COPY No.

UNIVAC® I

MAINTENANCE MANUAL

For Use With

Univac I Central Computer

Remington Rand Univac®
DIVISION OF SPERRY RAND CORPORATION
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UNIVAC® I

MAINTENANCE MANUAL

For

Univac I Central Computer Group

2434

INTRODUCTION

Remington Rand's Univac® I electronic data-automation system includes two major groups of equipment, the Central Computer and the input-output auxiliaries.

The Central Computer group comprises the computer and its power supply, the supervisory control console, and up to ten Uniservos.

The input auxiliaries accept typewritten, punched card, or punched paper tape information and place it on a magnetic tape.

The output auxiliaries translate data from the magnetic tape into whatever form the user wishes: typewritten, punched card, or punched paper tape.

Magnetized areas on magnetic tape are the only direct means of communication into and out of the Central Computer. The computer controls the flow of information in both directions.

A Univac I system installation is shown in the frontispiece. Although each system is individually installed, there are characteristics common to all. These include: the grouping of the supervisory control console group into the control panel and keyboard, the monitor oscilloscope, and the control printer; placement of an overhead wiring conduit from the right side of the computer to the group of Uniservos; access to the electronic components of the computer through the casework doors; and in most models placement of the power supply lines from the top of the computer down to the power distribution area in the false floor.

This manual gives details of the physical aspects of the Univac I system (Section I), built-in servicing aids (Section II), external servicing aids (Section III), maintenance (Section IV), and system analysis (Section V).

SECTION I
PHYSICAL DESCRIPTION

1-1. GENERAL

1-2. Remington Rand's Univac® I electronic data-automation system is modular in construction, which facilitates the location and repair of defective components, and the tracing of connections. Part numbers and wiring indications shown on schematic diagrams are derived from the mounting positions of the components. Once this modular system is understood, components can be readily located by referring to the schematic drawings.

1-3. CENTRAL COMPUTER LAYOUT

1-4. MODULES

1-5. The over-all layout of the Central Computer is shown in figure 1-1.

1-6. The largest structural module is a bay of equipment 2 feet, 4 inches wide, 7 feet, 2 inches high, and 3 feet, 10½ inches deep. Most of the equipment in the Central Computer is contained in 13 of these bays, mounted on the four sides of a rectangle as shown in figure 1-2. Bays are lettered as indicated in the drawing. Corner sections derive their names from adjacent bays.

1-7. The section is the second module of the system. There are three sections, designated T, V, and X from top to bottom, in each bay. In each section there is room for 12 removable chasses, numbered from 1 to 12, and two fixed fuseboards, numbered 13 and 14 (figure 1-3).

1-8. The chassis is the third module of the system. Each chassis contains mounting positions for 14 vacuum tubes and a large number of the basic electronic components which make up the circuitry: resistors, capacitors, inductors, diodes, and so forth. A chassis can be removed for servicing.

1-9. CABLING

1-10. In early systems all alternating and direct current comes to the computer from the power supply. In later systems (those which use chilled water to cool the air), only direct current comes to the Central Computer from the power supply; alternating current is brought to both power supply and Central Computer directly from the power-input installation.

1-11. The cables bringing the power into the Central Computer are terminated in terminal strips under the computer floor. Output leads from these strips are bound into a cable called the power harness. This harness runs completely around the base of the computer, delivering to each bay whatever voltages are required.

1-12. Signal lines from the supervisory control console enter the computer under the floor and terminate in connectors along the right side of the main access door. Computer signal lines from these plugs enter the low-speed wiring harness, around the top of the computer.

1-13. Certain signals that would be badly attenuated in the low-speed harness travel from bay to bay by the shortest route possible. This direct-route, high-speed wiring travels across the backs of the bays, and across the top of the computer if necessary. Coaxial cable is also used. This runs by the most convenient route, either directly or in the low-speed harness.

1-14. Across the top of the Central Computer there is a metal screen, on which standoff posts for the high-speed wiring are mounted. Around the edge of the roof sheet are mounted selenium diodes, which protect the clamping diodes in the equipment from overloads. A metal hood covers the roof.

1-15. COOLING

1-16. The Central Computer, power supply, and Uniservos are air-cooled. In the central computers of some early installations, blowers force air up into a space under the raised floor of the computer. This floor prevents the air from flowing into the central space of the computer and forces it to flow up past the sides of the computer, where the heat is most concentrated (figure 1-4). The air stream then passes into ducts at the top of the computer. These ducts carry the heated air out of the building. The air-cooling system is necessarily open, since fresh air is required constantly.

1-17. In newer installations, a closed air-cooling system is used. Air circulating inside the computer housing is alternately heated by the computer components and cooled by heat exchangers mounted at the bottom of each bay. Cool water is forced through the heat exchangers to dissipate the heat.

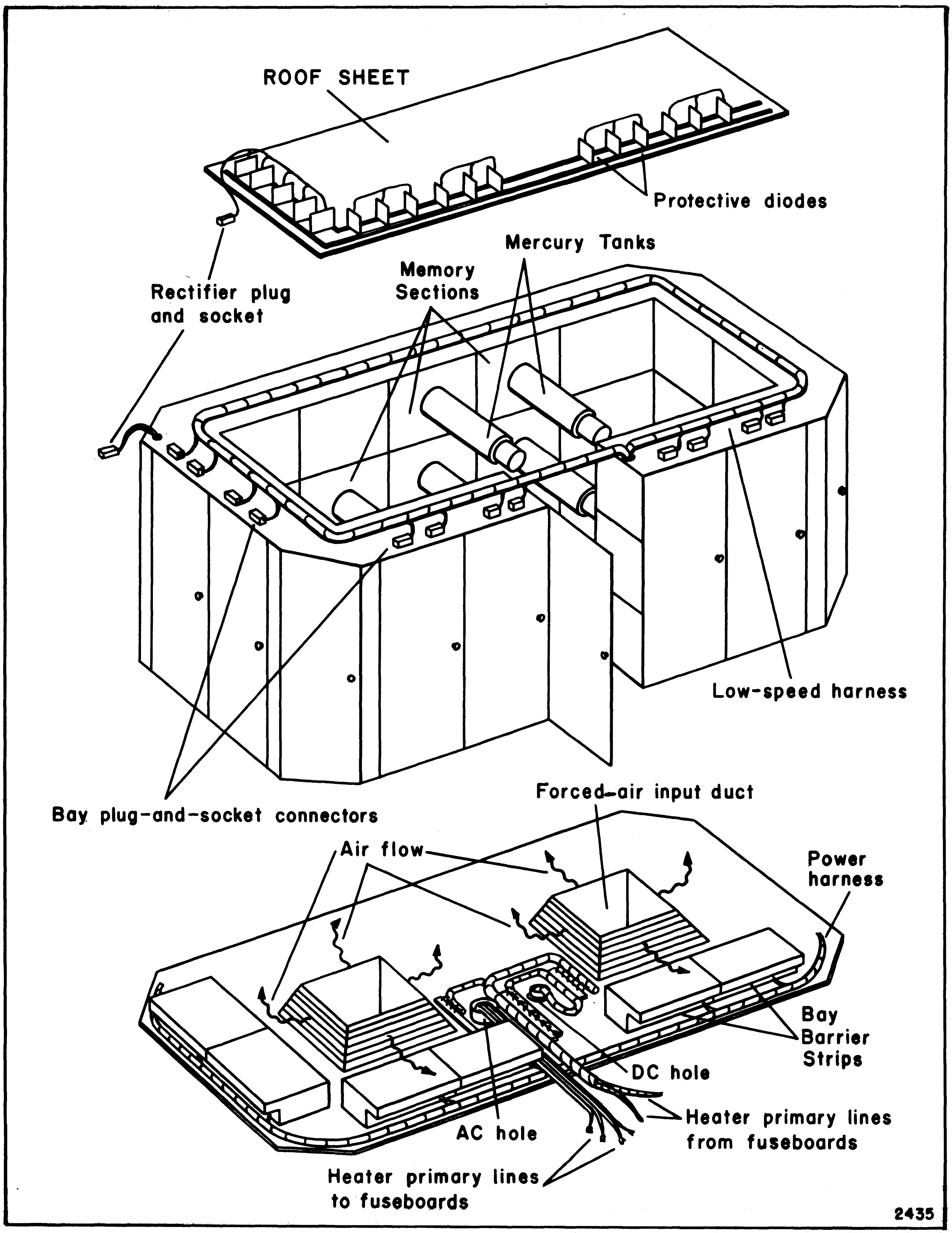

Figure 1-1. Exploded View of Univac I Central Computer

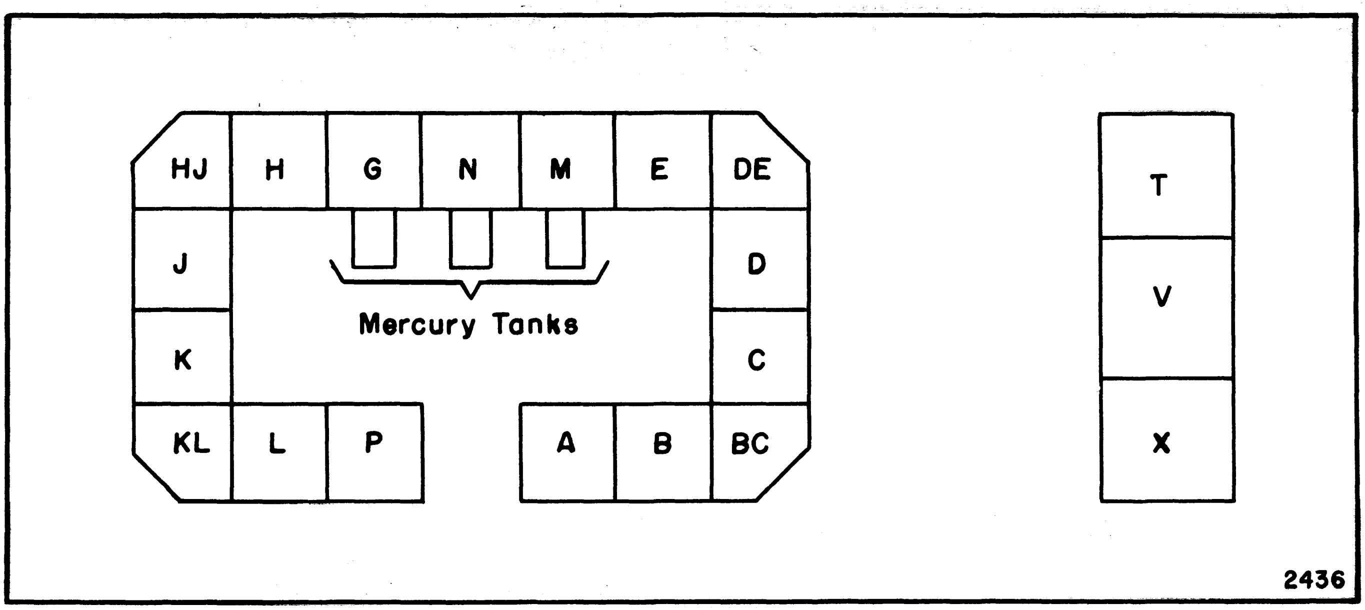

Figure 1-2. Bay and Section Layout of Univac I Central Computer

1-18. The air circulates in a closed loop as indicated in figure 1-4. Blowers mounted under the computer floor draw air from inside the computer through grills in the floor and force it across the heat exchangers in the bottom of the computer. The cooled air then passes up across the fronts of the bays, where the greatest concentration of heat-producing elements is. The heated air is then drawn over the tops of the bays into the hood, down through the roof sheet, and back to the blowers.

1-19. CHASSIS

1-20. The fundamental unit of modular construction in the system is the chassis (figure 1-5). The chassis is a prepunched aluminum channel with mounting positions for 14 tubes. These positions are numbered 1 to 14 from top to bottom. Mounted on this channel with 4½-inch spacers is a backboard with 87 numbered holes. Between the backboard and the channel are two internal-component boards mounted back to back. Along each long edge of the component boards are 52 mounting lugs, numbered 1 to 52 from top to bottom. Components are soldered between two lugs of like number. The rows of lugs are labelled K, J, M, and N. Rows M and J are next to the channel, while K and N are next to the terminal board. Components mounted on these boards derive part numbers from the mounting positions. Thus RN42 is a resistor (R) one end of which is connected to lug 42 on row N. There may also be lugs along the center line of the board. These lugs are labeled H on the JK component board and L on the MN board. They provide space for mounting very small components, such as diodes (for example, DM18 and DN18 in figure 1-5). Only low-wattage components are mounted on these internal boards, since cooling is less effective in this area.

1-21. The tube side of the chassis is mounted directly in the air stream, so as to take fullest possible advantage of the cooling. A maximum of four additional component boards can be mounted on this tube side of the chassis, in combinations of seven possible locations. These additional boards accommodate high-wattage components which must be cooled. Also, since the technician can reach these boards easily, test points

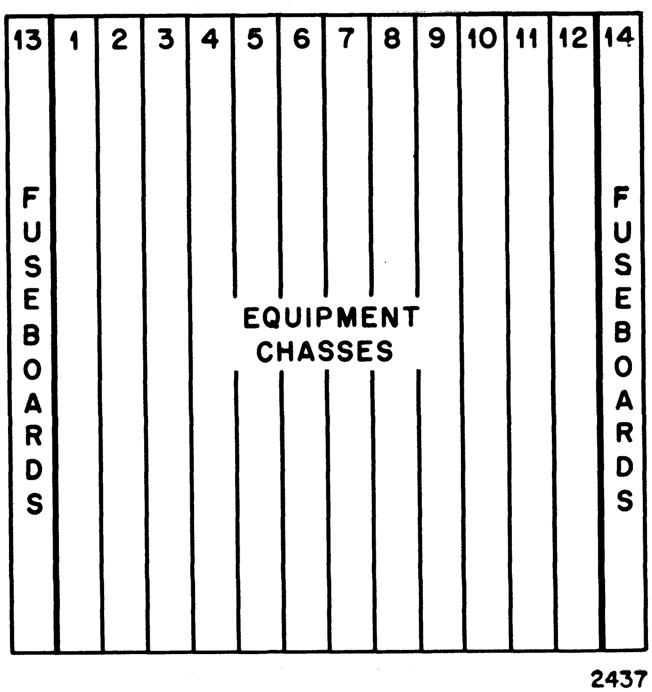

Figure 1-3. Standard Section Layout

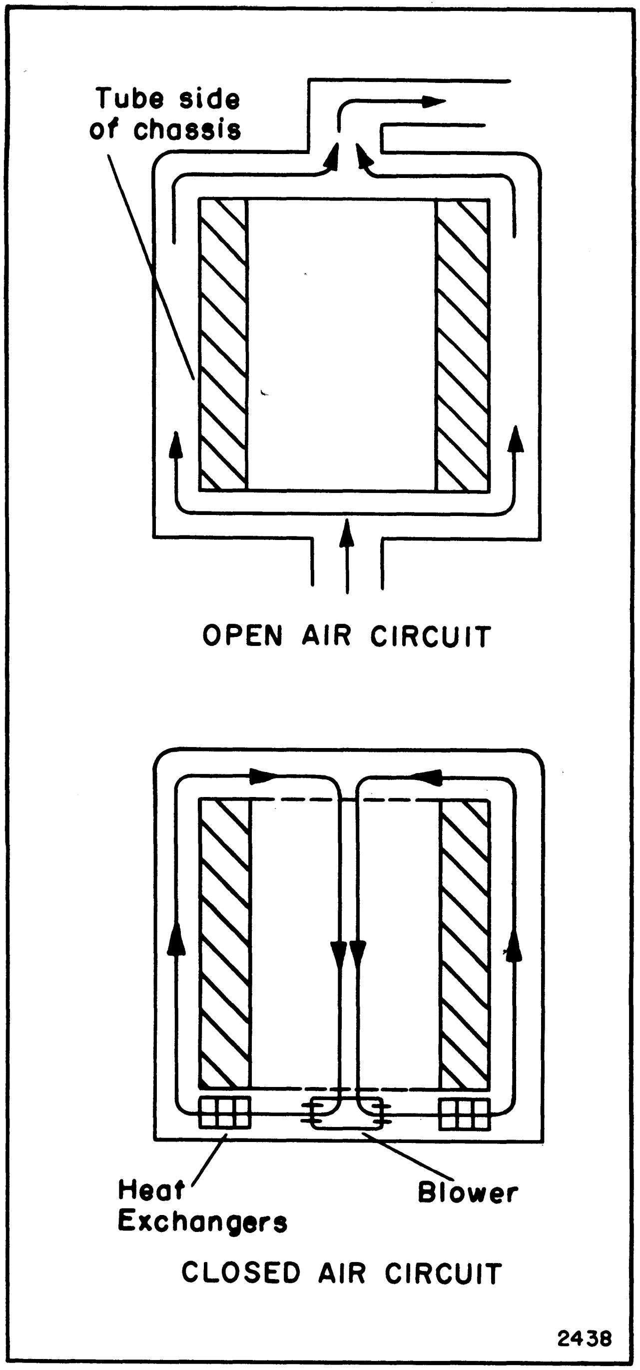

Figure 1-4. Cooling Systems

and indicator neons are brought out to them. The seven possible locations for these external-component boards are labelled A through G. The boards are mounted on the right side of the channel, on the tube side of the chassis. Each of these boards has two rows of eight lugs each.

1-22. The lugs next to the channel are numbered 1 through 8; those away from the channel are numbered 11 through 18. Again, parts derive numbers from the mounting position on these boards. Usually the outer lugs are used for part numbering. Thus NG15 is a neon lamp mounted between lugs G5 and G15. When the chassis is in position these lugs can be used conveniently as test points for meter and scope readings, since important signals such as gate and flip-flop outputs appear at them. Test terminals are indicated on schematics and blocks as short diagonal lines numbered according to board and terminal numbers.

1-23. The chassis backboard mates with a similar backboard mounted on the section framework of the computer. In order to identify each chassis in the equipment, and to prevent its being inserted in the wrong location, a system of coded key pins and holes is used. The key pins are mounted in the fixed backboards while chassis backboards contain the holes. Figure 1-5 shows the location of the coded key pins and holes. Just ahead of number 1 terminal are alphabetic positions, one for each bay and S for servo, plus T, V, and X to designate section. At the other end of the backboard are 12 numerical positions where the chassis number is specified. Thus a chassis with holes E, T, and 12 can be mounted only in position E12T. Duplicate chasses are exceptions to this rule.

1-24. If the part-numbering information for a given component is specified on a schematic drawing, the part can be located easily on the equipment. There is only one A4X-V12, for example, in the entire system. Note that the component mounted in this position is not necessarily a vacuum tube. It is simply the part mounted in the V12 position on chassis A4X. It may be a delay line, a relay, or some other part that fits in the space provided. Backboard terminals are similarly specified, as, for example, B4X50 (terminal 50 on chassis B4X). Complete wiring layout drawings are available for each chassis.

1-25. Double-width chasses are used in the Central Computer whenever it is necessary to mount components which will not fit on a single-width chassis. On schematics, both positions are specified; for example, E10 and 11T. The extender shown in figure 1-5 is used to bring the chassis out beyond the section for servicing.

1-26. A slightly different chassis is used on the memory tanks. For details, refer to paragraph 1-75.

1-27. SECTION LAYOUT

1-28. Twelve of the chasses described in paragraphs 1-20 through 1-24 are mounted together in a section. In most cases, the power lines are fused as they enter the section. There are exceptions, however. Wherever a voltage is used in only one or two chasses in a section, it may be fused through another section in the same bay. This possibility should be considered in troubleshooting a fuse fault.

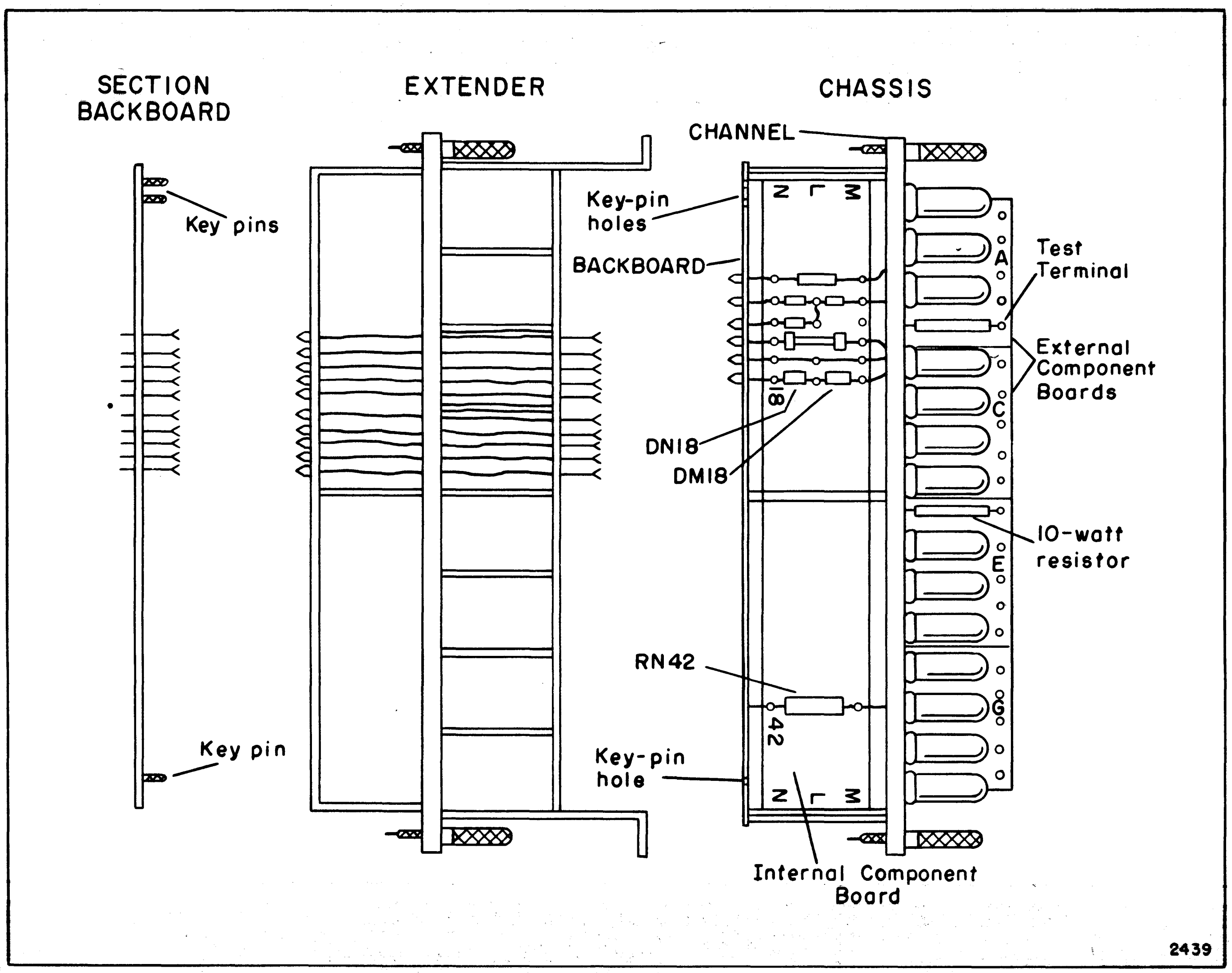

Figure 1-5. Standard Chassis Input, Side View

1-29. Direct current comes from barrier strips located at the bottom of the bay, while filament voltage comes from the secondaries of heater transformers mounted on the pillars between bays (paragraph 1-58). Direct-current and heater fuses are mounted on fuseboards 13 and 14, on the extreme left- and right-hand channels of the section (figure 1-6). Each fuseboard contains 26 pairs of terminals, numbered from 1 to 26. The input terminals are labelled F, while the output terminals are labelled W. Thus 13F25 designates the input terminal of fuse-position 25. A center terminal, labelled Q, is also available for the alarm contacts of grasshopper fuses (paragraphs 2-265 and 2-275).

1-30. Power wiring reaches and leaves the fuseboards through a pair of holes in the interbay channel underneath the center of the fuseboard. From here, power lines to the backboard run by way of the holes in the back of the section into a duct which croses the middle of the backboard, and then to specific backboard terminals (figure 1-7). Voltages are brought into the fuseboards in an ascending order which places the negative voltage at the bottom of fuseboard 13, and the highest positive voltage at the top of fuseboard 14.

1-31. The fuseboards have plastic covers to prevent personnel from coming in contact with voltages. These covers and the access doors are wired in series to form d-c interlock. (The door interlocks can be bypassed for serving the bays while power is on. Refer to paragraph 2-285.)

1-32. Around the four sides of the rear of a section are inter-section pin boards. These provide tie-points for the high-speed wiring as it passes from one section to another. Refer to paragraph 1-67 for further details. Component boards identical to the external component boards mounted on the chassis can be mounted at the top and bottom of each section. These are known as bypass and cable-termination boards, since for the

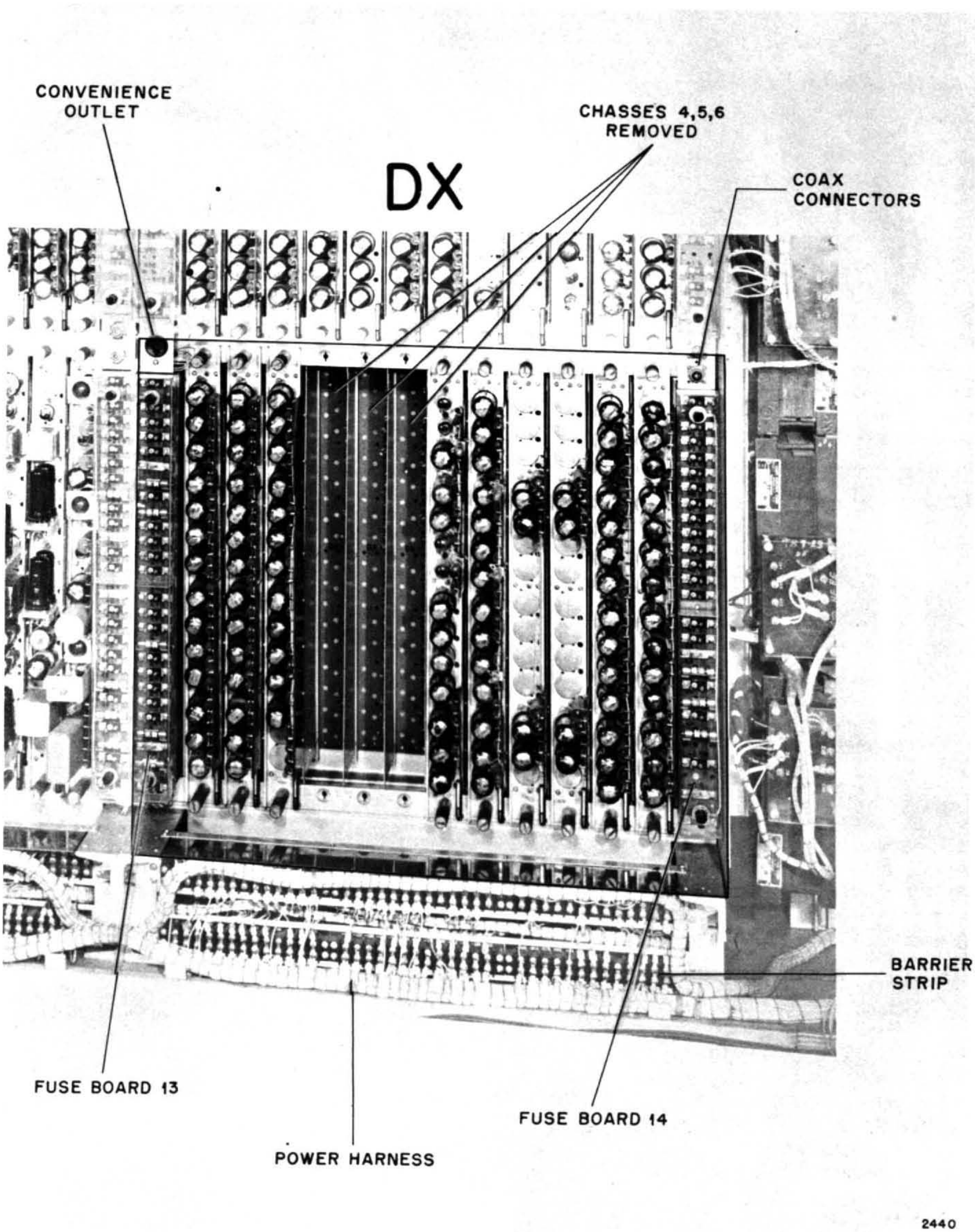

Figure 1-6. Section Detail

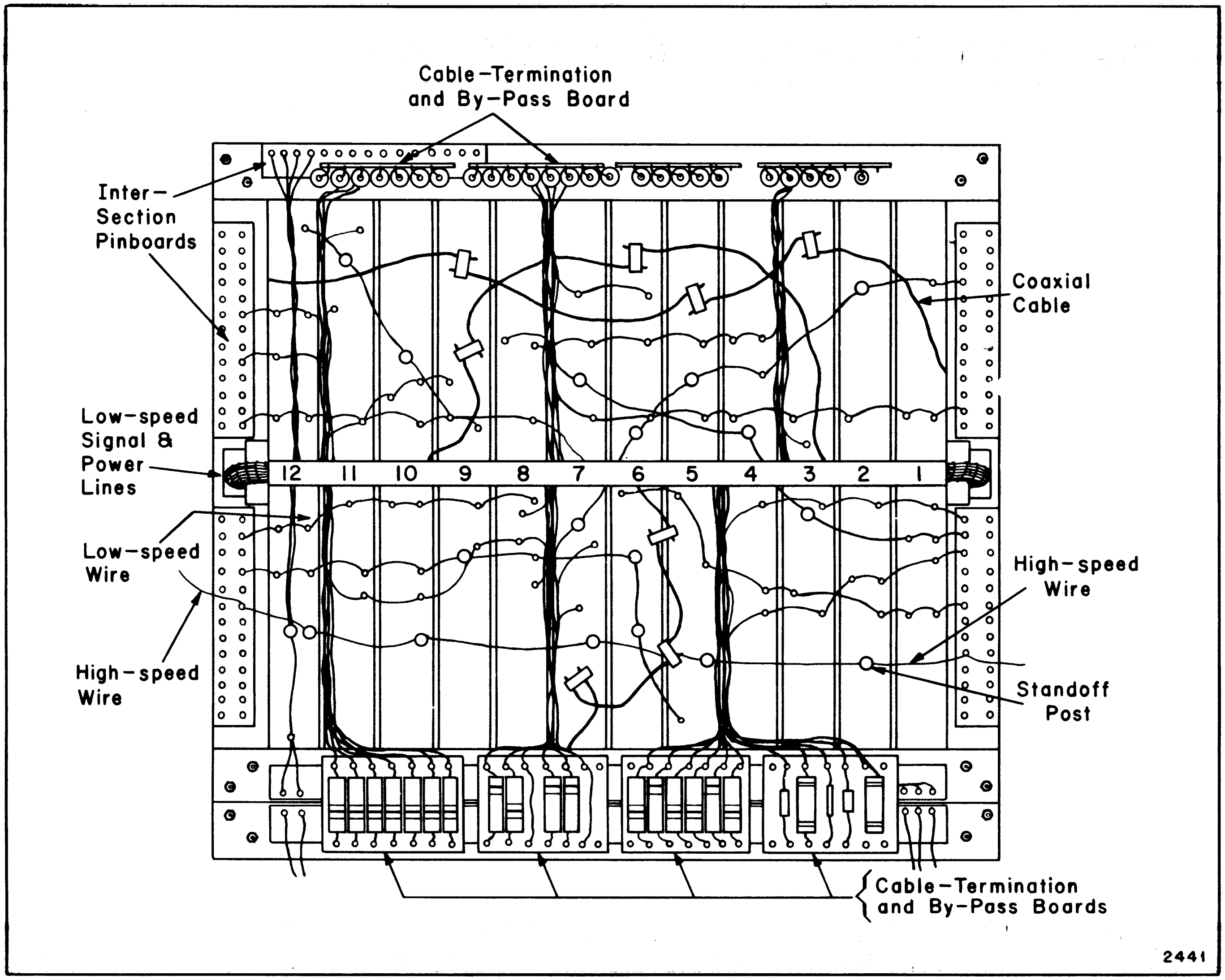

Figure 1-7. Section Detail, Rear View

most part they contain bypass capacitors for d-c inputs and terminating networks for coaxial cables.

1-33. The four possible locations for these boards are labelled A, B, C, and D from left to right facing the backboard. If there is need for more than four, extra boards are mounted on spacers extending beyond the original four boards. These are called A′, B′, C′, and D′. There may be as many as three layers of these boards. The layer closest to the backboard belongs to the section below. The two outer layers belong to the upper section.

1-34. Power and signal cables run inside the side channels of the bay and, through holes in the channel at the center of each section, into a trough that crosses the middle of the section (figure 1-7). Leads for individual backboards can leave this trough at any of four points along the trough. From these points, the wires run along a line of spacers to the point closest to the required backboard terminal and then proceed directly to that terminal. Connections between terminals in the same section are made directly across the backboard or through the trough. Power connections between terminals in the same section are made right against the backboard. When signal leads are short, they also are run next to the backboard. Long signal leads cross the backboard on standoff posts, each of which can carry three signal leads. High-speed wiring and coaxial cables also make use of these posts.

1-35. BAY LAYOUT

1-36. Three sections mounted on vertical channels form a bay. Two bays are shown in figure 1-8. Each bay has its own power and low-speed signal inputs. Alternating and direct current enter the bay by way of six barrier strips at the base of the bay (paragraph 1-40). Low-speed signals enter through plugs at the top of the bay. (Refer to paragraphs 1-62 and 1-64.)

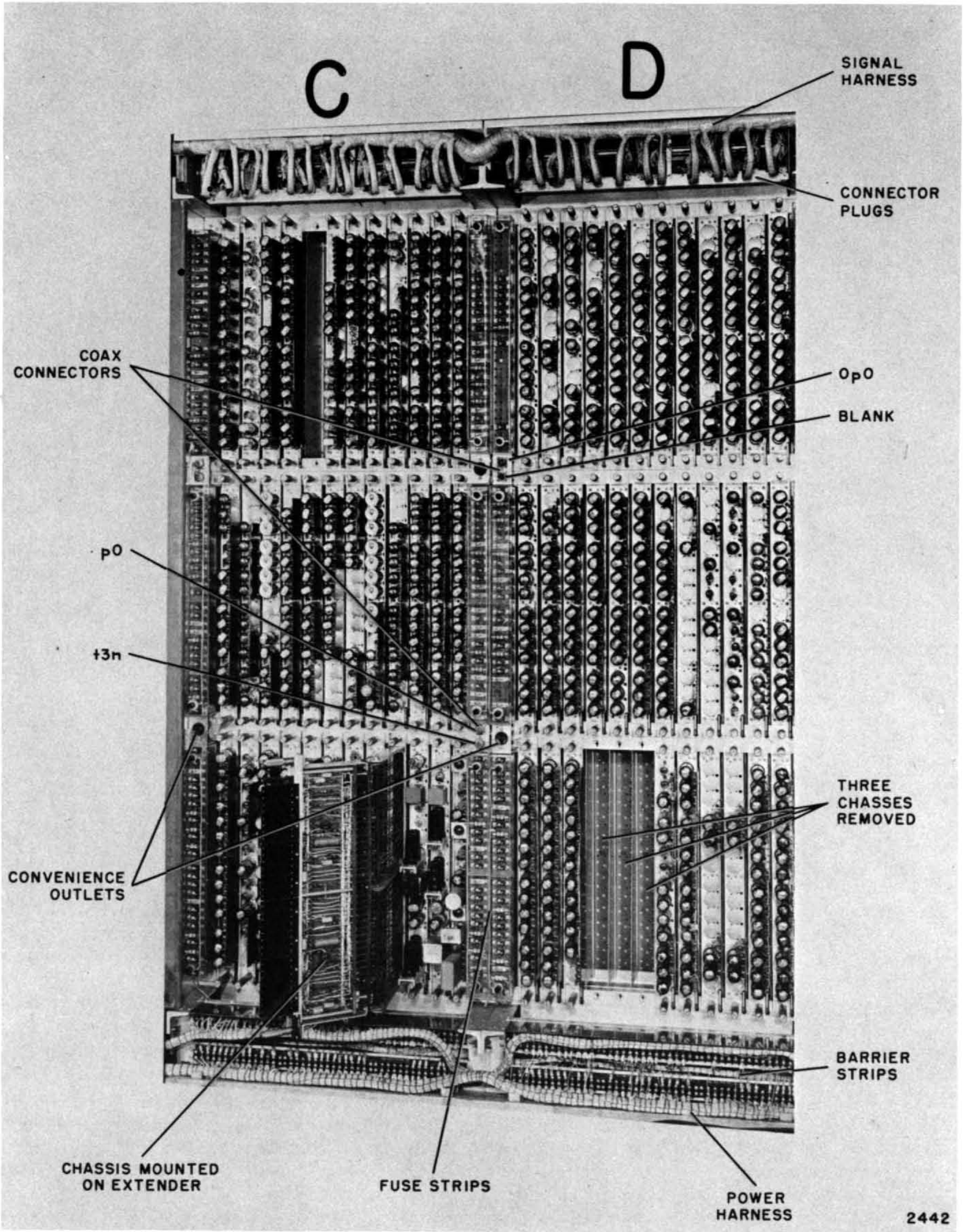

Figure 1-8. Two Bays, Exterior View

1-37. Two 115-volt a-c convenience outlets, and four coaxial-cable connectors for oscilloscope-sweep synchronizing signals are mounted in each bay. The three signals provided are the major-cycle synchronizing signal (0p0), the minor-cycle synchronizing signal (t90), and the digit synchronizing signal (t3n). The fourth connector is not used. The 115-volt a-c outlets are independent of the Central Computer fusing system. Wiring of these outlets is detailed in drawing number C431 060 23, supplied with the system. Alternating-current outlets inside the computer are located under the roof on the cross-member between bays H and L and bays B and E.

1-38. Mounted on the back of the bay framework are the filament transformers and other components that are too large for mounting on the chasses. At the top of each bay there are two extra sockets hanging loose, not mounted with the signal harness sockets. These are the rectifier plugs. They connect the protective selenium diodes on the roof to the d-c voltage points that the diodes protect. (Refer to paragraph 1-49.)

1-39. At the top of the back of each bay is a bimetallic resettable thermostat. If the air flowing through any bay gets warmer than 55°C (131°F), the thermostat energizes the overheat-protection circuit, which turns off alternating and direct current, and the blowers, and indicates the location of the overheat. (Refer to paragraph 2-237.)

1-40. POWER DISTRIBUTION

1-41. In early models of the Univac I system, all a-c and d-c power for the Central Computer comes from the power supply, through cables running under the floor. In models having closed-circuit air cooling (paragraph 1-17), the power distribution has been altered so that ac is brought to the Central Computer directly from the power input installation, and dc comes from the power supply through an overhead conduit.

1-42. Input power cables terminate in terminal strips located under a removable floor panel just inside the entrance door of the computer. Figure 1-9 shows the sub-floor assembly and the location of these terminal strips, as well as the barrier strips, heater-input lines, and convenience outlets, and the air-input ducts used on early models .

1-43. Power circuits are fused at several points for added protection and fault isolation. Direct-current power lines are fused in the primary windings of the rectifier transformers and at the rectifier power points in the power supply. The d-c lines are again fused at each section. The a-c power is fused in the primary winding of the heater transformers and in the secondary circuits at the sections.

1-44. From the terminal strips, power is distributed by a power harness that runs around the base of the computer. A complete terminal-by-terminal layout drawing of the sub-floor terminal strips is given in drawing number D431 251 81, supplied with the system.

1-45. D-C DISTRIBUTION. A cable carrying all d-c voltages from the power supply enters the computer at the terminal strip beneath the floor just inside the main access door (figure 1-9). The lines in this cable are brought to the input terminals of eight terminal blocks. Output lines from these blocks are bound together to become the power harness. This harness distributes power to each bay.

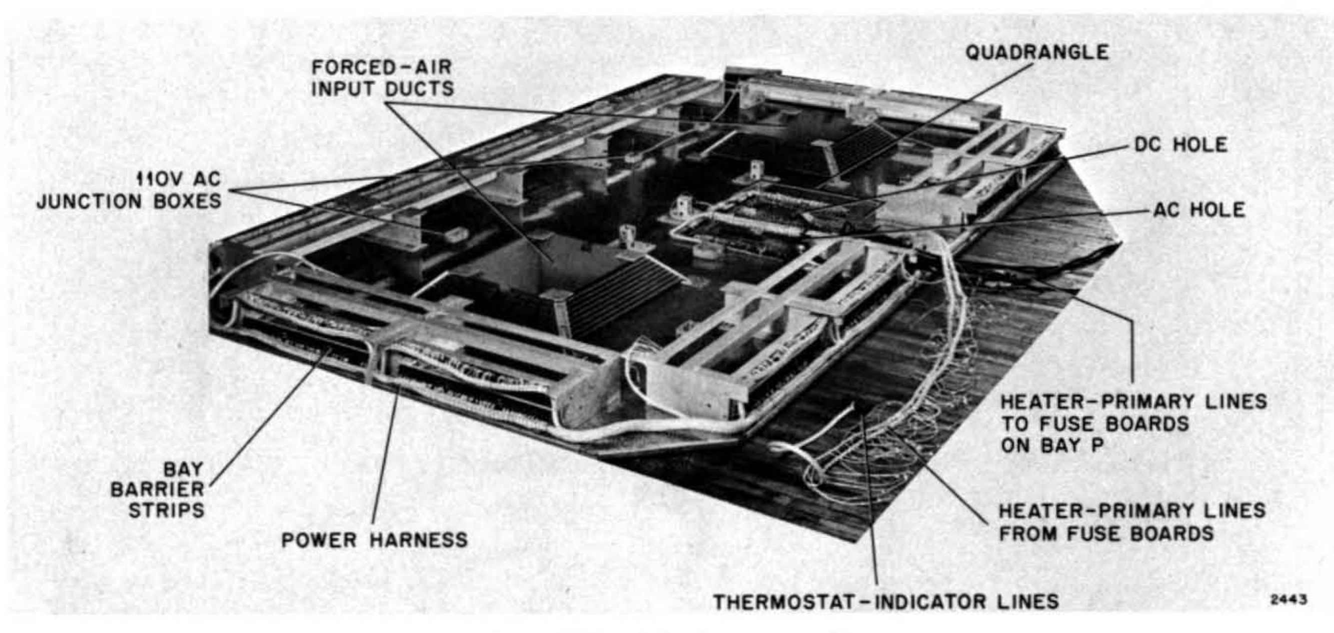

Figure 1-9. Sub-Floor Assembly

1-46. Six terminal strips, called barrier strips and lettered A through F, are mounted at the base of each bay. Each of these barrier strips has 13 terminals numbered 1 through 13, which are assigned voltage values as well as numbers. Terminals are wired in series through the harness. Each voltage circles the computer, supplying the designated number of terminals, and returns to its original terminal on the sub-floor terminal strip. Bay-to-bay wiring drawings for normal and for high-current power points, and layout drawings of the wiring of each barrier strip, are included in the drawing file supplied with the system.

1-47. Voltages on the barrier strips are arranged from left to right in descending order of magnitude, in order to minimize the difference in potential between adjacent terminals. The upper strips (A, B, and C) contain positive voltages and low-value negative voltages. The lower strips (D and E) continue the sequence from left to right to the most negative voltages, ending with –300 volts at terminal E13. Strip F contains the contact points for primary power to the heater transformers and also standby voltage contact points (marked with an S).

1-48. The outputs from the top barrier strips are bound together into a cable which runs up the right channel of the bay. Outputs from the lower strips run up the left channel. Power lines for each section leave the cables and pass through holes in the outside of the channel to the input terminals (F) of the fuseboards on the front of the bay. From the fuse output terminals (W), power lines pass back through the channel, into the d-c trough on the back of the section, and from the trough to the backboard terminals.

1-49. PROTECTION OF CLAMPING DIODES. Clamping diodes must be protected from excess currents that may develop because of accidental grounding of power-supply points. Protective rectifiers protect only from high currents due to grounding of the clamped supply voltage that is farthest from ground. Not every pair of diodes is protected. Only those pairs used in sections having a large number of stages using identical clamping voltages are provided with protective rectifiers.

1-50. To protect clamping diodes, selenium diodes are bridged across each pair of clamped voltages used in a section. The selenium diodes used as protective rectifiers are connected between the output sides of the section fuses, as shown in figure 1-10. In the absence of the selenium diodes, a short circuit to ground of +90 volts or –88 volts would cause excessive current flow in the clamping diodes. The diodes shunt most of the excess current around the clamping diodes, avoiding crystal overload. The protective rectifier is needed to handle only the initial surge of current. Shortly after such a short occurs, one of the fuses blows and turns off dc. The diodes mounted on the roof sheet (figure 1-1) are connected to individual bay fuseboards by two cables. Location and wiring information for these diodes is included in the drawing file.

1-51. As part of computer maintenance, it is necessary to check the forward and backward resistance of the protective rectifiers. This check must be made with the diodes disconnected from the circuitry. Means for disconnecting the diodes have been provided in the form of connectors and sockets in series with the cables connecting the diodes to the fuse panels. The left-hand cable connects to fuseboard 13 through a 12-pin plug-and-socket combination (designated RP13 and RS13). An 18-pin connector (RP14, RS14) joins the right-hand cable to fuseboard 14.

1-52. These connectors are wired into the d-c interlock system so that dc cannot be turned on unless all protective rectifiers are connected into the bays.

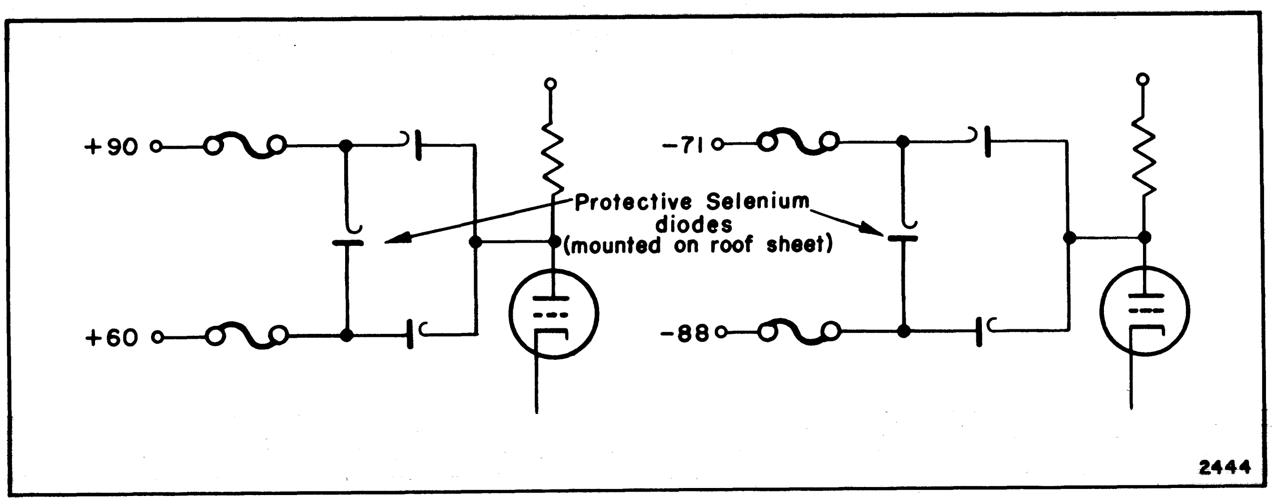

Figure 1-10. Protection of Clamping Diodes

1-53. A-C DISTRIBUTION. Alternating-current input to the Central Computer, in early models of the Univac I system, is diverted through the power supply; in later models, it is cabled directly to the Central Computer from the power input installation.

1-54. All a-c input lines except those for filament transformers terminate on terminal strips under the floor. Outputs from these strips are bound together and enter the power harness with the d-c lines. Blower lines go to the blowers under the computer through fusing on the side of bay P.

1-55. Four 230-volt lines for filament power pass directly up the left side of the main access doorway, each to a separate fuseboard on the side of bay P. The fuses mounted on these boards are the fuses in the primary circuits of the heater transformers. The input sides of all fuses on each board are connected in parallel. The separate outputs of all these fuses are bound together into the power harness.

1-56. The bottom panel at the left of the main door contains blower fuses on the outer side, and thermostat indicator neons on the inner side, excepting in models including the marginal-check feature. In these models, the indicator neons are mounted on the back of bay P, and a sixth fuseboard, mounted on the side of bay P, contains fuses for memory circuits which are not included in the regular marginal check. (Refer to paragraph 2-287.)

1-57. Terminals F10 through F13 on the bay barrier strips are reserved for the heater-transformer lines. Most of the heater transformers are mounted on the channel between bays inside the computer. There are six mounting positions numbered from 1 to 6 from bottom to top of the channel. Terminals F10 and F11 on the barrier strip supply the upper three transformers (numbered 4, 5, and 6) through a channel hole at section V; terminals F12 and F13 supply the lower three transformers (1, 2, and 3) through a channel hole in section X (figure 1-11A). Heater transformers not mounted on the channel are located in the corners of the computer.

1-58. A filament-transformer secondary winding services either the bay to the right or the one to the left, but not both. Figure 1-11B shows the location of all filament transformers in the computer. Blocks between sections each represent a bank of transformers. The arrows from the outside of the bay to a transformer block indicate the source of primary voltage. Transformer numbers are placed in the boxes adjacent to the bay serviced by the secondaries. For example, heater transformers between bays G and N receive primary power from barrier strips at the base of bay N. Transformers 2, 4, and 5 supply heater power for bay G while transformers 1, 3, and 6 supply bay N.

1-59. To minimize the possibility of heater-to-cathode arcing, all heater voltages are tied to a d-c potential close to the accompanying cathode potentials. As shown in figure 1-12, one side of the heater secondary lines is fused on the section fuse strip on the front of the section at the fuse position immediately below the d-c fuse. The other side, arbitrarily defined as the return, goes directly from the transformer to the backboard terminals by way of the d-c duct. It is this return line which is tied to the required d-c level.

1-60. On schematics, heater d-c levels are designated by the letter H followed by a code letter. The complete code is shown in figure 1-13. Schematic specification for d-c heater levels includes the code for the particular heater voltage and its d-c level, plus the code for the return line at that level. Thus, a 25-volt heater tied to –74 volts is coded as HJ on the fused side and HL on the return side.

1-61. Alternating-current distribution to convenience outlets and to the internal lighting circuits is shown in drawing number D431 061 92G, supplied with the system.

1-62. SIGNAL WIRING

1-63. Two general types of signals are generated within the Central Computer. The circuits over which each type is transmitted differ according to the frequency response required of them. Low-speed signals, or those with long rise times (such as function signals and supervisory-control switch signals) are transmitted over the low-speed wiring system. High-speed signals, or those with short rise times, such as timing and information pulses, are transmitted over a direct-route, high-speed wiring system, or by coaxial cables. The drawing file contains special drawings and tables for each type of wiring. In addition, the Signal Harness book contains wiring data on the low-speed harness. This book is supplied with the equipment.

1-64. LOW-SPEED WIRING. Low-speed wiring enters each bay by means of a row of 33-pin plug-and-socket connectors. There is room for 20 sockets on the signal harness framework above each bay (figure 1-8). These positions are labelled alphabetically from left to right. The letters are stamped on the framework above the socket and also on the connectors.

1-65. Signal lines for a bay terminate on a socket-pin above that bay. There the signal is picked up by the corresponding pin of the associated connector. Leads from the connectors run down the interbay channel to the section trough and chassis terminal. On schematics and in wiring tables, where reference is made to harness connections, the bay, connector, and pin number are specified in the designation. The first two letters (JP) identify the component as a connector, the third locates it in a bay, the fourth indicates through which

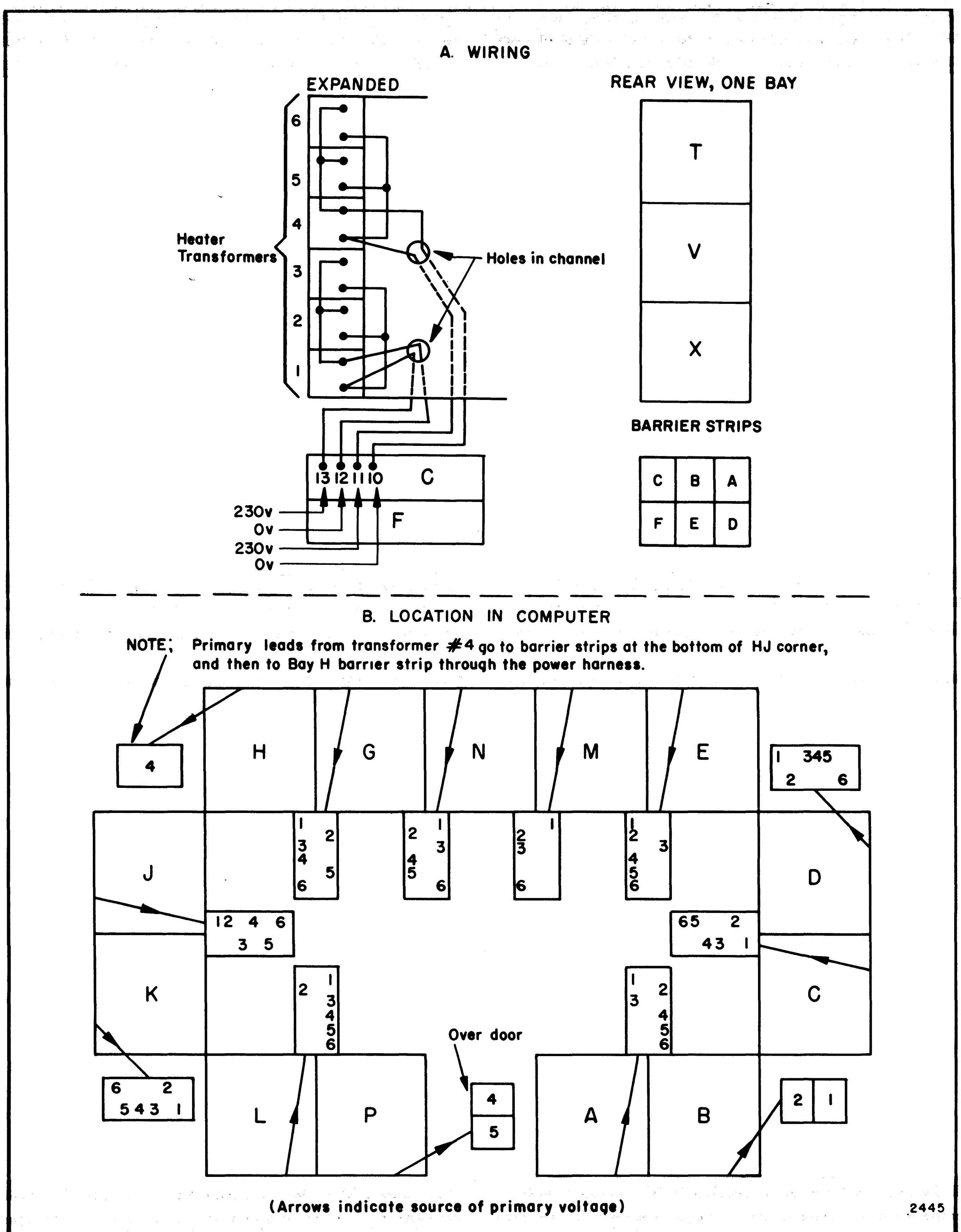

Figure 1-11. Filament Transformers

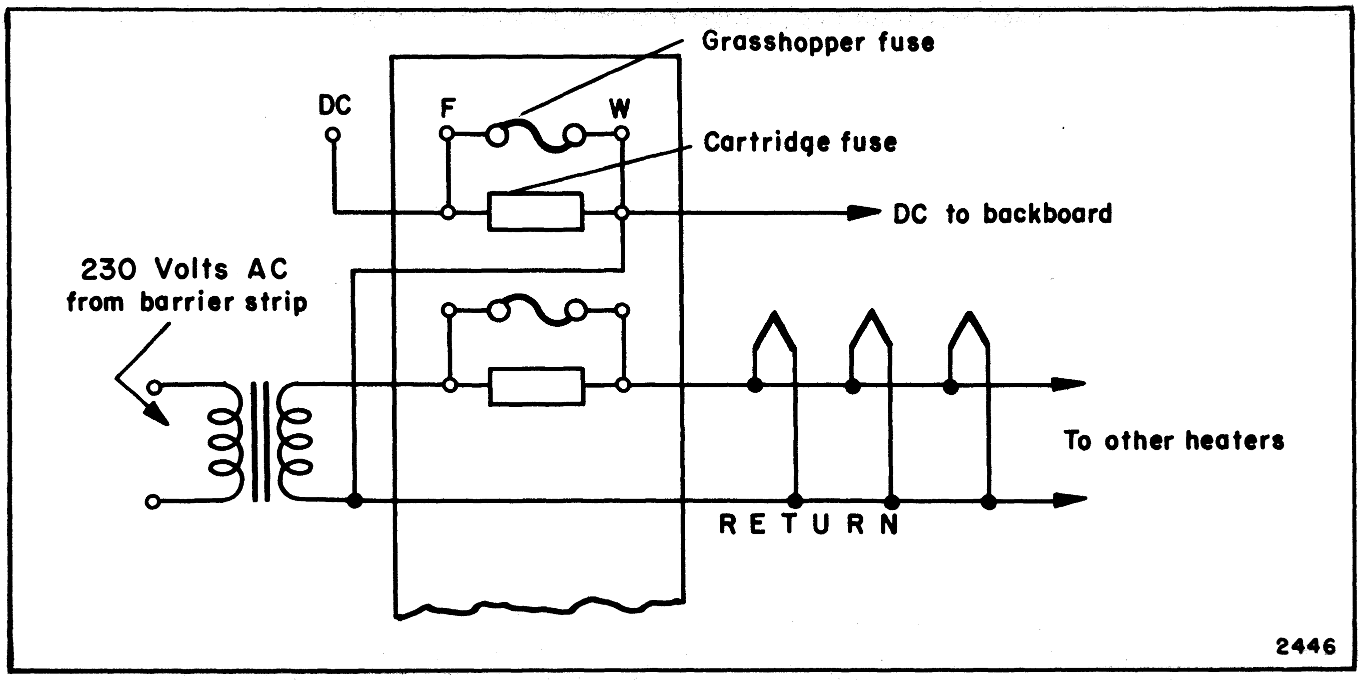

Figure 1-12. Minimizing of Heater-to-Cathode Arcing

of the 20 possible connectors the connection is made, and the final number is the pin number. Thus the designation JPAC8 identifies a line passing through connector C of bay A on pin 8.

1-66. On the section backboard, low-speed signal wires travel from terminal to terminal for short runs, but may go into the wiring trough and out again for longer runs. If it is necessary to trace low-speed wiring through the bay cables or the low-speed harness, refer to the low-speed wiring designations described in paragraph 1-65. The drawing file contains a section-by- section listing of wiring tables.

1-67. HIGH-SPEED WIRING. High-speed signals are carried either by coaxial cables or by the high-speed wiring. If the signal is used in only a few places, it is usually transmitted over the high-speed wiring system. When the signal goes to many circuits, coaxial cabling is used to prevent overloading of the source. In most cases, cathode followers drive the signal over the high-speed wiring. The coaxial lines are generally driven by pulse transformers.

1-68. High-speed wires run from source to load by the shortest possible route. If the line is more than a few inches long, it passes across the backboard on standoff posts. In this manner it may cross several sections before it reaches the load. At the edge of a bay, high-speed wires are connected to inter-section pinboards. Removable jumpers connect the lines from one section pinboard to the next.

1-69. Frequently the shortest route from source to load is across the top of the computer, on the roof sheet. Pinboards and jumpers located at the tops of the bays and on the edges of the roof sheet carry the high-speed lines to the roof sheet. The lines then cross the roof sheet on standoff posts.

1-70. Coaxial cables go from source to load by the most convenient route. In some instances a direct route is used; in others, the cable runs parallel to the low-speed wiring.

1-71. MISCELLANEOUS EQUIPMENT

1-72. The bulk of the electronic equipment for the Central Computer is mounted on chasses and can be located easily by referring to a part number given on a schematic. However, there is also equipment that, because of mechanical or electronic considerations, is not mounted on the chasses. The location of this equipment does not follow any standard system. Among these items are heater transformers, power-control circuits, some power supplies, voltage-monitor circuits, and the Uniservo control circuits. Much of this equipment is mounted in the corner sections, and the rest is mounted inside the computer on the framework.

1-73. ADDITIONAL COMPONENTS INSIDE COMPUTER. Table 1-1 lists all the frame-mounted components in a section-by-section breakdown. The table lists approximate location by section and chassis, a description of the component, the circuitry to which the component belongs, and, in some cases, a reference to the schematic drawing in the drawing file.

Table 1-1. Computer Components Not Mounted on Chasses

Numbers in parentheses refer to drawings supplied with the system.

Component	Approximate Location	Circuit
8 relays	A3-12T	rSYI1 and rSYI2 selector relays for supervisory monitor oscilloscope (D801,-416)
8-mh choke and capacitor	A7-9T	Cathode filter on threshold-controlled amplifiers for input flip-flops in input synchronizer (D800,200)
Plug-in relay	A5T	Disable-supervisory-control-keyboard relay (D800,432-1)
Relay	A1V	Timing relay for 10 and 50 instructions (D800,763)
Filter	AX	Direct-current voltages applied to head amplifiers (below floor in some models)
Ledex switch and plug connector	BT	Automatic reread subassembly
Selenium diode	B1-3T	Transient eliminator in clear circuit of BC600A and B, rSYI1 and rSYI2, for general-clear operation (D800,192)
Relay	B12V	Keyboard (K) relay (D800,432-1)
Relay	C1-2T	Clear-CY-to-β relay (D800,333)
Switch	DE corner	Permits check of FT intermediate checker circuits and legitimate FT intermediate error
Selenium diode and relay	D1-2T	This group is associated with the initial-read circuit (D800, 329)
Relay	D1T	do.
3 selenium diodes	D1-2T	do.
Stepping switch	D6T	do.
Timer	D8T	do.
Relay	D12V	Retain-CY relay (D800, 482)
Switch	DX (bypass board C)	Retain-PC switch
6 relay banks (8 or 9 relays each)	Bay M	Video or AGC monitor (supervisory monitor oscilloscope) relays operated by pushbuttons on the supervisory control console
6 relay banks (8 or 9 relays each)	Bay N	do.
12 relays	GT (on overhead)	do.
8 relays	G3-10T	do.
9 relays	G3-12T	do.
7 relays	G4-11X	do.
5 50-watt Koolohm resistors	G4-7T	Cathode resistors for high-speed bus output drivers
Switch	H6-7V	IER-OR test switch
Relay	P12T	HSB-to-rSYO2 relay
2-button switchbox	P12V	Red (start) button for DC off Black (stop) button to jam interlock
Neons	Side of PVX	Bay-overheat and main-fuse indicators

Table 1-1. Computer Components Not Mounted on Chasses (cont)

Component	Approximate Location	Circuit
Transformer	Overhead (over door on roof sheet)	Heater transformer for bay A
Selenium diodes	Around edge of roof sheet	Protective rectifier
Filters	Over bay A on roof sheet	For d-c voltages applied to head amplifiers
Emergency pullcord	Overhead (below roof sheet)	Emergency manual power-shutoff cord (ac and dc)
Filter	Below floor	For d-c voltages applied to head drivers. Mounted on section AX in some models
Bay CV and W	Airflow switches	Emergency power shutoff for failure of airflow (ac and dc)

1-74. EQUIPMENT IN CORNERS. Equipment mounted in the corner sections (figures 1-14 through 1-17) includes:

BC Corner	Uniservo control circuits
DE Corner	Short-tank overheat alarm circuit Function-signal neons Supervisory control relays and fuses
HJ Corner	Reference-voltage power-supply for voltage monitor Auxiliary power supply
KL Corner	Power-control circuitry Voltage monitor Elapsed-time meters

Each corner also contains some of the heater transformers. (Refer to paragraph 1-57.)

1-75. MEMORY SECTIONS

1-76. The principal internal storage in the Univac I system is the 1000-word acoustic delay-line memory, consisting of 100 10-word mercury registers. Twelve additional 10-word registers function as intermediate storage for input and output; six more are spares. With modified circuitry, seven more channels control the temperature of seven mercury tanks, and one more channel is used for the 10-word Y-register.

1-77. The total of 126 mercury channels is contained in the seven mercury tanks mounted on the backs of sections MT, MV, MX, NT, NV, NX, and GV. Each tank is divided into 18 channels.

1-78. Physically, each of the 10-word register circuits is made up of three sections:

(1) The acoustic delay, consisting of a channel in a column of mercury, with receiving and transmitting crystals mounted at opposite ends.

(2) An intermediate-frequency (i-f) chassis, electrically connected to the receiving crystal, and containing amplifiers, a detector, and a compensating delay. The i-f chasses are mounted on the shell of the mercury tank which they serve.

(3) A recirculation chassis, containing a cathode follower, a pulse former and retimer, a modulator, which drives the transmitting crystal, and input, clear, and memory-switch gates. These chasses are mounted in the sections adjacent to the mercury tanks.

1-79. All mercury channels except the 10-word Y-register channel are identical, as are the recirculation amplifiers and recirculation chasses of all 10-word memory registers and the six spares. The recirculation chasses of the input register and output register are slightly modified to enable use of control signals different from those used in the main memory. The 10-word Y-register mercury channel is shorter than the others, and the recirculation chassis is different, since this register is completely independent of the main memory controls. The temperature-control chasses have the following modifications:

(1) In the amplifier (i-f) chassis the compensating delay is removed (from V7), and a dummy plug with dummy connections is substituted.

(2) The bay-mounted chassis (chassis 2 in each memory section) is not a recirculation chassis. The temperature-controlling signal enters the mercury column from the cycling unit each word time. At the bay-mounted chassis, this signal is used to adjust the current through the heating coil to maintain constant temperature in the tank. Each temperature-control channel uses an entire bay-mounted chassis.

1-80. The interconnections among the three groups of circuitry in a standard channel are shown in figure 1-18.

