branch Offices. Comments concerning the contents of this publication may be addressed to: IBM, Product Publications Department, San Jose, Calif. 95114

CONTENTS

SAFETY

Personal safety cannot be overemphasized. To ensure your own safety, make it an everyday practice to follow safety precautions at all times. Become familiar with and use the safety practices outlined in IBM Forms 124-0002 and MO 4-8401, pocket-size cards issued to all Customer Engineers.

Caution notices apply to personal safety.

Warning notices apply when the machine (system) or equipment (scopes etc.) may be damaged.

CAUTION: Potential difference within the electronic gates, printed cards, and display back panel is -48 v DC to +30 v DC. Do not remove or replace circuit cards when DC power is on.

When a DC failure is sensed, a DC off sequence is initiated, but power remains on at the convenience outlets.

The power supplies are heavy and should be removed with care. Remove line cord from power receptacle and wait at least 15 seconds after power is turned off before attempting any repair or adjustment within any power supply.

Even though the voltage range on this machine is low, extreme caution should be exercised in the power supply area. Twenty amperes flow in some sections of the power supply. Each heat sink is at an electrical potential. Do not short heat sinks to each other or to the machine frame.

CONTENTS

1.1 INSTALLATION INSTRUCTIONS

Installation problems and time can be measurably reduced by carefully reading and adhering to the following instructions.

WARNING: Verify that customer's power outlet has the correct potentials at each terminal of the outlet. Be especially certain that the ground terminal is grounded.

Refer to power supply voltage change in Section 3 (3.8.2).

1. Remove packaging and inspect each unit for physical damage. Inventory shipping group parts and supplies against the check list in Section 6. Position the 1620 in its proper location in the room. If it is necessary to provide physical assistance be sure that there are enough customer personnel available to handle the equipment. It is recommended that johnson bars or similar equipment be used. Necessary service clearances are listed in the Physical Physical Planning Installation Manual. Remove casters after machine is located. Casters are installed to facilitate handling during shipment. Return casters to San Jose in carton provided.
2. Remove 1620 right rear table top. Four screws hold it on; two on the right end of the machine, and two available after opening gates A and B. Remove brackets on top of 1620 front legs. The reader table can now be installed without binds. Remove typewriter shipping braces. Two nylon rods are clamped to the front guide rail on each side of the typewriter carriage. Two rubber inserts are on each side of the type basket. When installing typewriter ribbon spools make certain that teeth on top of spools point toward rear of machine.
3. Install 1620 reader table (nine screws). Open display panel to allow access room to tighten four screws at back of reader table. Place the typewriter on table and connect electric cable. Install typewriter carriage guard and rubber trim. Install right rear table top.
4. Install the left table trim on 1620 console. Adjust the trim shimming with card stock if necessary, to level the trim with the front of console table.
5. Remove tape securing console display panel and mechanical parts.
6. Check all X, W, and Shoe connectors for dual contact terminals which may have backed out.
7. Check SMS card seating by pressing in on the cover slats. On machines with metal covers, remove cover and visually check for SMS card seating.
8. Check for tightness of console lamp terminal connectors.
9. Check for tightness of all screw type terminals including all ground connections.
10. Turn off 1620 mainline switch. Verify that the power supplies are wired for the correct AC input voltage. Refer to power supply voltage change in Section 3 (3.8.2). Check the power supply terminals for tightness.
11. Check for shorts between each power supply and ground. With ohmmeter set on lowest scale, test between ground and each supply terminal to see that a direct short does not exist (normal readings down to about 2 ohms are possible). Make this test at the voltage distribution terminal blocks located on the bottom of the A and B gates and on top of the D gate (01.00.15.1, 01.00.17.1, 01.00.19.1).
12. Check for shorts between power supplies. Test between voltage terminals to see that a direct short does not exist (normal

readings down to about 5 ohms are possible). Make this test at the same voltage distribution terminal blocks specified in item 11 previous.

13. Plug in the 1620 power cord. Check voltage at input terminals.
14. Check DC voltages (with scope or meter) at power supplies and at gate to see that they are within specifications as given on the power supply voltage chart (Figure 3-4).
15. Check emergency off switch operation as follows:
    a. Pull emergency off switch.
    b. Turn on 1620 mainline switch.
    c. Turn on console power-on switch; nothing should happen.
    d. Turn off 1620 mainline and console power-on switches, then reset emergency off switch.
16. Turn on 1620 mainline switch. Press RESET to turn off thermal light. Turn on console power-on switch. MACHINE READY will be delayed for from 1-1/2 minutes when system is warm to about 8 minutes when the system is cold. The ready light will not turn on until core storage (memory) reaches operating temperature.
17. Verify that all cooling fans are circulating air properly. On the 1620 there are fans in gates A, B, C, D, in each of the four power supply boxes, and one inside the front plenum on the memory unit. Air should circulate from bottom to top in the gates, and power supply boxes.
18. If the system includes an IBM 1311 Disk Storage Drive, attach the RC filter to the bottom of the 1620 frame as shown in Figure 1-1.
19. Perform 1620 console checkout, error free once, at normal machine voltages.

1.2 ADDITIONAL FEATURES INSTALLATION

Each of the additional units shipped from the factory is to be installed as described in its respective reference manual (see Bibliography in Section 6). Figure 1-2 shows cable requirements for a maximum 1620 System configuration. Figure 1-3 shows cable requirements for each unit added to the basic 1620 Central Processing Unit. Figure 1-4 lists the connectors used between the 1620 and the machine being attached. Figure 1-5 shows the five input points (routing) of external 1620 System cables. Intermachine signal and power cables should be routed and clamped as shown in Figures 1-6 through 1-9.

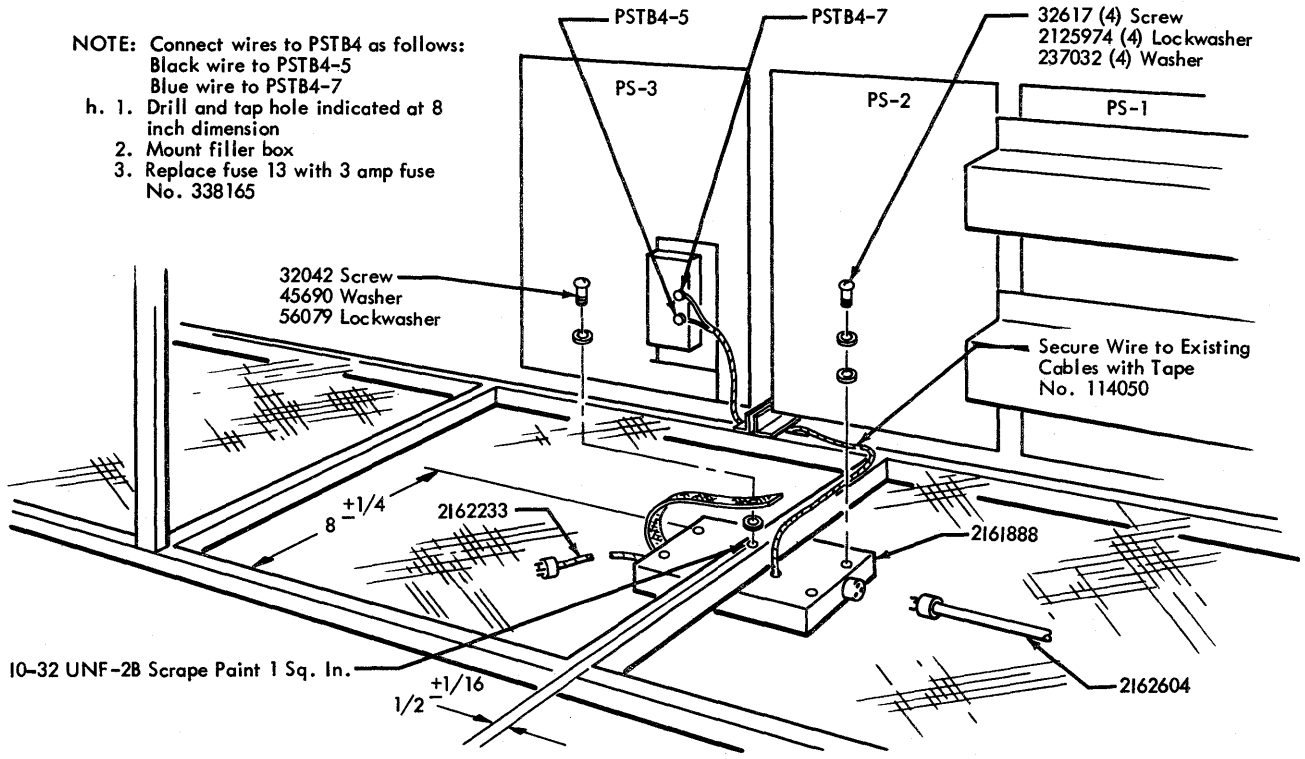


Figure 1-1. Filter Box and Cables for 1311 Power

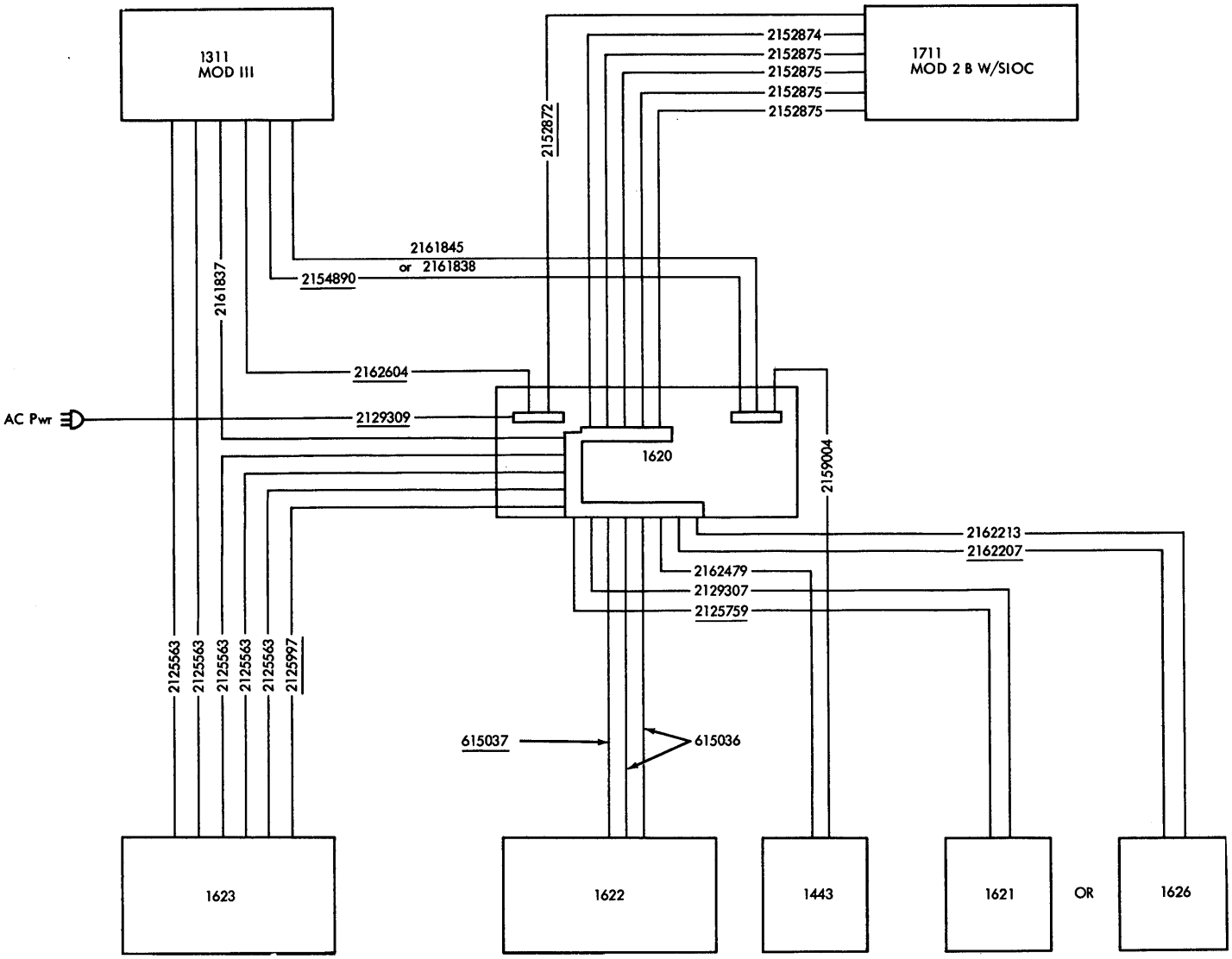


Figure 1-2. Intermachine Cables for Maximum 1620 System Configuration

Installation Instructions are included with the Shipping Bill of Material for each feature shipped from the factory. These instructions provide detailed procedures as required to install features in the field.

1.3 MACHINE SPECIFICATIONS

Detailed machine specifications related to power requirements, dimensions, and environmental conditions may be found in the IBM 1620 Physical Planning Manual (see Bibliography in Section 6). Any unique problems involving machine location, air conditioning, or power requirements should be referred to District Physical Planning through the IBM Sales Representative.

1.4 SIGNIFICANT DESIGN AND FUNCTIONAL CHANGES

1.4.1 E Suffix 1620 (Serial 10701 through 11549)

The 1620 System advanced to E-level with machine serial 10701. This level advance incorporated features wiring for the 1622 attachment. Changes initiated with E Suffix machines include the following:

1. Input and Output Translator circuits were completely redesigned for adaptation of the 1622 Card Read Punch.
2. The philosophy of C Bit Correction was changed so that C Bit Correction occurs as the data leaves MBR-O and MBR-E and before it reaches MDR.

1620 and Cable P/N	1622	1623	1621	1711	1311	1626	1443
615036	2*						
615037	1*						
2125563		Note 1 4			Note 1		
2125759			1				
2125997		1					
2129307			1				
2152872				1			
2152874				1			
2152875				4			
2154890					1		
2161837					1		
2161838					Note 2 1		
2161845					Note 2 1		
2162207						1	
2162213						1	
2162233					1		
2162604					1		
2159004							1
2162479							1

Note 1. If a 1623 and 1311 are both on the system then a total of 5 P/N 2125563 are required.

Note 2. P/N 2161838 for 1620-11550 and above P/N 2161845 for 1620-11549 and below.

* These 1620-1622 cables are shipped as a part of the 1620 attachment feature. They are not part of the 1622 Shipping Group.

Figure 1-3. Cable Requirements

3. A replaceable "Wire Wrapped" core storage unit was introduced. Previous core storage units were wired as an integral part of the A2 panel.
4. The triggers listed below were eliminated. The functions previously performed by these triggers (latches) are accomplished through other means.
   a. 00080
   b. Digit (see item 6 following)
   c. E Cycle
   d. P-3 Interlock
   e. Go
   f. Reader Instant Stop
   g. VRC Control
   h. Trigger 20
5. A single cycle trigger was added.
6. The functions of the Digit trigger were combined with those of the Record Mark trigger. The new trigger was named Digit/RM trigger.
7. The 00099/19999 trigger was renamed MEM O'FLOW trigger. The 00099 function was eliminated but the 19999 function remained the same.
8. The Increment/Decrement trigger was renamed to Decrement trigger to reduce confusion regarding its status.
9. The Sense and Branch Register was eliminated and its I/O Device designation and Branching functions were combined with the Digit Register. The new designation became the Digit/Branch Register.
10. The Multiplier Register function was expanded to include the storing of a quotient digit (formerly stored in Sense and Branch Register) developed on a divide operation and its name was changed to Multiplier/Quotient Register.
11. System diagrams were changed from hand drawn sheets to Automated Logic Design (ALD) pages.
12. New SMS Card types were introduced. These new card types included the CAU and DFD type AND latches.
13. Former intergate Y connectors were redesignated as W connectors.
14. Former upper T connectors were redesignated as Y connectors.
15. Former lower T connectors were redesignated as Z connectors.

1.4.2 G Suffix 1620 (Serial 11550 through 11659)

The 1620 System advanced to G level with machine serial 11550. This level advance incorporated the features wiring for the 1311 and the 1710 Features II attachment. Changes initiated with G Suffix machines include the following:

1. Three new indicator lamps for use with 1311 Disk Storage Drive units are located just to the left of the parity indicator lamps for MAR and MBR. These new lamps are the Address Check, Wrong Length Record/Read Back Check, and Cylinder Overflow.
2. Lamps were also added to the Instruction and Execute Cycle panel for file load cycles. These new lamps are the E50 Hundreds, E51 Disk, E52 OR-1, E53 PR-3, E54 OR-2, and E55 Units.
3. Two new lamps designated Interrupt Mode and Mask were added to the lower left Control Gage panel and are for the 1710 feature.
4. The > 50 trigger was replaced by an AND circuit and the > 50 lamp was removed.
5. The Punch-No-Feed light is now labeled Punch/Disk or Write/Disk Interlock and is turned on if the 1311 or the 1622 is selected but is not ready.

Cable Part Number	From		To	
	Mach Type	Connector(s)	Mach Type	Connector(s)
615036	1620	SCB	1622	AYA
615036	1620	SCC	1622	AZA
615037	1620	PSTB-4,PSTB-5,EC 301, EC 302	1622	AC Term, Gnds
2125563	1620	AXD (Note 1)	1623	AXF (Note 1)
2125563	1620	AXG	1623	AXG
2125563	1620	AXH	1623	AXH
2125563	1620	AXJ	1623	AXJ
2125563	1623	AXE (Note 2)	1311	AXE
2125563	1623	AXF	1311	AXG
2125759	1620	PSTB-4,PSTB-5, Gnds	1621	TB-2, TB-3, Gnds
2125997	1620	PSTB-4,PSTB-5,EC 301, EC 302	1623	PSTB-4, Gnds
2129307	1620	SCA	1621	SCA
2129309		AC Power Source	1620	
2152872	1620	PSTB-2, Gnds	1711	PSTB-4, Gnds
2152874	1620	DWA	1711	BXE
2152875	1620	BVC	1711	BWL
2152875	1620	BVF	1711	BXF
2152875	1620	BVG	1711	BXG
2152875	1620	BVH	1711	BXD
2154890	1620	PC4	1311	TS6,K1, Gnd
2161837	1620	AXD,AXJ,BVK (Note 5)	1311	AXD,AXE,AXF (Note 5)
2161838	1620G	AVJ, BVB,BVJ (Note 4)	1311	AXA,AXB,AXC
2161845	1620	D2,D3 (Note 3)	1311	AXA,AXB,AXC
2162207	1620	PSTB-4,PSTB-5, Gnds	1626	TB-1,TB-2, Gnds
2162213	1620	SCA	1626	SCA
2162233	1620	Filter Box		
2162604	1620	Filter Box	1311	CB, Gnd
2159004	1620	PC 5	1443	P5
2162479	1620	DWT01,DWT02	1443	E1F09,E1F10

Note 1. 1620 connector AXD to 1623 connector AXF is for systems without a 1311.

Note 2. 1623 connector FVA is used for 1623-10525 and lower; 1623 connector AXE is used for 1623-10526 and above.

Note 3. Cable P/N 2161838 is for 1620-11550 and above.

Note 4. Cable P/N 2161845 is for 1620-11549 and below.

Note 5. 1620 connector AXJ and 1311 connector AXE are tied back if a 1623 is also in the system

Figure 1-4. Intermachine Cable Connector Designations

6. The function of the Reset and Release Control keys was changed to initiate a Power-Off-Reset when both are pressed simultaneously.
7. SMS cards associated with core storage were rearranged in the A2 panel to reduce the effects of noise.
8. Indirect Addressing trigger 46 was eliminated and its function is now accomplished by holding trigger 49 ON for two cycles.
9. The A/B binary trigger was replaced by an OR latch and an AND latch for a more stable circuit.
10. A number of new SMS Multiple Use Package (MUP) card types were introduced in the

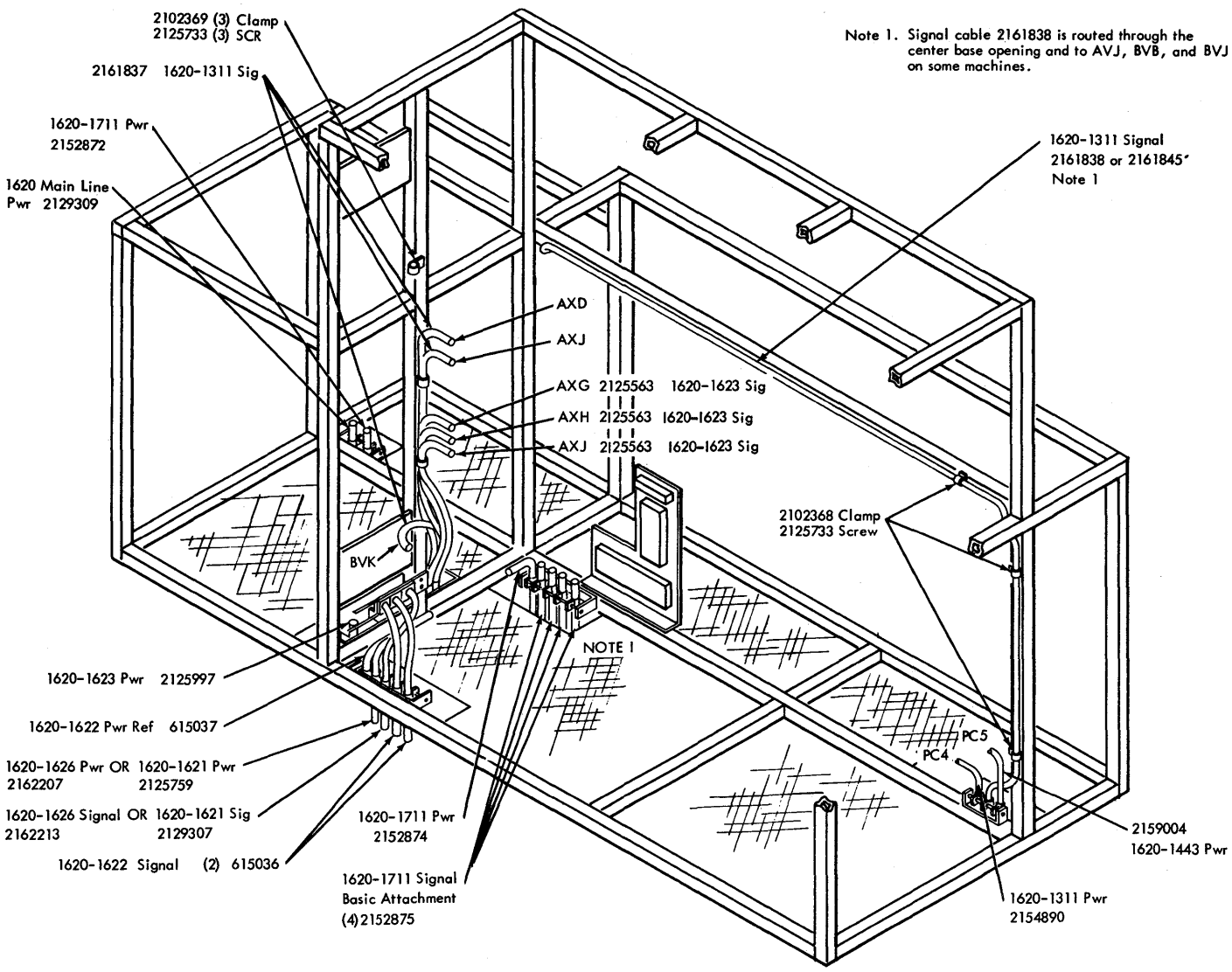


Figure 1-5. External Cable Entry Points, 1620

G-level machine. These MUP cards consist of circuits from former card types rearranged with interconnecting input and output lines jumpered directly on the card. This means that System Diagrams may show MUP card circuit blocks connected together with lines that do not have pin identification.

1.4.3 H Suffix 1620 (Serial 11660 and above)

The 1620 System advanced to H level with machine serial 11660. This level advance incorporated the features wiring for the IBM 1443 Printer, the adapter for the 1711 C suffix, and IR-4 MARS register. The muffin fans in the A and B gates were replaced with squirrel cage type blowers.