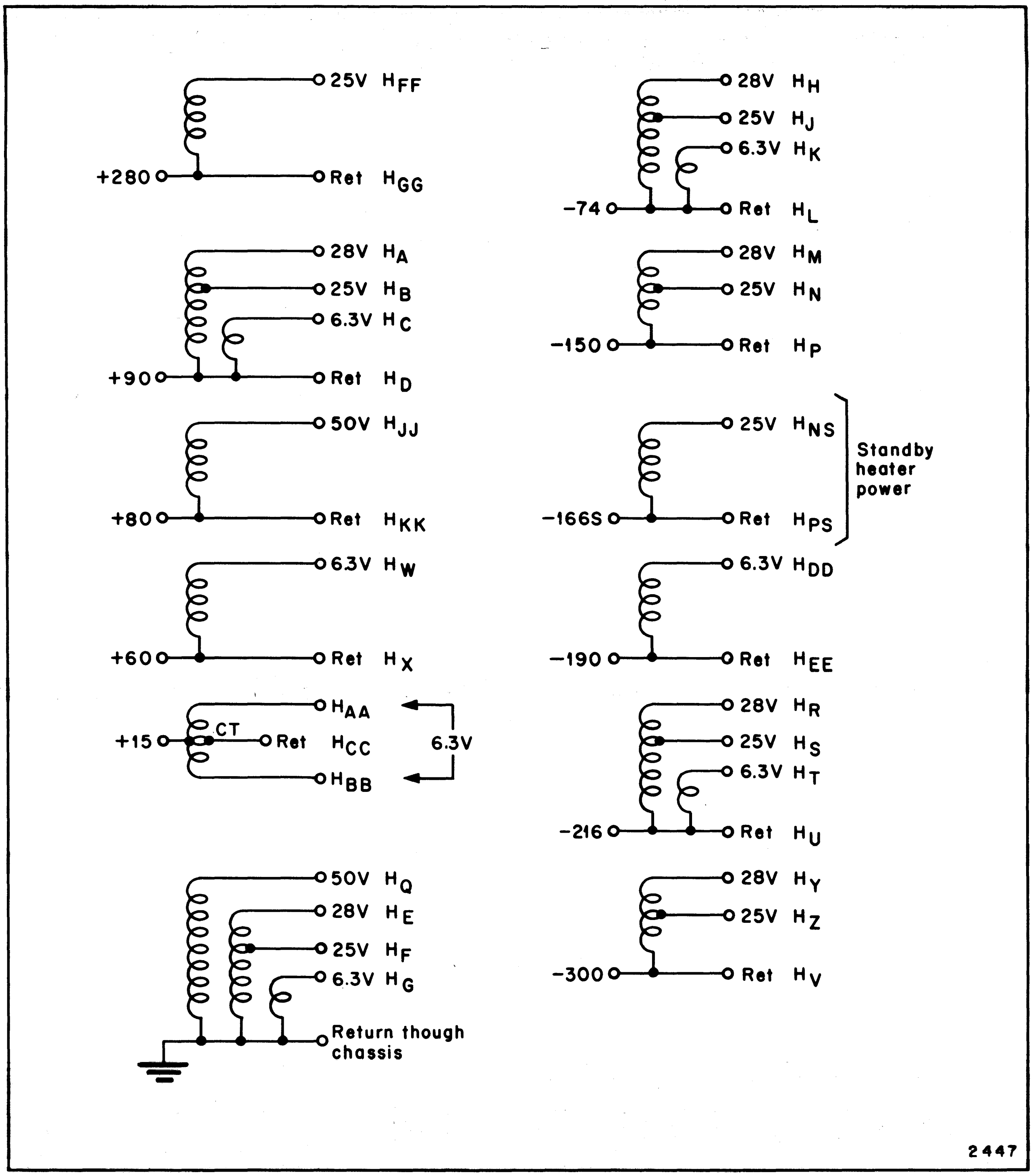

Figure 1-13. Heater D-C-Level Codes and Connections

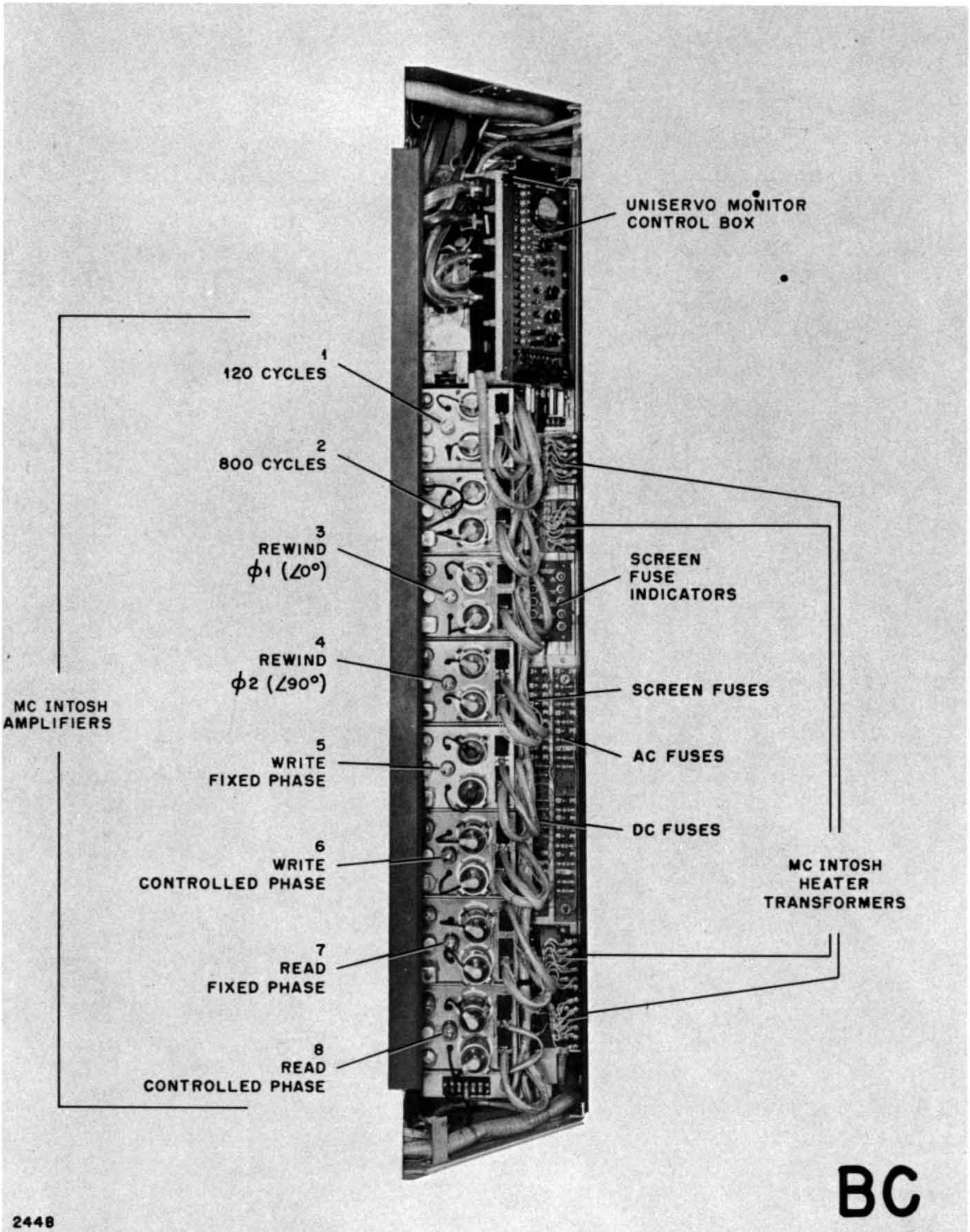

Figure 1-14. BC Corner

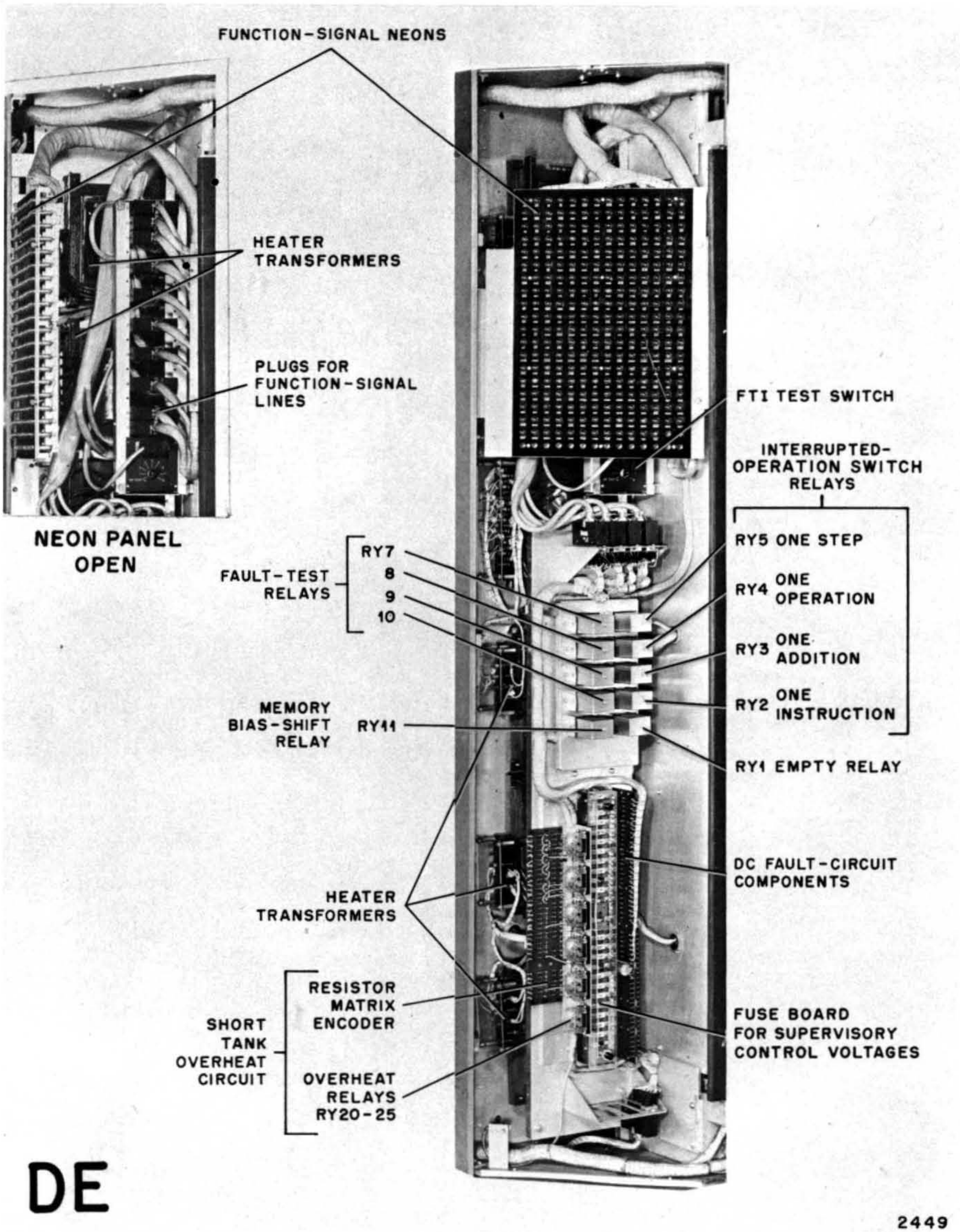

Figure 1-15. DE Corner

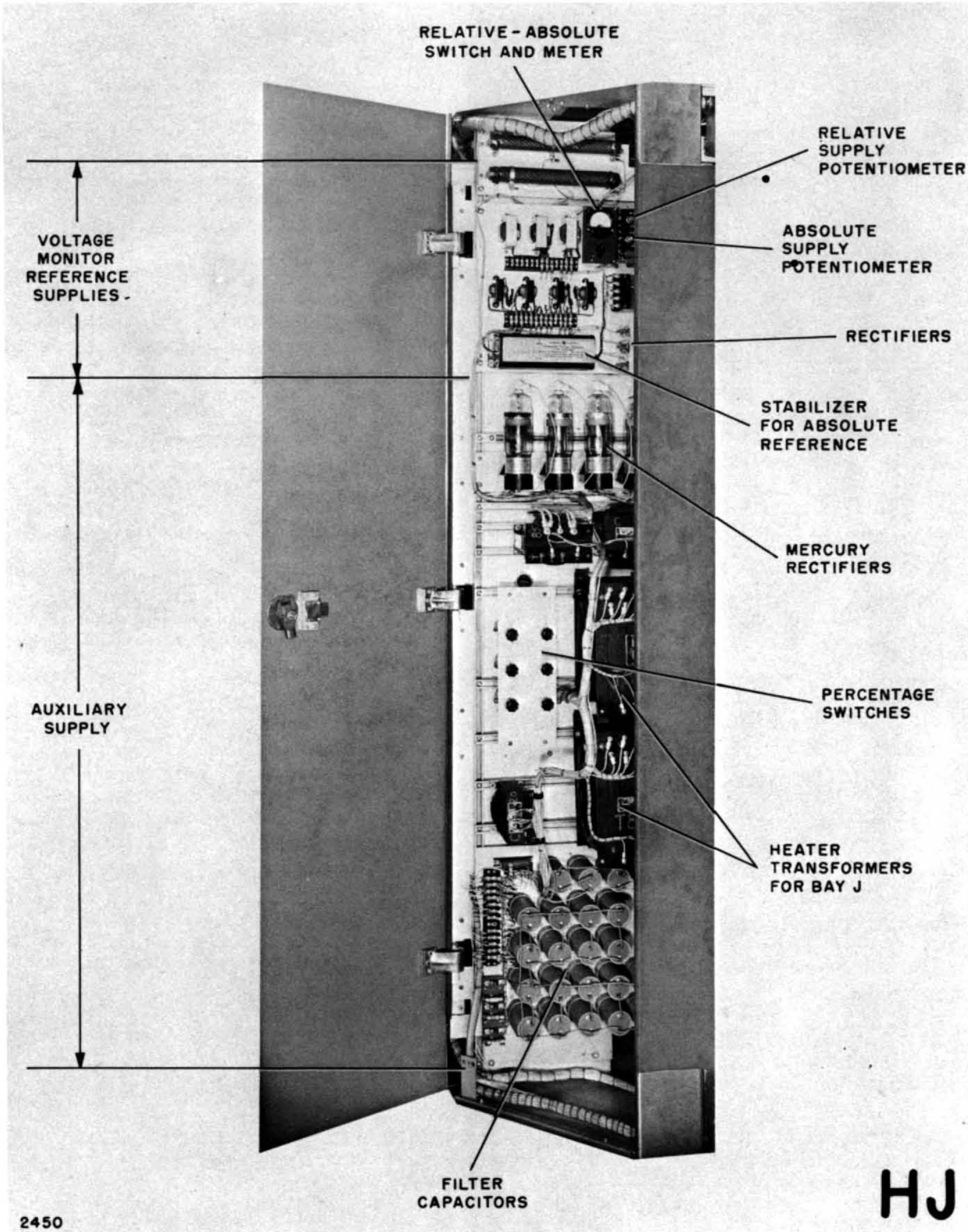

Figure 1-16. HJ Corner

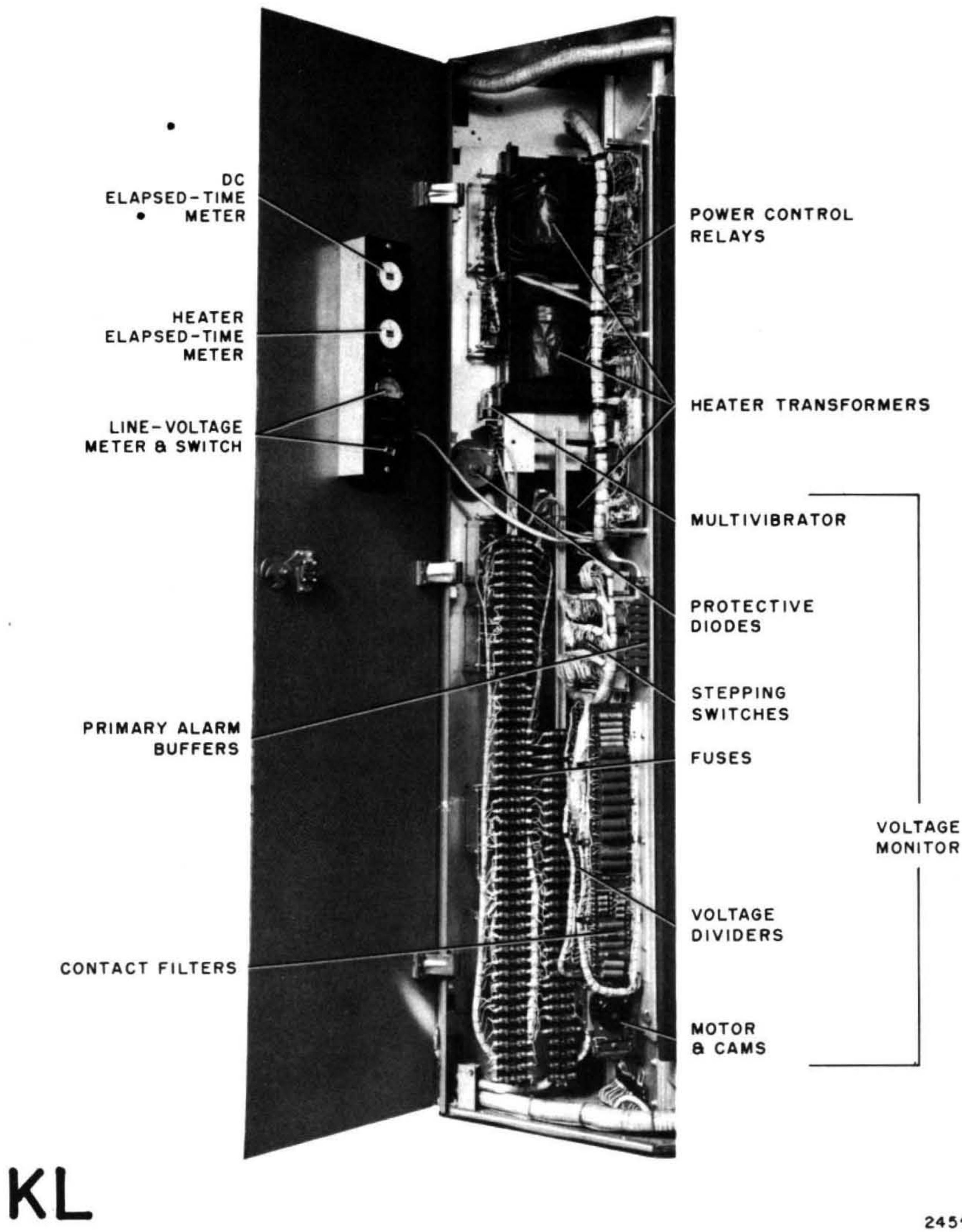

Figure 1-17. KL Corner

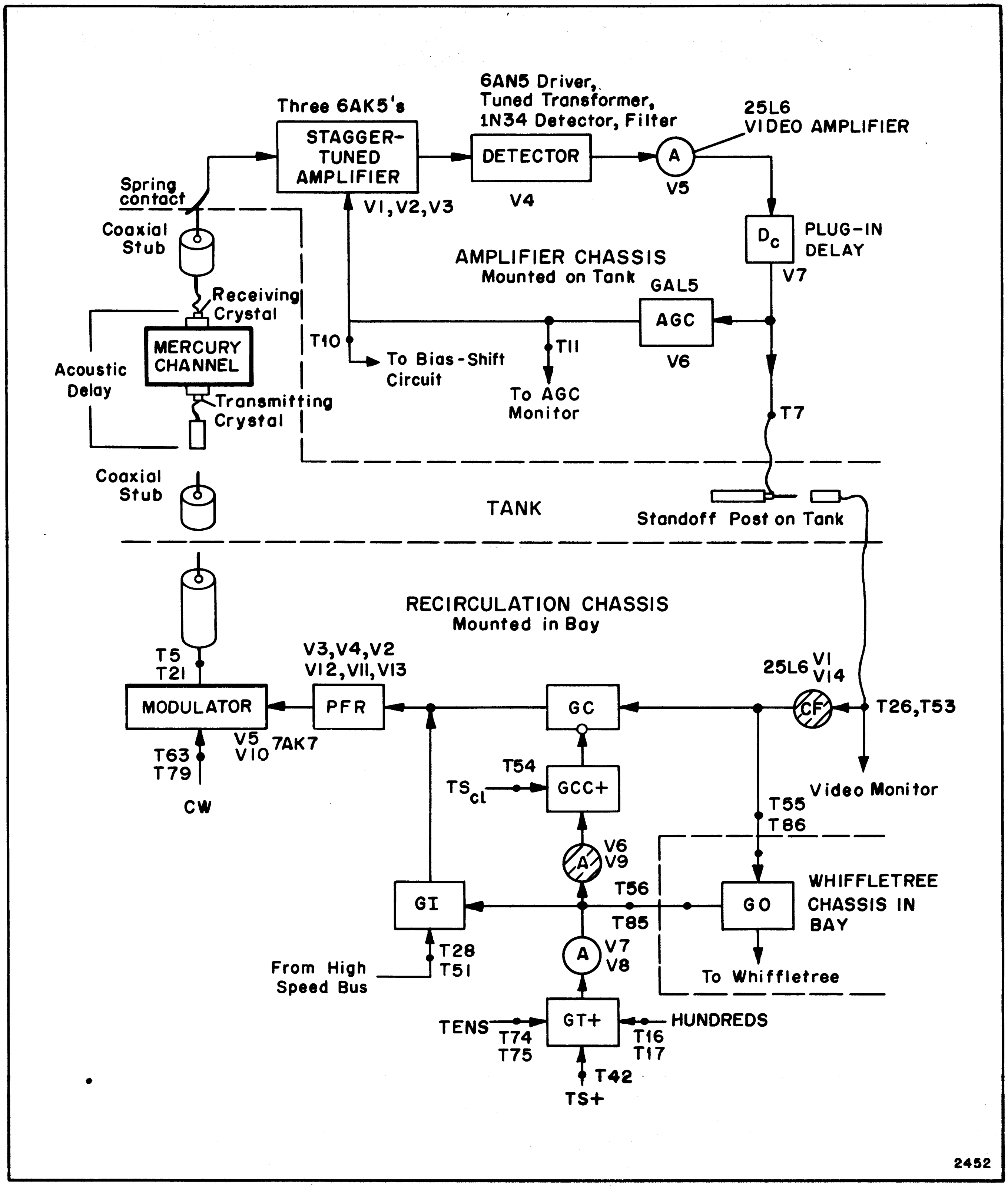

Figure 1-18. Memory Channel

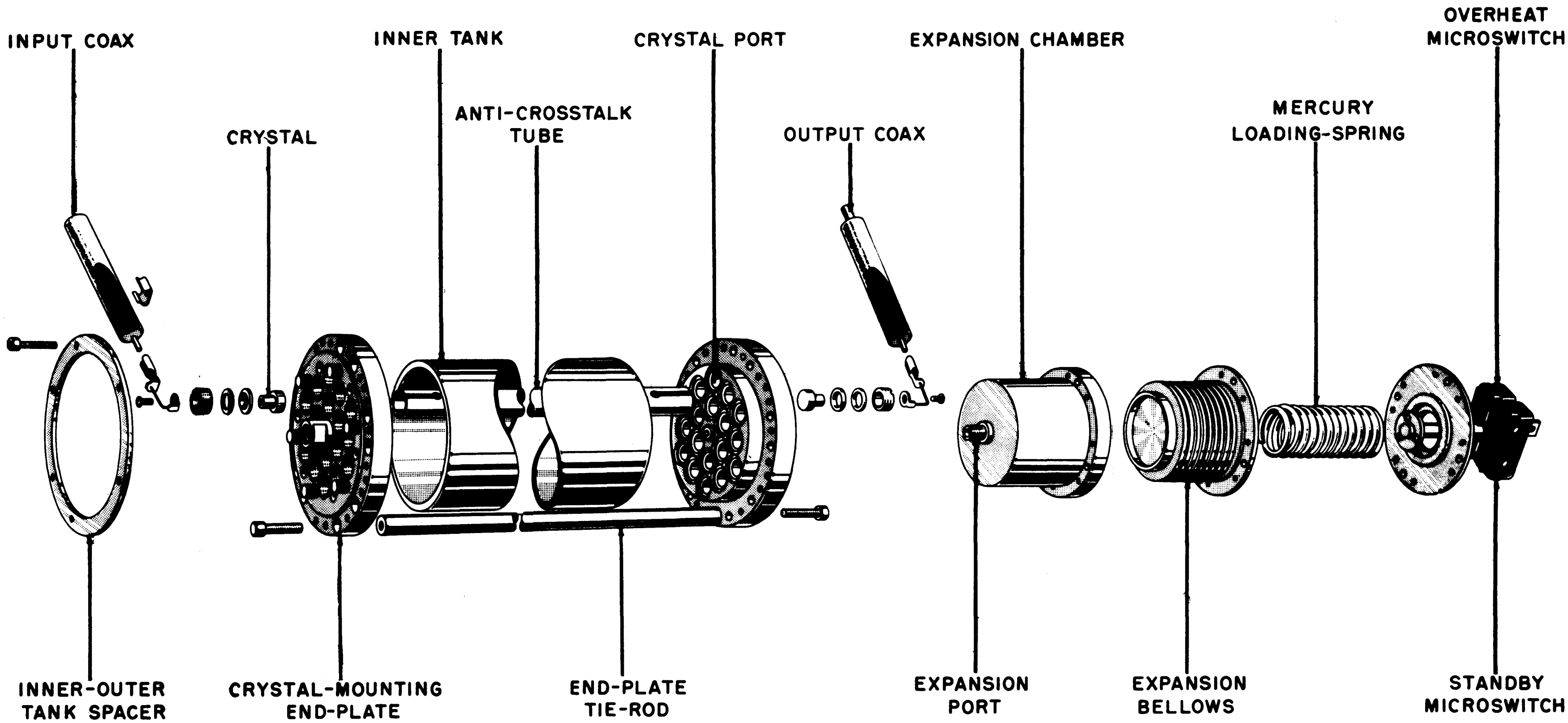

Figure 1-19. Inner Mercury Tank, Exploded View

1-81. MEMORY TANKS. A memory tank consists of two concentric cylinders. The inner tank is made of stainless steel and contains the column of mercury that is used in common by all the channels in the tank. The inner tank is 22¾ inches long and 3¾ inches in diameter (figure 1-19).

1-82. Crystal-mounting plates are placed on the ends of the inner tank. Eighteen transducing crystals are mounted in each plate. One face of each crystal is in contact with the mercury. The crystals are aligned so that each receiving crystal receives acoustic waves from the corresponding transmitting crystal at the other end of the tank. To minimize crosstalk between channels in the common mercury column, chrome steel tubes are mounted between corresponding transmitting and receiving crystals. These tubes act as waveguides.

1-83. Heating coils are wound around the outside of the inner tank. The space between the inner and outer tanks is filled with insulating material.

1-84. The outer cylinder of the mercury tank is approximately 35 inches long and 8½ inches in diameter. On this shell (figure 1-20) are placed mounting brackets for the i-f chasses, contact boards for the i-f chasses, input and output terminals, and r-f filters for the heater circuits. Electrical connection to the mercury tank is made by two cables, which terminate in 21-pin male connectors. As seen from inside the computer, the connector on the right (JP-2) carries automatic gain control (AGC) monitor lines, and the one on the left (JP-1) carries the power leads. On the opposite end of the tank from the contact board is an overheat neon which lights if dc is cut off because of overheating of the tank on which it is mounted. On a removable end-plate at the same end is a four-terminal barrier strip for the overheat and standby power lines. Under the end-plate are two adjusting screws for the microswitch stops and the overheat neon.

1-85. Each long mercury tank has two heating systems, each of which uses coils wrapped around the inner tank:

(1) Standby a-c heat; high power used to bring tank to approximate operating temperature, coarsely controlled by the contraction and expansion of the bellows which opens and closes the standby microswitch.

(2) The d-c heat; low power used to maintain operating temperature, accurately controlled by an electronic system.

1-86. The a-c standby heating system makes use of a 230-ohm coil powered with 230 volts from phase 1, lines 8 and 9.

1-87. Current through the ac standby heating coil is controlled mechanically by the expansion and contraction of the mercury in the tank. A port through the front crystal-mounting plate allows the mercury to flow into an expansion chamber. This chamber senses volumetric changes in the mercury as the temperature varies. As the mercury expands, it works a bellows which moves two microswitches against set-screw stops. One microswitch controls the a-c standby heating power, and the other is an emergency overheat cutoff. When the expansion of the mercury indicates approximate operating temperature, the microswitch contacts open and cut off the a-c heat. Should the tank cool and the mercury contract sufficiently, the contacts close and apply power to the coil again. If the standby microswitch fails to shut off ac, the tank continues to heat and the mercury continues to expand. The bellows then operates the overheat switch. The overheat switch cuts off a-c heat to all tanks, cuts off d-c power to the computer, and lights the indicator neon on the overheated tank. The tanks should be inspected immediately, because after the tanks have cooled the overheat switch closes again and the neon goes out.

1-88. A 3500-ohm coil provides d-c heat. This is the fine temperature-control coil. The current through the coil is adjusted by the temperature-control channel, which measures the transit time of a pulse through the mercury.

1-89. The pulse is sent through the delay and then matched against the sloping wavefront of a standard timing pulse. The position of the delayed pulse on the standard pulse determines whether the heat should be on or off. Just enough power is supplied to the heating coil to balance the heat dissipated from the tank.

1-90. MEMORY RECIRCULATION (I-F) AMPLIFIERS. The i-f amplifiers are mounted directly on the mercury tanks (figure 1-20). There are 18 chasses mounted radially around each tank. They are numbered counterclockwise from "three o'clock" as seen from inside the computer. Chassis 14 of each tank except tank GV is a spare and is on the bottom. (Tank GV has no spare chassis.) With the exception of chassis 18, the others are used as amplifiers in the recirculation path of one of the information channels. Channel 18 is the temperature-control channel.

1-91. The i-f chassis is built on the standard channel and has standard mounts. One half of the chassis contains the amplifiers; under this half of the chassis is a shield. The other end of the chassis contains external component boards, the compensating-delay stick and a 14-contact chassis terminal-board. Tube positions are numbered V1 through V7 from the amplifier end of the chassis.

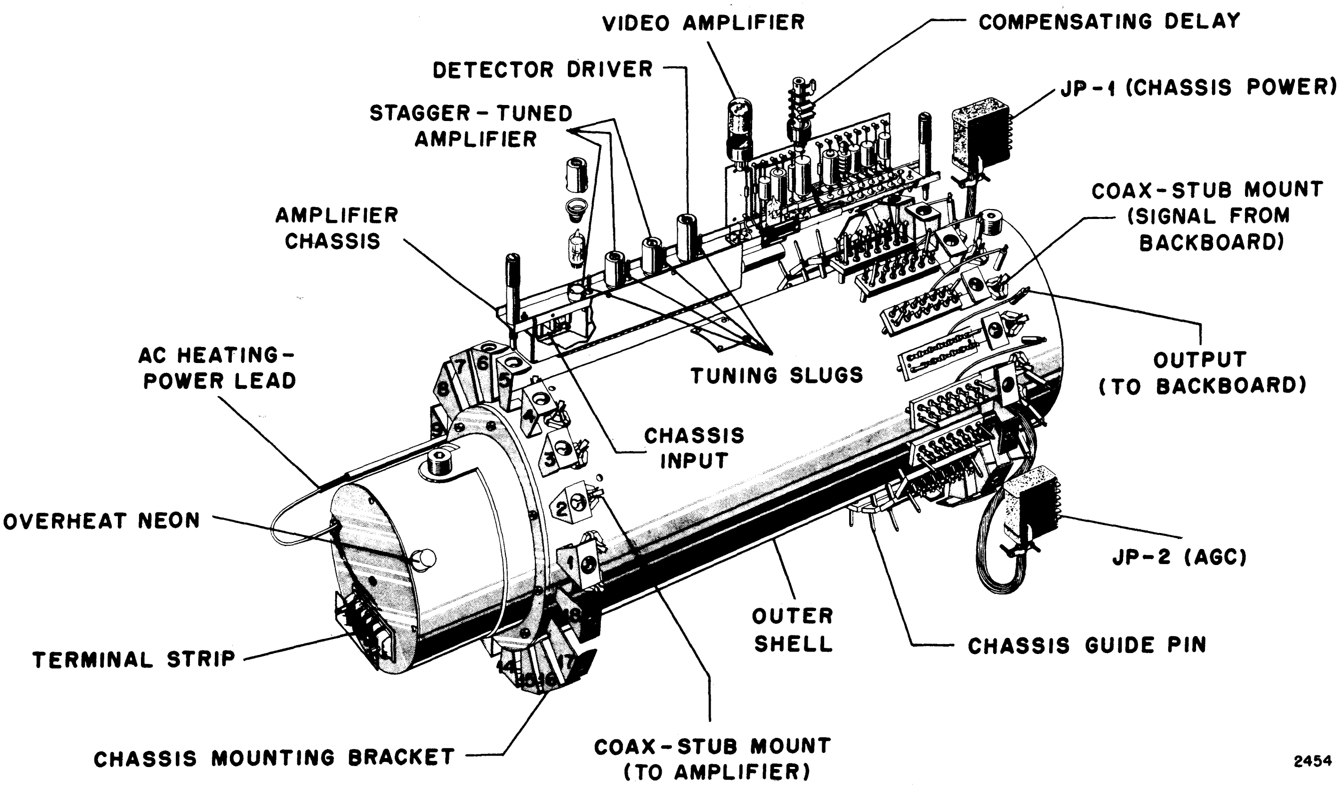

Figure 1-20. Tank Exterior, One Chassis Mounted

1-92. The input point of the chassis is a spring-leaf contact inside the shielded section just ahead of the V1 position. The shielded section rests directly on the shell of the mercury tank, and the spring-leaf contacts a special coaxial output stub from the mercury channel. The signal goes through three stages of amplifications in V1, V2, and V3, which are controlled by V6, the AGC tube. Tube V4 is also an amplifier. The tuning slugs associated with V1, V2, V3, and V4 are factory-adjusted and require special equipment for setting. Tube V5 is a broad-band video amplifier.

1-93. In the V7 position of the i-f amplifier is a plug-in compensating delay unit. Because of uneven heat distribution through the mercury, various channels have different delay characteristics. Compensating delays equalize this difference. The delay units are color-coded with a dot on the top of the delay stick. Usually, these sticks are placed in the chassis as shown in figure 1-21. Regardless of this layout, however, whenever a chassis is replaced, the delay stick from the old chassis or one of the same color should be used.

1-94. The output of the i-f amplifier chassis is taken from the 14-contact terminal board, which makes direct contact with a female-contact terminal strip on the shell, from which the signal lines run to the bay end of the tank. Terminal 7 on the board is the memory-output terminal; terminal 11 is the AGC-monitor output.

1-95. The line from pin 7 of the terminal board on the shell of the tank carries the memory output as far

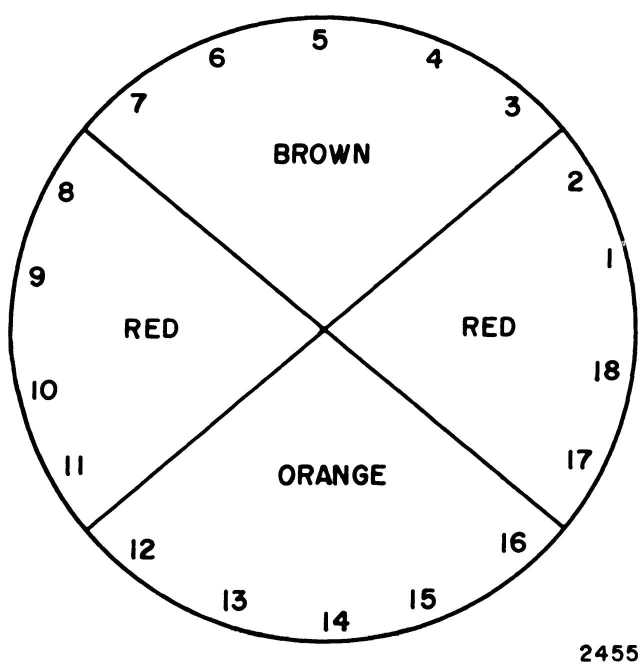

Figure 1-21. Color-Coding of Compensating Delay Sticks

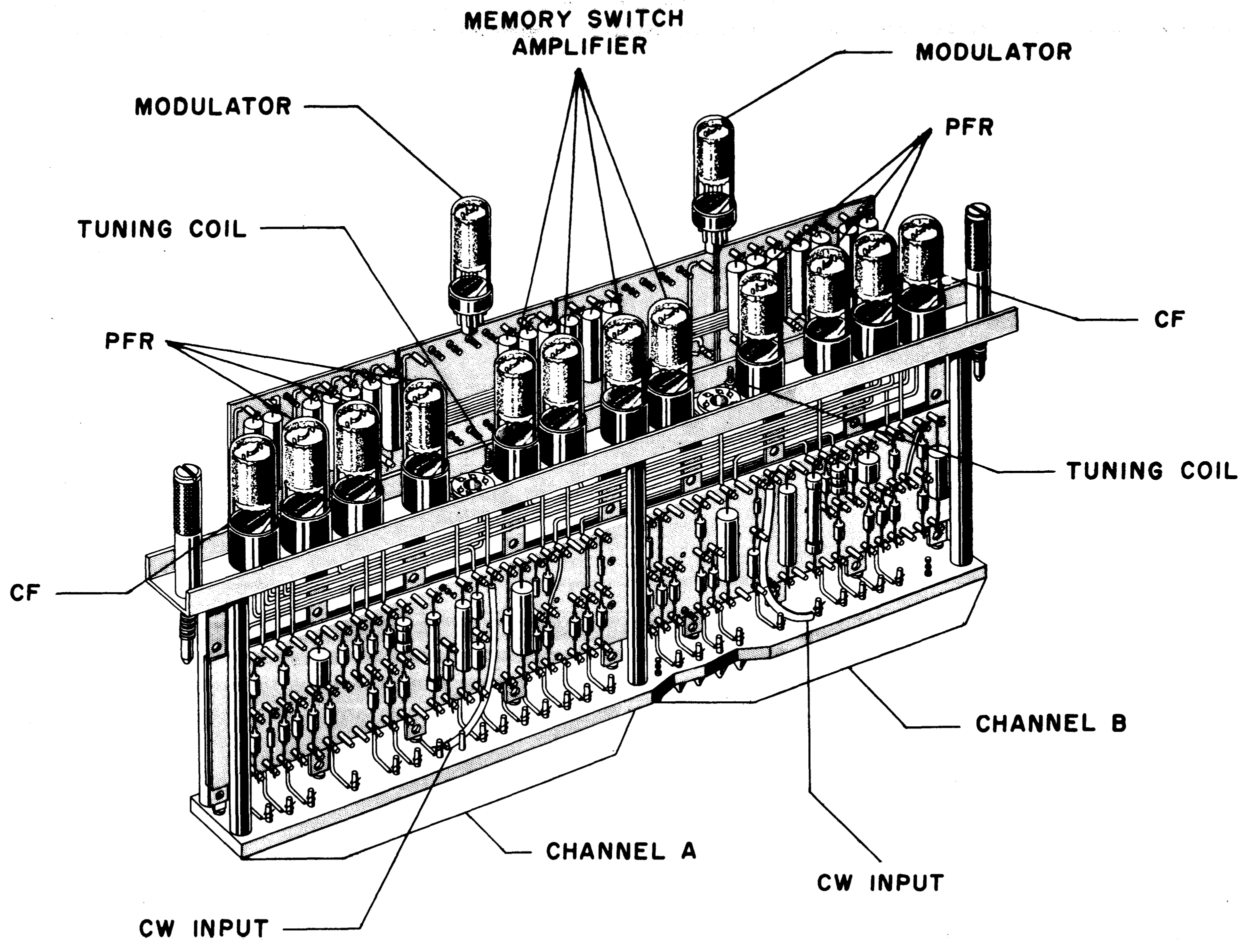

Figure 1-22. Recirculation Chassis

as a standoff post on the bay end of the tank. On the top of this post is a pin. A jumper wire from the bay fits over the pin. The jumper wire is soldered at the other end to a terminal on the backboard of the bay and connects the output line to the bay-mounted recirculation chassis.

1-96. All of the AGC lines from the contact boards on each tank are bound into a cable and connected to the AGC-monitor system by way of connector JP-2.

1-97. RECIRCULATION CHASSES. The recirculation chasses of the memory are standard Univac I system chasses (figure 1-22). They are located in chassis-positions 3 to 10 of sections GV, NT, NV, NX, MT, MV, and MX. Each chassis contains two identical circuits, and serves two memory locations. Each half-chassis has an address number, differing by 100 from the other half. The only exceptions are locations M3X to M8X and N5V to N8V. In both cases, the input and output registers share recirculation chasses. For example, channel 1 of rO and channel 1 of rI share chassis M8X. In all memory sections, chasses 1, 11, and 12 contain miscellaneous circuitry, such as output whiffletrees, continuous wave buffers, and local drivers. In all sections, chassis 2 serves memory channel 18, the temperature-control channel.

1-98. On a recirculation chassis, tubes V1 and V14 are identical cathode followers; tubes V13, V12, and V11 make up one pulse former and retimer; tubes V2, V3, and V4 make up the identical circuit. Tubes V5 and V10 are the output modulator tubes. Coaxial cables from terminals T63 and T79 respectively supply the continuous-wave signal from the cw buffer-drivers to these two modulator tubes. Tubes V6 and V9 are normally conducting amplifiers; tubes V7 and V8 are input-output control amplifiers.

1-99. Several components in the modulator stage are mounted in a nonstandard manner. These parts are capacitors that form an r-f—bypass network for the modulator. At operating frequencies like 11.25 megacycles, it is advisable to keep leads as short as possible. Consequently, the components are mounted between connecting points on the base of the tube instead of being put on the mounting boards. The parts so mounted are identified by the initial letter, the tube number, and one of the pins to which they are connected. Thus R10-6 is a resistor connected to pin 6 of V10.

1-100. Information from the i-f amplifier enters the chassis on backboard terminals T26 and T53. Terminals T26 and T53 are connected directly to cathode followers V1 and V14. A jumper wire with pin-connector is also connected to terminals T53 and T26. These jumpers are video monitor lines. They plug into pin jacks on the video monitor relay boxes mounted on the framework next to the backboard.

1-101. Connection from the modulators to the memory tank is made by means of short lengths of flexible coaxial cable connected to backboard terminals T5 and T21. This cable is terminated in a phono-pin connector, which mates with the coaxial stub on the memory tank.

1-102. Timing pulses for the pulse formers and retimers, and the continuous-wave signal for the modulator, are supplied by local drivers and cw buffer-drivers located in the memory sections. These signals are distributed to the chassis backboards over a rigid coaxial line. The inner conductor of this line is the sheathed inner conductor from a standard coaxial cable. A piece of aluminum pipe mounted on standoff posts, with a hole cut in its side over every chassis location, takes the place of the outer conductor. The inner conductor passes in and out of the pipe through the holes. Memory-section backboard-layout drawings and distribution charts supplied in the drawing file give details concerning the connections for these signals.

1-103. POWER SUPPLY

1-104. Power to be rectified for use in the Central Computer goes to the power-supply cabinet. This cabinet is separate from the Central Computer. See figure 1-23.

1-105. The power supply, which requires two-phase 60-cycle 230-volt input prestabilized to ±2 percent, is the principal source of rectified power for the Central Computer. An auxiliary power supply, and two reference-voltage supplies for the voltage-monitor circuits, are located in the HJ corner.

1-106. The power-supply cabinet contains 18 rectifier circuits similar to the one shown in the block diagram, figure 1-24.

1-107. POWER-SUPPLY LAYOUT

1-108. The power-supply layout does not follow the modular system. The transformers, with their adjusting switches (adjusting links are used in late-model computers), rectifiers, and filter chokes, are mounted on fixed trays. The trays are contained in three bays (figure 1-25). Trays are numbered 1 through 5 or 1 through 6 from the floor up. Capacitors for the L-C filter networks are mounted in the corner sections; those for positive-voltage filters are in the positive-voltage capacitor area, and those for negative voltages are in the negative-voltage capacitor area. All bays and corners, as well as the inner compartment, have full-length doors with d-c interlock. On the sides of the inner compartment are mounted fuse panels, terminal blocks, bleeder resistors, and intertray connectors, as shown in figure 1-25. Sections of the bleeder which carry heavy currents (on the order of 20 to 30 amperes) just above and below ground potential consist of Loopohms, which are ribbons of half-inch iron tape looped back and forth on insulated supports.

1-109. Input power cables enter the power supply through the floor or roof of the positive-voltage capacitor area; output cables leave the cabinet through a hole in the floor or roof of the negative-voltage capacitor area. Each cable is labelled with the voltage it carries.

1-110. Fifteen of the rectifier circuits in the power-supply cabinet use selenium stacks as rectifying elements. These 15 circuits are electrically stacked along one main bleeder to supply the principal voltages for the Central Computer. The selenium stacks are mounted on the lower trays of the bays in order to obtain maximum ventilation.

1-111. Trays W-5 and W-6 (figure 1-25) contain the remaining three rectifiers. Each comprises a pair of mercury-vapor tubes. These rectifiers supply:

Front pair: +400 volts to the McIntosh amplifier plate supply
Center pair: +350 volts to the McIntosh amplifier screen supply
Rear pair: standby supply

The two McIntosh amplifier supplies are controlled by a Haydon timer located on tray W-5. When power is first turned on, the anode supply comes on. Thirty seconds later the screen supply comes on. Because the two supplies are in series, the anode supply then rises to +750 volts.

1-112. The power-supply cabinet is cooled with a forced-air system similar to that of the Central Computer.

1-113. LOCATION OF COMPONENTS

1-114. Layout and wiring information for the power supply is supplied in the power-supply layout file. Drawing D801,833 is the master drawing for this file. It lists all schematic, wiring, and physical layout drawings.

1-115. The reference numbers given on schematics are an aid in the location of components mounted on the power-supply trays. These numbers contain the component initial (T = transformer, R = rectifier, C = choke) and the component number, plus a location code consisting of the bay letter and tray number. Thus, T81-1 (Z-2) is a transformer, T81-1, mounted

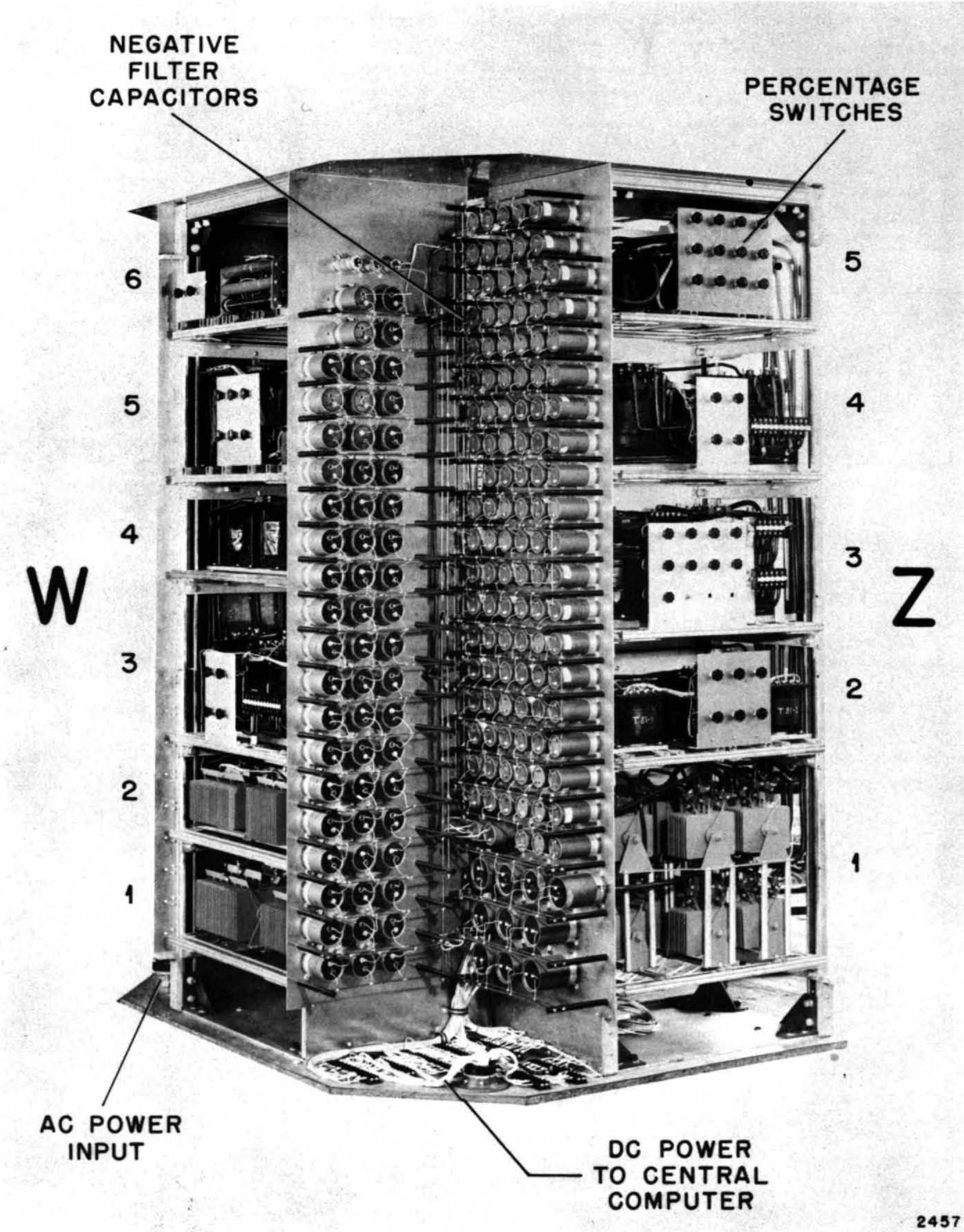

Figure 1-23. Power Supply, Casework Removed

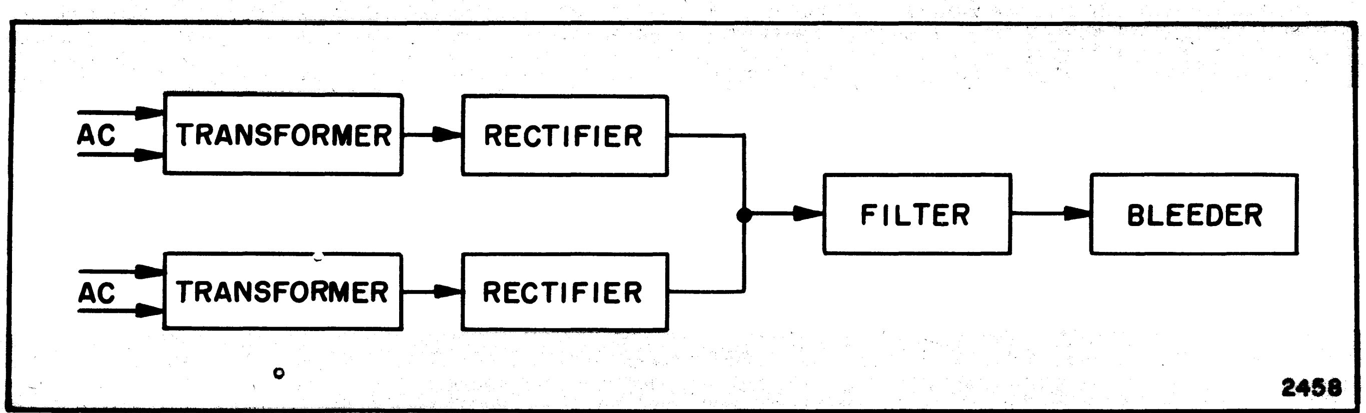

Figure 1-24. Power-Supply Rectifier Circuits

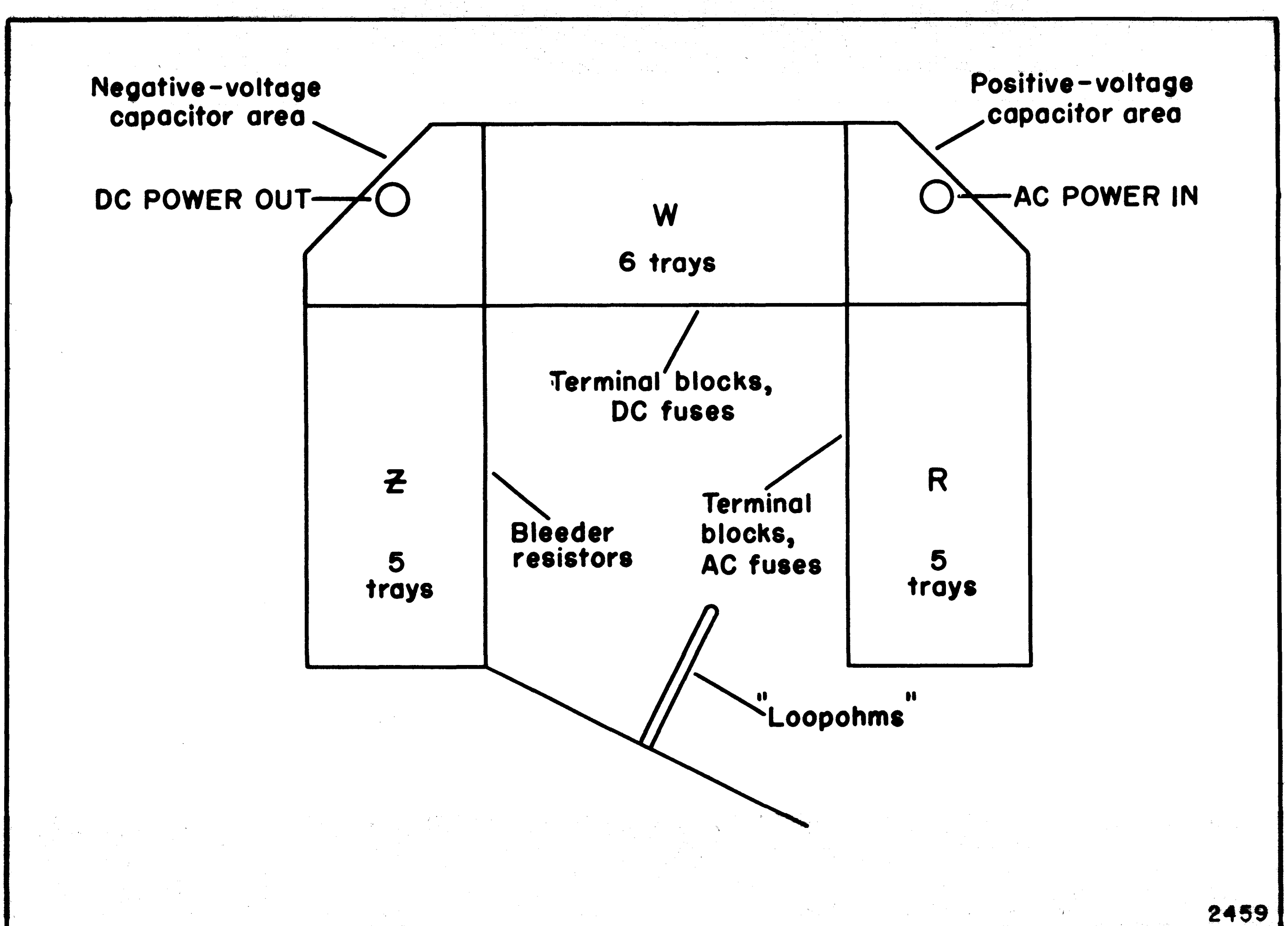

Figure 1-25. Power-Supply Layout

on tray 2 of bay Z. The number T81-1 is stamped on the transformer.

1-116. Resistors and capacitors are located by the layout drawings. Fuses are mounted in standard fuse strips; each fuse position is labelled with the value of the voltage applied.

1-117. WIRING. A great deal of the intertray wiring uses one-quarter or one-half inch cable. This type of wiring can be traced physically. Lighter leads run to connectors. These connectors are mounted in holes in the walls of the inner compartments. There are two or three of these connectors per tray, numbered from the bottom J1, J2, and J3. On schematics, the connector designation is followed by the number of the pin on which the connection is made; thus, J1-7 refers to pin 7 of connector 1. The connector numbers are stamped on the connector plug cover.

1-118. SUPERVISORY CONTROL CONSOLE

1-119. The supervisory control console is the principal control point of the Central Computer installation. From this console, the computer can be started, interrupted, or stopped; small amounts of data can be printed out on a typewriter at the order of the program or the operator; errors are indicated and in some cases can be corrected; and waveforms and voltages are monitored. Figure 1-26 shows the four units of the console: the main control panel, the keyboard, the printer dolly, and the monitor oscilloscope.

1-120. SUPERVISORY CONTROL PANEL

1-121. Figure 1-27 shows the logical layout of switches and indicators on the control panel and keyboard. A few of the switches and indicators do not follow this format (figure 5-1), but for the most part this sketch is a valid key to panel layout.•

1-122. Two pieces of test equipment are used with the console. They are a vacuum-tube voltmeter used with the AGC-monitor system, and a multivibrator used to operate the start circuits during troubleshooting. These are discussed further in paragraphs 3-60 through 3-66. The deviation meter mounted on the control panel is used with both the voltage monitor and the tank-heater monitor.

1-123. The front panel of the supervisory control desk is hinged at the bottom. After screws in the

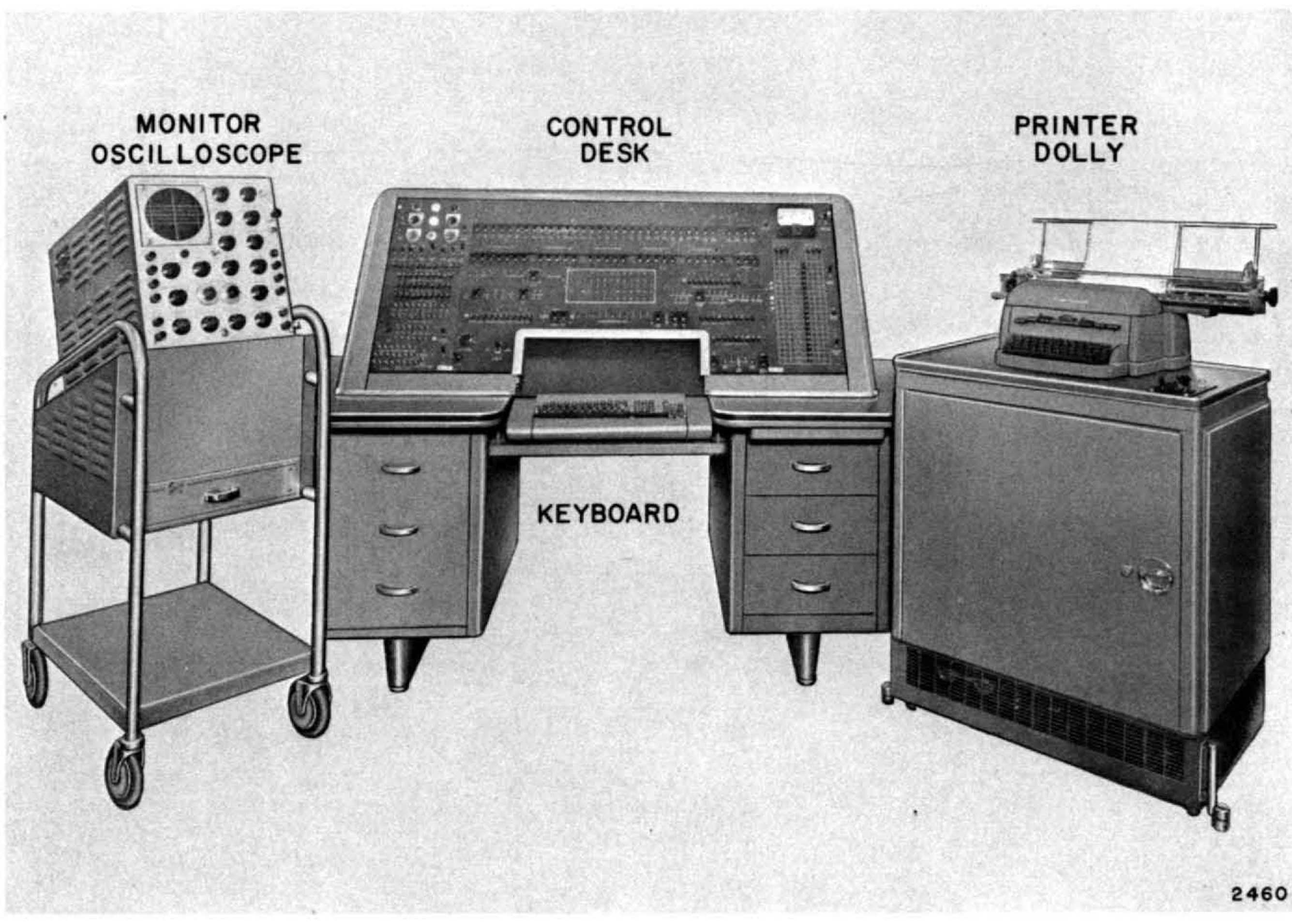

Figure 1-26. Supervisory Control Console Group

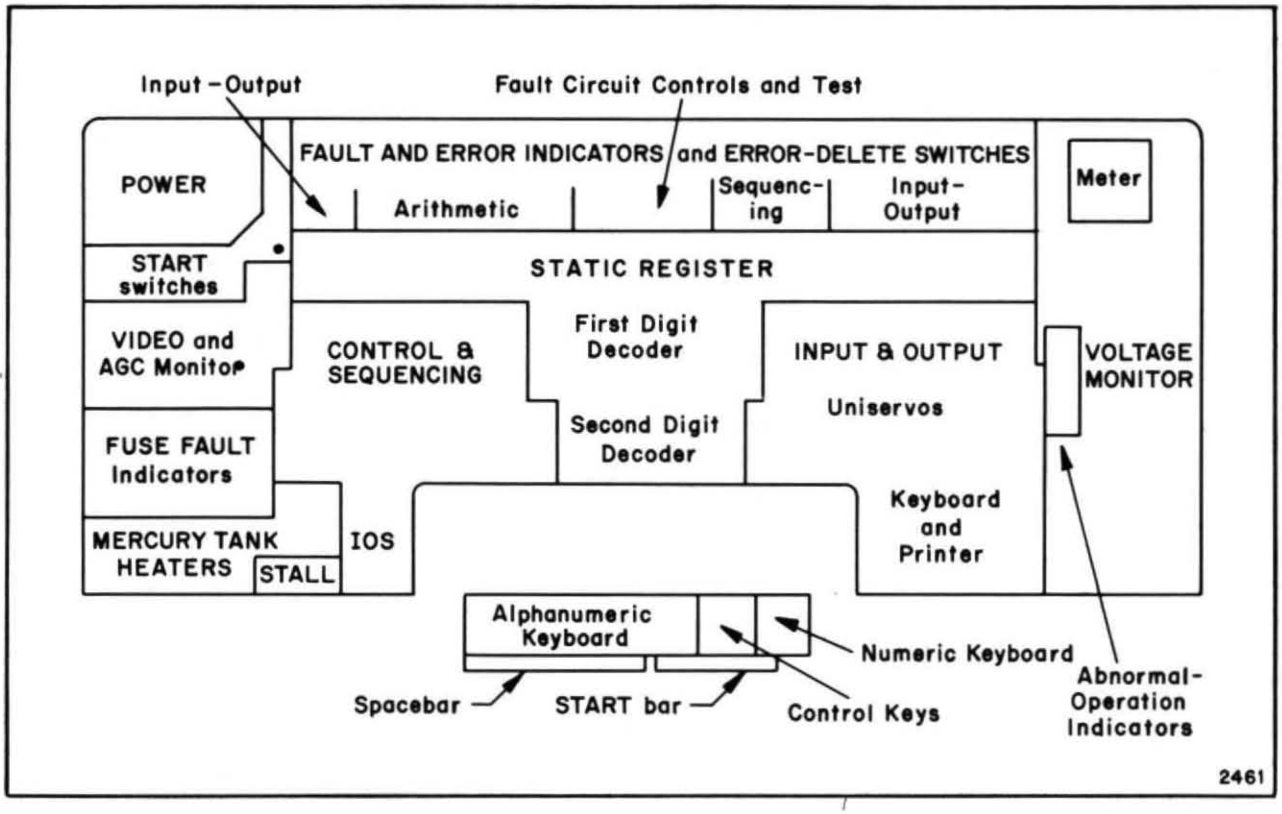

Figure 1-27. Supervisory Control Panel Layout

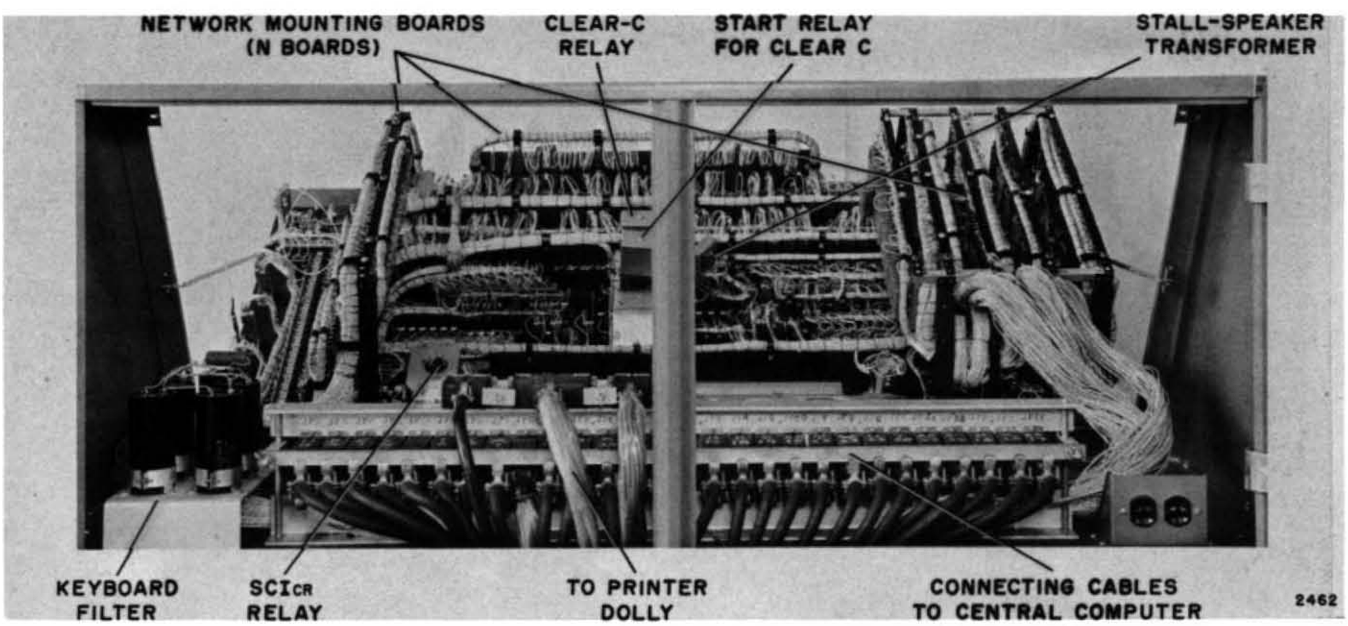

Figure 1-28. Supervisory Control Panel Wiring, Rear View

upper corners of the panel have been loosened, it can be tilted forward to expose components mounted on the back of the panel. Doors in back of the unit expose components mounted in the recess behind the panel. Figure 1-28 shows the upper part of the unit as seen through the rear doorways. The panel is tilted forward and hangs on its retaining chains. When the panel is in this position, the backs of all switches and neons are accessible. Switch filters, three relays, and stall-speaker transformers are mounted on the back of the panel.

1-124. Most of the filters are mounted on the network boards. These boards are arranged in alphabetical order. Special high-current chokes are used with the video-monitor switches. Because these are too large for the network boards, they are mounted on the chassis with the clear-C and start relays.

1-125. Inside the recess behind the panel are the keyboard filter, two convenience outlets, and a bank of 30 connectors.

1-126. Connection between the supervisory control panel and the Central Computer is made by cables from these connectors, which are labelled alphabetically A through Z and AA through KK, omitting some letters. At the Central Computer, the connectors are mounted on the side of bay A, as shown in figure 1-29. (Two exceptions to this rule are the keyboard plugs, JPL and JPKK, discussed in paragraph 1-128.) The connectors on bay A are numbered to correspond to the connectors at the console. The connectors are wired pin for pin. Connector C, pin 9, for example, is wired directly to connector 3, pin 9, on bay A. Abbreviated notes designating these connections appear on drawings and charts as JPC-9 JP3-9. From bay A, the lines run up the post and into the low-speed harness. This wiring can be traced with the help of the low-speed harness diagrams in the Signal Harness book, which is supplied with the equipment. Wiring from the connectors in the desk to the supervisory control panel can be traced by layout drawings and the Supervisory Control directory supplied with the system.

1-127. THE KEYBOARD

1-128. The keyboard unit houses three keyboards, keyboard microswitches, and capacitors (one of each for each key), and a resistor-matrix encoder. When a key is punched, it closes a microswitch to discharge the associated capacitor. Discharge pulses from information keys go into the encoder, which is mounted on the back of the keyboard unit. The encoder sends out coded signals on seven output lines consisting of microphone cable. These seven lines, plus single-wire lines from the control keys, are wired to a connector and cable mounted at the right of the encoder. The lines in this cable go to connectors JPL and JPKK, which are mounted at the rear of the recess above the other computer connectors. Connector JPL carries information and control signals to a connector mounted at the base of bay A, and thence to thyratrons in bay A. The lines which enter JPL also go to JPKK along with several additional control lines. Connector JPKK and its cable carry these lines to the printer dolly.

1-129. PRINTER DOLLY

1-130. The printer dolly prints information one word at a time from selected points in the computer. In normal operation, it also prints everything typed on the keyboard.

1-131. On the top of the dolly is a standard Remington Electric typewriter. In the cabinet below are mounted two removable chasses, which contain a relay decoder. This decoder selects typebar actuators in the typewriter. Information-handling and control circuits

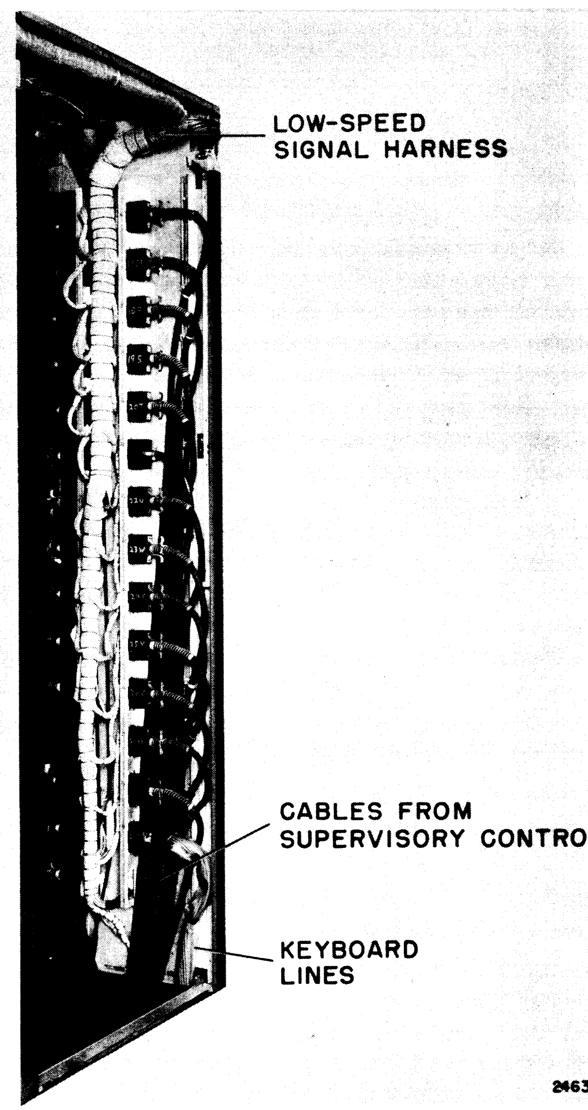

Figure 1-29. Supervisory Control Panel Connections to Bay A

for this unit are located in the Central Computer. A cable ending in connector JPKK connects this unit to the supervisory control desk, and thence to the computer. A door on the back of the cabinet provides access to the two removable chasses. A shelf on the outside of this door holds the bin for copy coming from the typewriter. The space between the chasses holds the paper supply for the typewriter.

1-132. Whenever a digit is set up in the decoder, an associated set of eight neon indicators shows the Univac I system code for the digit and the sprocket pulse. Each of seven lighted neons represents a binary one. The eighth neon represents the sprocket pulse. The neons can be an important aid in analyzing certain types of trouble, since they may be used to determine which pulses are incorrect in a coded character. On early models of the Univac I system, the indicator neons are mounted inside the cabinet on a panel, as shown in figure 1-30. On later models, they are also placed outside so as to be more readily visible; they are on a small panel on top of the printer dolly or in a row along the top front edge. A door on the front of the cabinet provides access to the chassis backboards.

1-133. THE MONITOR OSCILLOSCOPE

1-134. The monitor oscilloscope is a standard oscilloscope. It is used in conjunction with the video-monitor system. This unit plugs into a convenience outlet inside the supervisory control desk behind the control panel. Sweep-synchronizing signals and signals to be monitored are picked up by coaxial cables which run directly from the oscilloscope to terminals in the Central Computer.

1-135. The synchronizing-signal cable terminates at a monitor relay box in section AT. There it can be connected to a selection of three different sweep voltages by two relays. These relays are selected by the SYNC selector switch on the supervisory control panel. The three sweep signals are 0p0 for major-cycle synchronization, p0 for minor-cycle synchronization, and TSP for time-selector synchronization.

1-136. The monitor coaxial cable terminates at the output of the video-monitor whiffletree, cathode follower N1V-V4. This cathode follower receives the signals selected at the control panel.

1-137. THE UNISERVO

1-138. The principal input-output medium of the Univac system is half-inch wide, 0.0015-inch thick metallic magnetic tape. To read from this tape into the computer, and to record from the computer on tape, the system employs from two to ten Uniservos, as shown in the frontispiece. These units are each 66 inches high, 30 inches wide, and 21 inches deep. They normally extend away from the right front (BC) corner of the Central Computer at right angles to its length.

1-139. The Uniservos are controlled automatically by the Central Computer through the input-output control circuits or manually by means of the Uniservo monitor and control box in BC corner. A detailed physical description of the Uniservo and its functions is given in the Uniservo I manual (paragraph 3-111). Adjustments, servicing, and maintenance data are included in section VI of the manual.

1-140. BC CORNER AND CONNECTIONS

1-141. All power and signals to the Uniservos come from the BC corner of the Central Computer.

1-142. In the BC corner are the eight McIntosh amplifiers that provide centerdrive and synchro power, the Uniservo monitor and control box, transformers Tr97-1, 2, 3, and 4, the +410-volt filter, the BC corner a-c and d-c fuse boards, the Uniservo plugboard (for electrically changing the arrangement of the Uniservos), and the amplifier-screen fuse indicator. The eight amplifiers are numbered from top to bottom as follows:

(1) 120-cycles-per-second tachometer primary
(2) 800-cycles-per-second synchro primary
(3) Rewind, $\phi 1$ ($\angle 0°$)
(4) Rewind, $\phi 2$ ($\angle 90°$)
(5) Write $\phi 2$ (fixed)
(6) Write $\phi 1$ (controlled)
(7) Read $\phi 2$ (fixed)
(8) Read $\phi 1$ (controlled)

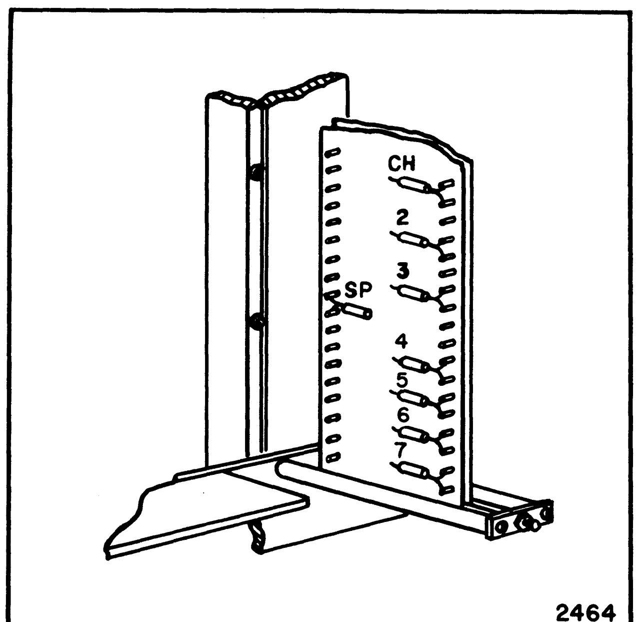

Figure 1-30. Mounting Panel for Decoder Neons

Six connectors carry the power and signals from the BC corner into the Uniservo wiring conduit. The distribution of connections is as follows:

JP1 . . Outputs of the head drivers

JP2 . . Instructions and input-output control signals

JP3 . . Uniservo selector signals

JP4 . . Centerdrive power, 120-cycle tachometer primary, 800-cycle synchro primary, all direct-current voltages, alternating-current and direct-current alarm, door-switch line

JP5 . . Alternating-current alarms (to KL corner), positive and negative alarms, +246 volts initial-clear voltage (from supervisory control desk)

JP6 . . 120-cycle signal, read and write-tachometer secondary signals, read-clear, write-clear, read-photocell lines.

1-143. The cables from the connector plate in the BC corner are routed to the first two Uniservos by way of a permanent overhead wiring conduit. Connections from the conduit to each Uniservo are made through connectors JPA, JPB, and eight coaxial connectors. Connector JPA carries the write lines, all centerdrive buses, all voltage and alarm lines, the 120-cycle tachometer primary bus and the 800-cycle synchro primary bus. Connector JPB carries the instruction signals, the Uniservo selector line, and all other input-output control signals. The eight coaxial connectors carry the read lines. The terminal plate on the conduit contains pin-socket and coaxial connections for attaching extension conduits to allow for additional sets of two, three or four Uniservos. Each additional set contains one JPA connector, one JPB, and one set of eight coaxial connectors.

1-144. Further information on the BC corner is given in section II of this manual (paragraph 2-155) and in the Uniservo I manual.

SECTION II
BUILT-IN SERVICING AIDS

2-1. GENERAL

2-2. The efficiency of the Univac I system depends to a great extent upon the proper use of servicing aids. A number of these aids are built into the equipment; a second category is special test equipment external to the computer; a third group consists of drawings, charts, and tables. Servicing aids external to the computer are discussed in section III.

2-3. Most of the internal equipment consists of circuits designed to detect incorrect operation. Some of these circuits stop computation when an error is detected and provide information that helps the maintenance technician to isolate the trouble. Another type operates when there are serious electrical failures. When a failure occurs, these circuits turn off direct current (and in some cases, alternating current). They indicate which circuit has failed and the location of the trouble. Other circuits monitor various points in the computer at the operator's discretion. These circuits do not stop the computer. They show the operator the conditions existing at the inspected points. Most errors may be deleted, enabling the computer to operate with an error flip-flop set.

2-4. Many of the servicing aids discussed in this section can be used from the supervisory control console. The results of the various tests and checks are displayed either in the supervisory control panel lights or on the monitor oscilloscope.

2-5. There are three general classifications of built-in servicing aids:

(1) Monitor circuits, which permit the operator to observe operating conditions without interrupting the normal operation of the equipment.

(2) Test switches, which permit him to interrupt operation or change the operating conditions.

(3) Fault circuits, which automatically interrupt operation and at the same time indicate the reason for the interruption and its location. The operator has no control over the functioning of the fault circuits.

2-6. VIDEO AND AGC MONITOR

2-7. Two built-in monitoring systems permit maintenance personnel to examine waveforms and read automatic-gain-control (AGC) voltages from the operator's position at the supervisory control console without disturbing normal circuit operations. These are the video monitor and the AGC monitor. Waveforms are viewed on the monitor oscilloscope. AGC voltages are read on a vacuum-tube voltmeter with an 11-megohm input impedance, which can be connected to and jack labelled AGC on the lower left section of the supervisory control panel (figure 5-1). Selection of the signal to be monitored in either case is made by two or three of a group of locking pushbuttons located on the left section of the supervisory control panel (paragraph 2-12). These buttons apply power to monitoring relays, which connect the oscilloscope and the meter to desired points in the circuitry. In most cases, AGC voltage may be measured at the same time the waveform is observed with the video monitoring system.

2-8. VIDEO MONITORING SYSTEM

2-9. The monitoring relays are arranged in a whiffletree as shown in figure 2-1, the vertex of which is a cathode follower (V4 in chassis N1V). The cathode follower is connected directly to the vertical inputs of the monitor oscilloscope by a coaxial line. This line passes over the top of the Central Computer to bay A, and from there goes to the supervisory control console along with the supervisory control signal lines. The coaxial cable, however, goes directly to the vertical input of the oscilloscope.

2-10. Diagonal lines through the circles in figure 2-1 indicate the normal positions of the relay contacts. Rectangles indicate the signal-pickup contacts of monitor relays.

2-11. When viewing a waveform, the operator can select one of three sweep-synchronizing signals by means of the SYNC-selector switch located above the pushbuttons on the left control panel (figure 5-1). The synchronizing signals, which are generated in the Central Computer, are:

(1) 0p0 major cycle for viewing 10-word pulse trains.

(2) p0 minor cycle for viewing 1-word pulse trains from the short registers; will present ten superimposed 1-word trains if used for viewing the contents of the long tanks.

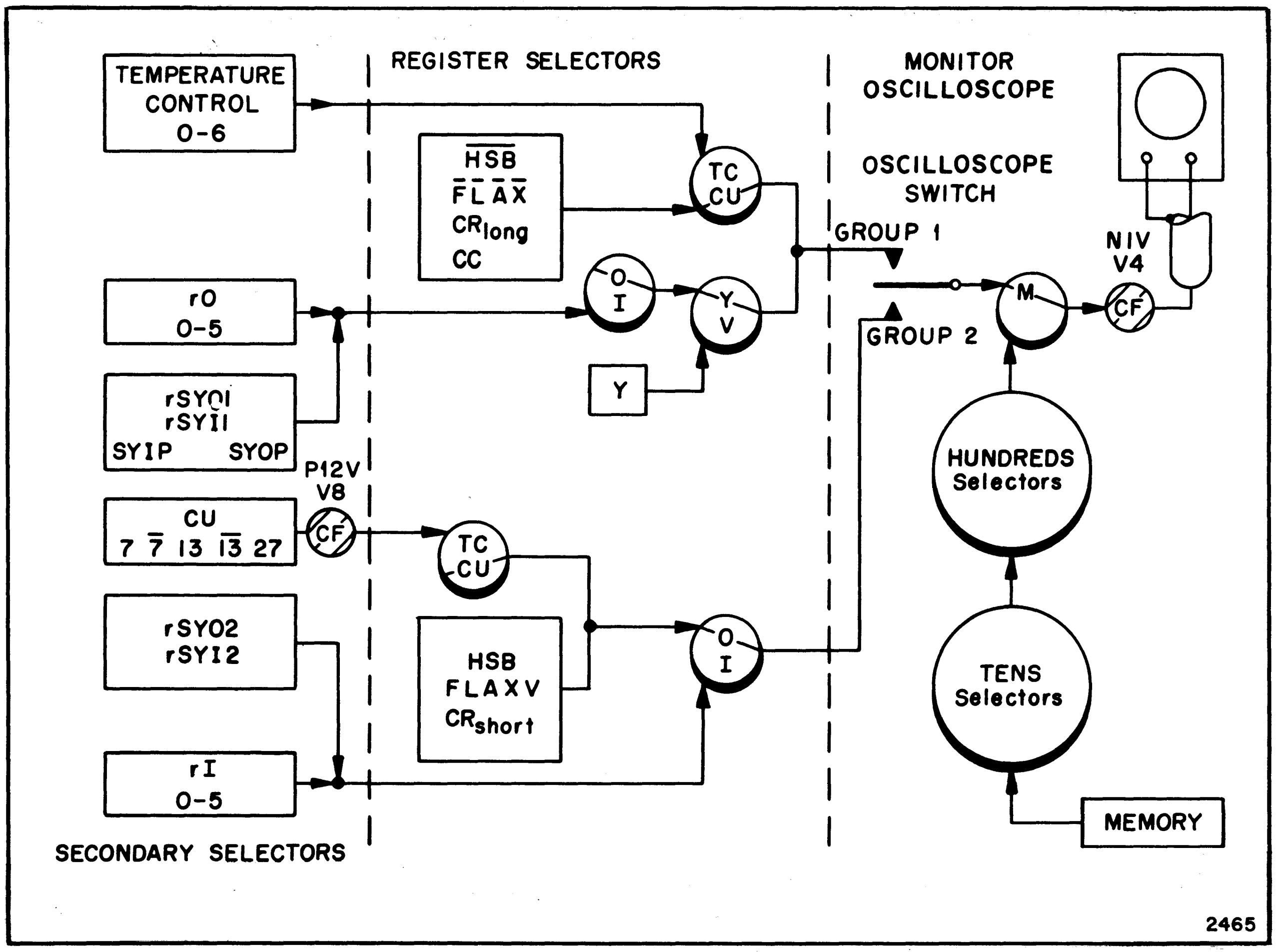

Figure 2-1. Video Monitor Whiffletree

(3) TSP, time-selector pulse for viewing a single word selected from a group of ten.

2-12. To monitor a memory channel requires that register-selector pushbutton M, and the appropriate hundreds and tens selectors, be pushed (figure 5-1). To monitor other points requires that the group-selector switch (labelled OSCILLOSCOPE on the control panel), a register selector, and in some cases a secondary selector, be pushed. As shown in figure 2-2, each register selector drives two relays. These relays connect the two sources named on the button to the group selector, which is then used for final selection between the two sources. For example, register-selector button F picks up both rF and $\overline{\text{rF}}$; GROUP 1 position of the OSCILLOSCOPE switch selects $\overline{\text{rF}}$; GROUP 2 selects rF.

2-13. To select input-output registers, cycling-unit registers, or temperature-control channels requires the use of 0/I, TC/CU, and the secondary selectors. For example, the cycling-unit 13-pulse register is monitored by the use of the group-selector switch in the GROUP 2 position, register-selector pushbutton TC/CU and secondary selector $\overline{\text{13p3}}$.

2-14. MONITORING VIDEO IN rSYI-O. Because of timing considerations, video monitor signals from rSYI1 and rSYI2, rSYO1 and rSYO2, and the input and output precessor registers are picked up directly from delay sticks in these registers and applied to the circuit shown in figure 2-3. This drawing is a detail of the two blocks in figure 2-1 labelled r-SYO1-rSYI1-SYOP-SYIP and rSYO2-rSYI2.

2-15. If these signals were passed directly through the relay contacts to the monitor lines shown in figure 2-2, the monitor lines would reflect spurious signals back into the registers. The gates are included in the signal path to isolate one circuit from the other and to prevent this feedback. The schematic diagram of the circuit for G419D is given in figure 2-4.

2-16. Control voltages for the monitor relays are applied to both grid and cathode circuits of the cathode-follower gates. These control voltages normally inhibit the monitor gates. When a monitor button is pushed, the relay contacts alert one or more of the monitor gates and connect the signal to the monitor whiffletree.

2-17. Applying control voltages to both grid and cathode circuits ensures that the gate tubes are fully cut off when not in use. The capacitive coupling from the cathode to the coaxial line and the contact filter between the relay contact and the cathode combine to prevent the steady-state control signal from seriously affecting the observed waveform.

2-18. Gates G419D and G419B drive a common coaxial line in the GROUP 2 side of the whiffletree, and for this purpose share the cathode-load resistor. The other four gates (figure 2-3) also drive a common load and coaxial line in the GROUP 1 half of the whiffletree. All six gates share the filter that consists of a 47-kilohm resistor and a 2700-$\mu\mu$f capacitor (figure 2-4).

2-19. AGC MONITOR

2-20. Most of the circuits that can be examined with the video monitor are simultaneously connected to the AGC monitor system (figure 2-5). Exceptions are the electrostatic delay circuits in the cycling unit and the precessor registers. The 11 local drivers, which have no video monitor output, are monitored by the AGC system. The drivers may be observed by use of GROUP 2 position of the group selector, register selector TPG, and secondary selectors 0-9 for local drivers 1 through 10. GROUP 1 position of the OSCILLOSCOPE switch, register-selector TPG, and secondary selector 0 will pick up local driver 11.

2-21. The AGC voltages are brought out to the AGC jack on the supervisory control panel, and measured with a vacuum-tube voltmeter.

2-22. All of the AGC circuits monitored by the system have isolating resistors built into the circuits. For this reason, the 1-megohm resistor normally present in the voltmeter probe should be removed. Adapted in this way, the meter can also be used for Uniservo-monitoring operations. (Refer to paragraph 2-165.)

2-23. USE OF VIDEO AND AGC MONITOR SYSTEMS

2-24. The video and AGC monitor systems can be used for both preventive maintenance and troubleshooting.

2-25. As troubleshooting tools, the systems, may be used for isolating certain complete and partial failures. The condition of a waveform in a selected channel usually depends on the condition of the circuit components. Distorted or sloppy waveforms indicate weak

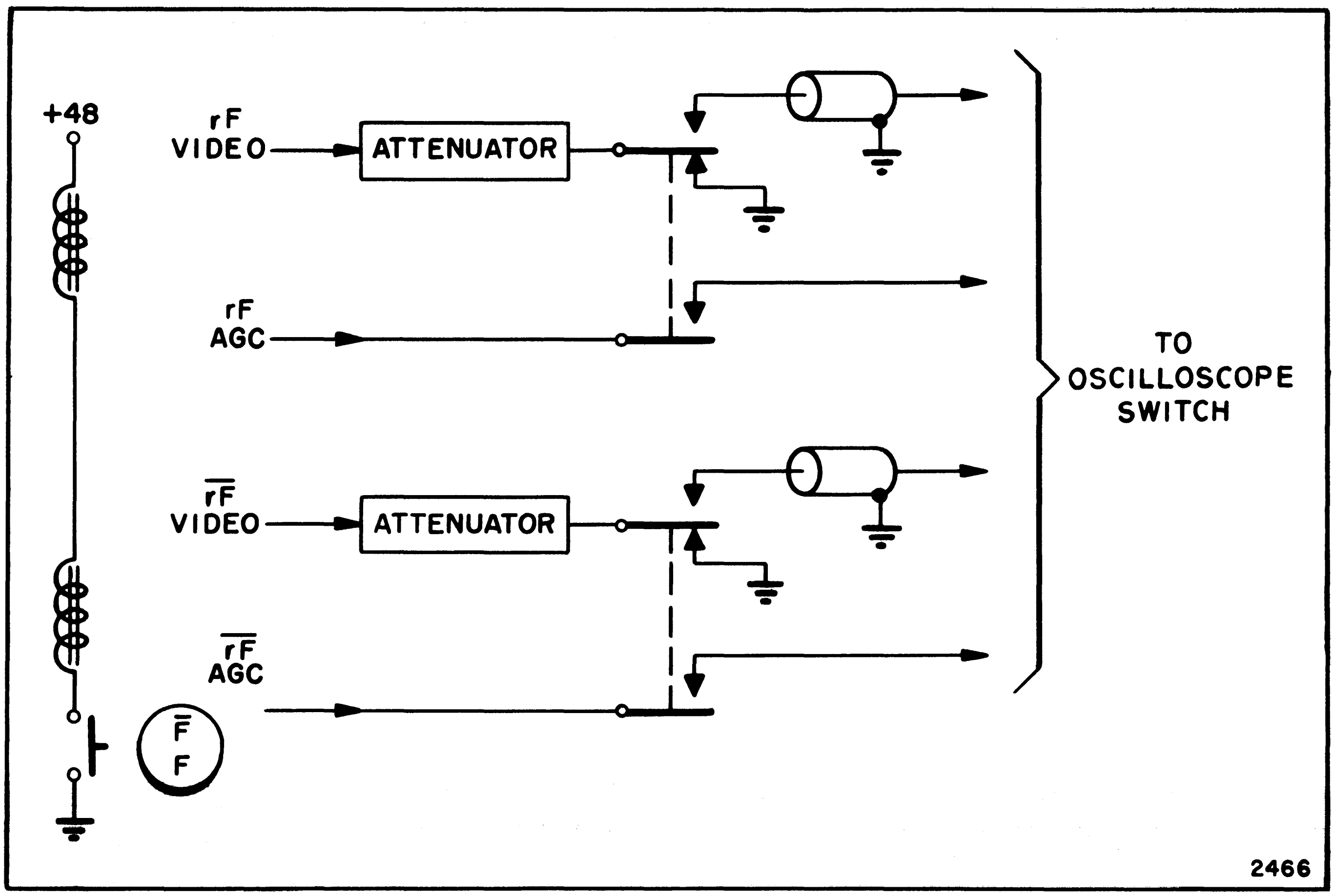

Figure 2-2. Monitor Relays

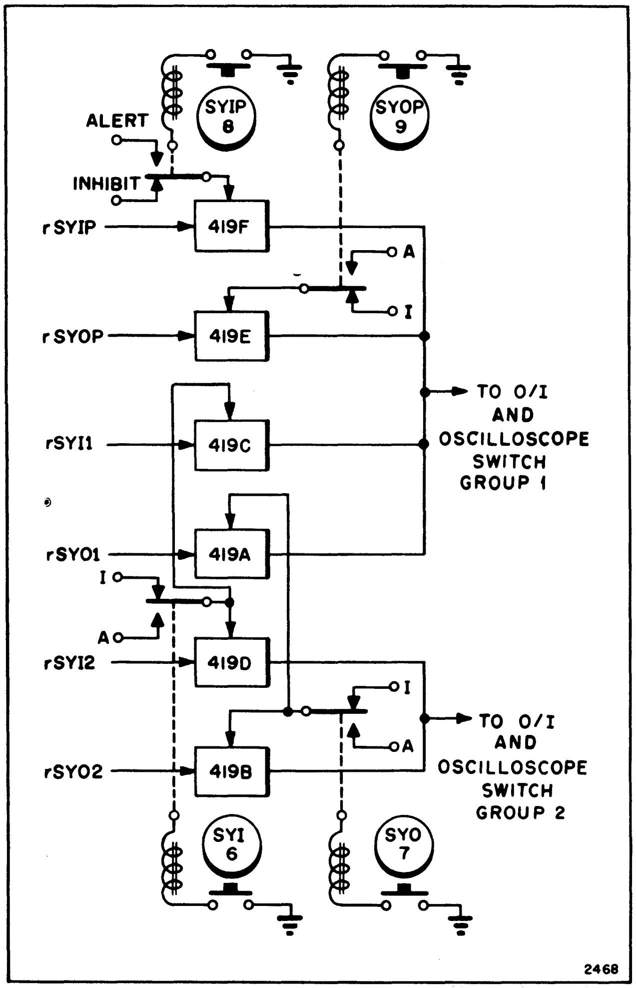

Figure 2-3. SYI-O Monitor Gates

or faulty elements. The absence of signal may reveal an open or grounded circuit. In some cases, a standard wave pattern should be expected. (The precessor registers, for example, should not contain more than one pulse.)

2-26. Proper interpretation of an oscilloscope pattern requires inspection of the associated AGC voltage. If a wave pattern is absent, for example, and AGC is low, the trouble is probably in the circuits of the channel. If automatic gain is high, the channel is probably not receiving an input signal.

2-27. Inspection of waveforms during preventive maintenance can show up weak components. The AGC voltage reading is even more useful. As components age, especially vacuum tubes, the AGC voltage gradually changes. If maintenance personnel monitor and record this voltage value at scheduled intervals, they will be able to anticipate failures and take corrective action during the maintenance period without interrupting computer working time.

2-28. The following listing gives the ranges over which AGC readings vary during the life span of the tubes in the various computer circuits. The gain-control voltages for the local drivers and the mercury channels are monitored from the AGC jack on the supervisory control panel; the timing-pulse generator, continuous wave generators, and continuous wave buffers must be monitored at the chasses.

	New	*Old*
Local drivers	–3 to –5 volts	–8 to –9 volts
Mercury channels	–3 volts	–1.75 volts
Timing-pulse generator	–3 to –5 volts	–8 to –9 volts
CW generators	100 volts	225 volts
CW buffers	90 to 125 volts	150 volts

2-29. Faulty operation of the timing-pulse generator, cw generator, and cw buffer circuits can be inferred from the AGC values for the memory and local driver circuits. For example, if all 11 local drivers give low AGC readings, the timing-pulse generator, which drives all local drivers, should be checked. Similarly, high AGC voltages observed simultaneously in a group of memory channels indicate a failure in a common signal source, such as a continuous-wave buffer driver, and high readings in the entire memory observed simultaneously with low readings in the short registers point to trouble with cw generator 1, which supplies the memory.

2-30. VOLTAGE MONITOR

2-31. DESCRIPTION AND FUNCTION

2-32. The Univac I system uses voltage-monitoring circuits to simplify measurement of voltage levels and to give an automatic indication of serious deviations from nominal values. The controls for the voltage monitor and the deviation meter are mounted on the right end of the supervisory control panel (figure 5-1).

2-33. Figure 2-6 shows the monitor circuit in simplified form. The ratio of the resistors R1 and R2 is fixed at such a value that a selected fraction of the measured voltage equals the reference voltage if the measured voltage is correct. The actual values of the resistors are chosen to make the maximum allowable deviation in measured voltage give full-scale deflection on the meter. Resistor Rs is required so that an open switch contact can cause some deflection on the meter and indicate a failure.

2-34. Two types of reference voltage are used in this monitor circuit: an absolute reference, which is constant in value and independent of line variations, and a relative reference, which is proportional to the mean of the two phases of the supply line.

2-35. An unbalanced voltage may be read either on the deviation meter on the control panel or on a meter connected to two terminals in the negative-voltage

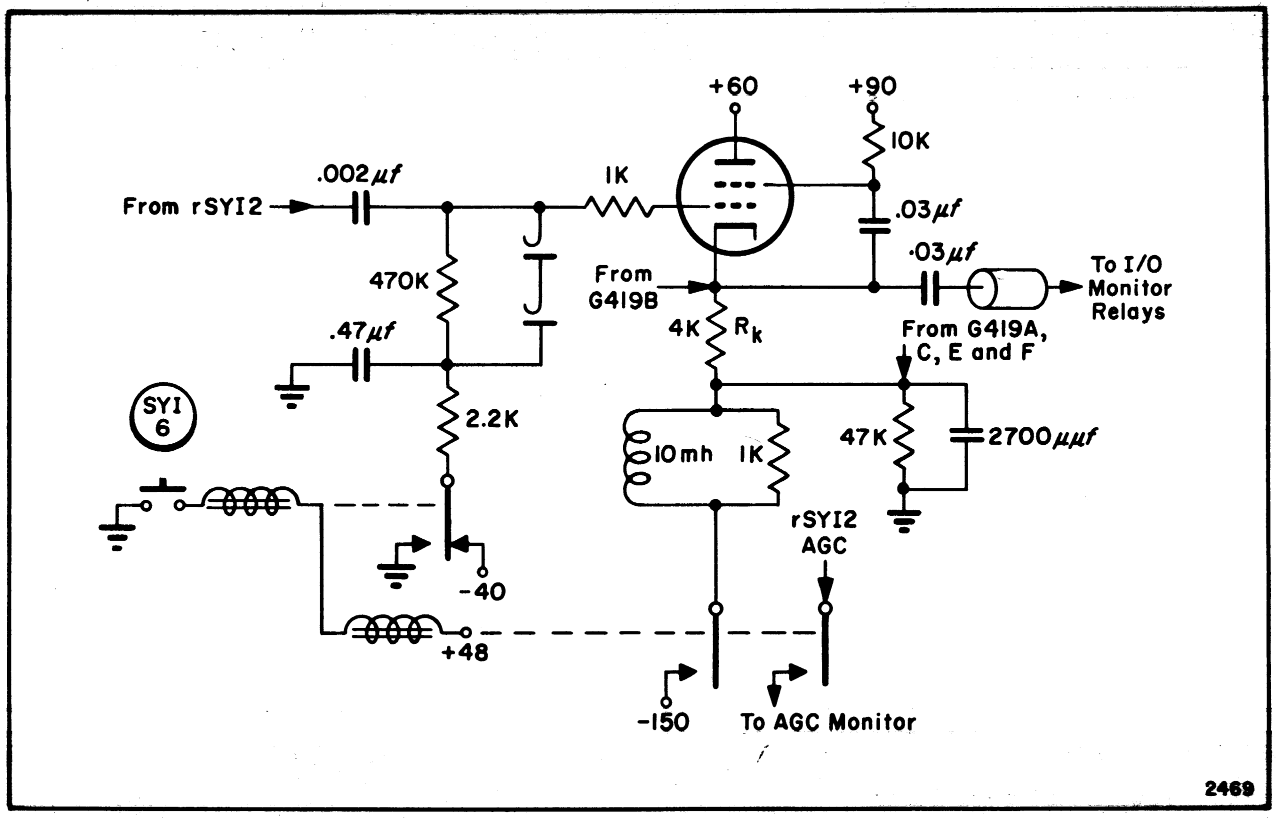

Figure 2-4. SYI-O Monitor Gate G419D

capacitor area of the power supply. The potential difference also can be applied to energize a sensitive relay which, when energized, turns off dc after a 30-second delay.

2-36. The circuit can be operated manually or automatically. For manual operation, the proper pairs of pushbuttons on the monitor section of the control panel must be pushed. During automatic operation, measurements are made at the rate of one a second. Four solenoid-driven stepping switches step the monitor through the circuits. If the sensitive relay is employed, automatic monitoring continues only until trouble is encountered. The stepping switch does not move from the position in which the fault was discovered; and, if the DELAYED SHUT-OFF switch is employed, 30 seconds later all dc is shut off. If the readings are being taken from the deviation meter, automatic operation continues until stopped.

2-37. VOLTAGE MONITOR THEORY

2-38. A complete discussion of the operation of the monitor circuits is given in the Maintenance Manual for Univac Power Supply. (See paragraph 3-112.) The voltage monitor is designed to detect differences in potential. Precision adjustment of all voltages, even with a 1-percent voltmeter, cannot take care of some of the voltage problems which the voltage monitor circuits are designed to detect.

2-39. For example, a vacuum tube may operate with a 15-volt bias established by a –150-volt cathode voltage and a –165-volt grid voltage. If the –150-volt and –165-volt supplies are adjusted to 1 percent, there is a possible $\pm(1.65 + 1.5)$-volt or ± 3.15-volt tolerance in the difference voltage. This means that the 15-volt bias is actually applied with a ± 21-percent tolerance, which is not within the standard 4-percent allowable deviation. An externally applied one-percent voltmeter could not detect this condition. The functions served by the various voltage levels could only be determined by extensive investigation of the circuits. The voltage monitor not only can measure computer voltages easily and quickly but also is a guard against voltage deviations which exceed the permissible limit.

2-40. As another advantage, the automatic voltage monitor can compensate for the condition of the line at the time of adjustment. Two reference supplies are available. The absolute reference is independent of the condition of the a-c power line, and the relative reference varies with the a-c power line.

2-41. Normally, both the line voltage and the various d-c levels may vary within certain limits and the circuits will still operate effectively. The relationship established among the tolerances is such that at a nominal value of line voltage, nominal values of dc will be obtained, and line variations within tolerance

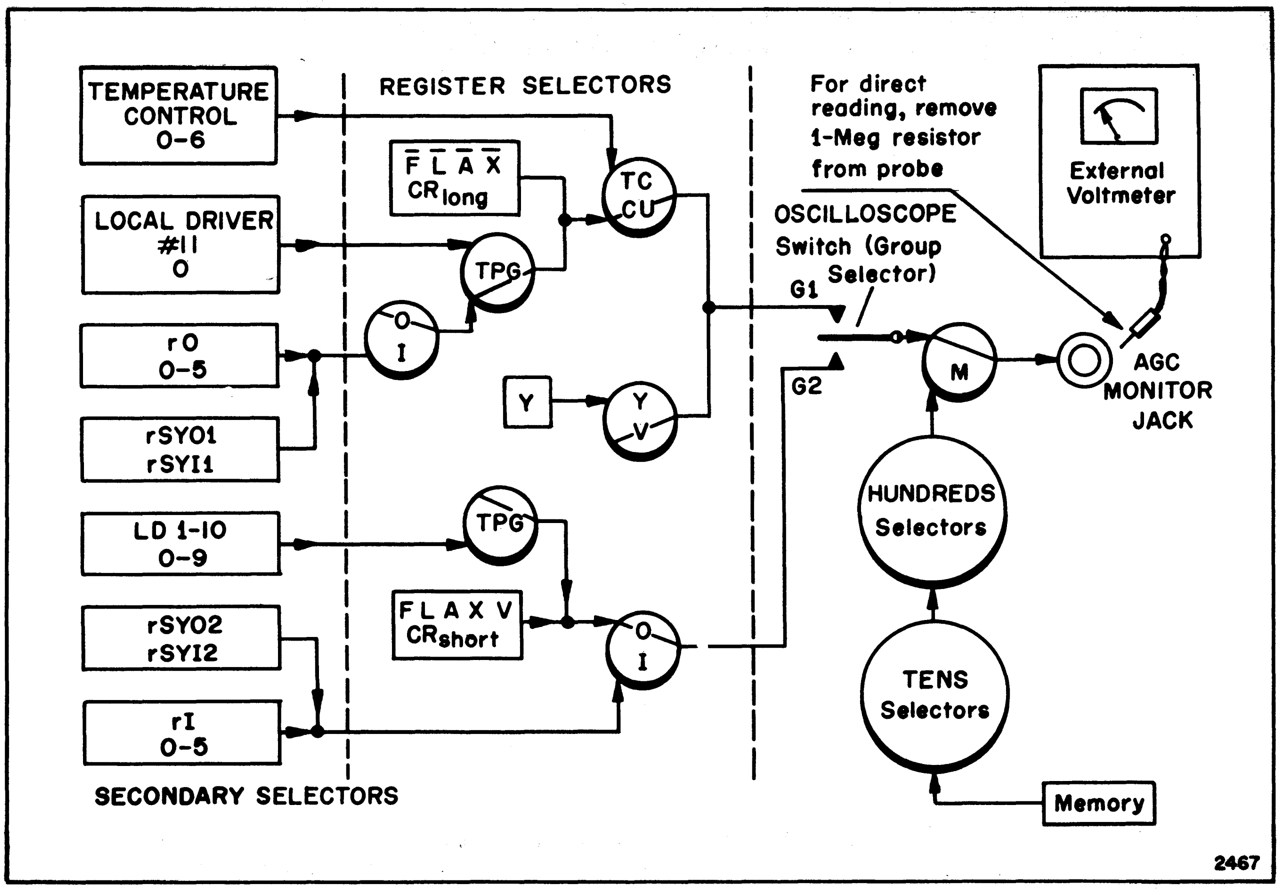

Figure 2-5. AGC Monitor

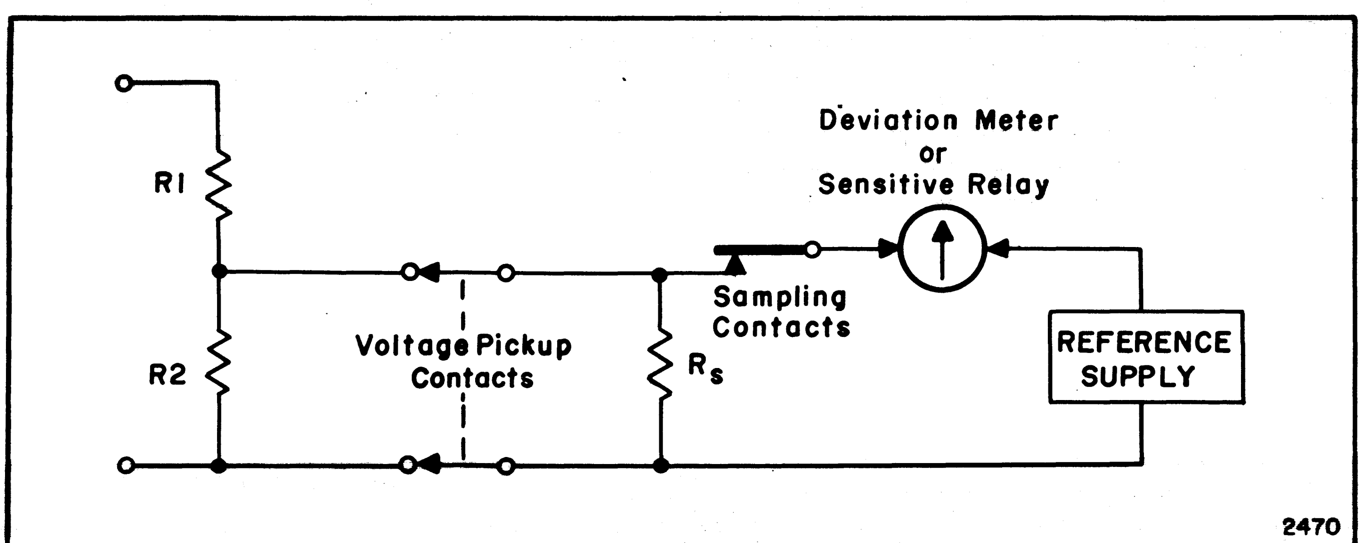

Figure 2-6. Voltage Measuring Circuit

limits will not push any d-c value over tolerance. Measurements made with reference to ground potentional are necessarily of an "absolute" nature and so do not account for line variations.

2-42. The relative reference supply will react to line variations exactly as the main supply reacts. Once calibrated, it is an automatically compensated reference for d-c voltage checking.

2-43. The Univac I system is normally operated from a stabilized power source. The absolute reference, or ground potential, is valid for making measurements and initial adjustments. Where the line is not stabilized, voltage monitoring with the relative supply is the only reasonable method of adjusting or measuring the d-c potentials.

2-44. USE OF VOLTAGE MONITOR

2-45. The voltage monitor should be used as a preventive maintenance tool at least once a week. The monitoring operation can be performed in conjunction with other maintenance tests and routines.

2-46. The procedure for monitoring voltages consists of three operations:

(1) The adjustment of the reference supplies.

(2) The monitoring operation itself, which includes making a record of all readings which exceed allowable deviations.

(3) Adjusting defective voltage supplies.

2-47. VOLTAGE ADJUSTMENT. To adjust the voltage supplies requires two men. Tools necessary for measurement and adjustment are a screwdriver, a pair of pliers, and a two-percent voltmeter.

2-48. In adjusting reference supplies to –1.75 volts, the reference-supply voltages are compared with a known –1.75-volt source, and adjusted for no deflection on the deviation meter (right side of supervisory control panel). The procedure follows:

(1) Adjust –1.75-volt supply in KL corner. Measure this voltage with a two-percent voltmeter. Terminals are located on the monitor fuse panel in KL corner. If this voltage is not correct, adjust the –1.75-volt tap on the power-supply bleeder.

NOTE

The –1.75-volt terminals in the KL corner are in series with the I.F. BIAS CONTROL switch. This switch changes the voltage at the test terminals in KL corner to –2.25 volts when it is in the HIGH position. For this reason, the I.F. BIAS CONTROL switch must be in the NORMAL position during this initial measurement.

(2) Push the third column button (marked 2) and the fourth row button (marked 3) on the voltage monitor panel (right side of supervisory control panel), connecting the deviation meter to the –1.75-volt terminals.

(3) Release the reference voltage switch, marked REF. VOLTAGE on supervisory control panel. When this switch is pushed down (ABSOLUTE position), it connects the absolute reference voltage to the meter; when released, it connects the relative reference voltage to the meter. Both of these supplies are in HJ corner.

(4) Adjust the relative reference potentiometer in HJ corner until the needle on the deviation meter (on the supervisory control panel) is centered. The potentiometer is to the right of the meter at the top of the corner.

(5) Push the reference voltage switch down (ABSOLUTE position).

(6) Adjust the absolute reference potentiometer in HJ corner until the needle on the deviation meter is centered.

2-49. MONITOR OPERATION. To operate the monitor, the reference voltage switch must be released to the relative reference position. The TANK HEATER VOLTAGE/VOLTAGE MON. REMOTE METER switch must be released to VOLTAGE MON. position, and the DELAYED SHUT-OFF switch should be left in neutral.

(1) Release the automatic/manual switch (marked VOLTAGE MON. MANUAL SWITCHING) to automatic position. The voltage monitor will start to measure voltages at the rate of one a second. When a voltage exceeds allowable deviation, the monitor will stop.

(2) Record the faulty voltage pair and the meter reading.

(3) Push down the automatic/manual switch to manual position. This will prevent a d-c shutdown and will cause the voltage monitor to "home" on whatever buttons are depressed, eliminating any indication of a faulty voltage reading.

(4) Release the automatic/manual switch to start the monitor.

(5) Continue this process until each voltage pair has been measured twice. (The double measurement is necessary because the stepping switches which pick up the voltages have two sets of armature contacts, which are used alternately. If there is a difference between two readings of the same voltage pair, the trouble probably lies in the monitor switch.)

2-50. To make the necessary adjustments:

(1) Analyze readings which exceed allowable deviation with respect to their locations along the power-supply bleeder. Table 2-1 will aid in this analysis. If isolated points are off tolerance, the bleeder taps should be adjusted (paragraph 4-37). If a series of

Table 2-1. Power-Supply Voltages

Terminal Marking	Voltage	Average Hum in Volts	Supply
750	750		Uniservo
410	410	1.2	
380	380		
375	350	3.6	Uniservo
290	285	1.8	Memory and function-table supplementary supply
280	280	1.3	
279	255		Function-table special supplementary supply
247	246		Memory special supplementary supply
246	246	1.0	
200	200		
165	165	0.9	
160	160		
150	150		
120	120	0.8	
105	105		
95	95		
90	90	0.8	
84	84		
80	80		
79	69		Function-table special
75	75		
70	70		
66	66		
60	60	0.9	
50	50		
48	48	0.6	Relay supply
40	40		
35	35		
30	30		
20	20		
15	18		
8	8		
5	5		
0	0		
–1.75	–1.75		Bias. (–2.25 when dc is turned on; changes to –1.75 when I.F. BIAS CONTROL switch is operated.)

Terminal Marking	Voltage	Average Hum in Volts	Supply
–4	–4		
–11	–11		Bias
–13	–13		
–14	–14		Bias
–15	–15		Bias
–16	–16		
–17	–17		
–18	–18		Bias
–20	–20		
–21	–21		Bias
–25	–25		
–30	–30		
–34	–34	0.5	
–40	–40		
–50	–50		
–55	–55		
–60	–60		
–71	–71		
–74	–74	0.6	
–80	–80		
–86	–86		
–88	–88	1.0	
–95	–95		
–100	–100	1.2	
–106	–106		
–117	–117		
–125	–125		
–140	–140		
–150	–150	1.4	
–163	–165		
–165	–166		Bias
–166S	–166S	0.8	Standby
–175	–175		
–190	–190		
–191S	–191S	0.8	Standby
–203	–203		Bias
–216	–216	1.2	
–217S	–230		Standby
–229	–229		Bias
–300	–300	1.8	

voltages from a common rectifier is off tolerance, the components in that rectifier may require adjustment. (This adjustment is made by means of phasing switches in the power supply.) Refer to the power-supply manual (paragraph 3-112).

(2) Turn dc off. Connect the two-percent voltmeter to the terminals in KL corner, while another man makes the necessary adjustments at the power supply. Voltages should be adjusted so that the meter reads the values given in table 2-1. After adjustment, recheck with the monitor to make certain that allowable deviations are not exceeded by any voltage pair.

2-51. TANK-HEATER MONITOR

2-52. In order to maintain a standard transit time through the mercury delay lines in the Central Computer, the temperature of the mercury is held at a constant level. Three separate heating and temperature-control systems are used, two for the long (10-word transit-time) tanks, and one for the short (2- or 1-word transit-time) tanks. The accuracy of temperature control is a direct function of the length of the delay; for this reason, the 1- and 2-word tanks require only coarse control, while the 10-word tanks require more precise control.

The three systems are:

(1) Long-tank standby heater: operating on alternating current, this heater provides initial heat for the long tanks, under a coarse mechanical control.

(2) Long-tank operating heater: operating on direct current, this heater maintains the operating temperature of the long tanks under fine electronic control.

(3) Short-tank heater: operating on direct current, this heater both provides initial heat and maintains operating temperature of the short tanks. It operates under a coarse control provided by a mercury thermostat.

2-53. LONG-TANK STANDBY HEAT

2-54. The long-tank standby circuit provides the initial heat for the 10-word mercury tanks. Alternating current, passed through a set of heating coils surrounding the long tanks, heats the mercury to 63°C (146°F) (2 degrees centigrade below operating temperature). The standby circuit maintains this temperature within a range of a few degrees. The standby heating circuit is shown in figure 2-7.

2-55. As soon as control power is turned on, power is applied across ϕ1L6, ϕ1L8 and ϕ1L9 if ϕ1L8 and ϕ1L9 are closed. (The notations mean phase 1, line 6; phase 1, line 8; phase 1, line 9.) The ϕ1L6 signal immediately energizes the long-tank overheat relays RP23 and RP27, and, after a delay, RP28. The three contacts of this relay close. The long-tank a-c heating coils, wound around the inner cylinder that contains the mercury, are connected across ϕ1L8 and ϕ1L9 through contacts of RP23, and through the closed contacts of deenergized relay RP22. In later models, RP22 has been eliminated and ϕ1L8 and ϕ1L9 go through RP23.

2-56. As soon as power is applied to the heating coils, the STAND-BY POWER (HEATER) neon at the bottom of the left section on the supervisory control panel comes on. As long as a-c heating power is available to the long tank, this neon remains lighted. In addition, all seven STAND-BY HEATERS—LONG TANKS neons come on. These neons indicate which tanks are connected to the standby power lines.

2-57. Under average conditions, about half an hour is required for all tanks to reach the a-c equilibrium temperature of 63°C (146°F). At this temperature, the mechanical control system described in paragraph 1-86 operates; the mercury expands enough to force the standby switch against its stop. The switch opens, disconnecting one side of the heating coil from the supply voltage, and the mercury starts to cool.

2-58. As the tank cools, the mercury contracts and releases the standby switch, reapplying heating power. In this manner the power on the individual tanks will come on (for about 30 seconds at a time) and go off (for several minutes at a time) until dc is turned on by the operator.

2-59. If the standby switch fails to turn off heating power when it should, the mercury expands until the overheat switch is engaged. When the overheat switch opens, it breaks the ground-return line of overheat relays RP23 and RP27, disconnecting a-c heating power from all tanks and interrupting d-c power by opening the d-c interlock line. Thus, the overheat switch protects against failure of either the a-c or d-c heating system. The opening of the overheat switch lights a neon indicator on the end of the overheated tank.

2-60. When the tank has cooled sufficiently, the overheat switch closes. RP23 is reenergized, again applying ac. The overheat neon also goes out. An immediate examination of the overheat neons is therefore necessary when an overheat occurs in order to determine which tank is overheated and isolate the trouble to one of the temperature-control circuits. (In later computer models this will not happen because of an interlock circuit which requires that ϕ1L6 be dropped before a-c heat is again applied.)

2-61. When all tanks have reached a-c equilibrium, d-c power can be turned on. When dc is turned on, relay RP10A is energized, in turn energizing RP10B, which applies power to RP22. The now open contacts of RP22 disconnect ϕ1L8 and ϕ1L9 from the long-tank heating coils; the STAND-BY POWER neon remains lighted; the individual tank indicator neons all go out; and, as soon as the cycling unit starts, the temperature of the tank is under control of the d-c heating system.

NOTE

On all but first six models of Univac I system, RP22 has been removed; ϕ1L8 and ϕ1L9 are applied directly through contacts of RP23. The d-c heat maintains the mercury temperature at 65°C (149°F), holding all seven standby switches open. The STAND-BY POWER neon remains lighted, but all individual long-tank heater indicator neons should be off. In the later models, the heating process can be speeded by the application of d-c power as soon as the yellow ready light comes on. The cycling unit should be started immediately after d-c power is applied.

2-62. LONG-TANK D-C HEAT

2-63. Operating temperature of each mercury tank is precisely controlled by a circuit which compares a standard timing pulse against a cycling-unit pulse sent through the temperature-control channel of the tank. Operation of the control system requires a $\underline{t16}$ pulse

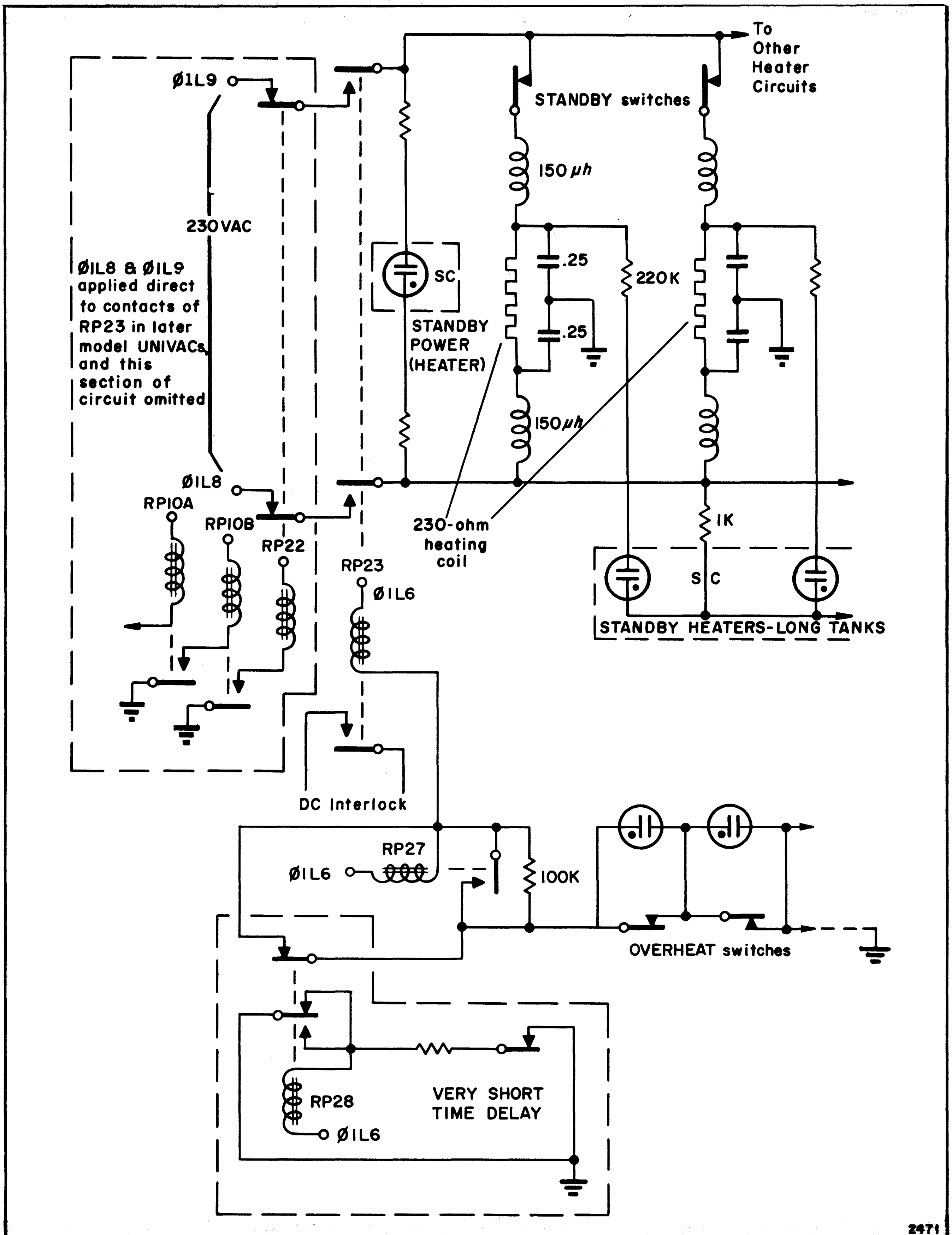

Figure 2-7. Standby Heating Circuit

from the cycling unit as well as a negative timing pulse (TP-). (A t16 pulse is a t16 pulse delayed one-half pulse time.)

2-64. The cycling unit should, therefore, be started as soon as dc is turned on. Until the cycling unit comes on, the d-c heating system supplies a minimum current of approximately 34 milliamperes, and 4 watts is dissipated in the heating coil.

2-65. The long-tank temperature-control diagram, (figure 2-8) explains the operation of the system.

2-66. The delay in the mercury is a direct function of temperature. Each mercury tank is heated by a 3500-ohm coil, which is wound around the inner cylinder of the tank. This coil forms the anode load of an 807 driver tube. The grid bias on the 807 controls the amount of current passed through the heating coil, thus controlling the temperature of the mercury.

2-67. The grid bias is governed by the temperature-control channel, which measures the transit time of a pulse through the mercury tank and produces an out-

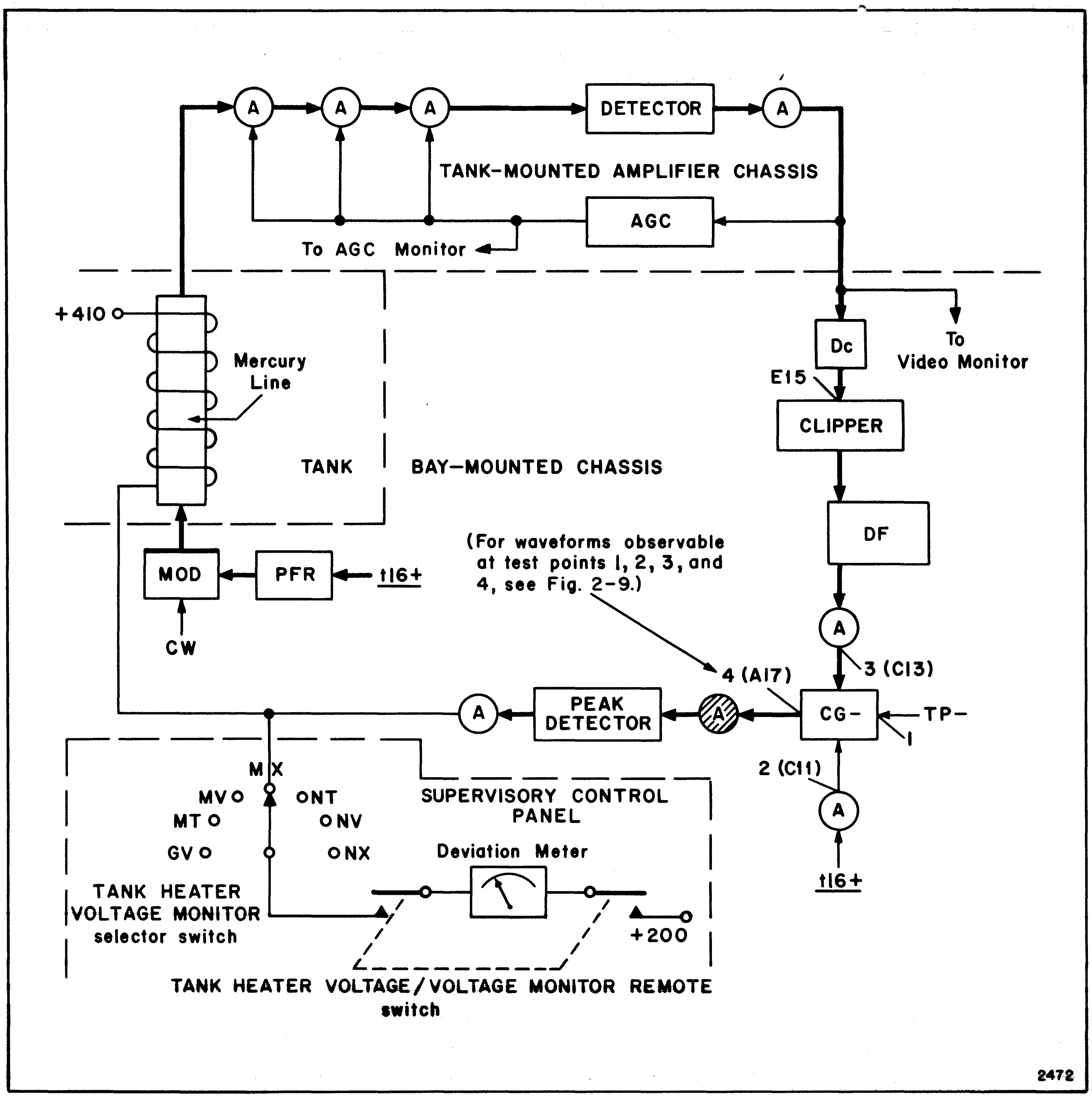

Figure 2-8. Long-Tank Temperature Control

put signal with an amplitude which varies with the tank temperature. Therefore, if the delay is too great, meaning that the tank is too hot, the bias rises and the heating power drops. If the delay is too small, current through the heating coil increases as the bias drops.

2-68. The transit time through the mercury is measured in this way: the t16 pulses from the cycling unit are cw-modulated and sent through the mercury channel. The output from the memory channel is amplified and detected, and applied to a delay flop through a clipper which discriminates against crosstalk from the information channels and against other noise. The t16 pulses also select negative timing pulses each minor cycle; these timing pulses are applied to the temperature-control gate. The output of the delay flop is applied to the temperature-control gate. The delay flop is not, in this instance, used to delay the signal, but merely to provide a waveform of short rise time for operating the gate. The gate develops an output voltage with an amplitude which depends on the relative timing of the delay-flop output and the negative timing pulse. The output of the gate is applied to a peak detector. The peak detector filters the output signals from the gate into a bias voltage for the heating-coil driver tube.

2-69. Three conditions of the control circuit are illustrated in figure 2-9. If the delay through the channel is correct, the timing pulse appears at the center of the waveform from the delay flop. The output of the gate is then a half-amplitude timing pulse. The peak detector maintains approximately the peak value from one pulse to the next and biases the driver so that approximately 12 watts is supplied to the heating coil. This is enough to compensate for heat losses under average conditions of ambient temperature.

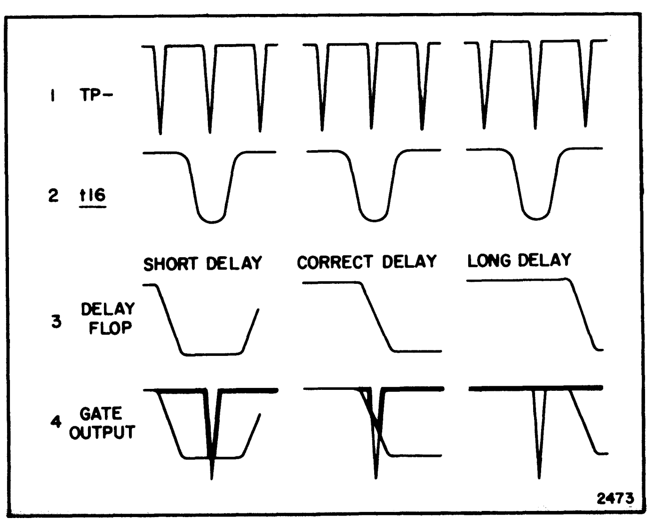

Figure 2-9. Temperature-Control System, Timing Chart

2-70. If the tank is cold, the delay of the t16 pulse will be too short. The delay flop will be set early, and the waveform will reach its maximum value before the timing pulse appears. Consequently a full-amplitude pulse will pass through the gate, and the peak detector will apply smaller bias to the driver tube. The heating power will then increase toward its maximum value of 35 watts, raising the temperature and increasing the delay to the correct value.

2-71. If the delay is too long, the tank is overheated. The timing pulse arrives at the gate early and does not get through. The peak detector then applies greater bias to the driver, decreasing the heating power toward its minimum value of 4 watts and cooling the tank.

2-72. The complete heating cycle for a long tank is shown in figure 2-10. As soon as control power is turned on, the heating coil draws 1 ampere of current from ϕ1L8 and ϕ1L9, and the temperature of the tank starts to rise. Within half an hour the temperature reaches the a-c equilibrium point of 63°C (146°F), and the expanding mercury opens the standby switch to turn off standby power. The mercury then cools slowly for a few minutes, until the contracting mercury releases the standby switch and power is reapplied. The temperature rises rapidly until the switch opens again. This cycling continues until dc is turned on, and a-c power is removed. (In all but the first six models of Univac I system a-c and d-c heating power can be applied simultaneously as long as the temperature remains below 63°C (146°F), because relay RP22 has been removed from the circuit.)

2-73. The d-c heating system, when first turned on, supplies its minimum output of 4 watts. When the cycling unit is turned on, the temperature-control system goes into operation. Since the tank is below its operating temperature, maximum d-c power of 35 watts is applied, and the temperature rises. As the tank temperature reaches 65°C (149°F), the control system reduces power to an average value of 12 watts, just enough to compensate for heat losses under average conditions.

2-74. MONITORING THE LONG-TANK HEATING SYSTEM

2-75. The long-tank d-c heating system can be monitored from the supervisory control panel. The upper position of the TANK HEATER VOLTAGE/VOLTAGE MON. REMOTE switch connects the panel-mounted deviation meter between a 200-volt source and the TANK HEATER VOLTAGE MONITOR selector switch, a seven-position rotary switch on the left center panel. The switch connects the deviation meter to the anode of the driver in the one of the seven temperature-control channels selected.

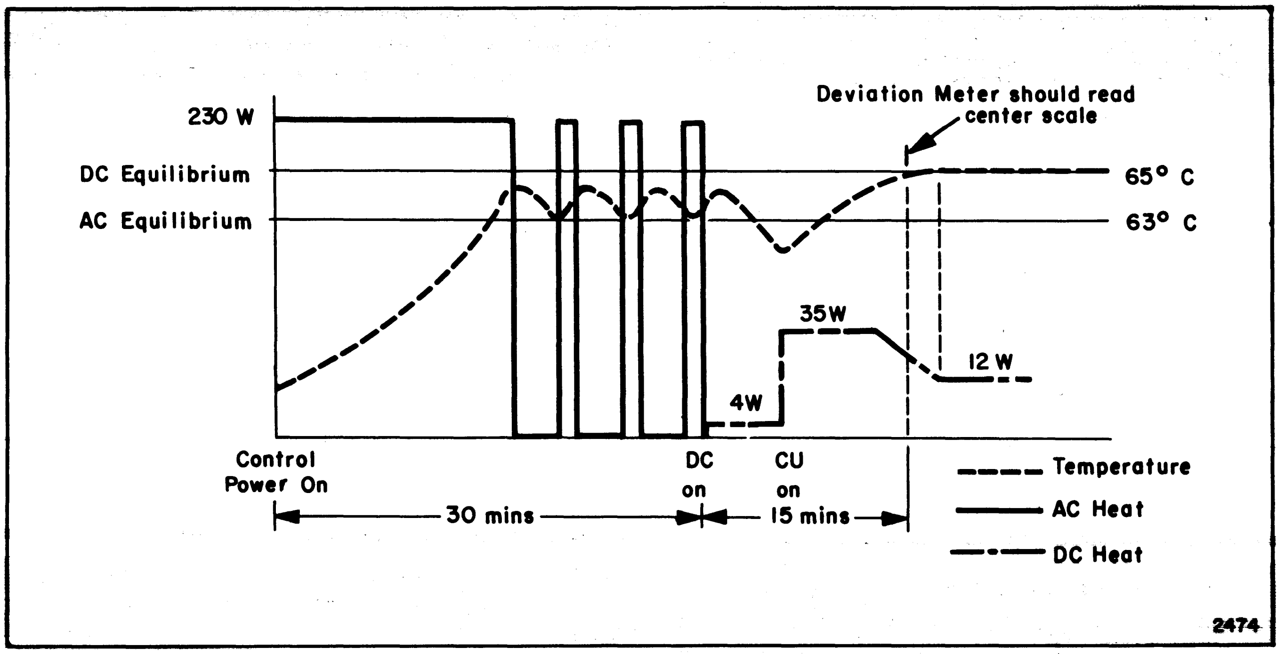

Figure 2-10. Long-Tank Heating Cycle

2-76. Under normal operating conditions, the voltage at the anodes of the seven heating-coil drivers is 200 volts. With both terminals connected to 200 volts, the deviation meter reads zero. If the tank requires more heat, the anode potential drops, and the needle on the deviation meter deflects to the left (LOW). As the temperature rises, the temperature-control channel reduces applied power, the anode potential rises, and the needle moves to the right (HIGH).

2-77. When dc is first turned on, the meter reads full right, indicating that no heat is being applied. As soon as the cycling unit is started, all tanks give a full-left reading. During the following 15 minutes, as the tanks heat to operating temperature, the needle moves slowly from left to center scale. Once the temperature has become stable, the meter reading may fluctuate slightly around zero. (This fluctuation is due to cross-talk between the temperature-control channel and the information channels and is no cause for concern.)

2-78. No valid conclusions can be reached concerning functioning of the long-tank heaters unless conditions in the other memory circuits are also observed. The same readings of the deviation meter may indicate either normal or abnormal operation, depending on these other conditions. In most cases, the heater circuits are only monitored after trouble has arisen in the memory. Certain troubles immediately indicate a fault in the temperature-control system, among them:

(1) High-speed bus odd-even errors on normal transfer from the memory, during periodic memory check, or during transfers from rI after an error-free tape reading (but only if there is an even number of bits in a digit).

(2) Output-synchronizer odd-even errors while writing on tape.

2-79. A normal reading on the meter (needle centered on scale, no deviation) indicates that trouble is not caused by failure of the tank temperature-control system. Extreme right or left readings indicate an abnormal condition in the tank:

Condition	*Possible Trouble*
Extreme Right	
Driver not conducting strongly; temperature-control circuit allowing tank to cool.	Circuit failure in control circuit; overheat in tank; open circuit between control-circuit input and cycling-unit output; if all tanks, failure in $\overline{t16}$ circuit in cycling unit.
Extreme Left	
Driver conducting heavily; temperature-control circuit is overheating the tank.	Circuit failure in control circuit; tank is cold and is calling for heat.

2-80. Table 2-2 gives the tank location for all of the 1000 memory addresses and the input, output, and Y registers.

Table 2-2. Memory Locations

Address	Tank	Address	Tank
000 - 079	MT	080 - 099	NV
100 - 179	MT	180 - 199	NV
		280 - 299	NV
200 - 279	NT	380 - 399	NV
300 - 379	NT	480 - 499	NV
		580 - 599	NV
400 - 479	GV	680 - 699	NV
500 - 579	GV	780 - 799	NV
600 - 679	NX	880 - 899	MX
700 - 779	NX	980 - 999	MX
		rI	MX
800 - 879	MV	rO	MX
900 - 979	MV	rY	MX

2-81. The overheat-protection circuit described in paragraphs 2-53 through 2-61 is effective in all but the first six models of Univac I system for a-c and d-c heating systems. If dc is turned off by this circuit, the operator should determine which tank is overheated by observing the neons on the ends of the tanks. As soon as the overheat neon goes out, he should restore d-c power. (In Univac I system models after the first eight, dc cannot be restored after a long-tank overheat unless control power is first turned off and then on again.) When dc is on again, the operator should push the MEMORY CLEAR switch down, reading decimal zeros into all channels of the memory.

2-82. If the previously overheated tank holds the pulses and otherwise operates normally, the overheat switch may be out of adjustment. (An adjustment procedure for the overheat and standby switches is given in paragraph 4-35.)

2-83. If the tank does not hold information pulses after dc is reapplied, a true overheat has occurred. The operator should immediately shut off all power, including control power, and call for service. The maintenance technician should check the following:

(1) The AGC on the affected channel. The AGC monitor meter should read –1.75 volts (paragraph 2-23).

(2) An output signal from the temperature-control gate in the memory section: the output-test terminal is TTA17 on chassis 2 (temperature-control chassis). The waveform should be a gated TP–. (See figure 2-9).

(3) All inputs to the temperature-control gate (paragraph 2-69).

(4) The 807 driver tube (paragraph 2-66).

2-84. SHORT-TANK HEATING SYSTEM

2-85. Sixteen chasses in the Central Computer are given over to short mercury-delay groups of ½- 1-, and 2-word capacity. Figure 2-11 shows an exploded view of the complete short-tank chassis. The chassis includes the circuitry referred to on block diagrams as MDG (main delay group). The chassis contains a pulse former and retimer, a modulator, the small mercury tank and the associated heating circuit, the detector amplifier, a compensating delay line, and an output cathode follower.

2-86. All short-tank registers use similar chasses; the major difference from one to another is the short tank. Even among 1-word tanks, individual transit times differ in order to compensate for differing requirements in the associated circuitry. In the short tanks, slight variations (3°C per pulse time) in the temperature of the mercury do not cause any serious change in the delay. For this reason the system used to control the temperature of the mercury in the short tanks is less precise than that used in the long tanks.

2-87. The temperature-control circuit, shown in figure 2-12, consists of a 25L6 driver tube with the tank-heating coil as the anode load. The heating coil is wound around the mercury cylinder. The thermostat that is mounted against the mercury cylinder controls the bias on the driver. Three contact points in the mercury column of the thermometer control the application of the heating current.

2-88. When d-c standby power is first applied to the circuit, the tank is cold, and a bias voltage of –166 volts is applied to the grid of the driver tube. In this state, the driver tube draws full current, which passes through the heating coil. The anode voltage is well below ground potential, and the indicating neon on the chassis and the HEATERS—SHORT TANKS neon on the supervisory control panel are at ground potential. Consequently, these neons light, indicating that heat is being applied to the tank.

2-89. As the temperature rises, the mercury in the thermometer expands. When it has expanded sufficiently to pass the first and second of the three contacts, it forms an electrical connection between them. Through this connection an overriding bias of –216 volts is applied to the driver. The driver tube is cut off, the indicator neons go out, and the temperature drops. As the mercury column contracts, the connection between the two contact-points is broken; the bias then drops back to –166 volts to reapply heat to the tank. A small "anticipator" coil, wound around the bulb of the thermometer, is in series with the heating coil. The anticipator minimizes the time lag in the circuit by applying heat directly to the thermometer.

2-90. If the heat does not cut off when it should, the mercury continues to expand. If it expands far enough to connect the second and third contact-points, it completes the circuit that applies power to the overheat alarm line.

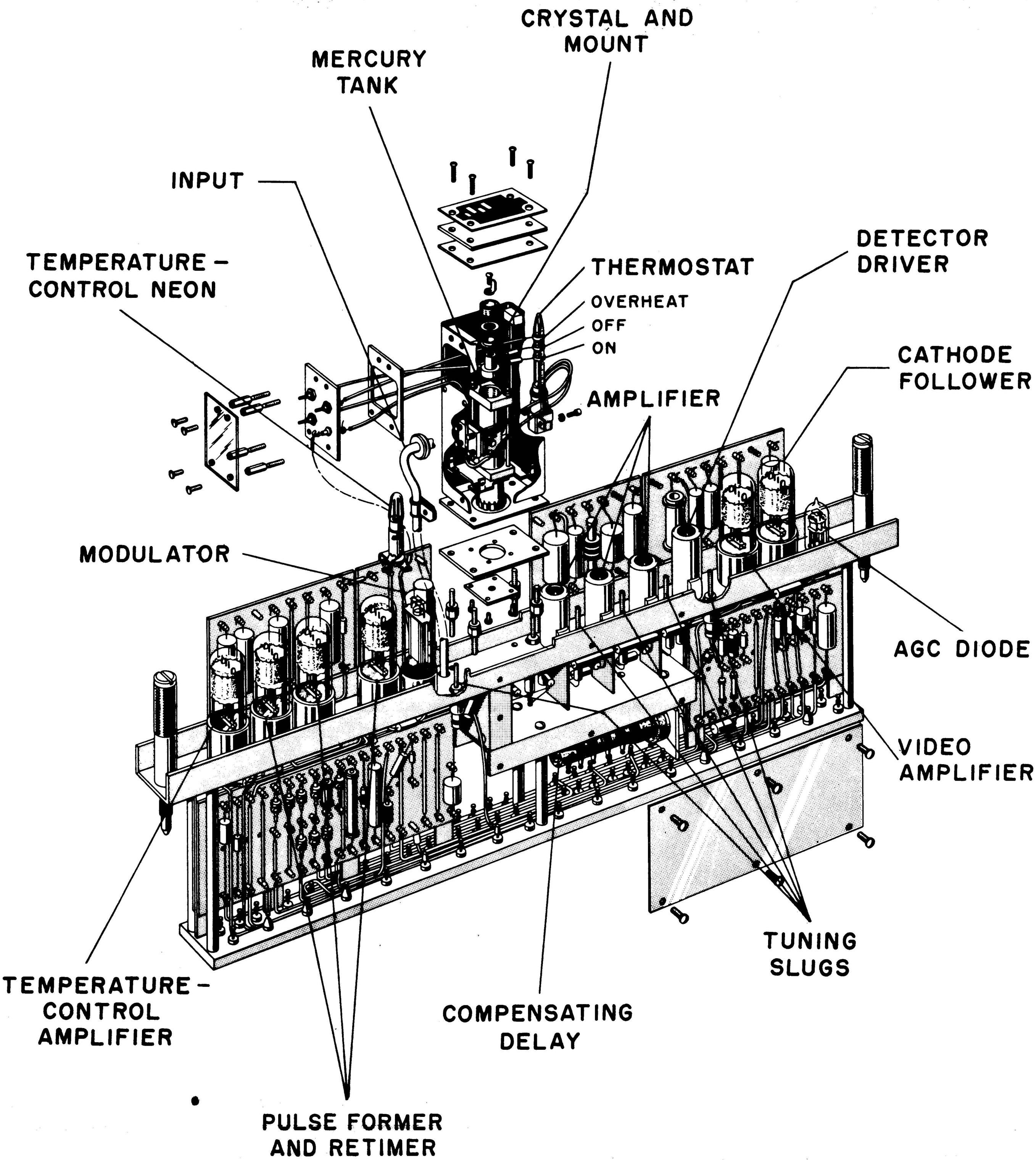

Figure 2-11. Short-Tank Register Chassis

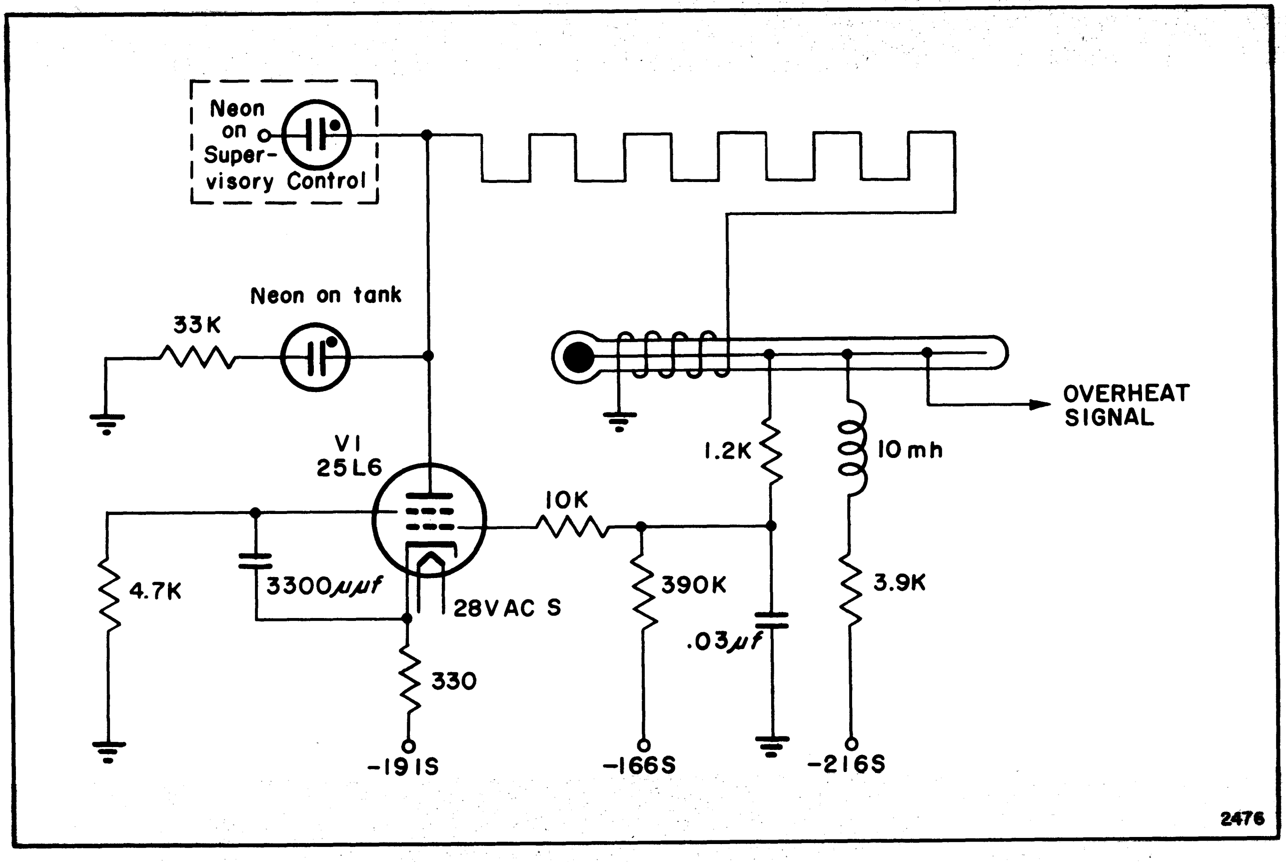

Figure 2-12. Short-Tank Temperature Control

2-91. The overheat alarm lines from all 16 short tanks are the inputs to the short-tank overheat circuit, as shown in figures 2-13 and 2-14. In the resistor-matrix encoder each overheat line picks up three of the six output lines in a particular combination representing the code for that overheat line. The code sets up a relay staticizer, which serves as a static memory of the location of the overheat, and at the same time opens the ground-return path of the standby-power interlock relay. When the interlock relay opens, it disconnects the a-c input to the standby power supply, and thus removes all power from the short-tank heater circuits. As the power is cut off, the STANDBY-POWER (HEATER) neon and the HEATERS—SHORT TANKS neons on the supervisory control panel go out, and in most cases an alarm bell rings.

2-92. The operator then must determine which tank is overheated by checking the group of six meter-movement relays that form the staticizer in the DE corner. A relay is connected to each output line of the resistor-matrix encoder. When one of the relays is energized, the needle of its meter moves off center and remains there.

2-93. Each overheat line energizes a particular combination of relays. The operator decodes this combination in order to determine which of the short tanks is overheated. The code combinations are shown in figure 2-15.

2-94. In order to resume operations after an overheat, the staticizer relays must be cleared. Pushing the button on the side of the plastic case clears the relay. After the staticizer is clear, pushing the STAND-BY POWER switch up to RESTORE turns the standby d-c power back on by applying ϕ1L6 to relay RP24. When RP24 is energized, its contacts reconnect ϕ1L6 to the standby power supplies; heating power is then applied to the short-tank circuits, and the neon above the STAND-BY POWER switch lights.

2-95. MEMORY CHECKING WITH BIAS SHIFT

2-96. A common riding level for the AGC voltage is applied to all mercury registers. Because the riding-level bias voltage represents the value by which the AGC voltages can vary, it provides an indication of aging components by way of the AGC monitor system (paragraphs 2-19 through 2-22). The biasing voltage also may be used as the basis of a marginal check of components in the memory channels.

2-97. During normal operation, with information pulses in the memory channel, the AGC circuit biases the three 6AK5 amplifier stages (at the output of the channels) to approximately -3 volts. If no information pulses are being sent through the channels, the AGC voltage rises to the applied minimum, or riding-level, bias voltage, nominally –1.75 volts.

2-98. When d-c power and the cycling unit are first turned on, the long tanks must be allowed to heat for about 15 minutes before the pulses will develop a reliable AGC voltage. During warmup periods, or whenever the channels are not being supplied with information pulses, the –1.75-volt bias would permit the overdriving of the stages and would accelerate the aging of the tubes. For this reason, the initial minimum bias applied is –2.25 volts; and the start procedure (table 5-25) includes pushing down the I.F. BIAS CONTROL switch, a nonlocking telephone-key switch just to the right of the power controls. In its down (NORMAL) position, the switch shifts the applied minimum bias from –2.25 volts to –1.75 volts. The bias circuit and shifting arrangement are shown in figure 2-16.

2-99. BIAS-SHIFT OPERATION

2-100. When dc is turned on, relay RY11, the bias-shift relay (in DE corner), is deenergized and the contacts apply –2.25 volts to the bias line. When the I.F. BIAS CONTROL switch is pushed down, the relay closes. One pole switches the bias line from –2.25 volts to –1.75 volts, and the other closes a holding circuit, lighting the neon above the I.F. BIAS CONTROL switch on the supervisory control panel.

2-101. In the temperature-control channels, a 330-kilohm resistor (figure 2-16) ties the bias voltage to ground; the AGC line connects to the junction of the 100-kilohm and 330-kilohm resistors. This divider reduces the applied bias voltages, so that even under high-bias conditions, aging components do not prevent the tank from warming up to operating temperature. The addition of the 330-kilohm resistor to an i-f strip that is to be used as a temperature-control amplifier is made by placing a special dummy plug in the V7 (com-

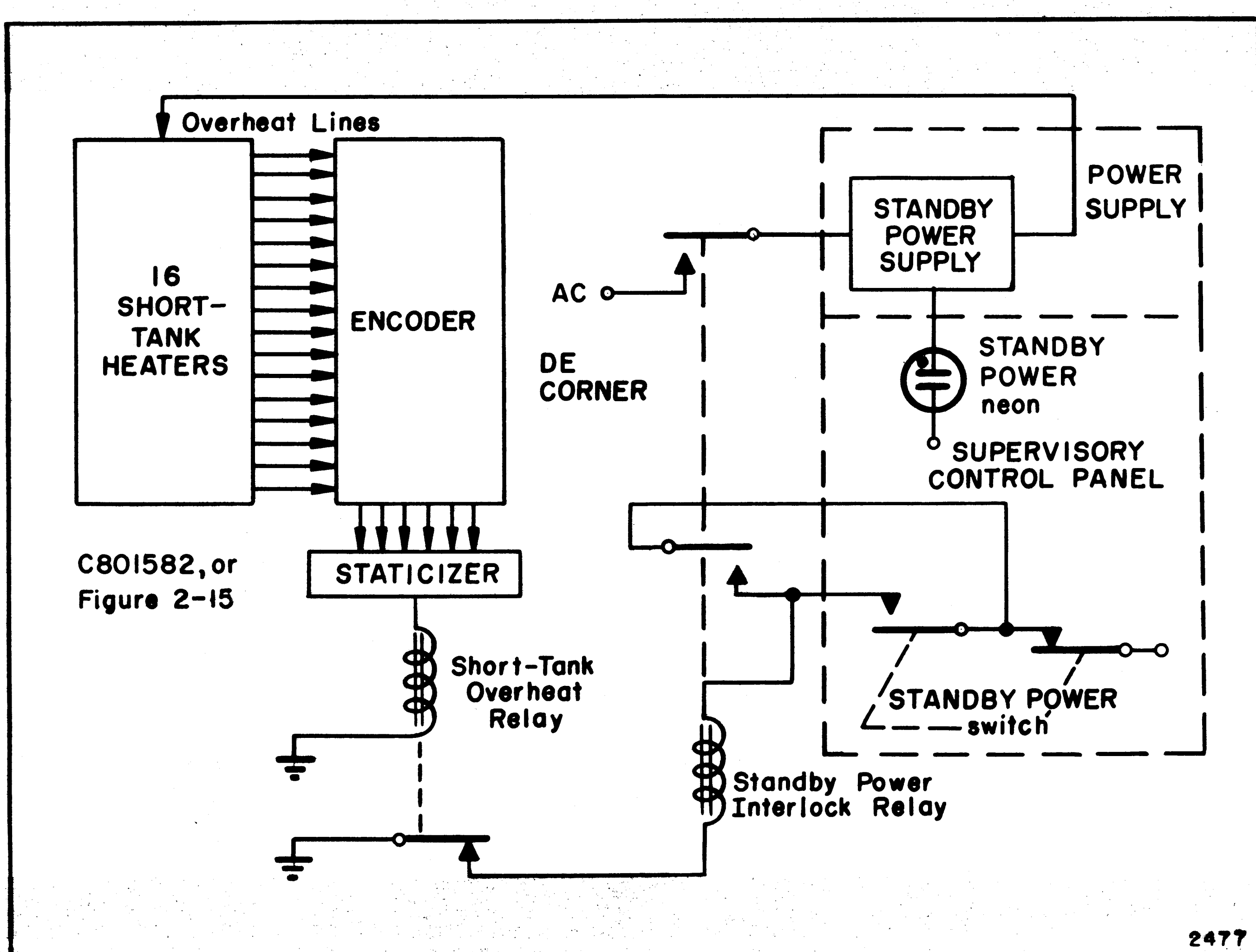

Figure 2-13. Short-Tank Overheat System

pensating delay) position. Both plug circuits are shown in figure 2-17.

2-102. Tube V5, the 1-kilohm resistor, and coil Y are mounted on the amplifier chassis. The compensating delay plug connects the delay line into the anode circuit of the video amplifier, and the output is taken from pin 3 of the compensating delay plug. The dummy plug connects the anode directly through pin 3 to the compensating delay in the bay-mounted chassis. Anode voltage for the video amplifier comes from the 120-volt terminal on the compensating delay line. The 330-kilohm ground-return resistor is connected between pin 6 of V5 (a tie-point for the bias line), through pin 4 of V7 and the grounded pin 6 of V7 (figure 2-16). The effect of the added resistor is to reduce the bias voltage to –1.6 volts (high) or –1.2 volts (normal).

2-103. The bias shift can be used in preventive maintenance and troubleshooting to determine the efficiency of the memory circuits. If a mercury register (long- or short-tank) will hold information under normal-bias conditions but not under high-bias conditions, the components in that register are nearing the wear-out point. This situation is a warning that trouble may develop. In cases of intermittent errors in mercury tanks, shifting the bias may aid in isolating the trouble.

2-104. STALL ALARM

2-105. When computation stops for more than 3 seconds for any reason except power shutdown, an alarm circuit lights the STALL neon on the supervisory control panel. In addition, the alarm circuit can send an audio signal to a stall speaker, mounted in the back of the supervisory control desk.