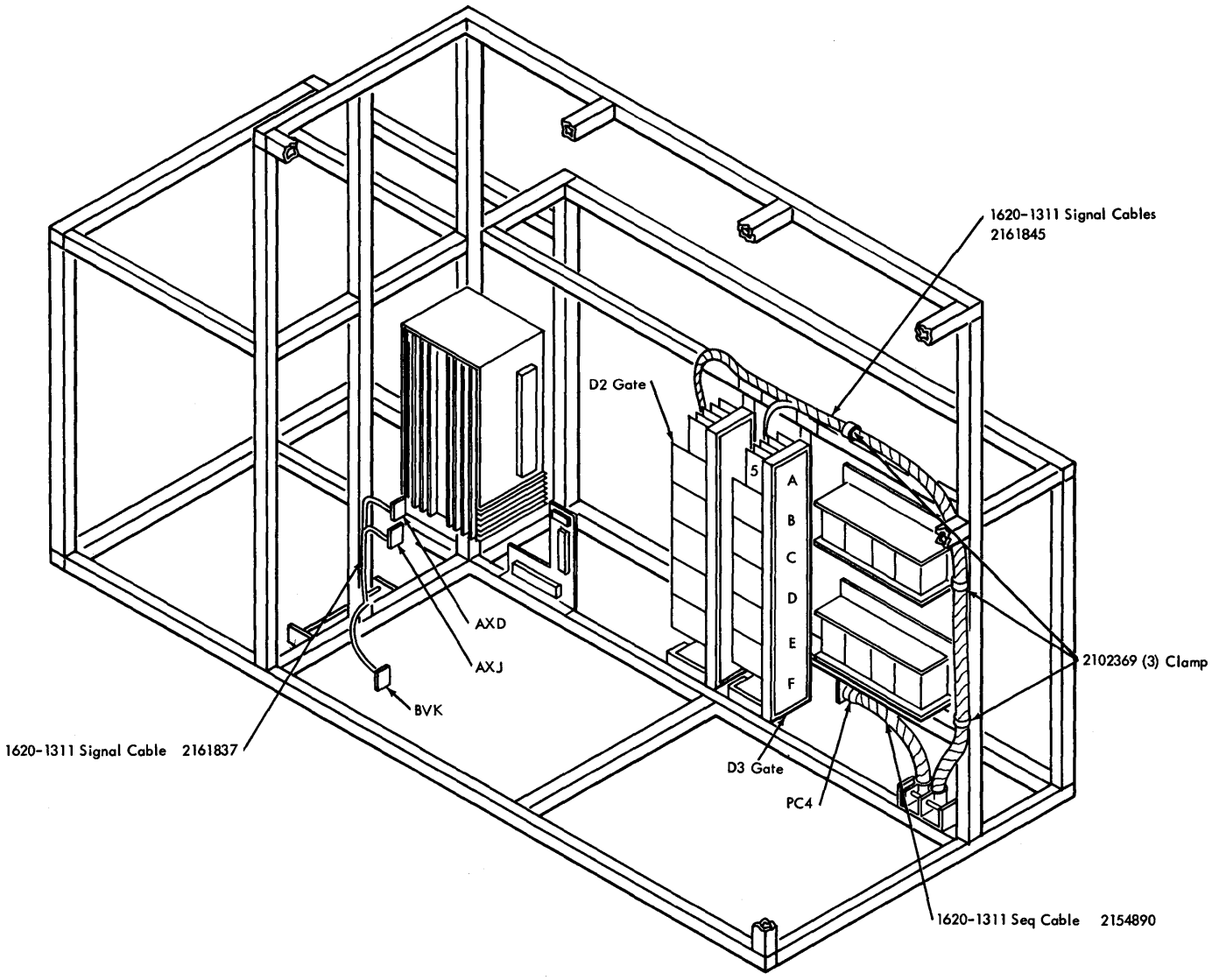


Figure 1-6. Cable Routing, 1620 (Serial 11549 and below) to 1311

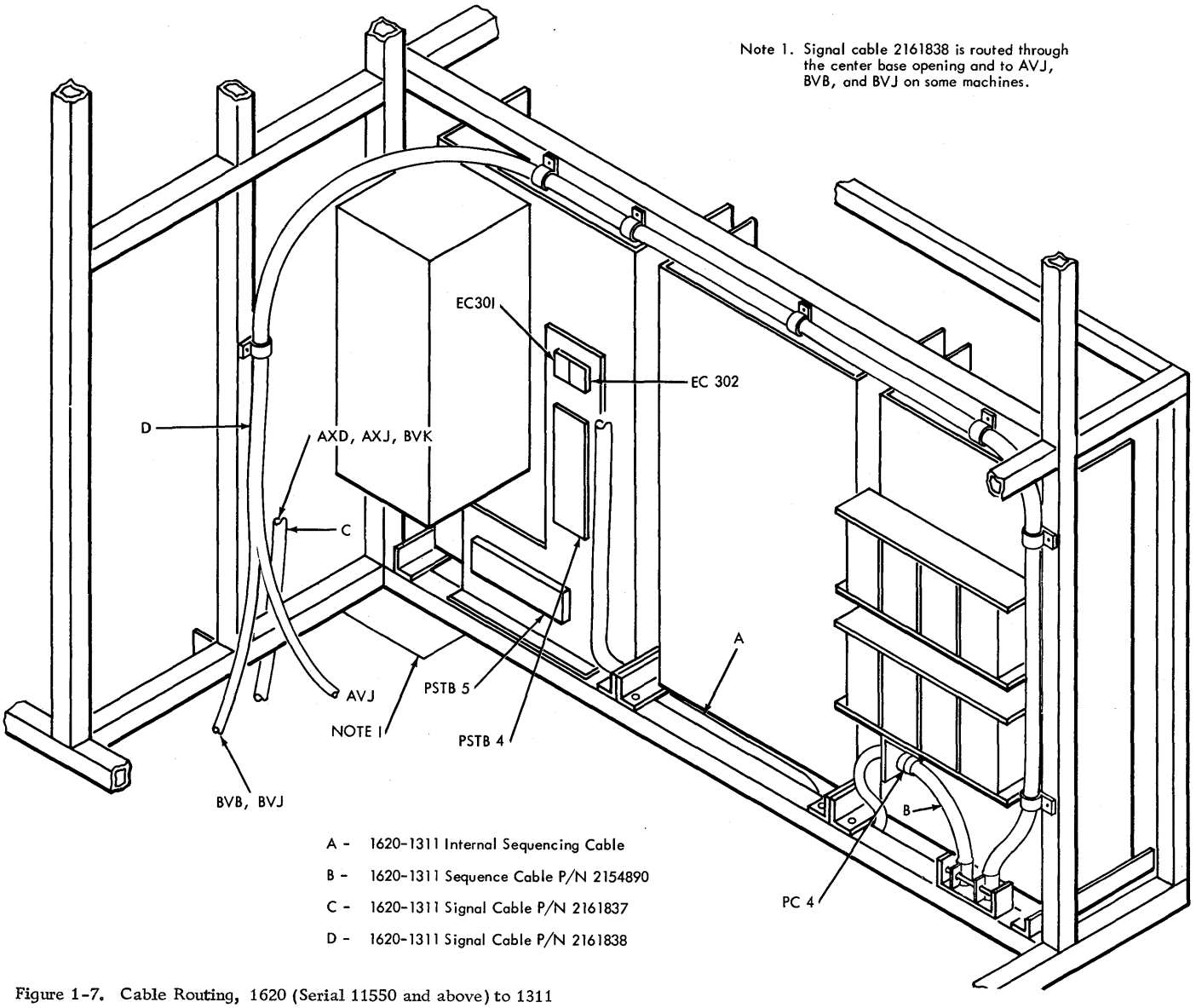


Figure 1-7. Cable Routing, 1620 (Serial 11550 and above) to 1311

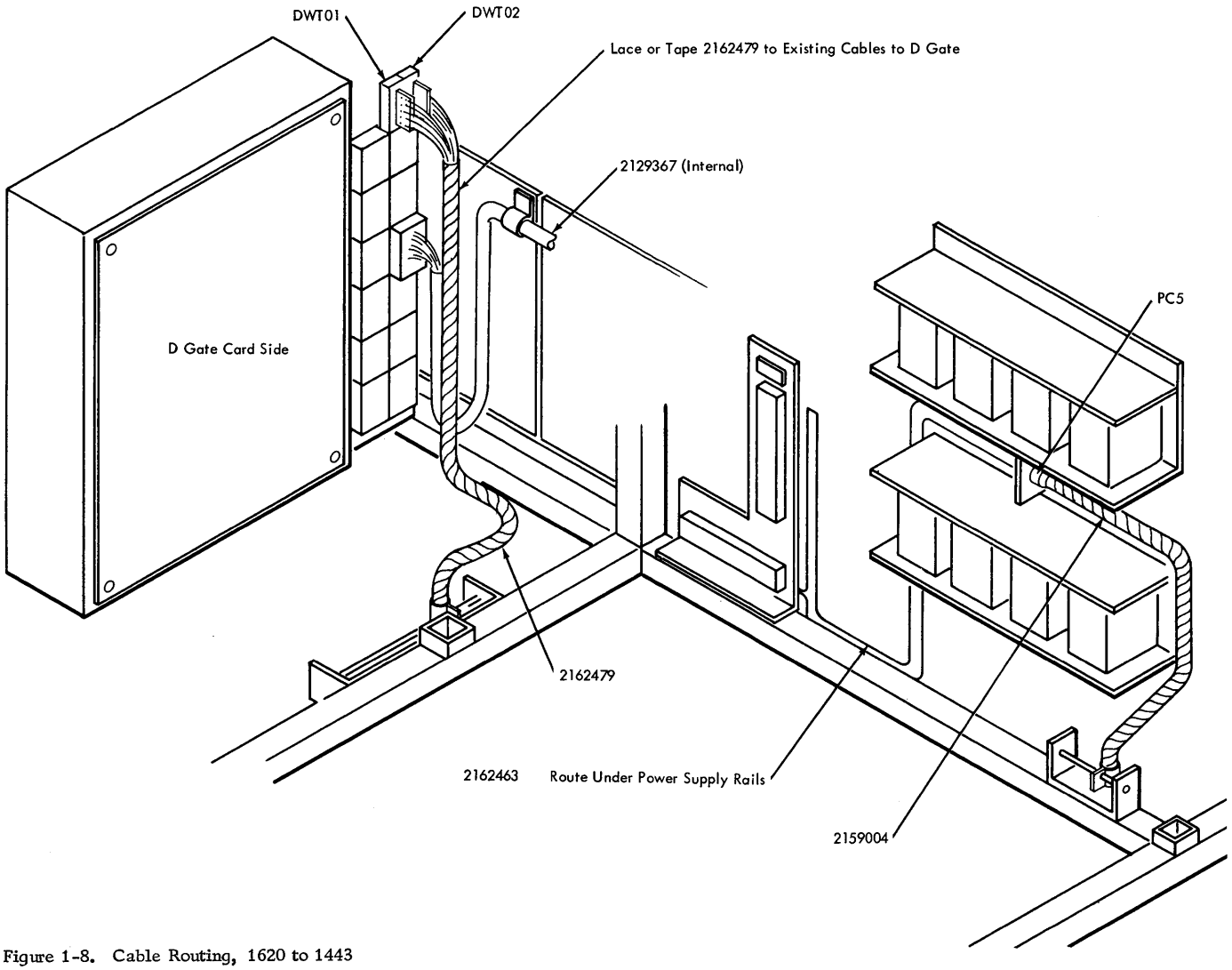


Figure 1-8. Cable Routing, 1620 to 1443

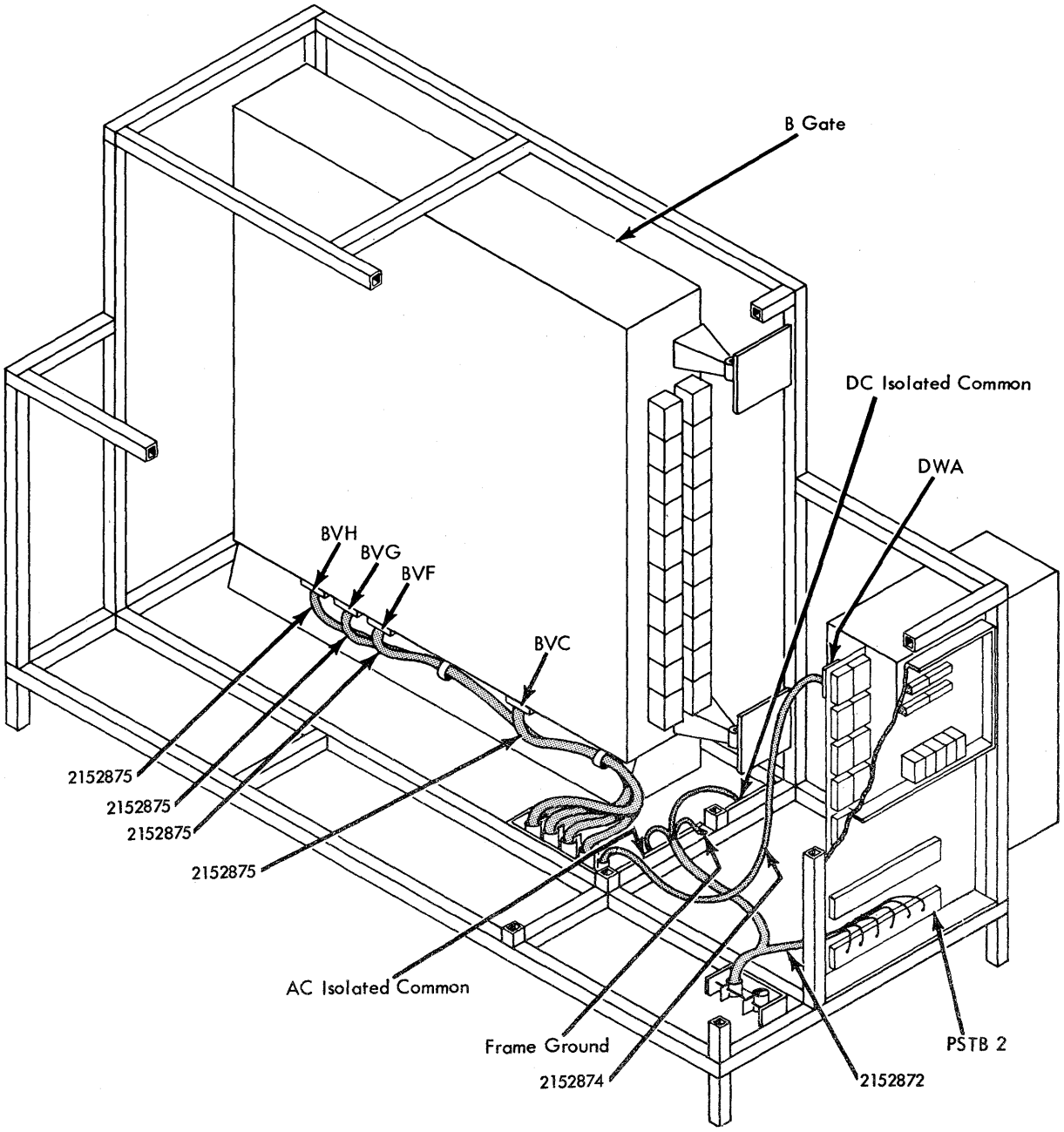


Figure 1-9. Cable Routing, 1620 to 1711

CONTENTS

P. M. ROUTINE

CODE U R	LOCATION OPERATION	FREQ.	LUBE / CLEAN
			Materials Required: IBM Typewriter Oil P/N 460052 IBM #17 Grease P/N 450556 IBM Cleaning Fluid P/N 450608 IBM Oil Brush P/N 9900014
0	Filters	1	Check for dirty filters. Replace as required. Check that the cooling fans are operating.
			Clean out all dust and dirt. Clean platen, paper bail rolls, feed rolls, type bars and all visible metal parts. Lubrication - Apply IBM Typewriter Oil P/N 460052 on the following parts, except as noted. All rubber parts must be kept free of lubricants. CARRIAGE: Platen bearings, detent arm and roller. REAR RAIL MECHANISM: Escapement pawl, trip lever and linkage. RIGHT SIDE OF MACHINE: Shift pusher and lever assembly linkage. FRONT OF MACHINE: Pivots of type bars, cam levers; wipe their fulcrum wires with a cloth moistened with IBM #6. LEFT SIDE OF MACHINE: Fill motor oil wells with oil IBM #6. BOTTOM OF MACHINE: Ribbon lift mechanism and linkage. Clean power roll and cams with IBM Cleaning Fluid P/N 450608. Replace power roll when worn. Apply IBM #17 to ribbon lift bail, pivot screws and ribbon lift bail vane.
1	Typewriter	3	OBSERVE MOTOR AND DRIVE: Coasts freely when power is turned off. 1/4" belt deflection. Power roll end play (.002" to .010"). CARRIAGE/PINWHEEL PLATEN: Move freely with no slop. TYPEBARS: (Do not change cam lever knock-off adjustments to improve impression.) Check commonly used typebars (zero, numeric, etc.) for binds, loose type slugs and hairline crack at hole below type slug. CARRIAGE RETURN AND TAB: Manually clear tabs and set new tabs at approximately 3, 60 and full carriage. Tab check lever two spaces to the right of tab stop on these tabs. Tab to the previous stops and carriage return. Check that carriage return speed is approximately the same as tab speed. Check that impact is reduced before striking left margin. Depress carriage return and backspace keys simultaneously; carriage should not lock up. RIBBON MECHANISM: By manually tripping ribbon reverse bails, make sure that ribbon reverses easily from either side. Check for missing or broken spring on the left end of the ribbon lift bail vane. SHIFT: Shift lock should hold basket securely in the up and down shift position. MAGNET UNIT: Tripping armatures by hand, make sure that all armatures cause a smooth typing speed and scan typed output for proper alignment and impression. Armature to stop bail clearance; check ends and midpoint for .070". Check cam to power roll clearance for a light drag on 2 IBM cards. INTERLOCK CONTACTS: Contacts should be clean and should close with adequate rise and tension. This includes: Ribbon Lift — 1 & 2 — (Selector Common) End of Line
	Marginal Tests		Run DT CU01 and CU02 at ± 15% on the + 12M supply. Correct all troubles indicated by these tests.

P. M. ROUTINE (Cont.)

CODE U R	LOCATION OPERATION	FREQ.	LUBE / CLEAN
2	CB's	6	Lubricate cams, rollers, pivots. Visually check for proper air gap and contact burning.
	Misc.		Check for loose D gate voltage jumpers. Inspect for loose voltage jumpers to panel from laminar bus strip on Gates A and B. Check ground connections on laminar bus terminal block, AC-DC isolated ground. Check line cord for safe condition and proper grounding.
3	Typewriter	12	Lubrication CARRIAGE: Paper release mechanism. Feed roll pivots and pressure levers. REAR RAIL MECHANISM: Carriage rails - left side, wipe rails clean. Tab lever linkage. Carriage return tab interlock pivot. Air cylinder bell crank. Intermediate bell cranks and linkage. Carriage rails (right side), carriage return pulley. RIGHT SIDE OF MACHINE: Righthand ribbon feed mechanism and linkage including link holes in bail end plate. Clutch lever and latch pivot. WARNING - avoid excess oil, keep lubricants off clutch disc. FRONT OF MACHINE: Link holes in type bars and cam levers. Functional cam release levers and linkage. LEFT SIDE OF MACHINE: Lefthand ribbon feed mechanism and linkages including link holes in bail end plate. Power roll idler and intermediate drive pulleys. Apply IBM #17 to the following parts: RIGHT SIDE OF MACHINE: Latching surface of clutch lever. Pivot screw at top of clutch operating arm. OBSERVE TYPEBARS: Check numeric letter cam levers for wear at pibot holes and type bar link holes. Replace "zero" typebar (pos 31) cam lever, typebar link every second Annual Maintenance, or when worn. SOLENOIDS: Remove and clean space tab and carriage return solenoid plungers. With plungers bottomed, key lever should clear bottom of slot by up to 1/32" as cam is tripped. Solenoid plunger centered in solenoid well. With power off cam release lever of a tripped functional cam should rest midway on cam lug. Check the following items for replacement: Power roll - if replaced, check impression and compromise impression versus selector common contact timing. Clutch disc - reinstall with operating clearance of .005 to .015".
	Relays		Check for burned points, air gap and rise.
	Power Supplies		Check cables and wiring for loose terminals and overheated insulation.
2	Blower Motors, Gate (Squirrel Cage)		Check that motors coast freely when power is turned off. Lubricate with IBM #6 oil (Two bearings each motor).

1620-1

2.1 APPROACH TO SCHEDULED MAINTENANCE

The prime objective of any maintenance activity is to provide maximum machine availability to the customer. Every scheduled maintenance operation should assist in realizing this objective. Unless a scheduled maintenance operation reduces machine downtime, it is unnecessary.

Do not adjust or disassemble a unit that is working properly, even if tolerances vary from specification.

2.1.1 Visual Inspection

Visual inspection is the first step in every scheduled maintenance operation. Always look for corrosion, dirt, wear, cracks, binds, burnt contacts, loose electrical connections, and loose mechanical parts. Alertness in noticing these items may save later machine downtime.

2.1.2 Electronic Circuits

Diagnostic programs, marginal checking, and pulse checking are the three basic tools used in scheduled maintenance of electronic circuits. All of these are effective in locating potential and intermittent troubles. These items are also excellent troubleshooting tools. When using them for scheduled maintenance, use them only as directed on the scheduled maintenance chart.

Do not adjust pulses unless the condition of the machine warrants it.

2.1.3 Mechanical Units

The three basic scheduled maintenance steps performed on every mechanical of electromechanical machine are clean, lubricate, and inspect. Remember, do not do more than recommended scheduled maintenance on equipment that is operating satisfactorily.

2.2 MARGINAL CHECKING

A pulse, as it travels through successive stages, may experience a decrease or increase in width, which if serious enough, will cause incomplete switching or improper timing.

Marginal checking is a preventive maintenance technique used to detect the marginal operation of circuits within a machine system.

By varying the +12M the CE can inspect a machine system and replace circuit assemblies which are approaching a failure condition.

This technique will reduce downtime of the system during customer operation.

Running the diagnostic test (CU 01) with the +12M reduced -15% (-1.8v) increases transition delay time in the transistors. If transition time has deteriorated, this test can be used to show the area involved. Transition delays are cumulative. The most critical areas are where a number of logic blocks are in series, for example, the incr/decr switch.

The Diagnostic Test Manual gives test routines with associated flow charts for aiding the Customer Engineer in locating trouble. The tests can be used to check machine performance following Scheduled Maintenance.

2.2.1 Marginal Check Unit

The marginal check unit consists of a special power supply with a variable output voltage. This unit is placed in series with the +12 v supply and permits the Customer Engineer to change the +12 v a maximum of ± 3 volts.

WARNING: The MC voltage must be at zero before any MC switches are transferred. Adjust the MC rheostat for a zero percent meter reading.

Five switches are provided (Figure 4-17) to allow control of the voltage by gate (A1, B2, etc.). Any one or two may be used at a time. In the normal (down) position the 12M supply is fed directly from + 12 v supply. With the switches transferred (up) the marginal check unit is in series with the + 12 v supply and the MC rheostat can be used to vary the 12M supply to the gate selected by the switch or switches.

WARNING: It is possible to overload the marginal check power supply. To prevent overloading the MC supply, no more than two switches should be up at any one time.

2.3 TYPEWRITER INSPECTION – LUBRICATION CHECKLIST

The following checklist has been designed to assist in correcting the more prevalent malfunctions, according to 1620 field experience. It should be followed rigorously, but special care should be taken against over-lubrication and over-handling of parts. Details of adjustment and repair are left to the B1 Typewriter CE Maintenance Manual (see Bibliography).

2.3.1 Frequency of Service

1. "Quarterly" Maintenance: Every 3 months.
2. Power Roll replacement: Whenever scheduled maintenance reveals excessive wear, in any position.
3. "Annual" Maintenance: In addition to "Quarterly" Maintenance, every fourth servicing.

2.3.2 Materials Required

1. IBM typewriter oil P/N 460052.
2. IBM cleaning fluid P/N 450608.
3. IBM #17 grease P/N 450556.

A small oil brush P/N 9900014 is helpful in applying lubricants and helps to prevent "over lubrication."

2.3.3 Quarterly Maintenance

Cleaning

1. Remove front, rear, and bottom covers, platen and paper deflector.
2. Clean out all dust and dirt.
3. Clean platen, paper bail rolls, feed rolls, type bars and all visible metal parts.

Lubrication

Apply IBM typewriter oil P/N 460052 on the following parts, except as noted. All rubber parts must be kept free of lubricants.

WARNING: Do not use IBM No. 6 in place of the specified typewriter oil (P/N 460052). IBM No. 6 migrates away from pivot and link holes leaving them dry.

1. Carriage
   a. Platen bearings
   b. Detent arm and roller
2. Rear Rail Mechanism
   a. Escapement pawl, trip lever and linkage
3. Right side of machine
   a. Shift pusher and level assembly linkage.
4. Front of Machine:
   a. Pivots of type bars, cam levers; wipe their fulcrum wires with a cloth moistened with typewriter oil.
5. Left Side of Machine:
   a. Fill motor oil wells with typewriter oil.
6. Bottom of Machine:
   a. Ribbon lift mechanism and linkage.
   b. Clean power roll and cams with IBM cleaning fluid P/N 450608. Replace power roll when worn.
   c. Apply IBM #17 to ribbon lift bail, pivot screws, and ribbon lift bail vane.