2-106. The stall-alarm circuit is shown in figure 2-18. The pulses which step the cycle counter (ending pulses) also are applied to RDF422. Each ending pulse sets this delay flop to reinitiate the 3-second delay. As long as the delay flop remains set, its output signal inhibits G490. In the normal course of operation, the

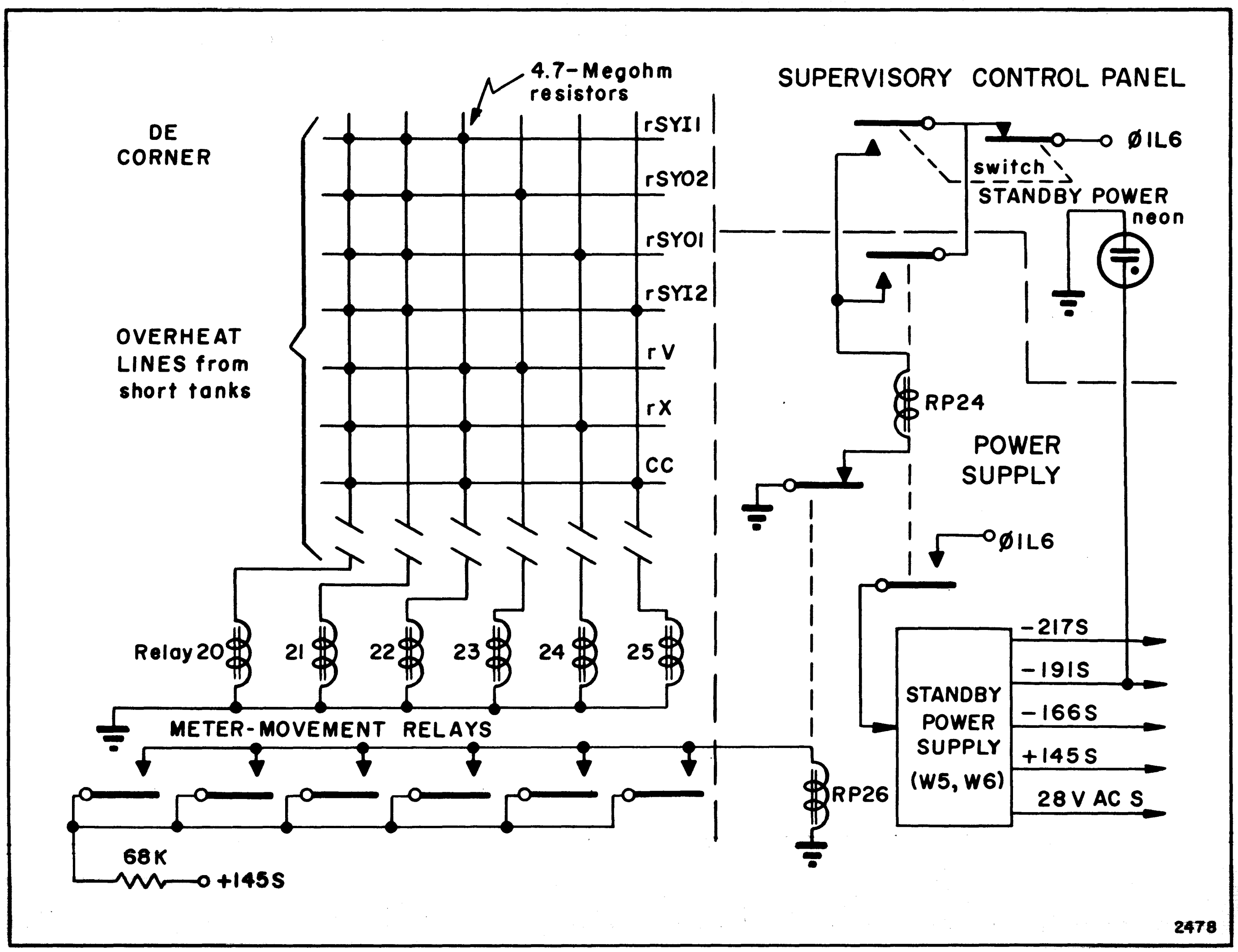

Figure 2-14. Short-Tank Overheat System, Schematic

Relay 20	●	●	●	●	●	●	●	●
Relay 21	●	●	●	●	○	○	○	○
Relay 22	●	○	○	○	●	●	●	○
Relay 23	○	●	○	○	●	○	○	●
Relay 24	○	○	●	○	○	●	○	●
Relay 25	○	○	○	●	○	○	●	○
REGISTER	rSYI1	rSYO2	rSYO1	rSYI2	rV	rX	CC	$\overline{rX}$
TOTAL CHASSIS DELAY	88pt	83pt	88pt	88pt	179pt	81pt	79pt	81pt
LOCATION	A12T	A7X	A8X	B3T	G4X	H1T	H8V	H1X

Relay 20	●	●	○	○	○	○	○	○
Relay 21	○	○	●	●	●	●	●	●
Relay 22	○	○	●	●	●	○	○	○
Relay 23	●	○	●	○	○	●	●	○
Relay 24	○	●	○	●	○	●	○	●
Relay 25	●	●	○	○	●	○	●	●
REGISTER	rL	rF	CRlong	CRshort	$\overline{rL}$	$\overline{rF}$	rA	$\overline{rA}$
TOTAL CHASSIS DELAY	88pt	88pt	79pt	42pt	88pt	88pt	67pt	67pt
LOCATION	J4T	J8T	J2V	J3V	J4X	J8X	K2T	K2X

Figure 2-15. Meter-Movement Relay Decoder Patterns

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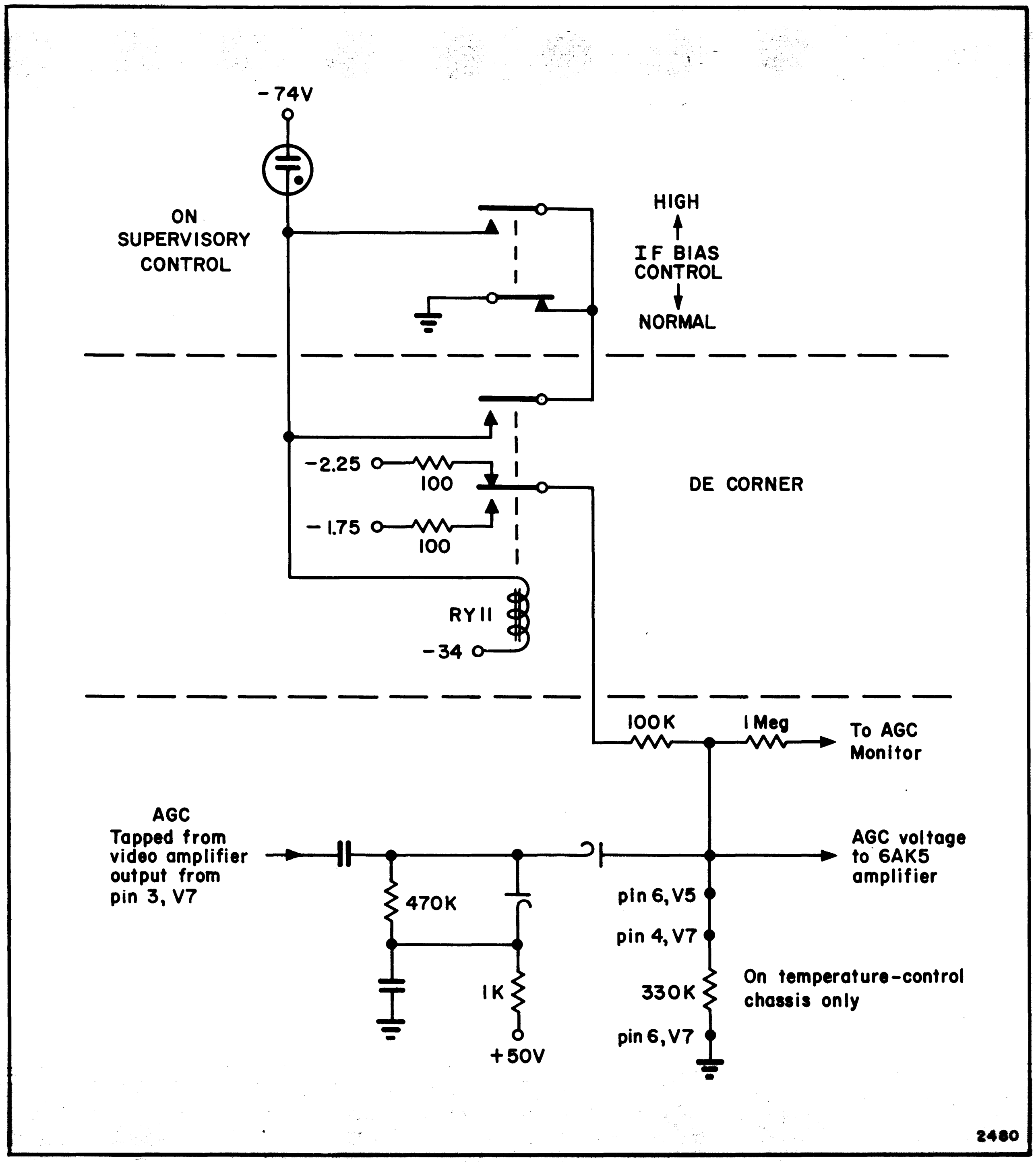

Figure 2-16. Bias-Shifting Circuit

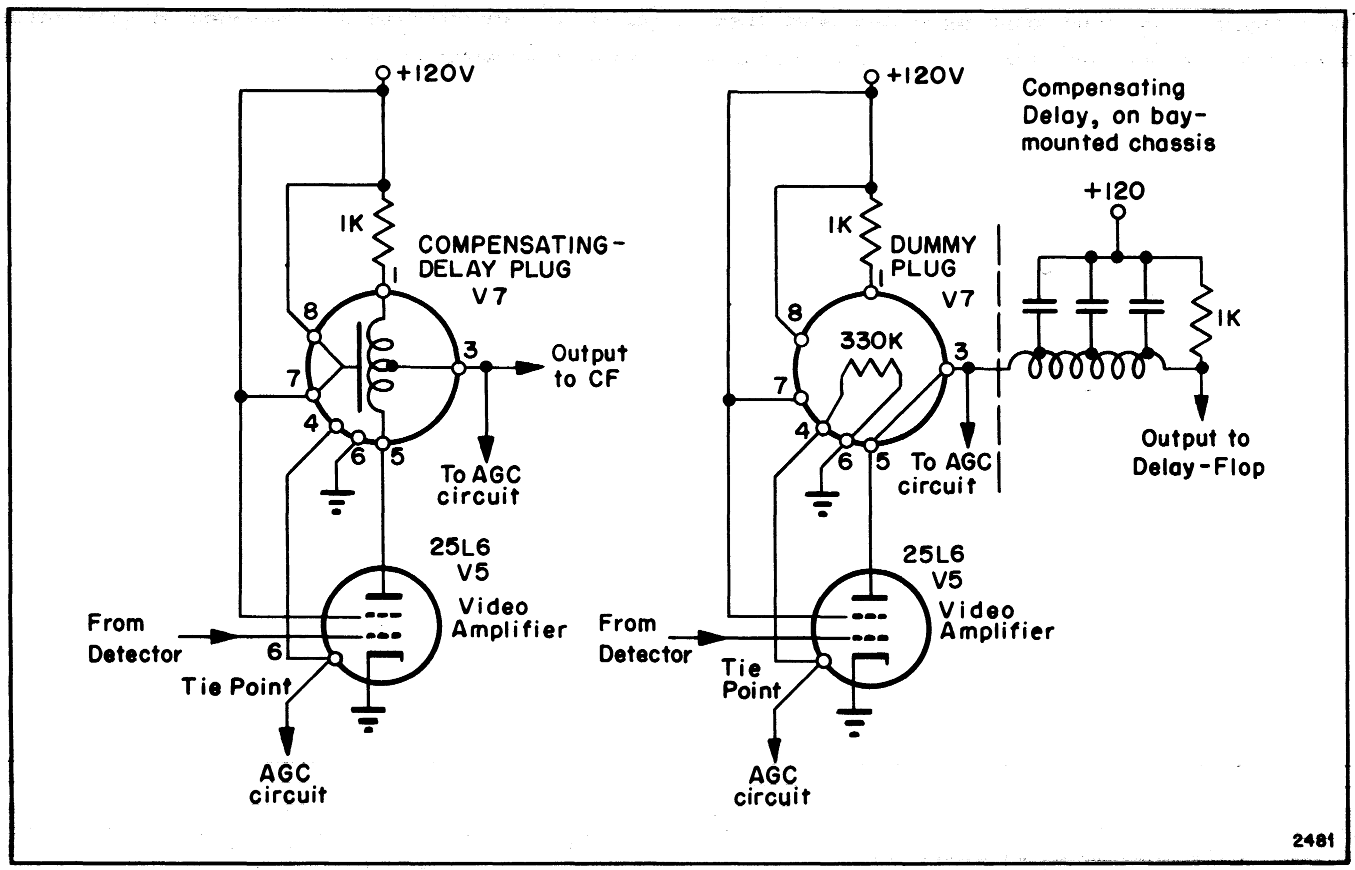

Figure 2-17. Bias Circuit in Temperature-Control Channels

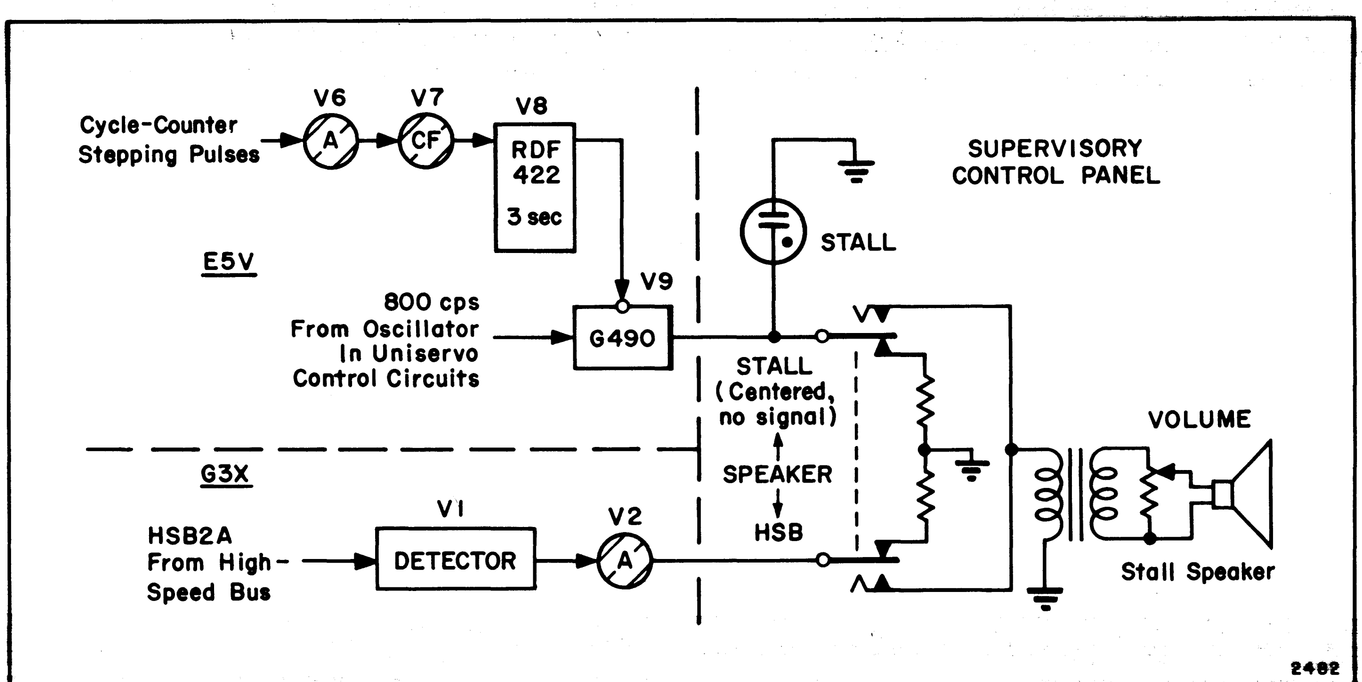

Figure 2-18. Stall-Alarm Circuit

cycle counter is stepped much more frequently than once each 3 seconds, and G490 is always inhibited.

2-107. When the computer fails to produce an ending pulse at least once every 3 seconds, RDF422 releases G490. This gate then passes an 800-cps signal to light the STALL neon on the supervisory control panel. The STALL neon and alarm remain on until the computer produces an ending pulse, or until power is shut off.

2-108. The SPEAKER switch, a three-position locking telephone-key switch at the bottom of the left panel, controls the audible alarm. When the switch is pushed up (HSB position), the contents of the high-speed bus are constantly detected and supplied as an audio signal; if the computer stops, the ensuing silence alerts the operator. If the switch is pushed down (STALL position), the speaker is silent as long as the computer functions normally. If the computer stops, the 800-cps signal, besides lighting the neon, goes to the speaker. When the switch is released (center position), both inputs to the speaker circuit are grounded and no audible alarm is given. Speaker volume is controlled by the VOLUME control, at the right of the SPEAKER switch, a 100-ohm potentiometer shunted across the speaker coil.

2-109. INTERRUPTED-OPERATION SWITCH

2-110. Occasionally a single fault will cause the computer to stop with several error indications on the control panel. These error indications occur because the computer stops on the first time out after an error is detected. Since some iterative program steps occur without intervening time outs, one error may reach into several circuits before the computer stops. The first step in correcting trouble is to determine which of the errors occurred first.

2-111. The interrupted-operation switch on the supervisory control panel enables the maintenance technician to break an instruction or a routine down into small segments. While the computer is stopped, the technician can inspect the panel for error indications. If no indication appears, he can push the start bar, and the computer will perform another program segment. The size of the program segment is determined by the position of the switch, which can set the stop flip-flop (to block the restoring input to the time-out flip-flop) after one addition, one program-counter step, one operation or one instruction. Generally, the first three positions, ONE STEP, ONE ADDITION, or ONE OPERATION, are used for determining the location of an original error. The technician selects the smallest program segment possible:

(1) ONE STEP: for noniterative multistep instructions, such as A, Q, S, and T, the first steps of M, N, P, D, or shift instructions. The computer stops each time the program counter is stepped.

(2) ONE ADDITION: for instructions containing reiterative additions, such as steps 5 through 15 of M, N, or P instructions, or steps 3 through 14 of D. The computer stops after one minor cycle.

(3) ONE OPERATION: for multiword transfer instructions. The computer stops each time the time-out flip-flop is set, but not until all words have been transferred.

2-112. The technician then sets up the suspect instruction in the static register, and strikes the start bar. The computer performs the part of the instruction specified by the interrupted-operation switch, and stops. If no error occurs, the technician strikes the start bar again, and the computer performs another segment. In this manner the computer can be stepped through the routine until the error recurs.

2-113. When an error indication appears, the technician retains the instruction, releases the interrupted-operation switch to its center position (continuous operation), pushes the MASTER DELETE switch down to prevent any error from stopping the computer, and strikes the start bar. The computer then performs the instruction repeatedly, while the circuit is further inspected with the oscilloscope.

2-114. In some cases, an error may occur consistently in continuous operation but not appear during any mode of interrupted operation. This type of fault is usually traceable to a marginal a-c coupling circuit, which has sufficient time to operate properly on the extended duty-cycle of interrupted operation, but which loads up in continuous operation, and vice versa.

2-115. The ONE INSTRUCTION position of the interrupted-operation switch is seldom used for troubleshooting. It is used principally as a means for stopping the computer in mid-program. In most cases, pushing the switch to the ONE INSTRUCTION position will stop the computer synchronously in time out. However, if the switch makes contact just as the duplicate time-out flip-flops are being restored, it is possible that one of the flip-flops will be restored while the other remains set. In this event, half of the computing circuits perform one more instruction than the other half, and as a result several comparison errors are generated. Each such case must be studied by the programmer, who can then decide whether he should reconstruct the segment of the program entirely or start again at the most recent breakpoint.

2-116. FTI TEST SWITCH

2-117. The FTI test switch (function-table intermediate), located in the DE corner, is an error-insert switch which may be used to check the instruction-line checker. The instruction lines are the output lines from the main decoder and the input lines to the main encoder. They are occasionally referred to as the intermediate lines of these two matrixes, as distinguished from the output lines of the encoder, which are the function signals.

2-118. The FTI test switch is a nine-position rotary switch, labelled 1 through 8 and NO TEST. In positions 1 through 8, this switch supplies an input to one of the eight greater-than-one detectors in the instruction-line checker. Each of these detectors receives several different input signals, no more than one of which should be present at the same time.

2-119. For instance, the inputs to one of the detectors are W, 10-M-1, SCI-CR, and TEST 1. These inputs are applied to a resistor comparator and, at the same time, are buffed into a gate that is further alerted by any input to the checker that receives signals TEST 2, PMC-3, 50-1, and 50-2. An output from either of the comparator detectors, or from the check gate between them, registers an instruction-line error.

2-120. The detector, for example, is checked by putting the FTI test switch on TEST 1, and jamming a W into the first-instruction digit of the static register. The F.T. INTER. neon on the supervisory control panel should light if the checker is functioning properly. A 50 signal jammed into the first and second digits of the static register will also light the F.T. INTER. neon if the FTI test switch is on TEST 1. Switching to TEST 2 in either case will cause no change, since the two detectors work together through G451, the check gate between them.

2-121. The Function-Table and Intermediate-Line Test Routines, which appear in section V of the Univac Test Routines manual, detail the procedure for using this switch.

2-122. INPUT-OUTPUT SERVICING AIDS

2-123. The input-output servicing aids provide means for analyzing troubles in the Uniservos and some of the input-output circuits. The GAIN switch on the supervisory control panel also enables certain types of marginal signals to be read from the tape; therefore, it is useful in analyzing input-synchronizer odd-even errors. The SERVO POWER switch, also on the supervisory control panel, allows the operator to turn off all power to all the Uniservos, either momentarily (in the nonlocking position) or for a longer time (in the locking position). The WE ELIMINATE switch on chassis A11X and the RE ELIMINATE switch on chassis B12T permit inspection of input- and output-synchronizer signals with an oscilloscope. The Uniservo monitor and control box in BC corner is the principal manual control point of Uniservo operation, and it also permits monitoring of normal Uniservo operations.

2-124. GAIN SWITCH

2-125. Signals read from tape are amplified before being sent to the input synchronizer, where they set the input flip-flops. The signal leaving any Uniservo read-write head amplifier is a mixture of information pulses and noise. To block out noise and consequent setting of an input flip-flop, a threshold-controlled stage is placed between each head amplifier and the associated input flip-flop.

2-126. The bias level on the tube in this stage is normally 20 percent of the standard signal level, safely above the predictable noise level (8 percent of standard), and below the predictable minimum signal level (40 percent of standard). However, a noise pulse may rise above the normal threshold and be read out as an information pulse, or a real information signal may drop below the threshold and be missed. In many such marginal cases, it is possible to read the tape without error if the bias level on the threshold-controlled stage is shifted. This shift is accomplished with the GAIN switch, the third switch from the left in the top center section of the supervisory control panel.

2-127. Figure 2-19 is a schematic illustration of this gain-control circuit. Figure 2-20 shows the effect of the three bias conditions. Normally, with the GAIN switch released, the amplifiers are biased to one-sixth of standard signal amplitude. This level safely passes all normal signals and blocks out noise pulses of average amplitude. If an input-synchronizer odd-even error is traced to marginal tape signals, the standard practice is to reread the faulty block of information with the switch in LOW gain position. The bias then stands at one-third standard signal amplitude. In this state, the circuit passes normal information signals, but above-normal noise usually cannot pass the higher threshold. If errors still show up, the tape is passed through a third time with the switch in HIGH gain position. This lowers the bias to one-eighth of standard signal amplitude. The circuit now can pass information pulses with a subnormal amplitude but still discriminate against normal noise.

2-128. It should be noted that only the combinations of normal information signals with abnormal noise and subnormal information signals with normal noise can be accommodated by means of the HIGH and LOW positions of this switch. If poor signals and abnormal noise occur simultaneously, the tape cannot be read, and the cause of the poor signal-to-noise ratio must be determined and eliminated.

2-129. AUTOMATIC REREAD

2-130. The entire tape rereading procedure can be taken over by the automatic reread circuit, which is controlled by the AUTOMATIC RE-READ switch on the supervisory control panel. The switch, a three-position telephone-key switch, with two associated neon indicators, is located on the right center of the supervisory control panel.

2-131. As long as the AUTOMATIC RE-READ switch is in the normal (released) position, the automatic reread circuit assumes control of the input control circuits whenever an input error occurs. The tape stops at the end of the block of information which produced the error. The reread circuit then returns the tape to the beginning of the block and attempts to read the block again. This operation is repeated five times, and the bias level is shifted each time. During this process, the computer is free to proceed with normal processing operations, including output operations, but it cannot perform additional input operations.

2-132. The automatic reread circuit accommodates an IS > 720 error, if the input tank count is 59 or 60, a tape-check error, and odd-even errors. If the input tank count is not 59 or 60, a 720 error indicates an erroneous two-block read. Rereading will result in spurious information. Since the two-block read indicates poor acceleration, writing over bad-spot holes, or other problems more serious than random input error, corrective maintenance is required.

2-133. As soon as the block has been read successfully, the automatic reread circuit restores all error circuits and the input interlock, and releases control of the input circuits. If all five attempts to read the block fail, the error circuits remain set, and the computer stops either at the next tape input instruction or at the instruction calling for the Uniservo which was involved in the faulty read operation.

2-134. Pushing the AUTOMATIC RE-READ switch to CLEAR position clears the input error circuits and interlocks. Pushing it to LOCK OUT position disables the automatic reread circuit, and input errors must be treated manually. The CLEAR position is a momentary contact. The LOCK OUT position is mechanically locking.

2-135. Two associated neon indicators are labelled AUTO RE-READ and ORIGINAL DIRECTION. The AUTO RE-READ neon informs the operator that an automatic reread operation is in progress. In case the computer stops during rereading, the neon remains lighted. The second neon lights when the tape is moving in the same direction as it was when the original error occurred. This information is useful if automatic reread fails to enter the correct block, and manual efforts are being made to correct the error after a stop. The automatic reread circuit will stop when five attempts at reading the information have failed or a two-block error occurs during reread.

2-136. An electromechanical counter, pulsed from the automatic reread circuit, is located at the top of bay B. This counter counts the total number of rereads performed by the circuit. The counter may be used to evaluate the input tape system.

2-137. ELIMINATE READ-ENDING SWITCH

2-138. When trouble develops in the input synchronizer, it is occasionally desirable to have the computer perform a continuous read operation without interruption. Continuous reading permits the technician to inspect input-synchronizer waveforms with an oscilloscope. For continuous reading, it is not enough to retain the instruction, since the computer and the Uniservo stop between individual instructions and interrupt the continuity of the program. The ELIMINATE RE switch, in V14 position of chassis B12T, permits continuous reading operation by blocking the read-ending signal (RE).

2-139. Normally, the read-ending signal is produced in the input synchronizer at the end of each block of data. Its function is to terminate the read instruction by stopping the Uniservo, clearing the input-output control circuits, and jamming the input synchronizer so that it can accept no new information. While the read-ending signal is blocked, the instruction cannot be terminated.

2-140. Figure 2-21 shows the effect of the switch on the read-ending circuit. Each digit read from the tape generates a TFPA (transfer-pulse A), which sets RDF613. Since the interval between TFPA signals is less than 3.5 milliseconds, RDF613 remains set until the last TFPA from a block of data has passed. Then 3.5 milliseconds after the last TFPA arrives, RDF613 restores itself. Its output signal is differentiated and applied to G605, passing through that gate if the 60th-word signal is there. The output of G605 is the read-ending signal.

2-141. If the ELIMINATE RE switch is closed, G822 is inhibited, and the read-ending signal is not produced; consequently the read operation continues, although the input register is not cleared as each successive block of information is read in. The continuous read operation can be stopped at any time by a manual read-ending signal (MRE), which is produced when the I.S. ERROR CLEAR switch on the supervisory control panel is pushed down.

2-142. ELIMINATE WRITE-ENDING SWITCH

2-143. As in the input synchronizer, analysis of certain types of faults in the output synchronizer requires a continuous write operation rather than successive

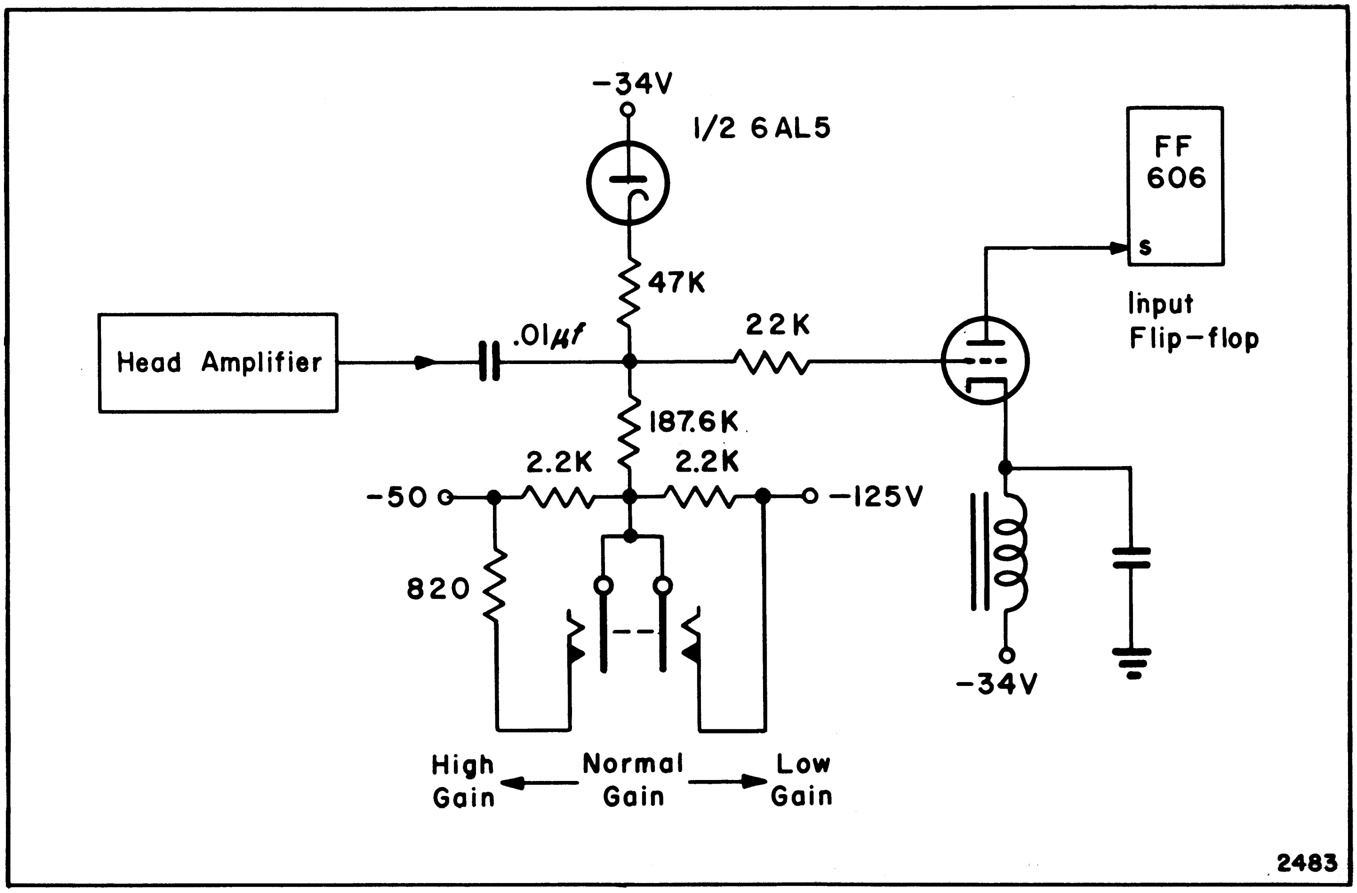

Figure 2-19. Gain-Control Circuit

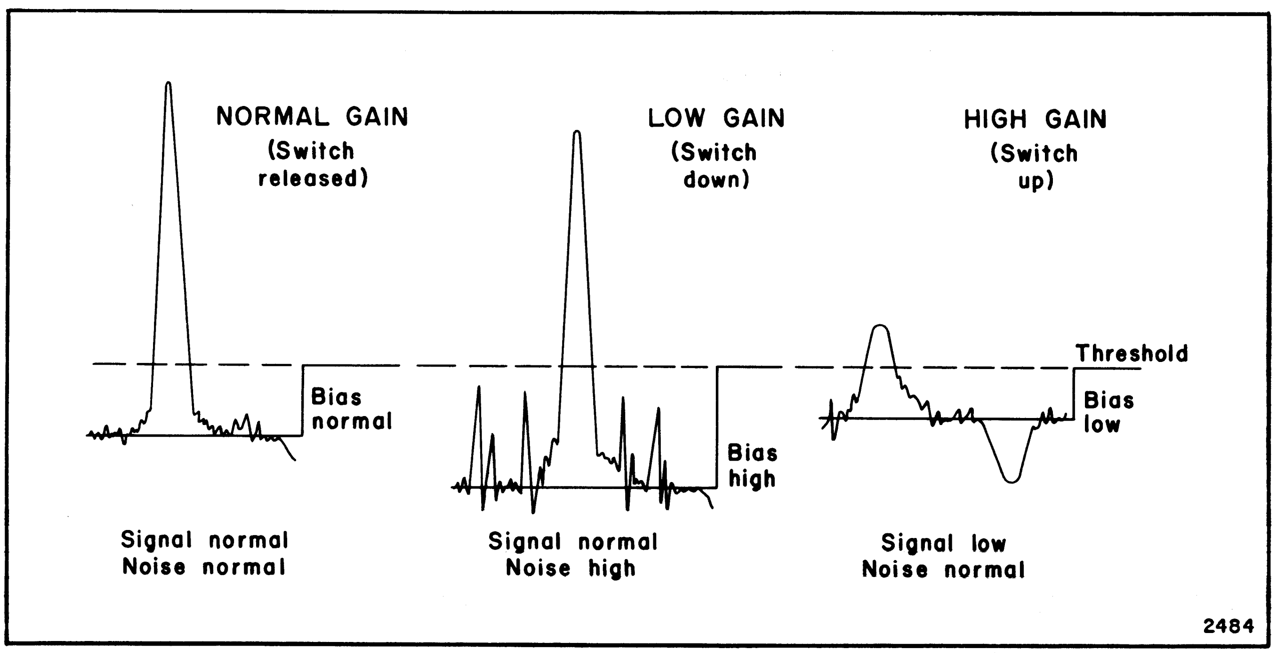

Figure 2-20. Effects of Bias Conditions

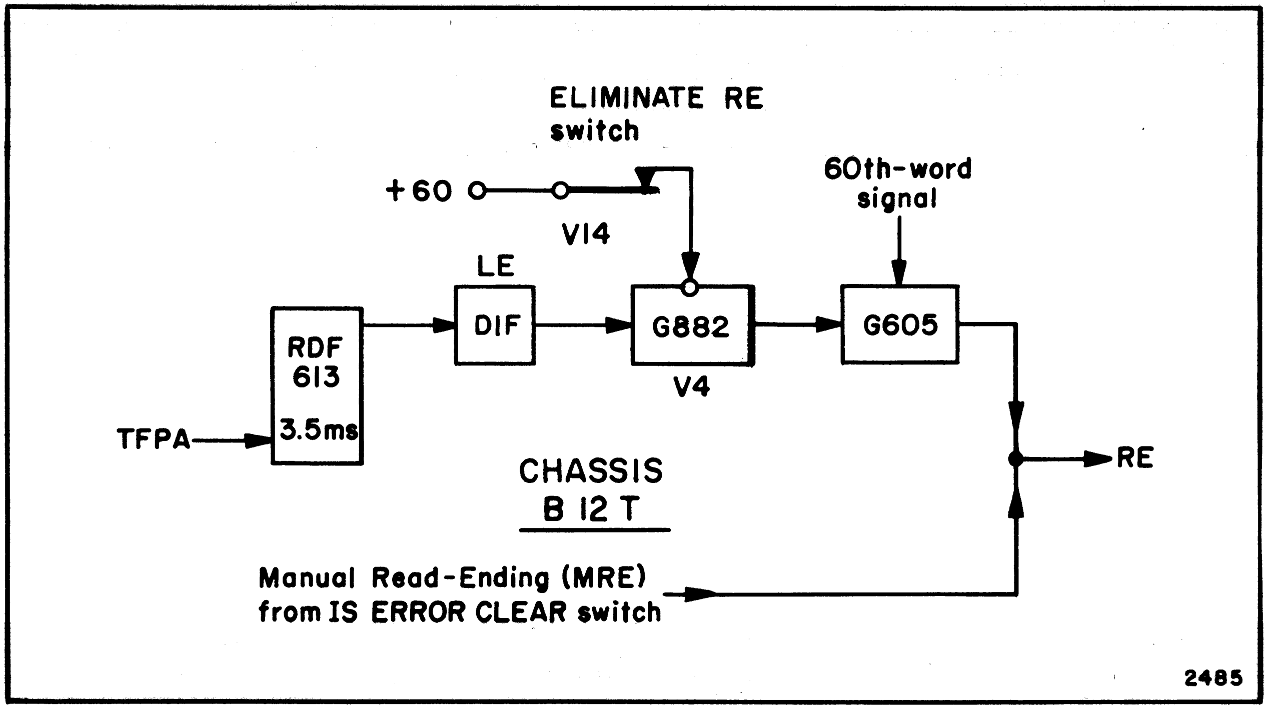

Figure 2-21. Read-Ending Circuit and ELIMINATE RE Switch

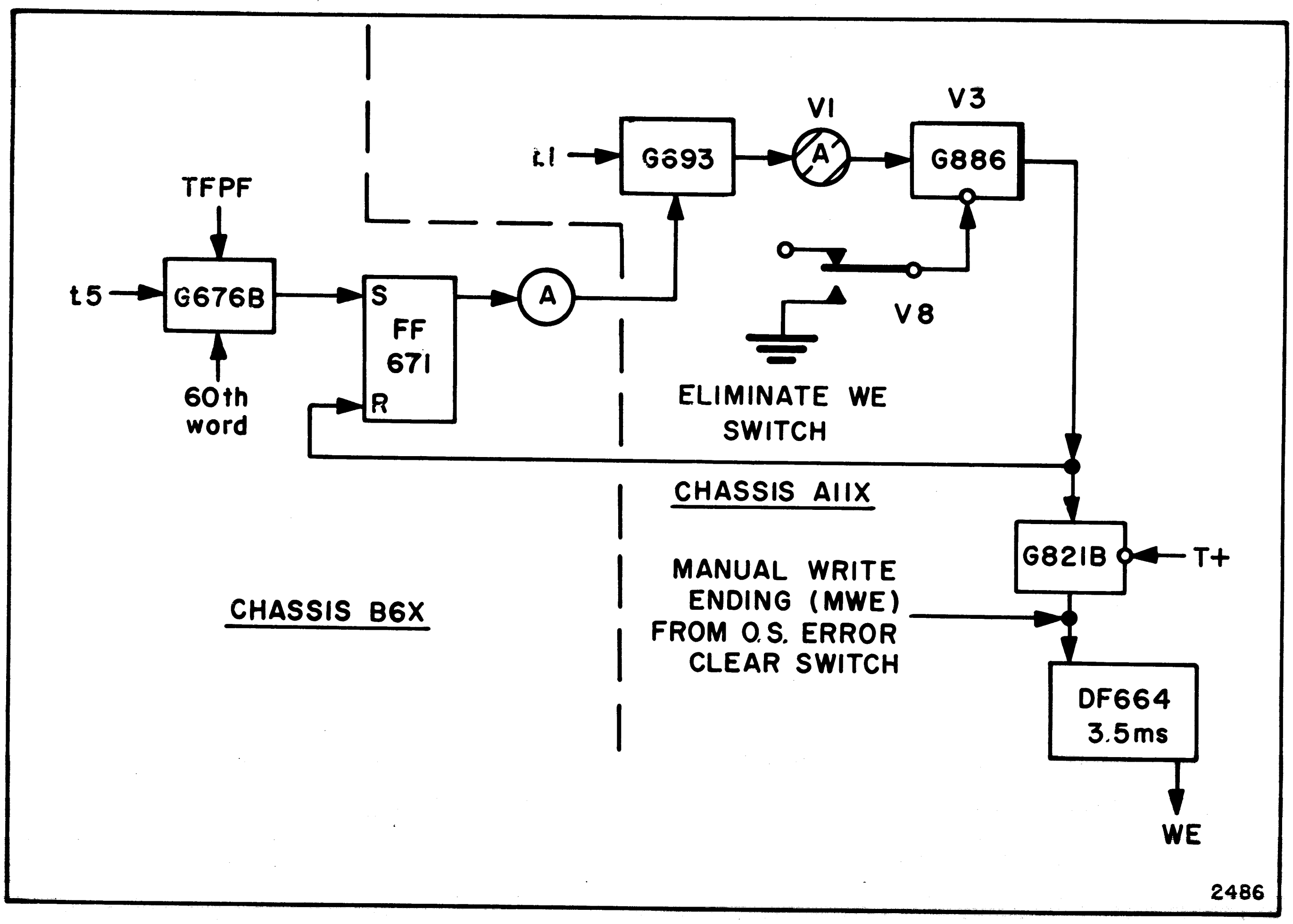

Figure 2-22. Write-Ending Circuit

write instructions. The ELIMINATE WE switch, in V5 position of chassis A11X, permits such continuous operation by blocking the write-ending signal (WE).

2-144. The write-ending circuit, and the ELIMINATE WE switch, are shown in figure 2-22. Each time a digit is written on tape, a TFPF (transfer-pulse F) signal is produced. Normally, the write-ending signal is developed when the 60th-word signal combines with a t5 to pass the last TFPF of the 60th word through G676B, to set FF671. The next t1 passes G693 to set DF664. After 4.3 milliseconds, the delay flop restores itself. Its differentiated output becomes the write-ending signal, which stops the Uniservo and clears the input-output control circuits.

2-145. If the ELIMINATE WE switch is closed, G886 is blocked and no write-ending signal is produced. As a result the Uniservo continues to pass tape across the head. However, by this time the output precessor register has been cleared, and the remainder of the operation will record only binary zeros in all channels. The continuous write operation can be stopped at any time by a manual write-ending signal (MWE), which is produced when the O.S. ERROR CLEAR switch on the supervisory control panel is pushed down.

2-146. SERVO POWER SWITCH

2-147. The SERVO POWER switch is the twenty-first from the left in the row of switches across the top center of the supervisory control panel. It is a telephone-key switch, locking in the up (OFF) position, and nonlocking in the down (ON) position. In either position, it interrupts the +246-volt input circuit to all Uniservos. The power-input circuit is shown in figure 2-23.

2-148. Normally, whenever dc is turned off, the SERVO POWER switch is pushed up to lock power off from the Uniservos. After dc is turned on, the switch is released, applying the +246-volt input and permitting all Uniservos to assume the first-block condition (all instruction-thyratrons extinguished).

2-149. However, if dc is turned on while the SERVO POWER switch is released, it is possible that spurious random pulses may fire an instruction thyratron in one or more Uniservos, causing those units to assume some condition other than first-block. Since all units should start in a first-block condition, the operator interrupts power momentarily by means of the SERVO POWER switch. Pushing this switch down opens the +246-volt circuit momentarily, extinguishing all thyratrons, and clears the Uniservos to the starting condition.

2-150. The switch is pushed up whenever it is necessary to check, service, or troubleshoot the Uniservos, or before turning off dc at the control panel. When it is pushed up, the red voltage monitor jewel light on the right of the panel lights.

2-151. It is important to remember that the SERVO POWER switch removes (whether temporarily or permanently) all power from all Uniservos, directly or through the main interlock relay. Do not use this switch for trouble involving only one Uniservo.

2-152. The door switch on the individual Uniservo serves much the same purpose for the one unit as the SERVO POWER switch does for all units. When the door switch is turned, it opens the main and rewind interlocks, removing all power except +246 volts on the anodes of five instruction thyratrons. Use of the door switch on one unit does not affect the other Uniservos.

2-153. If Uniservo power is interrupted during normal operation, the units will all assume first-block condition when the power is restored. This will result in errors, in temporary or permanent loss of data, and possibly in jamming of a Uniservo, depending on the next instruction received by the unit; for instance:

(1) A Uniservo receiving a read-forward instruction will pass 10 feet of tape across the head before beginning to read. If it begins to read in the middle of a block, it will read to the end of the next block and produce an IS > 720 error.

(2) A Uniservo receiving a read-backward instruction will pass 10 feet of tape across the head before beginning to read. If less than 10 feet of tape has previously passed across the head, the unit will pass tape backward without reading anything until the tape-end bumpers are encountered. The bumpers trip an interlock which opens the main interlock and rewind interlock relays, jamming the Uniservo, rendering it unusable until the door interlock is tripped. On the other hand, if the unit does begin to read, it will continue to read until the input register is full; but there is a strong possibility that the Uniservo will read to the end of the subsequent block and produce an IS > 720 error.

(3) A Uniservo receiving a write instruction will pass 15 feet of tape across the head before beginning to write. It will then write on tape regardless of where other blocks of material are recorded. The intervening recorded material will be erased.

2-154. The SERVO POWER switch is useful in one other special instance. Following a rewind-with-interlock on all Uniservos (a standard instruction used to terminate a program), all the units are locked so that they cannot be used. If it is necessary to use them again without changing the tapes, the SERVO POWER switch obviates the necessity of tripping each door interlock separately.

2-155. UNISERVO MONITOR AND CONTROL BOX

2-156. During normal operation of the Uniservos, and more particularly when they are being serviced, it is frequently necessary to monitor waveforms, voltages, and currents without disturbing operating conditions. The Uniservo monitor and control box, shown in figure 2-24, provides facilities for performing these functions. It is located in the BC corner of the Central Computer.

2-157. The Uniservo monitor and control box is divided into three sections:

(1) The monitor section contains selector switches which pick up signals to be monitored and supply them to a meter or to oscilloscope terminals. This section also supplies sweep-synchronizing signals for the oscilloscope. It is used for inspecting voltages and currents in the McIntosh amplifiers, voltages in the head amplifiers, and amplifier, head, and photocell waveforms.

(2) The instruction section contains switches for simulating Uniservo selector (nS) and instruction-control (RP, WP, FP, BP, RIR-RE, RC, and WC) signals. The plugboard in this section permits rearrangement of the numbering of the Uniservos.

(3) The control section initiates and terminates the operation specified by the instruction switches by trig-

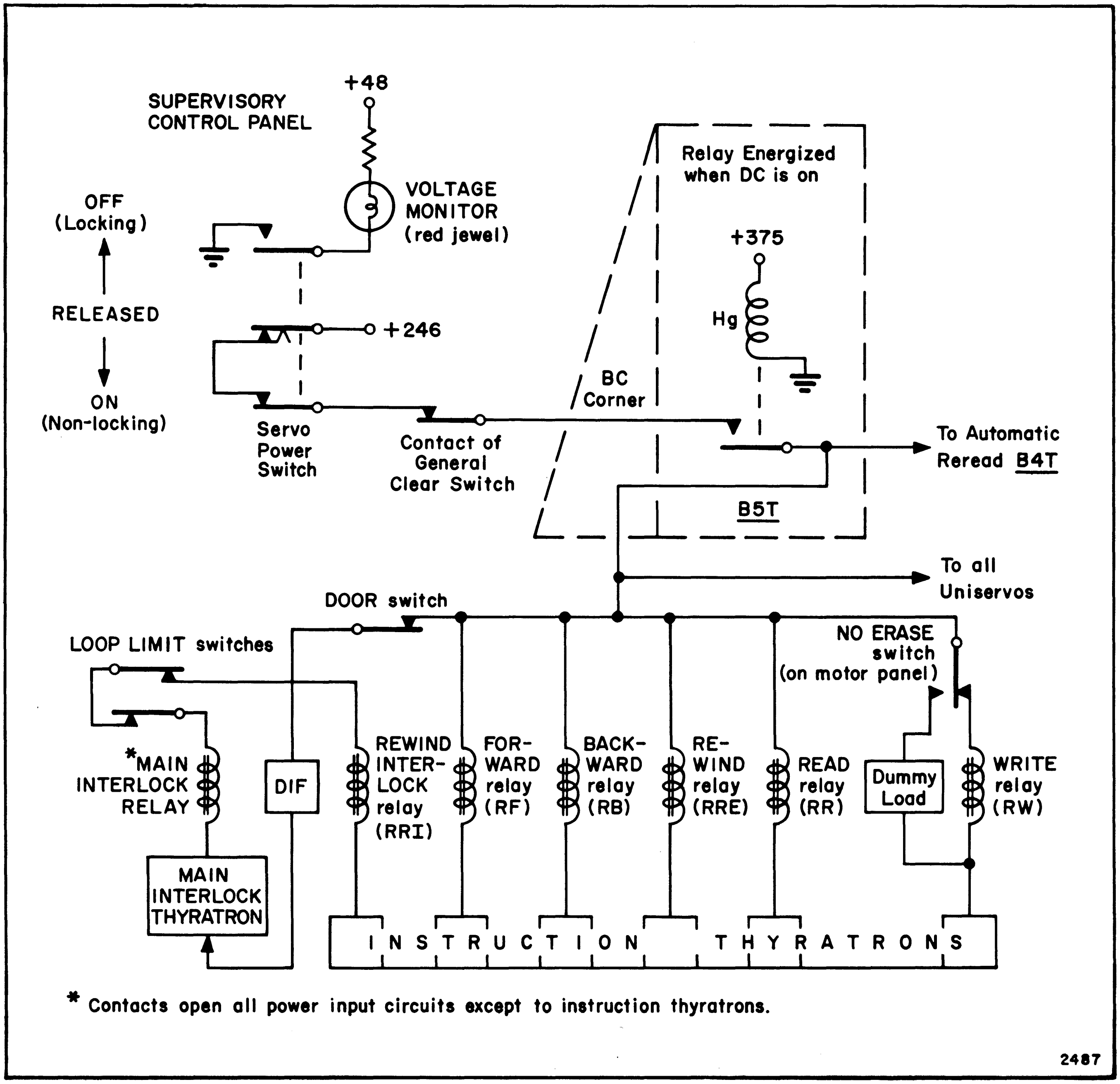

Figure 2-23. Servo Power Switch

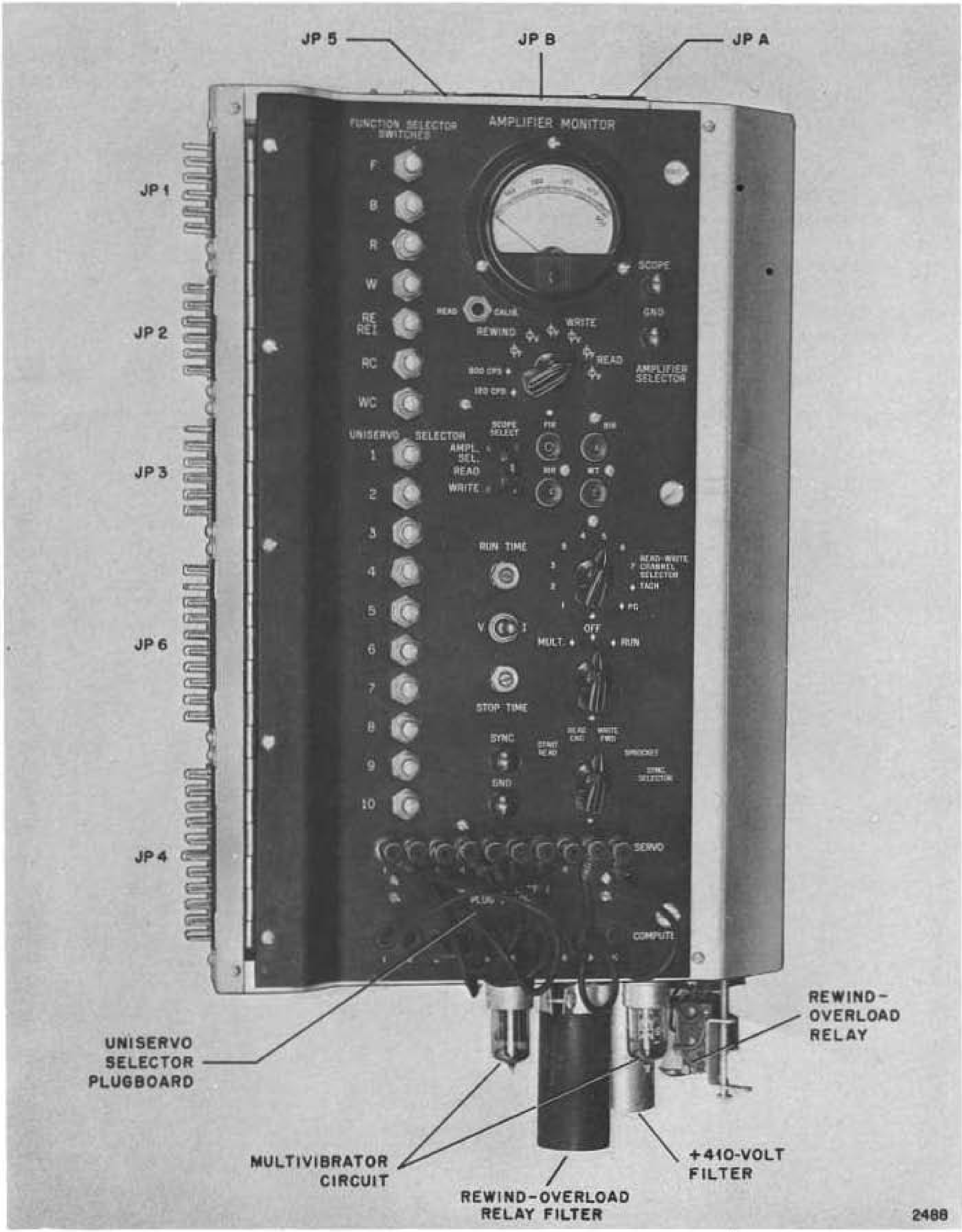

Figure 2-24. Uniservo Monitor and Control Box

gering the control flip-flops and delay-flops in the input-output control circuits. Through these circuits, it generates control signals RF, RB, RAD, WF, and WAD.

2-158. With the Uniservo monitor and control box, two modes of operation are possible, continuous and iterative. In continuous (switch-controlled) operation, the Uniservo starts when the switch triggers the start signal and continues either until the end of the tape is reached, or until a stop signal is produced by means of the switch. In iterative (multivibrator-controlled) operation, the control section repeatedly supplies start and stop signals, and the Uniservo repeatedly performs operations specified by the instruction section. The start-stop duty cycle can be varied by means of potentiometers on the Uniservo monitor and control box. Stops and starts are under the control of either the read or the write power-control circuit.

2-159. MONITOR SECTION. The monitor section is subdivided into two parts: an amplifier monitor for measuring currents and voltages in the McIntosh and head amplifiers, and an oscilloscope monitor for inspecting various waveforms. Figure 2-25 shows the amplifier monitor section.

2-160. The AMPLIFIER SELECTOR is a two-deck, eight-position switch. The monitoring circuit is connected by the contacts on one deck to the cathode circuits of the eight McIntosh amplifiers, and by contacts on the second deck to the corresponding anode circuits. A voltage-current toggle switch (VI) selects one of the two decks and connects it to the meter. In the I position, this switch connects the cathode-current

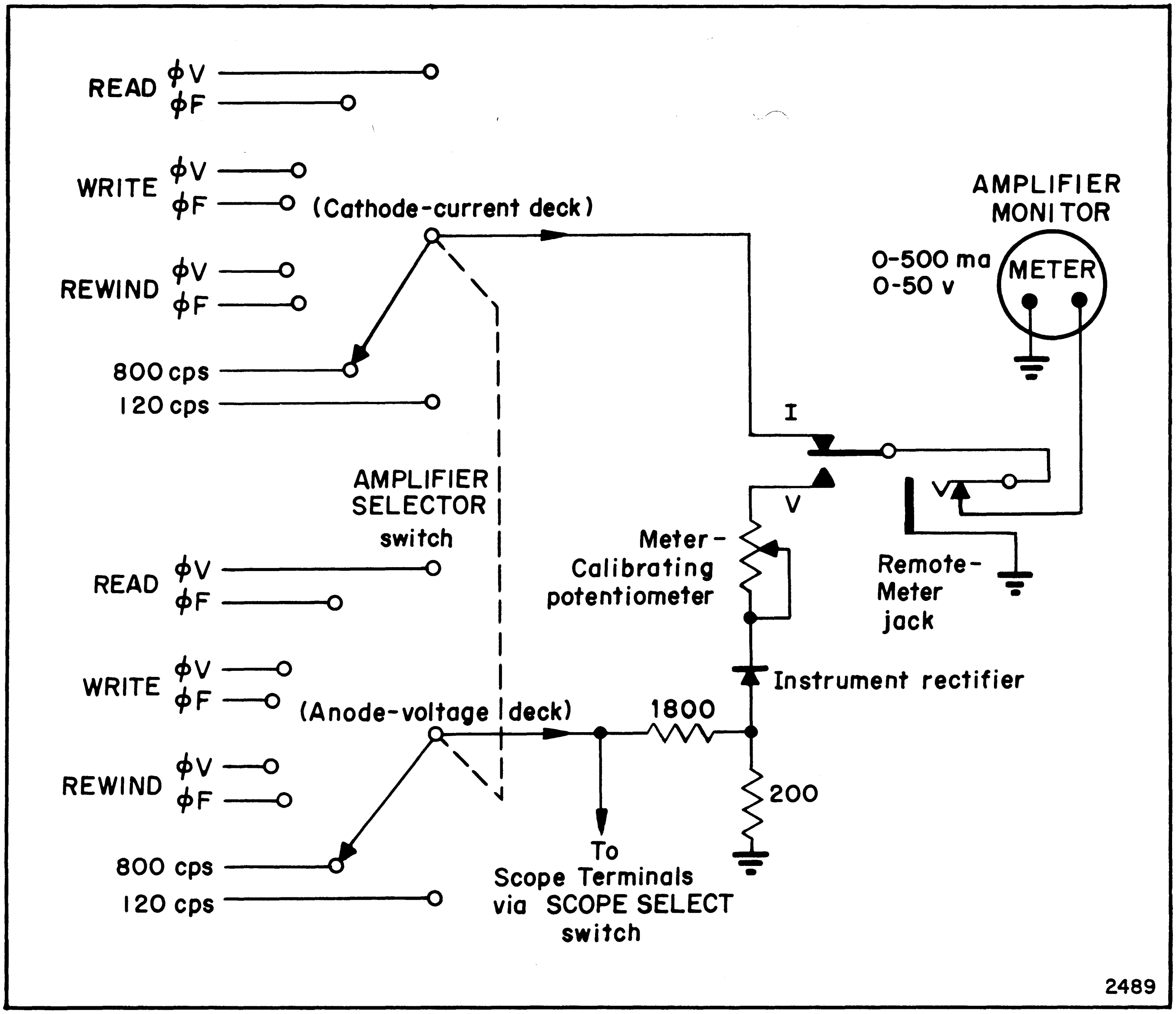

Figure 2-25. Amplifier Monitor Section, BC Corner Box

deck directly to the meter, which then indicates the value of current in the selected cathode circuit. In the V position, the voltage-current switch connects the anode-voltage deck to the meter through a voltage divider, a copper-oxide instrument rectifier, and a calibrating potentiometer. With these elements in the circuit, the meter can be calibrated to read voltages up to 50 volts. Calibration requires three steps:

(1) Measure and adjust the output of the 800-cps amplifier; set the AMPLIFIER SELECTOR switch to 800 CPS and push the SCOPE SELECT switch to AMPL SEL position. Connect a 2-percent voltmeter across the oscilloscope binding posts at the right of the AMPLIFIER-MONITOR meter. Adjust the input potentiometer of the 800-cps amplifier (McIntosh amplifier) until the external meter reads 50 volts.

(2) Set the VI switch to V.

(3) Adjust the meter-calibrating potentiometer inside the monitor box (figure 2-26) to give full-scale deflection on the AMPLIFIER MONITOR meter.

2-161. The amplifier monitor is used principally in Uniservo system alignment and in making adjustments on the individual centerdrive circuits. Since many of these adjustments are made at the Uniservo, it is frequently impossible for the technician to see the monitor meter. For this reason, there is a remote-meter jack on the bottom of the monitor box. A meter identical to the one in the box should be equipped with a probe (consisting of 30 feet of RG620 coaxial cable terminated in a PL55 plug) to fit this jack. The remote meter can be placed on the Uniservo being tested. As long as the plug is in the remote-meter jack, the AMPLIFIER MONITOR meter is disconnected from the circuit (figure 2-25).

2-162. In addition to its metered output, the anode-voltage deck of the AMPLIFIER SELECTOR switch sends an output to the oscilloscope terminals through contacts of the SCOPE SELECT switch. When this three-position telephone-key switch is pushed up (AMPL SEL), it connects the selected amplifier output to the oscilloscope binding-posts at the right of the meter. The circuit of this part of the monitor section is shown in figure 2-27.

2-163. This part of the circuit is further used to monitor the outputs of the head amplifiers and drivers, and the photocell and tachometer signals. These signals are picked up by the two-deck READ-WRITE CHANNEL SELECTOR switch shown in figure 2-27. Like the amplifier output signal, these signals are sent to the oscilloscope terminals through the SCOPE SELECT switch. When this switch is released (READ) it connects the read deck of the READ-WRITE CHANNEL SELECTOR to the oscilloscope terminals. When pushed down (WRITE), it connects the write deck of the channel selector to the oscilloscope.

2-164. Four oscilloscope sweep-synchronizing signals also are provided. The four-position rotary SYNC SELECTOR switch connects the selected signal line to the SYNC terminals on the panel. Signals selected by this switch are:

(1) Start read: from FF627 in the input-output control circuits.

(2) Read end: from RDF613 in the input synchronizer. (This signal can be inhibited by the eliminate read-ending switch on chassis B12T; refer to paragraph 2-137.)

(3) Write forward: from FF621B in the input-output control circuits.

(4) Sprocket: from the head amplifier for the sprocket channel.

2-165. The amplifier monitor section has one other function. The outputs from the read deck of the READ-WRITE CHANNEL SELECTOR are detected and applied to the HEAD CALIB jack on the front panel of the monitor box. This jack can be used for setting all Uniservo head outputs. The circuit is adapted for use with the AGC monitor meter. Since this meter has had the 1-megohm resistor removed from the probe (paragraph 2-22), one has been put into the circuit between the detector and the jack. For this reason, only the AGC monitor meter should be used.

2-166. To calibrate the heads, a calibration tape is read from a Uniservo; the head-balancing potentiometers on that Uniservo are then adjusted to provide equal outputs from all eight channels. The complete adjustment procedure is given in section VI of the Uniservo I manual. Photocell and tachometer signals can also be measured at this jack.

2-167. INSTRUCTION SECTION. The instruction and control sections of the monitor box are interdependent. Pushing a UNISERVO SELECTOR pushbutton in the control section selects a Uniservo; the FUNCTION SELECTOR switches set up the instruction in the Uniservo. The instruction signals and Uniservo-selector signals are normally sent to the Uniservo thyratron gates from the input-output control circuits, through the normally closed contacts of the switches in the monitor box. Operating a switch breaks the connection from the input-output control circuits and sends artificial signals to the Uniservos instead.

2-168. In normal computer operation, the negative-going servo selector (nS) signal from the input-output control circuits cuts off a normally conducting amplifier as shown in figure 2-28. The anode voltage of this amplifier then rises from –25 volts to +5 volts. This voltage is sent through the Uniservo-selector plugboard, and through one of the ten UNISERVO SELECTOR pushbuttons, to alert all thyratron gates in

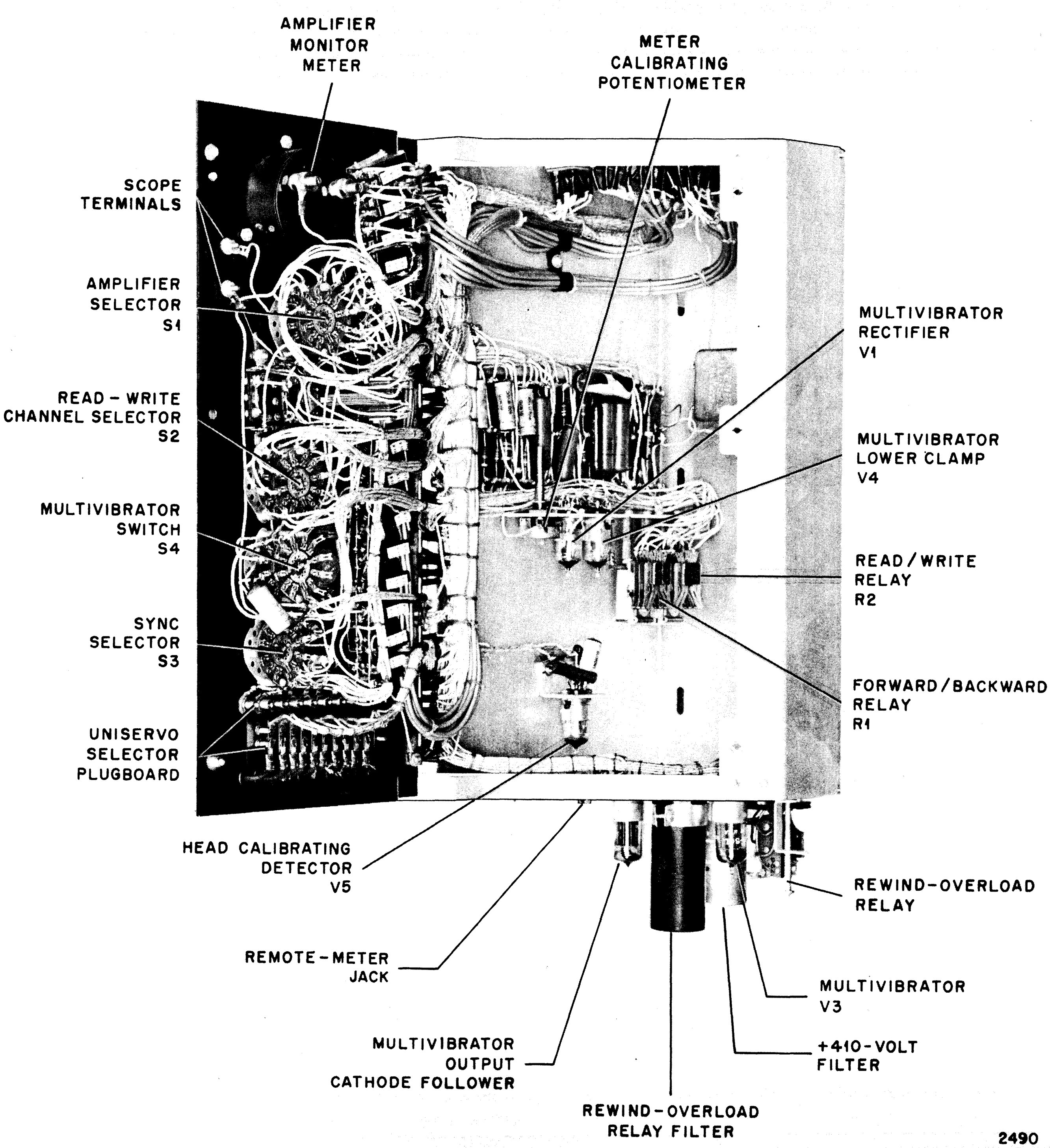

Figure 2-26. Monitor Box

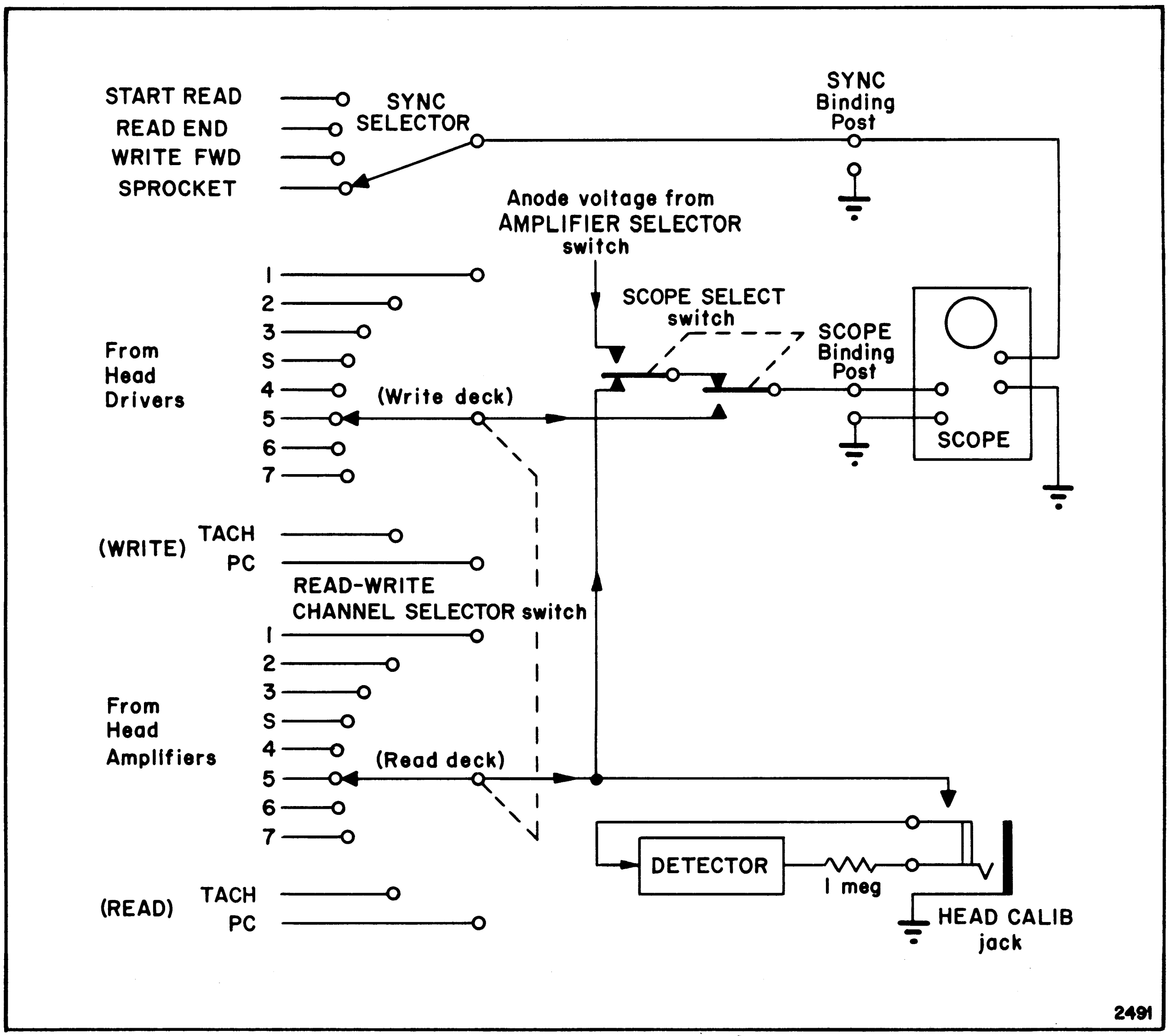

Figure 2-27. Head-Waveform Monitor Section

the selected Uniservo. It should be noted, however, that the nS signal from the BC corner does not pass through the Uniservo plugboard and that normal interlock conditions are not observed because it is possible to read two Uniservos simultaneously.

2-169. The Uniservo-selector plugboard is used whenever it is necessary to change the logical designation of a Uniservo. For a selector signal to be effective at all, its cord from the COMPUTER side of the board must be connected to a terminal on the SERVO side of the board. If computer cord 2 is connected to Uniservo terminal 6, selector signal 2 (2S) always alerts Uniservo 6.

2-170. When a selector button is pushed, the selector line from the computer is momentarily disconnected from its Uniservo, and the +5-volt line is connected instead. The +5 volts on the striker grid of the thyratron gate operates as a pseudo nS signal and alerts the selected Uniservo.

2-171. The instruction can then be set up in the Uniservo by means of the FUNCTION SELECTOR switches. These switches specify the operation to be performed (read, write, or rewind) and the direction of tape motion. Normally, the instruction signals RP, WP, RW, and RI, which are generated during the second program-counter step in the input-output control circuits, are connected to the Uniservo thyratrons through buttons in the monitor box. When one of these buttons is pushed, it disconnects the normal signal source, and applies +5 volts to the screen grids of all associated thyratron gates. If a UNISERVO SELECTOR button and a FUNCTION SELECTOR button are pushed at the same time, the correct instruction thyratrons in the selected Uniservo will conduct, pro-

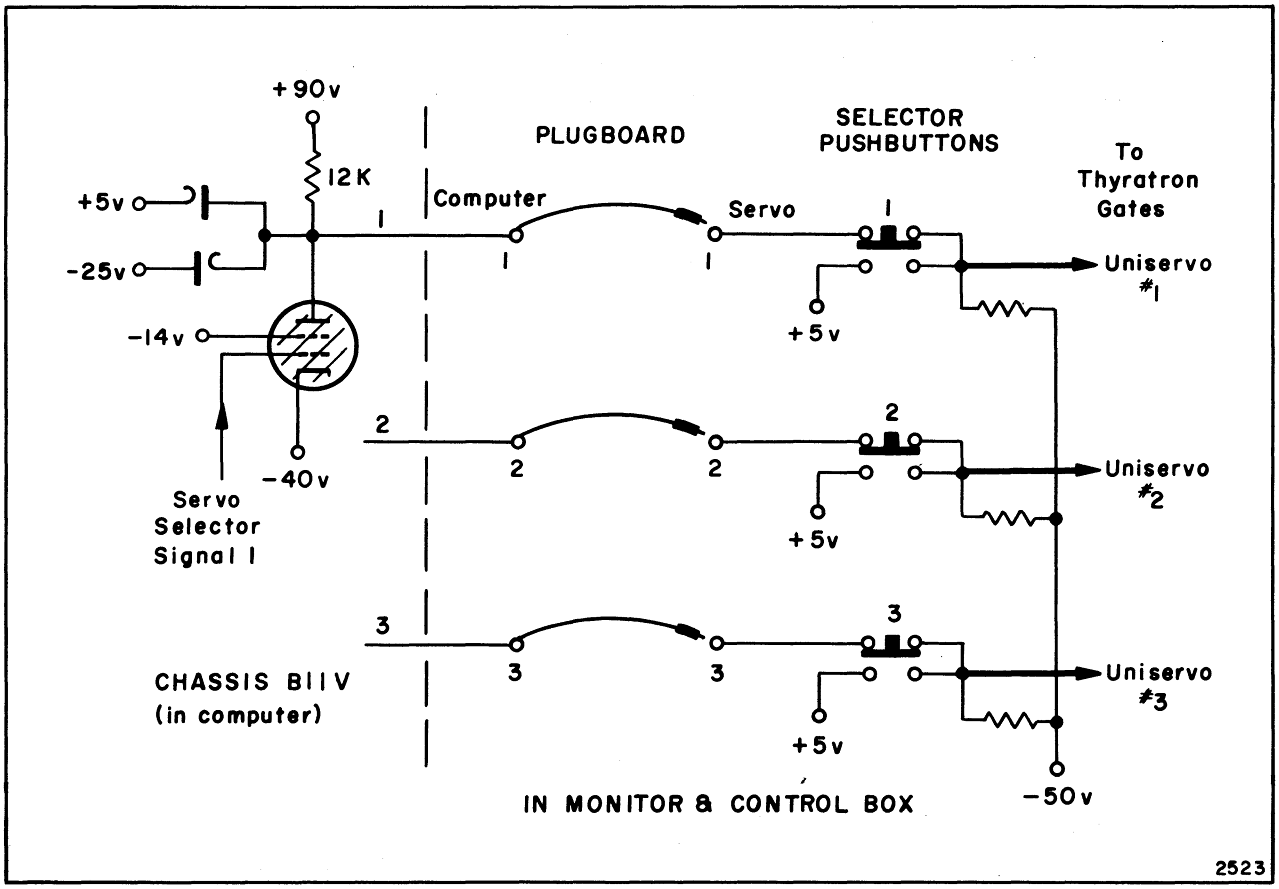

Figure 2-28. Plugboard and Selectors

vided there is no Uniservo number in the second digit of the static register.

2-172. The circuit that produces the artificial instruction signals is shown in figure 2-29. Note that, in addition to producing an FP signal, the F (forward) button applies power to the forward-backward relay. One of the three poles of this relay is used to transmit starting signals for the Uniservo from the control section. Another contact is part of a hold-interlock circuit for the relay. The relay remains energized until a BP signal is produced by means of the B (backward) button. Forward and backward starting signals cannot coincide.

2-173. The third contact of the forward-backward relay prevents the RE-REI (rewind-rewind interlock) button from initiating a rewind operation as long as the forward-backward relay is energized. Starting a rewind operation requires the use of three buttons:

(1) Push a UNISERVO SELECTOR button and hold it.

(2) Push the B (backward) button: this produces the B signal and clears the forward-backward relay. The balance points of the tape loops on the Uniservo shift if necessary. Do not perform step 3 until they do. If the balance points are not given time to shift, the tape loops may exceed the limit and knock out the main interlock.

(3) Still holding the selector button, push the RE-REI button. This action applies a voltage that fires the rewind and the rewind-interlock thyratrons, and the rewind operation proceeds. The RE-REI button must be pushed last if the Uniservo is forward. Since the normal 600-millisecond reversal delay is bypassed, this time delay must be inserted manually.

(4) Release the selector button.

2-174. The buttons marked R and W produce the RP and WP (read-pickup and write-pickup) signals, which fire the read and write thyratrons. As is the case with the circuits that produce the forward and backward starting signals, the RP and WP circuits are interlocked so that the two signals cannot occur at the same time. Pushing the R button energizes the read-write relay. Two of the contacts of this relay transmit the read and write starting signals from the control section to the input-output control circuits, while the third closes a holding circuit through contacts of the W button. Pushing the W button deenergizes the read-write relay.

2-175. CONTROL SECTION. No tape is actually moved on the Uniservo until proper initiating signals are generated in the input-output control circuits of the Central Computer. The controlling flip-flops and delay-flops are triggered by signals from the control section of the Uniservo monitor and control box, as shown in figure 2-30.

2-176. To perform a continuous read or write operation, turn the MULTIVIBRATOR switch to the RUN position. The contacts of the switch then send a –50-volt signal through a pair of cathode followers and to contacts of the read-write and forward-backward relays. Through the contacts of these two relays, the signal passes to the input-output control circuits. The state of the two relays determines which of the controlling elements will be set.

2-177. For example, since in a read-forward instruction both relays are energized by the FUNCTION SELECTOR signals, the RF (set) and RAD (set) signals are produced. The Uniservo then performs a continuous read operation either until the end of the tape is reached and the tape bumpers terminate the operation or until the operator turns the MULTIVIBRATOR switch to the OFF position. The restore RF, RB and WF signals are produced when the MULTIVIBRATOR switch is turned off. At the same time, the RAD delay-flop is set to stop the tape. Pushing the RC button (read clear) terminates the operation by clearing the read thyratron.

2-178. If it is necessary to simulate successive rather than continuous tape instructions, the MULTIVIBRATOR switch is turned to MULT. In this position, the switch connects the set line (the line across which the operating signals RF set, WF set, RB set, RAD set, and WAD set pass) to one side of the multivibrator, and the restore line to the other side. As the multivibrator oscillates, it generates alternate set and restore signals. (The clamping diodes connected to the center poles of the MULTIVIBRATOR switch (figure 2-30) limit the voltage swing of the multivibrator output.)

2-179. The duty cycle of the multivibrator, and therefore of the tape operation, can be varied by the STOP TIME and RUN TIME potentiometers, which can be adjusted at the front panel of the monitor box with a screwdriver. The STOP TIME potentiometer determines the time between successive tape operations. The RUN TIME potentiometer determines the duration of any operation.

2-180. After Uniservo operation in either the continuous or iterative mode, the read or write thyratrons must be cleared. The RC and WC (read clear and write clear) pushbuttons clear the associated thyratrons. If the thyratrons in a Uniservo are not cleared, that Uniservo cannot be selected by the Central Computer to perform another instruction. In addition, if the Uniservo is not cleared and another is selected, both operate together. This condition is serious. The Uniservo should be checked carefully to determine that the read or write thyratron has been cleared.

2-181. INDICATORS. A group of four neon lamps on the front panel of the monitor box indicates the condition of any selected Uniservo. A selector signal from the static register decoders is returned from the Uniservo as a forward-interlock release (FIR), backward-interlock release (BIR) (both if the Uniservo has just rewound tape), or as the rewind-interlock release (RIR) signal. The neons indicate which of these three

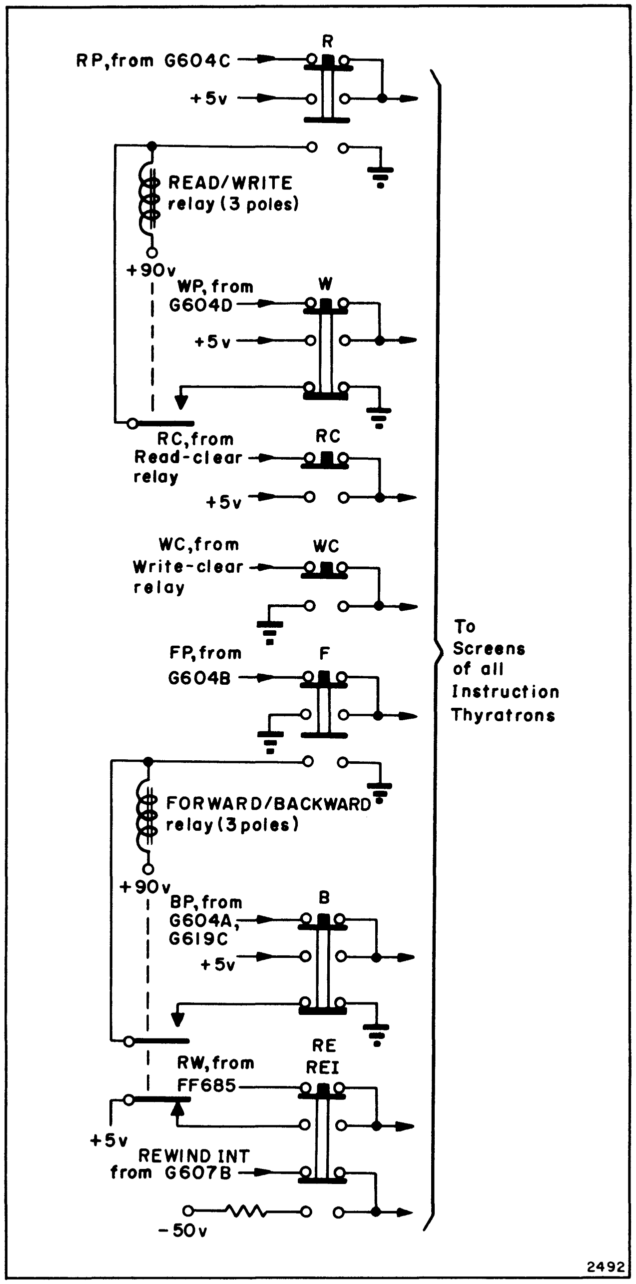

Figure 2-29. Instruction Section, BC Corner Box

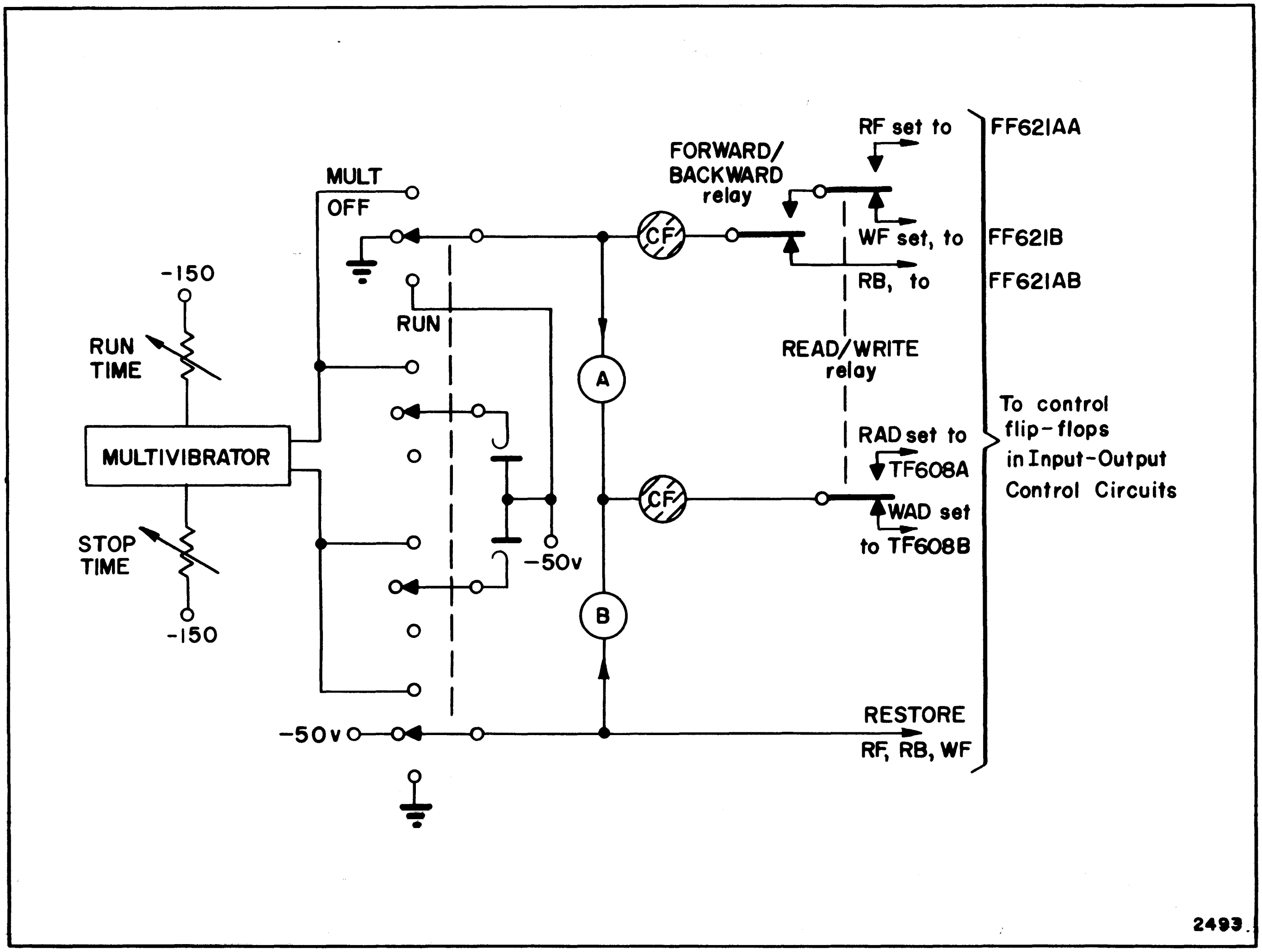

Figure 2-30. Multivibrator Control Section

signals has been returned. The fourth neon, marked WT, is lighted by the write test signal, which is present whenever a write thyratron is fired in any Uniservo.

2-182. These neons are useful principally in indicating the reason for computer stoppage on program-counter step 1 of a tape instruction. A lighted RIR neon indicates that the Uniservo has performed a rewind-with-interlock (8n) instruction. If neither FIR nor BIR is present, the selector signal never reached the Uniservo or was blocked at the Uniservo. (Blocking occurs if the Uniservo is in use or has not been cleared.) If the WT neon is lighted, it indicates that the Uniservo is performing a write operation.

2-183. Three other components mounted on the bottom of the monitor box are not associated with any of the circuits described in this section. One of these is the filter for the +410-volt anode supply used in all the McIntosh amplifiers. The other two components are the rewind-overload relay and filter. This adjustable relay prevents overloading the rewind amplifier (McIntosh amplifier 3).

2-184. The rewind-overload relay coil is connected directly to the cathode winding of the output transformer of the McIntosh amplifier. If too many tape rewind operations are attempted at the same time, the relay, which is current-sensitive at 350 milliamperes, is energized. Its contacts then apply an inhibiting voltage to G619A and G619B, and the outputs of these gates set the rewind control flip-flop in the input-output control circuits. At the same time, power is applied to light the RWOL (rewind overload) neon on the supervisory control panel. As soon as one of the rewind operations in progress has been completed, the relay is deenergized, releasing the gates and enabling a new rewind to begin.

2-185. CONNECTORS. Signal and power lines enter and leave the Uniservo monitor and control box through eight connectors, five of which are mounted on the left side of the box, and three of which are on top. Connectors to cables that carry lines between the computer and the monitor box are designated numerically JP1 through JP6. The two which connect the monitor box to the Uniservos are designated JPA and JPB.

2-186. CHECKING CIRCUITS

2-187. Certain circuits in the Central Computer are duplicated so that their operations may be easily checked by comparison. These duplications include the algebraic adder and its comparator, the circuits and registers comprising the accumulator, parts of the control circuits, the memory-selection circuits, and the cycling unit.

2-188. A number of other circuits check for the correct operation of these data-processing circuits and of the rest of the computer. These others are referred to generally as checking circuits, and they are of several types.

2-189. Some are essentially interlocks, requiring that a certain set of conditions be established before an operation can be carried out. Some, such as resistance comparators, are calibrated detectors that determine whether the circuit is functioning correctly. Others are coincidence checkers, producing an error indication when certain signals coincide or fail to coincide. A subgrouping within this category includes the comparison circuits, which constantly compare the contents of various duplicated circuits and registers. Most familiar are the parity (odd-even) checkers.

2-190. TYPES AND EXAMPLES

2-191. The discussion that follows gives examples of the circuit types, shows how error indications are presented, and notes the effect of the check circuits on computer operation.

2-192. DUPLICATE CIRCUITS AND COMPARISON. In all cases, the outputs of duplicate circuits are compared for agreement, although this comparison is not always direct. If the information is dynamic, a half-adder is used for direct comparison, the half-adder produces no output so long as the duplicate signals agree. If the information is static, the output gates of the duplicated circuit are sampled for agreement. In some cases, a disagreement is disclosed only by subsequent discrepancies in other duplicated circuits.

2-193. The directly inspected duplicated circuits, and the associated half-adders or sampling gates, error flip-flops, and error-delete gates are listed in table 2-3. (An error-delete gate is included in the output circuit of each error flip-flop so that the effect of the error can be cancelled.) The supervisory control error-delete switches inhibit these gates and prevent the error from affecting computer operation. (Refer to paragraph 2-227.)

2-194. Other duplicate circuits provide no direct indication of errors. The multiplier-quotient counter, the program counter, the cycle counter, the stop, time-selection, overflow, repeat, ≥ 3, IER-OR, IER, and OR flip-flops, and FF152 (which produces the S1 signals), all are duplicated. Each circuit is represented on the control panel by a set of neon lamps. The upper and lower neons in any set indicate the setting of the unbarred and the barred circuit and show up any discrepancy between the circuits. The direct indication of any disagreement, however, will in most cases be an algebraic error resulting from the difference in controlling signals sent out by the two circuits.

2-195. If the two multiplier-quotient counters disagree, for example, one adder may perform more operations than the other, resulting in adder-comparison

Table 2-3. Elements Used for Comparison in Duplicate Circuits

Duplicate Circuit	Half-Adder or Sampling Gate	Error Flip-Flop	Error-Delete Gate
High-speed bus	HA414	FF414	G343
Algebraic adder	HA415	FF415	G344
F register	HA410	FF410	G349
L register	HA411	FF411	G350
A register	HA412	FF412	G351, G440, $\overline{G440}$
X register	HA413	FF413	G348, G440, $\overline{G440}$
Conditional-transfer flip-flop	G438, G439	FF402	G346
Time-out flip-flop	G247A, G247B	FF206	G347
Cycling unit "A" check[a] (duplicate 7- and 13-pulse loops)	HA422	FF422	G336
Cycling unit "B" check (both pulse loops against 27-pulse delay)	HA416	FF421	G335

[a] Also checks for two pulses in CU.

(ADDER COMP) and A-register—comparison (A COMP) errors. On the other hand, different numbers passing from the duplicate counters to the duplicate X-registers result in an X-register—comparison (X COMP) error.

2-196. If the program counters or cycle counters disagree, their diode matrixes produce no outputs, and the computer stops, since it cannot continue without the necessary control signals.

2-197. If one stop flip-flop is set while the other is restored, the associated time-out flip-flops will be restored and set, and a time-out error will result. The STOP and TO neons give a visual indication of the time-out comparison error, which stops the computer.

2-198. Disagreement between duplicate IER, OR, IER-OR, repeat, S1, ≥ 3, or overflow flip-flops results in algebraic errors, which usually show first as adder-comparison or register-comparison errors; additional visual indication is provided by the control-panel neons.

2-199. PARITY CHECKERS. The Univac I system code is such that each digit contains an odd number of pulses. At five points in the Central Computer, the pulse trains are diverted through parity checkers which check for the odd-even count of each digit and produce an error indication if the count is wrong.

2-200. Two of the five checkers are passive (sometimes called negative) checkers; that is, they produce an error indication only when the count is wrong. These are the input-synchronizer and high-speed bus odd-even checkers. The other three are the algebraic adder minuend, algebraic adder subtrahend, and output-synchronizer odd-even checkers; these checkers assume an error in each digit and require a correct count to remove the error indication.

2-201. In the high-speed bus checker, which is a passive parity checker, the pulse train passing across the bus is diverted through a clock gate into a binary counter (BC400). At the end of the first, the third, and every succeeding odd-numbered decimal digit, the counter should alert one of a pair of sampling gates (G426); at the end of every even-numbered decimal digit, it should alert the other gate (G427). Meanwhile, another binary counter (BC402) steps each digit time, alerting the even and odd gates alternately in the opposite order.

2-202. Alerting signals can coincide on either gate only when a digit has contained an even number of pulses. The output of either gate can alert an output clock gate (CG414), which when open passes a timing pulse to set the error flip-flop (FF418).

2-203. The input-synchronizer checker has the same function, but is electronically simpler. Transfer pulses are used as sampling signals and to reset the counter at the beginning of each decimal digit. The resetting feature reduces the circuitry required. Only one decision is possible for any decimal digit. The binary counter must produce an odd-count indication at the end of each digit time, or the circuit will pass an error. The check circuit is duplicated, even though the synchronizer circuit is not, in order to isolate input troubles.

2-204. The two positive checkers on the adder minuend and adder subtrahend input are identical. They do not differ from the high-speed bus checker except that the error flip-flops are set at the start of each decimal digit, and restored only if the correct count is given by the binary counter. The fifth check circuit, however, which checks the output synchronizer, differs from the others. It checks the static signals from the output flip-flops. If an odd number of output flip-flops is set, a signal is produced by a whiffletree of quarter-adders, but an even number produces no output. A transfer pulse F (TFPF) sets up the output flip-flops and also sets the two error flip-flops operated by the quarter-adder whiffletree. The whiffletree terminates in duplicate quarter-adders, which provide a check on the check circuit. The transfer pulse also triggers a delay flop for a 20-microsecond period, which gives the output flip-flops time to stabilize; after this the delayed TFPF samples the output gates (G826A and G826B) of the whiffletree. If the quarter-adders have alerted the gates, the transfer pulse passes to restore the two error flip-flops, which remove the error indication.

2-205. GREATER-THAN-ONE DETECTORS. Resistance comparators are used to check the hundreds and tens (memory) selectors, the Uniservo selector, the shift selector and certain instruction lines.

2-206. The input signals in each case are buffed together into a resistive biasing circuit on the grid of an output tube. As long as no input, or only one input, is present, the tube is biased below cutoff. When two or more signals are present, the grid voltage rises above the cutoff point, the output tube conducts, and an error signal passes through the following circuitry.

2-207. In the memory-selector checkers, the error flip-flop is set by a t10 pulse whenever the time-selection flip-flop is set (TS signal present). A separate resistance comparator checks half of the ten input lines of each checker (hundreds and tens). The memory-selector checker is calibrated to detect any of the following conditions:

(1) No energized line in either half.

(2) Coincidence of one or more energized lines in both halves.

(3) Two or more energized lines in either half. Any of these conditions blocks the restoration of the error flip-flop.

2-208. The shift-selector, Uniservo-selector, and instruction-line checkers function as simple greater-than-one detectors. The Uniservo-selector checker is duplicated.

2-209. COINCIDENCE DETECTORS. Certain circuits in the Central Computer are inspected for coincident signals. In some cases they produce an error when the coincidence occurs, and in other cases when it does not occur. The alphabetic detector in the algebraic adder, the function-signal checker, the input-output interlock circuit, the tape check, IS > 720, and direction-memory checkers, are examples of this type of circuit. Also, the diode matrixes on the outputs of the duplicate program counters and cycle counters produce no output unless the barred and unbarred counters are in agreement.

2-210. The adder alphabetic detector normally by-passes the digit of any alphabetic character occurring in either minuend or subtrahend inputs directly through a 7-pulse delay to the sum output. If both minuend and subtrahend inputs are alphabetic, however, the coincidence sets an error flip-flop, and lights the ADDER ALPH. neon on the control panel. The alphabetic detector circuits do not operate during 12-place addition.

2-211. The input gates to the function-signal checker are alerted so that the coincidence of certain function signals which should not coincide passes an error signal. The circuit is not a general type, but is designed specifically to cover function-signal faults that would not be shown through other error indications. The function-signal errors detected by this special detector drive two output error flip-flops and light two neons on the control panel.

2-212. When a read or write instruction is performed, the input-output interlock checker sets an error flip-flop and inhibits the input-output interlock circuit. This operation succeeds when the read or write interlock flip-flops have not been set, and when a read-forward operation coincides with a B2 (backward) signal from the forward-backward relay. The output from the input-output interlock error flip-flop also inhibits the read-interlock gate.

2-213. The tape-check circuit registers an error whenever a group of input information signals fails to coincide with a sprocket. The information signals combine to set the error flip-flop. If the flip-flop is not restored by the sprocket within 50 microseconds, an error results.

2-214. The IS > 720 error circuit detects two types of miscounts in the input synchronizer. An error is indicated whenever 3.5 milliseconds elapse between transfer pulses (specifically between TFPA's), and the number of digits read into the synchronizer is between 708 and 720; or when a TFPA is produced after the 720th digit has been read in. The 3.5-millisecond value is not critical. It is determined by RDF613.

2-215. The error flip-flop is set by a TFPA from either of two gates. To indicate that more than 708 but less than 720 digits have been read into the input synchronizer, an error pulse is passed by a gate alerted during the 59th word. The greater-than-720 error pulse is passed by a gate alerted as the 60th word is transferred from the synchronizer register. If any block of information contains less than 708 digits (59 words), an entire additional block of information will be transferred into the input register, and an IS > 720 error will show at the end of the second block.

2-216. Another checking circuit in the input-output control circuits is the direction-memory checker, which detects coincident forward and backward signals to block an input-output ending pulse and stop the computer. This type of error is not indicated directly among the error neons on the control panel but is easy to analyze. Failure to pass interlock on program-counter step 1 can give similar indications. Disagreement of this type can stop the computer in the middle of a read instruction with no error showing and the time-out flip-flop not set. If the DIRECTION STORAGE neon is lighted (direction memory set to forward) and a 2n or 4n instruction (read backward) is set up in the static register, or if the neon is out, and a 1n or 3n instruction is set up, a direction-memory error is indicated.

2-217. A rewind error also can stop the computer without an apparent cause. If the rewind (RW) signal is not produced by FF635, no rewind-ending pulse is produced, and the computer stops in the middle of an operating cycle (time-out flip-flop not set) with a rewind (6n) or rewind-with-interlock (8n) instruction set up in the static register.

2-218. Other parts of the input-output control circuits operate partly as checks, because signals necessary to start tape moving, for reading or writing, are interlocked to avoid passing until the correct circuit conditions are fulfilled.

2-219. EFFECT OF CHECK CIRCUITS ON COMPUTER OPERATION

2-220. There are two ways in which check circuits affect computer operation when errors occur and several variations within these divisions. Most of the checking circuits stop the computer in the time-out period following the instruction during which the error is detected. The input-output checkers stop the computer just before the execution of the next instruction of the same kind (read or write) or the next instruction calling for the Uniservo that was in use when the error was detected.

2-221. The outputs of all check circuits except those in the input-output equipment are buffed together to inhibit G216 in the control circuits, and G311 in the memory time selector, as shown in figure 2-31.

The following check circuits inhibit G216 and G311:

- High-speed bus comparison (HSB COMP)
- High-speed bus odd-even (HSB O-E)
- F-register comparison (F COMP)
- L-register comparison (L COMP)
- A-register comparison (A COMP)
- X-register comparison (X COMP)
- Adder-sum comparison (ADDER COMP)
- Adder-subtrahend comparison (ADDER SUB)
- Adder-minuend comparison (ADDER MIN)
- Adder alphabetic-character (ADDER ALPH)
- Conditional-transfer (COND TRANS)
- Time-out (TIME-OUT)
- Servo-selector (SERVO SEL)
- Cycling-unit, HA422 (CU "A")
- Cycling-unit, HA416 (CU "B")
- Instruction-line and shift-selector or function-table intermediate-line (FT INTER)
- Function-signal, or function-table output (FT OUTPUT)
- Tens-selector (TANK SEL)
- Hundreds-selector (TANK SEL)

Gate G311 normally enables the correct time-selection count to set the time-selector flip-flop. Gate G216 normally passes a t1 signal to restore the time-out flip-flop except when the stop flip-flop is set. If the t1 signal cannot pass to restore time out, the computer stops. Set up in the static register is the instruction following the one in which the error developed. Gates G216 and G311 are also inhibited if the stop flip-flop, FF205, is set.

2-222. All of these error circuits can be restored by operation of the start bar or the GENERAL CLEAR switch. The RESET CONTROL switch on the supervisory control panel alerts or inhibits a gate that is in series with the start-circuit output of the error flip-flops. If the gate is alerted, the start circuits restore all error flip-flops; if it is inhibited (switch pushed down), the start bar starts the computer without restoring the error flip-flops. The RESET CONTROL switch is generally used during troubleshooting. (Refer to table 5-16.)

2-223. The outputs of input-output checking circuits do not stop the computer in the following time-out period, except for the two instances mentioned in paragraph 2-197. They operate directly on the Uniservo in use at the time of the instruction and on the interlock for the type of instruction in which the error occurred. For example, an error occurring during a read instruction on Uniservo 3 stops the computer only during program-counter step 1 or the next instruction calling for Uniservo 3.

2-224. The input-output errors are not cleared by operation of the start bar. The input-synchronizer or output-synchronizer error clear (I. S. ERROR CLEAR and O. S. ERROR CLEAR) switches, or the GENERAL CLEAR switch, must be used. The error circuits are listed in table 2-4.

2-225. BAD-SPOT DETECTOR

2-226. The bad-spot detector circuit does not stop the computer. It blocks the reading or writing operation at the Uniservo until the bad-tape area has passed over the head.

2-227. DELETE SWITCHES AND OTHER ERROR SWITCHES

2-228. The effects of all error circuits on computer operation may be cancelled individually or collectively. Each error flip-flop passes its signal through an output gate, which is normally alerted. If the associated error-delete switch is pushed down, the gate is inhibited; the error indication is presented at the supervisory control panel, but the computer does not stop.

2-229. The DELETE SELECTOR switch deletes the effects of one of two duplicate error circuits. When the individual error-delete switch is pushed up, the error-delete gate of either the barred (DELETE SELECTOR pushed down) or unbarred (DELETE SELECTOR released) circuits can be inhibited.

2-230. The MASTER DELETE switch inhibits all error-delete gates of all checking circuits, except the five input-output checkers; consequently, the computer does not stop.

2-231. None of the delete or delete-control switches should be used during normal operation, since they enable the propagation of errors throughout the computer. They should only be used when tracing errors and troubleshooting.

2-232. The multiply-divide error stop (X ÷ ERROR STOP) switch alerts G440, which passes signals from either FF412 or FF413. These two flip-flops produce the error outputs for the A-register—comparison and X-register—comparison errors. If any disagreement occurs during a multiply or divide instruction, the normal procedure of waiting until the following time-out period before stopping the computer would enable widespread propagation of an algebraic error. When G440 is alerted, however, an A COMP or X COMP error alerts G246 in the control circuits, which pass the next t1 signal to set the time-out flip-flop.

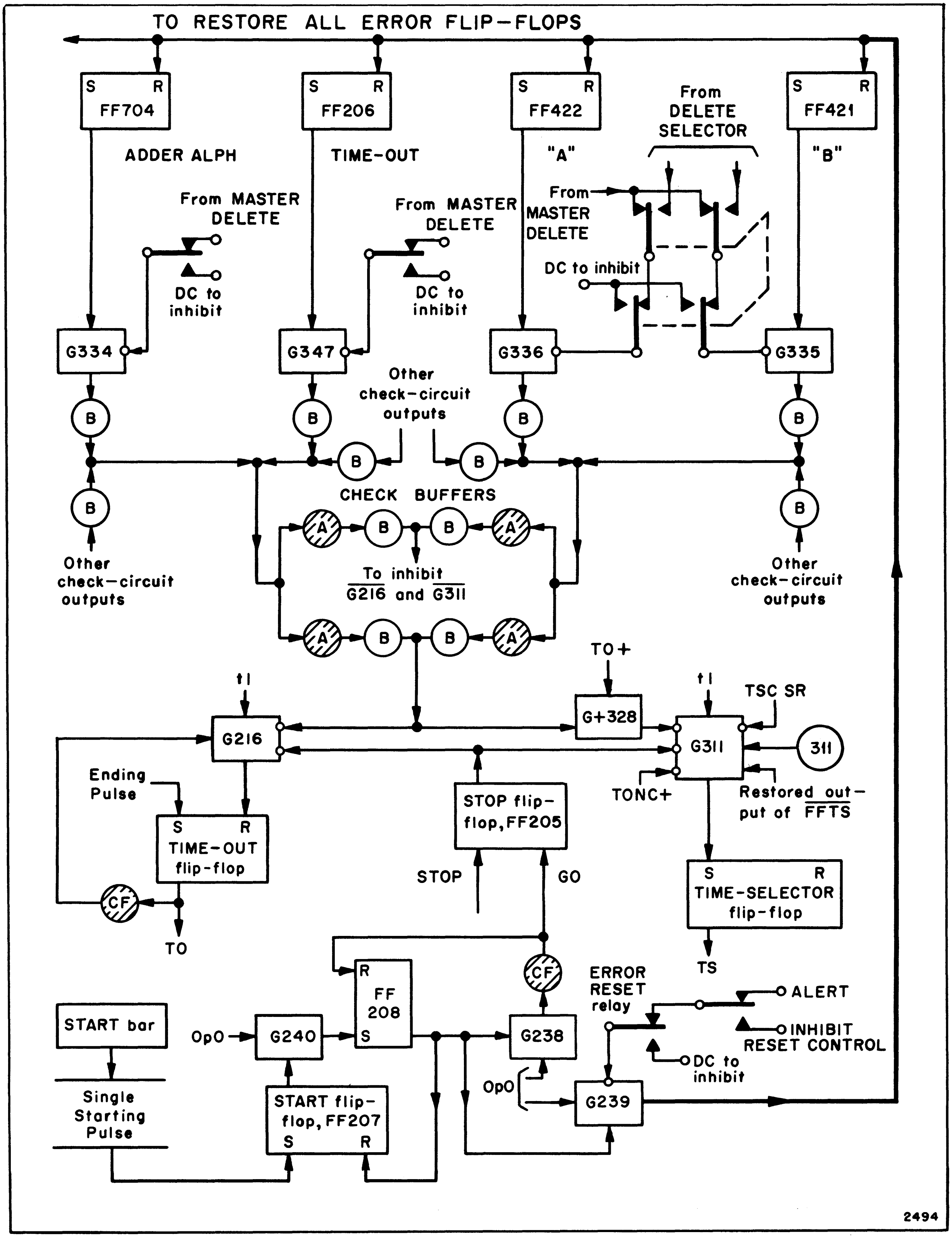

Figure 2-31. Output Buffing

Table 2-4. Error Circuits

Error Circuit	Error Flip-Flops	Error-Delete Gates	Function
Input synchronizer odd-even check	FF641A, FF641B	G883	Inhibits G652A, the supervisory control input error gate, to prevent generation of a supervisory read ending (SRE) signal.
		G814	Inhibits read-interlock gate G603A, prevents clearing read thyratron and restoring read interlock. As long as read interlock is set, read-interlock test gate G606A is inhibited, and input-output interlock gate G618A is inhibited.
Output-synchronizer odd-even check	FF646A FF646B	G818A G818B	Inhibits write-interlock gate G603B, prevents clearing write thyratron and restoring write interlock. As long as the write interlock is set, write-interlock test gate G606B is inhibited, and input-output interlock gate G618A is inhibited.
Input-output interlock	FF631	G815	Inhibits read-interlock gate G603, prevents clearing read thyratron and restoring read interlock. Inhibits input-output interlock gate G618A, so that no subsequent tape operation can be started.
Tape check	FF632	G819	Inhibits read-interlock gate G603A, prevents clearing read thyratron and interlock.
Input synchronizer $>$ 720	FF609	G884	Inhibits read-interlock gate G603A, prevents clearing read thyratron and restoring read interlock.

2-233. The three error-insert switches provide means for checking the operation of the cycling-unit comparator, the input-synchronizer odd-even checker, and the high-speed bus comparator.

2-234. The C. U. ERROR INSERT switch produces either of two errors. When pushed up (position A), it inserts a pulse into one side of HA422, the half-adder that compares the duplicate 7- and 13-pulse loops. When pushed down (position B), it deletes one input to HA416, the half-adder that compares the pulse loops with the 27-pulse delay line. In either case, a CYC UNIT error results.

2-235. The HSB ERROR INSERT switch alerts G+445 to read random t76 pulses into the duplicate high-speed bus. This should produce an immediate disagreement in HA414, the half-adder that compares the high-speed buses. It should also produce an HSB O-E error during an instruction which uses FT signals 428 or 429, with the lower neon lighted.

2-236. The I. S. ERROR INSERT has two functions: either to delete all check pulses by permanently restoring FF601A, the check-pulse flip-flop in the input synchronizer, or to put check pulses on all digits by permanently setting FF601A. The immediate result should be an I. S. O-E error. The faulty information can then be conducted through the computer to check all odd-even checkers by careful manipulation of the delete and control switches:

(1) If the I. S. O-E delete switch is pushed down, a faulty pulse train can be sent across the high-speed buses where it should produce a high-speed bus odd-even error.

(2) When a faulty pulse train is read out of the memory, it can be read into a register with the HSB O-E error-delete switch pushed down. The information will go from the input synchronizer and will be used in an instruction with the algebraic adder. If the information is supplied to both adder inputs alternately or simultaneously, it will produce an ADDER MIN or ADDER SUB error, or both.

(3) An output instruction will carry a faulty pulse train from the register of the memory it was stored in to the output synchronizer, and then to the output flip-flops. When it has reached this point, an O. S. O-E error should result. In performing such a check, it is best to read the information into and out of the computer by means of the supervisory control typewriter and printer, rather than by a tape instruction.

2-237. POWER INTERLOCK SYSTEMS

2-238. Two interlock systems protect the Univac I system equipment and operating personnel. An a-c interlock circuit turns off all a-c power to the installation except for certain standby voltages, those supplied by the control-power lines. This interlock is opened by circuits in which failure could cause serious damage if power remained on. Less serious failures open a d-c interlock circuit, which turns off all d-c power except that used to heat the short mercury registers.

2-239. The circuits shown in figure 2-32 control the application and removal of power. Power is normally applied and removed by means of switches on the supervisory control panel; in abnormal circumstances, the interlocks automatically remove power.

2-240. The power installation circuits, also shown in figure 2-32, consist of two main circuit breakers, two contactors, and several branch circuit breakers. The a-c and d-c main breakers divide the incoming power, one controlling the power that is to be used as ac, and the other, the power to be rectified. There is a contactor in series with each breaker. The power-control circuits turn power off and on through the two contactors.

2-241. In most computer models of the Univac I system the a-c main breaker also connects power to the control-power (sometimes called service power) branch circuit breaker. This circuit breaker applies not only the a-c control power, but also the input to the standby (d-c) power supply.

2-242. Stabilizers, boosters, and phase-shifting transformers are not shown in figure 2-32, since the number and use of these elements depend upon the design of the circuitry.

2-243. The power-control circuits are interlocked with the circuit breakers in the power installation, so that all circuit breakers must be closed before the contactor can be energized. This interlock line is shown traversing all of the circuit breakers to ground. [The control circuit, 115 volts across ϕ1L6, is not included in the interlock although it operates the interlock. Control and standby power are both applied independently, so that when the rest of the computer is turned off, power is still available for the power-control relays, contactors and indicators, convenience outlets and

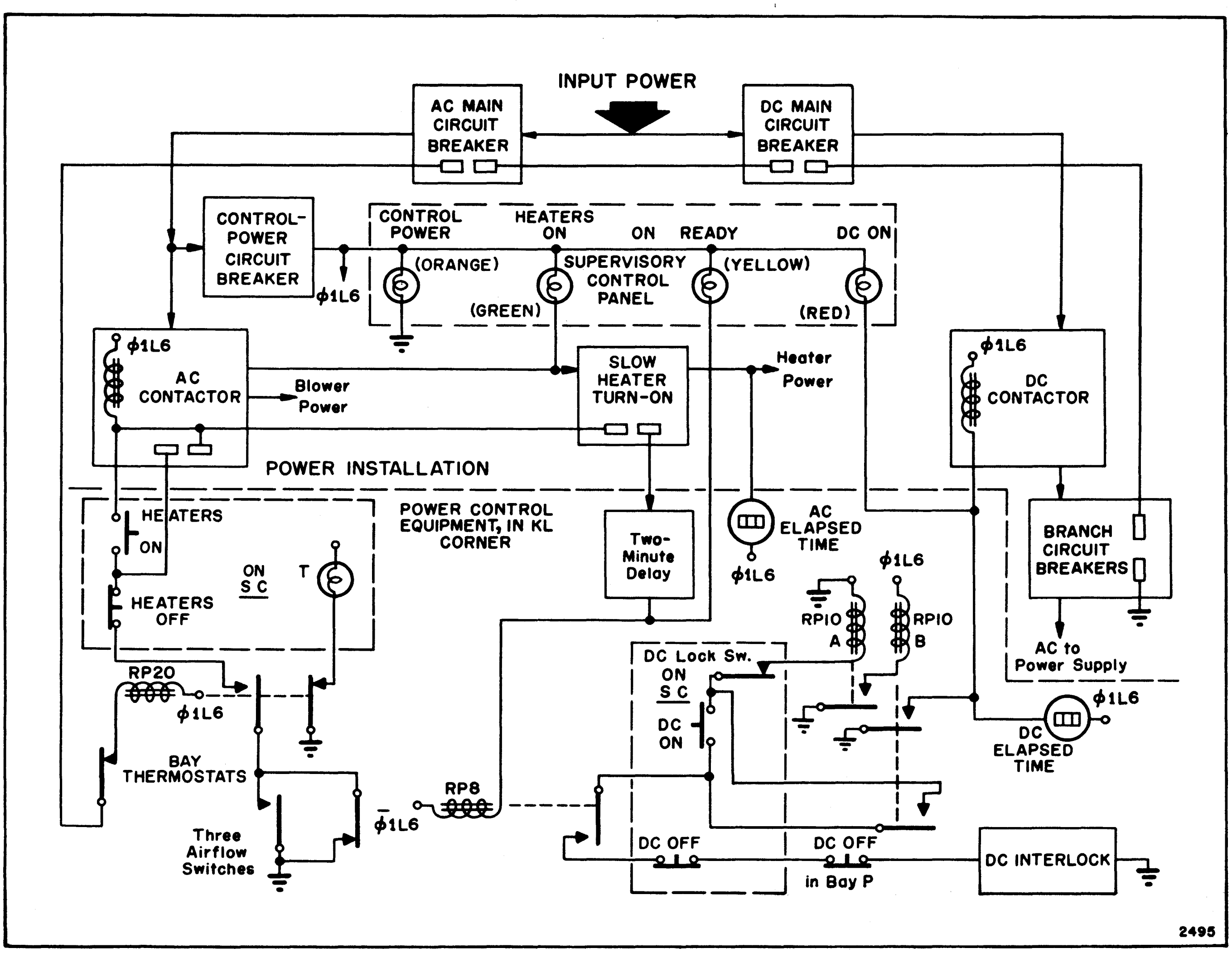

Figure 2-32. Power Control System

lights, the supervisory control printer, and the long- and short-tank standby heating circuits.]

2-244. When all of the circuit breakers are closed, the a-c interlock relay (RP20) grounds. Normally, the control-power branch breaker is the last to be closed. When it is closed, the relay is energized and the orange control power jewel light on the supervisory control panel lights. When this light is on, power can be turned on from the supervisory control console.

2-245. Pushing the HEATERS ON pushbutton completes the circuit for the a-c contactor through an energized contact of RP20 and a deenergized contact of RP8. Closing the a-c contactor:

(1) Lights the HEATERS ON (green) jewel light on the control panel.

(2) Closes a hold-interlock circuit (A interlock), which holds the ground connection on the coil after the button is released.

(3) Turns on the three blowers in the cooling system. The three air flow switches, closed by the air streams from the cooling system, provide an additional ground circuit for the a-c contactor.

(4) Starts the timer motors in the slow heater—turn-on circuit.

2-246. Initially, the slow heater—turn-on circuit supplies 115 volts, one half of the full heater primary voltage. After each of three delays, it increases the voltage by 16 percent of the full value until 230 volts is applied to the heater-transformer primaries. The steps are 115 volts, 153 volts, 191 volts, and 230 volts. The line-voltage meter in the KL corner (figure 1-17) indicates the value of this voltage. For use of the slow heater—turn-on circuit in the marginal checking process, refer to paragraph 2-287. The HEATER ELAPSED TIME meter in the KL corner starts as 115 volts is first applied to the heaters.

2-247. When heater voltage reaches its full value, a 2-minute delay, controlled by a thermal element, begins. At the end of this delay, the a-c—to—d-c interlock relay, RP8, is energized. Three contacts of this relay are used:

(1) A holding contact which bypasses the thermal element, energizes RP8, and maintains some current-flow through the thermal element. This latter feature shortens the time delay in case RP8 must be turned on and off repeatedly, as when the a-c interlock circuit is being checked out.

(2) An air-vane-bypass contact provides the initial ground return for the a-c contactor coil until the blowers are turned on and the air stream closes the air-flow switches.

(3) An a-c—to—d-c interlock contact connects the ground line from the d-c interlock circuit to the circuit that turns dc on.

As soon as RP8 is energized, the ready (yellow) jewel light on the supervisory control panel lights, to indicate to the operator that dc can be turned on.

2-248. Closing the d-c lock switch (turning the key to the right) and pushing the D. C. ON pushbutton energizes RP10A by completing its ground-return circuit. The single contact of this relay also energizes RP10B, which in turn energizes the d-c contactor. The contactor connects 230 volts ac from the d-c circuit breaker through the branch breakers to the primaries of the power-supply transformers. As soon as the contactor is closed, the D. C. ON (red) jewel light on the supervisory control panel lights and the d-c ELAPSED TIME meter in the KL corner starts.

2-249. The dc can be turned off directly by two separate spring-loaded D. C. OFF buttons. One of these is on the supervisory control panel. The other is a red emergency-shutoff button, marked STOP, inside the computer, on the side of bay P. Both of these open the d-c interlock to drop out RP10A, RP10B, and the d-c contactor. The emergency button can be jammed off by means of a tab which can be pulled across the button to hold it in the OFF position.

2-250. Heater power is shut off with the HEATERS OFF pushbutton on the supervisory control panel. This button opens the a-c interlock to drop out the a-c contactor. In addition, it drops out the a-c—to—d-c interlock relay RP8, which, in turn, opens the d-c interlock and so turns off the dc. The a-c—to—d-c interlock ensures that dc can never be turned on, or remain on, if ac is off.

2-251. Two other contacts of RP10B are used in addition to the one that energizes the d-c contactor. One closes a holding circuit for RP10A, RP10B, and the d-c contactor. The other connects the voltage-monitor measuring circuit to its sampling contact.

2-252. The lines from the power installation are labelled according to phase and line. Table 2-5 gives the source and function of each of these lines.

2-253. A-C INTERLOCK

2-254. The a-c interlock has two branch circuits. If either branch opens, the a-c contactor drops out, removing both ac and dc.

2-255. One branch contains three airflow switches. These switches, mounted under the false floors of the Central Computer and the power-supply unit, are held shut by the airstreams from the three blowers. If the volume of air flowing through any of the three airflow paths is not enough for cooling, the switch in that path opens the a-c interlock. Indications of the failure are:

(1) Loss of ac and dc.

(2) STAND-BY POWER (HEATER) neon lights.

(3) The P lamp (green) in the primary fault indicator lights when a blower fuse fails.

Table 2-5. Lines from Power Installation

Phase and Line	Voltage	Source	Function
ϕ1L1-L2	230	Branch breakers	Rectifier primaries
ϕ1L3-L4	230	Slow heater—turn-on circuit	Heater primaries + 48v relay supply (not reduced by marginal checking)
ϕ1L5-ground	115	Control-power breaker	Convenience outlets Lights Control printer
ϕ1L6-ground	115	Control-power breaker	Control power Standby power-supply anodes Initial-read timer
ϕ1L7-ground	115	Control-power breaker	Standby power-supply heaters
ϕ1L8-L9	230	Control-power breaker	A-C heat for long tanks
ϕ2L1-L2	230	Branch breakers	Rectifier primaries
ϕ2L3-L4	230	Slow heater—turn-on circuit	Heater primaries
ϕ2L5-L6	240	Branch breakers	Uniservo supplies

2-256. Occasionally an unusual sequence of indications follows:

(1) The D. C. ON light and the ready light go out.

(2) One to two minutes later, the yellow ready light comes on.

(3) The HEATERS ON, and ready lights immediately go out.

This sequence may result from the difference in response times of the armature of RP8 and the hold contact of the a-c contactor. When the airflow switches open, the a-c contactor and RP8 are deenergized, but RP8 responds much more quickly than the larger contactor. Consequently the airflow-switch bypass contact of RP8 may close, maintaining the ground connection on the contactor before the contactor has completely opened. The a-c—to—d-c interlock contact of RP8 deenergizes the d-c contactor in the normal manner. After a short delay, the thermal element reenergizes RP8. When RP8 is energized, it lights the ready lamp, reconnects dc, and opens the airflow-switch bypass contact to drop out the a-c contactor again. This time, however, the bypass circuit does not close before the hold circuit on the a-c contactor opens. The circuit opens completely, removing all power except control and standby power.

2-257. Elements of the second branch of the a-c interlock open the interlock by deenergizing relay RP20, the two poles of which disconnect the ground-return of the interlock and light the T (thermostat) indicator lamp on the supervisory control panel. This branch also contains 18 bay thermostats, two emergency power-shutoff switches, and auxiliary switches associated with all the a-c and d-c branch breakers except the control power breaker. If any one of these elements opens the interlock, all the indications previously mentioned (the D. C. ON, ready and HEATERS ON lamps out, STANDBY POWER (HEATER) neon lighted) are present. Further, when the T (thermostat-fault indicator) lamp is lighted, all of the 17 neon indicators mounted on the back of bay P down to and including the one causing the fault will be lighted.

2-258. Figure 2-33 shows the circuit that controls the neons on bay P. Bimetallic resettable thermostats are mounted at the tops of all bays in the Central Computer and power supply and at the tops of the HJ and BC corners. These thermostats protect the equipment from local overheat. When a hot spot develops, the thermostat opens the interlock to turn off the ac, and to light the T lamp and one or more indicators in bay P. As figure 2-33 shows, all of the indicator neons are normally grounded on both sides. The common ground line on the side to which the thermostats connect is also the ground return for a 110-volt a-c line (ϕ1L6). When a thermostat responds to a hot spot, it opens the ground line, but leaves the neons above it in the circuit connected to the power source. These neons light, but only the lowest one in the conducting group is significant. Once opened, a thermostat remains open, until it is reset manually, to prevent the power from being restored.

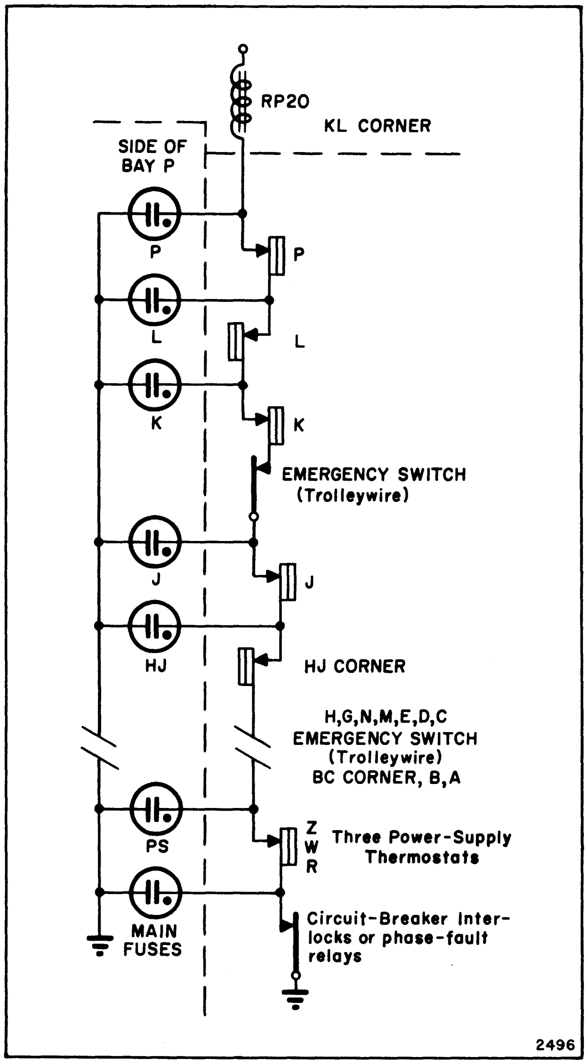

Figure 2-33. Thermostats and Indicators

2-259. Figure 2-33 shows the exact order in which the switches are wired. The emergency power-shutoff switches are mounted at both ends of the Central Computer and are opened when the emergency cord is pulled. The emergency cord extends the length of the computer, underneath the roof sheet. If the cord is pulled down and held, the indicator for bay K will light. After a short delay the main fuse indicator (MFI) will light.

2-260. Any one of the three power-supply thermostats lights the PS indicator neon on bay P. The bottom neon (MFI) of the string is lighted when any one of the overload circuit breakers in the power installation opens (except the control power breaker).

2-261. In installations where fuses are used instead of circuit breakers, phase-fault relays are connected across each phase. As long as each power phase is present, the relay contacts close the a-c interlock. If a power phase is not present, a main fuse blows; the fault relay opens the a-c interlock and lights the MFI neon.

2-262. D-C INTERLOCK

2-263. The d-c interlock is in series with the D. C. OFF buttons. It turns off dc by opening the power line to the control relay RP10A through the closed contact of relay RP8. In addition to turning off dc, most of the elements in this interlock provide indications for the technician to trace sources of trouble. The circuit elements are illustrated in figure 2-34.

2-264. The only normally open contact in this series is the long-tank overheat relay, RP23. As soon as control power is turned on, ϕ1L6 energizes this relay (figure 2-7) to close the interlock. If any long tank becomes overheated, RP23 drops out to cut power to the tank heating coils and to open the d-c interlock.

2-265. Four of the relays whose contacts are in the interlock line are energized by the a-c and d-c fuse-fault systems. These are:

(1) RP6, positive d-c fault relay.
(2) RP7, negative d-c fault relay.
(3) RP16, the heater primary alarm relay.
(4) RP17, the d-c—transformer primary alarm relay.

The fuse-fault systems not only protect the equipment and isolate power failures but also provide an indication at the supervisory control panel of the type and location of the failure. Alarm fuses are used to open the d-c interlock and to light the fault indicators. The alarm fuses have three terminals. Normally the current through the fuse passes from the input terminal through a coiled spring and a fusing-metal contact, to a leaf-spring member, and then to the load terminal. When the fusing metal melts, the circuit from source to load is broken, and the leaf spring is released. The leaf member springs down and connects the source voltage to the alarm contact on the fuseboard. The source voltage is then applied to the alarm circuit.

2-266. If the load current exceeds the current rating of the largest available grasshopper fuse, a cartridge fuse of the required capacity is used instead, with an alarm fuse of about 1/10 the capacity paralleled across it. If the cartridge fuse blows, all the current is shunted through the alarm fuse, which opens the normal circuit and closes the alarm circuit. Both primary and secondary circuits of all transformers, except the standby-power heater transformers, are fused. Alarm circuits for these primary and secondary fuses present separate trouble indications in order to facilitate locating the trouble.

2-267. There are two types of primary fuses, a-c and d-c. The a-c type is associated with the primary circuits of the transformers which provide power for heaters and for the blower motors. The fuses are mounted on fuseboards on the side of bay P. The alarm contacts of these fuses light the P lamp (green) on the

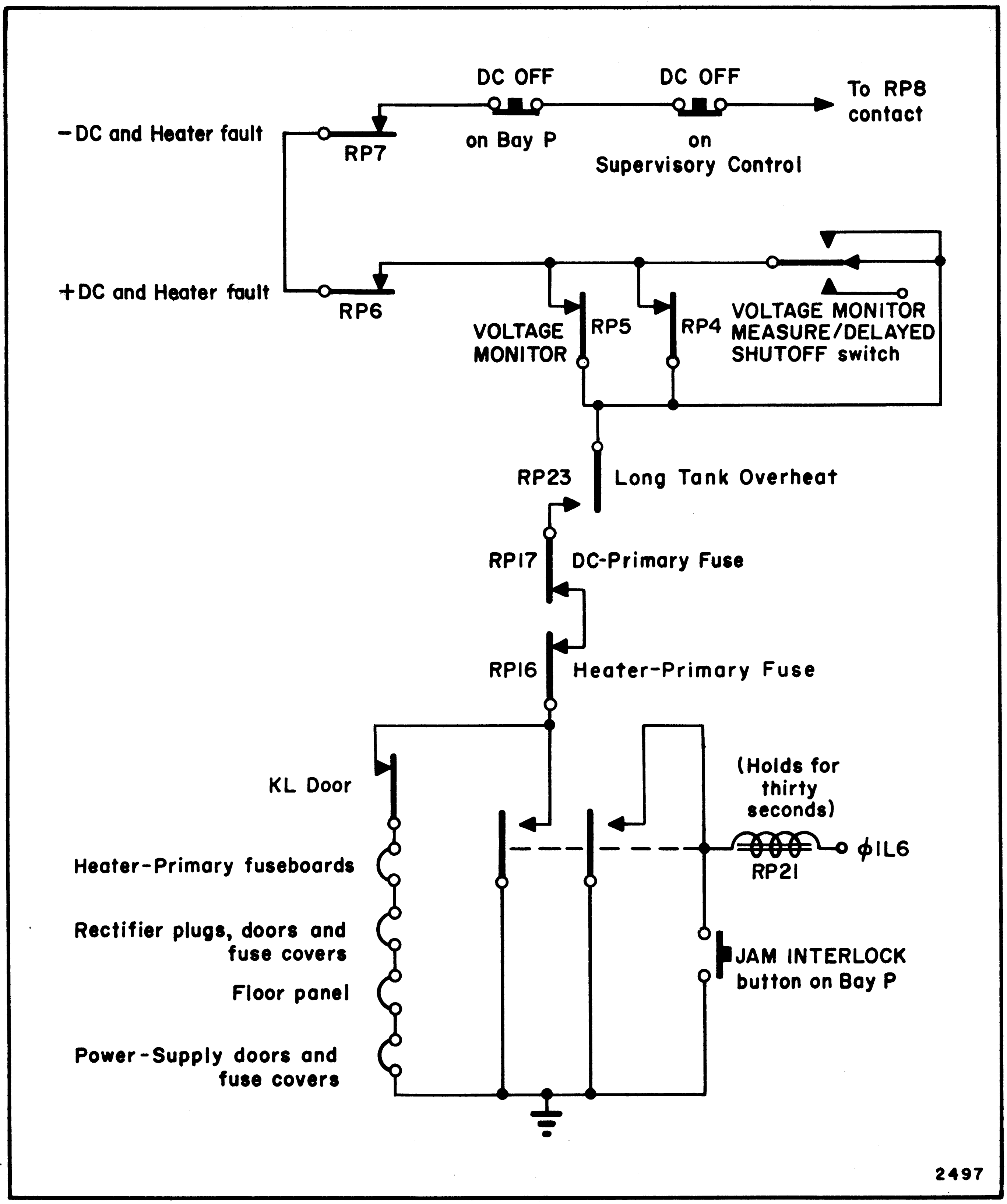

Figure 2-34. D-C Interlock

control panel. The d-c type is associated with the primary circuits of the transformers from which the rectifiers derive power. These fuses are located inside the power-supply cabinet on the back of bay R (figure 1-25). The alarm contacts of these fuses light the P lamp (red) on the control panel.

2-268. The two primary-alarm circuits are similar. Only the notations differ, as shown in figure 2-35, where ϕ1L1, ϕ1L2, ϕ2L1, ϕ2L2, RP17, RP19, and heater primary fault apply to the d-c primary alarm, and the signals and relays noted directly above the d-c system, plus the AC PRIMARY FAULT indicator, apply to the a-c—primary alarm circuit.

2-269. When a primary fuse blows, its alarm contact connects the line voltage to a primary-interlock relay (either RP16 or RP17) through one of the eight primary-alarm buffers. There are four primary-alarm buffers for ac and four for dc. These eight buffers are small selenium stacks, which are mounted on the right side of the KL corner (figure 2-7). They prevent simultaneous fuse failures from short circuiting the input power lines.

2-270. When an interlock relay is pulled in by a fuse fault, one of its two contacts opens the d-c interlock to turn off power. The other contact grounds the coil of an alarm relay (either RP18 or RP19) and lights the associated primary-fault indicator lamp on the control panel. The alarm relay has one contact that closes a hold-circuit to ground through the PRIMARY FAULT RELAY RESET switch on the supervisory control panel. Since power to the +48-volt relay is not turned off by opening the d-c interlock, the alarm relay remains energized, and the indicator lamp remains lighted, until the PRIMARY FAULT RELAY RESET switch is pushed down to break the ground connection.

2-271. When a primary fuse blows, the various indications presented by the alarm circuits guide the search for the fault. Figure 2-36 shows the primary alarm circuits in block form.

2-272. The d-c primary alarm (red indicator lamp on the panel) is actuated by the failure of fuses in the primary circuits of the rectifier transformers. All of these fuses, including those for the HJ-corner supply, are located on four fuseboards on the back of bay R in the power supply. The flag on the alarm fuse indicates the fuse fault. A label beside each fuse states the location of the transformer, the input of which passes through the fuse. For example, Z2 refers to a transformer mounted on tray 2 of bay Z. At the bottom of each of the four d-c primary fuseboards is an alarm fuse marked R2. Each of these is in parallel with one of the heavy cartridge fuses on the nonstandard fuseboard to the right of the group. In figure 2-36, fuseboards and cartridge fuses are numbered to show which of the special alarm fuses is in parallel with each cartridge.

2-273. All other primary fuses actuate the a-c primary alarm (green indicator lamp on the panel). Most of these fuses are in the primary circuits of heater transformers. Exceptions are the blower fuses and the d-c primary fuse for the +48-volt relay supply. Since this voltage operates the alarm circuits, it must remain on after dc has been turned off. For this reason, primary

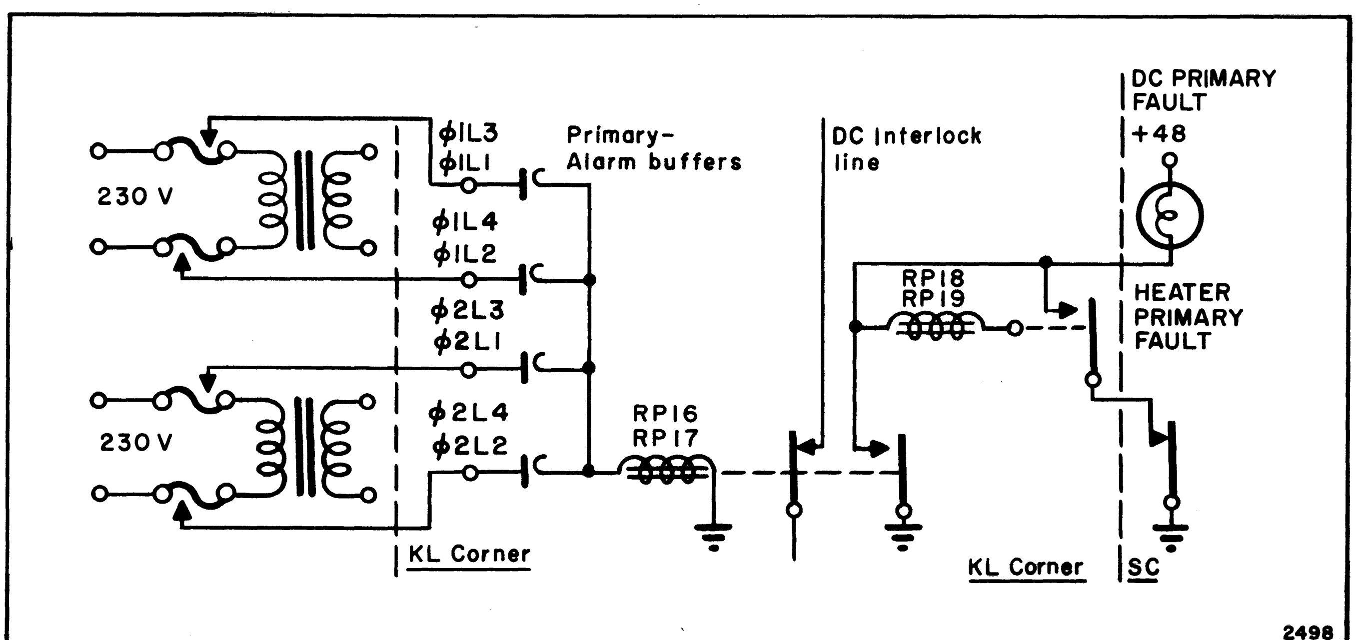

Figure 2-35. Primary Alarm Circuit

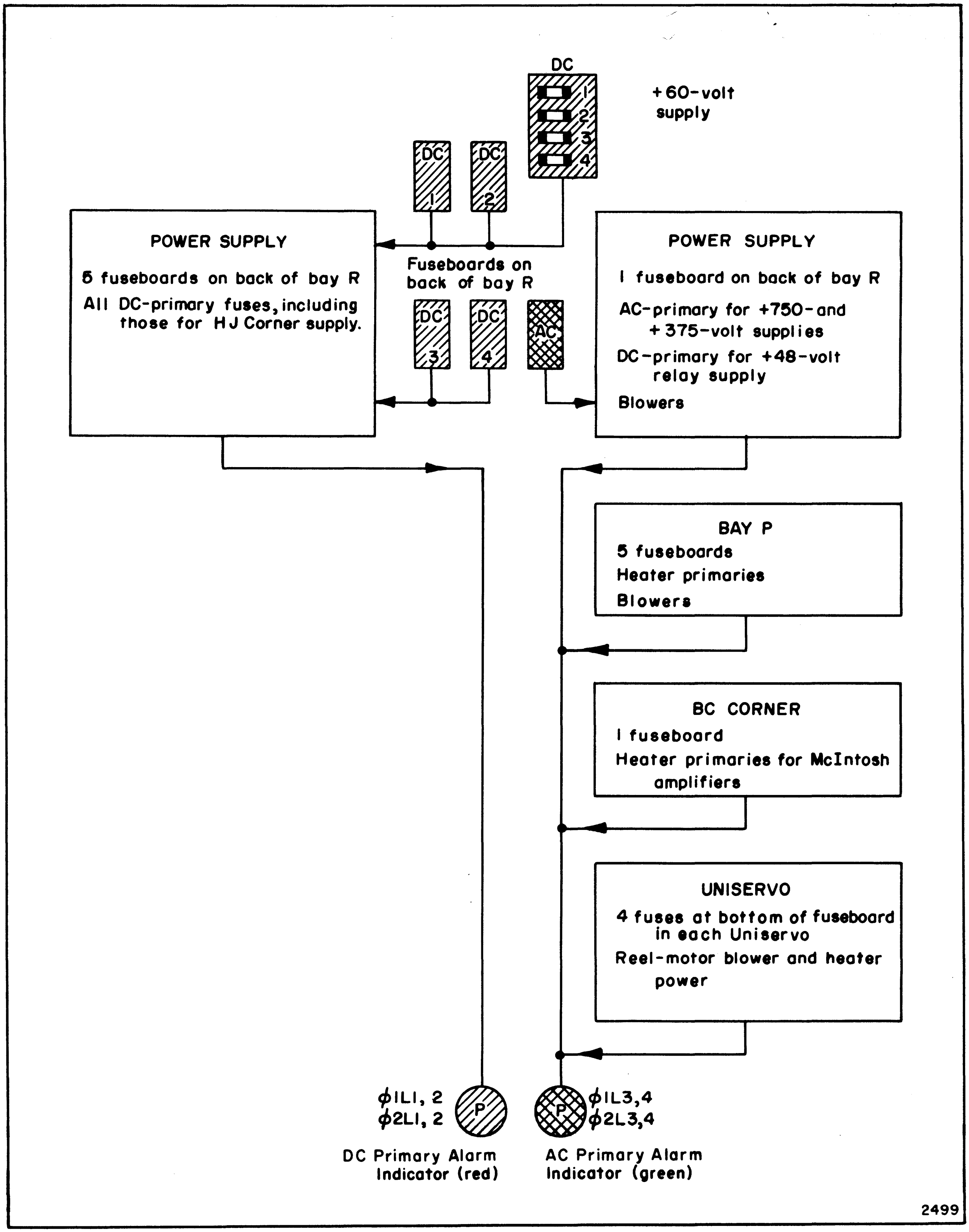

Figure 2-36. Primary Alarm Indicators

voltages for this circuit are supplied by ϕ1L3 and ϕ1L4, fuses of which actuate the a-c primary alarm.

2-274. When an a-c primary alarm (green) is indicated, check the fuses on the side of bay P first, since most of the fuses that actuate this alarm are located here. Check other locations in order of their convenience: BC corner (figure 1-14), the power supply at the back of bay R, and the Uniservos.

2-275. Both the primary power circuits and the secondary circuits are fused. Heater transformers are mounted adjacent to the bays they service, and fuses for their secondaries are mounted in fuseboards 13 and 14 on the sides of each section. In the d-c lines there are fuses at several points in the circuit: in the power supply between rectifier and bleeder and at the taps of the bleeder; in the Central Computer, at the section in which the particular voltage is used. At these fuse points are alarm fuses, either alone or in parallel with cartridge fuses. All alarm contacts on one side of a bay are connected to a common line of the fuse-fault circuit. There are two alarm lines for each bay, one for channel 13, and the other for channel 14. Channel 13 is negative, and channel 14 is positive. When an alarm fuse opens, its contact connects the alarm line to the supply voltage normally passed by the blown fuse. The other end of the alarm line is connected through an alarm relay, either RP6 or RP7, to an unfused alarm-voltage source (AU), as shown in figure 2-37. A contact of the d-c FAULT TEST switch on the supervisory control panel is also included in the circuit.

2-276. This circuit draws enough current through the alarm relay to energize the relay and open the d-c

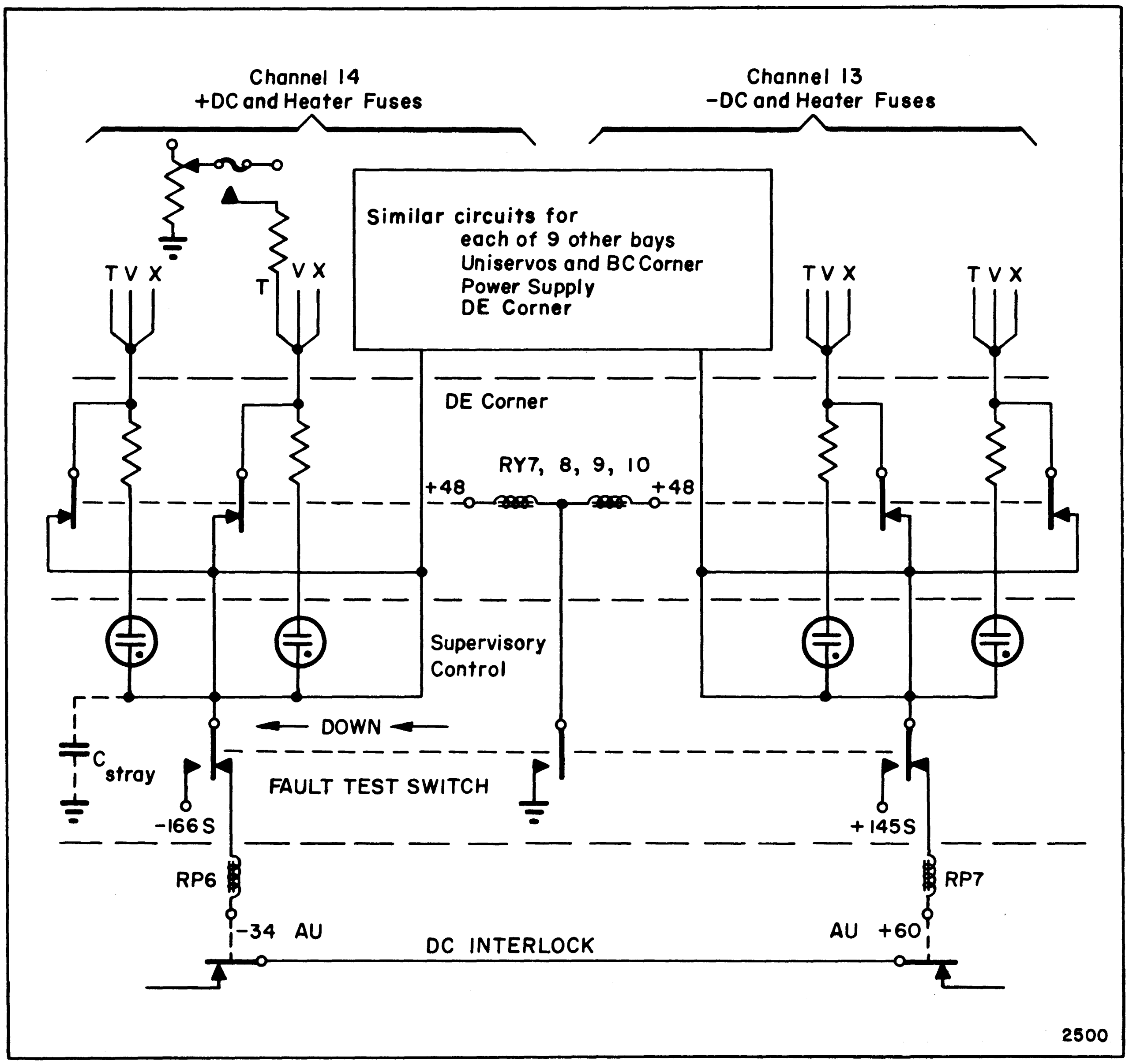

Figure 2-37. D-C and Heater Secondary Fuse-Fault Circuit

interlock circuit. As soon as dc goes off, the alarm relay opens to close the interlock circuit. The alarm voltages (+48, -166S and +145S) are not turned off by the d-c interlock.

2-277. When the d-c FAULT TEST switch (shown in figure 2-37) is pushed down it disconnects the alarm lines from the alarm relay and connects these lines to standby voltage sources.

CAUTION

Do not push the FAULT TEST switch down while dc is on. If the switch is pushed down while dc is on, the stray capacitances on the long lines between the switch at the control panel and the fuse circuits in the computer charge to -166 volts. Releasing the switch may cause a pulse to be applied to the associated fault interlock relay. If the amplitude of the pulse is sufficient to pull in the relay and open the interlock, dc will be turned off.

Another pole of this switch energizes the four fault-test relays, RY7, RY8, RY9, and RY10, in the DE corner. Each contact of these relays normally shorts out one of the d-c and heater-fault indicator neons on the control panel. When the relays are energized, this short circuit is opened. Any neon connected to a blown alarm fuse will light, since it is bridged between -166S and ground and +145S and ground through the power-supply bleeder. The indicator neons are mounted in two horizontal rows. Those in the upper row are connected to the positive-alarm system (fuseboards 14), and those in the lower row to the negative-alarm system (fuseboards 13). Therefore, by pushing down the d-c FAULT TEST switch, the operator can determine in which bay the overload occurred, and also on which side of the bay the blown fuse is mounted.

2-278. As shown in figure 2-37, neons for indicating fuse faults in the Uniservos, the power supply, or in the DE corner are also connected to the supervisory control panel.

2-279. Either of the two interlock relays, RP6 or RP7, requires between 1 and 2 milliamperes of current before it will operate. No alarm-fuse contact may draw more than 2 milliamperes through the relay coil. For this reason, the alarm contacts are connected to the alarm line through a series of constant-current resistors shown in figure 2-38. The resistors are mounted between alarm contacts, directly on the backs of the fuseboards. The value of each resistor is such that the circuit will never draw more current than the sensitive relay will stand.

2-280. A variation of the circuit, used for heater-secondary fuses, is illustrated at the bottom of figure 2-38. One side of the heater secondary is connected to the d-c potential present on the cathodes of the tubes to which the transformer supplies heater voltage (figure

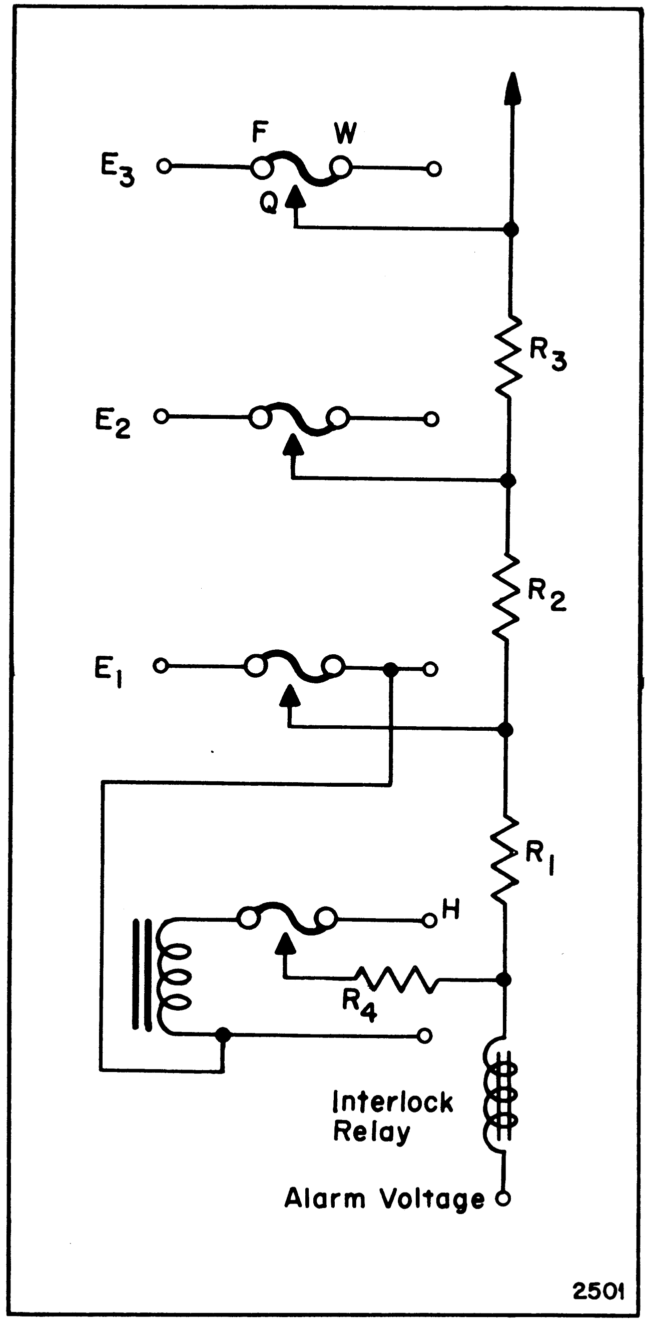

Figure 2-38. Constant-Current Circuit

1-12). This d-c voltage energizes the interlock relay, whenever the d-c supply or the heater supply is overloaded. Consequently, resistor R4 is made equal to resistor R1 (figure 2-38), so that the current will be limited correctly in either case.

2-281. The voltage monitor turns off dc when the MEASURE/DELAYED SHUT-OFF switch is pushed down. If the monitor circuit detects an off-tolerance voltage, it energizes relay RP5. Thirty seconds later, relay RP4 also closes. One contact of each of these relays is in the d-c interlock line. The two contacts are connected in parallel. If both relays are energized, the interlock opens to turn off dc.

2-282. When the MEASURE/DELAYED SHUT-OFF switch is not pushed down, these contacts are short-circuited and dc is not turned off. If the switch is released during the 30-second period between the energizing of RP5 and RP4, the interlock circuit will remain closed, and dc will not be turned off. The two relays are cleared by the VOLTAGE MON. FAULT RELAY RESET switch which closes the interlock. The dc is then turned on from the supervisory control panel.

2-283. The remaining elements of the d-c interlock circuit, the interlock switches on the doors and floor panels in the Central Computer and the power supply, and connections through the fuseboard covers, are wired directly into the interlock line. In each bay of the Central Computer the interlock line traverses the two rectifier plugs that connect the protective diodes to the fuseboards. (Refer to paragraph 1-49.) Switches in the interlock line are opened by each bay door, the door to the KL corner, and the floor panels in both units. Also, when a fuseboard cover is removed or a rectifier plug is disconnected, the d-c interlock is interrupted.

2-284. Figure 2-39 shows a complete bay interlock circuit. The line enters each bay through the rectifier connector on the left side. From there it goes to a phono-pin connector at the top of fuseboard 13T. The removable plastic covers that guard each fuseboard are fixed in place by means of phono-pin connectors; the two jacks, one at each end of cover, are joined by a wire that completes the interlock line. On computers that have three doors per bay, the bottom connector on fuseboard 13T is connected through a door switch to the top end of fuseboard 13V, and 13V is similarly connected to 13X. The connection between fuseboards is made directly. Connection is made from 13X to 14X through a door switch on all models. The line then passes up through fuseboards 14X, 14V, and 14T, through the connectors at the right side, into the low-speed harness, and on into the next bay. In this manner the interlock traverses all door switches, fuseboard covers, rectifier plugs, and floor panel switches in the Central Computer and power supply.

2-285. If it becomes necessary to operate the computer with any of its doors open, push the black jam-interlock button on the side of bay P. This button energizes relay RP21 for 30 seconds. See figure 2-34. One contact of this relay forms a holding circuit for the 30-second period. The other bypasses the interlock switches of all doors, fuseboard covers, and rectifier plugs. During this period the operator jams the interlock switches on the doors he wishes to leave open. A switch is jammed

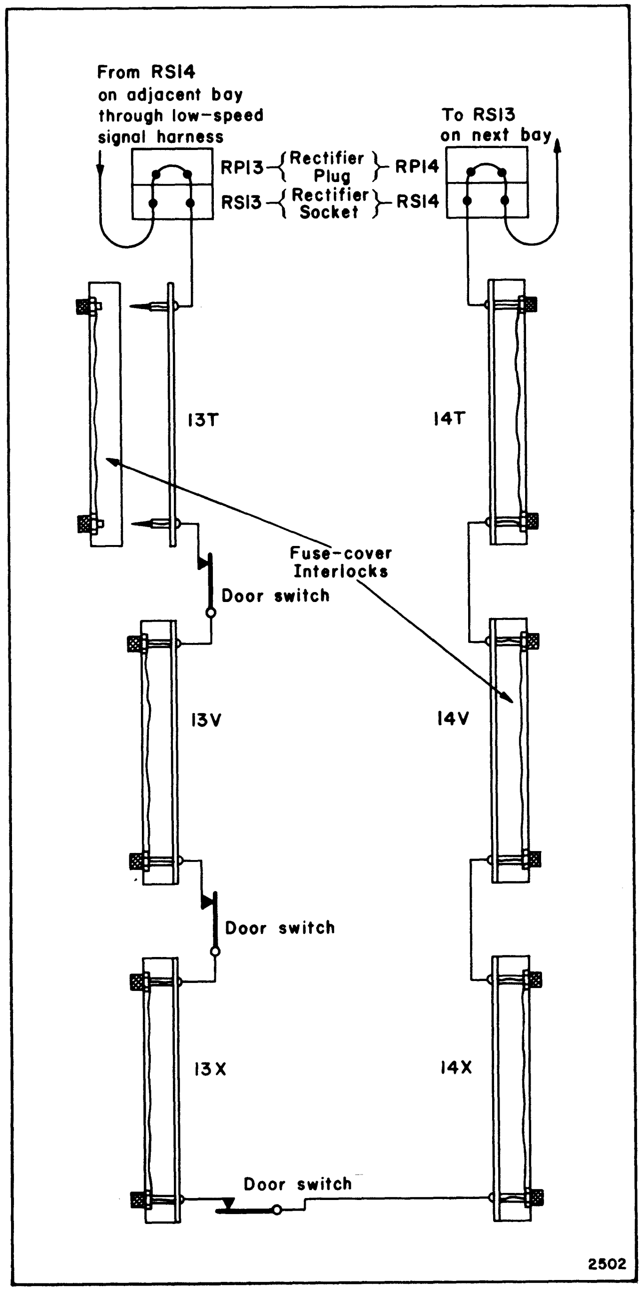

Figure 2-39. Bay Interlocks

closed if the switch button is pulled out until it catches. The switch is restored automatically as soon as the door is closed.

2-286. Table 2-6 analyzes some typical failures and indications that occur in the power-supply system. In all cases a failure opens either the a-c or the d-c interlock circuit to turn off power and energizes an indicator.