Inspection Procedure

1. Motor and Drive:
   a. Coasts freely when power is turned off.
   b. 1/4" belt deflection.
   c. Power roll end play (. 002" to . 010").
2. Carriage/Pinwheel Platen move freely with no slop.
3. Typebars. Do not change cam level knock-off adjustments to improve impression. If trouble is suspected, contact an ET CE and review the problem with him.
   a. Check commonly used typebars (zero, numeric, etc.) for binds, loose type slugs and hairline crack at hole below type slug.
4. Carriage Return and Tab:
   a. Move margin stops to maximum right and left. Manually clear tabs and set new tabs at approximately 3, 60, and full carriage.
   b. Tab to each new stop position. Tab check lever tip should be two spaces to the right of tab stop on these tabs.
   c. Clear tabs at 3 and 60. Cause typewriter to alternately tab and carriage return. Check that carriage return speed and tab speed are approximately equal.
   d. Check that impact is reduced before striking left margin.
   e. Press carriage return and backspace keys simultaneously and repeatedly in quick succession (6 to 10 times); carriage should not lock up.
5. Ribbon Mechanism
   a. By manually tripping ribbon reverse bails, make sure that ribbon reverses easily from either side.
   b. Check for missing or broken spring on the left end of the ribbon lift bail vane.
6. Shift
   a. Shift lock should hold basket securely in the up or down shift position.
7. Magnet Unit
   a. Tripping armatures by hand, make sure that all armatures cause a smooth typing speed and scan typed output for proper alignment and impression.
   b. Armature to stop bail clearance; check ends and midpoint for . 070".
   c. Check cam to power roll clearance for a light drag on 2 IBM cards.
8. Interlock Contacts
   a. Contacts should be clean and should close with adequate rise and tension. This includes:
      Ribbon Lift - 1 & 2 - (Selector Common)
      Space Cam - 1 & 2
      Shift
      End of Line
      Tab Interlock
      CR Interlock

2. 3. 4 Yearly Maintenance

The following items should be added to the Quarterly Maintenance check list every fourth servicing.

Lubrication

Apply typewriter oil (P/N 460052) to the following parts:

1. Carriage
   a. Paper release mechanism.
   b. Feed roll pivots and pressure levers.
2. Rear Rail Mechanism
   a. Carriage rails - left side, wipe rails clean.
   b. Tab lever linkage.
   c. Carriage return tab interlock pivot.
   d. Air cylinder bell crank.
   e. Intermediate bell cranks and linkage.
   f. Carriage rails (right side), carriage return pulley.
3. Right side of Machine:
   a. Right hand ribbon feed mechanism and linkage including link holes in bail and plate.
   b. Clutch lever and latch pivot.

WARNING: Avoid excess oil, keep lubricants off clutch disk.

4. Front of Machine
   a. Link holes in type bars and cam levers.
   b. Functional cam release levers and linkage.
5. Left Side of Machine
   a. Left hand ribbon feed mechanism and linkages including link holes in bail endplate.

b. Power roll idler and intermediate drive pulleys.

6. Right Side of Machine
   Apply IBM #17 to the following parts:
   a. Latching surface of clutch lever.
   b. Pivot screw at top of clutch operating arm.

Inspection

1. Typebars
   a. Check numeric letter cam levers for wear at pivot holes and type bar link holes. Replace "zero" typebar (pos 31) cam lever, typebar link every second Annual Maintenance, or when worn.

2. Solenoids
   a. Remove and clean space, tab, and carriage return solenoid plungers.
   b. With plungers bottomed, key lever should clear bottom of slot by up to 1/32" as cam is tripped.
   c. Solenoid plunger centered in solenoid well.
   d. With power off cam release lever of a tripped functional cam should rest midway on cam lug.

Check the Following Items for Replacement

1. Power Roll. If replaced, check impression and compromise impression versus selector common contact timing.
2. Clutch disk. Reinstall with operating clearance of .005 to .015".

CONTENTS

3.1 GENERAL TROUBLESHOOTING HINTS

When a failure occurs that stops the machine, make a note of all pertinent information. Record the contents of the memory address register (MAR), the memory buffer registers (MBR), the memory data register (MDR), the operation register, and other console and panel indicators. This check of indicators will usually reveal the operation and the particular step of the operation being performed when the error occurred.

Check power supply voltages. If any are not within specified limits, correct the condition. This may be the trouble.

Try to localize the trouble before operating the machine. It is possible that a static check, with the computer remaining in the error condition, will reveal the trouble. If it doesn't, try to reconstruct the operation (instruction) using the same addresses and data. Single cycle through the I and E cycle, observing all indicators. Analysis of indicators and data may point to the trouble.

The Diagnostic Tests and the CE test panel are effective aids in diagnosis.

3.1.1 Diagnostic Tests

The Diagnostic Test manual gives procedures for:

1. A console check out.
2. A fault detection test to check for proper functioning of operation codes and additional features and units.
3. A fault detection test to check for proper functioning of the VRC circuits (DFT CU02).

The fault detection tests are made up of a number of subroutines. Test CU01 checks an operation code for specific conditions. Each subroutine can be run as an individual test. Test CU02 causes invalid information to be presented to the various checking circuits. Each CU02 subroutine can be run as an individual test.

For a complete description of this test program see the Diagnostic Test manual.

NOTE: When running CU02, CE switch 9 should be on to allow MAR Stop Bypass. Remote start key must be used. See Section 3.1.2.

The following DFT's are designed for use with the 1620 system.

CU01 - Test of Standard Machine Computer Unit (General Op Codes) and Divide Optional Feature

Manual Pages	PN 2128301
Paper Tape	PN 2128302
Card Deck	PN 2125686

CU02 - Test of Standard Machine Error Checking Circuits

Manual Pages	PN 2128303
Paper Tape	PN 2128304
Card Deck	PN 2125687

*CU03 - Test of Indirect Address Optional Feature

Manual Pages	PN 2125574
Paper Tape	PN 2125573
Card Deck	PN 2125688

*CU04 - Test of Additional Core Storage Optional Feature

Manual Pages	PN 2125704
Paper Tape	PN 2125705
Card Deck	PN 2125689

*CU05 - Test of Special Instructions Optional Feature

Manual Pages	PN 2125637
Paper Tape	PN 2125638
Card Deck	PN 2125639

*CU06 - Test of Floating Point Optional Feature

Manual Pages	PN 2153435
Paper Tape	PN 2153437
Card Deck	PN 2153436

*IO02 - Test of 1622 Card I/O Optional Feature

Manual Pages	PN 2125684
Card Deck	PN 2125685

*IO03 - Reliability Test of 1622 Card I/O Optional Feature

Manual Pages	PN 2125682
Card Deck	PN 2125683

3.1.2 Customer Engineering Test Panel

The CE test panel (Figure 3-1) contains switches and circuits to provide a means for checking the operation of memory and associated circuits, operating the clock without a program, and repeating a specific cycle. The panel contains a light which, when on, indicates the clock is running.

CE Switches 3, 4, 5, and 6 (True/Complement Switches).

These four switches are used in various combinations. They allow a CE to perform the operations described following:

*Supplied only to systems incorporating optional feature.

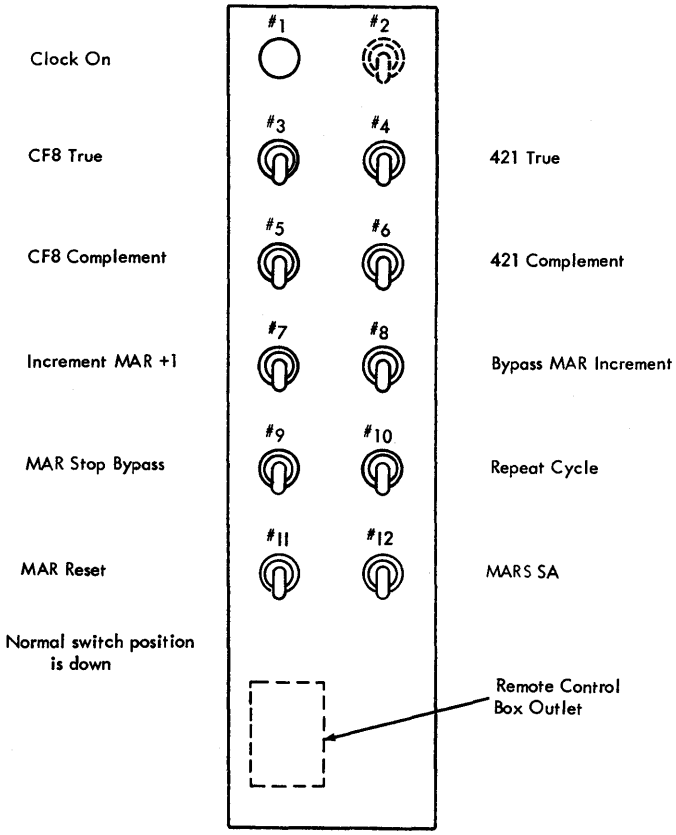


Figure 3-1. Customer Engineering Test Panel

True Operation. All four true/complement switches are set normal (down). At read time, data in memory is placed in MBR. At write time, the data in MBR is written into memory. The data in MBR controls the Z or inhibit drivers.

Complement Operation. All four true/complement switches are placed in the transferred (up) position. At read time the data in memory is placed in MBR. At write time the data in MBR is passed through the inhibit control logic. The bit complement of the data is then written in memory. For example, if C, F, and 1 bits are read from memory at read time, 8, 4, and 2 bits are written back into memory at write time. Regardless of the bit configuration read out, the complement bit configuration (all other bits) is written back at write time.

Force Operation. The true/complement switches control all data that is written into memory. They may cause data to be stored in every bit position of a memory address, called "forcing all bits." They may cause no data to be stored in each of the six positions, called "blanking memory." They may cause data to be stored in the C, F, and 8 bit positions, called "forcing flag-eights."

They may cause data to be stored in the 4, 2, and 1 bit positions, called "forcing sevens."

When forcing, data is read from memory into MBR at read time. At write time, MBR has no control over what is to be written back into memory. The true/complement switches control writing. Figure 3-2 shows the proper switch settings for "forcing" operations.

WARNING: Set CE switches 3, 4, 5, and 6 to true (down) before returning computer to customer.

CE Switch 7 (Increment MAR + 1)

Transferring this switch (01.05.50.1) suppresses the instruction cycles and allows MAR to increment by one when the clock is running. This switch is used to start the computer cycling, beginning with any address which is stored in the MARS register and which is selected by the MAR Display Selector switch. Pressing the Insert key while the MAR INC switch is ON will set the selected MARS register to zero.

CE Switch 8 (Bypass MAR Increment)

This switch (01.05.50.1), when transferred, causes MAR to remain at the address which is stored in the IR-1 register of MARS. With this switch and CE switch 7 transferred and the clock running, the 1620 will continually read and write at the same memory address, the address in IR-1.

CE Switch 9 (MAR Stop Bypass)

Transferring this switch (01.05.50.1) allows the clock to run when there is a MAR check. Transferring it also cripples the Console Start switch. With this switch transferred, the clock may be started 1) by the CE remote control box or 2) by pressing the console SIE or SCE key. Transferring CE switch 7 allows the console SIE key to substitute for the console start key.

	True		Complement	
CE Switches	3	4	5	6
Normal Operation	↓	↓	↓	↓
Force 7	↓	↓	↓	↓
Force $\bar{8}$	↓	↓	↑	↑
Force Blank	↑	↑	↓	↓
Force All Bits	↓	↓	↑	↑
*Force Comp Bits	↑	↑	↑	↑

1. Complement switches ↑ - WRITE All Bits
2. True switches ↓ - INHIBIT All Bits

*Fill core with 7s then 31 00014 00013 will alternate 7s with $\bar{8}$s. With all switches on (↑), the complement of the bit structure read out to MBR is written back into memory.

Figure 3-2. CE Switch Settings for "Forcing" Operations

This switch should be used for diagnosing trouble in the clock, MAR, MARS, and increment-decrement circuitry. It is not recommended for use in analyzing memory troubles, because a MAR error would adversely affect memory operation.

CE Switch 10 (Repeat Cycle)

This switch (01.05.50.1) when transferred prevents the A/B trigger from changing. Use it when it is desired to repeat a particular cycle during machine analysis. This switch must be transferred in the cycle preceding the one to be repeated. For example, to repeat a particular E14 cycle:

1. Single cycle to the E13 cycle known to precede it.
2. Transfer (up) CE switch 10.
3. Start clock.

NOTE: During this operation, addresses will change unless bypass MAR increment, CE switch 8, is transferred. Also certain logic conditions may have to be grounded to give a complete repeat cycle.

CE Switch 11 (MAR Reset)

Transferring this switch (01.05.50.1) blocks MAR reset to retain the MAR address.

CE Switch 12 (MARS SA)

Transferring this switch (01.05.50.1) blocks the MARS SA gate. Blocking of MAR reset and MARS sense amp gate by CE switches 11 and 12, permits the exercising of MAR and associated circuitry in one specific address without regenerating MAR errors. CE switches 11 and 12 are usually used together and in conjunction with other CE switches.

Remote Control Box

The Remote Control Box plugs into the CE test panel. It contains five control keys, Reset, Insert, Release, Single Cycle, and Start. These keys perform the same function as their counterparts on the console. The Single Cycle key causes the system to perform one 20-μsec memory cycle.

3.1.3 General Servicing Hints and Precautions

1. Do not pull Emergency OFF switch or turn off the main line switch when power is on unless there is an emergency.
2. When the 1620 is in a Power Off status, 24 v AC is present on card gate and memory thermal switches.
3. Turn off power whenever a thyratron card, memory card (any card in gate A2), or a clock circuit card is removed or replaced.
4. Never turn on power with a memory card removed.

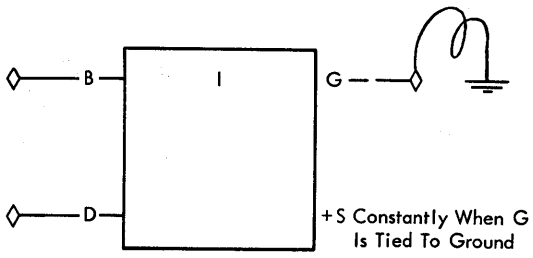


Figure 3-3. Holding an Inverter Output at +S

5. Turn off power whenever wrapping or unwrapping wire, or continuity testing.
6. An inverter output may be kept at + S, regardless of its input, by grounding the output. See Figure 3-3.
7. Any ± S signal level may be grounded during trouble analysis unless that level is at a memory SMS card or the output of an emitter follower (DE). If a DE output is tied to + S, the + S will be transmitted to the DE input line and represent a short on the transistor driving the DE.
8. Never apply - S (- 12 v) on the input of a trigger as a means of forcing it on. Transistors in preceding circuits may be destroyed. Apply + S (Pin J - ground) on the on-side output.
9. The system should never be returned to the customer with an invalid (even bit count) character in memory. This will cause an unnecessary MBR VRC when the invalid character is read from memory.
10. Use caution when installing or removing plastic covers over terminal blocks A and B (TBA, TBB, Figures 4-2 and 4-3). The cover mounting springs are easily bent so they touch a terminal thereby shorting the terminal to the frame.
11. Avoid operating the system for prolonged periods of time with the SMS card covers removed.
12. If the output of an emitter follower (DE) goes to + 12 v, the DE transistor is burned out or the DE input is floating.
13. If the value of an S line goes to + 2 v or more, a possible cause is a broken line to the Q pin (+ 12 v) of an emitter follower (DE). The cause may be found on the DE developing the S line or on a DE whose output line is common with other S lines at an AND block.
14. Inadequate air circulation has caused random data checks (MAR, MBR) and other intermittent machine malfunctions as a result of a burned out, frozen, or slow turning fan. These failures are usually hard to diagnose because the gate thermals do not always kick out to initiate a power down sequence.
15. A maladjusted or binding Start key will lock the machine in an error status when the machine RESET is attempted. Triggers that should be reset will remain on and, in general, the console display will be difficult to interpret.
16. Loose X, W, slipon, and terminal connectors can cause intermittent troubles that are difficult to diagnose. Loose X, W connector pins can be detected by a visual check of the rear of the connector for pins that have slipped back from the plastic X, W block. The crimped end of the X, W connector pins should all have a uniform projection from the rear of the X, W block. The use of a flashlight or trouble light is recommended.
17. Excessive CB noise or overly critical CB timings may be caused by an undersized CRCB shaft within the CRCB Shaft assembly (P/N 2128557). These undersized shafts have been installed on some machines built prior to July, 1962. An undersized shaft may be detected by excessive play at the bearings. Improved CRCB Shaft assemblies retain the same part number (P/N 2128557) as the earlier assemblies.
18. Static electricity discharging through the machine frame to ground can induce noise spikes throughout the machine circuitry. These spikes will, at times, be of sufficient amplitude and duration to cause random failures that are almost impossible to diagnose.

    The static electricity is usually caused by low humidity coupled with the existence of carpets in the area of the 1620. Machine failures as a result of static electricity can be directly related to personnel or objects that are statically charged contacting the machine frame. If it is determined that this condition exists, contact the local IBM Physical Planning representative or Plant Customer Engineering, San Jose.
19. Intermittent input/output failures have been traced to loose voltage connections in "D" gate. The voltage jumpers to the SMS pins connect to edge connectors on the right side of the gate by means of a round barrel type terminal that slips over the small pins in the edge connector blocks. If the barrel terminal is malformed, or if it is not fully inserted on the pin, a poor connection exists.

3.1.4 Use of Oscilloscopes

1. When scoping pulses within the 1620, ground the scope probe shell near the probe, preferably on a pin J (ground) of the same

gate being scoped. Do not use the machine frame as ground when observing DC voltages. Unwanted noise may appear on the scope.

2. Synchronize an oscilloscope as follows to observe DSP output pulses (approx. 0.1 to 0.4 μsec).

   On gated DSP blocks, sync on the gate (Pin C). On ungated DSP blocks, sync on the input of the block supplying the AC set input or sync on the AC set input (Pin B) to the DSP. If possible, use a sweep time of 1 μsec per division.

3.1.5 Console Indications

Console lights indicate trigger conditions at the end of the 20 μsec memory cycle just completed. The instruction and execute cycle triggers indicate which cycle has just been completed. Only one instruction or execute cycle trigger light should be on at any one time.

T1 and T2 Console Lamps

Console test lamps T1 and T2 (located below I8) are provided for CE use. Each lamp is equipped with a driver card. The inputs (- S) to the driver can be jumpered to monitor circuits. See System Diagram 01.06.10.1 for locations and pins.

Caution should be exercised in the use of test indicator lamps T1 and T2. Incorrect and distorted results can be obtained if the inputs to the lamp driver cards are connected into an SMS circuit, which is already carrying maximum load, thus overloading the circuit. The test indicator lamps should be used for preliminary diagnostic purposes only.

3.1.6 Clock Operation

The 1620 clock will run continuously without processing if the Start key is depressed and: 1) no program is available in memory at the address at which the machine is started and; 2) the CE MAR bypass switch is on (up).

3.1.7 MAR Analysis

1. When analyzing trouble in MAR (for example, extra bits in a position of MAR) or MBR, the sense amplifiers on the input lines of that position may be removed. This technique will assist in determining if an extraneous readout of MARS is the cause of the trouble.
2. The read and write drivers for each MARS register are on the same SMS card.
3. If errors occur during an increment operation and it is determined that MARS is being set incorrectly, the failure is most likely to be in the Incr/Decr switch network. The output of the Incr/Decr switch (or MARS entry) can be scoped with the machine running by writing a Transmit Record (Op 31) instruction to transmit a record mark into the address that fails when incrementing. This procedure causes the address to be incremented and written back into MARS. The incremented address will never appear in MAR because only one Trigger 26 - Trigger 27 cycle occurs.

   In a decrement operation MARS entry may be scoped by writing a Transmit Digit (Op 25) instruction to transmit a digit to the failing address. Again, the incremented address will never appear in MAR because only one Trigger 26 - Trigger 27 cycle will occur. Either trigger is a good sync point.
4. CE switches 11 and 12 (Section 3.1.2) are useful in diagnosing troubles in the MARS-MAR-Incr/Decr Sw-MARS loop.

3.1.8 Display MAR

To display MAR between single cycle operations:

1. Single cycle by pressing the SCE key to the point in the execution of the instruction at which it is desired to look at a MARS register.
2. Press Reset. Start 1 trigger must be off in order to initiate a display MAR operation.
3. Position MAR display selector. (If it is desired to look at OR-2, place it at OR-2.)
4. DISPLAY MAR. The selected register is now displayed on the console panel. This operation makes it impossible to complete the instruction.
5. To look at another MARS register repeat steps 3 and 4.

3.1.9 Repeat Branch Instruction

To repeat a branch instruction definitely:

1. Make the P address of the instruction equal to the O_0 address of the instruction. For example, write the instruction 46 00012 00200 starting at address 00012.
2. Transfer program switch #2. Press START. The instruction will repeat indefinitely.
3. To check the equal zero indicator, ground the equal zero trigger on-side output on 01.60.41.1 and modify the Q address appropriately.

3.1.10 Input Circuitry

As an aid to analyzing input problems, the 1620 can be made to continuously cycle through the input operations as follows:

1. Float (insulate SMS card contact with cellophane tape) the output pin(s) of the OR on

01.80.25.1. that has - S TPWR RESP as an input.
2. Jumper + S CLOCK ON OR RUN (01.10.05.1) to the input pin of the AND (01.80.25.1) from which the output of the OR was insulated in step 1. This removes the Sync trigger from the control of the selector common contacts.
3. Turn on Bypass switch.
4. Press INSERT. This sets up a read numerical operation with the typewriter as the input device.
5. Manually lift a typebar up to the platen and block it in this position. This will cause the coding relay(s) associated with this typebar to stay energized. The 1620 will be going through repetitive input cycles. The Input translator, Hold trigger, and Triggers 30 and 31 can now be scoped.

3.1.11 Locating Grounds

1. Remove the green (or black) wire between DC isolated ground and frame ground.
2. Remove the green (or black) wire between AC isolated ground and frame ground.
3. Measure the resistance between any J pin and the frame. The resistance should be in megohms. If not:
   a. Isolate each gate by taking off terminal No. 1 of the laminar bus terminal block.
   b. Isolate each row by removing the wire that connects each row to the laminar bus.

3.1.12 Locating Marginal SMS Cards

If an error shows when running marginal tests, the SMS card giving the trouble can be readily found by:
1. Isolating the gate where problem is located by using switches on marginal check unit.
2. Isolating the rows by transferring the 12 M wire to the 12 v terminal one row at a time.

WARNING: Turn off power before transferring voltage wires.

NOTE: When a row is located that appears to be giving trouble, it may be that the actual marginal card is the card that is driving the card located in the row found by test. This driving card may be in another row.

3.1.13 Measuring Transistor Delay Time

Transistor delays (slow response) can cause intermittent machine failures that are difficult to diagnose. A slow card may cause delays on either the rise or the fall of a pulse. Following is a method of measuring transistor delay:

1. Sync scope on the input to the card in question (while the clock is running).
2. Probe the input and note the rise and fall time of the pulse.
3. Probe the output and compare with input pulse. The difference between the rise and fall times is the "Turn on delay" and "Turn off delay" respectively.
4. Compare this information with the data given in Section 3.5.4.

In extreme cases, the delay introduced by the defective card may be so great that the rise or fall time may be as much as one second. In these cases, it will be necessary to progressively increase the oscilloscope sweep time to measure the amount of delay.

3.2 MEMORY UNIT

If analysis of a memory failure proves the problem to be within the memory unit, contact Customer Engineering Technical Operations, Department 901, San Jose, for further information.

3.2.1 Precautions

WARNING: Use extreme caution when working around the memory unit. Do not disturb the core planes or leave the memory unit unattended when the covers are removed. To prevent damage to the main memory and its associated soldered lead-in wires, the memory unit must be securely fastened. On each corner of the memory array is a T shaped bracket that fastens to a slotted bar. The slotted bar is then held onto the gate frame in Panel A2 by three retaining screws. If misalignment of the memory unit is noted, it will be necessary to position the slotted bar by shifting the screws in the T bracket.

WARNING: Accidental shorting or grounding with potentials present can destroy decode switches or the bias winding. Destruction of the bias winding will necessitate replacement of one or both matrix switches.

The oscilloscope current probe may be used on the memory unit. For example, at the output of a matrix switch. Use an insulated probe when scoping. Shorting of the + 12 or - 12 v when the + 30 v is present can destroy the transistors in the memory decode switches.

WARNING: The + 30 v is set at the factory for optimum memory operation. It is not to be changed unless tests and checking with a precision voltmeter calibrated to ± 0.25% (such as Weston 901 Model 2) indicate the power supply output checked at the gate is incorrect.