2-287. MARGINAL CHECKING

2-288. The marginal checking process is a means of forcing weak components on the verge of failing to become inoperative during a scheduled maintenance pe-

Table 2-6. Power-Supply System Failures

Symptom	Indication on Supervisory Control Panel	Source of Failure
DC off (red D.C. ON light out)	Any top row D.C. FAULT INDICATORS neon lighted	+D-C fuse, or heater fuse, in indicated bay
DC off	Any bottom row D.C. FAULT INDICATORS neon lighted	–D-C fuse, or heater fuse, in indicated bay
DC off	POWER SUPPLY neon lighted	D-C fuse in power supply
DC off	Upper BAY H neon lighted	Fuse in HJ corner or +d-c fuse in bay H
DC off	UNISERVOS neon lighted	Fuse in BC corner or in a Uniservo
DC off	DE CORNER neon lighted	Fuse in DE corner
DC off	Voltage monitor HIGH or LOW jewel, voltage monitor abnormal (red) jewel, and one pair of voltage-monitor selector jewels lighted	Voltage-monitor automatic shutoff, due to excessive deviation in voltage levels
DC off	Red P jewel lighted	Power supply d-c–primary fuse
DC off	Green P jewel lighted	A-C fuses in Uniservos, a-c fuses in BC corner, blower fuses, a-c line fuses in power supply, or heater-primary fuses (side of bay P)
DC off	None	Door interlock open, fuse covers off, interlock open, or emergency OFF button at left of entrance door pushed in
AC and dc off (red D.C. ON and green HEATERS ON jewel lights out)	White T jewel lighted	Emergency shutoff cord held, or bay thermostat
AC and dc off	White T jewel and all neons on back of bay P lighted	Main fuse (MFI is bottom neon), phase-fault relays, or Uniservo-primary phase fault
AC and dc off, yellow ready jewel light out	Only orange control-power jewel and STAND-BY POWER neon lighted	Airflow switches
AC, dc, and control power off	Everything out on the control panel and in computer except convenience outlets and control typewriter	ϕ1L6 or ϕ1L7 at power installation
AC, dc, and control power off	A-C, d-c, and control power jewel lights glowing weakly	ϕ1L6 in power supply
Short-tank heaters off	STAND-BY POWER neon out (upper left corner), HEATERS-SHORT TANKS neons out, three of the six meter-movement relays in DE corner tripped	Short-tank overheat
Long-tank heaters off, dc off	STAND-BY POWER (HEATER) neon out (lower left corner), D.C. ON jewel light out, neon lighted on one of the long tanks	Long-tank overheat
Long-tank heaters off	STAND-BY POWER (HEATER) neon off	ϕ1L8 or ϕ1L9 out at power installation
Uniservos will not operate (ac and dc on)	UNISERVO SCREEN FUSE neon out, screen-fuse neon in BC corner lighted	Uniservo screen fuse
Typewriter off, convenience outlets dead	Lights inside the computer and power supply off	ϕ1L5 out at power installation

riod. Detecting and replacing such components during the maintenance period reduces the number of interruptions during operations.

2-289. Marginal checking requires that the computer operate under abnormal conditions. As long as abnormal conditions continue, most of the components defined as marginal cannot operate correctly. A test routine run through the processing circuits will show failures of the marginal tubes by the occurrence of errors. The failures are isolated in the usual way and corrective action is taken during the maintenance period.

2-290. Defective vacuum tubes are the major source of circuit failures in the computer. The life of a sample lot of vacuum tubes is divided into three periods:

(1) Within the first 200 hours, substandard tubes fail.
(2) During the next 5000 hours, there are few failures.
(3) During the period from 5000 to 30,000 hours, the standard tubes fail.

2-291. Tubes fail during the first 200 hours because of interelectrode short circuits or open heater circuits. These failures are easy to locate, since they make the circuit inoperative. No means has been found for predicting these types of tube failure.

2-292. Most tubes (80 percent) become defective after a long time because of decreasing emission. This is a recognized and predictable characteristic of vacuum tubes and was taken into account in the design of the computer. The circuits were designed to tolerate one-half normal tube emission. Correspondingly, the Univac Tube Tester (paragraph 3-36) was designed and calibrated to rate tubes as GOOD (over half-emission) or BAD (half-emission or under).

2-293. Marginal tubes are prospective sources of trouble when heater voltage is reduced, a condition that reduces emission. When the MARGINAL CHECK switch is pushed, it disconnects the fourth contactor in the slow heater-turn-on circuits. The voltages applied to the heater transformers are then reduced from an operating value of 230 volts to approximately 200 volts. The heater-turn-on circuit controls the heater voltages applied to all tubes except the long-tank i-f, 7AK7 modulator and the cathode follower. Since no test routine can check the computer unless the memory functions properly, these tubes are excluded from this check. They are checked separately for marginal conditions. The bias on the 6AK5 amplifier tubes is increased by the I.F. BIAS CONTROL switch. (See paragraph 2-95.) Advantages of regular marginal checking are:

(1) Intermittent errors are made to occur as failures. The time required to find a failure is less than the time required to find an intermittent error.

(2) Weak tubes are forced to fail during a scheduled maintenance period.

(3) Defects other than low emission may be discovered. (Weak input signals which result from defective diodes or poor timing are discovered during the marginal check.)

(4) Routine tube checks reject the tube at one-half emission. Marginal check shows when a tube is barely adequate in the actual circuit under normal conditions.

2-294. Additional components and a few changes in physical layout are necessary to equip the computer to perform the marginal check without reducing the voltage of the five tubes of the long-tank recirculation loop:

(1) Five special heater transformers for these tubes are mounted on top of the regular transformers in the memory sections.

(2) An extra heater-primary fuseboard for the heater transformers is placed on the side of bay P.

2-295. REPEAT-OPERATION SWITCHES

2-296. When troubleshooting the Central Computer it is necessary to repeat the dynamic conditions in which an intermittent fault occurs. In the arithmetic and other central processing, sequencing, and control circuits, the development of a trouble can be observed on an oscilloscope if the exact conditions under which the trouble develops are repeated.

2-297. The interrupted-operation switch (IOS), discussed in paragraph 2-109, enables the parts of an instruction or a programmed routine to take place one program-counter (PC) step at a time, one operation at a time, one addition at a time, or one complete instruction at a time, each time the start bar is pressed.

2-298. Two repeat-operation switches, the RETAIN C/RETAIN INSTRUCTION switch on the supervisory control panel and the retain-PC switch in the computer, enable the repetition of one instruction or one instruction pair, or of one program-counter step of an instruction.

2-299. When either repeat-operation switch is used during operation and the interrupted-operation switch is in the continuous (center) position, a segment of a routine is repeated at computer speed. Conversely, when either repeat-operation switch is used and the interrupted-operation switch is not in the continuous position, a segment of a routine can be repeated every time the operator presses the start bar. In each case the segment is repeated because a controlling number is retained in either the cycle counter, the program counter, or the control counter.

2-300. The number is held in one of three ways. The RETAIN INSTRUCTION position of the RETAIN C/RETAIN INSTRUCTION switch prevents the cycle counter from stepping. (See paragraph 2-301.) The retain-PC switch (paragraph 2-307) blocks the program counter from stepping. The RETAIN C position of the RETAIN C/RETAIN INSTRUCTION switch suppresses the normal sequence of adding 1 to the number in the control counter. (The retain-PC switch is useful in troubleshooting multiply-divide intermittent errors in conjunction with the IER/OR switch.)

2-301. RETAIN C/RETAIN INSTRUCTION SWITCH

2-302. The RETAIN C/RETAIN INSTRUCTION switch, a three-position locking telephone-key switch, is in the upper left section of the supervisory control panel. In the RETAIN C position it retains the control number stored in the control counter, forcing the repetition of the same operating cycle and the same pair of programmed instructions. In the RETAIN INSTRUCTION position it retains the control number stored in the control counter, and prevents the retain-CY relay from stepping the cycle counter, forcing the repetition of the same instruction.

2-303. The following function signals are affected by a retain-C or a retain-instruction operation:

Signal 201, which allows read-in to the control register,

Signal 203, which sends information through control register 2 so that the 6 least-significant digits will be set up in the static register by an ending pulse,

Signal 204, which sends information from the control register to the static register so that when the ending pulse occurs, the 6 most-significant digits will be set up in the static register,

Signal 212, which sends the control-counter reading to the adder to be increased by 1,

Signal 436, which alerts the adder odd-even check circuits (subtrahend and minuend) and the adder-comparator check circuit.

Signals 203K and 203L are dummy lines, used only in the function-signal checker.

2-304. Table 2-7 shows the effect of the switch on the function signals of each cycle-counter stage.

2-305. See also figures 2-40 and 2-41.

2-306. It is inadvisable to retain C if a transfer-of-control instruction (Q, T, or U) is one of the instruction pair, since these instructions can clear the control counter, and read a new number to it, through signals not affected by the RETAIN C/RETAIN INSTRUCTION switch.

2-307. RETAIN-PC SWITCH

2-308. The retain-PC switch, a two-position toggle switch on bypass board C of section DX, retains only the reading of the program counter. As figure 2-42 shows, the switch opens the stepping-input circuits of both program counters. Function signals present are retained with the retained program-counter readings. Unlike the RETAIN C/RETAIN INSTRUCTION switch, retain-PC does not force the recurrence of an identical set of operating signals. The clearing inputs

Table 2-7. Signals Affected by the RETAIN C/RETAIN INSTRUCTION Switch

Cycle-Counter Stage	Function Signals					
	For Normal Position		For RETAIN C Position		For RETAIN INSTRUCTION Position	
	Present	Inhibited	Present	Inhibited	Present	Inhibited
Alpha	201 203	—	201 203	—	201 203 203K 203L	—
Beta	201 204 212 436	—	201 204	212 436	203 203K	201 204 212 436
Gamma	203 203K	—	203 203K	—	203K 204	203
Delta	—	—	—	—	203 203K	—

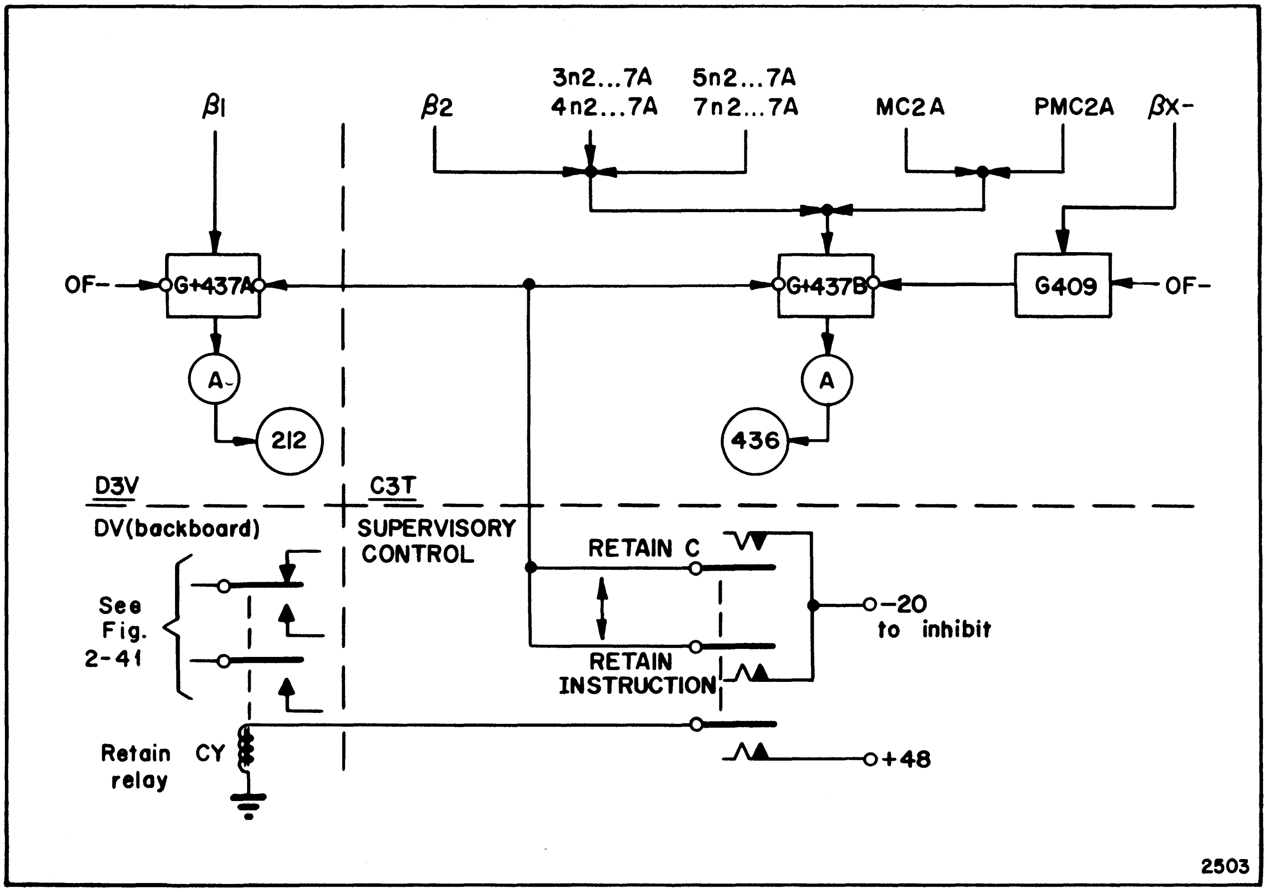

Figure 2-40. Retain C

to the counter are not affected by the switch. As a consequence, any program-counter step that generates a program-counter clearing signal, such as an ending pulse or an improper division signal, is not retained unless the ending-pulse lines are blocked. If normally nonconducting amplifier tube V1 is removed from both position E8T and position E8V, the ending-pulse lines are interrupted. Use of the switch requires a thorough knowledge of the instruction being attempted, since the information signals and operating signals may change as the step is repeated. For example, any of the repetitive steps of division (D3 through D14), or multiplication (MNP5 through MNP15) can be retained, but the operands and the results will change. If the step is repeated many times, the quotient or product will be shifted out of the register, and the dividend or multiplier will be lost. In both cases, the numbers are replaced by decimal zeros.

2-309. Within these limitations, the switch can be used in troubleshooting when it is desirable to repeat one program-counter step of an instruction. For example, consider a trouble which occurs on program-counter step 1 of a Qm instruction. The trouble is occurring during comparison of the contents of register A and register L in the comparator. Examine the suspected circuits with an oscilloscope after:

(1) Retaining program-counter step 1 of the Qm instruction.

(2) Releasing the interrupted-operation switch to the continuous (center) position.

(3) Pressing the start bar.

Program-counter step 1 will be repeated over and over, making it easy to observe with the oscilloscope. To retain program-counter step 2 of a Qm instruction, it is necessary to remove tubes V1 from positions E8T and E8X and block the ending pulse.

2-310. IER-OR SWITCH

2-311. The multiply and divide instructions performed by the Central Computer are broken down into reiterative program-counter steps. Each consists of a series of additions or subtractions. To end one step and set up the next requires a break period, during which any such operation as right or left shift is performed. Lines into and out of the multiplier-quotient counter are switched if necessary, and the quotient digit is collected from gates in the output lines of the multiplier-quotient counter decoder or the multiplier digit is set

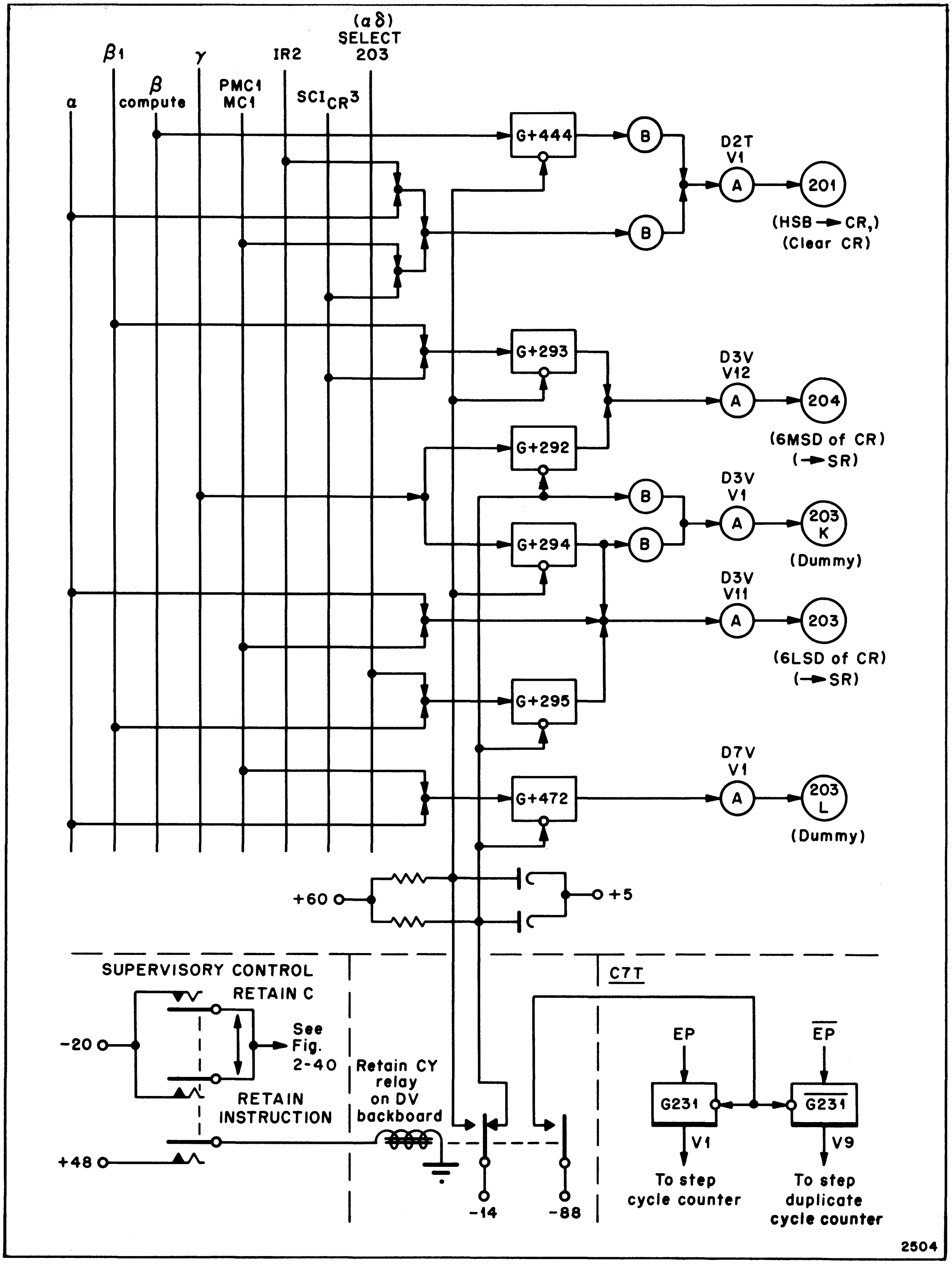

Figure 2-41. Retain Instruction

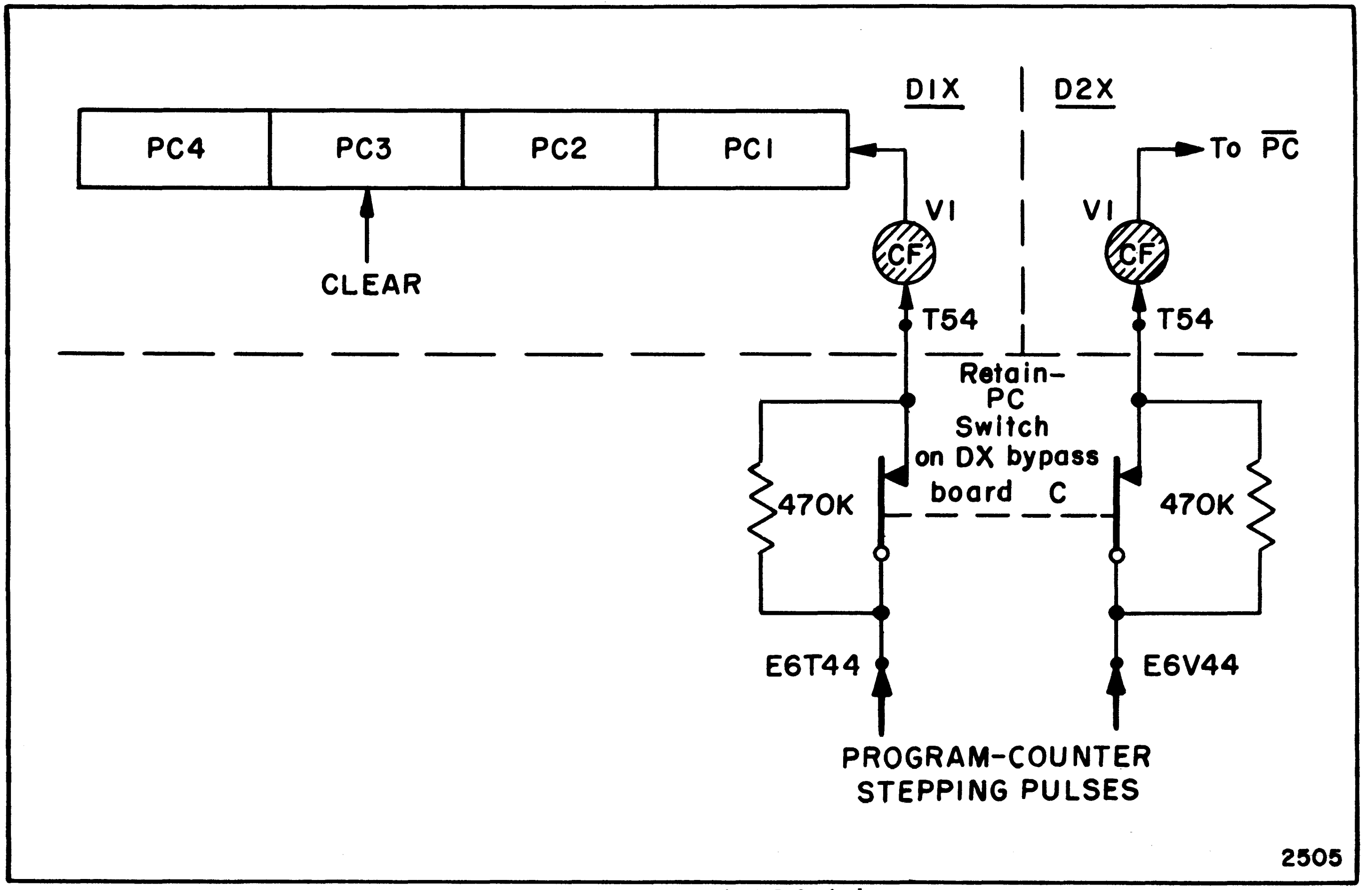

Figure 2-42. Retain-PC Switch

up in the counter. Then the computer performs whatever other changeover operations are necessary.

2-312. These changeover operations are caused by two of a set of three flip-flops in the multiplier-quotient counter, called the IER/OR flip-flops. FF121A, used in multiply instructions, is the IER (multiplIER) flip-flop; FF121B, the OR (divisOR) flip-flop; FF121C, which is set whenever either of the other two is set, is called the IER-OR flip-flop.

2-313. All of the IER/OR flip-flops and associated circuits are duplicated. However, when troubles occur in these flip-flops and the associated circuits during multiply and divide instructions, the program counters get out of step with one other. To check out these circuits requires that they be stepped synchronously. For this reason, the IER-OR switch, mounted on the backboard of H4X, enables either set of IER/OR flip-flops to drive both sets of normally nonconducting drivers. The circuits produce both positive and negative signals. The test switch affects only the negative signals.

2-314. Figure 2-43 shows the connections from one of the three pairs of decks of this three-position rotary switch. In the position marked N (normal), the outputs from FF121A, FF121B, and FF121C are connected to the unbarred drivers, and the outputs from the duplicate (barred) flip-flops FF121A, FF121B, and FF121C are connected to the barred drivers. In the counterclockwise position, marked T, the switch disconnects the barred flip-flops from the circuit entirely and connects the unbarred flip-flops (in H4T) to both sets of drivers. In the clockwise position, marked X, the switch disconnects the unbarred flip-flops and connects the barred flip-flops (in 4HX) to both sets of drivers.

2-315. Analysis of the multiply- and divide-instruction circuitry depends on the ability of the IER-OR switch to connect and disconnect the flip-flops, drivers, and associated circuitry.

2-316. If an improper division signal is generated while the circuit is being analyzed, the effect of the signal as an ending pulse must be nullified. Remove tube V4 from positions E8T and E8V, to block the signal from the control and sequencing circuits.

2-317. If it is necessary to investigate the functions of the IER and IER-OR signals during one of the repeated stages of a multiply or divide instruction, use the IER-OR and retain-PC switches together. The precautions and limitations mentioned in the discussion of the retain-PC switch (paragraph 2-307) apply in this case.

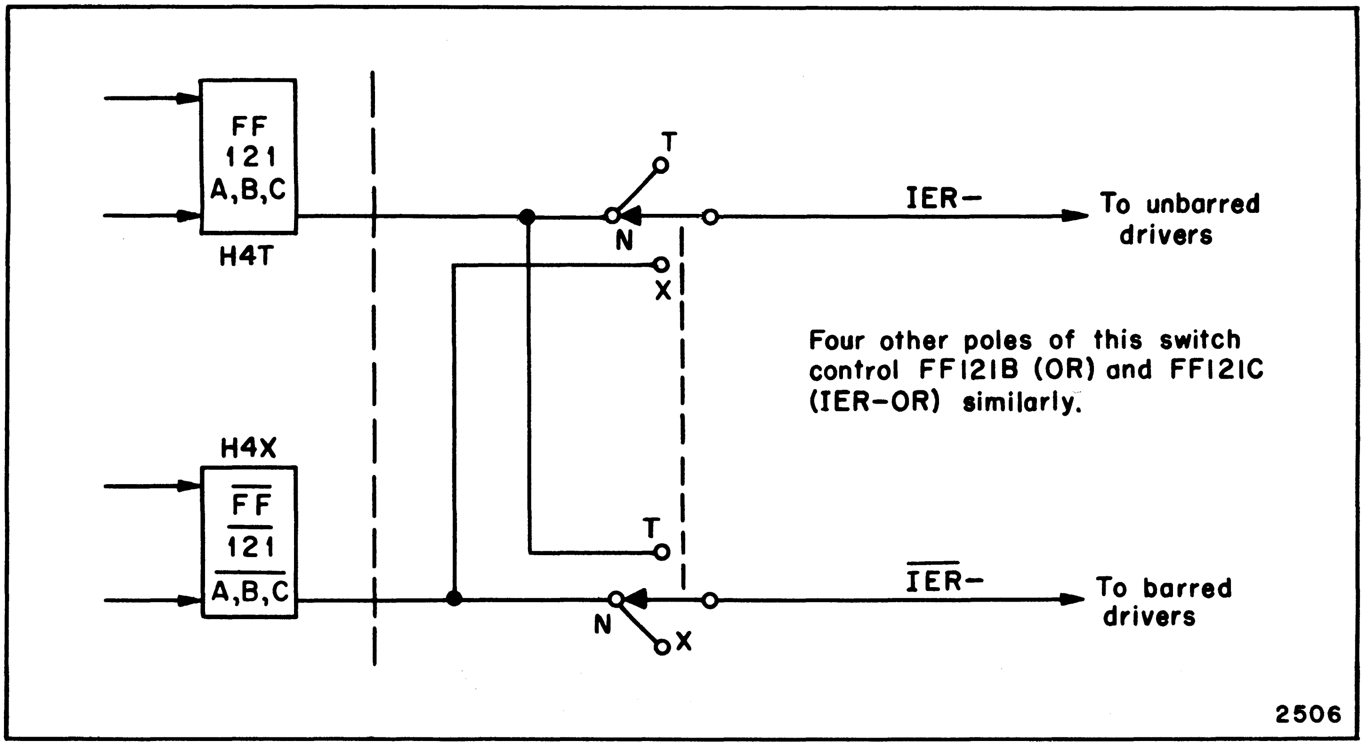

Figure 2-43. IER/OR Test Switch on H4X Backboard

NOTE

The IER-OR switch must be in normal (center) position during computer operation or certain errors will not be detected.

2-318. FUNCTION-TABLE OUTPUT SWITCH

2-319. The function-table output switch (FTO) is used in troubleshooting the function table output checker. The switch is shown in figure 2-44. The checking apparatus consists of three quarter-adders, which total the counts from four binary counters. The binary counters pulsed at t5n depend on the number of function signals present. The checker is of the positive type that registers an error at the beginning of every operating period. If the sum of the function signals at this time is even, the quarter-adders restore the error flip-flops during time out. If the sum is odd, the error is not cleared, and the computer stops during time out.

2-320. During time out, the counting circuit is prevented from stepping by a time-out inhibition on gate G471. When trouble develops in the checker, this inhibition prevents troubleshooting, since the circuit cannot operate without the stepping pulses. The FTO test switch (figure 2-44) holds the counting gates open to bypass the t5n circuit.

2-321. Consequently, the switch enables pulses from the function-signal checking gates to pass and operate the counters and quarter-adders. Check these circuits with an oscilloscope. Observation of errors during the troubleshooting of the instruction-line and the shift-selector checking circuits depends on the fact that this switch can inhibit or alert these circuits.

2-322. FUNCTION-SIGNAL NEON BANK

2-323. The function-signal neon bank is used to analyze trouble in the instruction- and sequencing-control equipment. The panel, or bank, of neons is designed to be fastened to the DE corner (figure 2-15). The panel is as wide as the corner section and less than 2 feet high. It swings forward to show the transformers and other components mounted in the corner (figure 1-15). Every function signal from the main encoder requires an amplifier. When more power is required to drive a circuit than one amplifier can provide, an output line must be split into several branches, each with an amplifier. For example, the four branches of function signal 242, and the amplifier of each, are: 242A (amplifier V8), 242B (amplifier V10), barred 242A (amplifier V7), and barred 242B (amplifier V9), all located on chassis C3T. The barred signals go to duplicated circuits. Each of these amplifiers is connected by a socket and a plug in the DE corner to an associated function-signal neon. Each neon in the function-signal neon bank is marked with the designation of the associated function signal.

2-324. When an encoder amplifier is conducting, its neon lights. (However, when FT161+ amplifier is

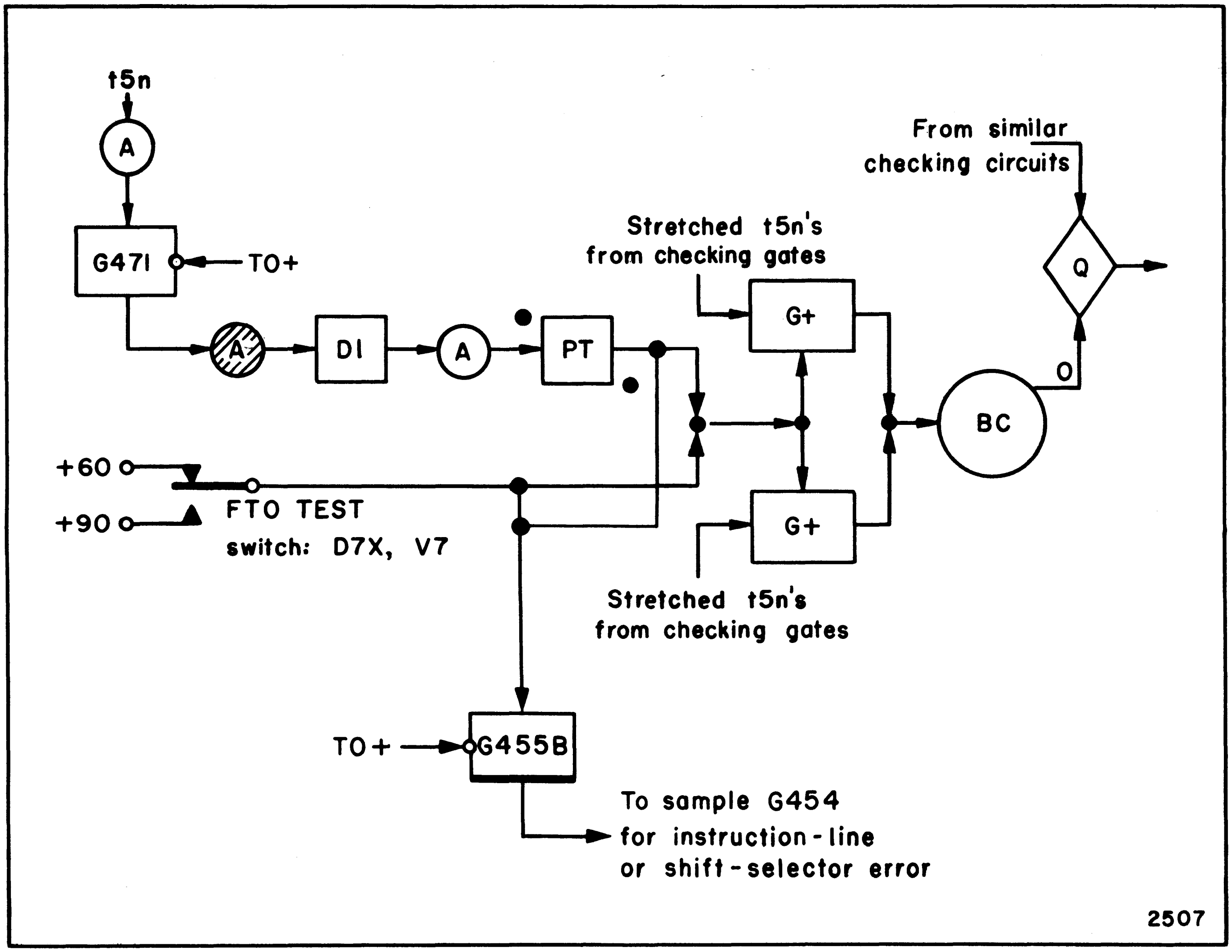

Figure 2-44. FTO Test Switch (D7X, V7)

nonconducting, its neon lights.) The operation of the main encoder can be observed if the interrupted-operation switch is in a noncontinuous (abnormal) position. Hitting the start bar then causes the cycle-, control-, or program-counter to step from one phase of a routine to the next. While this sequence is controlled from the supervisory control console, observe the function-signal neons at DE corner to determine whether the required signals are all present.

2-325. As is the case with any other fault indicator, a spurious error indication may be presented. If the neon does not light when it should, check the neon. If the neon is good, then the circuit should be investigated further.

SECTION III

SERVICING AIDS EXTERNAL TO THE CENTRAL COMPUTER

3-1. GENERAL

3-2. The technician needs servicing equipment outside the Central Computer, in addition to the circuits and controls built in as servicing aids. The external equipment to be discussed in this section is used primarily to inspect operations of the computer, or components lifted from the circuits. If a circuit is tested in the computer, the technician must bear in mind changes in voltage levels and waveforms due to the operation of the computer itself. If accurate analysis is impossible within the computer, then the testing must be done outside.

3-3. Some of the items of external equipment are commercially available in quantities entirely adequate to the needs of the technician (paragraph 3-94). The Univac I system requires some special equipment, however (paragraphs 3-6 and 3-79).

3-4. The equipment commercially available is discussed here only in the light of the requirements of the system. The catalogs and manuals of the equipment manufacturers contain all necessary theory and maintenance information.

3-5. The theory included here about specially designed equipment is sufficient to enable the user to understand the functioning of the unit and its use as a servicing aid. For additional information, the user is referred to the Remington Rand Univac Electronic Services Division.

3-6. SPECIAL TEST EQUIPMENT

3-7. Four major items of test and inspection equipment have been designed specifically as special auxiliary servicing aids external to the computer. Two of these units, the tube tester and the d-c test bench, are manufactured by Remington Rand Univac.

3-8. Two other units, the diode tester and the multivibrator, are not available as assembled instruments, but are simple to build, using readily available components. A recommended circuit is included in this manual with the discussion of each unit.

3-9. The d-c test bench (paragraph 3-14) is useful for troubleshooting any single chassis in the Central Computer. Its power section supplies every heater voltage and d-c potential used in the computer, except the McIntosh anode and standby voltages. No signal source is built into the test bench.

3-10. The Univac Tube Tester (paragraph 3-36) accommodates all tubes used in the Central Computer, and reads GOOD or BAD in accordance with the tolerances of the computer circuits. Several special circuits permit testing thyratrons, checking for interelement shorts, and preheating tubes in quantity.

3-11. The diode tester (paragraph 3-67) measures the characteristics of germanium crystal diodes, under conditions approximating static operating conditions in the computer. It can be used to check any diode, before or after use.

3-12. The test multivibrator (paragraph 3-60) provides a means of repeatedly triggering either the computer start circuit, or the cycling-unit start circuit. The period of the multivibrator is controllable.

3-13. In addition to these test units, other special servicing aids either are available or can be fabricated according to available specifications. They include test tapes, head-calibration tapes, special oscilloscope leads, tube and chassis extenders, chassis- and backboard-contact tools, and socket tools. These are discussed in paragraph 3-79.

3-14. D-C TEST BENCH

3-15. The d-c test bench is an auxiliary aid for servicing and troubleshooting any single chassis in the computer. It is a self-contained unit housed in a cabinet 2 feet square and 6 feet high. It requires either a single-phase 115-volt a-c source, or a 230-volt source, and consumes about 2.7 kilowatts. The following schematic, layout, and wiring diagrams are supplied with the equipment:

C801 398 Resistor panel	C801 401 Left side panel
D801 184 Fuseboard 1	D801 188 Front inner section
D801 187 Fuseboard 2	D801 190 Capacitor section
D801 186 Fuseboard 3	D801 191 Inner section, rear
D801 185 Fuseboard 4	D801 192 Rectifier section

D801 100 Power supply-1	D102 255 Board, insert, test stand
D801 101 Power supply-2	D802 014 Wiring, test bench plugboard
BSK 2274 Power supply-3	D801 189 Test bench front door
PL 441, 442-Parts lists	D801 935 Recirculation amplifier chassis adapter

3-16. The test bench enables maintenance personnel to simulate the operation of the computer around a a single chassis. It measures voltages on a chassis under repair or test, and obviates the possibility of damage to other computer circuits from accidental short circuits or faulty components. Voltages and currents can be measured, but realistic tests of the signal-handling functions of the chassis cannot be made when it is removed from the computer.

3-17. The test bench comprises a power section and a test stand, shown in simplified form in figure 3-1. The power section, which takes up most of the test bench, provides all heater and d-c operating voltages required by any chassis, except the +750-volt McIntosh-amplifier supply, and the standby voltages. The standby voltages are used in the computer itself only in the short-tank heaters and fuse-fault circuits. The +750-volt power is used only as the anode voltage of the McIntosh amplifiers. Heater and d-c operating voltages connect to the test stand, which is made up of a plugboard, a test-point board, and a chassis holder.

3-18. The plugboard is divided into two groups of connectors. One group connects to the pickoff points in the power section. Each connector in this group is labelled with the voltage that it carries. The other group connects to the pins on the backboard of the chassis-holder through the test-point board. Short leads ending in phono-pin connectors link the plugboard sections.

3-19. The test-point board consists of pin jacks, which duplicate the terminals of the chassis backboard. It is convenient for connecting a voltmeter to any chassis terminal.

3-20. The chassis holder is an electrical and mechanical duplicate of a computer backboard with every

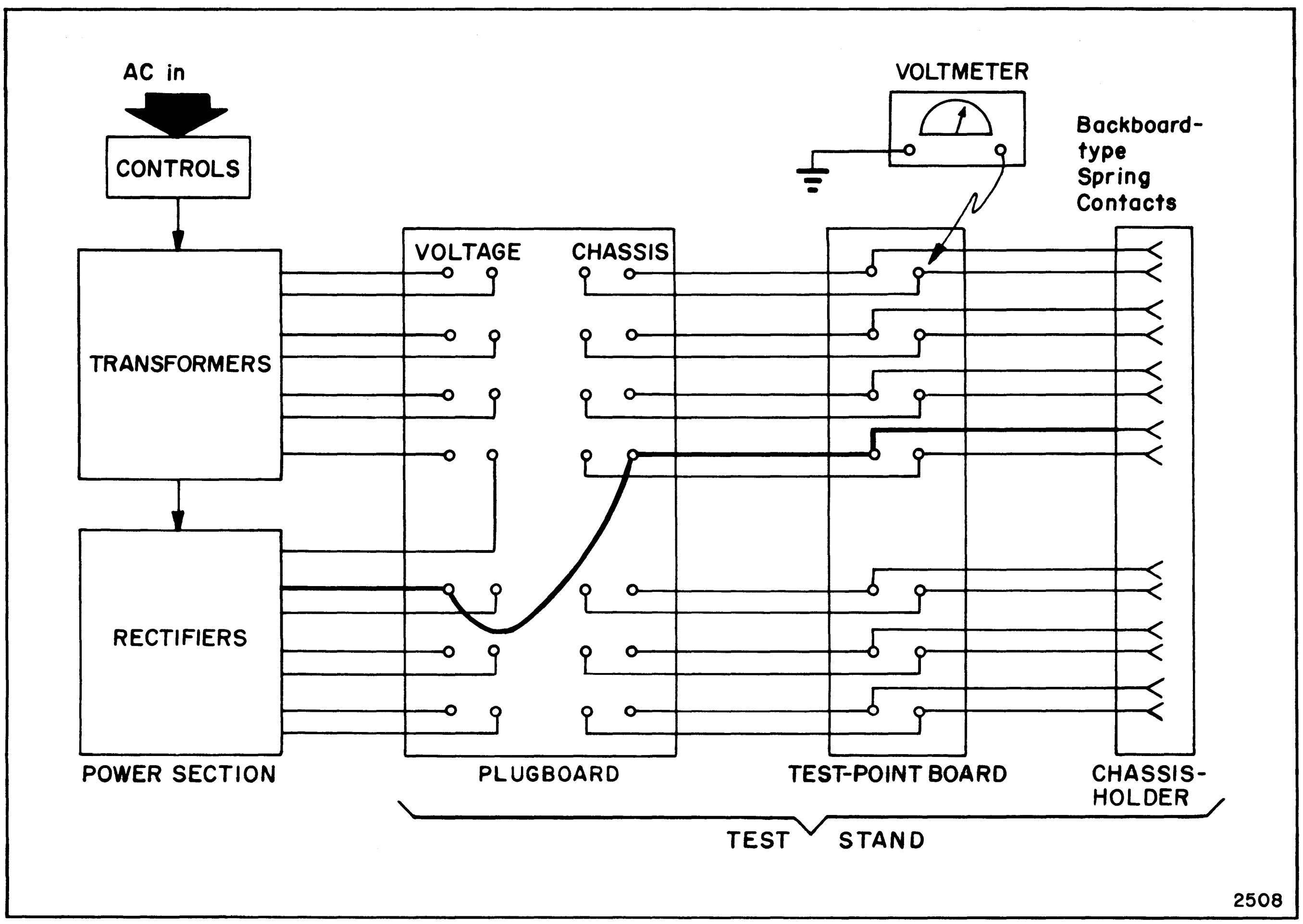

Figure 3-1. D-C Test Bench

spring contact in place. When the voltage supplies have been connected on the plugboard and the chassis is inserted in the test stand, the effect is that of a dummy computer, except that all conditions are static.

3-21. POWER AND POWER CONTROL. The power section contains two banks of transformers, one to supply heater power, and the other to drive rectifiers for d-c power. As shown in figure 3-2, there are 12 rectifiers in a series-parallel bleeder network. Mercury-vapor tubes are used in the most positive and most negative rectifiers, because of the voltage ratings required of these two circuits. The other ten rectifiers are selenium-bridge circuits. All the supplies use double-inductance filters, except for the 10-volt supply

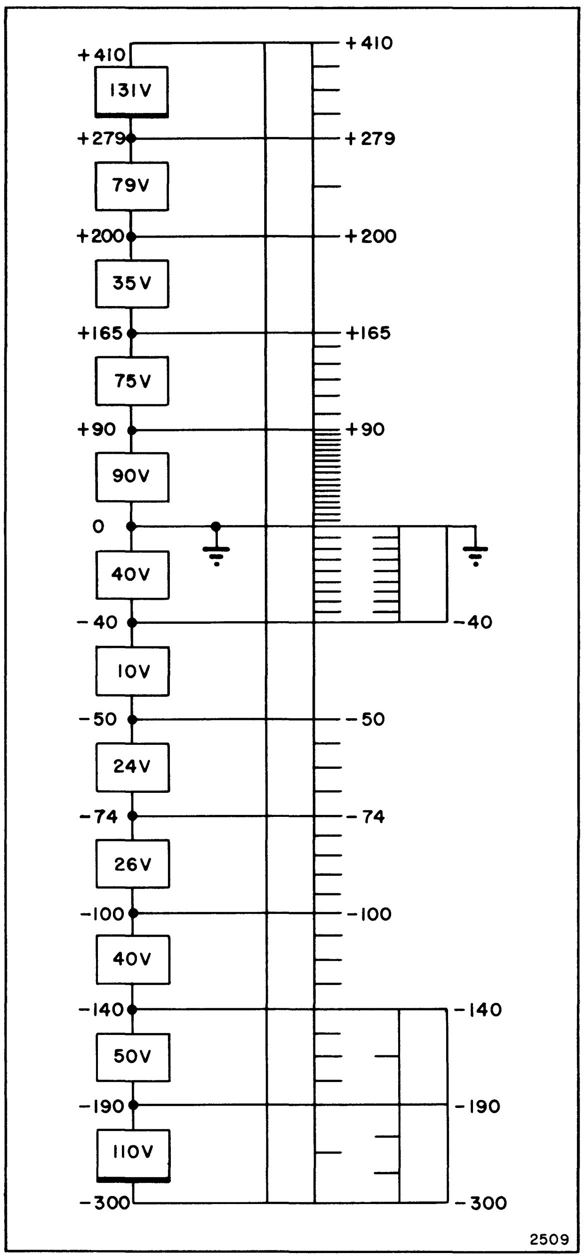

Figure 3-2. Test Bench Rectifiers and Bleeder

for –40 to –50 volts, which uses a single-inductance filter.

3-22. Each output line from the bleeder is fused before it connects to the input (voltage) side of the plugboard. The d-c fuses are mounted on fuseboards 2, 3, and 4. Grasshopper fuses are used in the lines. The alarm contacts of the fuses in the positive-voltage lines apply power to one alarm relay; those from the negative-voltage lines operate another. The fuses on fuseboard 1, through which the ac is applied to the heater transformers and rectifier transformers, combine similarly to operate an a-c alarm relay. Contacts of these three relays, two overheat thermostats, and the D. C. OFF pushbutton combine to form a d-c interlock. If any alarm relay is energized, if the equipment is overheated, or if the D. C. OFF button is pushed, the interlock opens to remove all dc. The heater-power circuit is not interlocked, but it is fused (fuse 14 on fuseboard 1).

3-23. A timer forces a 1-minute delay between the application of heater power and dc. The delay permits the heaters of the mercury-vapor tubes in the +410-volt and –300-volt supplies, and of the tubes in the computer chassis mounted in the test stand, to come up to operating temperature before dc is applied.

3-24. The HEATERS switch, besides applying power to all heater transformers (through fuses 17 through 26 on fuseboard 1), and to the timer motor, also starts the ventilating fan (through fuses 15 and 16) and lights the HEATERS ON lamp. When the timer motor has closed the contacts in the a-c line, the yellow ready light comes on, indicating that power is present at the top of the d-c relay. When the spring-loaded D. C. ON button is pushed, all other conditions permitting, the interlock closes momentarily; the number-4 contact of the relay bypasses the pushbutton and holds the relay closed, and power is applied (through fuses 1 through 12 of fuseboard 1) to the rectifier transformers. The power-control circuit is shown in block form in figure 3-3.

3-25. TEST STAND. When the test bench is used, insert the plugboard for the chassis to be tested. The schematic and layout drawings for that chassis are essential to this procedure. Three courses are possible for dummying in connections to terminals on which a signal-or pulse-waveform is normally present:

(1) One of the two voltage levels at which the waveform is clamped can be connected from the power section. This single-level test is adequate for static conditions.

(2) The two voltage levels can be plugged in alternately. This test provides information about the

efficiency of gates and the cutoff and conduction characteristics of amplifiers.

(3) For testing circuits under dynamic conditions, a high-frequency signal generator can be connected to an input terminal. The connection can be made at the plugboard. This test provides a fair indication of the response characteristics of gates, or the loading characteristics of a-c coupling circuits, especially if a pulse generator is used.

3-26. After the plugboard is inserted, the chassis is inserted in the receptacle and power applied.

CAUTION

Do not turn power on until the chassis is in place, since the heaters in both the chassis tubes, and the mercury-vapor tubes in the test bench, require the delay that the timer institutes.

While making tests on the chassis, the technician can turn on a normally off tube by shorting the grid to the cathode, or applying the same potential to both. To simulate nonconductivity in a normally on tube, remove the tube.

3-27. All chasses except the tank-mounted i-f amplifiers (paragraph 3-28) are tested as follows:

(1) Make the heater and d-c operating voltage connections on the plugboard.

(2) Add other connections for voltages to represent signal- and pulse-inputs. Do not allow any terminals to "hang."

(3) Turn heaters on at the test bench.

(4) Turn dc on. With a vacuum-tube voltmeter, check all terminals at the test-point board, or at the sockets in the chassis holder, to make certain that all connections have been made correctly.

(5) Turn all power off and insert the chassis. Turn heaters on. After 1 minute turn dc on.

(6) If a fuse blows on fuseboard 2, 3, or 4, check all points and components in the chassis that receive the voltage passed by that fuse.

(7) If the chassis does not blow any fuses, proceed with other voltage, signal, or operational checks.

3-28. To align and service the tank-mounted i-f amplifiers in the memory requires two additional pieces of equipment:

(1) The i-f amplifier chassis adapter, which is supplied with the d-c test bench and is described in layout drawing D801 935.

(2) A signal generator capable of producing frequencies of 8.1, 8.9, 11.25, 14.2, and 15.6 megacycles, at approximately 20-millivolts amplitude.

3-29. A switch on the adapter connects to terminal T40 of the chassis either the correct bias-voltage supply plugged in from the power section, or the detected and filtered amplifier output-voltage supply. A potentiometer control on the adapter varies the bias value. A connector at one end of the adapter links the coaxial cable from the signal generator across an 82-ohm terminating resistor into the amplifier. The 82-ohm resistor can be replaced with one which matches the impedance of the specific coaxial lead.

3-30. To service the tank-mounted i-f amplifiers, proceed as follows:

(1) Turn on the signal generator and the test bench heaters.

(2) Make the connections for the required heater and d-c operating voltages on the plugboard. Check the voltages by turning on dc and inspecting either test points or female connectors with a vacuum-tube voltmeter.

(3) Turn off all power in test bench. Then:

(a) For a general check of voltages, insert the 8-pin male connector on the adapter into its socket. Unless this connection is made, V5, the 25L6 amplifier, will not be supplied with bias voltage.

(b) For a gain check or an alignment procedure, remove tube V5 from the chassis. After the adapter and chassis are in place, plug the 8-pin male connector into V5 socket. Insert the adapter and connect the signal generator. Insert the chassis. Turn on heater power, and after the 1-minute delay, turn on dc.

3-31. To align the tank-mounted i-f memory amplifiers, proceed as follows:

(1) With the chassis adapter and chassis in place, the connector in socket V5, the signal generator connected, and all power applied (paragraph 3-32), move the toggle switch on the adapter to ALIGN position. Connect the d-c probe of the vacuum-tube voltmeter to the test-point for terminal T40. Set the meter to a 10-volt scale.

(2) Set the signal generator to produce a 15.6-megacycle signal of 10-millivolt amplitude, and adjust the bias (with the potentiometer control) so that some deflection can be seen on the voltmeter. Tune the coil closest to tube V4 for peak reading on the voltmeter.

(3) Set the signal generator to 8.1 megacycles, same amplitude, and tune the coil closest to tube V3 for peak reading.

(4) Set the signal generator to 14.2 megacycles, same amplitude, and tune the coil closest to tube V2 for peak reading.

(5) Set the signal generator to 8.9 megacycles, same amplitude, and tune the coil closest to tube V1 for peak reading.

(6) Repeat steps 2 through 5. Perform gain check (paragraph 3-32).

3-32. To perform the gain check:

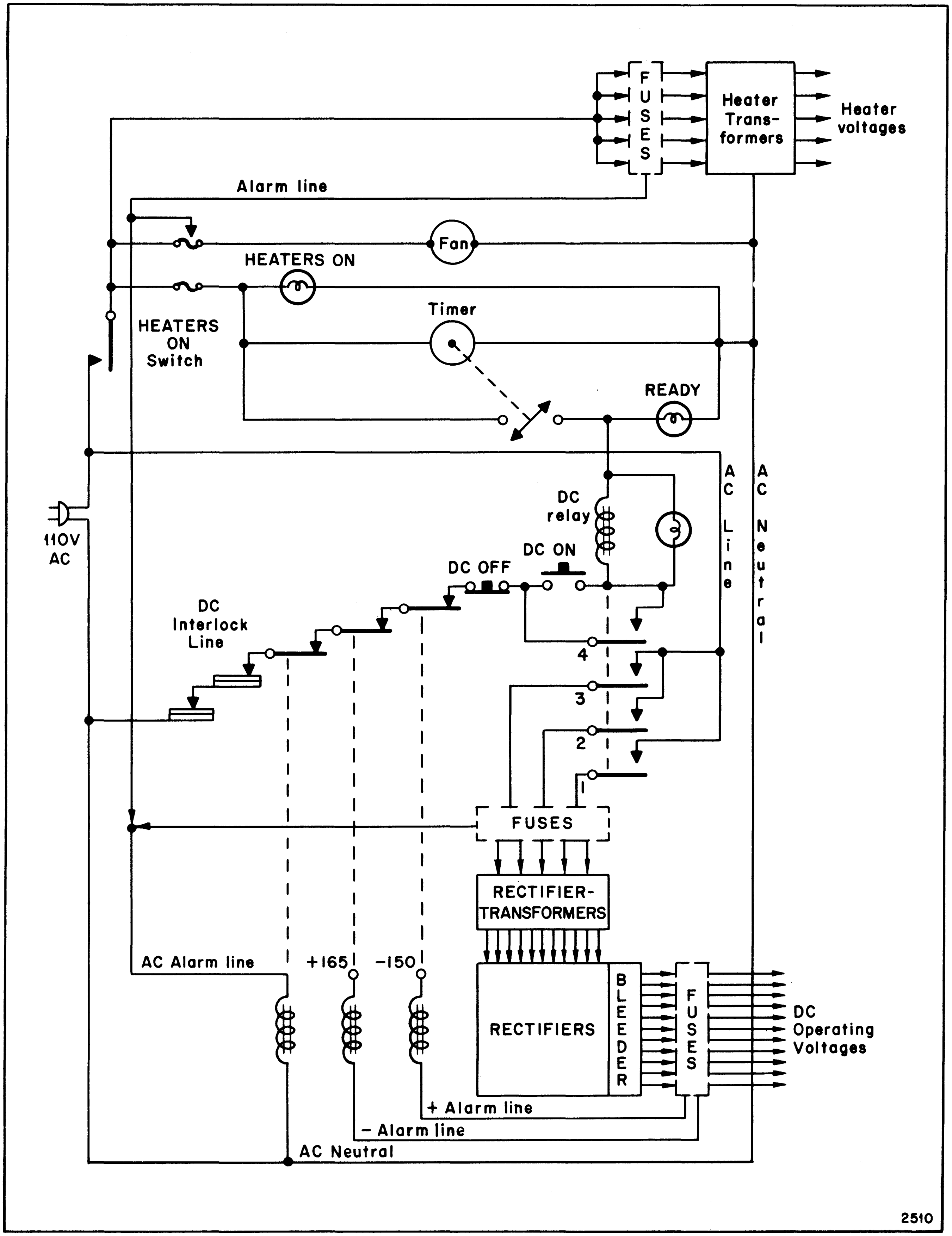

Figure 3-3. Test Bench Power Control System

(1) Set the signal generator to produce an 11.25-megacycle signal of 15-millivolt amplitude. When making any of these checks, be careful that the input does not overload the amplifier. This is especially important when making the response check (paragraph 3-34), where an overload may seriously affect the response characteristics. With the toggle switch still in ALIGN position, adjust the potentiometer control for a +6-volt reading on the voltmeter.

(2) Push the toggle switch to BIAS position. The reading on the voltmeter should be not less than –2.5 volts. If the reading is below 2.5 volts, check the three 6AK5 amplifiers (V1, V2, V3) or the 6AN5 detector driver (V4) for low emission. Also check the +150-volt d-c plate supply, and the 6.3-volt a-c heater supply. These two voltages are critical. If they are low, the gain drops considerably.

3-33. If the gain check does not indicate failure of marginal components, check the 7AK7 modulator, or the 25L6 amplifier (V5). The tubes following the amplifier and preceding the modulator have no appreciable effect on the overall gain of the amplifier chassis, since the flip-flop output is clamped at two constant levels. Two important checks to make at the computer in the modulator stage are the continuous-wave input, which should be 8 to 10 volts rms (root mean square), and the heater voltage, which must not be less than 5.8 volts rms.

3-34. To check the amplifier response requires, in addition to the test bench, an oscilloscope and a sweep generator capable of sweeping across the 5- to 17-megacycle band. Proceed as follows:

(1) Remove the vacuum-tube voltmeter from the T40 test point, and insert the vertical-deflection probe of an oscilloscope.

(2) Connect the oscilloscope for external sweep. Synchronize the sweep generator with a marker from the signal generator.

(3) From the sweep generator, tap off a signal for the i-f chassis input, and the sweep voltage for the oscilloscope.

(4) Gradually sweep across the band from 5 to 17 megacycles with the signal generator, recording the amplitude variations as observed on the oscilloscope. The frequency-versus-amplitude plot should fall in the area between the two curves shown in figure 3-4. Gradual variations in the slope of this curve below 9 megacycles and above 13.5 megacycles are not important. Serious variations indicate such component troubles as open damping resistors (indicated by a sharp peak observable while aligning the chassis or sweeping across the band), off-value damping resistors, open bypass capacitors, or resonating bypass capacitors.

3-35. If the shield is removed from the amplifier chassis for investigation of the condition of internal components, the response of the amplifier will be altered. Any readings taken with the shield off are invalid. If new tubes are inserted in the recirculation amplifier it is not necessary to retune the chassis. New tubes do not materially affect the response.

3-36. UNIVAC TUBE TESTER

3-37. The tube tester is an auxiliary servicing aid for determining the adequacy of tubes to meet the operating requirements of the Central Computer. It is a self-contained unit.

3-38. The tester requires a single-phase, 115-volt a-c source, and consumes 230 watts. The schematic drawing and all necessary layout and wiring diagrams are supplied with the equipment.

3-39. The main meter on the tester panel is the GOOD-BAD meter. Two other meters on the tester

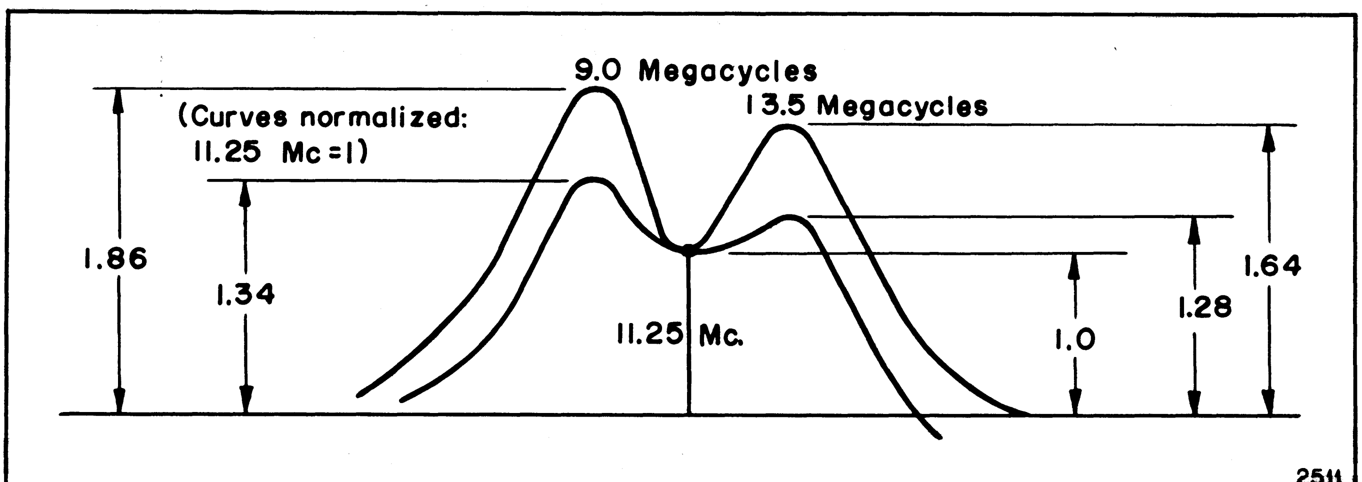

Figure 3-4. Frequency-Versus-Amplitude Plot for Amplifier Response Check

indicate control-grid current and screen current. Other indicators are the POWER ON jewel light, and the indicator neon in the short-test circuit.

3-40. In the top of the tester are 41 tube sockets of various types. Only heater voltages are applied to these sockets, which are used for preheating tubes prior to testing. Other special circuits include one to test 2050-type thyratrons, and the short-test circuit.

3-41. A jack marked PLATE CURRENT, on the front panel of the tester, normally completes the line from the plate bus (common to all ten test sockets) to the plate voltage supply. When an ammeter is plugged into the jack, plate current is diverted through the ammeter and read directly. A connector assembly is supplied to make this connection.

3-42. POWER SECTION. The tube tester requires a 115-volt single-phase a-c source. The power is applied to three transformers, which provide power to the rectifiers for d-c voltages, heater voltages for the 41 preheat sockets, and the various heater voltages required in the ten test sockets. The input to the d-c-supply transformer is regulated by a 50-volt per ampere stabilizer.

3-43. Of the six secondaries of the d-c-supply transformer, only three are used. The outputs of these three, 87, 81, and 41 volts, are applied to bridge rectifiers and the L-section filters.

3-44. A common voltage divider is shunted across the three rectifiers to produce a voltage range from +130 volts to –30 volts. From the voltage divider, 25 d-c voltages are tapped off and supplied through the TUBE SELECTOR decks and the test control switches to the ten test sockets, and to the various indicators.

3-45. The preheater transformer supplies only 6.3-volt heater power to the preheat sockets. The POWER ON lamp, which lights when the POWER switch is closed, is across the preheat lines.

3-46. CIRCUITS. The tube tester is similar to most dynamic mutual-conductance tube checkers, in that it measures the values of tube currents, or analogs of these values, under artificial dynamic conditions. It differs from commercially available equipment in that its measurements of transconductance, emission, cutoff, and other factors are presented in terms of the specific requirements of Univac I system circuits.

3-47. Besides the general measuring circuit, which has ten test sockets, calibrated and adjustable resistance values, and three meters, there are three special circuits. These are the preheat circuit, the 2050-test, and the short-test circuits.

3-48. The 41 preheating sockets are supplied with heater power only. They are used whenever a large group of tubes is being tested. There are six lines of six sockets each, one of three sockets, and one of two. All the following tubes can be preheated simultaneously: six 28D7 tubes, six 2050 thyratrons, six 7AK7 tubes, six 807 tubes, three 4D32 tubes, two 829B tubes, six 25L6 tubes or six 6SN7 tubes, and six tubes of type 6BE6, 6AL5, 6AK5, 6AN5, or 6AU6.

3-49. A separate transformer supplies most of the 6.3-volt heater power for the preheat sockets. The 25-volt and 28-volt power, and some of the 6.3-volt power, are tapped from the regular heater transformer.

3-50. Another special circuit tests the emission and cutoff values of 2050-type thyratrons. One contact of the EMISSION switch connects either –3 or –0.5 volts to the thyratron striker grid for making the cutoff test. With –3 volts on the grid, the tube should be cut off. When –0.5 volts is applied, the tube should fire.

3-51. When the tube conducts, it sends current through a relay. The contacts of the relay place a 270-kilohm shunt across the 820-kilohm resistor in series with the GOOD-BAD meter, which connects from anode to cathode of the tube through deck 10 of the TUBE SELECTOR switch. The bottom scale of the meter, calibrated in volts, should register a drop of no more than 11 volts across a good 2050 thyratron.

3-52. The third special circuit tests for short circuits from any grid or the anode of the tube to its cathode. The circuit includes a 2D21 thyratron, which is the monitor tube of the circuit. The striker grid of the 2D21 is connected through a 680-kilohm resistor to –22 volts, and through the SHORT-TEST rotary switch to one of the buses for grids or anodes. Each of the buses connects through the SHORT LOCK to a 1-megohm resistor and a +14-volt supply. The cathode bus also is connected to +14-volts in the same way.

3-53. The result, in the case of a good tube, is a 10-to-6.8 voltage divider which yields +14 volts and –22 volts and maintains the potential on the grid of the 2D21 at a point below the firing potential. When a short occurs, the bottom and top ends of the two 1-megohm resistors in the two lines (from the cathode and the element to which the cathode is shorted) are tied together; the resistance present between +14 volts and the grid of the 2D21 drops to 500 kilohms; the voltage divider assumes a ratio of 5 to 6.8, and the potential at the striker grid rises above the firing point.

3-54. The 2D21 serves as a memory in the event of an intermittent short-circuit, for once it is fired, it continues to conduct. In the anode circuit is the SHORT INDICATOR neon, which remains lighted as long as the thyratron conducts. To turn the neon off, push the SHORT RESET button, which opens the cathode circuit of the thyratron.

3-55. INDICATORS. There are two indicators and three meters on the tube tester:

(1) The POWER ON jewel light, connected across the secondary of the preheater transformer, lights whenever the POWER switch is on.

(2) The GOOD-BAD meter, calibrated separately for each tester, has five scales. The first four scales register the conditions which the instrument was designed to test: emission and transconductance of a hard tube; cutoff potential of a hard tube; heater-to-cathode and cathode-to-heater leakage, and emission and cutoff of a 2050 thyratron. Each of these top four scales is divided into GOOD and BAD areas; the bottom scale is calibrated in volts. The meter is protected by a selenium diode. An instrument rectifier is switched into the input line whenever the TRANSCONDUCTANCE switch is pushed down.

(3) To the left of the GOOD-BAD meter is a 0-to-30-milliampere SCREEN CURRENT meter. This meter is in the common screen bus, and reads screen currents directly. It is protected by a ⅛-ampere fuse.

(4) On the right side of the GOOD-BAD meter is a ±100 microampere GRID CURRENT meter. This meter is in the bus that connects all control grids through deck 4 of the TUBE SELECTOR switch to the bias-power points. The GRID-CURRENT METER SHUNT toggle switch, next to the meter, places a 100-ohm resistor in parallel with the meter. When the shunt is across the meter, the range of the reading is increased to ±1 milliampere. A 2-milliampere fuse protects the meter.

(5) The SHORT INDICATOR neon is in the anode circuit of the 2D21 short-test thyratron. When an interelement short circuit causes the 2D21 to fire, the neon lights.

3-56. CONTROLS. There are 14 controls on the tester panel. Seven telephone-key switches and four toggle switches operate as test controls. There are also two rotary switches. One sets up general test conditions, and the other sets up short-circuit test conditions. The fourteenth control is a nonlocking push-button. The controls are numbered S1 through S14. Their names and functions are:

(1) TUBE SELECTOR: 12-position, 10-deck rotary wafer switch. Each position of this switch is marked for one of the 13 tube types used in the Univac system, except position 11, which is marked for both type 829 and type 4D32. The switch selects the operating voltages to be applied to the screen, suppressor, and plate buses for the particular tube type, and carries them to the test-control switches. The TUBE SELECTOR applies control-grid voltages to the test sockets, while cathode and heater connections are built into the sockets. The TUBE SELECTOR also connects the meters into the test circuits and selects the appropriate shunt resistors and calibrating resistors.

(2) SHORT-TEST: five-position single-deck rotary wafer switch, in the circuit whenever the SHORT LOCK (S10) is closed. The positions of this switch are NO TEST (the normal position when it is not in use), G1, G2, G3, and P. Each of the four effective positions of the switch connects one element of the tube undergoing a test to the grid of a thyratron. A short circuit from the element to the cathode halves the value of one section of a voltage divider, and brings the potential at the thyratron grid above the firing point. The SHORT INDICATOR neon in the plate circuit of the thyratron lights whenever the thyratron conducts.

(3) H-K LEAKAGE: three-position telephone-key switch. This switch reverses the polarity relationship of the cathode and heater potentials applied to the test socket. The switch is used to test heater-to-cathode and cathode-to-heater leakage. When the switch is pushed up, the heater is negative with respect to the cathode; down, the heater is positive with respect to the cathode. The leakage value is read at the GOOD-BAD meter, on the third scale.

(4) EMISSION: three-position locking telephone-key switch. When the switch is pushed down, it grounds the control-grid bus. When it is pushed up, it connects switch S5, the OVERDRIVE switch, into the circuit so that the selected overdrive current is drawn into the grid circuit. The switch is used also to test the cutoff point of a 2050 thyratron: UP to apply –3 volts to the striker grid, DOWN to apply –0.5 volts.

(5) OVERDRIVE: toggle switch, in the circuit whenever switch S4, the EMISSION switch, is pushed UP. This switch connects either 0.5 milliamperes or 0.25 milliamperes of overdriving current to the control-grid bus.

(6) SECTION 1-SECTION 2: two-position locking telephone-key switch, used for testing each half of a twin tube separately. For the 28D7, this switch connects plate and grid voltage to one side of the socket at a time. For the 6AL5 or 6AN7, it completes the cathode circuit from one side of the socket at a time.

(7) TRANSCONDUCTANCE: two-position telephone-key switch. This switch applies power to the screen-grid bus, to which the anode pin of the 2050 socket also is connected through deck 1 of the TUBE SELECTOR switch; it also applies plate voltage to the plate bus through deck 2, and feeds a 60-cps signal into the control-grid bus. It places the GOOD-BAD meter in series with a blocking capacitor and a limiting resistor, and across whichever test-load resistor is selected by deck 6 of the TUBE SELECTOR switch. The meter, consequently, reads an analog of plate current.

(8) CONTROL-GRID CUTOFF: two-position telephone-key switch, applies power to the screen-grid bus through deck 1 of the TUBE SELECTOR switch and connects plate voltage through decks 3 and 9. Operating conditions are established for testing the control-grid cutoff point of a tube.

(9) G3 CUTOFF: two-position telephone-key switch, applies power to the screen-grid bus through deck 1 of the TUBE SELECTOR, connects plate voltage through decks 3 and 6, connects the normally grounded suppressor grids of 6BE6 tubes and 7AK7 tubes to −10 and 8 volts respectively through deck 5, and grounds the control-grid bus. Operating conditions are established for testing the suppressor-grid cutoff point of a tube.

(10) SHORT LOCK: two-position locking telephone-key switch, connects the cathode, control-grid, screen-grid, suppressor-grid and plate buses each through a 1-megohm resistor to +14 volts, and opens normal return lines of all these buses. The three grid lines and the plate line connect into the SHORT-TEST rotary switch contacts, and then to the short-test thyratron.

(11) POWER: toggle switch, connects 115 volts ac from the connector to the power transformers.

(12) GRID-CURRENT METER SHUNT: toggle switch, when pushed UP, shunts the GRID CURRENT meter with a 100-ohm variable resistor, so that the meter presents readings over a ±1-milliampere range. When pushed DOWN, the switch removes the shunt, and the meter reads grid currents across its normal range of ±100 microamperes.

(13) 829B-4D32 SELECTOR: toggle switch, next to test socket VI, switches the connections into test socket VI so that either 829B tubes or 4D32 tubes can be tested in it. Voltages for both these tubes are selected by position 11 of the TUBE SELECTOR. The switch is normally left in the 829B position.

(14) SHORT RESET: nonlocking (momentary contact) pushbutton, interrupts the ground connection to the cathode of V12, the 2D21 short-test thyratron. This switch extinguishes the thyratron and the SHORT INDICATOR neon in the anode circuit of the thyratron.

3-57. The POWER switch releases power to the three transformers. Heater power is applied to all test sockets and to the preheat sockets as long as power is on, and the d-c operating voltages are applied to the TUBE SELECTOR switch. The grid bias normally is connected to the control-grid bus. Other voltages are not connected into the test sockets, however, until the test-control switches are pushed. A 60-cps a-c voltage is applied to the control-grid bus when the TRANSCONDUCTANCE switch is closed.

3-58. The SCREEN CURRENT and GRID CURRENT meters give direct readings when they are connected into the test circuit. The plate current can be measured directly from the PLATE CURRENT jack.

3-59. Several conditions can be tested (table 3-1). Specific directions for four of these tests are as follows:

(1) Grounded-grid test: push the EMISSION switch down.

(2) Overdrive test, in which overdrive currents of 0.5 and 0.25 milliamperes are drawn at the grid: push the EMISSION switch up, and select either of two overdriving currents by means of the OVERDRIVE switch.

(3) Heater-cathode or cathode-heater leakage may be tested. The heater is positive with respect to the

Table 3-1. Tube Tests

Selector Position	Tube		Test
	Type	Socket	
1	25L6	V6	Heater-cathode leakage, emission, control-grid cutoff, short test
2	28D7	V4	Heater-cathode leakage, emission, control-grid cutoff, use SECTION 1-SECTION 2, short test
3	6SN7	V3	Heater-cathode leakage, emission, control-grid cutoff, use SECTION 1-SECTION 2, short test
4	6BE6	V8	Heater-cathode leakage, emission, control-grid cutoff, suppressor-grid cutoff, short test
5	7AK7	V7	Heater-cathode leakage, emission, control-grid cutoff, suppressor-grid cutoff, short test
6	6AL5	V9	Heater-cathode leakage, emission, use SECTION 1-SECTION 2, short test
7	6AK5	V10	Heater-cathode leakage, transconductance, short test
8	6AN5	V10	Heater-cathode leakage, transconductance, short test
9	6AU6	V10	Heater-cathode leakage, transconductance, short test
10	807	V2	Heater-cathode leakage, emission, control-grid cutoff, short test
11	4D32 829B	V1	Heater-cathode leakage, emission, control-grid cutoff, use 829B-4D32 SELECTOR, short test
12	2050	V5	Special 2050-test for emission and control-grid cutoff

cathode when the H-K LEAKAGE switch is pushed down, negative when it is pushed up.

(4) To make the short test, push the SHORT LOCK switch down. Then rotate the SHORT-TEST selector switch. Any short circuit between the indicated elements and the cathode will be indicated by the lighting of the SHORT INDICATOR neon. To clear the short-test thyratron, push the SHORT RESET button.

3-60. TEST MULTIVIBRATOR

3-61. When performing routine or nonscheduled maintenance on the Central Computer, it is sometimes necessary to provide a repeating trigger for the start circuits. Normally, the start circuits are triggered manually by the start bar on the supervisory control keyboard. If a very short duty cycle or a start pulse of regular frequency is required, the start circuit can be triggered automatically by a multivibrator.

3-62. Similarly, if it is necessary to check out the single-pulse device in the cycling unit, the multivibrator can provide repetitive starting pulses, doing the job of the CU START switch on the supervisory control panel. The cycling-unit start circuits do not send a pulse on to the rest of the cycling unit unless the CU START INTERLOCK switch is held down. Consequently, if it is necessary to feed an artificial signal through the cycling-unit delay lines for test or check purposes, the interlock switch must be jammed down. Otherwise the artificial signal is blocked at the output gates of the single-pulse circuits, G503 and G504.

3-63. Figure 3-5 is the schematic diagram for a test multivibrator of controllable period which the technician can construct. The circuit consists of a d-c supply, a relay, and a variable resistance-capacitance network.

3-64. The multivibrator requires the following controls:

(1) COARSE FREQUENCY control switch (S1): changes the capacitance in parallel with the relay. Three positions are possible, with a range of 32 to 660 milliseconds recovery time. Changing the frequency affects the symmetry of the output waveform.

(2) FINE FREQUENCY control potentiometer (R1): varies the resistance, controlling the recovery time of the relay. The potentiometer gives the following ranges to the coarse frequency control switch: position 1, 500 to 660 milliseconds; position 2, 104 to 126 milliseconds; position 3, 32 to 36 milliseconds. Changing the resistance with the fine frequency control also affects the symmetry of the output waveform. The period of the output waveform is adjustable between 32 milliseconds and 660 milliseconds.

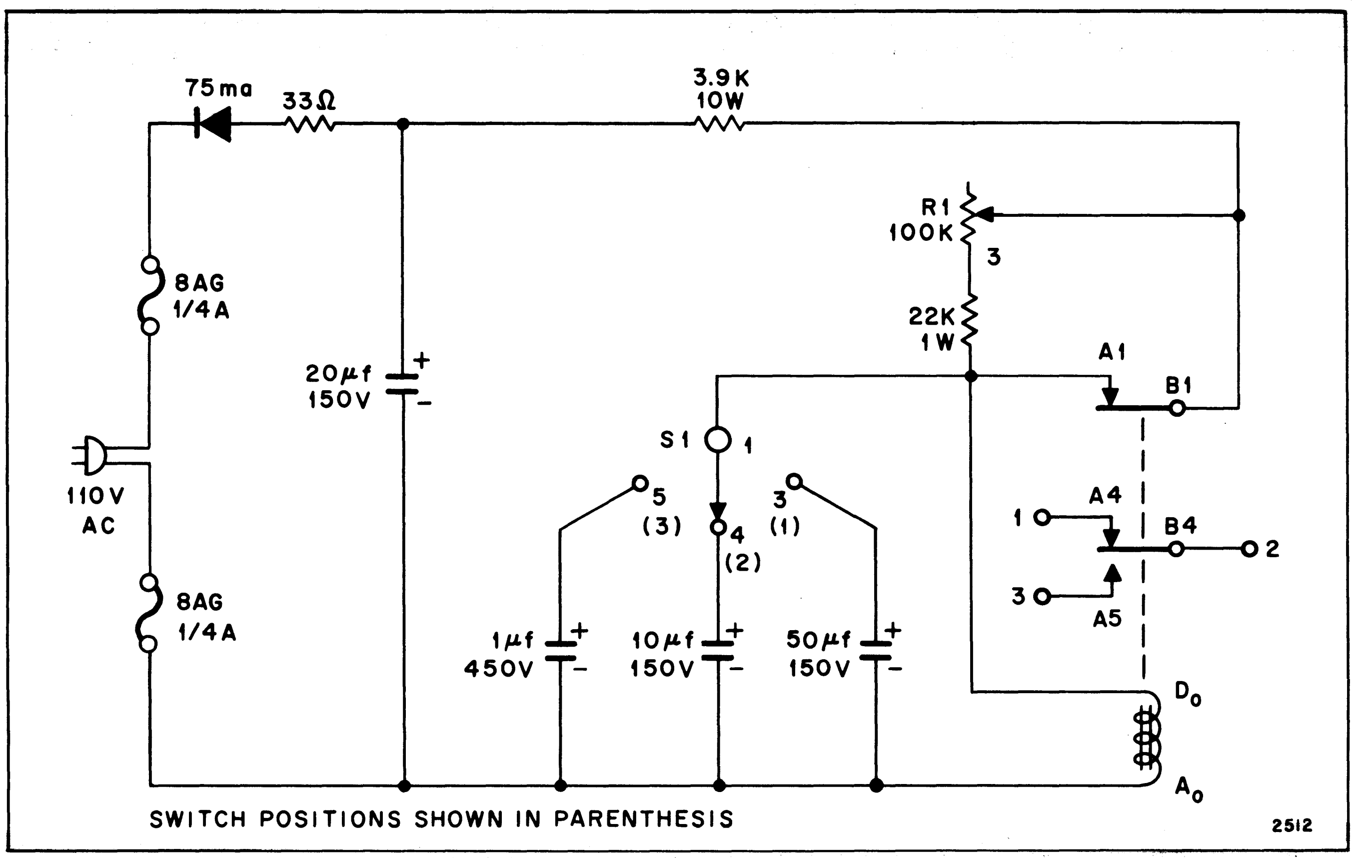

Figure 3-5. Test Multivibrator

3-65. To provide an automatic computer-start signal, plug the multivibrator into the TIME-OUT RESET jack in the lower left corner of the supervisory control panel. When plugged in and operating, the multivibrator-relay contacts short circuit the start bar, grounding the start relay whenever the multivibrator relay is energized. The start circuits and connections are shown in figure 3-6, and in engineering schematic D800 337.

3-66. The connection into the single-pulse device in the cycling unit is made through a specially constructed substitute connector that replaces the dummy connector in V5 position of chassis P8V. Normally, the dummy connector in this standard octal tube socket links the CU START switch to G505, the input gate of the single-pulse device. When the switch is closed, the gate is alerted to pass a positive timing pulse (TP+), which triggers the single-pulse device. The replacement connector permits the multivibrator-relay contacts to perform the same function as the switch, feeding a TP+ into the single-pulse device every time the relay closes. The normal and replacement connectors, and the associated circuits, are shown in figure 3-7 and in engineering schematic D800 194.

3-67. DIODE TESTER

3-68. Germanium-crystal semiconductor diodes are used in the Central Computer in many ways. Standard lots of these crystals are not entirely reliable, and the characteristics of the diodes vary widely, even in the same lot. Normal inspection procedure before assembly of the Univac I system includes a test of the diodes. As they are tested, the diodes are classified into five usable categories, representing five levels of circuit requirements. The diodes are retested before being installed in the computer. Users of the computer should follow the same procedure. All crystal diodes should be checked on purchase, classified, and checked again before being used as replacements.

3-69. The circuit and specifications for the diode tester (sometimes called the crystal tester) used by builders of the Univac I system are given in figure 3-8. This device tests germanium-crystal diodes under static conditions simulating the standard operating conditions of current and voltage in the computer. As the schematic drawing shows, the circuit consists of a rectifier to provide the proper values of current and voltage, three meters placed across or in the lines to the crystal undergoing test, and calibrated values of resistance.

3-70. Although data can be obtained from any of the several standard crystal testers commercially available, or even from an ohmmeter, the results are not so reliable or realistic as those obtainable with the recommended circuit. The expense in time and cost required to build the diode tester is minor in comparison with the advantage of possessing reliable data.

3-71. The controls required for the diode tester include:

(1) A test switch, which applies power to the rectifiers, and so passes current through the test crystal.

(2) A sensitivity switch, which temporarily removes a shunt across the back-current—forward-voltage

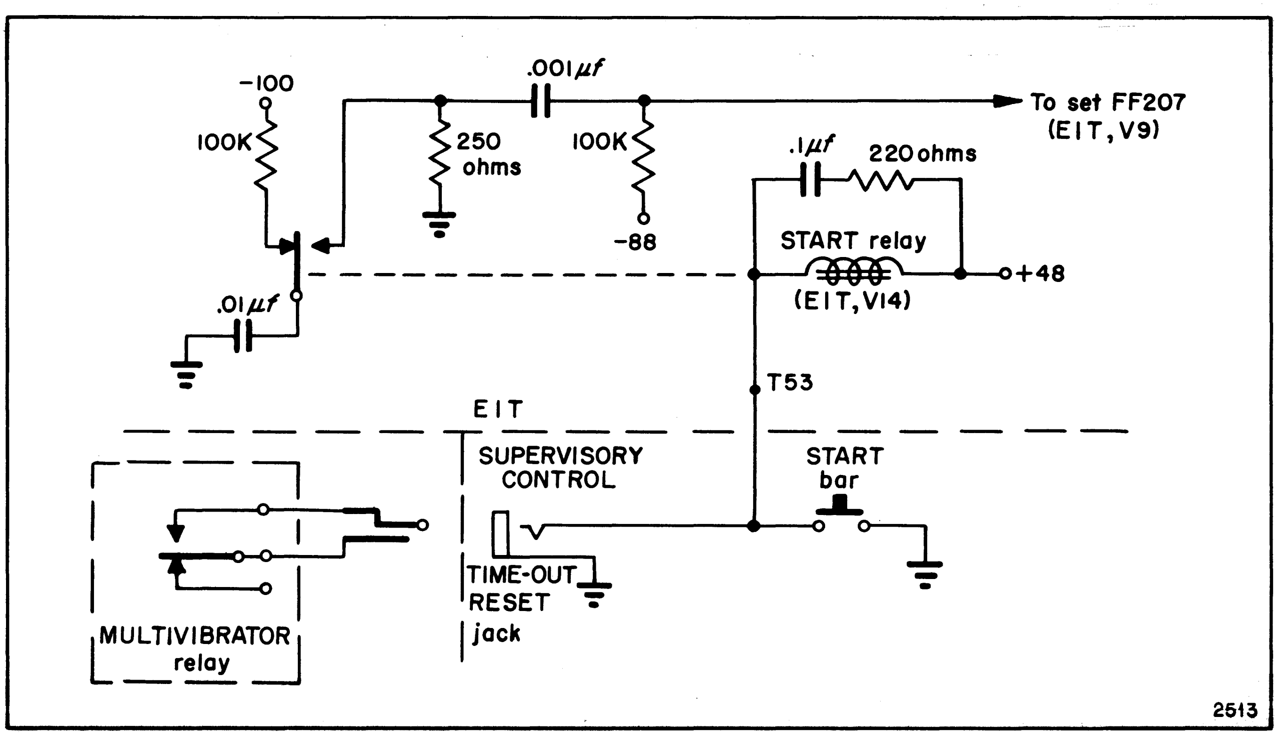

Figure 3-6. Multivibrator, Start Circuits and Connections

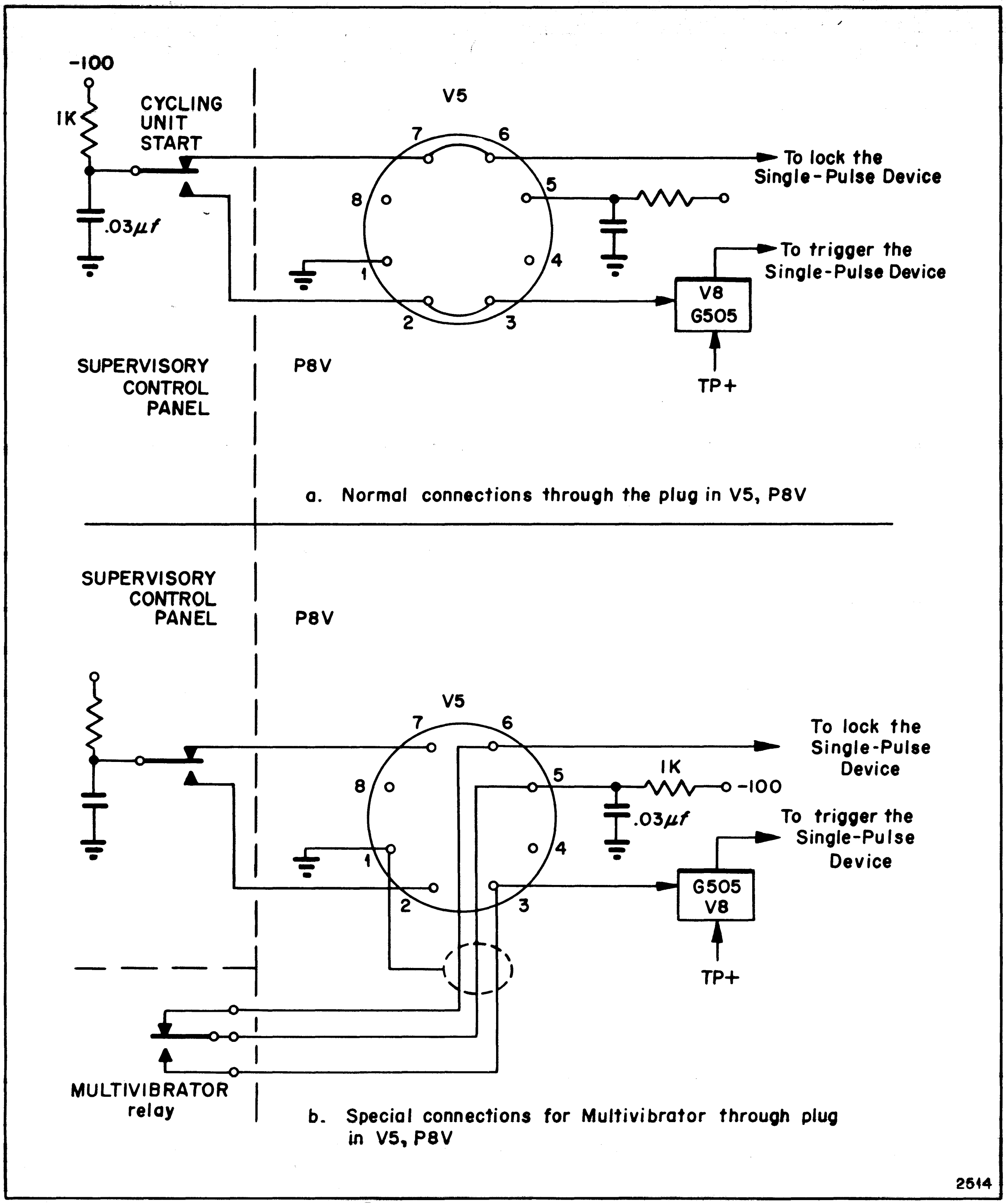

Figure 3-7. Multivibrator, Cycling-Unit Start Circuits

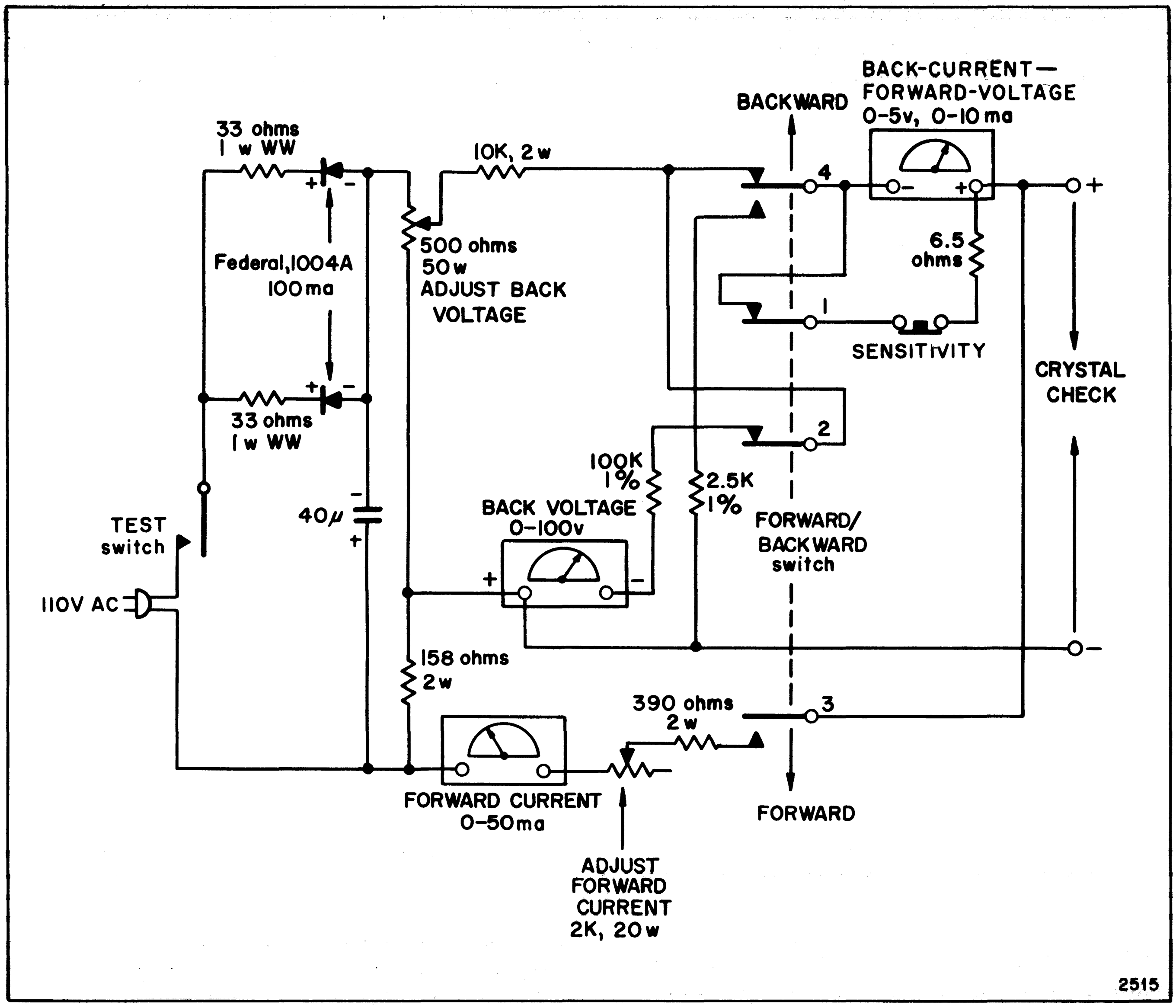

Figure 3-8. Crystal Diode Tester

meter, increasing its sensitivity from full deflection at 10 milliamperes to full deflection at 2 milliamperes.

(3) A forward-backward switch, which sets up the conditions for the test and switches the meters into and out of the circuit.

(4) Two potentiometer controls, which adjust back voltage or forward current to a standard value for taking comparative readings on back current or forward voltage.

3-72. Three meters present the readings:

(1) A 0-to-100—volt back-voltage meter, the voltage across which is adjusted to read 27.5 volts.

(2) A 0-to-50—milliampere forward-current meter, the current through which is adjusted to read 27 milliamperes.

(3) A 0-to-5 volt per 0-to-10 milliampere forward-voltage to back-current meter, from which test readings are taken.

3-73. Figure 3-9 shows the circuit with the switches set for a back-current test. The forward-backward switch is set to backward. Since the sensitivity switch is disengaged, the 6.5-ohm shunt-resistor is across the meter and the circuit requires 10 milliamperes for full-scale deflection of the meter movement. The back-voltage-adjust potentiometer is set so that the back-voltage meter reads 27.5 volts. This is the same as the voltage across the crystal undergoing test. Under these conditions, the reading of the forward-voltage to back-current meter, now functioning as an ammeter, should not exceed 0.4 milliamperes. If the back current is less than 2 milliamperes, the sensitivity switch can be

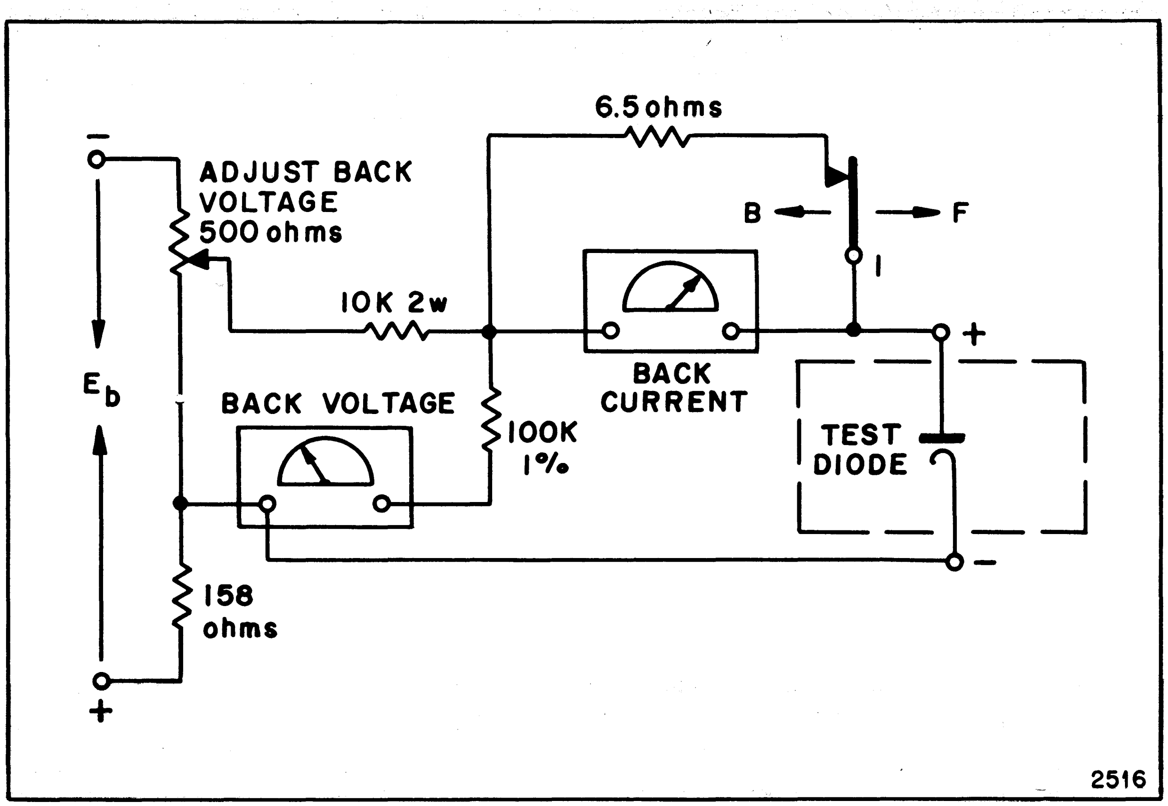

Figure 3-9. Diode Tester for Back-Current Check

held down for taking more precise readings on the 2-milliampere scale.

CAUTION

To protect the meter, do not hold down the sensitivity switch unless the back current is less than 2 milliamperes.

3-74. The circuit as set for a forward-voltage check is shown in simplified form in figure 3-10. The forward-backward switch is set to forward, the test switch is closed, and the sensitivity switch is not in the circuit. The forward-current-adjust potentiometer is set so that the forward-current meter reads 27 milliamperes. This same current is passed through the crystal undergoing test. In these conditions, the reading of the forward-voltage to back-current meter, functioning now as a voltmeter, should not exceed 3 volts. The readings can be used to classify the diode in terms of the test data chart (table 3-2).

3-75. Crystal diode types 1N34A (Sylvania) and 1N48 (General Electric) are used interchangeably in the Univac system. Before being installed in the computer, the diodes are tested and color-coded according to reverse current, forward voltage, and drift or erratic behavior in the reverse direction. (Drift is a slow, unidirectional change in the measured current or voltage; erratic behavior includes more rapid and bidirectional variations, such as oscillations. Either characteristic reduces the efficiency of a tube and makes it likely to fail.) The color code used on the diode determines in what circuits the diode may be used.

3-76. When diodes are replaced in the computer, the characteristics of the replacement diode and the original diode should be as nearly similar as possible. Note that the reverse characteristics of a diode color-coded green or yellow are the same as those for one coded white or red (table 3-2), but that the forward resistance in each case is higher (forward voltage higher for the same current). Therefore, if it becomes necessary to replace a green-coded diode and one is not available, it is wiser to use a white-coded diode than a red.

3-77. Diodes should be rejected whenever under prescribed test conditions:

(1) Reverse current exceeds 400 microamperes.

(2) Reverse drift exceeds 150 microamperes.

(3) Reverse erratic behavior exceeds 40 microamperes.

(4) Forward voltage exceeds 3 volts.

The drift and erratic behavior are those variations still present after 10 seconds has elapsed, since the diode characteristics should stabilize within that period.

3-78. If a diode tester other than the one discussed and recommended here is used, the specifications should approximate those shown in figures 3-8, 3-9, and 3-10. It should place approximately 25 to 30 volts across the

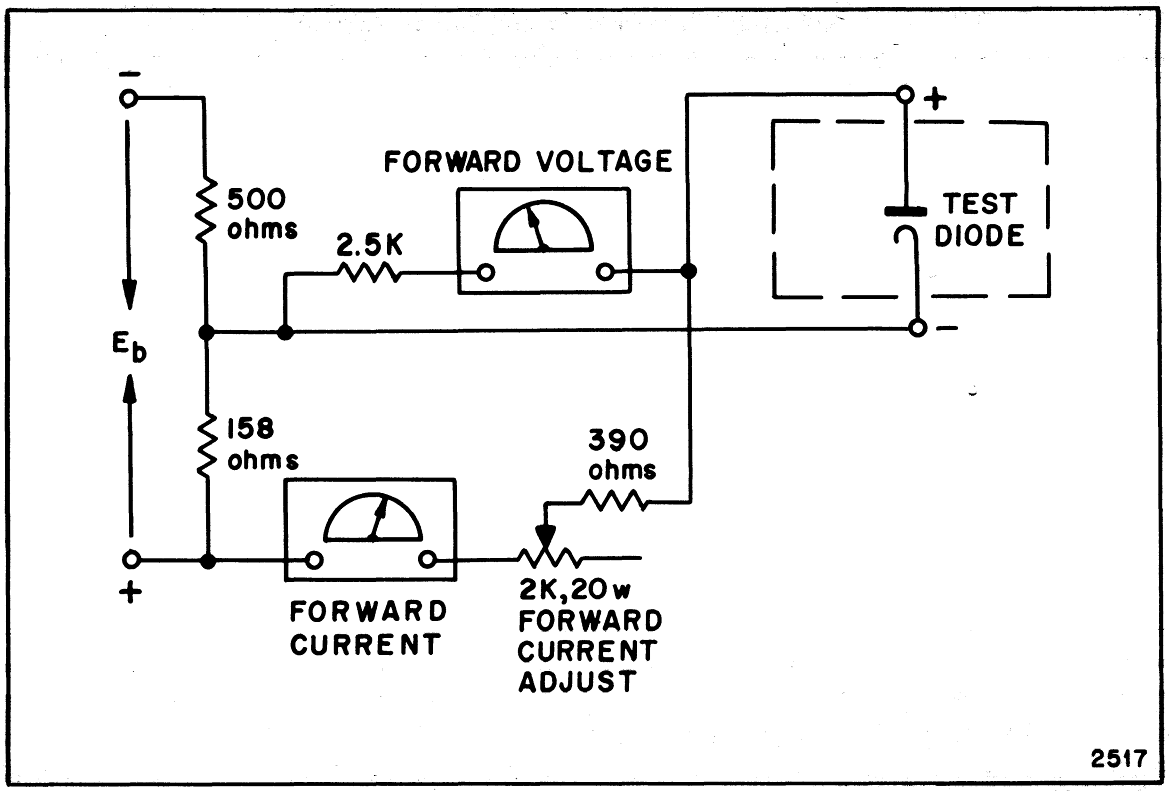

Figure 3-10. Diode Tester for Forward-Voltage Check

crystal in testing reverse characteristics, and pass approximately 25 to 30 milliamperes through the crystal in testing forward characteristics.

3-79. SPECIAL TAPES AND TOOLS

3-80. In addition to special test equipment, maintenance requires special test tapes and tools. A list of all special test equipment and tools is given in table 3-3.

3-81. TEST-ROUTINE TAPES. The available test-routine tapes contain test and other routines used in regular maintenance and in checking out circuitry in the major units of the Univac I system.

3-82. The test-routine programs are discussed in section IV in connection with specific preventive maintenance procedures. Information is given on how to use them and what results to look for. Univac I Test Routines, a separate handbook, provides a complete description of the manual check-circuit test routine, and of the automatic test routines and programming routines on the standard Service Routines tape.

Table 3-2. Diode Reverse Characteristics

Test Conditions:
27.5 volts back voltage for reading back current;
27 milliamperes forward current for reading forward voltage;
wait 10 seconds for diode to stabilize.

Color Code	Backward Current, μa	Permissible Drift, μa	Permissible Erratic Behavior, μa	Forward Voltage
White	0-100	0-40	0-20	0-1.75
Red	100-400	0-40	0-20	0-1.75
Green	0-100	0-40	0-20	1.75-3.0
Yellow	100-400	0-40	0-20	1.75-3.0
Orange	0-400	0-150	0-40	0-3.0

Table 3-3. Special Tools and Test Equipment

Quantity	Item	Drawing or Part Number	Supplied with System	Paragraph Reference
2	Test tapes	762 400 39	yes	3-81
2	Calibration (or standard) tapes for Uniservo	B501 260	yes	3-83
1	Backboard contact driver Backing bar	A900 377 A900 664	yes	3-89
1	Backboard contact extractor	A900 378	yes	3-89
4	Flexible chassis extenders	DSK 987	yes	3-87
1	Tape-splicing kit	P890	yes	3-91
1	Univac tube tester	D501 622	yes	3-36
1	Set of tube socket tools Crimping tool Feeler	 A900 385 A900 384	yes	3-92
1	Diode tester	B801 890	no	3-67
1	Test multivibrator	C803 061	no	3-60

3-83. STANDARD OR CALIBRATION TAPES. These are reels of tape on which all eight channels are recorded at a density of 128 pulses per inch. The tapes are used in calibrating the magnetic heads on the Uniservos, and in troubleshooting the heads and head amplifiers. They are 200 feet long, recorded as follows: 5 feet blank, 130 feet solidly recorded, 5 feet blank, 50 feet solidly recorded, and 10 feet blank. The signals are recorded to saturation on preselected tape. The maximum variation in output amplitude is less than 10 percent.

3-84. OSCILLOSCOPE LEADS. Long and short coaxial or shielded cables are required equipment for the oscilloscopes that are part of the maintenance equipment. Ordinary paired leads are entirely adequate for inspecting low-frequency signals and d-c levels, but do not carry high-frequency signals efficiently.

3-85. Ordinary coaxial leads sometimes suffice for high-frequency work. Synchronizing signals from the Central Computer, for example, can be tapped from any bay by a cable terminated in a coaxial connector. For maximum efficiency in dealing with pulse trains and using the more precise instruments, a special cable should be made up. The only difference between the two recommended cables is the length and the value of the compensating capacitor. The circuit for the short cable (6 feet) is given in figure 3-11.

3-86. The switch across the d-c blocking capacitor in the signal line permits direct application of a composite a-c and d-c voltage to the deflection plates of the cathode-ray tube. The 22-kilohm resistor across the

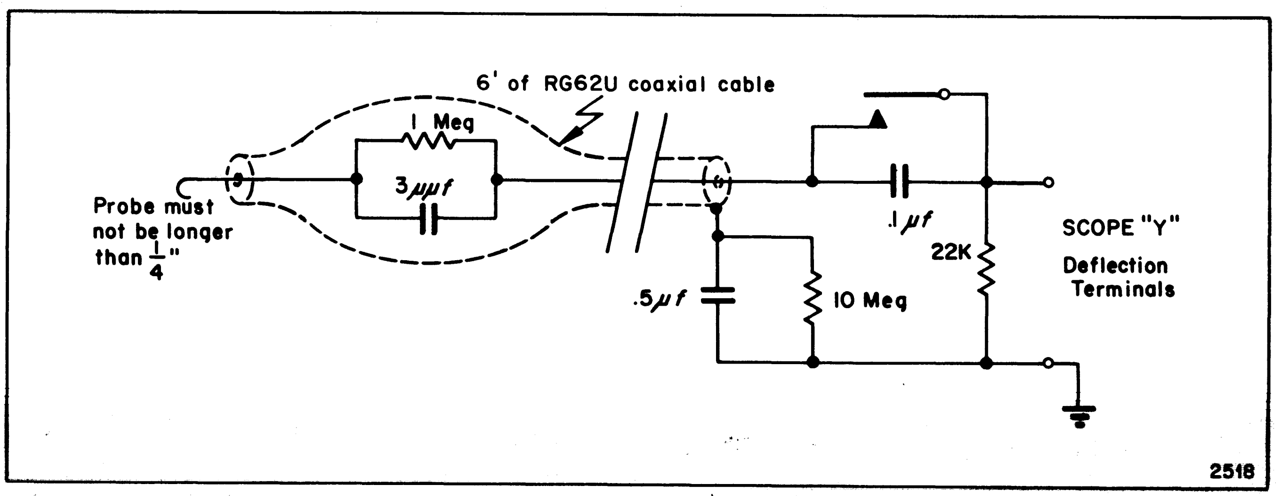

Figure 3-11. Short Lead for Precision Oscilloscopes

line is a terminating (matching) resistor, across which is shunted approximately 7 micromicrofarads of distributed capacitance. To make a long lead, use 18 feet of RG62U coaxial cabling, and replace the 3-micromicrofarad compensating capacitor with one of 10-micromicrofarad value. These special leads are the most efficient means of carrying the high-frequency pulse trains present in the memory, the accumulator and its registers, and the cycling unit to the instruments necessary for inspecting them. It is not necessary to fabricate leads for Tektronix oscilloscopes, since these leads are supplied with the system.

3-87. EXTENDERS. Maintenance on the Central Computer frequently is made simpler by the use of chassis and tube extenders. These are special adapters that permit bringing a single tube or chassis out of the bay while maintaining the signal and voltage connections. The extender is merely a mount, terminated in the appropriate connectors, and containing wires that join the chassis or tube under test and the computer. (Figure 1-5 illustrates the use of the chassis extenders.) A tube extender, for example, connects from a dummy plug, which plugs into the tube socket, to a dummy socket into which the tube plugs. The extender raises the tube above the surrounding tubes, and permits measuring voltages and signals at its pins without disturbing any other circuitry.

3-88. The flexible chassis extender raises a single chassis above the rest of the section, making all connections from a chassis-type contact board (which plugs into the bay) to a backboard-type receptacle (into which the chassis is plugged). It can be deflected as much as 30 degrees to either side, providing increased access to the chassis and backboard contacts, and making the entire inspection process simpler.

3-89. CONTACT TOOLS. It occasionally becomes necessary to replace or remove contacts in backboards. For these purposes, two special tools are supplied. They are the backboard-contact driver, drawing A900 377, and the backboard-contact extractor, drawing A900 378.

3-90. It is necessary to remove a contact only if one breaks. When the backboard-contact tools are used, remove the chassis from the position over the contact.

3-91. TAPE PUNCH. When a tape is spliced, or when any area of a tape becomes unusable, reading and writing operations must be suppressed over the bad-tape area. The tape punch is a special tool for hand-punching the bad-spot indicator holes. Its advantages over a standard round-die punch are that the burring effect of the die is reduced, and that a tape guide enables the technician to punch the holes close to the center of the tape. The tape punch is shown in drawing B501 125.

3-92. SOCKET TOOLS. There are two tube-socket tools of a special nature: a gauge, or feeler tool (drawing A900 384), and a crimping tool for repairing the socket pins (A900 385). These two tools enable a technician to avoid replacing and rewiring a faulty tube socket if the damage to the socket is not severe.

3-93. Other materials used in maintaining the equipment include light mineral oil, watch oil, a number-4 artist's sable brush, Visimag, vinylite electrician's tape, a chamois, and any solvent without an oil base. The use of Visimag is explained in paragraph 3-110.

3-94. COMMERCIALLY AVAILABLE EQUIPMENT

3-95. Tables 3-4 and 3-5 and paragraph 3-93 list commercially available test equipment and tools required to maintain the Univac system. The list of commercially available test units is published for the information and guidance of anyone setting up a maintenance program, not to recommend specific vendors or manufacturers of equipment. Commercial equipment purchased by Univac system users should meet the specifications given in the following paragraphs.

3-96. TEST METERS

3-97. A variety of meters should be available to measure voltage, current, and resistance. Multipurpose meters, except the very expensive ones, are seldom accurate over all ranges and for all functions. The single-purpose meters are generally smaller and more portable, an important consideration in efficient maintenance. High-precision voltmeters of relatively low input impedance are useful for adjusting and testing the power supply, where their low input resistance does not seriously load the circuits. Voltmeters with 1000-ohms-per-volt ratings and mirror-scales, calibrated to 2-percent accuracy, are commercially available, including pocket-size instruments adaptable to field service work.

3-98. A high-impedance meter is essential for measuring the electronic circuits in the computer. Because of loading and other considerations, grid and cathode circuits cannot be measured accurately with low-impedance instruments. A vacuum-tube voltmeter is the best instrument, although a 20,000-ohms-per-volt instrument may serve. Such a voltmeter should have scales ranging from 0-to-3 volts to 0-to-1000 volts. Meters with a maximum reading of 600 volts are adequate for all measurements except in the McIntosh amplifier anodes, where the plate supply is +750 volts. The maximum error of an instrument of this nature should be less than 3 percent of full-scale deflection. Requirements of a-c voltmeters are somewhat less stringent. Tolerances of ±5 percent are permissible.

3-99. Instruments are available that were designed as signal-tracing aids. These are capable of measuring

Table 3-4. Required Tools

Quantity	Item	Source
1 set	Allen wrenches up to ½ inch	Generally available
1 set	Phillips head screwdrivers	Generally available
6	Tube extractor (Model 1001)	Insuline Corp. of America Insuline Bldg. Long Island City, N. Y.
1 set	Open-end wrenches ½ inch to 1 inch	Generally available
1 set	Ratchet box wrenches ⅛ inch to ⅝ inch	Generally available
1 set	Offset open-end wrenches 3/16 inch to ½ inch	Generally available
1	Flexible-shaft screwdriver 8 inches long with ¼-inch blade	Generally available
1 set	Screwdrivers ranging in size from jeweler's screwdrivers to one 15 inches long with ½-inch blade	Generally available
1 set	Clare relay contact setting and burnishing tools	C. P. Clare and Company 3101 W. Pratt Blvd. Chicago 45, Ill.
1	½-inch electric drill	Generally available
1 set	Drills up to ½ inch	Generally available
1	Amphenol bolt cutter for 4-40 to 10-32 bolts	Amphenol Electronics Corp. 1858 S. 54th Ave. Chicago 50, Ill.
1	Amphenol crimping tool (Amp) red	Amphenol Electronics Corp.
1	Amphenol crimping tool (Amp) yellow	Amphenol Electronics Corp.
1	Amphenol crimping tool (Amp) blue	Amphenol Electronics Corp.
2	Bulb extractor and inserter for Western Electric C2 incandescent lamps—Model C2-553A	Western Electric Co. 120 Broadway New York 5, N. Y.
2	Flashlight	Generally available
2	Diagonal cutter	Generally available
4	Soldering iron and stand	Generally available
4	Long nose pliers (one large, one small)	Generally available
2	Wire stripper	Generally available
2	Hytron soldering aid	Hytron Radio and Electronics 423 Fourth Ave. New York 16, N. Y.
1	Scribe	Generally available
2	Center punch	Generally available
2	Scale (12-inch)	Generally available
2	Hammer (8-ounce ball peen)	Generally available

a-c and d-c voltage levels and complex waveforms, including pulse waveshapes. Such an instrument is valuable in troubleshooting the computer if it contains circuits for measuring both peak-to-peak and rms values of sinusoidal or complex waves, if it is compensated so as to respond evenly over a wide range of frequencies, and if the meter does not respond unevenly when the measured waveform is asymmetrical about the baseline. Some such meters can measure either a-c or d-c components of a complex waveform. Zero-center scales on any voltmeter adapt it for measuring bias levels and voltages the polarity of which is not known.

3-100. Many of the commercially available voltmeters have 50-microampere D'Arsonval movements. These are adapted frequently for use as ohmmeters and milliammeters, both of which are necessary for maintaining the computer equipment. Both types of instrument should be correct to within 3 to 5 percent at full-scale deflection. The ohmmeter should measure resistance values from 1 ohm to 10 megohms. The milliammeter should have a range from 100 microamperes to 10 amperes. Most multimeters meet these requirements.

3-101. For measuring large values, such as the currents flowing in certain power-supply circuits and in the power installation, an inductive-pickup ammeter is valuable. Portable snap-around types that can measure values up to 100 amperes are available.

3-102. Resistance and capacitance bridges are also useful. The Wheatstone-bridge circuits, commercially available for measuring resistance values, have less

Table 3-5. Commercially Available Test Equipment

Quantity	Item	Model	Manufacturer
1	Oscilloscope	535	Tektronix, Inc.
1	Oscilloscope	531	7709 Ogontz Ave.
2	Scopemobile	500	Philadelphia, Pa.
2	Dual trace plug-in unit	53-C	
2	Oscilloscope probes (66-inch lead)	P-510A	
2	Oscilloscope probes (144-inch lead)	P-510A	
1	Tube tester	539-B	Hickok Electrical Inst. 10514 Dupont Ave. Cleveland 8, Ohio
1	Tube checker	—	Remington Rand UNIVAC 1900 W. Allegheny Ave. Philadelphia 29, Pa.
1	Strobotac	631BL	General Radio Co. 275 Massachusetts Ave. Cambridge, Mass.
1	D-C voltmeter, 0.5% 10-100-500v	931	Weston Electrical Inst.
1	D-C voltmeter, 0.5% 7.5-30-75v	931	619 Frelinghysen Ave. Newark 5, N. J.
1	A-C voltmeter, 0.75% 12.5-25—125v	330	
1	RC bridge TO-4 Tel Ohmike	TO-4	Sprague Elec. Co. North Adams, Mass.
1	Vacuum-tube voltmeter	WV98A	Radio Corp. of America 415 S. 5th St. Harrison, N. J.
3	Multimeter	260	Simpson Electrical Co. Division of American Gage & Machine 5200-5218 W. Kinzie St. Chicago 44, Ill.
	Stabiline regulators		Superior Electric Co. 385 Laurel St. Bristol, Conn.
	Voltage-monitor stepping switches		C. P. Clare & Co. 3101 W. Pratt Blvd. Chicago 45, Ill.

than 0.02 percent error, and can accommodate resistances of 1000 ohms. These bridge circuits are necessary for making precise measurements in resistive circuits where small deviations can mean much trouble. To measure capacitive circuits requires such instruments as a capacitance bridge and a decade-capacitor box. Decade capacitors should be accurate at the terminals to ±2 percent, and provide a capacitive range from 0.001 to 1.0 microfarad. Available capacitance bridges are accurate to 1 percent.

3-103. Q-meters for measuring inductive circuits are available in accuracies of ±3 percent, with oscillators the frequency ranges of which extend to 75 megacycles. Those with very-high-frequency oscillators (up to 200 megacycles) are usually less accurate, but can measure quality coefficients up to 1200 with accuracies of ±10 percent.

3-104. A very-high-frequency signal generator is another valuable piece of test equipment. An internally modulated generator that also can be pulse- or amplitude-modulated by externally applied signals is required, preferably one capable of continuously variable output frequencies of from 2 to 400 megacycles. As little as 1 microvolt or as much as 100 millivolts may be required of such a generator. Some excellent generators that meet all of these specifications are commercially available.

3-105. To adjust the speed of the tape transport requires a stroboscope that can be calibrated in revolutions per minute and is capable of detecting speeds up to 3800 rpm. The angular velocity of the centerdrive is 950 rpm, equivalent to a tape speed of about 100 inches per second.

3-106. TEST OSCILLOSCOPES

3-107. The pulse- and square-wave shapes in the computer can be inspected only by cathode-ray oscilloscopes. One oscilloscope is a part of the supervisory control console group. It is connected to the video-monitor circuits, and is kept ready for instant use. This monitor oscilloscope may be a model 515, 524 or 531 Tektronix, a commercially available instrument chosen because of its good high-frequency response characteristics and the wide range of available sweep frequencies that increases its adaptability. In addition to this oscilloscope, other instruments are needed for maintenance and troubleshooting. Ordinarily two other oscilloscopes are considered necessary. Of these only one need be of the caliber of the supervisory monitor oscilloscope. The second instrument, of somewhat broader tolerances, can be used successfully in checking out circuits in the Uniservos and other input-output auxiliaries, where response requirements are not so stringent. The user should familiarize himself with the circuits of every instrument he uses, especially with the input circuits. Paralleling the impedance of these circuits across the circuit being inspected sometimes invalidates the readings.

3-108. REQUIRED TOOLS

3-109. Table 3-4 lists hand tools that should be available to the maintenance force. Manufacturer's model numbers have been specified on certain tools that are designed specifically for use with the components in the equipment, or that have proved most useful by experience. For example, the Western Electric bulb-extractor is designed to handle Western Electric C2 pilot lamps, which are used as the small jewel lights on the supervisory control panel, as the voltage-monitor, abnormal-operations, primary-fault and thermostat indicators. Amphenol crimping tools are necessary for fastening the Amphenol lugs in the equipment. Information on the use of Clare relay tools should be obtained from the manufacturer. No attempt should be made to adjust relays without consulting the manufacturer's recommendations. On the other hand, the model 1001 tube extractor is specified only because experience has shown that it is the easiest model to use without interfering with components on the external-components boards. Similarly the Hytron soldering aid is especially suited for work on Univac system terminal boards.

3-110. OTHER MATERIALS

3-111. Paragraph 3-93 lists items that are useful in certain special maintenance procedures. The first four are used for cleaning and lubricating the voltage-monitor stepping switches. Visimag is a suspension of magnetically susceptible powder in a liquid carrier. It is useful for inspecting the residual magnetic fields on tape, to determine whether information is being recorded properly in all channels. The residual fields can be seen best when Visimag is applied to recorded tapes for a short time, to avoid building up an accumulation of powder. The resulting image then can be transferred to transparent gummed tape. If a piece of gummed tape is laid over the magnetic tape, the powder pattern will adhere to the gum; the gummed tape can then be removed and pressed on clean white paper. This process gives an image with greater contrast between powder and background, simplifying study of the result.

3-112. PUBLISHED INFORMATION

3-113. Most problems in isolating and remedying difficulties in the Univac I system require reference to published lists, charts, and diagrams. Prints are supplied with the computer, and there are also manuals available.

3-114. The prints supplied with the equipment include:

Backboard Wiring Troubleshooting Charts
: Diagrams of the backboards of all the bays, showing the routes of the most frequently used sequencing and control signals: time-out and time-selection signals, clock pulses, timing pulses, continuous-wave signals, and cycling-unit signals.

Bypass and Cable Termination Boards
: One print per section. Describes the wiring of all screen-voltage bypass boards and coaxial-cable termination boards in the section, specifies voltages to which bypass capacitors are connected and the names of the signals associated with the coaxial-cable terminations.

Coaxial Cable Wiring Table
: One print per section. Contains pictorial diagram of wiring of all coaxial cables in the section, indicates chassis terminals to which the cables connect, the location of the cable terminations, and the connectors. The accompanying wiring table specifies the type of cable, name of the signal, connections between terminals, and the wiring route.

DC and Heater Power-Wiring Table
: One table per section. Lists every voltage in the section, indicates the fuseboard terminal on which the voltage first enters the section, lists all backboard terminals that are supplied with the voltage, and specifies wire size.

Fuse Panel 13, Fuse Panel 14
: One print of each per section. Pictorial layout and wiring table. The layout section shows the fuse-

board and all wiring on that board, and resistors for the alarm system. The table specifies voltages at the load sides of fuses, types of fuses, and connections to heater transformers and to alarm lines on other fuse channels. These prints also give rectifier-plug wiring data.

High-Speed Wiring Diagrams

Single-section backboard, pictorial, one print per section. Shows the routing of all high-speed wires on the section, indicates where each line connects to a terminal, names the inter-section wires, specifies the next section and chassis terminal, and shows components mounted on the backboard.

Low-Speed Wiring Table, or Backboard Signal Wiring Table

One print per section. Describes five types of low-speed wiring for each section: within section, inter-section, function table, supervisory control, and relay wiring. Also specifies source, route, destination, and name of the signal. The direction implied on the table is merely a wiring direction to guide the assembler. It is not necessarily the same as the functional direction of current flow.

Signal Harness Book

One table for each signal-harness plug-and-socket connector on each bay, and for each connector on the side of bay A. Describes each connector pin by pin, giving the name of the signal and all harness connections to the pin.

Supervisory Control Directory

One table for each plug-and-socket connector in the supervisory control desk, giving the names of the signals by pin number. Lists all signals and voltages entering or leaving the control console, specifies connector pins at the console and at bay A, and specifies schematic and layout drawing numbers and the inital tie-point in the control desk.

3-115. Six of these groups of prints are indexed by bay and chassis on a print entitled Layout of Bays and Associated Drawing Numbers, drawing number C801 820. The six are Bypass and Cable Termination Boards, Coaxial Cable Wiring Table, DC and Heater Power-Wiring Table; Fuse Panel 13, Fuse Panel 14; High-Speed Wiring Diagrams, Low-Speed Wiring Table.

3-116. The following manuals are available. All are published by Remington Rand Univac, Division of Sperry Rand Corporation, at Philadelphia, Pennsylvania.

Analyses of Univac Instruction. October 1956.

Summarizes each step of each instruction. Lists function signals as they arise on each step, and describes all gates, flip-flops, and delay flops used during the instruction.

Univac I System Signals and Logical Components. February 1958.

Lists operating signals, function signals, gates, flip-flops, delay flops, and binary counters. Each list tells where, when, and how each component is used, and supplies block and schematic diagram numbers as well as chassis and test terminals.

Maintenance Manual for Uniprinter. June 1951.

Contains a functional, physical, and electronic description of the Uniprinter, an auxiliary of the Univac system for transcribing from magnetic tape to typewritten copy.

Maintenance Manual for Univac Power Supply. June 1952.

Describes the operation and wiring of the Central Computer power supply.

Supervisory Control Manual. June 1952.

Gives function of each of the switches on the supervisory control panel and the wiring connections between supervisory control and the Central Computer.

Uniservo I Handbook and Maintenance Manual. February 1958.

Gives operating and maintenance procedures for Uniservo I as used with Univac I Central Computer Group, high-speed printer, and card-to-tape converter.

Univac Test Routines for Univac I Central Computer Group. January 1958.

Gives manual check-circuit test routines, step by step, and description and operation of automatic test routines, and useful programming routines, of the standard Service Routines tape.

Univac Troubleshooting Diagrams for Univac I Central Computer. July 1957.

Shows separate electronic circuits, such as amplifiers, gates, and flip-flops, in the form of logically connected blocks. Troubleshooting information, including chassis designations, vacuum tube locations, chassis terminals, and test terminals, is included with the block symbols.

SECTION IV

PREVENTIVE MAINTENANCE

4-1. GENERAL

4-2. Efficient, dependable operation of the Univac I system requires strict adherence to a regular system of maintenance. Although routine maintenance will interrupt a 24-hour operating schedule, eliminating or short-cutting maintenance procedures is false economy. Maintenance should be scheduled into the computer program, not conducted on a hit-or-miss basis. If the computer operates on a 168-hour week, 15 percent of this time should be set aside for maintenance. This allows 80 percent of the schedule for operating and 5 percent for downtime or other contingencies. In drawing up a schedule for the individual installation, it is better to overestimate maintenance requirements, then gradually readjust them as time and usage dictate. If a two-shift operating schedule is set up, routine maintenance can be carried out during the 8-hour break between operating shifts.

4-3. Table 4-1 breaks down maintenance requirements according to period—daily, weekly, biweekly, monthly, quarterly, and semiannually. Following each listing in this table are numbers of the paragraphs in this manual in which the maintenance procedure is described in detail. References to the Uniservo I manual are also indicated. The maintenance schedule for the Uniservo should not interfere with the operating schedule of the computer. Generally, an installation does not use all ten Uniservos on each shift. Schedule cleaning, adjustments, or other Uniservo maintenance during an operating shift. This will avoid overlapping servo maintenance time with computer maintenance time.

Table 4-1. Routine Maintenance Schedule

Note: Procedures for the Uniservo are given in section VI of the Uniservo I manual.

DAILY
Clean printer dolly.
Clean control desk and printer (paragraph 4-11).
Clean and dust supervisory control panel (paragraph 4-10).
Clean, inspect, and perform daily maintenance on all Uniservcs (paragraph 4-8).
Perform weekly maintenance for one or two Uniservos.
WEEKLY
Check memory channels (paragraph 4-13).
Perform routine tube test (paragraph 4-14).
Check AGC voltage (paragraph 4-15).
Check control printer (paragraph 4-16).
Perform monthly maintenance for two or three Uniservos.
BIWEEKLY
Check power supply (paragraph 4-19.)
MONTHLY
Perform check-circuits test routine (paragraph 4-22).
Lubricate blowers (paragraph 4-23).
Lubricate the interrupted-operation switch (paragraph 4-24).
Check supervisory control switches and lubricate as necessary (paragraph 4-25).

QUARTERLY
Measure power-supply hum (paragraph 4-27).
Check phase fault detectors (paragraph 4-28).
Lubricate voltage-monitor motor (paragraph 4-29).
Inspect voltage-monitor stepping switches (paragraph 4-30).
Inspect microswitches (paragraph 4-31).
Check airflow switches (paragraph 4-32).
Check bay thermostats (paragraph 4-33).
Check fuse and chassis screws (paragraph 4-34).
Adjust long-tank standby and overheat switches (paragraph 4-35).
Check short-tank alarm circuits (paragraph 4-36).
Make bleeder adjustment (paragraph 4-37).
Clean control printer chassis (paragraph 4-38).
SEMIANNUALLY
Check timing-pulse generator (paragraph 4-40).
Check cw generator (paragraph 4-41).
Check cw buffer drivers (paragraph 4-42).
Check fuse alarm circuits (paragraph 4-43).
Check alarm primary contacts (paragraph 4-44).
Check protective rectifiers (paragraph 4-45).
Clean and inspect all components of the Central Computer (paragraph 4-46).
Inspect Uniservo components for signs of wear, overheating, and breakage.

(For details of Uniservo routine maintenance, refer to section VI of the Uniservo I manual.)

4-4. SAFETY PRECAUTIONS

4-5. For his personal safety, the technician should follow these suggestions:

(1) Never work on the computer alone.

(2) If it is necessary to turn dc off, the d-c lock switch also should be turned off.

(3) When working inside the computer, remove the key from the d-c lock on the supervisory control panel, or push the tab over the D. C. OFF button in bay P.

(4) Turn dc off when:

- (a) Making resistance measurements in d-c circuits.
- (b) Removing or replacing a chassis.
- (c) Pulling any capped tubes.
- (d) Making any power supply adjustments.
- (e) Repairing any mounted chassis.

(5) Turn ac off when:

- (a) Making resistance measurements in a-c circuits.
- (b) Replacing heater fuses or any d-c fuse next to a heater fuse.

(6) Turn standby power off, as well as dc, when:

- (a) Removing a short-tank chassis, or a chassis next to a short tank.
- (b) Replacing a standby-voltage fuse.

(7) Interlocks and power alarms are safety devices. Do not jam them unnecessarily; repair them if they fail, and advise others if they are faulty or jammed.

(8) Ring the warning bell twice when applying power. Ring it once when removing power. Always look at the power warning lights before working on the computer.

4-6. OPERATING PRECAUTIONS

4-7. To avoid damaging the computer, follow these suggestions:

(1) Do not hold the FAULT TEST switch down while turning on dc.

(2) If the load on a circuit continues to blow fuses, investigate carefully for a serious trouble.

(3) Insert and remove tubes gently, using a tube extractor. Be sure that the rim of the tube base does not catch on resistors or other external components.

(4) Do not use alligator clips as probes. A probe should have no more than ¼ inch of exposed tip.

(5) After replacing a 4D32 or 829B tube, always allow at least 2 minutes to elapse before turning on dc. When replacing mercury vapor rectifiers, allow at least 15 minutes.

(6) Keep doors and kickplates closed. Loss of air is serious. If a bay thermostat opens, investigate immediately.

(7) When inserting extenders or chasses, be careful not to bend the backboard contacts.

(8) Replace chasses as quickly as possible. While a chassis is mounted on a flexible extender, deflect it as little as possible.

(9) Never short an error circuit or fault alarm to force the computer to start operating.

(10) When changing fuses, be sure that no screws or pieces of fuse fall into the fuseboards.

(11) Uniservo chasses should be removed only after connectors JPA and JPB are removed. Connectors JPA must be removed first and replaced last.

(12) Turn off power before trying to remove any foreign object from the computer or any of the input-output auxiliaries.

(13) Except in an emergency, do not make any substitutions of components or fuse sizes.

4-8. ROUTINE MAINTENANCE

4-9. DAILY

4-10. The daily routine maintenance requires the technician to:

(1) Clean and inspect all Uniservo heads, strings, pulleys, and mylar tape. Details of these procedures are given in section VI of the Uniservo I manual.

(2) Clean printer dolly.

(3) Dust supervisory control panel.

(4) Perform weekly preventive maintenance and cleaning on one or two Uniservos. The number of Uniservos that must receive weekly maintenance depends, of course, on the number of Uniservos at the installation and on the number of operating shifts. Refer to section VI of the Uniservo I manual for weekly preventive maintenance procedures.

4-11. CONTROL DESK AND PRINTER. Use a vacuum cleaner with a soft dusting attachment to clean the control panel, the inside of the control desk, and the inside and outside of the control printer.

4-12 WEEKLY.

4-13. MEMORY CHANNELS. Examine the contents of all memory channels with the supervisory control oscilloscope. This procedure overlaps the AGC check, but is simplifies the detection of weak signals. The procedure is as follows:

(1) Read pulse trains into all memory channels.

(2) Push the SYNC switch up to select 0p0 as the sweep synchronizer signal.

(3) Examine the contents of each channel, first with –1.75-volt bias with the I.F. BIAS CONTROL set to NORMAL, then with –2.25-volt bias with the I.F. BIAS CONTROL set to HIGH. If a channel shows a 20-percent difference in amplitude, the 6AK5 tubes, or the 6AN5 tube, are getting weak and should be replaced.

4-14. ROUTINE TUBE TEST. In computers with marginal-checking equipment, check tubes with the MARGINAL CHECK switch on and the I.F. BIAS CONTROL set to HIGH. In computers without marginal-checking equipment, check one bay of tubes every two weeks. Always use a Univac Tube Tester. Proceed as follows:

(1) Test a complement of tubes at least 100 hours old to replace the tubes in the scheduled bay.

(2) Remove tubes in bay and replace them with tested tubes.

(3) Test removed tubes, and use all that pass inspection for the next bay.

(4) Allow a few minutes for troubleshooting at the conclusion of this procedure.

4-15. AGC-VOLTAGE CHECK. The procedure for checking AGC voltage is:

(1) Plug the monitor voltmeter into the AGC jack on the supervisory control panel. Use a voltmeter without a 1-megohm resistor in the probe.

(2) Using the AGC monitor pushbuttons, read and record the AGC voltages on the local drivers. These should read from –3 to –5 volts. If the voltage drops below –8 volts the 807 tubes in the driver circuit should be checked. If all the driver voltages read below –8 volts, check the timing-pulse generator (paragraph 4-40).

(3) Read all pulse trains into mercury channels.

(4) Use the AGC monitor pushbuttons to select channels. Measure and record the AGC voltage on all memory channels. These should read from –3 to –2 volts.

(5) Decrease the a-c filament voltage from 230 to 220 volts on computers that have Stabiline regulators (table 3-5). Record the AGC readings and investigate the i-f values and recirculation chasses that cannot hold a –2-volt level.

(6) If the voltage in a channel approaches –1.75 volts, check the channel. The fault should be traced without using the computer as a tube tester. Put in a new video amplifier tube, 25L6, in position V5 on the amplifier chassis. If the reading continues to be low, replace the amplifier chassis, check all the amplifier tubes type 6AK5, and the detector driver, 6AN5.

(7) If several chasses have low AGC voltages, look for failure patterns that indicate a defective element common to the group, such as cw buffer-driver, or a local timing pulse driver.

(8) If all memory channels read low, and the short tanks read high, one of the two cw generators is faulty (paragraph 4-41).

(9) If all the mercury channels are low, the timing pulse generator should be checked (paragraph 4-40).

4-16. CONTROL PRINTER. The control printer requires a weekly check of:

(1) All voltages on the fuseboard located in the cabinet of the printer dolly on the power rack. Check the voltages of the two d-c fuse connections with a voltmeter. They should read between –90 and –100 volts. The a-c supply fuse connection should read 110 volts.

(2) The printer-action signal. Check with an oscilloscope at terminal T46 of chassis 12. This signal is actuated by the printer-action switch and should produce a sharp positive signal. All bounce signals should occur within 5 milliseconds of the original signal. If the printer-action switch does not operate, the signal is not returned to the printer-action flip-flop. The switch is the second, counting from left to right, in the back of the typewriter. To adjust it, loosen the two bracket-mounting screws which pass through slotted holes of the bracket. Move the bracket up to make the switch close sooner, and down to make it close later. The switch should close when the type bar is lifted by hand approximately ½ inch from the platen. When the type bar returns to rest position, the switch should open. The switch arm should travel slightly after the type bar returns to rest position.

(3) The operation of the margin switch. Operate the printer. The switch is normally open. If the switch sticks, the line-spacing operation will continue. The margin switch is the fourth, counting from left to right, in the back of the typewriter. To prevent sticking, the mounting-switch operating slide should be cleaned, the slide-guide aligned, or the switch mounting bracket positioned by the two mounting-bracket screws.

(4) The EMPTY operation.

(5) The carriage-return operation. The carriage-return switch is the first, counting from left to right, in the back of the typewriter. The switch is open when the carriage-return operation is normal. The carriage-return switch should close at the same instant the carriage-return dog-crank returns to normal position. If the carriage-return switch operates too late, the carriage will return but no printing will follow. If the switch operates too soon, the typewriter will print while the carriage is moving. When either fault interferes with the operation of the carriage, adjust the mounting bracket of the switch. Loosen the two screws that pass through the slotted holes of the bracket and move the bracket down if the switch operates too late. Move the bracket up if the switch operates too soon. If the adjustment cannot be made by moving the bracket, form the contact arm of the switch in the direction of the adjustment.

(6) The tabulating operation. The TAB switch is the third, counting from left to right, in the back of the typewriter. The switch is open during a TAB operation, and closed just before the bell-crank reaches its normal position. If the TAB switch operates too

late, the carriage will move but printing will cease. If the switch operates too soon, the typewriter will print while the carriage is moving. When either fault interferes with the tabulating operation, adjust the mounting bracket of the TAB switch. Loosen the two screws that pass through the slotted holes of the bracket, and move the bracket up if the switch operates too soon. Move the bracket down if the switch operates too late. If the adjustment cannot be made by moving the bracket, form the contact arm of the switch in the direction of the adjustment.

4-17. UNISERVOS. Perform monthly maintenance for two or three Uniservos, depending on the number at the installation and the number of shifts being worked. Refer to the Uniservo I manual.

4-18. BIWEEKLY

4-19. POWER SUPPLY. Small variations in power-supply voltage can cause trouble. For example, variations in the grid-return voltage would make the operation of a flip-flop unstable. As part of regular preventive maintenance, check the 14 power-supply voltages (located in the power-supply unit and read in the KL corner) with a 0.5-percent d-c voltmeter. The voltage of each supply should be within 1 percent of the required voltage output (table 2-1) after a reasonable warmup time. Correct a greater deviation by adjusting the percentage links or switches in the power supply. If the voltage rises to half the expected value, one of the two phases in the power supply is open. Turn off the dc immediately and investigate and correct the cause. This type of trouble may be caused by a defective percentage switch or an incorrectly seated link.

4-20. Switches also oxidize and accumulate dirt. If a switch is rotated in and out of a new position several times and does not function when dc is turned on, replace the switch. When a switch cannot be adjusted to compensate for an aging selenium rectifier, replace the rectifier. Keep a log of the voltage readings of power-supply rectifiers to observe the aging process.

4-21. MONTHLY

4-22. CHECK-CIRCUIT TEST ROUTINE. The principal maintenance operation in the monthly schedule is the check-circuit test routine. This routine is important because the reliability of the computer depends on the correct functioning of the checking circuits. If these circuits do not function, errors are not detected. The test routine consists of running errors inserted by the operator or by a recorded program. These intentional errors must effect certain results, which stop the computer and light the error neons on the control panel. This and other routines are described in detail in the Univac I Test Routines manual (paragrap 3-115).

4-23. BLOWER LUBRICATION. Lubricate all blowers and blower motors in the Central Computer and the power supply according to the manufacturer's specifications.

4-24. INTERRUPTED-OPERATION SWITCH LUBRICATION. Lubricate the ball bearing at the base of the interrupted-operation switch with DC 200 oil or graphite. The ball bearing can be reached by removing the supervisory control keyboard, or by opening the front of the supervisory control panel. A dry ball bearing is the primary cause of broken interrupted-operation switches.

4-25. SUPERVISORY CONTROL SWITCHES. Check all supervisory control switches for freedom of movement. If any of them stick, open the supervisory control panel to lubricate the pivots with DC 200 oil.

4-26. QUARTERLY

4-27. POWER-SUPPLY HUM MEASUREMENT. Power-supply measurements are made to detect faulty filter capacitors. To detect excessive hum, use a Tektronix 531 or 535 oscilloscope (table 3-5), calibrated to one volt per inch on the d-c amplifier, and switch to the a-c amplifier input to measure and record the hum at all power points in the KL corner with the oscilloscope. If there is a pronounced difference between the measured hum value and that given in table 2-1, or between the current readings and a set of previously recorded readings, the capacitor is aging. Excessive hum is corrected by replacing faulty filter capacitors in the power supply.

4-28. PHASE-FAULT DETECTORS. The phase-fault detectors are not the same in all computers. In some computers, the detectors consist of four relays, RP28, RP29, RP30, and RP31, connected in series with the main fuses. In other installations, the phase-fault detectors are auxiliary switches ganged to the main circuit breakers. To test the detectors, open the a-c main circuit breaker. The associated relay or auxiliary switch should turn off ac and light all neons on the side of bay P and the main fuse indicator. Replace any neon that does not light. If none of them lights, check wiring.

4-29. VOLTAGE-MONITOR MOTOR. Inspect the oil cup on the voltage-monitor motor. If necessary, add SAE20 motor oil to the cup.

4-30. VOLTAGE-MONITOR STEPPING SWITCHES. Inspect the four voltage-monitor stepping switches in the KL corner. Clean and check for free movement. For detailed maintenance information, consult Clare and Co. specification M1001 (table 3-5).

4-31. MICROSWITCHES. Inspect the microswitches in the KL corner. Clean cams and switches and adjust contacts.

4-32. AIRFLOW SWITCHES. Manually check the three airflow switches. Two are located in the Central

Computer: one in the bottom of bay C, and one in the bottom of bay J. The third is located in the power-supply unit in the bottom of bay W. Proceed as follows:

(1) Make certain that the switch housing is bolted tightly to the bay beam, and that the airvane is perpendicular to the air stream.

(2) Open the airflow switches momentarily. Each one should turn off dc. Do not hold the switches open. If they are held open, a-c power also will be turned off.

4-33. BAY THERMOSTATS. There is a thermostat in the top of each bay in the Central Computer, in the power-supply unit, in the HJ corner, and in the BC corner. Each thermostat is manually operated. Proceed as follows:

(1) Push the bimetallic disc on the back of each thermostat until it clicks and opens the thermostat. The a-c interlock then opens, turns off ac and lights an indicator on the side of bay P (paragraph 2-253). Reset the thermostat by pushing the ceramic button on the front of the thermostat.

(2) Repeat the procedure on each thermostat.

4-34. FUSE AND CHASSIS SCREWS. Tighten screws at fuse terminals and remove any fallen parts. Tighten chassis screws in all bays and tanks.

4-35. LONG-TANK STANDBY AND OVERHEAT SWITCHES. The long-tank standby and overheat switches control ac to the long-tank heating coils. If either switch gets out of adjustment, the ac may either overheat or underheat the tank. Overheat alarms and abnormally long periods for dc to reach equilibrium can indicate that the overheat switch and the standby switch are out of adjustment. If a tank that develops an overheat can hold pulses when the neon goes out, the overheat alarm is false and the overheat switch is out of adjustment. If the tanks are slow in reaching d-c equilibrium after the cycling unit has been turned on, the standby switch is out of adjustment. (Slow means longer than 15 minutes if only ac has been turned off, while standby power remained on; 30 minutes to an hour if the computer has been turned off only a few hours; a full hour, after a weekend shutdown.)

To adjust the standby and overheat switches:

(1) Shut off dc.

(2) Remove the cover plate held by the four screws on the exposed end of the tank.

WARNING

When working on the GV tank, transfer the overheat-alarm ground wire from the cover plate to the chassis strut. This wire is hot when it is removed from ground. The terminals next to the switches also have a high potential (230 volts ac).

Two screws are mounted under the cover plate on the end of the tank. One is labeled OH (overheat), and the other SB (standby). These are the stop-set screws by which the system is adjusted. If the label is not near the adjusting screw, follow the arrow to the adjusting screw.

(3) Turn on dc. Start the cycling unit and wait until the memory tanks have reached the operating temperature (d-c equilibrium). (In all Univac I systems except the first eight, dc will not come on unless control power is turned off and turned back on again, or relay RP27 in KL corner is picked up manually, or RP28 is dropped out.)

(4) Turn the standby adjusting screw counterclockwise until the STAND-BY HEATERS-LONG TANKS neon for the tank lights. (This light is on the supervisory control panel.) Rotate the screw one-third turn clockwise.

(5) Rotate the overheat adjusting screw clockwise until the overheat neon on the end of the tank lights. At this point dc should go off. Turn the adjusting screw one-third turn counterclockwise. (In all installations from the ninth on, RP28 in KL corner is dropped out to reestablish dc after an overheat.)

(6) Turn off dc to replace the coverplates. The ground connection for the GV tank must be replaced.

4-36. SHORT-TANK ALARM CIRCUITS. Check the short-tank overheat alarm circuits for correct operation. A short-tank overheat may be simulated by connecting a 3.9-kilohm resistor with insulated leads between terminals A and C on a short tank. This should cause standby power to drop, and the drop should show on the six meter-movement relays in the DE corner. When a short tank overheats during normal operation, three of the six meters identify the tank. A short-tank overheat chart in the DE corner lists the combination of meters that indicates each tank.

4-37. BLEEDER ADJUSTMENTS. Check all power-supply voltages quarterly. Ensure before adjusting bleeders that supply voltages are correct (paragraph 4-19). When components age, the bleeder taps require adjustment. This adjustment is more difficult than a power-supply adjustment because there is an interaction between the various levels in a power supply. When one resistor tap is moved, all other voltages in the particular supply must be checked, adjusted, and the defective bleeder resistors replaced. Taps should be set within 2 percent of the bleeder resistor values in table 2-1. Before the power supply is adjusted, the computer must be in operating condition and at normal temperature, and the memory must be clear. (The procedure for clearing the memory is given in table 5-25.)

WARNING

To avoid shock when adjusting bleeder taps, dc must be turned off momentarily.

If the voltage monitor is used to check the voltage levels, the taps should be set with an accurate meter and the voltage monitor checked at the same time. Even though two voltages may be within 2 percent of normal, their differences may be 4 percent, which is the maximum deflection on the voltage monitor meter.

4-38. CONTROL DESK AND PRINTER. Remove all chasses from the control printer and clean them thoroughly. Inspect all components for breaks, signs of wear, and overheating.

4-39. SEMIANNUALLY

4-40. TIMING-PULSE GENERATOR TUNING. The purpose of this check is to tune the timing-pulse generator (figure 4-1). The timing-pulse generator is located on chassis G11, in position 12V. Proceed as follows:

(1) Connect a 20,000-ohm per volt meter to the screen grid of the clipper tube at test terminal B8.

(2) Adjust the tuning capacitor in the oscillator circuit for minimum reading at test terminal B8.

(3) Connect a precision oscilloscope to the plate of tube V4, chassis G11, position 12V, and observe the waveform of the ringing circuit. Tune the inductor in this circuit so that the ringing circuit produces the third harmonic wave of the input signal. The last cycle of the decaying third harmonic wave should follow smoothly into the first cycle of the next group.

4-41. CW-GENERATOR TUNING. The purpose of this check is to tune the cw generators (figure 4-2).

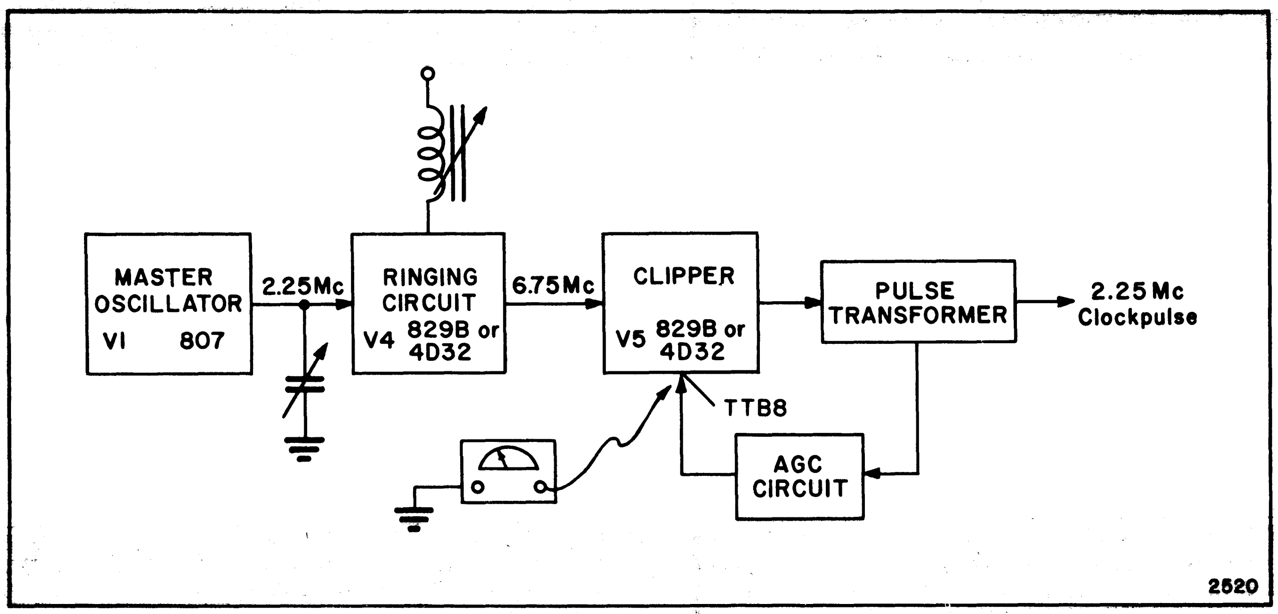

Figure 4-1. Timing-Pulse Generator

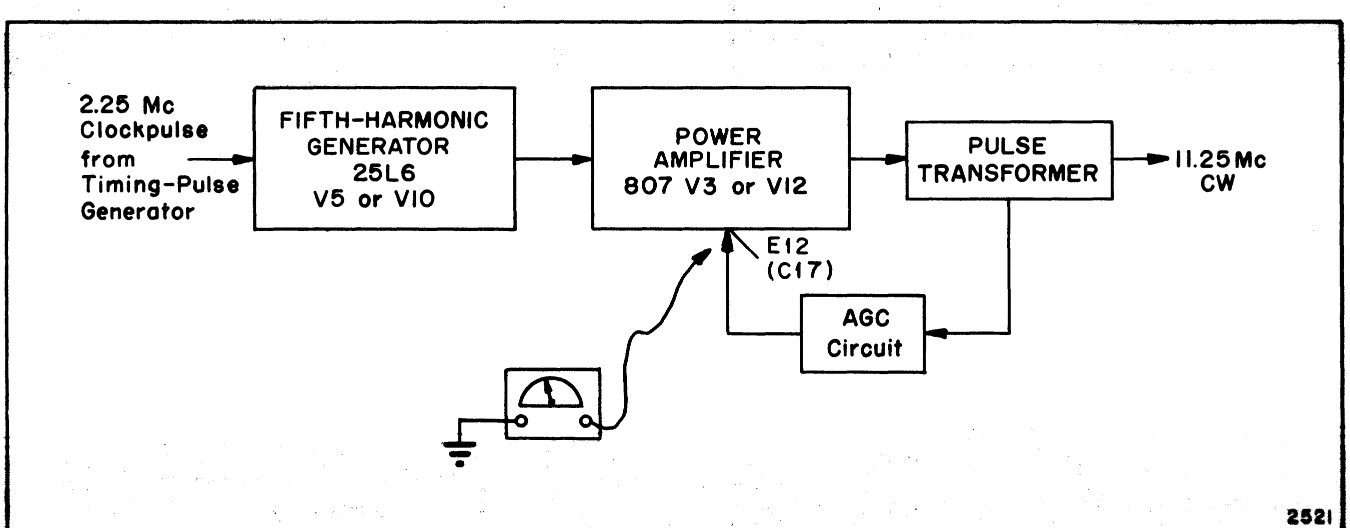

Figure 4-2. CW Generator

The cw generators are located on chassis N1T:
To tune:

(1) Connect a 20,000-ohm per volt meter between the screen grid of the power-amplifier stage at test terminal C17 and ground for generator 1, and between test terminal E12 and ground for generator 2.

(2) For generator 1, tune the inductor (V4-position) in the first stage, and the inductor (V2-position) in the second stage, for minimum reading at test terminal C17.

(3) For generator 2, tune the inductor (V11-position) in the first stage, and the inductor (V13-position) in the second stage for minimum reading at test terminal E12.

4-42. CW BUFFER DRIVER TUNING. The purpose of this check is to tune the 16 cw buffer drivers. Four buffer drivers are mounted on each of chasses M12T, M12V, M12X, and N12X. Each chassis has four test terminals, TTA11, TTE15, TTC11, and TTG15, connected to the screen grids of the driver tubes. There is a variable inductor in the anode circuit of each driver tube. To tune each buffer driver:

(1) Connect a 20,000-ohm per volt meter to the test terminal.

(2) Tune the inductor for minimum reading at the test terminal.

4-43. D-C AND HEATER-SECONDARY ALARM CIRCUITS. The purpose of this check is to test the fuse-alarm circuits. Proceed as follows:

(1) Short an alarm contact on a negative fuse to the line side. This should turn dc off and the d-c fault indicators on the control panel should indicate the location of the fuse being tested.

(2) Short an alarm contact on a positive fuse to the line side. This should turn dc off and the d-c fault indicators on the control panel should indicate the location of the fuse being tested.

(3) Turn dc off. Check the d-c and heater-secondary alarm contacts listed in table 4-2. Do this by shorting each alarm contact to the supply side of the fuse and depressing the d-c fault switch on the control panel. The d-c fault indicators on the control panel should indicate the location of the fuse being tested (figure 2-37).