WARNING: Do not exchange positions of current source cards when trouble is experienced because more cards may be destroyed (decodes and driver).

WARNING: When an SMS card in the memory area fails, it is possible to damage the remaining cards if the machine is allowed to run continuously for more than four or five minutes.

3.2.2 Trouble Symptoms and Diagnostic Procedures

Diagnosis

Because of the small size of core storage wires and terminals, a strong light and a magnifying glass are necessary for proper servicing.

In diagnosing memory problems, bear in mind that a short in core storage will cause a split in current which will cause the shorted line to carry less current than is necessary for proper operation. Therefore, with this type of failure, unpredictable results can occur.

If highly intermittent failures occur, the diode across relay 102 should be checked for an open or shorted condition. If this diode is defective, failures may occur at the time the memory heater is turned on and off by the memory heater control thermostat and relay 102.

Problem	Possible Cause
1. No read or write in any position of memory.	Bias winding, current source, or current driver.
2. Missing bits in all even or all odd addresses in which the addresses are either < 50 or > 50.	Sense winding or pre-sense amplifier.
3. Extra bits in all even or all odd addresses in which the addresses are either < 50 or > 50.	Inhibit winding or inhibit driver.
4. Dropping all bits in groups of 10 addresses, i.e., X09XX, X19XX to X99XX.	Decode switch or associated wire in matrix switch. An open decode switch can cause damage to other decode switches.
5. Dropping all bits in addresses in a pattern as follows: (a) 200 addresses, (b) common digits in either units, tens, and ten thousands or hundreds and thousands.	Open X or Y line. Note: X line — hundreds and thousands, Y line — units, tens, and ten thousands
6. With conditions in Step 5 but in groups of 10.	Open inductor.

Dropping or Picking up Bits in Memory

1. Intermittent dropping of bits in memory can be caused by the voltage difference between the + 30 and the + 12 being less than stated on the power supply voltage specification chart (Figure 3-4). Adjust the voltages to specifications.

   Intermittent picking up of extra bits in memory can be caused by the voltage difference between the + 30 v and the + 12 v being greater than specified. Adjust the voltages to specifications.

   To test with worse case bit pattern, press INSERT: type 3100016000127788; RELEASE; START. The test pattern should now be reading and writing progressively through memory.

   WARNING: The + 30 v is set at the factory for optimum memory operation. It is not to be changed unless tests and checking with a precision voltmeter calibrated to ±0.25% (such as Weston 901 Model 2) indicate the power supply output checked at the gate is incorrect.

2. A defective WY card (pre-sense amplifier) in the memory area will drop a particular bit every fourth cycle while incrementing through memory. That is, every other odd or every other even cycle in the less than 50 or greater than 50 address area.

   As a rule only one side of a card will fail. Therefore, it will accept a pulse of only one polarity.

   Set the CE switches to increment through memory with a bit pattern to include the dropped bit (determined by MBR-VRC). If the failure shows every fourth cycle, replacement of that particular WY card is indicated.

   Scope output of pre-sense amp and replace those cards in which the pulse has not been flattened on top. (Signal must be driven into saturation.) If all pre-sense amp cards fail to do this it is possibly a bad current driver or current source card.

   WARNING: Do not exchange positions of current source cards when trouble is experienced because more cards may be destroyed (decodes and driver).

Matrix Switches and Associated SMS Cards

WARNING: When an SMS card in the memory area fails, it is possible to damage the remaining cards if the machine is allowed to run continuously for more than four or five minutes.

Use the following procedure to assist in locating the defective card in the least amount of time. Four points are scoped.

1. Scope set up:
   a. Set time base to observe one memory cycle.

Nominal Voltage	Meter Reads		Nominal Voltage	Meter Reads	
-36	%	+ 12M	10.2	%	The Difference Between The +12 And +30 Supplies Must Be Volts ± 4% For Optimum Memory Operation. The Set Points Shown Provide This Difference.
-12A	%		Norm	%	
-12B	%		13.8	%	
+12	%	+24			
+48	%	+30			

Figure 3-4. Power Supply Voltage Specification Chart

b. Set vertical amplifier to 10 volts/ division.
c. Sync scope on an A-advance.

2. Machine setup:
   a. Set CE switches to increment through memory and force sevens in all positions.
3. Observe (scope) the output of the four current source cards for possible defective card patterns. See Figures 3-5a and 3-5b.

WARNING: Scope current source before cycling through memory. In a static condition the current source card has an output of 250-270 milliamperes, unless it is open or shorted. A shorted current source will destroy each decode switch as the decode switch is selected.

WARNING: Run clock only long enough to observe pattern. Continuous running can damage other cards.

NOTE: Open lines or bad components between MAR triggers and the decode switches give the same indication as an open decode switch. An open wire between pin C of the current driver and a decode switch will also give the same indication as an open decode switch.

Current Probe and Matrix Switches

The current probe is used to monitor the input or output of the matrix switches. When probing, orient the probe on the wire so that the core "read" wave shape is positive, and the core "write" wave shape is negative. The vertical deflection of the current wave is read directly as if it were voltage. That is if the scope vertical amplitude is set at 0.1 volt per division a wave deflection of one division is read as 0.1 amp.

Machines With Matrix Switch P/N 596168. The particular wires to be probed may be determined by referring to System Diagram 01.30.01.1 through 01.30.05.1. The following example explains how to locate a pair of wires to be probed.

To probe memory address 12345, refer to the side A table on 01.30.05.1. Locate the address 1XX44. (Only even memory addresses are shown.) This address indicates the matrix switch A output number to be E-5. Refer to this number, E-5, on 01.30.01.1 to find the physical location of the wire. It will be seen that it is approximately in the center of the matrix switch.

To find the intersecting wire from matrix switch D refer to 01.30.05.1. Locate the number X23XX on the side D table. In the column "matrix switch D outputs," opposite X23XX, appears the number G-8. This number (G-8) on 01.30.03.1 shows the actual position of the wire on matrix switch D.

Machines with Matrix Switch P/N 209435 (approximately at machine Serial 10474 and above). To probe memory address 12345, refer to side A table on 01.30.05.1. Locate the address 1XX44. (Only even addresses are shown.) This address indicates the matrix switch output number to be A-35. Refer to A-35 on 01.30.01.1 to find the physical location of the wire. It will be located on side A (top), eleventh terminal, center row.

To find the intersecting wire from matrix switch D, refer to 01.30.05.2. Locate the number X23XX on the side D table. This address indicates the matrix D output number to be C-66. Refer to C-66 on 01.30.03.1.

To find the common wire from the matrix switch to the noise cancellation inductors, refer to the matrix switch input, pages 01.30.02.1 or 01.30.04.1. Find the matrix row, A through K,

associated with the units or hundreds address. Locate row A through K on 01.30.01.1 or 01.30.03.1 and find the output pin number. "Row A = com" through "Row K = com."

Address Set Up

Troubles in memory may be peculiar to a particular address. The following procedures show methods of placing an address in MAR. Once this address has been set into MAR, the MAR bypass switch may be transferred and the problem at the address selected may be diagnosed by using the true/complement switches.

1. If the failing address is known, it may be placed in MAR by the following procedure: Place the MAR Display Selector switch in the IR-1 position, Press the Reset key and Press the Insert key. Key in 49 01492 00000. The example considers that a failure occurred at address 01492. Press RELEASE, then single cycle until trigger I8 console lamp comes on. At this time IR-1 has 01492 in it. Press RESET. Transfer CE switches 7 and 8. Now this memory location can be cycled repeatedly.
2. If the failing addresses are not known, it is possible to read out and in at each memory address by doing the following: Press RESET, then INSERT. This sets MAR to 00000, a good known starting point. Trasnfer the CE increment MAR + 1 switch. Place parity switch in the ON position. This switch setting causes the clock to stop at a memory address where an error is encountered. Press RELEASE, then START. The machine will read and write at each memory position, then stop at the memory address where an error is found. Follow the procedure given in the opening paragraph to repeatedly read and write at the failing memory address.

The following technique may be used to advance past a program without performing its execution cycle or to advance MAR to the address of an instruction that is to be performed. The computer will be ready to start the instruction cycle:

1. Press the Single Cycle Execute (SCE) key 8 times. The machine will have completed Trigger 8 time.
2. Press RESET. The machine is then ready to perform the next instruction per IR-1.
3. The instruction at IR-1 may be bypassed by repeating Items 1 and 2.

Grounding Decode Switch Outputs

The decode switch used in the 1620 memory circuits provides a ground for a particular address selected. It is possible to remove all decode switches associated with one side of a matrix switch and ground the wire from the matrix switch to the decode switch at the point it enters the decode switch.

WARNING: If a current driver and/or current source is shorted and this jumper is added, it may destroy the matrix switch; therefore, the following precautions should be taken:

1. Check the transistors and diodes on the current source and current drivers to ensure that they are not shorted.

NOTE: Do not swap current sources or current drivers from one position to another to determine if one is defective. To verify if one is operating properly, replace it with a new card.

2. Solder a 1/2 amp fuse, P/N 3577, into the jumper wire to prevent matrix switch damage if the current source or current driver is suspected. Once this is done, the machine may be run. The grounded matrix switch line will be selected all of the time. Scope the inputs of the current drivers and compare the scope pattern with correct scope pattern as shown in Figure 3-5a.

   This procedure may be used to determine if a trouble is in a decode switch and its associated drivers or in the current source, current driver, or matrix switch.

CAUTION: When removing decode switch and installing jumper, 1620 power must be off. Fuse holder, P/N 179946, may be used to facilitate connection of jumpers to fuses.

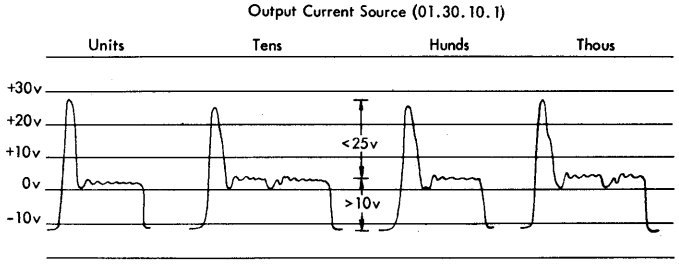


Figure 3-5a. Typical Waveforms for Good Cards

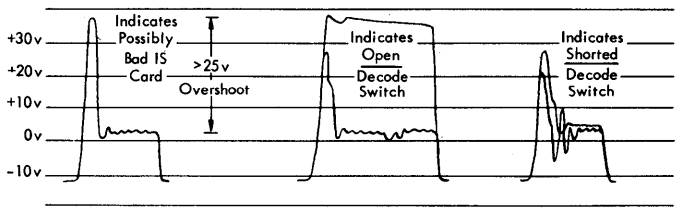


Figure 3-5b. Typical Waveforms for Bad Cards

WARNING: A fuse larger than 1/2 amp could cause matrix switch wires and current source cards to be destroyed before the fuse opens.

3.2.3 Memory Thermoswitches

The operating temperature range for the memory unit is 95° to 105° F. Three thermoswitches are located inside the memory unit. Two of the thermoswitches control the memory temperature. The third thermoswitch will cause a power-off sequence if the memory unit overheats. The thermostats are not adjustable. The n/c over temperature thermoswitch (01.90.40.1) is designed to open when the memory unit reaches 120° F. The memory under temperature thermoswitch (01.90.40.1) opens when memory is below operating temperature. The heater control thermoswitch (01.90.40.1) controls memory temperature.

Removal

1. Remove all power to the system.

WARNING: Use extreme caution when working around the memory unit. Do not disturb the core planes. Do not leave the memory unit unattended when a plenum is removed.

2. Remove the 12 screws from the front plenum (cover). Place a cloth or piece of paper over the SMS cards below the memory unit so that the screws or other small parts will not fall between cards. Move the plenum only far enough to disconnect the leads to the fan and thermoswitches mounted on the duct.
3. The over temperature thermoswitch is mounted on the top side of the duct. The heater control thermoswitch is located on the bottom side of the duct. The lower limit thermoswitch is located on the right side of the front plenum. These switches are shown on System Diagram 01.90.40.1.
4. The duct must be removed before attempting to remove either of the switches mounted on it. Mark the top of the duct so it can be reinstalled correctly. Remove 8 screws holding the duct to the memory assembly.
5. Replace by reversing steps 1 through 4.

3.2.4 Memory Circulating Fan

The memory circulating fan circulates the warmed air to maintain an even temperature throughout the memory unit.

The fan in the memory unit has sealed bearings and is lubricated for life.

Removal

1. Remove all power from the machine.

WARNING: Use extreme caution when working around the memory unit. Do not disturb the core planes or leave the memory unit unattended when the covers are removed.

2. Remove the 12 screws from the front plenum (cover). Place a cloth or piece of paper over the SMS cards below the memory unit so that screws or other small parts will not fall between cards. Move the plenum only far enough to disconnect the leads to the fan and thermoswitches mounted on the duct.
3. Mark the top of the duct so it can be reinstalled correctly. Remove the 8 screws holding the duct to the memory assembly.
4. Note the direction of the two arrows on the fan and the location of the leads. Remove the fan from the duct.
5. Replace by reversing steps 1 through 4. Mount the fan to blow air at the core planes.

3.3 COOLING FANS

3.3.1 Muffin and Redesigned (Howard) Fans

Three different types of cooling fans may be found in the 1620. Beginning with H suffix machines (1620-11660 and higher) the muffin fans in Power Supplies 1, 2, and 3 and in Gate D were replaced with a redesigned fan (Howard). Also, the muffin fans in gates A and B were replaced with squirrel cage type blowers.

The muffin and redesigned (Howard) fans in the card gates and memory unit have sealed bearings and are lubricated for life. Two arrows on the side of the muffin fans indicate correct air flow and rotation. Refer to these arrows when installing a fan. Air circulates from the bottom of a card gate to the top.

Removal and Replacement.

1. Turn off all power. Unplug line cord from the power receptacle. (Hazardous voltages exist within the fan housing.)
2. Remove 4 screws holding laminar bus to fan housing. (This is to prevent damage to the laminar bus.)

NOTE: If laminar bus is bolted, replace bolts with sheet metal screws.

3. Remove fan leads from terminal block located on the underneath side of the fan housing.

NOTE: The leads are soldered on the fan.

4. Remove the screws holding the fan housing to the gate frame.

NOTE: On some machines it will be necessary to loosen the cabling that covers the six screws on the back panel side of the gate before the screws are accessible for removal.

5. Lower the housing.
6. Muffin fans are mounted on a plate which is mounted on the inside bottom surface of the fan housing. Remove the plate and fan assembly from the fan housing.
7. Remove the fan from the plate.
8. To install the new fan, reverse the removal procedure.

3.3.2 Squirrel Cage Blowers (A & B Gates)

Removal and Installation Procedure

1. Turn off all power. Remove line cord from receptacle as hazardous voltages exist with machine off and line cord plugged in.
2. Remove 4 screws holding laminar bus to blower housing.
3. Remove blower motor leads from terminal block located on the blower housing, and remove the terminal block from the housing.
4. Remove filters and remove screws holding the blower housing to the gate frame.
5. Lower the blower housing assembly.
6. Remove mounting screws and remove motor and blowers from the housing.
7. Disassemble squirrel cage blowers from motor.

NOTE: Be sure to note the motor-blower relationship before disassembling to avoid reassembling with reversed blower rotation.

8. Install new motor. Be sure that the blower set screws are on the flat portion of the motor shaft. The oil hole on the motor should be accessible through the filter opening. Extend motor lead length as required for proper connection.
9. To reassemble reverse steps 1 through 7.

3.4 CABLE CONNECTORS AND TERMINALS

Dual contact terminals are used in V, W, X, and shoe connectors.

3.4.1 Dual Contact Terminals

Removal of Individual Contact

1. Loosen the captive cap screw. Disconnect the two connector blocks.
2. Locate the dual contact terminal to be removed. Each terminal is numbered on both sides of the block. See Figure 4-6.
3. Push the ear of the contact back until it clears the edge of the hole. See Figure 3-6. Pull the contact from the hole.

3.4.2 Wrapped Wire Terminals

Each wrapped wire terminal is limited to a maximum of 10 rewraps. The terminal should be replaced when this limit is reached, or if it loses tension on the SMS card side. Do not rewrap a wire that has been unwrapped.

Removal

WARNING: Damage to the bus bar or ground plane will occur if it is exposed to excessive heat. Therefore, apply just enough heat to release the pin or to resolder the connection. If damage to the bus bar or to the ground plane occurs, repair by wrapped wire connections between pins affected.

1. Remove all wires wrapped on terminal.
2. Remove SMS card behind terminal to be removed.

Removing A Dual Contact Terminal From A Connector Block

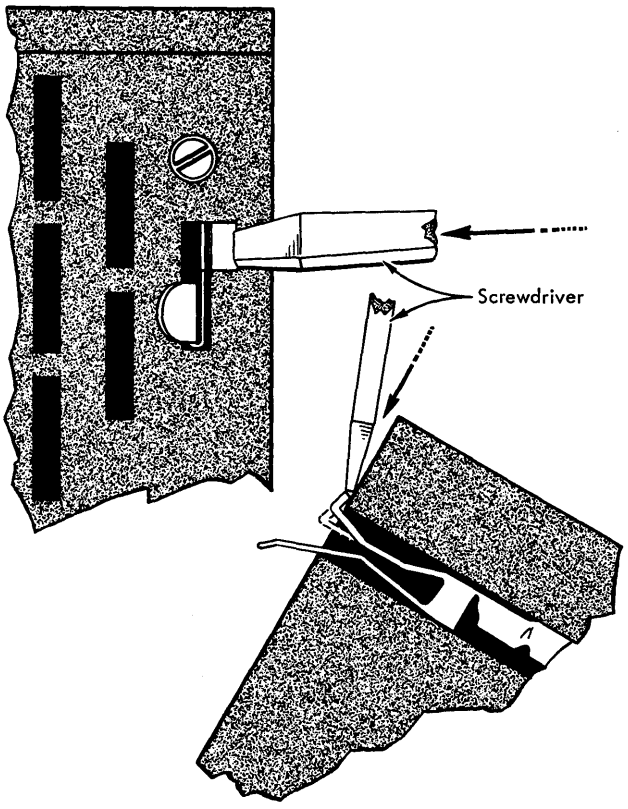
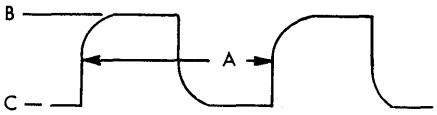


Figure 3-6. Removing a Dual Contact from a Connector Block



Scope At Output Of Oscillator

A Max 1.1 μ Sec
A Min 0.9 μ Sec
B Min Up Level -0.5v.
C Min Down Level -4.5v.

Figure 3-7. Oscillator Output

3. If pin to be removed is soldered, heat solder iron tip, P/N 451111, before proceeding to step 4. If pin is not soldered, disregard instructions about soldered pins, and use solder iron tip cold.
4. Insert solder iron tip over terminal to terminal's full length or until it bottoms.
5. As solder flows, tap plunger extension with pliers to release terminal. Remove terminal.
6. To replace insert new terminal, then pull it into place with pliers.
7. Use solder iron tip to resolder terminal to land pattern.

3.5 SMS CARD SPECIFICATIONS

3.5.1 Oscillator

The frequency of the IBM 1620 oscillator on 01.10.05.1 is 1 megacycle ± 0.1%. See Figure 3-7.

3.5.2 Sample Pulse Generator

The output pulse width of a sample pulse generator (for example, the DSP on 01.63.20.1) should fall within the range of 0.1 to 0.4 μsec. The nominal output pulse width is 0.2 μsec (200 nanoseconds).

3.5.3 Signal Levels

Acceptable levels for the different signals in the circuitry are as follows:

Use	Signal	Acceptable Range
DE, TB, A, O, DSP, ID	+S	-0.5 to -0.1 v
	-S	-10.0 to -7.0 v (drift)
		-10.0 to -5.6 v (alloy)
R (01.30.80.1) Current Probe	+R	0 ma
	-R	250 to 300 ma
Thyratron (DP) Output	Not Fired	+43.0 to +53.0 v
Thyratron Output	Fired	0.0 to +0.5 v
DSP, TB AC Sets	+Set	0 to -0.5 v
	-Set	-4.5 to -6.2 v

3.5.4 Transistor Delay Times

The two types of transistors used in the 1620, alloy and drift, have an inherent delay time; that is, it requires time to saturate the transistor and time to unsaturate the transistor. See Section 2.2. In general, it takes longer to unsaturate than to saturate a transistor. These delay times are known as "Turn On Delay" and "Turn Off Delay," and are a function of the type of logic block under consideration and also whether the output is rising or falling.

The total delay in a series of logic blocks is the sum of the individual transistor delays. Some SMS cards have transistors internally connected. These internally connected drift cards include the DFD and TCZ latches and the various multiple use package (MUP) cards such as the DEQ, DES, DEV, DEW, DFB, DFC, DFE, DFG, and the DFP cards. Because several circuits are mounted on one card and connected internally, there are no external check points between logic blocks (no input or output pins are shown in the System Diagrams).

The following paragraphs give the turn ON delay and turn OFF delay times for some SMS cards and indicate whether the turn ON or turn OFF delay is associated with a rising or falling output pulse. The cards listed comprise most of the cards used in the 1620. The remaining cards are special purpose cards such as: thyratrons, thermoswitches, load resistors, current sources, current drivers, and decode switches.

The following alloy cards have a turn ON delay of 0.24 to 0.62 μsec on a rising output pulse, and a turn OFF delay of 1.28 to 3.9 μsec on a falling output pulse:

Card Code	Part Number
AHK	370322
CD	371029
MX	371661
CAB	371931

The AYX (P/N 372388) card is an alloy type Exclusive OR circuit. The turn ON delay is between 450 and 860 nsec and the turn OFF delay is between 210 and 360 nsec.

The following alloy cards have a turn ON delay of 0.34 to 1.6 μsec on a falling output pulse, and a turn OFF delay of 0.27 to 2.3 μsec on a rising output pulse:

Card Code	Part Number
CE	371487
CEYB	371032

The following alloy card has a turn ON delay of 0.1 to 0.7 μsec on a rising output pulse, and a turn OFF delay of 0.2 to 3.0 μsec on a falling output pulse:

Card Code	Part Number
MH	371487

The following drift cards have a turn ON delay of 12 to 140 nsec on a rising output pulse and a turn OFF delay of 38 to 175 nsec on a falling output pulse.

Card Code	Part Number
DAW	370083
DAX	370084
VE	371869
TAG	370366
VF	371870
TAH	370367

The following drift cards have a turn ON delay of 2 to 26 nsec on a falling output pulse, and a turn OFF delay of 4 to 48 nsec on a rising output pulse.

Card Code	Part Number
VM	371871
TFC	370646

The following drift card has a turn ON delay of 0 to 14 nsec on a falling output pulse, and a turn OFF delay of 2 to 14 nsec on a rising output pulse.

Card Code	Part Number
DAR	370082

The total delay in a series of logic blocks is the sum of the individual delays. If too long a delay is experienced in a series of logic blocks, the individual logic blocks should be scoped to determine which block is at fault.

NOTE: Turn OFF delays (unsaturating) are generally the longest. See Section 3.1.13 for method of measuring transistor delay.

3.5.5 Emergency SMS Card Component Replacement.

Replacing components on SMS cards is not recommended because heat and handling can easily damage the card and/or component. However, in case of emergency, it may be necessary to replace components when a replacement card is not available. Extreme care must be used to minimize the possibility of damage. The following procedure should be followed:

1. Carefully heat the soldered connection until the solder just starts to flow, then remove the solder with a flipping motion of the card.

CAUTION: Use extreme care to flip the liquid solder away from yourself or other personnel. Use safety glasses!

2. Carefully remove the component from the card.
3. Gently form the leads on the new component.
4. Insert leads into the holes in the card being repaired.
5. Melt a small amount of solder on the tip of the soldering iron and apply to the connection just long enough for the solder to flow around the lead and into the hole.

WARNING: Overheating can permanently damage transistors and diodes. Whenever possible, a heat sink, such as long nosed pliers, should be applied to the lead between the component body and the point of contact with the soldering iron.

6. Cut lead next to solder connection. It is important to solder leads before cutting them to length. Shock transmitted to the transistor or diode body through the leads can cause serious damage. Presoldering the leads will greatly reduce the shock transmitted to the body. Wire cutters, P/N 450694, generate very little shock and should be used whenever possible.

Careful observation of the above procedure will help reduce the possibility of component damage, but does not provide complete protection against damage and the resulting marginal operation. It is important, therefore, that field replacement of components on SMS cards be limited to cases of extreme emergency.

3.6 CRCB UNIT

Adjustment

1. Position the drive motor so that there is 0.5" deflection in the drive belt when the belt is depressed midway between pulleys. The drive motor can be moved toward the front or back of the machine when its four mounting screws are loose.
2. CB cam index rotation is clockwise as seen in Figure 3-8.

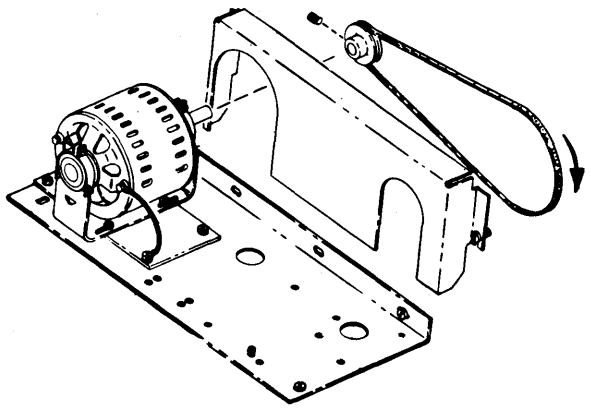


Figure 3-8. CRCB Drive Motor

3. Cam shaft speed should be 600 ± 25 RPM (100 ± 4.2 msec per revolution). To check speed, sync scope on CB1; scope CB1. There should be 100 msec ± 4.2 msec maketime to maketime.

3.7 TYPEWRITER

The typewriter used with the 1620 is a modified IBM B1 Electric Typewriter for data processing equipment. The Customer Engineering Maintenance Manual, (Form 223-6652) explains all adjustments, lubrications, and maintenance procedures except for the 1620 selector common contacts. See also the typewriter Inspection-Lubrication procedure in Section 2 (2.3).

3.7.1 Selector Common and Letter Cam Contracts

The selector common contact in the 1620 machine consists of two n/o contacts. Maintaining the timing relationship between selector common contact No. 1 and No. 2 and the timing relationship between letter cam contacts and the selector common contacts is very important. Failure to do so can cause intermittent problems that are difficult to diagnose. An oscilloscope is required to satisfactorily measure the contact durations.

Selector Common Contact - Preliminary Adjustment

1. Form the n/o strap supports to give an air gap of 1/32" when the contacts are normal.
2. Position the contact mounting bracket so that the contact closes when any typebar is about 2/3 of the distance from the platen. For preliminary adjustment of letter cam contact assembly, see CE Maintenance Manual, B1 Electric Typewriter, (Form 223-6652).

Proper tension of the selector common contact is directly dependent upon proper adjustment of the ribbon lift mechanism. Refer to page 20 of the B1 Electric Typewriter CE Maintenance Manual, (Form 223-6652). If the operating link is not adjusted so that the ribbon left is against its stop and the ribbon bail against the cam levers, the selector contact timing will vary. This adjustment should be checked prior to checking selector common contact adjustments.

Timing Requirements

1. Letter cam contacts 35 to 45 ms duration.
2. Selector common No. 1, 25 to 34 ms duration.
3. Selector common No. 2, 12 to 18 ms duration.
4. The letter cam contacts must make before and break after selector common contact No. 1 with equal overlap at both ends.
5. Selector common contact No. 1 must make before and break after selector common contact No. 2 with equal overlap at both ends.
6. Adjust selector common contact No. 1 to make after the letter cam contacts stop bouncing.
7. Adjust selector common contact No. 2 to make after selector common contact No. 1 stops bouncing.

   Contact bounce can be identified by a ripple in the scope trace.

Adjustment Procedure

The following procedure gives steps for checking timing relationships between the two selector common contacts and the letter cam contacts. It should be noted that binds in any part of the ribbon lift mechanism or an extreme setting of the Impression Control Lever, either high or low, can affect Selector Common Contact timing.

1. Turn off machine power.
2. Short R54-1 n/o (isolating R54-1 n/c) to provide + 48 v to the contacts.
3. Insulate R7-4 n/c points to prevent a carriage return.
4. Remove all wires from the selector common contact No. 1 n/o point to prevent a continuous response signal.
5. Place the letter cam contact common wire (just removed from the selector common contact No. 1 n/o point) on the selector common contact No. 1 Op point to provide 48 v directly to the letter cam contacts.
6. Remove CRCB cover.
7. Place four IBM cards between the platen and the typebars to prevent platen damage.
8. Turn on machine power.
9. Sync the scope on CRCB-5.

   WARNING: Wrap the sync lead around the sync post to prevent damage to the scope which could occur with a direct 48 v connection to the sync post.

10. Set the scope time base at 5 ms/div.
11. Jumper the CRCB-5 pulse to the desired print magnet. Letter cam timings will vary depending upon key locations. Test various positions of letter cam contacts spaced across the keyboard (for example Q, V, I, $). Typewriter bit relay points (01.82.80.1, 01.82.82.1, 01.82.84.1, 01.82.86.1) are convenient access points to the print magnets.
12. The desired contacts may now be scoped.

3.7.2 Carriage Return Contact

The n/o contact must have a minimum of .010" rise from its support strap. The .010" rise must be maintained during the entire length of the carriage return.

3.7.3 Tab Interlock Contact

The n/o strap must be adjusted for a .020" to .030" contact rise when made.

3.7.4 Miscellaneous Servicing Information

To ensure reliable 1620 operation, all typewriter contacts must be carefully adjusted for proper contact air gap, adequate strap tension and sufficient overtravel when made.

1. A maladjusted selector common contact may cause MAR to increment when the flag key is activated. (MAR should not increment.) A bouncing contact may send double digits into memory (31224 instead of 3124). Selector common contact No. 1 must make before and break after the No. 2 contact. In addition, the keyboard contacts must make before and break after selector common contact No. 1. Selector common contract No. 2 should have a minimum duration of 10 ms. See Section 3.7.1 for adjustments.
2. A bouncing carriage return contact may cause skipped I/O instructions, multiple I cycles and/or simultaneous I and E cycles. The n/o contact should have at least .010" rise from its support strap. This .010" minimum rise must be maintained during the entire length of the carriage return.
3. Insufficient strap tension of the tab interlock contact will cause contact bounce that results in skipped I/O instructions. The n/o strap must be adjusted for a .020" to .030" contact rise when made.
4. Characters may fail to print if the clearance between the print magnet armature stop bail and the print magnet armature is greater than .075" with the armature attracted.
5. The invalid typewriter character (✳) prints on any bit combination that does not energize any other key magnet. It does not necessarily indicate incorrect parity.
6. As the zero typebar starts to fracture, the type moves up causing the zero to print higher than the other typewriter characters. At the first sign of misalignment, it is advisable to replace the typebar to prevent an emergency service call.
7. Improper positioning of the multiple copy lever can be a contributing factor to typebar fractures.
8. The usage of the typewriter on the IBM 1620 is usually very high and therefore must be kept well lubricated. The Inspection-Lubrication Procedure given in Section 2 should be followed.

3.8 POWER SUPPLY

3.8.1 Power Specifications

The IBM 1620 System operates from either a 208 or a 230 v, 60 cycle, single phase, three wire service line. To change the voltage input to the system refer to Voltage Change, Section 3.8.2.

Input voltage may have a total variation of ± 10% of the rated voltage. Line frequency must be 60 ± 0.5 CPS.

The power circuit breaker (PCB), mainline switch, is designed to trip when the input current reaches 30 amps. It must be reset manually.

The 50 cycle version of the 1620 requires an input voltage of 195 v AC, 220 v AC, or 235 v AC. The 195 v supply can vary between the limits of 175 v and 215 v. The 220 v supply can vary between the limits of 198 v and 242 v and the 235 v supply can vary between 211 v and 259 v.

WARNING: The emergency OFF switch is to be used for emergencies only. Data in memory may be destroyed if the emergency switch is operated when the machine is running. The switch is manually reset by tipping the console panel forward and pushing the spring loaded interlock plunger downward to clear the interlock plate.

CAUTION: Extreme care must be exercised when servicing or inspecting the power supply. Dangerous voltages and currents are present even when the system is in a power off status. If necessary to connect a test instrument within the power supply, or to reach into it for any reason, the main line cord should be disconnected. Discharge capacitors before working near them. Each heat sink is at an electrical potential. Do not short heat sinks to each other or to the machine frame.

3.8.2 Voltage Change

Converting to a different source of voltage (208-230) effects five wires on the IBM 1620. These wires lead to transformers T1 and T2 on 01.90.10.1, to the regulated supplies on 01.90.20.1, and to the IBM 1621 48 v power supply on 02.70.10.1. See Figure 3-9.

Unit	System Diagram	208V	230V
T1	01.90.10.1	Term 1 & 2	Term 1 & 3
T2	01.90.10.1	Term 1 & 2	Term 1 & 3
1250W Reg.	01.90.20.1	Term 1 & 4	Term 1 & 5
415W Reg.	01.90.20.1	Term 1 & 4	Term 1 & 5

Figure 3-9. Power Supply Voltage Change Connections

Converting to a different source of voltage (195, 220, 235) affects five wires on the 50 cycle machine. These wires lead to transformers T1 and T2 on 01.90.10.1, to the regulated supplies on 01.90.20.1, and on the IBM 1621 48 v power supply on 02.70.10.1.

When ordering parts for 50 cycle machines, check the cross index in the 1620, 1621, and 1623 parts catalogs for special parts used with 50 cycle systems.

3.8.3 Individual Power Supply

Specifications

For normal operation, the SMS power supply DC output voltages must be maintained within the following levels:

+12 from +11.52 to +12.48
*+48 from +43.20 to +52.80 (Measured at power supply)
-36 from -34.56 to -37.44
-12 from -11.52 to -12.48
+3 from +2.94 to +3.06

All machine functions must operate correctly when the +12M DC supply is set between +10.2 and +13.8 (Marginal test).

Removal

1. Turn off the mainline switch. Remove the line cord. Bleed capacitors. To discharge (bleed) capacitors:
   a. Short posts 6 and 7 on SMS power supplies.
   b. Short posts 6 and 8 on AC regulators. (See System Diagrams 01.90.20.1 and 01.90.21.1.)
2. Disconnect the leads to the particular study to be removed.
3. Lift the two catches on the power supply rails. Slide the supply forward and out of the machine.

*Experience has shown that optimum operation is obtained when the 48 v supply is maintained at + 48 to 52 volts.

Replacement

When a 30 v DC power supply is replaced, set the 30 v variac so that the difference in potential at A gate between the +12 v DC and +30 DC is the value recorded on the right side of power supply gate 4. Make all voltage measurements at gate A with a precision voltmeter (such as Weston 901-Model 2) calibrated to ± 0.25%. Clamp the variac setting when its proper position has been determined. Record the reading of the box 4 voltmeter at this setting.

Voltage Check

The output of both regulators should be 133 v AC ± 4%. All DC voltages, except the + 30 v, should be within ± 4% of their labeled values.

If an MC switch fails to make contact when transferred, voltages will not be varied at the gate controlled by the switch. If an MC switch fails on the n/c side, the + 12 v will not reach the gates. However, the marginal check voltmeter will indicate just as if everything were operating correctly.

Loose wires at voltage distribution connectors can cause loss of voltage to the gates while the voltmeter indicates correctly.

For installation and scheduled maintenance routine, measure all DC voltages at the card gates.

The setting of the + 30 v is determined at the factory and its setting is recorded (Figure 3-4) on the right side of power supply box 4. The 30 v variac is then clamped. Do not vary this setting. This setting allows optimum memory operation.

3.9 MISCELLANEOUS SERVICE AIDS

3.9.1 Waveforms and Levels

Figures 3-10a, 3-10b, and 3-10c show typical waveforms and voltages. The sync point and all test points are indicated on the figures.

The voltage probe is used except where indicated.

The voltages given are typical. However, the voltages may vary from machine to machine. See Section 3.5.3 for acceptable levels.

3.9.2 Program for Listing a FORTRAN Object Program (Without Format)

If difficulties are experienced in analyzing FORTRAN object programs, the following program may be useful in listing the FORTRAN object program in machine language.

Clear Memory (31 00003 00002)
Set Switches 1, 2, 3, and 4 off.
Parity and I/O check switches on.
TW Margins - Left at 10, Right at end of carriage.
TW Tab Stops at 17, 24, 31, 38, 45, 52, 59, 66, 73, 80, and 87.
Load FORTRAN Object program.
When machine types out "Load Data," enter
36 02200 00100 49 02200
Release and Start
Then enter following program:

Location	OP	P	Q
02200	25	02291	02455
02212	34	00000	00102
02224	16	02232	0000$\bar{4}$
02236	25	02218	$\bar{0}$7512
02248	25	$\bar{0}$7512	02455
02260	38	02286	00100
02272	34	00000	00108
02284	38	$\bar{0}$7500	00100
02296	25	$\bar{0}$7512	02218
02308	45	02340	$\bar{0}$7507
02320	16	02278	0000$\bar{8}$
02332	49	02352	0
02340	16	02278	0001$\bar{2}$
02352	21	02247	02278
02364	21	02254	02278
02376	21	02290	02278
02388	21	02302	02278
02400	21	02319	02278
02412	12	02232	0000$\bar{1}$
02424	46	02212	01200
02436	34	00000	00108
02448	16	02285	‡00$\bar{3}$8
02460	16	02273	00$\bar{3}$4
02472	16	02261	00$\bar{3}$8
02484	47	02236	00100
02496	16	02285	0004$\bar{1}$
02508	16	02273	0004$\bar{1}$
02520	47	02236	00200
02532	16	02261	0004$\bar{1}$
02544	49	02236	‡

Release and Start

Machine will type out Object program in the following format:

Address	Instruction
$\bar{0}$7500	$\bar{1}$6 01234 56789
$\bar{0}$7512	$\bar{4}$5 98765 43210
$\bar{0}$7524	$\bar{2}$1 02468 13579, etc.

Switch #1 ON will delete the instruction and allow printing of the address only:

$\bar{0}$7500, $\bar{0}$7512, $\bar{0}$7524, $\bar{0}$7536, $\bar{0}$7548, etc.

Switches #1 and #2 ON will delete all printing. The typewriter will tabulate once for each instruction. This will allow progression through the Object program instructions at a rate of 100 instructions per minute.

Occasionally the machine will stop if program switches are operated while the machine is running. To restart, insert 49 02236 - Release and Start.

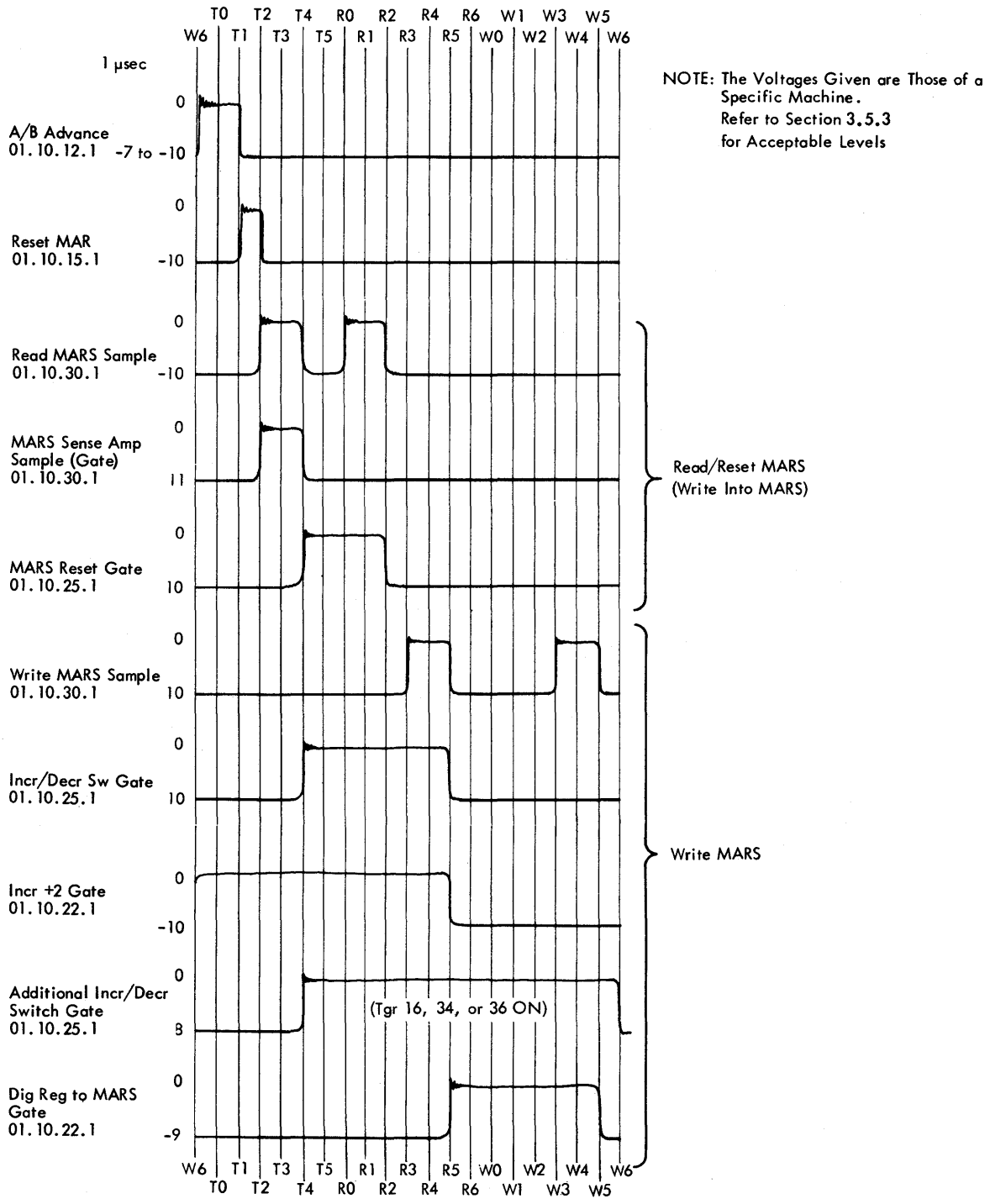


Figure 3-10a. Typical Waveforms and Levels

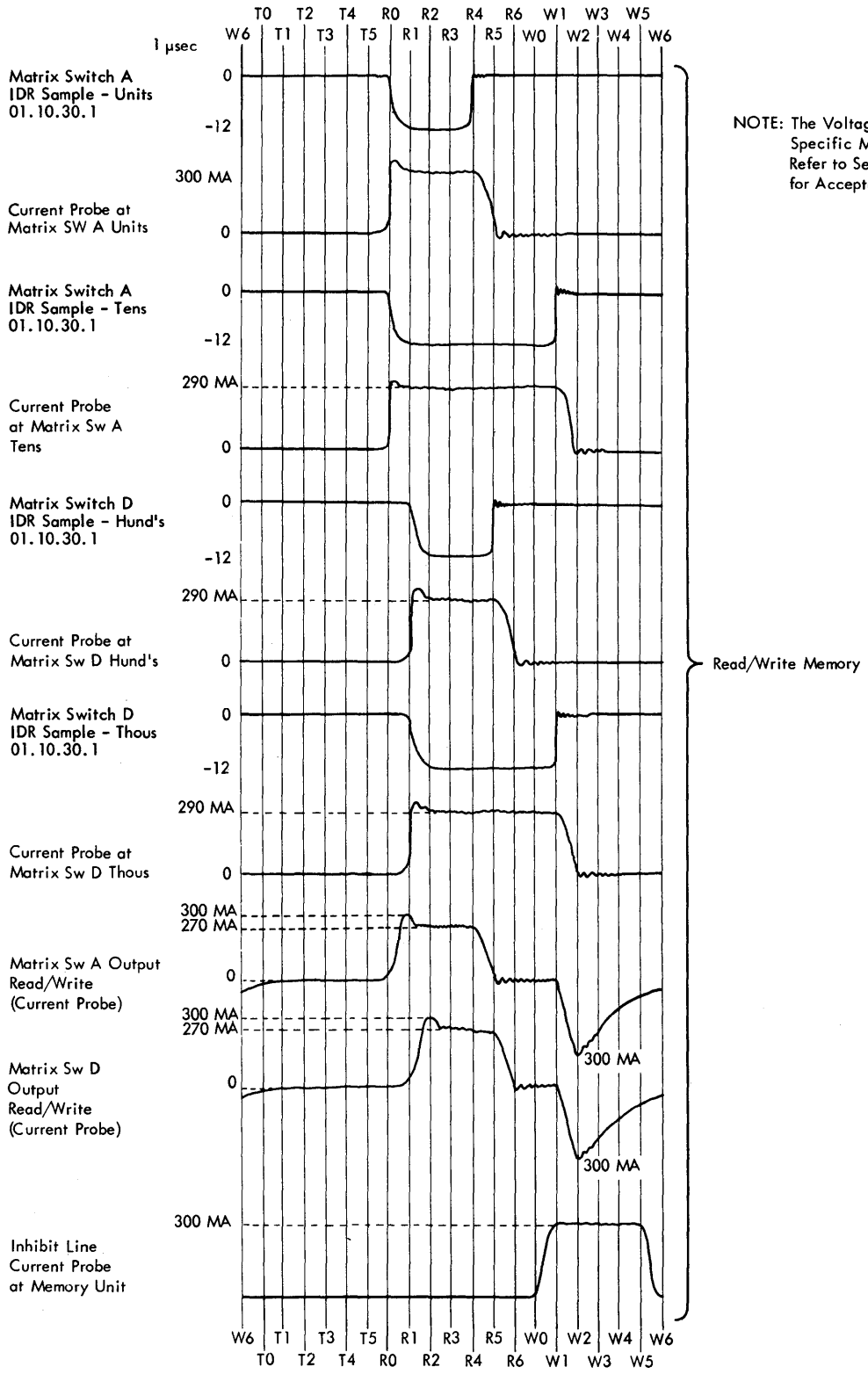


Figure 3-10b. Typical Waveforms and Levels

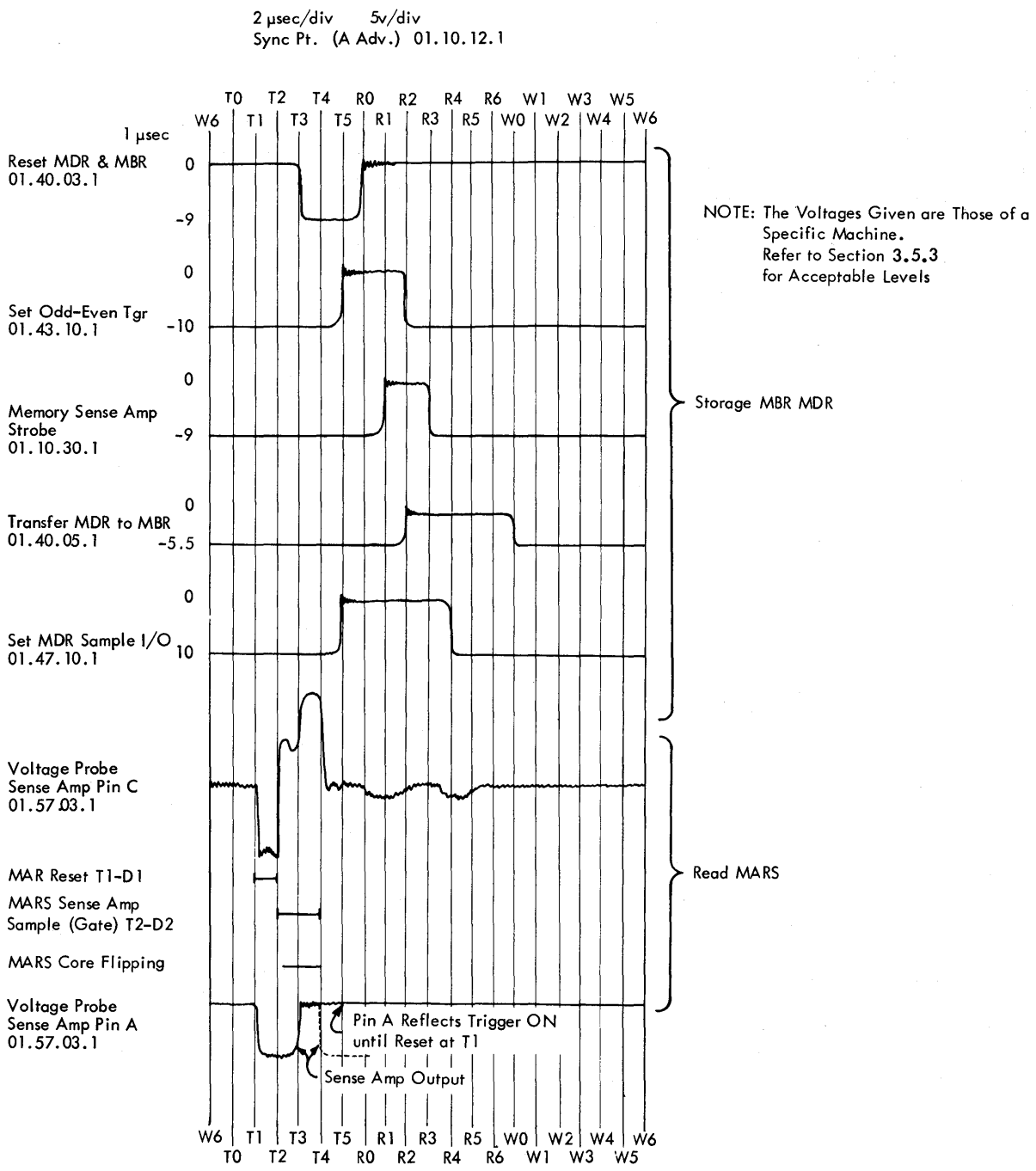


Figure 3-10c. Typical Waveforms and Levels

CONTENTS

4.1 SMS CARDS

The lettering within a logic block on a System Diagram gives the location of that block in the card gates. It also indicates other pertinent data, as seen in Figure 4-1. Identification of panels, rows, columns, and pins is shown in Figures 4-2, 4-3, 4-4, and 4-5.

Logic block locations within the System Diagram Card Location Charts, for example 01.00.14.1. The lettering in the top left-hand corner at each card location in the charts indicates the card code. The lettering, if any, in the top right-hand corner, indicates an optional feature code with which that the card is used. The second line within each location block includes the card part number and the number of circuits that the card contains. Subsequent lines indicate the System Diagram pages on which the card circuits are depicted.

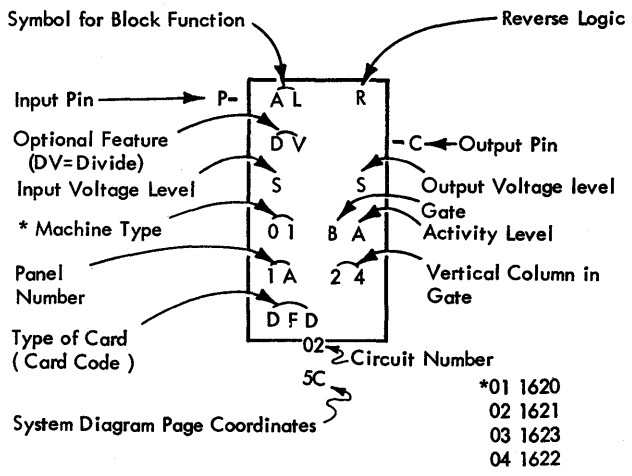


Figure 4-1. Logic Block Coding

4.2 CABLES AND CONNECTORS

4.2.1 V, W, and X Connectors

Intergate and intermachine cables are connected to card gates by V, W, and X connectors as indicated on 01.00.25.1. The V connectors are located on the bottom of the gates and are used exclusively for intermachine cable connections. The W and X connectors are located on the ends of the gates. These cable connectors are shown in Figures 4-2 and 4-3.

Each terminal within a connector is identified by a code. An example of this is "01BXB11." This number is on the bottom of 01.20.35.1. It represents machine 01, the 1620 (02 represents the 1621, 03 the 1623, and 04 the 1622), B gate, X connector, B row, pin 11. The *7 to the left of this code number identifies the connector pin on System Diagrams 01.20.35.1. The pin number at the other end of the cable is also numbered on the connectors. The pins on the connector are numbered as shown in Figure 4-6.

4.2.2 Upper and Lower Connectors

Upper and lower connectors (formerly known as T connectors) are presently designated as Y and Z connectors respectively and are called out in the System Diagrams by an "*" and a number. For instance, "*1" on the upper right side of 01.15.13.1 refers to connector designation 01B1Y14A at the bottom of the page. This code for the connector represents machine 01 (for the 1620; 02 represents the 1621; etc.), gate B, panel 1, Y = upper, column 14, pin A. The tables on 01.00.20.1 locate the upper and lower connectors in the System Diagrams.

4.2.3 Shoe Connectors

Intermachine signal cables to the 1621, 1622, and 1443 are attached to the machine by shoe connectors.

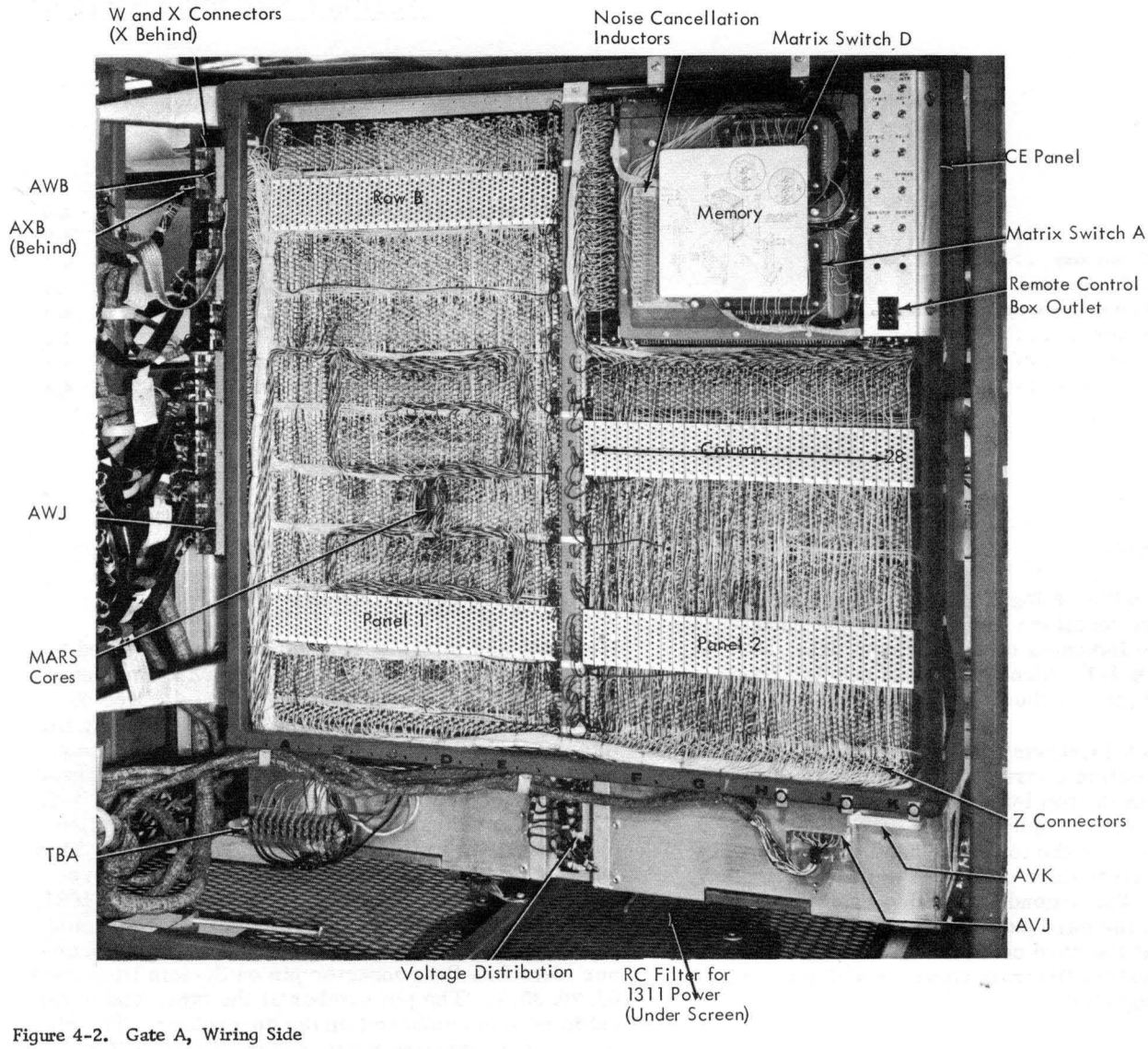


Figure 4-2. Gate A, Wiring Side

System Diagram 00.00.20.1 shows the location of the show connector terminals in the System Diagrams. For example, the "Punch EL" terminal is on 01.84.20.1. It is identified by an "*1" on 01.84.20.1. At the bottom of 01.84.20.1, the "*1" code number is 01SCA01. This number translates to machine 01, shoe connector A, terminal 01. The terminals are numbered on the connector as shown in Figure 4-6 and 4-7. Figure 4-3 locates shoe connectors on the 1620.

4.3 TERMINAL BLOCKS

There are many terminal blocks within the IBM 1620. Their physical location within the 1620 is shown in the Reference Section of the System Diagrams, and by Figures 4-2 through 4-9. TBM is located on the side of the front plenum covering the memory unit (Figure 4-10 shows the rear plenum). The locations index at the front of this section should assist in identifying the various terminal blocks.

Terminal block numbers 74 through 98 are the wire relay type (Figures 4-11 and 4-13). All of the "C" hubs are common. The other hubs are common in groups of three; for example, the three 12B hubs are common.

4.4 DIODE BOARD

The diodes on gate C are numbered from 1 to 33. Their location in the System Diagrams is called out on 01.00.35.1. The diodes are numbered from front to back, right to left, when facing the front of the machine (Figure 4-12).

4.5 RC UNITS AND INTEGRATORS

4.5.1 RC Units

RC units are mounted in relay positions on the C gate and numbered as relays (Figure 4-13). An example of RC unit wiring is shown at the lower right-hand corner of 01. 82. 72. 1. Here, RC89B-1 terminal is the #1 terminal B side of RC 89. It is connected to R40 LT coil.

4.5.2 Integrators

The integrators used in the console circuits of the 1620 are behind the right side of the console display panel (Figure 4-8). The wiring schematic and location of the integrators in the System Diagrams is shown on 01. 00. 40. 1.

4.6 RELAYS

4.6.1 Sequencing Relays

Relays 101 through 107 are the sequencing relays and are located on the right side of the 1620 (01. 00. 80. 1 and Figure 4-9). Their contact terminals are numbered left to right as shown in Figure 4-14 and locations within the system diagrams are indicated on 01. 00. 81. 1.

4.6.2 Voltage Sense Relays

Relays 109 through 117 are the voltage sense relays and are located on the right side of the 1620 (01. 00. 80. 1 and Figure 4-9). Their contact terminals are numbered left to right as shown in Figure 4-15.

4.7 POWER SUPPLIES

The power supplies in the 1620 are located in the four boxes across the front of the machine (Figures 4-16 and 4-17). The eight capacitors for the two regulated AC supplies (01. 90. 20. 1) are mounted on the back side of the box number one (Figure 4-8). The 48 v, 6 amp, DC supply is mounted on the back side of the box number three (Figure 4-8). Items on the back of the boxes are accessible by opening card gates A and B. The power supply system on the 1620 consists of:

1 1250 watt AC Regulator
1 415 watt AC Regulator

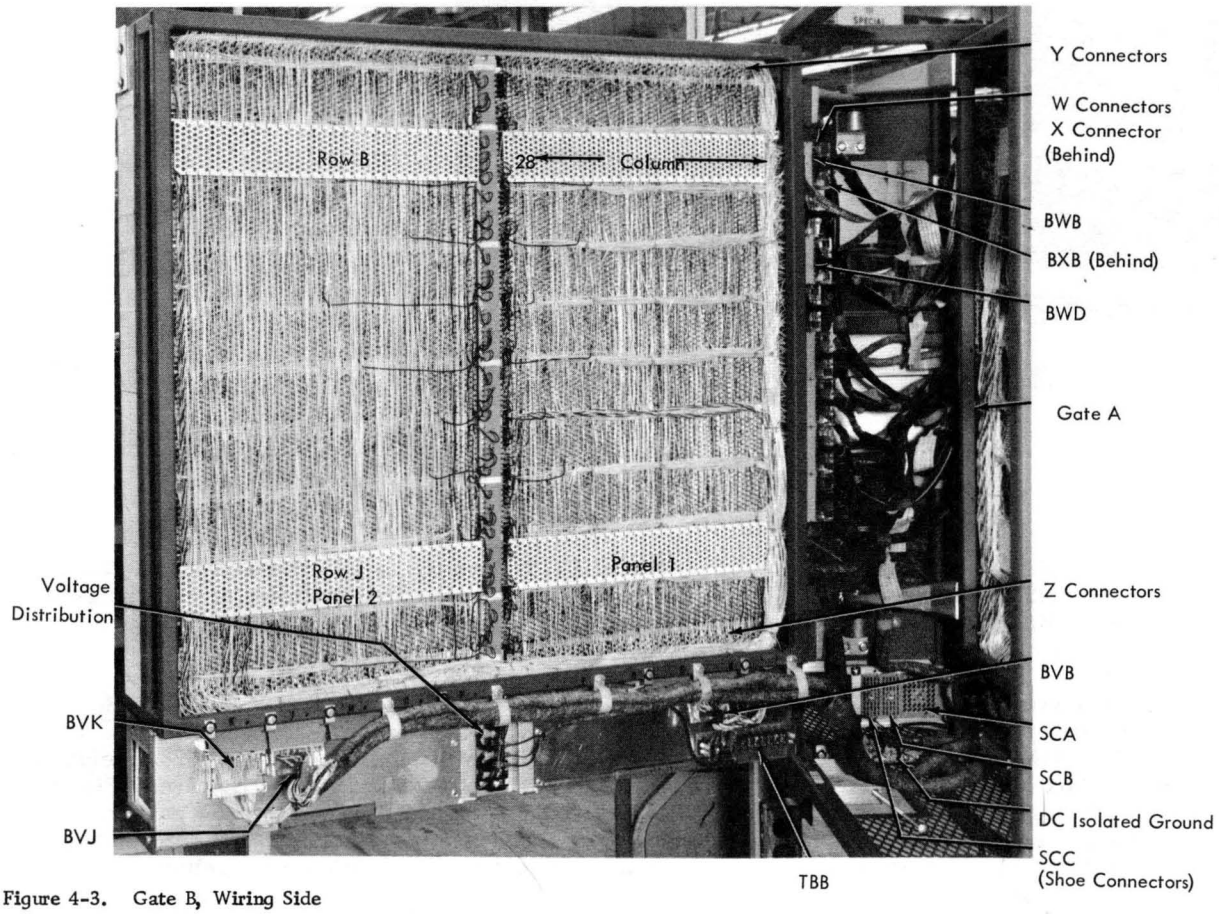


Figure 4-3. Gate B, Wiring Side

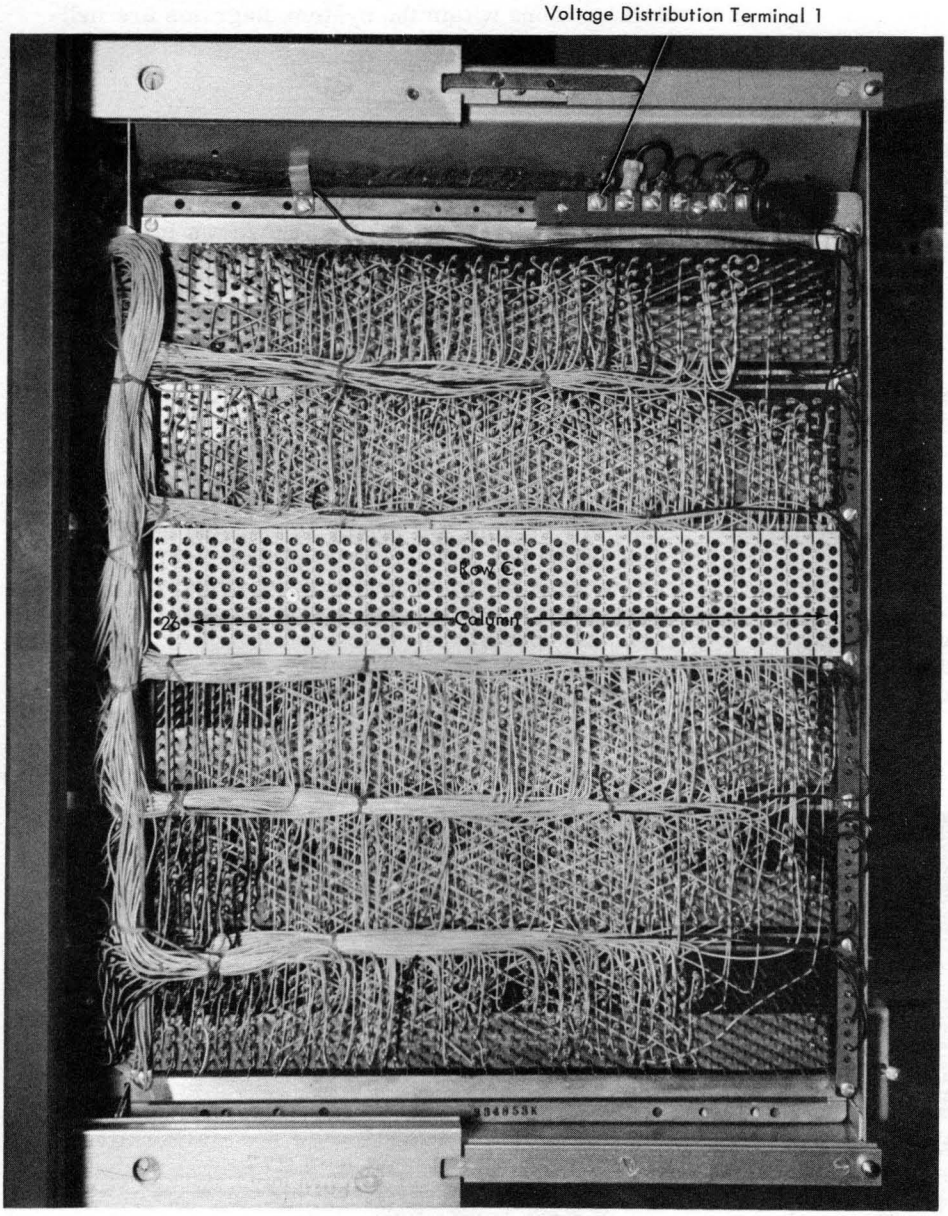


Figure 4-4. Gate D, Wiring Side

1 -36 v 2 amp DC SMS Power Supply
2 -12 v 20 amp DC SMS Power Supplies
1 +12 v 16 amp DC SMS Power Supply
1 +30 v 4 amp DC SMS Power Supply (Memory supply)
1 +48 v 6 amp DC Power Supply
1 ±3 v 5 amp DC Power Supply used with the Marginal Checking

The gate mounted in box four contains the five marginal check (MC) toggle switches (01. 90. 30. 1) the DC meter selector switch (01. 90. 45. 1), the DC meter, the +30 v variac (01. 90. 21. 1), and the 3v MC rheostat (01. 90. 21. 1). The marginal check panel is shown in Figures 4-16 and 4-17.

4. 8 IDENTIFICATION ON EARLY MACHINES

This manual is written primarily for 1620 machines serial 10701 (E Suffix) and later. However, Figures 4-18 through 4-23 are included to show panels, locations, and identifications of some 1620 machines prior to serial 10701 (D Suffix and earlier).

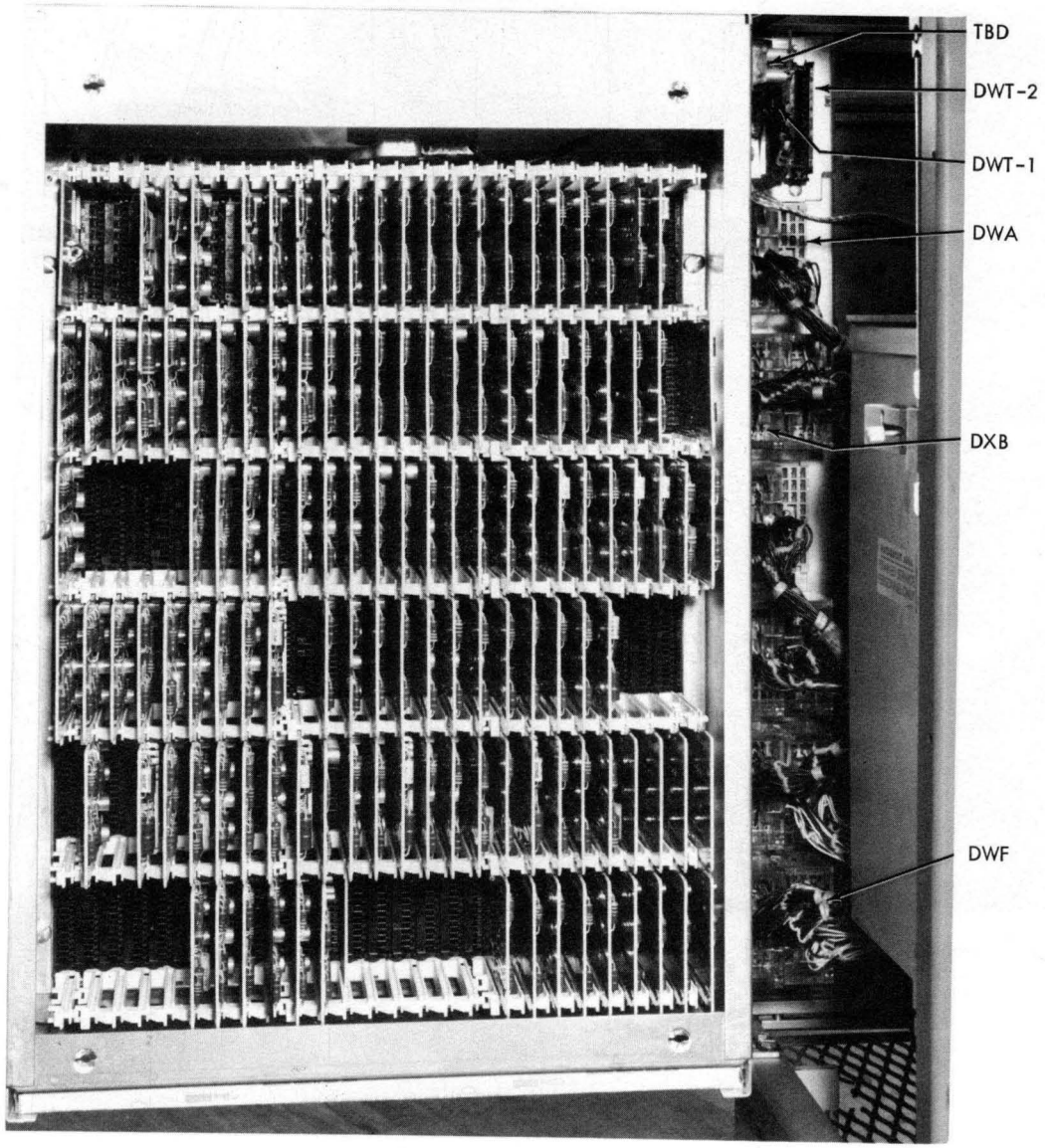


Figure 4-5. Gate D, Card Side

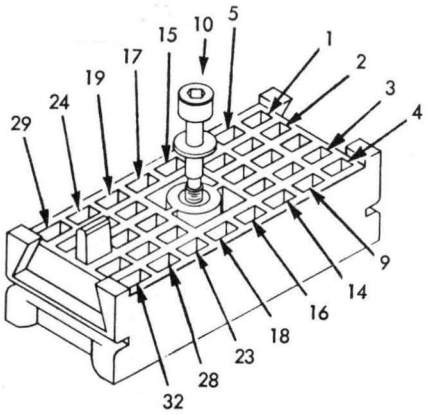


Figure 4-6. Cable Connector Terminal Numbering

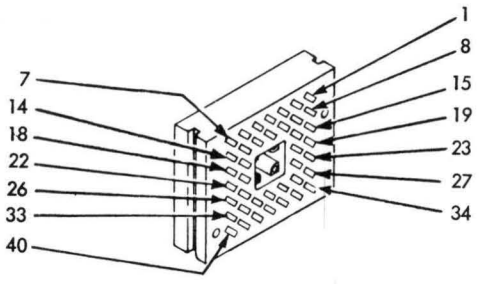


Figure 4-7. Shoe Connector Terminal Numbering

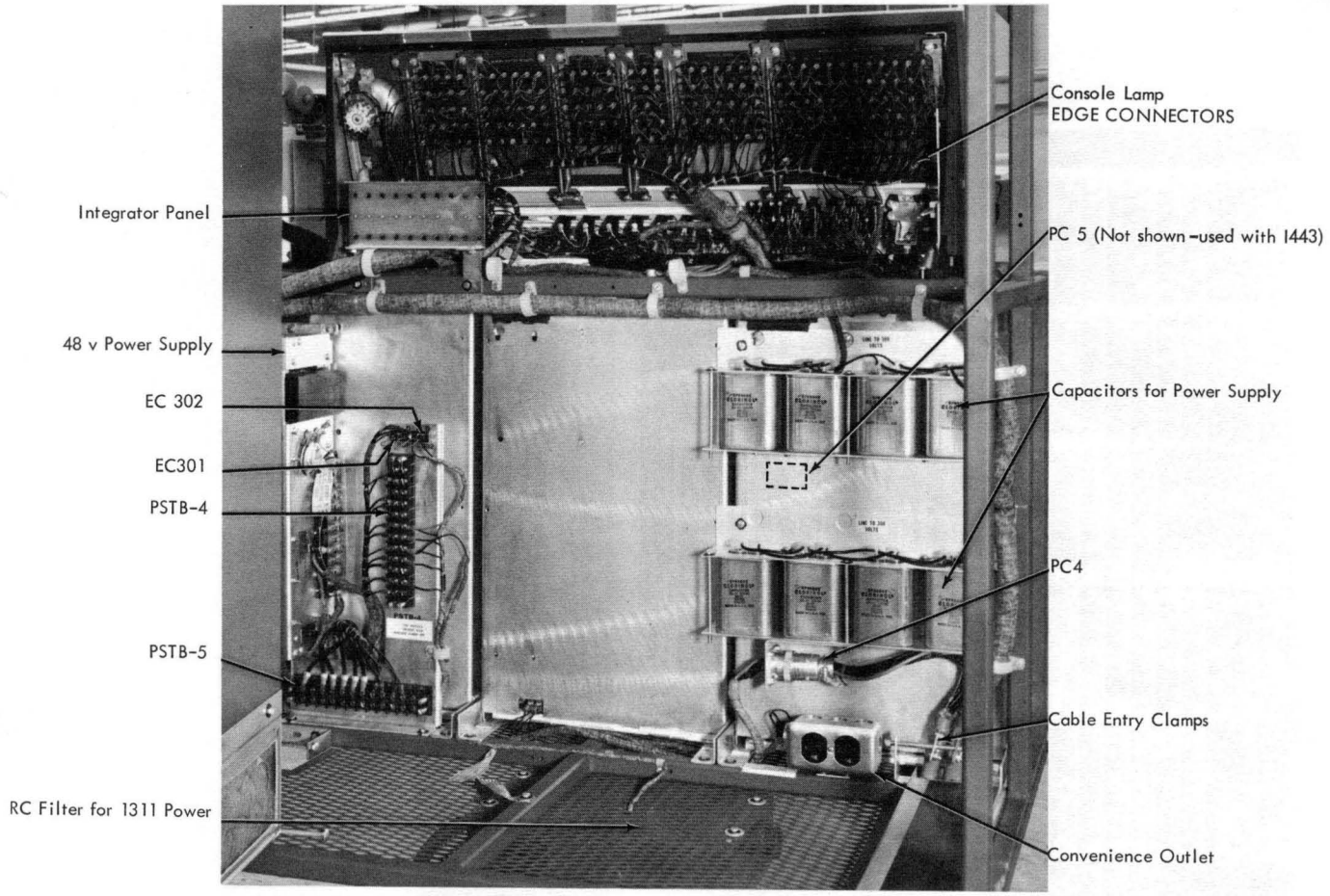


Figure 4-8. Back Side of Console and Power Panels

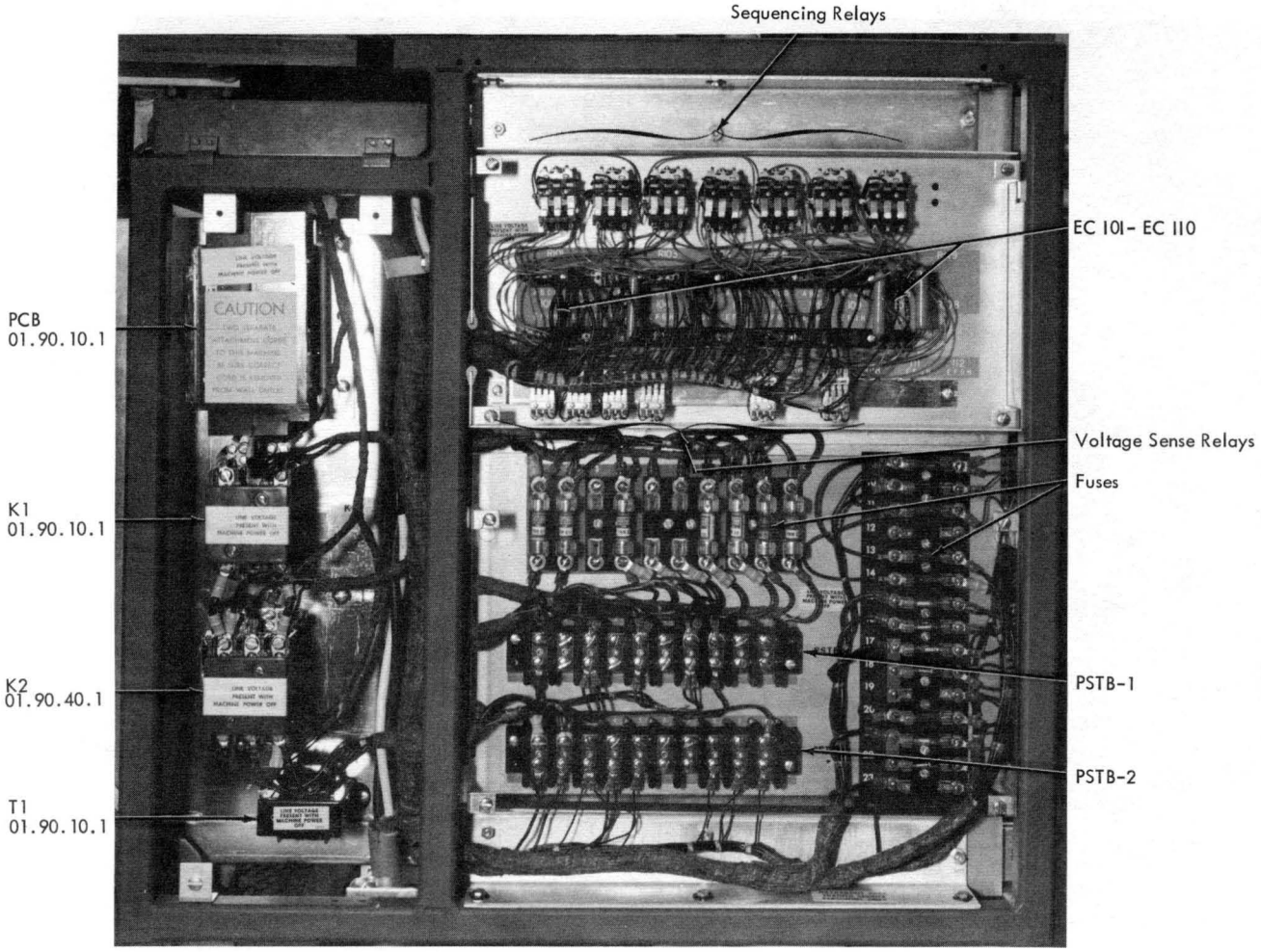


Figure 4-9. 1620 Right Side View

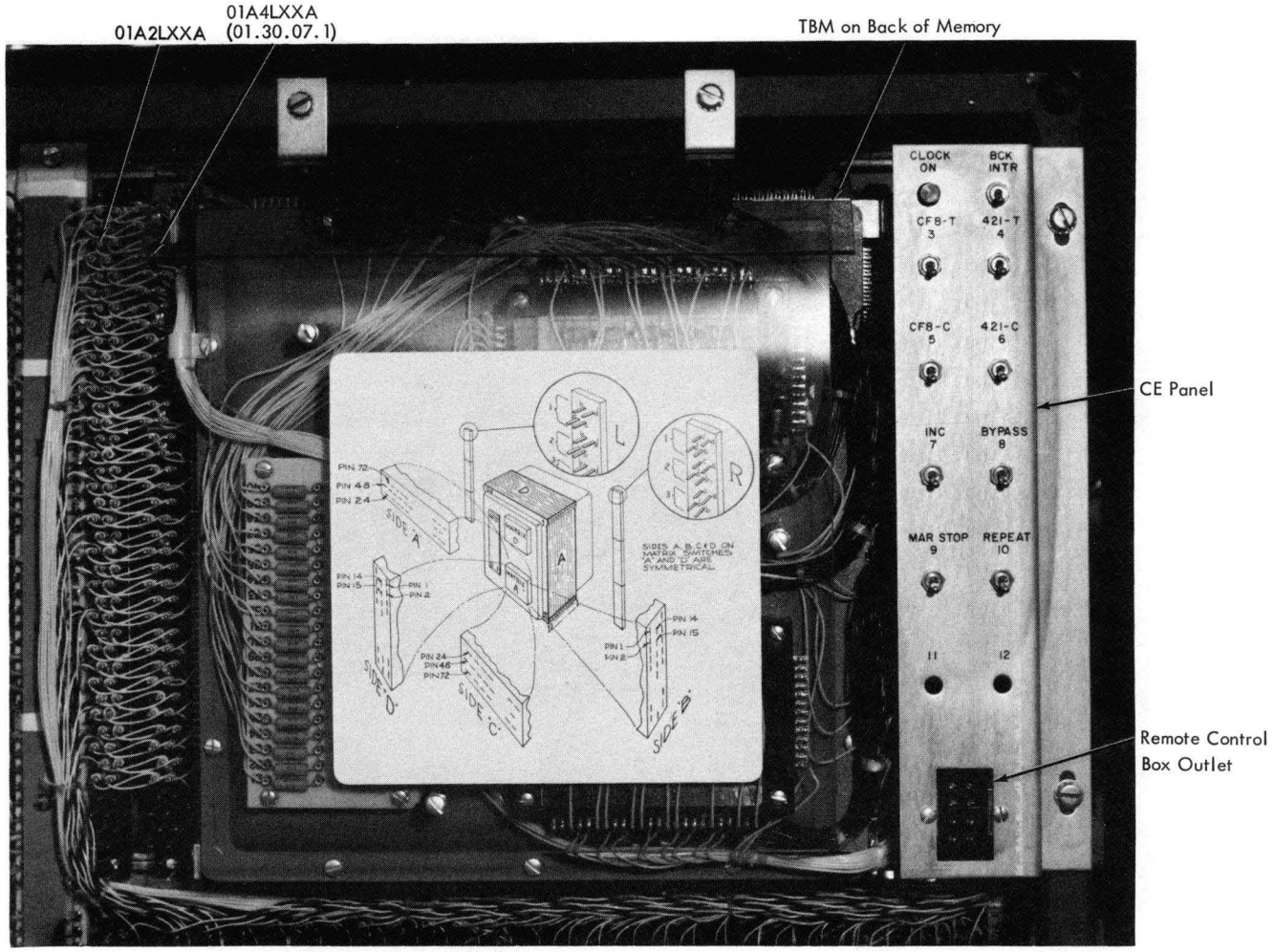


Figure 4-10. 1620 Memory - Rear View

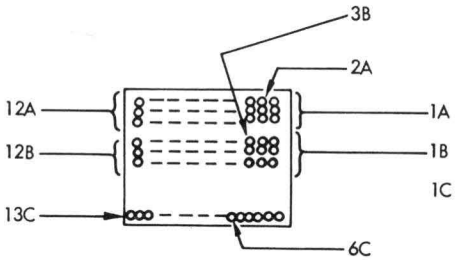


Figure 4-11. Wiring Side of Wire Relay Type Terminal Block

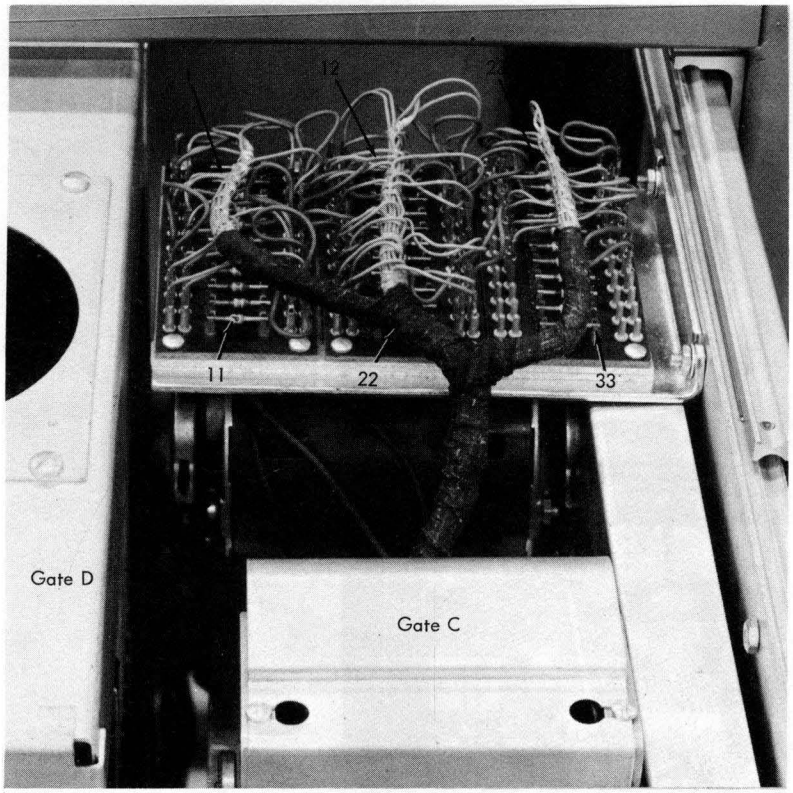


Figure 4-12. 1620 Gate C Diode Board Identification

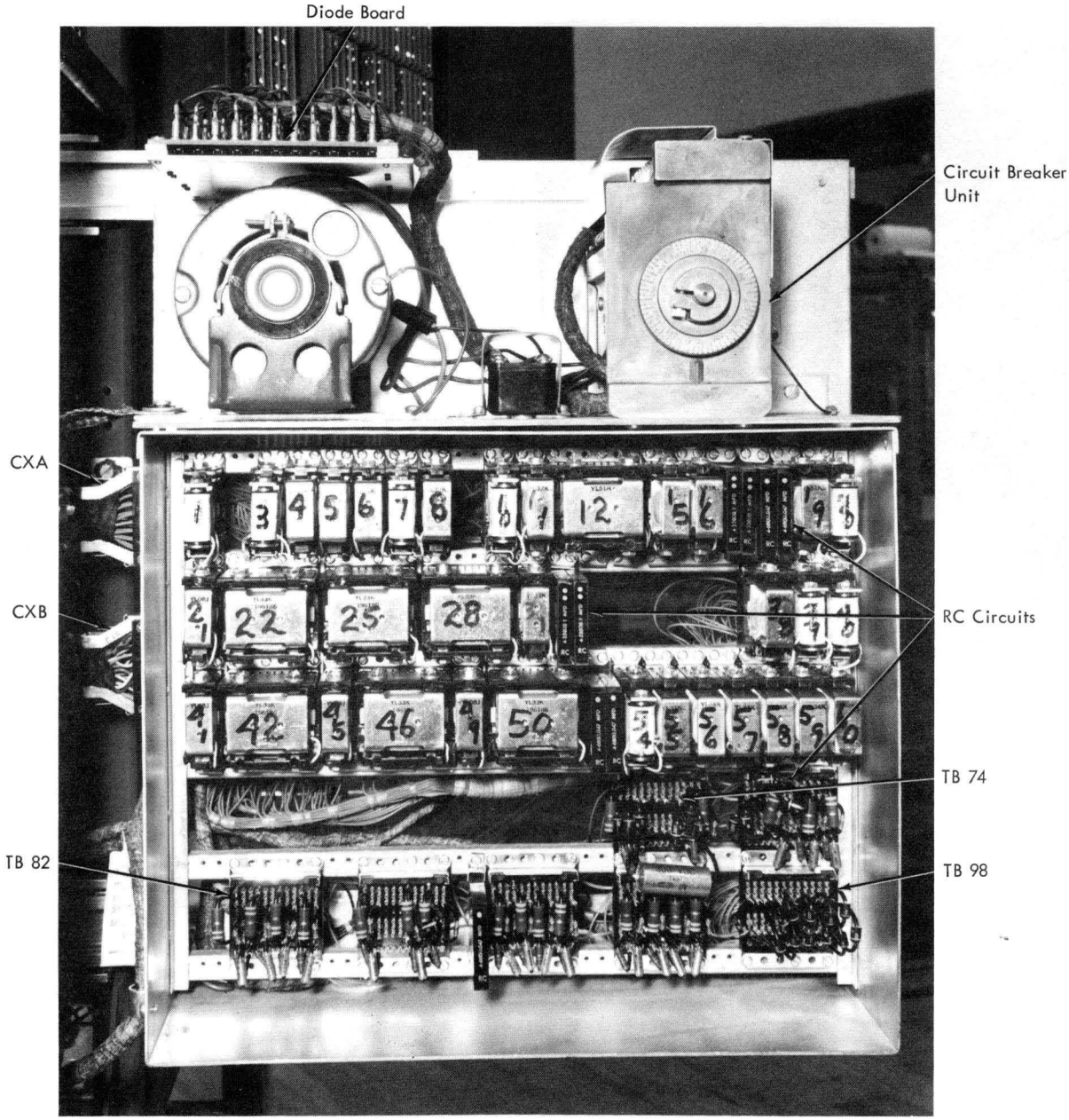


Figure 4-13. Gate C Relays and RC Blocks

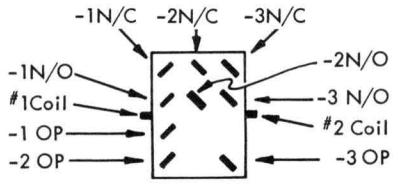


Figure 4-14. Sequencing Relay Terminal Numbering

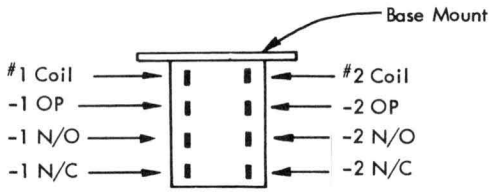


Figure 4-15. Voltage Sense Relay Terminal Numbering

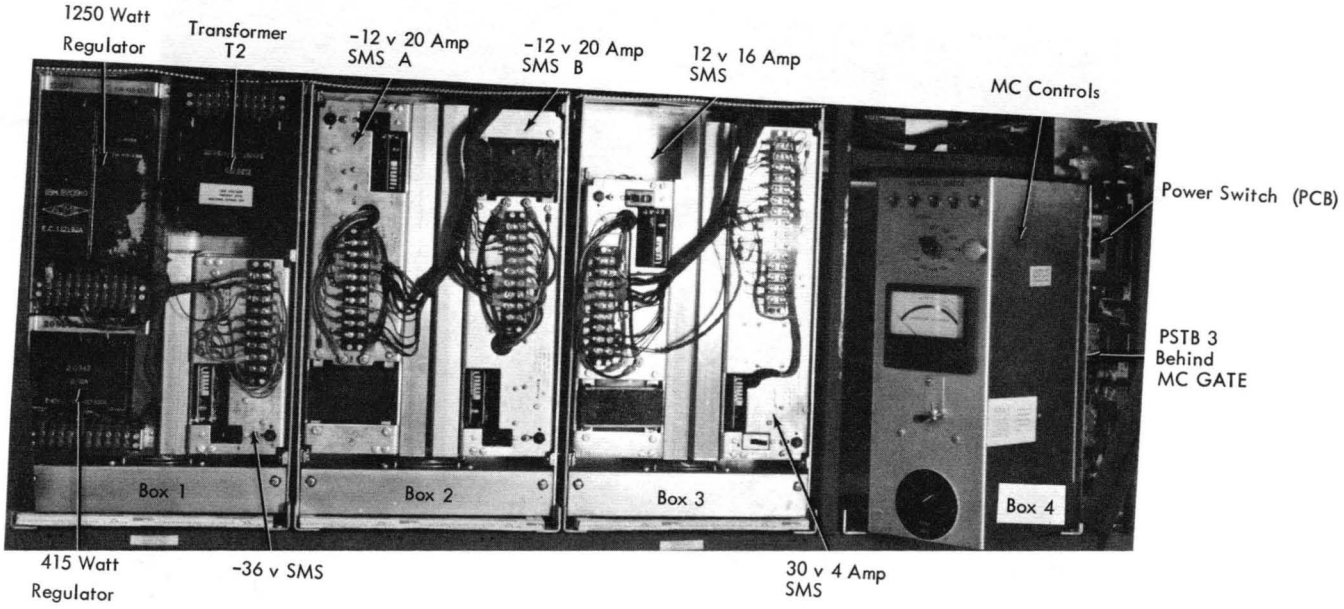


Figure 4-16. Power Supplies

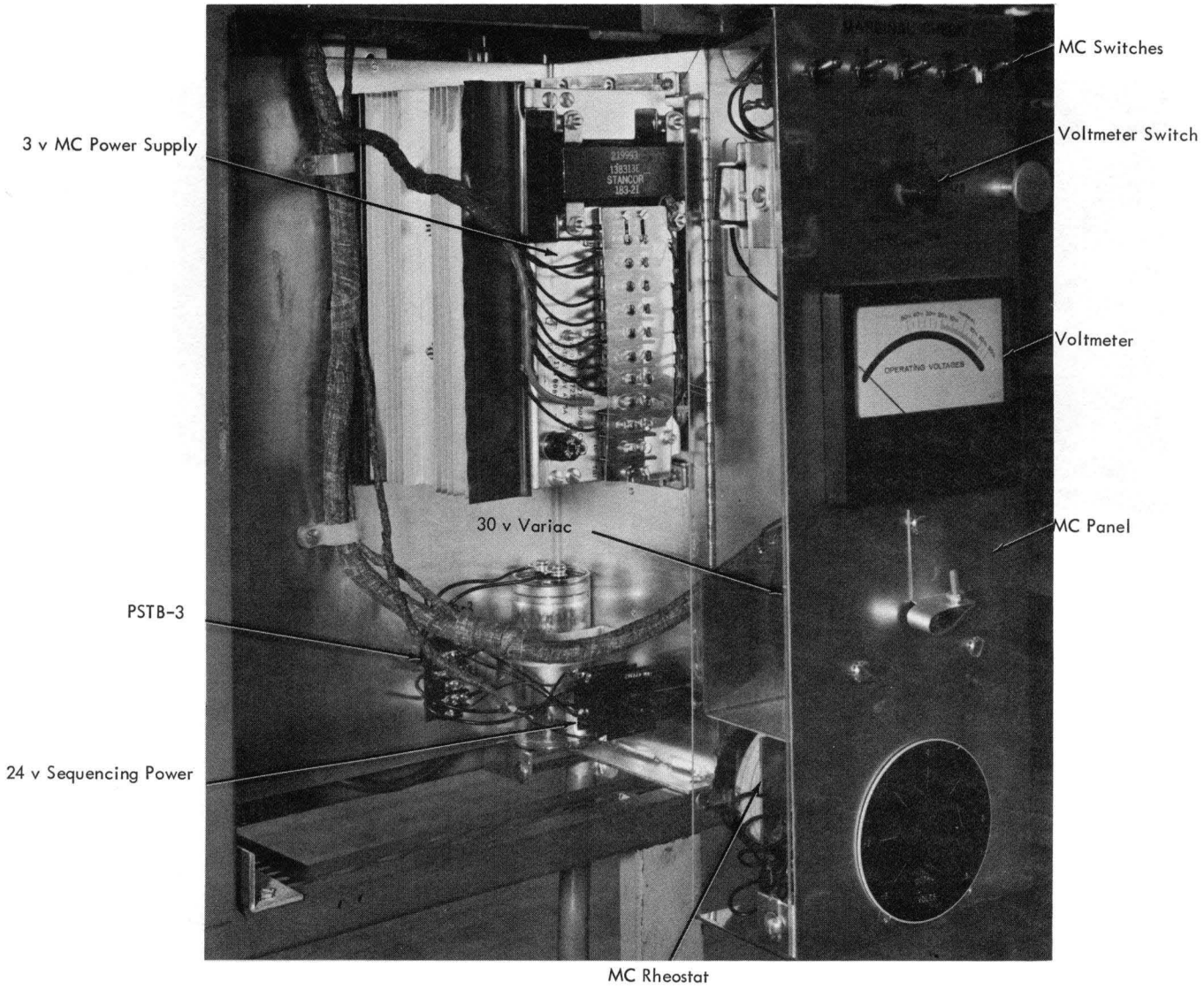


Figure 4-17. Box 4, Marginal Power Supply Controls

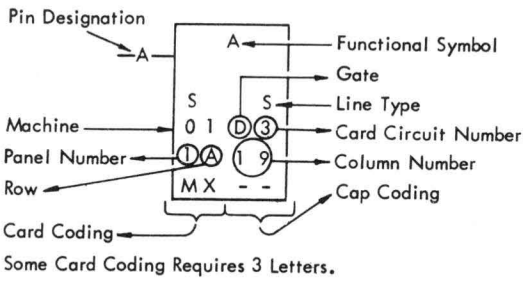


Figure 4-18. Hand-drawn Logic Block Coding

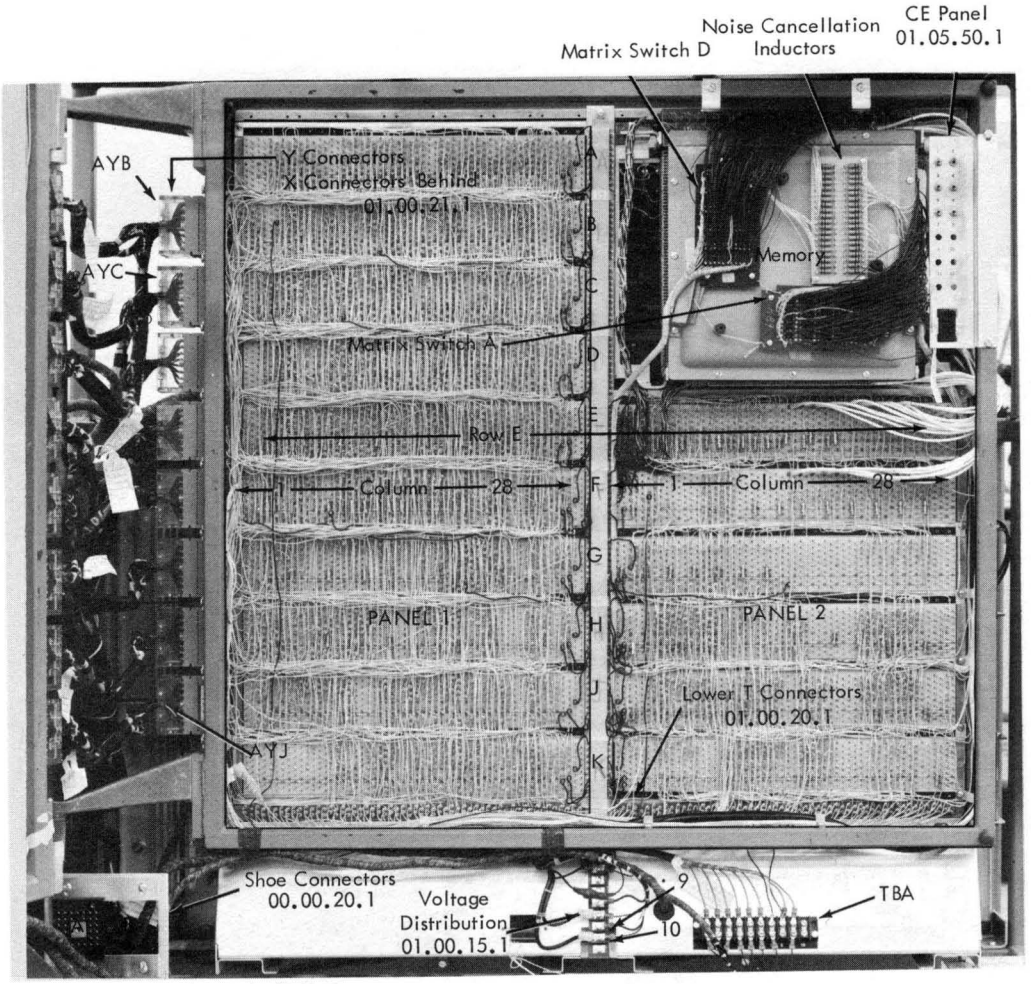


Figure 4-19. Gate A Prior to Serial 10701

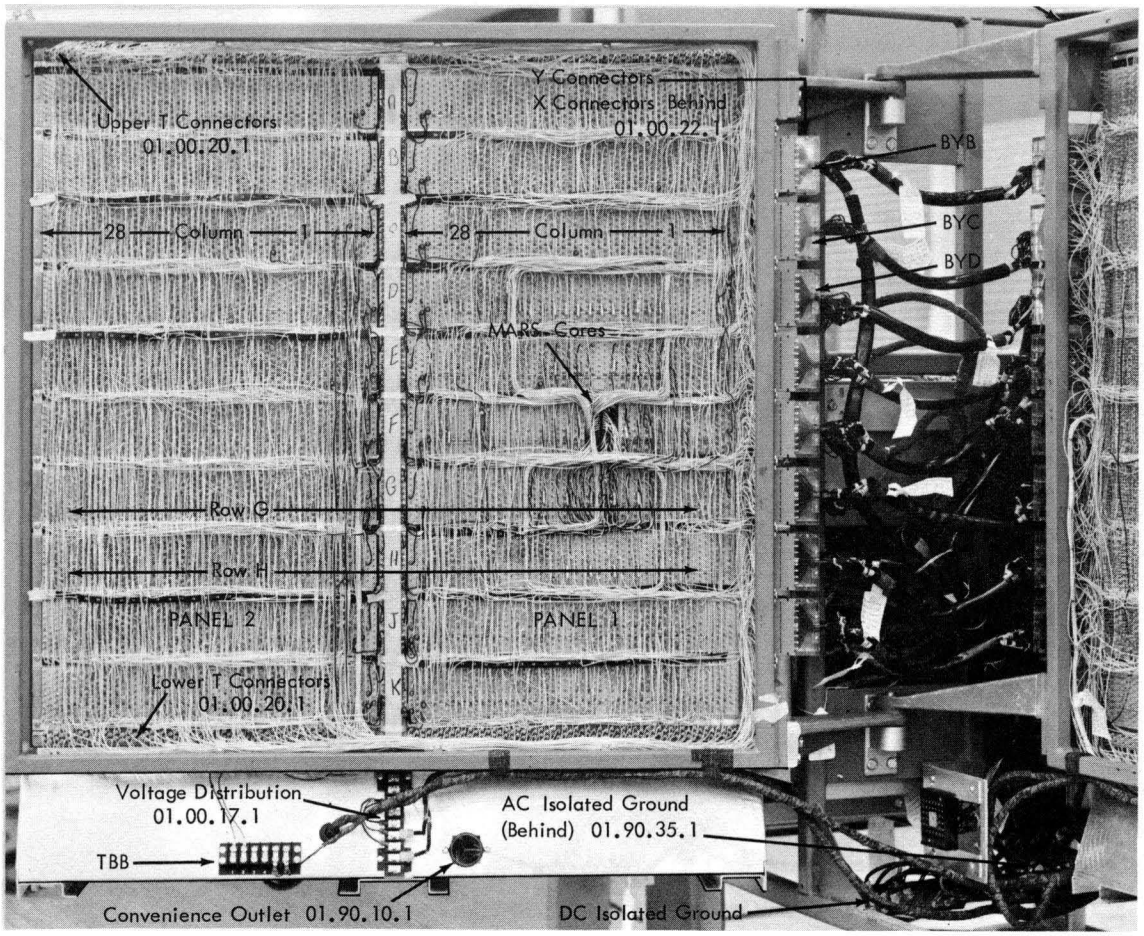


Figure 4-20. Gate B Prior to Serial 10701

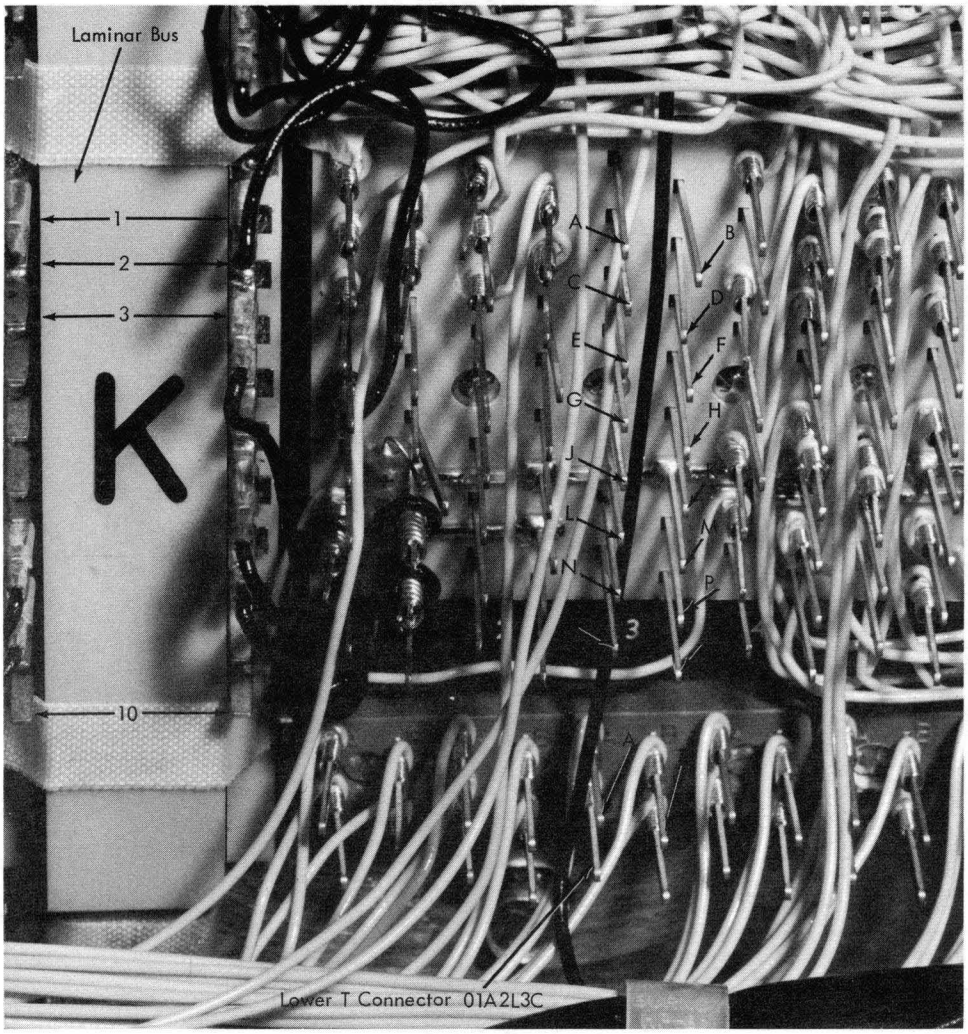


Figure 4-21. Terminal Identification Prior to Serial 10701

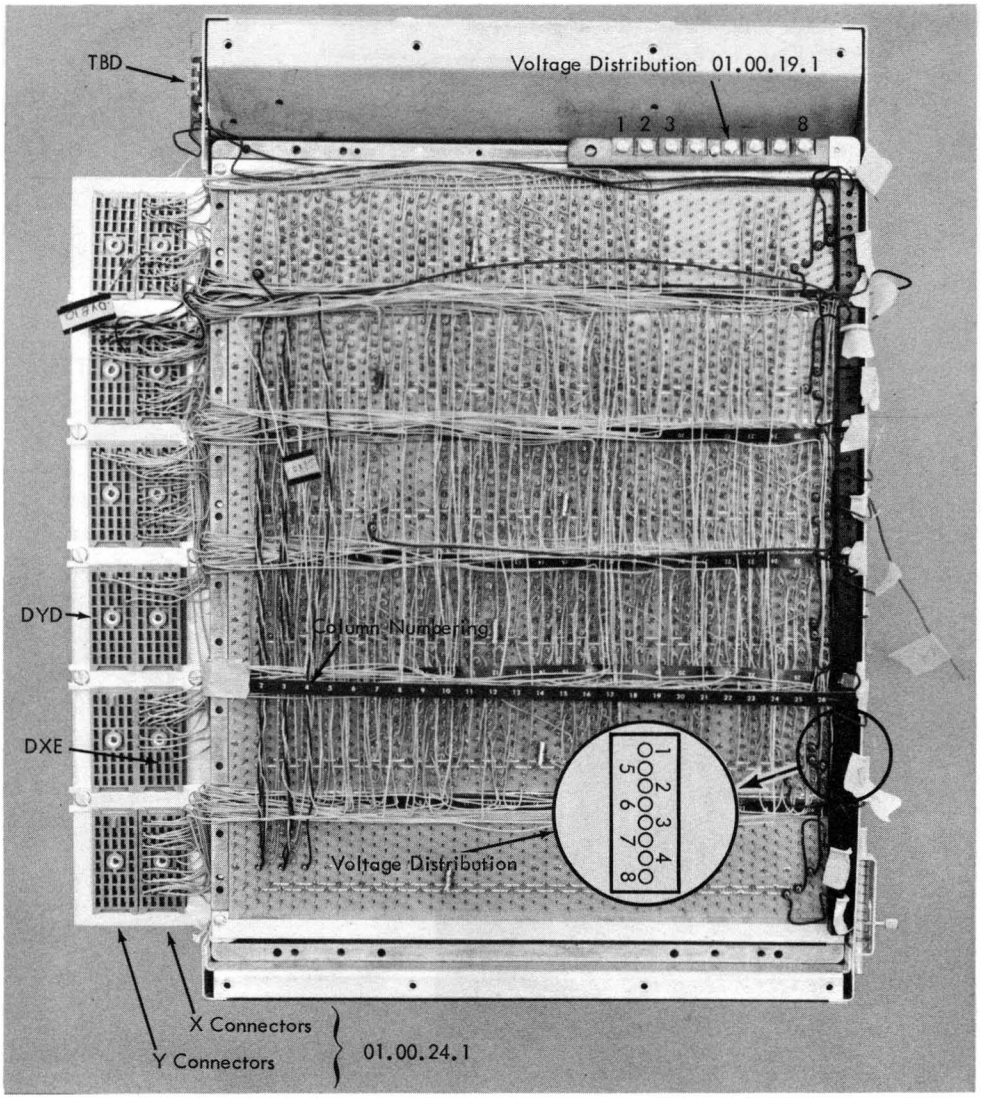


Figure 4-22. Gate D Prior to Serial 10701

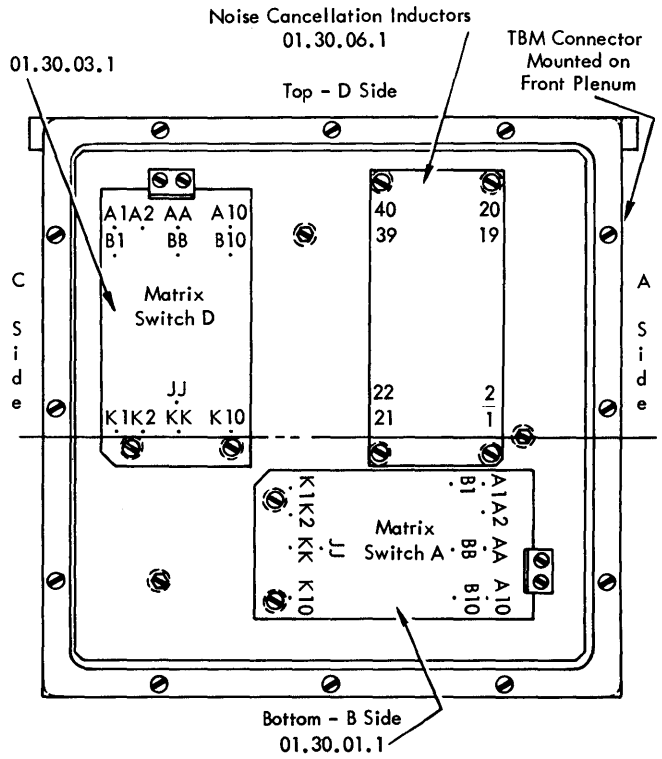


Figure 4-23. Memory Unit Prior to Serial 10474

CONTENTS

5.1 ADDITIONAL INSTRUCTIONS AND FUNCTIONS

5.1.1 Divide and Load Dividend

The divide and load dividend instructions require the addition of SMS cards in specified locations. The basic 1620 is pre-wired for this feature. Diagnostic Test CU01 includes divide and load dividend.

5.1.2 Transfer Numerical Strip, Transfer Numerical Fill, and Move Flag

These instructions require the addition of SMS cards in specified locations. The basic 1620 is pre-wired for this feature. Diagnostic Test CU05 provides a test of the three instructions.

5.1.3 Indirect Addressing

The indirect addressing feature requires the addition of SMS cards in specified locations. The basic 1620 is pre-wired for this feature. Diagnostic Test CU03 provides a test of this function.

5.1.4 Floating Point

The floating point feature requires the addition of SMS cards in specified locations. The basic 1620-10951 (F Suffix) and later is pre-wired for this feature. Diagnostic Test CU06 provides a test for this feature.

5.2 ADDITIONAL PERIPHERAL EQUIPMENT

5.2.1 IBM 1622 Card Read-Punch Unit

The basic 1620 is pre-wired for the card read-punch unit. Installation of the 1622 requires the addition of SMS cards in specified locations and connection of power and signal cables. Diagnostic Test IO02 and IO03 are provided for testing the 1622.

5.2.2 IBM 1623 Core Storage Unit

The basic 1620 is pre-wired for the Core Storage Unit. Installation of the 1623 requires the addition of SMS cards in specified locations and connection of power and signal cables. Diagnostic Test CU04 is provided for testing the 1623.

5.2.3 IBM 1621 Paper Tape Unit

The basic 1620 is pre-wired for the Paper Tape Unit. Installation of the 1621 requires the addition of SMS cards in specified locations and connections of power and signal cables. Diagnostic Tests CU01 and CU02 are provided for testing the 1621. The Paper Tape Punch may be added to the system by a single power-signal cable plugged into the 1621.

5.2.4 IBM 1626/1627 Plotter

The 1626/1627 may be added as additional peripheral equipment to any 1620. The basic 1620 is pre-wired for this feature as it uses the same circuits and connectors as the 1621. Installation of the 1626/1627 requires the addition of SMS cards in specified locations and connection of power and signal cables. Diagnostic Test 44 is provided for testing the 1626/1627.

5.2.5 IBM 1311-3 Disk Storage Drive Unit

The 1311 Model 3 may be added as additional peripheral equipment to any 1620-10701 (E Suffix) or later machine. Installation of the 1311-3 requires the addition of SMS cards in specified locations and connection of power and signal cables. Diagnostic Tests 20, 21, and 22 are provided for testing the 1311-3.

5.2.6 IBM 1443 Printer

The 1443 may be added as additional peripheral equipment to any 1620-10474 (D Suffix) or later machine. Installation of the 1443 requires the addition of SMS cards in specified locations and connection of power and signal cables. Diagnostic Test 43 is provided for testing the 1443.

NOTE: See Bibliography in Section 6 for the form numbers of Customer Engineering Publications pertaining to Additional Features.

CONTENTS

6.1 SHIPPING GROUP

The 1620 Shipping Group (B/M 2128599) includes special tools and supplies that are sent with the machine from the factory and are to be kept at the machine installation. Following is a partial list of items on the shipping group B/M.

	Form No.	Part No.
1620 Parts Catalog	127-0753	
B1 Maintenance Manual	223-6652	
1620 Maintenance Manual	227-5500	
Service Index	229-5012	
Core Chart	229-5013	
Diagnostic – Console Check		2128300
Diagnostic – CU01 Manual Pages		2128301
Diagnostic – CU02 Manual Pages		2128303
ILD – Test Manual Pages		2153200
Instruction – Meter Install		2165078
Glide – Frame Leg		2125564
Table Asm – Front		2128725

6.2 OFFICE TOOLS

The following tools will normally be located in the branch office and can be obtained when needed.

	Part No.
Meter, Simpson (Gen. CEM #57)	450497
Meter, 904 Weston, or equivalent (iron vane meter with low range voltage scale)	460880
Meter, 901 Weston (Model 1 is 1.0% precision; Model 2 is 0.25% precision)	460879
Scope Clip Assembly, black 12" (Gen. CEM #149)	2108156
Scope Clip Assembly, red 12" (Gen. CEM #149)	2108157
Wire Stripper	461075
Wire Stripper Stop (Gage)	461076
Scope dual input switch	450934
Scope, 310 Tektronix and accessories: Probe Attenuator – P6017-9' cable Binding post adaptor Filter Instruction Manual Viewing hood	450841
Test lead, 10' black	450840
Test lead, 10' red	450839
Probe, additional attenuator scope (Gen. CEM #90, #99, and #113)	451215
Probe, direct coaxial scope	461019
Probe tip	450778
Current Probe Adaptor	2108279
Current Probe (Gen. CEM #96 and #103)	2108282
Probe Feed Through Termination	2108281
Pistol Tool, Wire Wrapping (Gen. CEM #129)	461012
Wrapping Bit-Wire Size #24 (Gen. CEM #129 for other sizes)	461235
Sleeve Wire Size #24 (Gen. CEM #129 for other sizes)	461015
Paper Tape Gage	460005
Bare Wire Crimping Tool (Gen. CEM #39 and #55)	450898
No. 24 gage solid tin copper wire (in feet) (Gen. CEM #110 for other sizes)	216226
Hand Wire – Wrapping Tool (Gen. CEM #129)	451572
Soldering iron Tip-SMS Pin Removal (Gen. CEM #66)	451111
Hand Crimping Tool – Burndy (Gen. CEM #64)	461034
Typewriter Oil (Gen. CEM #175)	460052

6.3 TOOLS FOR SMS SERVICING

This list names the tools and supplies which are not shipped with the machine and should be ordered for each installation.

	Part No.
Un-Wrap Tool (Gen. CEM #129)	451573
Card Extender – Cable Isolation Tool (Gen. CEM #69)	451075
SMS Card Contact Lubricant	451053
SMS Card Insertion – Extraction Tool (Gen. CEM #50)	451030
Hand Wrap Tool (blue) #24/#26 (Gen. CEM #129)	451142

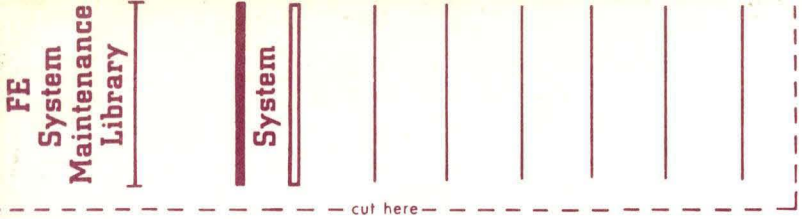
Refer to General CEM's for latest information on newly released SMS tools and supplies.

6.4 BIBLIOGRAPHY

Form No.	Type*	Manual Name
227-5751	CEMI	IBM 1620 Data Processing System, Model 1
227-5769	CEISD	IBM 1620 Data Processing System, Model 1, Vol. I
227-5770	CEISD	IBM 1620 Data Processing System, Model 1, Vol. II
227-5771	CEISD	IBM 1620 Data Processing System, Model 1, Vol. III
227-5812	CEMI	IBM 1620 Data Processing System, Model 1, Automatic Divide Feature
227-5813	CEMI	IBM 1620 Data Processing System, Model 1, Indirect Addressing Feature
227-5814	CEMI	IBM 1620 Data Processing System, Model 1, Additional Instructions Feature
227-5815	CEMI	IBM 1620 Data Processing System, Model 1, 1621 Paper Tape Unit Feature
227-5816	CEMI	IBM 1620 Data Processing System, Model 1, 1622 Card Read-Punch Feature
227-5818	CEMI	IBM 1620 Data Processing System, Model 1, 1443 Printer Feature
227-5819	CEMI	IBM 1620 Data Processing System, Model 1, 1626-1627 Plotter Feature
227-5630	CEMI	IBM 1620 Data Processing System, Model 1, Floating Point Feature
223-6900	CEIMM	Standard Modular System
227-5715	CEMM	IBM 1622 Card Read-Punch Unit
S27-5831	CEMM	IBM 1622 Supplement to 227-5715
227-5612	CEISD	IBM 1622 Card Read-Punch Unit
227-5711	CEMI	IBM 1621 Paper Tape Unit
227-5712	CEMM	IBM 1621 Paper Tape Unit
S27-5830	CEMM	IBM 1621 Supplement to 227-5712
225-3056	CEMI	IBM 1443 Printer
225-3032	CEMM	IBM 1443 Printer
227-5721	CEIMM	IBM 1626 Plotter Control Unit and IBM 1627 Plotter
227-5738	CEMI	IBM 1710 Control System
227-5737	CEMM	IBM 1710 Control System
227-5703	CEMI	IBM 1311 Disk Storage Drive
227-5705	CEMI	IBM 1311 Model 3 Controls
227-5649	CEMM	IBM 1311 Disk Storage Drive
227-5679	CEMI	IBM 1713 through IBM 1717
227-5680	CEMM	IBM 1710 Attached Units (1713 through 1717).
223-6652	CEMM	IBM Typewriter, Model B1
229-5012		IBM 1620 Service Index
229-5013		IBM 1620 Core Chart
A26-5692		Systems Reference Library IBM 1620 Bibliography
A26-5695		Systems Reference Library IBM 1710 Bibliography
223-6725	CEMI	Tektronix Oscilloscopes
223-6889	CEMI	Transistor Component Circuits
223-6783	CEMI	Transistor Theory and Application
223-6794	CEMI	Transistor Theory Illustrated
225-6478	CEMI	60 Cycle SMS Power Supply

*Type

CEMI	Customer Engineering Manual of Instruction
CEMM	Customer Engineering Maintenance Manual
CEIMM	Customer Engineering Instruction Maintenance Manual
CEISD	Customer Engineering Instructional System Diagrams



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