Table 4-2. D-C and Heater-Secondary Alarm Contacts

Section	Board and Contact	Section	Board and Contact	Section	Board and Contact	Section	Board and Contact	Section	Board and Contact
AT	13Q23	DV	13Q26	NT	14Q26	HT	14Q26	LT	14Q1
AT	13Q26	DV	14Q1					LT	14Q25
AT	14Q1			NV	13Q1	HV	13Q26	LT	14Q1
		DX	13Q26	NV	13Q26				
AV	13Q25	DX	14Q1	NV	14Q1	EX	13Q25	LV	14Q25
AV	13Q26	DX	14Q23	NV	14Q26	EX	141Q1	LV	14Q26
AV	14Q1					EX	141Q3		
AV	14Q4	ET	13Q23	NX	13Q1			LX	14Q1
		ET	13Q25			JT	13Q26	LX	14Q25
AX	13Q22	ET	14Q1	CT	13Q26	JT	14Q1		
AX	13Q24	ET	14Q14	CT	14Q16	JT	14Q26	PT	13Q26
AX	14Q2			CT	14Q1			PT	14Q1
		EV	13Q26			JV	13Q26	PT	13Q25
BT	13Q26	EV	14Q1	CV	13Q26	JV	14Q1		
BT	14Q1	EV	14Q15	CV	14Q1	JV	14Q24	PV	13Q5
BT	14Q25							PV	13Q25
		MT	131Q1	GT	13Q4	JX	13Q25	PV	14Q20
BV	13Q26	MT	13Q25	GT	13Q25	JX	14Q1	PV	14Q1
BV	14Q1	MT	14Q1	GT	13Q26	JX	14Q26		
		MT	14Q26	GT	14Q1			PX	13Q26
BX	13Q26			GT	14Q25	KT	13Q26	PX	14Q1
BX	14Q1	MV	13Q10			KT	14Q1		
BX	14Q17	MV	13Q25	GV	13Q1	KT	14Q24	HV	14Q1
BX	13Q17	MV	14Q1	GV	13Q25	KT	14Q25	HV	14Q26
		MV	14Q25	GV	14Q1				
CX	13Q26			GV	14Q13	KV	13Q25	HX	14Q1
CX	14Q1	MX	13Q1	GV	14Q25	KV	14Q1	HX	14Q26
		MX	13Q25						
DT	13Q24	MX	14Q1	GX	13Q26	KX	13Q26	KX	14Q24
DT	14Q3	MX	14Q24	GX	14Q1			KX	14Q25
DT	14Q24			GX	14Q22	NX	13Q23	KX	14Q1
		NT	13Q1	GX	14Q25	NX	13Q26		
DV	13Q6					NX	14Q1	PX	14Q25
DV	13Q7			HT	14Q1	NX	14Q26		

4-44. ALARM PRIMARY CONTACTS. The alarm primary contacts to be checked are:

(1) The alarm contacts on the four d-c fuseboards on the back of bay R should turn off dc and light the red primary-fault indicator.

(2) The following contacts should turn off dc and light the green primary-fault indicator:

- (a) The contacts on the a-c fuseboard on the back of bay R.
- (b) The contacts of each of the five fuseboards on side of bay P.
- (c) Q1 and Q14 on the a-c fuseboard in the BC corner, and Q25 in each Uniservo.

4-45. PROTECTIVE RECTIFIERS. The purpose of this check is to locate protective rectifiers that have aged too much to protect the clamping diodes. (Refer to paragraph 1-49.) If a selenium diode does not pass this test it should be replaced. When a faulty component has been detected, refer to drawing D800 297, which shows the location of components and detailed connections. To check:

(1) Turn off dc.

(2) Disconnect the two rectifier plug connectors, RP13 and RP14, from their sockets, RS13 and RS14, on bay A.

(3) Refer to drawing D800 297 and determine which pairs of pins on RP13 and RP14 are connected to the same selenium diode. With an ohmmeter (scale R x 100), measure and record the resistance in both directions through all protective diodes. Record readings. Compare these readings with previously recorded readings. The ratio of backward to forward resistance should be 10 to 1 or greater. If it is not, replace rectifiers.

(4) Repeat this procedure for all bays in the Central Computer.

4-46. CLEANING AND INSPECTION OF ALL COMPONENTS OF CENTRAL COMPUTER. Accumulations of dirt can reduce the effectiveness of the cooling system, accelerate aging of components, and cause partial short circuits and arcing or dissipated signals. Proceed as follows:

(1) Turn off all power except ϕ1L5 while cleaning the computer. This line supplies power to the convenienee outlets and lights.

(2) Clean all components, backboards, terminal strips, and structural members with a vacuum cleaner. Use a soft dusting attachment. Remove each chassis for cleaning. Do not disturb any fixed component or bend the spring contacts. Inspect all components for breaks, indications of arcing and overheating, and other signs of trouble.

(3) Clean the power supply, using the same procedure as in steps 1 and 2.

(4) Tighten barrier strip connections at quadrangle and bay bases.

(5) Inspect all fan belts for signs of wear, and replace them if necessary.

4-47. UNISERVOS. Inspect Uniservo components for signs of wear, overheating, arcing, and breakage. Refer to Uniservo I manual.

4-48. MAINTENANCE LOG

4-49. It is sound maintenance practice to record intermittent troubles and their symptoms in a maintenance log, as soon as the troubles occur. Enough evidence will build up in the log concerning the trouble to enable the technician to trace it with minimal waste effort during maintenance periods. The Electronics Services Division of Remington Rand Univac has devised an Intermittent Log Report and has distributed it to Univac system installations. See figure 4-3.

4-49. SPARE PARTS

4-50. A complete supply of spare parts is essential to the maintenance of an installation. The spare-parts procurement schedule and the maintenance schedule should be managed so as to assure that replacement parts are always on hand. Lists of recommended spare parts are supplied on request by the Electronic Services Division of Remington Rand Univac. Some of these parts are available on the open market. Others are manufactured and supplied solely by Remington Rand.

4-51. Purchase spare parts on the open market with caution. Many of the components for the Univac system must meet more rigid specifications than those supplied to the radio and television industry. Crystal diodes that are erratic, or that drift, or that are mechanically unstable, may be adequate for many uses but cause errors when used in certain high-speed computing circuits. Tubes that have screen or plate currents greater or less than standard values, irregular cut-off characteristics, low emission, and a slow response time may function adequately in some circuits, but be completely unusable in others. The "sleeper" tube is an example. Such tubes have many applications. Their dynamic characteristics are only slightly different from those of standard tubes. The sleeper is inadequate, however, in a sequencing circuit or an instruction-control circuit, in which amplifier tubes are forced to remain cut off for long periods and then stabilize rapidly at full conduction for a brief period.

INTERMITTENT LOG REPORT

DATE: TIME:

Maintenance Personnel:

Operator:

Programmer:

PROGRAM INFORMATION

Type of run:

Phase of run:

Elapsed time into run:

Had operator intervened in program progress?

FAILURE INFORMATION

Instruction:

Cycle Counter:
Program Counter:

Other pertinent counter readings:

Other supervisory control indications (Time Selection, Overflow, Direction of Memory, etc.):

Errors:

Typeouts:

DETAILS OF INVESTIGATION:

THEORIES:

FURTHER INVESTIGATION:

Figure 4-3. Form for Logging Intermittent Troubles

SECTION V
SYSTEM ANALYSIS

5-1. GENERAL

5-2. Four methods are available to diagnose troubles in the Univac I System Central Computer. They are:

(1) Analysis of the indications at the control panel.

(2) Forcing recurrence of the error, if possible.

(3) Isolating the faulty circuit by operational analysis.

(4) Tracing signals, and checking voltages and components.

5-3. In paragraph 5-4, controls and indicators on the supervisory control panel and the associated keyboard are explained in detail. Paragraph 5-24 explains analysis by power turn-on, start procedure, error analysis, and sample troubles.

5-4. SUPERVISORY CONTROL

5-5. GENERAL

5-6. The supervisory control console group, consisting of the panel (figure 5-1), the associated keyboard (figure 5-2), the monitor oscilloscope, and the control printer, is the principal means of communication between the operator or programmer and the Central Computer. Power turn-on and start procedures as well as subsequent operations are performed from the control panel. In addition, the controls and indicators on the panel are useful maintenance and troubleshooting tools.

5-7. SUPERVISORY CONTROLS AND INDICATORS

5-8. All the switches and pushbuttons (controls) and neons and jewel lights (indicators) of the supervisory control panel are listed and explained in tables 5-1 through 5-31.

5-9. KEYBOARD AND PRINTER CONTROLS

5-10. GENERAL. Keys on the control keyboard and switches on the printer dolly activate some of the supervisory control console functions. The control keyboard is the same as the keyboard used on the Model I Unityper; it consists of three sections (figure 5-2). One is a slightly modified version of a standard typewriter keyboard. The second is a bank of 12 control keys. The third section is a 12-key numeric keyboard. At the bottom of the composite keyboard are two bars —the space bar on the left, and the start bar on the right.

5-11. The keyboard is used to type information directly into the memory or the control register, and to start the computer after a breakpoint or stop.

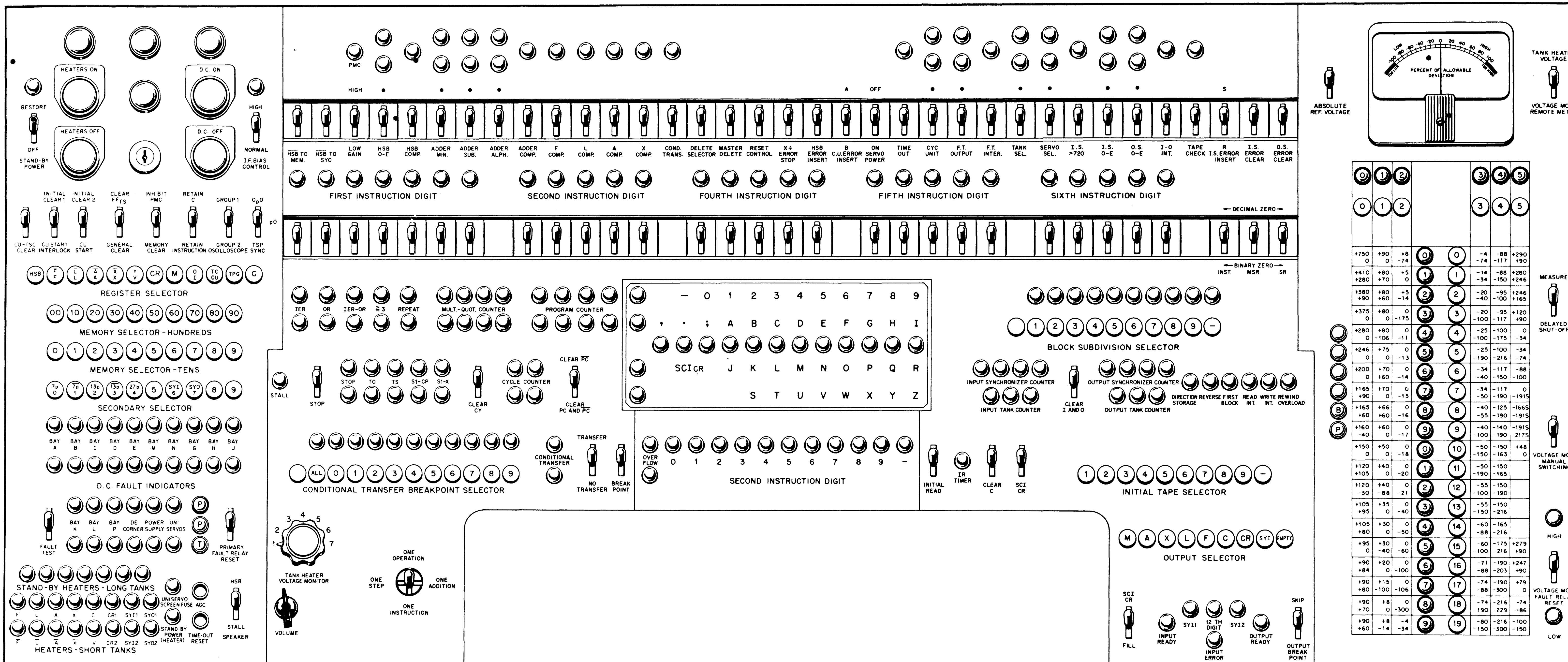

Figure 5-1. Supervisory Control Panel

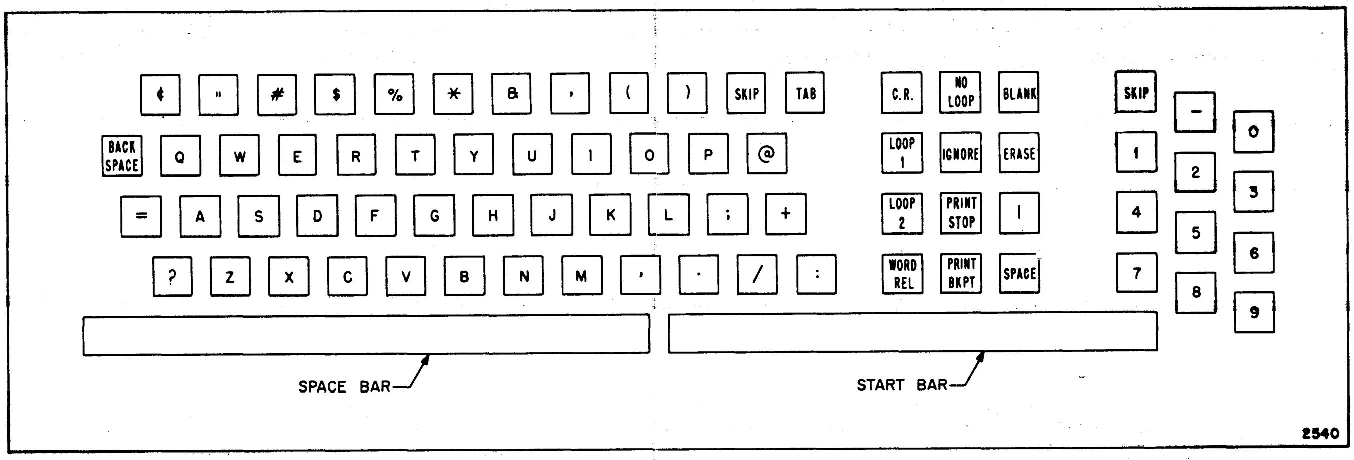

Figure 5-2. Supervisory Control Panel Keyboard

Table 5-1. Power Controls and Indicators, Located on Top Left Panel

Number and Type	Distribution	Function
	CONTROLS	
1 telephone-key switch marked STAND-BY POWER, 3-position, with associated neon (see Indicators)	——	Released: Acts as holding contact for stand-by power relay RP24 (figure 2-14). Up: nonlocking, marked RESTORE above switch, turns on d-c stand-by power supply to heat short mercury tanks, lights neon above switch. Down: locking, marked OFF below switch, turns off stand-by power and neon.
1 lock-and-key	——	Must be turned on before dc can be applied.
4 pushbuttons, spring-loaded, with associated jewel-lights (see Indicators)	1 pushbutton marked HEATERS ON	Turns on heater power, lights green jewel-light above push-button; after warmup delay, lights yellow jewel-light to right of pushbutton to indicate that dc may be turned on. Effective only when orange jewel-light (diagonally to right of pushbutton) is on.
	1 pushbutton marked HEATERS OFF	Turns off heater power and green jewel-light; also turns off dc and red jewel-light above D.C. ON pushbutton.
	1 pushbutton marked D. C. ON	Turns on dc, lights red jewel-light above pushbutton. Effective only when d-c lock switch is turned on and yellow ready jewel-light is on.
	1 pushbutton marked D. C. OFF	Turns off dc and red jewel-light above D.C. ON pushbutton.
	INDICATORS	
1 neon	——	Lights when d-c stand-by power is on. Turns off when d-c stand-by power is off, or when a short mercury tank is overheated.
4 jewel-lights	1 orange	Lights when control power is on.
	1 green	Lights when heater power is on.
	1 yellow	Lights 5 minutes after heater power is turned on. (Often called ready light.)
	1 red	Lights when dc is on.

Table 5-2. I-F Bias Control and Indicator, Located on Top Left Panel

Number and Type	Distribution	Function
	CONTROL	
1 telephone-key switch marked I.F. BIAS CONTROL, 3-position nonlocking, with associated neon (see Indicator)	———	Released: no effect. Nonrestoring circuit.* Up: marked HIGH above switch, places –2.25v bias on IF stages in all memory channels. Down: marked NORMAL below switch, places –1.75v bias on IF stages in all memory channels.
	INDICATOR	
1 neon		Lights when –1.75v bias is applied (NORMAL position of switch).

* Nonrestoring circuits, as identified here, are those from which the control switch is automatically disconnected immediately after it is pushed up or down. The released, or middle, position of a switch that affects a nonrestoring circuit is not significant, in that the last engaged position continues to control the switch until it is pushed in the opposite direction.

Table 5-3. Start Controls, Located on Upper Left Panel

Number and Type	Distribution	Function
5 telephone-key switches	1 switch, 2-position nonlocking	Released: no effect. Down: marked CU-TSC CLEAR, clears 7- and 13-pulse loops in cycling unit, restores cycling unit error flip-flops, and clears time-selection counter to decimal zero.
	1 switch, 3-position nonlocking	Released: no effect. Up: marked INITIAL CLEAR 1, clears rV, rY, and all arithmetic registers to binary zero. Down: marked CU START INTERLOCK, alerts output of single-pulse device in cycling unit.
	1 switch, 3-position nonlocking	Released: no effect. Up: marked INITIAL CLEAR 2, inserts pulses into each register to stabilize automatic gain-control circuits. Down: marked CU START, triggers single-pulse device in cycling unit.
	1 switch, 3-position nonlocking	Released: no effect. Up: marked CLEAR FF TS, restores time-selection and repeat flip-flops. Down: marked GENERAL CLEAR, clears cycle counter to alpha, and restores many of the flip-flops and binary counters throughout the computer.*
	1 switch, 3-position locking	Released: (unmarked) permits memory check to occur automatically every 3 seconds during normal computer operation. Up: marked INHIBIT PMC, permits normal computer operation without periodic memory check. Lights green error-delete jewel-light. (Refer to Abnormal Operation Indicators, table 5-24.) Down: marked MEMORY CLEAR, inserts decimal zero in all memory locations; stops computer.

* A complete description of the effect of the INITIAL CLEAR and GENERAL CLEAR switches is given in the Supervisory Control Manual (paragraph 3-111).

Table 5-4. Sequence Indicators, Control Circuits, Located on Left of Center Panel

Number and Type	Distribution	Function
20 neons	8 neons marked PROGRAM COUNTER, upper 4 for PC, lower 4 for $\overline{PC}$	Indicate reading of program counter in binary code. All neons out indicates first program-counter stage.
	4 neons marked CYCLE COUNTER, upper 2 for CY, lower 2 for $\overline{CY}$	Indicate reading of cycle counter in binary code. All neons out indicates the alpha stage.
	2 neons marked REPEAT, upper 1 for unbarred repeat flip-flop, lower 1 for barred repeat flip-flop	Light when repeat flip-flops are set.
	2 neons marked TO, upper 1 for FFTO, lower 1 for $\overline{FFTO}$	Light when time-out flip-flops are set.*
	2 neons, marked TS, upper 1 for FFTS, lower 1 for $\overline{FFTS}$	Light when time-selection flip-flops are set.
	2 neons marked STOP, upper 1 for unbarred stop flip-flop, lower 1 for barred stop flip-flop	Light when stop flip-flops are set.*

* The STOP, STALL, and TO neons are all lighted:

1. when a 90m (stop) instruction has been completed;
2. when the STOP switch is pushed down;
3. when a 50m (supervisory control printout) instruction is set up in static register and OUTPUT switch is in BREAKPOINT position;
4. when a ,m (breakpoint stop) instruction is set up in static register and BREAKPOINT switch is in BREAKPOINT position;
5. when a Qnm or Tnm (conditional transfer breakpoint stop) instruction is set up in static register and either ALL pushbutton or pushbutton numbered the same as the n in the instruction is pushed (CONDITIONAL TRANSFER BREAKPOINT SELECTOR pushbuttons);
6. when interrupted-operation switch is in noncontinuous position and the computer has been stopped for 3 seconds;
7. during initial read operation. STALL neon blinks on and off during initial read operation because no ending pulse occurs for 3 seconds.

Table 5-5. Sequence Indicators, Arithmetic Circuits, Located on Left of Center Panel

Number and Type	Distribution	Function
20 neons	8 neons marked MULT.-QUOT. COUNTER, upper 4 for MQC, lower 4 for $\overline{\text{MQC}}$	Indicate reading of multiplier-quotient counter in binary code. 0011 indicates decimal-zero stage when S1-X neon is on.
	2 neons marked IER, upper 1 for IER, lower 1 for $\overline{\text{IER}}$	Light when FF121A in multiplier-quotient counter is set.
	2 neons marked OR, upper 1 for OR, lower 1 for $\overline{\text{OR}}$	Light when FF121B in multiplier-quotient counter is set.
	2 neons marked IER-OR, upper 1 for IER-OR, lower 1 for $\overline{\text{IER-OR}}$	Light when FF121C in multiplier-quotient counter is set.
	2 neons marked ≥ 3, upper 1 for ≥ 3, lower 1 for $\overline{\geq 3}$	Light when FF120 in multiplier-quotient counter is set.
	2 neons marked S1-CP, upper 1 for S1-CP, lower 1 for $\overline{\text{S1-CP}}$	Light when FF152 in comparator is set to produce the S1 (complement adder input) signal.
	2 neons marked S1-X, upper 1 for S1-X, lower 1 for $\overline{\text{S1-X}}$	Light when BC120 in multiplier-quotient counter is in the "do not complement" (alert noncomplementing gates in the MQC) condition, but does alert complementer in the adder.

Table 5-6. Interrupted-Operation Switch, Located on Lower Left Center Panel. (Operation Control)

Number and Type	Function
1 toggle switch, 5-position locking, in shape of a cross	Released (center position): normal operation position, also called continuous position. No effect. Up: marked ONE OPERATION, stops computer operation each time the time-out flip-flop is set. Lights TO and STOP neons. Lights orange IOS lamp. (Refer to Abnormal Operation Indicators, table 5-24.) Down: marked ONE INSTRUCTION, stops computer operation after each ending pulse. Lights TO and STOP neons and orange IOS lamp. Right: marked ONE ADDITION, stops computer operation after each addition, subtraction, or shift during the repeated steps of a multiply or divide instruction, and at every time out. Lights TO and STOP neons and orange IOS lamp. Left: marked ONE STEP, stops computer operation each time the program counter is stepped during a multistage instruction, and at every time-out. Lights TO and STOP neons and orange IOS lamp.

Table 5-7. Conditional Transfer Breakpoint Controls and Indicators, Located on Lower Left of Center Panel (Operation Control)

Number and Type	Distribution	Function
	CONTROLS	
11 pushbuttons, locking, with associated neons, marked CONDITIONAL TRANSFER BREAKPOINT SELECTOR	1 pushbutton marked ALL.	Stops computer operation after the first program counter step of all conditional transfer instructions (Qnm and Tnm).
	10 pushbuttons marked 0 through 9	Stop computer operation after Q and T instructions if the second instruction digit, n, equals the number on the pushbutton. Any number of these pushbuttons will stay down together. Each pushbutton lights the neon above it. Any pushbutton lights the BREAKPOINT INDICATOR jewel-light. (Refer to Abnormal Operation Indicators, table 5-24.)
1 release pushbutton, red	———	Releases all the conditional-transfer pushbuttons.
1 telephone-key switch, 3-position nonlocking, with associated neons	———	Released: no effect. Up: marked TRANSFER, during time-out of program-counter step 2 of a Qnm or Tnm instruction, sets FF155 in comparator to produce a CT (conditional transfer) signal regardless of actual result of comparison performed during the first program counter step of the conditional transfer instruction. Down: marked NO TRANSFER, restores FF155 so that CT signal will not be produced.
	INDICATORS	
11 neons	11 neons, one above each CONDITIONAL TRANSFER BREAKPOINT SELECTOR pushbutton	Lights when associated pushbutton is pushed in.
2 neons, marked CONDITIONAL TRANSFER	———	Upper neon lights when FF155 in comparator is set to produce CT signal. Lower neon, same for $\overline{FF155}$.
2 neons, marked OVERFLOW	2 neons, located to right of BREAKPOINT switch	Upper for unbarred flip-flop, lower for barred. Light when overflow flip-flops in adder are set.

Table 5-8. Stop Controls, Located on Left of Center Panel (Operation Control)

Number and Type	Distribution	Function
2 telephone-key switches, 2-position	1 switch, nonlocking, marked STOP	Released: no effect. Down: marked STOP, sets stop flip-flop and TO flip-flop; stops computer operation. Lights TO and STOP neons. (Should be used only when computer is stalled.)
	1 switch, locking, marked BREAKPOINT	Released: interprets the ,m instruction (breakpoint stop) as an 00m (skip) instruction. Down: marked BREAKPOINT, interprets the ,m instruction as a stop, sets stop flip-flop (FF205). Lights TO and STOP neons (table 5-4). 3 seconds later STALL neon lights (table 5-14). Also lights white breakpoint jewel-light (table 5-24).

Table 5-9. Static-Register Controls and Indicators, Located on Center Panel

Number and Type	Distribution	Function
	CONTROLS	
27 telephone-key switches, 3-position locking, with associated neons (see Indicators)	7 switches for FIRST INSTRUCTION DIGIT	Correspond to the 7 pulse-positions (1 check pulse, 2 zone-indicator pulses, 4 numeric pulses) of 1st instruction digit. Released: no effect, the circuit is nonrestoring. Up: restores associated static-register flip-flop (binary zero), lights blue static-register light. Down: sets associated static-register flip-flop (binary 1), lights indicator neon, lights blue static-register light.
	5 switches each for SECOND, FOURTH, FIFTH, SIXTH INSTRUCTION DIGIT	Correspond to 5 pulse-positions (1 check pulse, 4 numeric pulses) of 2nd, 4th, 5th, and 6th instruction digits. Released: no effect, the circuit is nonrestoring. Up: restores associated static-register flip-flop (binary zero), lights blue static-register light. Down: sets associated static-register flip-flop (binary 1), lights indicator neon, lights blue static register light.
3 telephone-key switches, 3-position nonlocking	1 switch to clear static register, marked INST.	Released: no effect. Up: marked DECIMAL ZERO above switches, clears instruction register (first 2 digits of static register) to decimal zero. Down: marked BINARY ZERO below switches, clears first 2 digit positions of static register to binary zero.
	1 switch to clear static register, marked MSR	Released: no effect. Up: (DECIMAL ZERO), clears memory-switch register (4th, 5th, 6th digits of static register, containing memory address) to decimal zero. Down: (BINARY ZERO), clears 4th, 5th, 6th digit positions of static register to binary zero.
	1 switch to clear static register, marked SR	Released: no effect. Up: (DECIMAL ZERO), clears entire static register to decimal zero. Down: (BINARY ZERO), clears entire static register to binary zero.
	INDICATORS	
27 neons	7 neons for FIRST INSTRUCTION DIGIT	Lights when associated switch is down or associated flip-flop is set (binary 1).
	5 neons each for SECOND, FOURTH, FIFTH, SIXTH INSTRUCTION DIGIT	Lights when associated switch is down or associated flip-flop is set (binary 1).

Table 5-10. Instruction Digit Decoding Indicators, Located in Center of Center Panel

Number and Type	Distribution	Function
	FIRST INSTRUCTION DIGIT	
16 neons	4 vertical	Comprise the coordinates of a decoding table. Reading top to bottom, signify 00, 01, 10, or 11 in the zone-indicator positions of the 1st instruction digit.
	12 horizontal	Reading left to right, signify 0001-1100 in the numeric-pulse positions. These excess-3-coded representatives are decoded in the printed letters and numbers above and below the horizontal neons.
	SECOND INSTRUCTION DIGIT	
11 neons	11 marked 01234567890-	Each represents one of the 11 possible code combinations of the 2nd instruction digit.

Table 5-11. Input-Output Controls and Indicators, Located on Right of Center Panel

Number and Type	Distribution	Function
	CONTROLS	
1 telephone-key switch, marked INITIAL READ, 2-position nonlocking, with associated neon	——	A tape input control. Released: no effect. Down: marked INITIAL READ, fills input register with one block of information (from tape on Uniservo selected by INITIAL TAPE SELECTOR pushbuttons), transfers the information to memory locations 000 through 059. Lights IR TIMER neon.
10 pushbuttons, interlocking, marked INITIAL TAPE SELECTOR	10 pushbuttons marked 123456789-	A tape input control selects one Uniservo for initial read operation. Only one button can stay down at a time.
10 pushbuttons, locking, marked BLOCK SUBDIVISION SELECTOR, with associated neons	10 pushbuttons marked 123456789-	A tape output control. Select a Uniservo by number. Uniservos 1-7, Uniservos selected insert a 1-inch space on tape between groups of 10 words during write instructions. Uniservos 8, 9 and - subdivide blocks by 0.1-inch spaces. Any combination of pushbuttons can be pushed down. Each lights its associated neon, and white block subdivider jewel-light (labelled P for printer).
1 reset pushbutton, red	——	Must be used to release BLOCK SUBDIVISION SELECTOR pushbuttons.
	INDICATORS	
8 neons, tape input indicators	1 marked IR TIMER	Lights during initial read operation.
	4 marked INPUT SYNCHRONIZER COUNTER	Tape-input indicators. Give the reading of the 4-stage input synchronizer binary counter. Counter is initially cleared to 0011 (decimal 0 in excess-3 code) and counts to 1100 (9 in excess-3 code). At 1100, clears to 0011 and steps input tank counter.
	3 marked INPUT TANK COUNTER	Give reading of the 3-stage input tank binary counter. Counter is initially cleared to 001 and counts to 110 (6th tank). Any programmed instruction which requires the input tank clears the counter to 001.
6 neons, input-output indicators	1 marked DIRECTION STORAGE	Lights when an instruction calling for forward read is set up. Remains lighted until a backward read instruction.
	1 marked REVERSE	Lights while the reversal memory flip-flop is set.
	1 marked FIRST BLOCK	Lights when selected Uniservo is in position to read or write first block. Remains lighted until the 1.0-second read-first-block (1.5-second write-first-block) delay has been initiated.
	1 marked READ INT.	Lights during a tape or supervisory control read instruction.
	1 marked WRITE INT.	Lights during a tape or supervisory control write instruction.
	1 marked REWIND OVERLOAD	Lights while the rewind overload relay is energized.
17 neons, tape-output indicators	4 marked OUTPUT SYNCHRONIZER COUNTER	Give the reading of the 4-stage output synchronizer binary counter. Counter is initially cleared to 0011 (decimal 0 in excess-3 code) and counts to 1100 (9 in excess-3 code). At 1100, clears to 0011 and steps output tank counter.
	3 marked OUTPUT TANK COUNTER	Give the reading of the 3-stage output tank binary counter. Counter is initially cleared to 001 and counts to 110 (6th tank). Any programmed instruction which requires the output tank clears the counter to 001.
	10 above BLOCK SUBDIVISION SELECTOR pushbuttons	Light when associated pushbutton is down.

Table 5-12. Keyboard Input-Output Controls and Indicators, Located on Right of Center Panel

Number and Type	Distribution	Function
	CONTROLS	
3 telephone-key switches	1 switch, 3-position locking, marked SCI above switch (Supervisory Control Input)	Released: no effect. Up: marked CR, interlock for SCI CR switch. Down: marked FILL, inserts words typed on supervisory keyboard into successive memory locations, starting with the location specified by the control-counter reading when fill operation begins.
	1 switch, 2-position nonlocking, marked SCI CR (Supervisory Control Input to Control Register)	Released: no effect. Down: sets up 1 10 0010 in 1st-digit position of static register if SCI switch is in CR position. Sets cycle counter to beta time. Lights SCI CR neon in 1st-digit decoder.
	1 switch, 3-position locking, marked OUTPUT directly below switch (Supervisory Control Output)	Released: when a 50m (supervisory control output) instruction occurs in a program, released position permits supervisory control printer to print out one word selected by OUTPUT SELECTOR pushbuttons. Up: marked SKIP, the 50m instruction is decoded as a 00m (skip). Down: marked BREAKPOINT, the 50m instruction is interrupted just before printout, after interlock test has been performed in input-output control circuits. Computer stops with TO, STOP, and OUTPUT READY neons lighted. Operator can read from source selected by OUTPUT SELECTOR pushbuttons. Computer starts when start bar is pushed down.
9 pushbuttons marked OUTPUT SELECTOR	1 marked M	Reads word from memory location specified by static register to printer.
	7 marked A, X, L, F, C, CR, and SYI	Reads word from specified short-tank register to printer.
	1 marked EMPTY	Not associated with 50m instruction. Computer proceeds normally to next beta-period, then performs empty operation, printing out contents of memory beginning at location specified by control number. Computer does skips in gamma and delta after each word is printed, performs alpha, and types next word during beta, continuing until (1) IOS switch is pushed to any noncontinuous position, or (2) another OUTPUT SELECTOR is pushed, or (3) carry of a 1 to 2nd instruction digit causes F.T. INTER. error to stop computer.
	INDICATORS	
6 neons	1 marked INPUT READY	Lights when interlock test for any supervisory control input instruction has been completed. Indicates that operator may start typing. Remains lighted until the WORD REL. key on keyboard is pushed down.
	2 marked SYI1 and SYI2	Lights when output gate of corresponding synchronizer register is first opened. Remains lighted until output gate of other synchronizer register is opened. One neon is always on.
	1 marked 12TH DIGIT	Lights when the 12th digit of a word has been typed on supervisory keyboard and sent to the input synchronizer register. Remains lighted until WORD REL. or ERASE key on keyboard is pushed down.
	1 marked INPUT ERROR	Lights if (1) 2 or more keys on the supervisory control keyboard are struck less than 50 msec apart; (2) WORD REL. key is pushed down when fewer than 12 digits have been typed; (3) a 13th digit is typed before the WORD REL. key is pushed down; (4) a key is pushed down during a carriage return or tab operation. As long as the input-error remains, the keyboard encoder-matrix is disabled, which prevents the transfer of the word out of input synchronizer register.

Table 5-12. Keyboard Input-Output Controls and Indicators, Located on Right of Center Panel (cont)

Number and Type	Distribution	Function
		INDICATORS
		Remains lighted until ERASE key or GENERAL CLEAR switch is pushed down.
	1 marked OUTPUT READY	Lights when program-counter step 1 of a 50m or empty instruction is completed. Remains lighted until 50m or empty instruction is completed.

Table 5-13. Fuse-Fault Controls and Indicators, Located on Lower Left of Panel

Number and Type	Distribution	Function
		CONTROLS
2 telephone-key switches, 2-positions, 2-position non-locking	1 marked PRIMARY FAULT RELAY RESET	Released: no effect. Down: opens ground-return circuit of RP18 and RP19 (primary-fault-indicator relays in KL corner). Turns off either primary-fault jewel-light.
	1 marked FAULT TEST	Released: no effect. Down: connects stand-by power to all D.C. FAULT INDICATORS (neons). When a fuse blows, its alarm contact grounds the associated neon.
		INDICATORS
3 jewel-lights	1 green, marked P	A-C primary fault indicator. Lights when a fuse blows in heater primary circuits (in BC corner or power supply or bay P) or when a Uniservo heater fuse blows. Remains lighted until fault relay is reset.
	1 red, marked P	D-C primary fault indicator. Lights when a fuse blows in d-c primary circuits (in power supply). Remains lighted until fault relay is reset.
	1 white, marked T	Thermostat fault indicator. Lights when bay thermostat or phase-fault breaker opens. Remains lighted until thermostat is restored or phase-fault breaker is reset. Also lights when master thermostat is energized and remains lighted until thermostat is restored. (Master thermostat, under computer floor, turns off a-c and d-c.)
16 pairs of neons	Pairs marked BAY A, B, C, D, E, M, N, G, H, J, K, L, P; DE CORNER, POWER SUPPLY, UNISERVOS	Each pair detects blown fuse in associated bay (or DE corner, bay W for power supply, BC corner for Uniservos). Upper neon indicates fuse faults in positive-voltage lines (fuseboard 14 of Central Computer bays). Lower neon indicates fuse faults in negative-voltage lines (fuseboard 13). The neons do not light when fuses fail until FAULT TEST switch is used. Upper neon for bay H can be lighted by alarm contacts in either bay H or HJ corner.
1 neon	1 marked UNISERVO SCREEN FUSE	Normally lighted. Goes out when any of 8 Uniservo-screen-supply fuses in BC corner blows. Remains off until fuse is replaced.

Table 5-14. Stall Alarm Controls and Indicator

Number and Type	Distribution	Function
	CONTROLS	
1 telephone-key switch, 3-position locking	1 marked SPEAKER, on lower left of panel	Released: no effect. Up: marked HSB, produces audible signal while computer is functioning properly. Down: marked STALL, produces an 800-cps signal if computer stops for 3 seconds.
1 knob-control	1 marked VOLUME, on left of center panel	Regulates stall-alarm volume.
	INDICATOR	
1 neon	1 marked STALL, on left of center panel	Lights when cycle counter does not receive an ending pulse for 3 sec. Remains lighted until pulse is received or dc goes off. (Refer to note following table 5-4.)

Table 5-15. Clearing Switch Controls and Indicator

Number and Type	Distribution	Function
	CONTROLS	
6 telephone-key switches	1 marked GENERAL CLEAR, 1 marked MEMORY CLEAR, on upper left of panel	Refer to table 5-3, Start Controls.
	1 switch, 2-position nonlocking, marked CLEAR CY, on left of center panel	Released: no effect. Down: clears both cycle counters (CY and $\overline{\text{CY}}$) to alpha.
	1 switch, 2-position nonlocking, marked CLEAR C, on right of center panel	Released: no effect. Down: actuates the start circuits; clears control counter and static register to decimal 0, and program counter to binary 0 (PC1). Stops computer in alpha time-out. Should not be operated during continuous operation.
	1 switch, 3-position nonlocking, marked CLEAR PC, on left of center panel	Released: no effect. Up: marked CLEAR $\overline{\text{PC}}$, clears barred program counter to binary 0 (PC1). Used for test purposes only. Causes the 2 program counters to get out of step; therefore program-counter comparator-decoder has no output. Down: marked CLEAR PC AND $\overline{\text{PC}}$, clears both program counters to binary 0 (PC1).
	1 switch, 2-position nonlocking, marked CLEAR I AND O, on right of center panel	Released: no effect. Down: clears input and output tanks to binary 0.
	INDICATOR	
1 neon	1 marked PMC, located top center panel	Lights during periodic memory check and memory clear. Normally remains lighted for less than 0.1 sec. If computer stops during a memory check, or memory clear, however, neon remains lighted.

Table 5-16. Troubleshooting-Aid Controls

Number and Type	Distribution	Function
	RETAIN C/RETAIN INSTRUCTION CONTROL	
1 telephone-key switch, 3-position locking	1 on upper left of panel	Released: no effect. Up: marked RETAIN C, inhibits addition of 1 to control-counter reading which occurs during beta-time. Permits cycle counter to repeat same alpha-beta-gamma-delta cycle. Down: marked RETAIN INSTRUCTION, prevents ending pulse from stopping cycle counter and retains cycle-counter and control-counter readings. Computer performs same instruction (in static register) repeatedly.
	FAULT CIRCUIT CONTROLS	
3 telephone-key switches, 2-position locking [15th, 16th, 17th on top center panel]	1 marked DELETE SELECTOR	Operates only in conjunction with 10 delete switches for duplicated check circuits, marked by dot for up position. Released: inhibits output gate of an unbarred check circuit when its delete switch is pushed up. Down: inhibits output gate of a barred check circuit when its delete switch is pushed up.
	1 marked MASTER DELETE	Released: no effect. Down: inhibits output gates of all check circuits that inhibit G216 and G311, thus prevents error signals from stopping computer. Lights green error-delete jewel-light (table 5-24).
	1 marked RESET CONTROL	Used for test purposes only. Released: permits a signal from the start bar, through start circuits, to restore all error flip-flops. Down: prevents start circuits from restoring the error flip-flops.

Table 5-17. Uniservo, Input-Output, and HSB Controls and Indicators, Located Across Top Center Panel

Number and Type	Distribution	Function
	CONTROLS	
17 telephone-key switches	1 switch, 3-position, marked SERVO POWER	Released: power for Uniservos comes on with dc. Up: locking, marked OFF, turns off all 246v power to Uniservos. Lights red voltage-monitor jewel-light (table 5-24). Down: nonlocking, marked ON, turns off all 246v power to Uniservos *only while switch is held down.* Does not light voltage-monitor jewel-light.
	1 switch, 3-position locking, marked GAIN	Released: biases trigger amplifiers of input flip-flops. Bias value is one-fifth standard signal strength. Up: marked HIGH, changes bias on trigger amplifiers to one-third standard signal strength. Down: marked LOW, changes bias on trigger amplifiers to one-seventh standard signal strength.
	1 switch, 3-position locking, marked SERVO SEL., with 2 associated neons	Released: no effect. Up: marked with dot, connects the 2 check circuits on the Servo selector to DELETE SELECTOR switch. Down: inhibits output gates of both servo-selector check circuits. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked TAPE CHECK, with 1 associated neon	Released: no effect. Down: inhibits output gate of the check circuit which inspects for a sprocket pulse in every taped digit. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked I.S.>720 with 1 associated neon	Released: no effect. Down: Restores the 720-error flip-flop (FF609) in input synchronizer. Lights green error-delete jewel-light.

Table 5-17. Uniservo, Input-Output, and HSB Controls and Indicators, Located Across Top Center Panel (cont)

Number and Type	Distribution	Function
	CONTROLS	
	1 switch, 3-position locking, marked I.S. O-E, with 2 associated neons	Released: no effect. Up: marked with dot, connects the 2 odd-even check circuits in the input synchronizer to DELETE SELECTOR switch. Down: inhibits output gates of input-synchronizer odd-even check circuits. Lights green error-delete jewel-light.
	1 switch, 3-position locking, marked O.S. O-E, with 2 associated neons	Released: no effect. Up: marked with dot, connects the 2 odd-even check circuits in the output synchronizer to DELETE SELECTOR switch. Down: inhibits output gates of output-synchronizer odd-even check circuits. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked I-O INT., with 1 associated neon	Released: no effect. Down: inhibits G815 to release input-output interlock gate. Lights green error-delete jewel-light.
	1 switch, 3-position, marked I.S. ERROR INSERT	Released: no effect. Up: nonlocking, marked S, sets FF601A, the final-storage flip-flop in check-pulse position (in input synchronizer) to add a check pulse to combinations containing an odd number of pulses. Introduces an artificial error in input synchronizer to test operation of odd-even check circuits. Down: locking, marked R, restores FF601A to remove check pulse from combinations containing an even number of pulses. Introduces an artificial error in input synchronizer to test operation of odd-even check circuits.
	1 switch, 2-position nonlocking, marked I.S. ERROR CLEAR	Released: no effect. Down: clears input synchronizer errors by clearing tape-check, input-synchronizer-greater-than-720, input-synchronizer-odd-even, and input-output-interlock error circuits, generating a read-ending signal to clear the read-interlock flip-flop and read thyratron, restoring the final-storage flip-flops, and clearing BC601 to odd.
	1 switch, 2-position nonlocking, marked O.S. ERROR CLEAR	Released: no effect. Down: clears output synchronizer errors by clearing tape-check, output-synchronizer-odd-even, and input-output-interlock error circuits, and generating a write-ending signal to clear the write-interlock flip-flop and write thyratron.
	1 switch, 2-position locking, marked $\overline{\text{HSB}}$ TO MEM.	Released: alerts G414 to read contents of high-speed bus to memory during normal operation. Down: alerts $\overline{\text{G414}}$ to read contents of barred high-speed bus to memory.
	1 switch, 2-position locking, marked HSB TO SYO	Released: no effect. Normal operating procedure: contents of unbarred high-speed bus read to output-synchronizer register during output instructions. Down: energizes HSB-to-rSYO2 relay on PT backboard to read contents of barred high-speed bus to output-synchronizer register during supervisory control output instructions.
	1 switch, 3-position locking, marked HSB O-E, with 2 associated neons	Released: no effect. Up: marked with dot, connects output gates of both odd-even check circuits in HSB to DELETE SELECTOR switch. Down: inhibits output gates of both HSB-odd-even check circuits. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked HSB COMP., with 1 associated neon	Released: no effect. Down: inhibits output gate of the check circuit that detects a disagreement between the duplicate high-speed buses. Lights green error-delete jewel-light.

Table 5-17. Uniservo, Input-Output, and HSB Controls and Indicators, Located Across Top Center Panel (cont)

Number and Type	Distribution	Function
	CONTROLS	
	1 switch, 2-position nonlocking, marked HSB ERROR INSERT	Released: no effect. Down: alerts G+445 to read random t76+ pulses into the barred high-speed bus. Used to test HSB comparator circuit, which should indicate disagreement when switch is down.
	1 switch, 3-position, marked AUTOMATIC RE-READ above switch, located on right center panel, with 2 associated neons. (See Indicators.)	Released: permits automatic re-read when input error is detected. (Normal operation.) Up: nonlocking, marked CLEAR, clears all automatic re-read circuits. Down: locking, marked LOCKOUT, prevents input errors from starting an automatic re-read.
	INDICATORS	
14 neons	2 located above SERVO SEL. switch	Upper for unbarred check circuit, lower for barred. Lights when servo-selector check circuit has detected more than 1 line energized in servo selector. Remains lighted until start bar is pushed down.
	1 located above TAPE CHECK switch	Lights when tape-check circuit detects information without a sprocket pulse. Remains lighted until I.S. ERROR CLEAR or O.S. ERROR CLEAR switch is pushed down.
	1 located above I.S.>720 switch	Lights when check circuit detects error in input count. Remains lighted until GENERAL CLEAR, I.S. ERROR CLEAR, or I.S.>720 switch is pushed down.
	2 located above I.S. O-E switch	Upper for unbarred check circuit, lower for barred. Lights when input-synchronizer odd-even check circuit detects combination with even number of pulses. Remains lighted until I.S. ERROR CLEAR switch is pushed down.
	2 located above O.S. O-E switch	Upper for unbarred check circuit, lower for barred. Lights when output-synchronizer odd-even check circuit detects combination with even number of pulses. Remains lighted until O.S. ERROR CLEAR switch is pushed down.
	1 located above I-O INT. switch	Lights if read or write instruction takes place when appropriate interlock is not set, or if tape direction indicated by static-register instruction differs from direction indicated by input-output control circuits. Remains lighted while input-output interlock gate is inhibited until GENERAL CLEAR, I.S. ERROR CLEAR, or O.S. ERROR CLEAR switch is pushed down.
	2 located above HSB O-E switch	Upper for unbarred, lower for barred check circuit. Light when odd-even check circuits detect combination with even number of pulses. Remain lighted until start bar is pushed down.
	1 located above HSB COMP. switch	Lights when high-speed comparator detects disagreement between the duplicate high-speed buses. Remains lighted until start bar is pushed down.
	2 located above AUTOMATIC RE-READ switch	1 marked AUTO RE-READ lights when RY2 is energized during all automatic re-read operations. 1 marked ORIGINAL DIRECTION lights when tape resumes the direction in which it was moving when error was detected. Also lights when Ledex switch is in even-numbered position.

Table 5-18. Sequencing-Fault Controls and Indicators, Located Across Top Center Panel

Number and Type	Distribution	Function
	CONTROLS	
6 telephone-key switches	1 switch, 3-position nonlocking, marked C.U. ERROR INSERT	Released: no effect. Up: marked A, inhibits G502 to delete one input to HA416 (one output from barred 7-pulse and 13-pulse loops in the cycling unit). Down: marked B, inserts one extra pulse in HA422, half-adder which compares duplicate 7-pulse and 13-pulse loops in the cycling unit. Used to test cycling-unit check circuits, which should indicate error when switch is used. Does not insert pulse in the cycling unit loops; affects the check circuit.
	1 switch, 2-position locking, marked TIME OUT with 1 associated neon	Released: no effect. Down: inhibits output gate of circuit which checks for agreement between the 2 time-out flip-flops (FFTO and $\overline{\text{FFTO}}$). Lights green error-delete jewel-light.
	1 switch, 3-position locking, marked CYC UNIT, with 2 associated neons	Released: no effect. Up: marked with dot, connects output gates of the 2 cycling-unit check circuits (G335 and G336) to DELETE SELECTOR switch. G335 normally passes an A-type error (disagreement between the barred 7-pulse and 13-pulse loops and the 27-pulse delay), while G336 passes a B-type error (disagreement between duplicate 7-pulse and 13-pulse loops). Down: marked CYC UNIT, inhibits both G335 and G336. Lights green error-delete jewel-light.
	1 switch, 3-position locking, marked F.T. OUTPUT, with 2 associated neons	Released: no effect. Up: marked with dot, connects to DELETE SELECTOR switch the 2 output gates of the duplicate circuits which check for an even number of function signals. Down: marked F.T. OUTPUT, inhibits output gates of the duplicate function-table output checkers. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked F.T. INTER., with associated neon	Released: no effect. Down: inhibits output gate of intermediate-line check circuit, which detects simultaneous selection of more than one intermediate line. Lights green error-delete jewel-light.
	1 switch, 3-position locking, marked TANK SEL., with 2 associated neons. (See Indicators.)	Released: no effect. Up: marked with dot, connects output gates of both memory-selector check circuits to DELETE SELECTOR switch. Down: marked TANK SEL., inhibits output gates of both memory-selector check circuits. Lights green error-delete jewel-light.
1 jack	1 marked TIME-OUT RESET, located bottom left panel	The multivibrator unit plugs into this jack. Since the multivibrator energizes the start relay, it performs much the same function as the start bar and can provide a start pulse at controlled intervals.
	INDICATORS	
8 neons	1 located above TIME OUT switch	Lights when time-out check circuit detects disagreement between duplicate time-out flip-flops.
	2 located above CYC UNIT switch	Upper for A-type error, lower for B-type error. Light when respective comparison circuits detect disagreement among the cycling-unit loops. Remain lighted until CU-TSC CLEAR switch or start bar is pushed down.
	2 located above F.T. OUTPUT switch	Upper for unbarred check circuit, lower for barred. Light when duplicate function-table output check circuits detect an odd number of function signals. Remain lighted until start bar is pushed down.
	1 located above F.T. INTER. switch	Lights when function-table intermediate-line check circuit detects an error. Remains lighted until start bar is pushed down.

Table 5-18. Sequencing-Fault Controls and Indicators, Located Across Top Center Panel (cont)

Number and Type	Distribution	Function
	INDICATORS	
	2 located above TANK SEL. switch	Upper: marked 4TH, for check circuit on 1st address-digit (hundreds) selector. Lower: marked 5TH, for check circuit on 2nd address-digit (tens) selector. Light when selector check circuits detect 1 or more, 2 or more, or no selector lines energized, during an operation which requires memory selection.

Table 5-19. Arithmetic Fault Controls and Indicators, Located Across Top Center Panel

Number and Type	Distribution	Function
	CONTROLS	
10 telephone-key switches	1 switch, 3-position locking, marked ADDER MIN., with 2 associated neons	Released: no effect. Up: marked with dot, connects output gates of adder-minuend odd-even check circuit and minuend-comparison check circuit to DELETE SELECTOR switch. Down: marked ADDER MIN, inhibits output gates of odd-even check circuit and comparison check circuit on the minuend inputs to duplicate algebraic adders. Lights green error-delete jewel-light.
	1 switch, 3-position locking, marked ADDER SUB., with 2 associated neons	Released: no effect. Up: marked with dot, connects output gates of adder-subtrahend odd-even check circuit and adder-subtrahend comparison check circuit to DELETE SELECTOR switch. Down: marked ADDER SUB., inhibits output gates of odd-even check circuit and comparison check circuit on subtrahend inputs to duplicate algebraic adders. Lights green error-delete jewel-light.
	1 switch, 3-position locking, marked ADDER ALPH., with 2 associated neons	Released: no effect. Up: marked with dot connects to DELETE SELECTOR switch the output gates of circuits that detect alphabetic characters occurring simultaneously in minuend and subtrahend inputs to duplicate algebraic adders. Down: marked ADDER ALPH., inhibits output gates of duplicate detector circuits. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked ADDER COMP., with 1 associated neon	Released: no effect. Down: inhibits output gate of circuit that detects disagreement between sums produced by duplicate algebraic adders. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked F COMP., with 1 associated neon	Released: no effect. Down: inhibits output gate of circuit that detects disagreement between the contents of duplicate F registers. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked L COMP., with 1 associated neon	Released: no effect. Down: inhibits output gate of circuit that detects disagreement between the contents of the duplicate L registers. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked A COMP., with 1 associated neon	Released: no effect. Down: inhibits output gate of circuit that detects disagreement between contents of the duplicate A registers. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked X COMP., with 1 associated neon	Released: no effect. Down: inhibits output gate of circuit that detects disagreement between the contents of the duplicate X registers. Lights green error-delete jewel-light.

Table 5-19. Arithmetic Fault Controls and Indicators, Located Across Top Center Panel (cont)

Number and Type	Distribution	Function
	1 switch, 2-position locking, marked COND. TRANS., with 1 associated neon	Released: no effect. Down: inhibits output gate (G346) of flip-flop FF402. FF402 is set when there is disagreement between barred and unbarred FF155, the flip-flop which produces the conditional transfer signal. Lights green error-delete jewel-light.
	1 switch, 2-position locking, marked X÷ ERROR STOP	Released: (unless MASTER DELETE switch is pushed down) alerts G440 and $\overline{\text{G440}}$ to pass error-signal output from A-register comparison check or X-register comparison check circuits to set time-out flip-flop in control circuits. Error detected by check circuits cannot stop computer until subsequent time-out. Down: no effect. Computer stops in next time-out if an error develops.
	INDICATORS	
14 neons	2 marked OVERFLOW, located to left of SECOND INSTRUCTION DIGIT decoder (center panel)	Upper for FF705, lower for $\overline{\text{FF705}}$. Light when the duplicate overflow flip-flops are set, indicating capacity of adder has been exceeded and a carry from the 11th place has been produced.
	2 located above ADDER MIN. switch	Upper: marked O-E, lights when odd-even check circuit on unbarred minuend input to algebraic adder detects digit with even number of pulses.* Lower: marked COMP., lights when disagreement occurs between 2 minuend inputs. Remain lighted until start bar is pushed down.*
	2 located above ADDER SUB. switch	Upper: marked O-E, lights when odd-even check circuit on unbarred subtrahend input to algebraic adder detects digit with even number of pulses. Lower: marked COMP., lights when disagreement occurs between 2 subtrahend inputs. Remain lighted until start bar is pushed down.
	2 located above ADDER ALPH. switch	Upper for unbarred detector circuit, lower for barred. Light when alphabetic-character detector circuits find simultaneous alphabetic characters in minuend and subtrahend inputs to adder during 11-place addition (A, S, and X instructions). Also light when any character other than a sign is detected in sign position. Remain lighted until start bar is pushed down.
	1 located above ADDER COMP. switch	Lights when disagreement is detected between sums produced by duplicate adders. Remains lighted until start bar is pushed down.
	4 located above F COMP., L COMP., A COMP., and X COMP. switches, respectively	Lights when disagreement is detected between duplicate F (L,A,X) registers. Remains lighted until start bar is pushed down.
	1 located above COND. TRANS. switch	Lights when FF402 is set, indicating disagreement between 2 conditional-transfer flip-flops. Remains lighted until start bar is pushed down.

* ADDER MIN. and ADDER SUB. neons: In early Univac systems, the upper neon is the indicator for the unbarred odd-even checker, the lower for the barred. These systems have no comparison circuit between the 2 check circuits.

Table 5-20. AGC and Video Monitor Controls, Located on Left of Panel

Number and Type	Distribution	Function
2 telephone-key switches	1 switch, 3-position locking, marked OSCILLOSCOPE (also called group selector switch)	Released: no effect; the circuit is nonrestoring. Up: marked GROUP 1, makes final selection, for AGC and video monitoring, between pairs of circuits tapped by REGISTER SELECTOR pushbuttons. The upper source of the pushbutton is the one selected: $\overline{HSB}$, $\overline{F}$, $\overline{L}$, $\overline{A}$, $\overline{X}$, Y, CR (long delay), O (further selection is made by SECONDARY SELECTOR pushbuttons: 0-5 for r0, 6 for rSYI1, 7 for rSYO1, 8 for SYIP, and 9 for SYOP), TC (the temperature-control channels, selected by SECONDARY SELECTOR 0-6), TPG (the 11th local driver, selected by SECONDARY SELECTOR 0), and C (the control counter). The M pushbutton does not connect through the OSCILLOSCOPE switch. Down: marked GROUP 2, selects from the lower sources of the REGISTER SELECTOR pushbuttons: HSB, F, L, A, X, V, CR (short delay), I (further selection is made by SECONDARY SELECTOR pushbuttons: 0-5 for rI, 6 for rSYI2, 7 for rSYO2), CU (further selection is made by SECONDARY SELECTORS 0-4), and TPG (first 10 local drivers, further selection made by SECONDARY SELECTORS 0-9). The control-counter selector pushbutton (C) is ineffective when the OSCILLOSCOPE switch is pushed down (GROUP 2 position).
	1 switch, 3-position locking, marked SYNC below switch, located on top left panel	Released: marked p0, selects minor-cycle synchronizing pulse from the Central Computer time-selection circuits, for synchronizing sweep on monitor oscilloscope when inspecting short-tank registers. Up: marked 0p0, selects major-cycle synchronizing pulse from time-selection circuits, for inspecting all contents of a 10-word register at one time. Down: marked TSP, selects a synchronizing pulse from time-selection circuits for inspecting one selected word from a 10-word group (according to the 6th instruction digit in the static register) on the oscilloscope.
12 pushbuttons, interlocking, marked REGISTER SELECTOR, located on center of left panel	1 marked HSB	Connects both high-speed buses to OSCILLOSCOPE switch.
	5 marked $\overline{F}$/F, $\overline{L}$/L, $\overline{A}$/A, $\overline{X}$/X, and Y/V	Connects indicated pairs of registers to OSCILLOSCOPE switch.
	1 marked CR	Connects long-delay and short-delay halves of control register to OSCILLOSCOPE switch.
	1 marked M	Connects MEMORY SELECTOR - TENS and MEMORY SELECTOR - HUNDREDS pushbuttons to AGC jack and monitor oscilloscope.
	3 marked O/I, TC/CU, and TPG	Connects SECONDARY-SELECTOR circuits to OSCILLOSCOPE switch.
	1 marked C	Connects control counter signal to GROUP 1 contacts of OSCILLOSCOPE switch.
20 pushbuttons, interlocking, marked MEMORY SELECTOR-HUNDREDS and MEMORY SELECTOR-TENS	10 pushbuttons marked 00, 10, 20, 30, 40, 50, 60, 70, 80, 90	Selects one group (of 10 possible groups) of 100 successive memory locations, when M pushbutton of REGISTER SELECTOR is pushed.
	10 pushbuttons marked 0, 1, 2, 3, 4, 5, 6, 7, 8, 9	Selects one group of 10 memory locations from 100 selected by the MEMORY SELECTOR-HUNDREDS pushbuttons. The 10 words in the 10 selected memory locations are sent through contacts of relay governed by M pushbutton of REGISTER SELECTOR, to monitor oscilloscope and AGC jack. The 10 words are presented on oscilloscope as a 10-word grouping when SYNC switch is pushed up to 0p0, as 10 superimposed single words when SYNC switch is released, or individually when SYNC switch is pushed down to TSP, which selects the word determined by the 6th instruction-digit flip-flops.

Table 5-20. AGC and Video Monitor Controls, Located on Left of Panel (cont)

Number and Type	Distribution	Function
1 jack	1 marked AGC	External voltmeter used for measuring automatic-gain-control voltage is plugged into this jack. The various circuits whose AGC voltages are measured at this jack are selected by REGISTER, MEMORY, and SECONDARY SELECTOR pushbuttons and OSCILLOSCOPE switch.
10 pushbuttons, interlocking, marked SECONDARY SELECTOR	10 pushbuttons marked 7p/0, $\overline{7p}$/1, $\overline{13p}$/2, 13p/3, 27p/4, 5, SYI/6, SYO/7, SYIP/8, SYOP/9	Pushbuttons are used in conjunction with O/I, TC/CU and TPG pushbuttons of REGISTER SELECTOR. Connections are shown in table 5-21.

Table 5-21. Register-Selector Connections

Secondary Selector	To O/I Relay		To TC/CU Relay		To TPG Relay	
	Group 1	Group 2	Group 1 (Temperature Control)	Group 2 (Cycling Unit)	Group 1[a]	Group 2[a]
7p/0	rO-1	rI-1	GV tank	7-pulse loop	11	1
$\overline{7p}$/1	rO-2	rI-2	NT tank	Duplicate 7-pulse loop[b]	—	2
13p/2	rO-3	rI-3	NV tank	13-pulse loop	—	3
$\overline{13p}$/3	rO-4	rI-4	NX tank	Duplicate 13-pulse loop[b]	—	4
27p/4	rO-5	rI-5	MT tank	27-pulse line	—	5
5	rO-6	rI-6	MV tank		—	6
SYI/6	rSYI1	rSYI2	MX tank		—	7
SYO/7	rSYO1	rSYO2	—		—	8
SYIP/8	SYIP	—	—		—	9
SYOP/9	SYOP	—	—		—	10

[a] Local drivers.

[b] Part, but not all, of the cycling unit is duplicated. The duplicate outputs of these 7- and 13-pulse loops are not always used in duplicate circuits.

Table 5-22. Heater Monitor Control and Indicators

Number and Type	Distribution	Function
	CONTROL	
1 rotary switch, marked TANK HEATER VOLTAGE MONITOR, located at left of lower center panel	1 rotary switch, 7-position, marked from left to right GV, NT, NV, NX, MT, MV, MX	Used with TANK HEATER VOLTAGE/VOLTAGE MONITOR REMOTE switch. Selects 1 of 7 long-tank temperature-control channels for monitoring voltage present at anode of heater-coil driver. Switch is, in some cases, numbered counterclockwise instead of being marked with the tank designations. In these instances, position 1 picks up GV tank; 2, NT tank; 3, NV tank; 4, NX tank; 5, MT tank; 6, MV tank; 7, MX tank.
See paragraphs 2-91 through 2-94.	*INDICATORS, Located Bottom of Left Panel*	
1 neon, marked STAND-BY POWER (HEATER)		Lights when control power is turned on, which applies a-c standby heating power to long-tank heating coils. Remains lighted until control power is removed or when computer overheats. In early installations (I to VI), remains lighted until dc is turned on, which opens contacts of RP22 to disconnect stand-by power from long-tank heater circuits.

Table 5-22. Heater Monitor Control and Indicators (cont)

Number and Type	Distribution	Function
	INDICATORS	
7 neons, STAND-BY HEATERS - LONG TANKS	marked from left GV, NT, NV, NX, MT, MV, MX	Lights when a-c standby power is applied to heater circuit in associated long-tank. Remains lighted until ac is removed. These lights should never be on after dc is turned on, cycling unit is started, and the long-tank d-c heat has stabilized.
16 neons, HEATERS - SHORT TANKS	marked from left to right, top and bottom F, $\bar{F}$, L, $\bar{L}$, A, $\bar{A}$, X, $\bar{X}$, C, V, CR1, CR2, SYI1, SYI2, SYO1, SYO2	Light when driver for an associated short-tank heater coil is conducting, indicating that heat is being applied to short tank. Remain lighted until heater-coil driver is cut off.

Table 5-23. Voltage Monitor Controls and Indicators, Located on Right of Panel

Number and Type	Distribution	Function
	CONTROLS	
1 voltmeter, zero-centered, graduated in percentage of allowable deviation		Connected to voltage-monitor circuit when TANK HEATER VOLTAGE/VOLTAGE MONITOR REMOTE METER switch is released, and MEASURE switch is pushed up. If VOLTAGE MON. MANUAL switch is pushed down, voltage-pair selector pushbuttons must be used. If it is released, automatic voltage-monitor stepping circuit connects meter to successive pairs of voltages. See paragraphs 2-78 through 2-83.
5 telephone-key switches	1 switch, 3-position locking, marked TANK HEATER VOLTAGE above switch	The switch is also called the meter-transfer switch. Released: connects the deviation meter between MEASURE switch and sampling contact to which selected voltages are brought from pickup of stepping switches. Up: marked TANK HEATER VOLTAGE, connects deviation meter between +200-volt source and TANK HEATER VOLTAGE MONITOR selector switch. Down: marked VOLTAGE MONITOR REMOTE METER, removes deviation meter from monitor circuit, and connects monitor circuit to terminals B6-13 and B6-7 in negative-voltage capacitor area of power supply. Voltmeter can be connected to these terminals, for remote monitoring. Negative-voltage capacitor area is between bays Z and W of power supply; terminals B6-13 and B6-7 are on terminal strip just next to bay Z.
	1 switch, 3-position locking, marked MEASURE/DELAYED SHUT-OFF	Released: connects relay RP3 located in KL corner, between voltage-sampling contact and REF. VOLTAGE switch. When switch is in this position any voltage that has deviated beyond its maximum allowable range does not shut off dc, but stops automatic stepping circuit. Up: marked MEASURE; connects deviation meter between voltage-sampling contact and REF. VOLTAGE switch. Permits automatic sampling of voltages until switch is pushed down. Lights red voltage-monitor jewel-light. Down: marked DELAY SHUT-OFF, connects relay RP3 between voltage-sampling contact and REF. VOLTAGE switch. Lights red voltage-monitor jewel-light. When faulty voltage is found with switch in this position, relay RP3 inhibits stepping circuit, and after 30-second delay, shuts off dc.
	1 switch, 2-position locking, marked REF. VOLTAGE	Released: connects armature of MEASURE/DELAYED SHUT-OFF switch to relative reference supply. Down: marked ABSOLUTE, connects armature of MEASURE/DELAYED SHUT-OFF switch to absolute reference supply.

Table 5-23. Voltage Monitor Controls and Indicators, Located on Right of Panel (cont)

Number and Type	Distribution	Function
	CONTROLS	
	1 switch, 2-position locking, marked VOLTAGE MON. MANUAL SWITCHING	Also called automatic/manual switch. Released: applies power to automatic stepping circuit which activates solenoid that turns stepping switches. The 120 voltage-pairs are selected and monitored at rate of one a second. Down: marked VOLTAGE MON. MANUAL SWITCHING, permits selection of individual voltage-pairs by means of selector pushbuttons, and removes power from stepping circuit.
	1 switch, 2-position nonlocking marked VOLTAGE MON. FAULT RELAY RESET	Used during automatic monitoring operations. When monitoring operation stops, fault relay must be reset before monitoring can continue. Released: no effect. Down: marked VOLTAGE MON. FAULT RELAY RESET, resets fault relay.
26 pushbuttons, interlocking	6 horizontal, marked from left to right 0-5, and 20 vertical pushbuttons marked from top to bottom 0-19	Column-selector pushbuttons used with row-selector pushbuttons to select voltage-pair during manual monitoring.
	INDICATORS	
2 jewel-lights	1 purple marked HIGH and 1 green marked LOW	Lights if relay RP3 detects voltage deviation that exceeds (falls below) allowable range. Remains lighted until fault relay is reset by pushing the VOLTAGE MON. FAULT RELAY RESET switch down.
26 neons	6 horizontal, marked from left to right 0-5 and 20 vertical, marked from top to bottom 0-19	Light when associated pushbuttons are pushed down, or when, during automatic monitoring, associated voltage-pair is being inspected. Remain lighted until another pushbutton is pushed down.

Table 5-24. Abnormal-Operation Indicators, Located at Middle of Right Panel

Number and Type	Distribution	Function
6 jewel-lights	1 red	Voltage monitor and servo power indicator. Lights when the MEASURE/DELAYED SHUT-OFF switch is pushed either up or down, when SERVO POWER switch is pushed up to OFF.
	1 green	Error-delete indicator. Lights when any error-delete switch is pushed down, when the MASTER DELETE switch is pushed down, or when the MEMORY CLEAR switch is pushed up to INHIBIT PMC position.
	1 blue	Static register indicator. Lights when any static register switch is pushed up or down.
	1 orange	Interrupted-operation switch indicator. Lights when the interrupted-operation switch is in any position other than continuous.
	1 white, marked B	Breakpoint indicator. Lights when the BREAKPOINT switch is pushed down, or when one or more of the CONDITIONAL TRANSFER BREAKPOINT SELECTOR pushbuttons is pushed down.
	1 white, marked P	Block subdivider. Marked P for printer. Lights when one or more BLOCK SUBDIVISION SELECTOR pushbuttons is pushed down.

5-12. The control printer is not intended to be used as an output device during normal operation, but for testing, correcting programs, inspecting intermediate results, and in other special conditions, it is invaluable.

5-13. The printer is the same as that used with the Unityper and Uniprinter. It is an electronically-actuated electromechanical typewriter. The control circuits are in the cabinet and in bay A. The printer itself is on top of the cabinet. All information typed in on the supervisory keyboard is printed out on the printer unless the printer is on SKIP. If the printer is turned off, the absence of the first printer-action signal from the printer prevents type-in.

5-14. The printer also can be used independently of the supervisory keyboard. The printer cabinet controls and indicators are discussed in paragraphs 5-22 and 5-23. Further information concerning the printer is available in the Uniprinter Maintenance manual.

5-15. ALPHANUMERIC KEYBOARD. There are 72 keys, a spacebar on the left, and a start bar on the right of the supervisory control keyboard.

5-16. All of the character keys operate microswitches under the keyboard, discharging capacitors through an encoding matrix to send pulse combinations into one of the two input-synchronizer registers. At the same time, the same pulse-combination is set up in the printer thyratrons. The SKIP, BACKSPACE, NO LOOP, LOOP 1, and LOOP 2 keys are effective only on the Unityper.

5-17. Each of the printer control keys (SHIFT, SPACEBAR, SHIFTLOCK, UNSHIFT, CARRIAGE RETURN, and TAB) also sends a pulse-combination into the input synchronizer register, on NORMAL and COMPUTER DIGIT positions of the PRINT SELECTOR switch, besides performing the necessary operation at the control printer when on NORMAL. A complete description of the supervisory control keyboard is given in the Uniprinter manual.

5-18. The start bar is at the bottom right of the control keyboard. It starts the computer by:

(1) Restoring the STOP flip-flop, FF205.

(2) Restoring all error flip-flops except the five input-output error and tank-selection error flip-flops.

5-19. The ERASE and the WORD REL. keys are used during supervisory type-ins. The ERASE key deletes an incorrect type-in. The word-release key permits the computer to accept a completed word. The ERASE key is used whenever the operator has made an error and wishes to cancel an uncompleted word. There are several circumstances in which this is necessary, the most obvious being a typographical error. There are several types of input errors that the computer detects (for example: characters typed without sufficient time between them; more or fewer than 12 digits in a word). These errors light the INPUT ERROR neon and deenergize the keyboard.

5-20. The ERASE key clears the precessor and restarts it. It clears the partially constructed word out of the input-synchronizer register, and clears the input flip-flops. It also clears the input-error flip-flop. When the key is released, it clears the odd-even counter, BC601, in the input synchronizer to odd. The operator then retypes the word.

5-21. When the twelfth-digit neon lights, a word has been correctly typed into the input-synchronizer register and the operator can push the WORD REL. key. This key closes a relay, one pole of which sends a voltage through a special encoder that causes the control printer to print a period at the end of the word. Voltage from the second pole samples the input-error circuits; if no error is present, it opens the output gate from the synchronizer registers and generates a supervisory read-ending (SRE) signal. This signal steps the program counter, and the new program-counter step enables function signals to transfer the word from the input-synchronizer register to the memory or the control register. The function signals also terminate the operation.

5-22. PRINTER CONTROLS. The printer controls are:

(1) Print selector, or FUNCTION SW, a 2-position rotary switch on the printer dolly. Left, marked NORMAL, permits the printer to operate normally, printing each character and performing each control function, under control of the supervisory keyboard or the Central Computer. Right, marked COMPUTER DIGIT (or sometimes, CHECK), permits the printer to type out a character for every decoded pulse-combination except the space and printer-stop symbols. Carriage-return and tab operations are not carried out as they are decoded; the carriage returns automatically when it reaches the margin stop. The printer-stop symbol stops the printer; the space symbol permits the carriage to move one space. Thus there is only one character-space on paper for every computer digit received from the memory or inserted from the keyboard.

(2) BREAKPOINT STOP: two-position locking telephone-key switch on the printer dolly. When the switch is released, the printer interprets the breakpoint symbol as an ignore. If the PRINT SELECTOR switch is in NORMAL position, the printer skips over the symbol: if PRINT SELECTOR is in COMPUTER DIGIT position, the printer prints an "x." If the BREAKPOINT STOP switch is down, marked BRKPT. (breakpoint), the printer interprets the breakpoint symbol as a stop, stops the printer and lights the BREAKPOINT neon, regardless of the position of the PRINT SELECTOR.

(3) SKIP: two-position locking telephone-key switch on the printer dolly. Released, no effect on printer operation. This switch is to be used only in Uniprinter operation and must be released on the control printer at all times.

5-23. PRINTER INDICATORS. The three printer indicators are:

(1) PRINTER STOP: neon indicator, lights whenever the pulse-combination meaning stop is decoded by the printer. Remains lighted (the printer remaining stopped) until any key is pushed on the printer keyboard.

(2) BREAKPOINT: neon indicator, lights whenever the pulse-combination meaning breakpoint is decoded by the printer, if the BREAKPOINT switch is pushed down. Remains lighted until any typewriter key is pressed.

(3) Eight neon decoder indicators (figure 1-30) are inside the printer dolly. On later models, these neons are duplicated on top of the cabinet. Seven of these neons are associated with the seven pulse positions in a computer digit. The eighth is associated with the sprocket pulse. They are used to indicate what digit is set up in the decoder.

5-24. TROUBLESHOOTING PROCEDURES

5-25. GENERAL TROUBLESHOOTING SUGGESTIONS

5-26. REFERENCES AND LABELS. Keep reference books containing the following information on the control desk: Analyses of Univac Instructions, a list of function signals, sources of function signals, a list of important synchronizer-signal points, and a list of calibration points. Post a list enumerating important test points, and any other information pertinent to the bay, on the back of each bay door. Label the positions of important chassis neons such as those for TO, TS, FIR, BIR, photocell, and tape-channel flip-flops.

5-27. FUNCTION SIGNALS. Use the function-signal neon bank in the DE corner. Be sure that the function signal indicators lighted are the correct indicators, and that the neons that should not be lighted are not lighted. When trouble appears, check voltages at the source terminals of the function table. Any permissive voltage higher than +60 volts, or any inhibitory voltage lower than +90 volts, is a potential source of failure.

5-28. TEST SWITCHES. Use these test switches in the Central Computer:

ELIMINATE RE	B12T, V14
ELIMINATE WE	A11X, V5
RETAIN PC	DX, bypass board C
IER/OR	H4X backboard
FTI TEST	DE corner
FTO	D7X, V7

5-29. TEST OSCILLOSCOPES. Use test oscilloscopes:

(1) Always have the sync leads and signal probe assembled and ready to use. A 1-second delay can mean the difference between finding or losing an intermittent trouble.

(2) Some signals that have a long duty cycle, such as tape instructions and multiply and divide instructions must be examined with a direct-coupled oscilloscope.

(3) Changes in baseline level observed on a direct-coupled oscilloscope are indications of trouble.

(4) The monitor or test oscilloscopes give only an approximate indication of amplitude and uneven form. Check the signal at its source to be sure.

(5) Use a dual-sweep oscilloscope to trace signals and compare waveforms in duplicate circuits.

5-30. EXTENDERS. If a circuit has no satisfactory test terminals, an extender can be used to probe. Before installing an extender:

(1) Turn dc off.

(2) Turn dc on to see if the trouble has corrected itself. If not, turn dc off and install the extender. Never use a chassis extender if a tube extender will suffice.

5-31. ANALYSIS BY POWER TURN-ON AND START PROCEDURE

5-32. Each step of this analysis and its check procedure is detailed in table 5-25. When this procedure has been successfully completed, the operator is ready to perform an initial read operation from the tape on a selected Uniservo.

5-33. ERROR ANALYSIS

5-34. GENERAL. The technician must be able to interpret the symptoms of a trouble, if he is to troubleshoot the failure as quickly as possible. For example, a stall alarm is usually the first indication of trouble in the computer. The alarm occurs when the cycle counter has not been stepped for more than three seconds. The indication depends on the setting of the SPEAKER switch and can be either a silence, if the switch is set to HSB, or an 800-cycle tone from the stall speaker, if the switch is set to STALL. When an alarm occurs, push the STOP switch down to prevent the computer from starting. The symptom should be recorded immediately in the computer log book, the trouble traced and recorded. The practice of recording troubles and their symptoms will provide a source of information useful in isolating future troubles.

5-35. If errors occur in different circuits at the same time, a circuit or signal common to all or most circuits is the probable cause of the trouble. For example, the control and sequencing signals, and the cycling-unit signals can cause trouble in the adder, the registers, or any other related part of the computer, but the circuits

Table 5-25. Power Turn-On and Start Procedure

Step	Procedure	Check
1	Make certain that d-c lock and SERVO POWER switches are in OFF position.*	Turn d-c switch fully counterclockwise and push SERVO POWER switch up.
2	Turn on power at main power installation: (1) Control power lamp should light. (2) Supervisory control bell starts to ring. (3) STAND-BY POWER (HEATER) neon lights. (4) All STAND-BY HEATERS - LONG TANKS neons light.	If no indicators light, check phase 1L6 in the power installation. If (3) or (4) does not occur, measure voltage between phase 1L8 and phase 1L9 at power installation. Voltage reading is 208. If (4) does not occur check neon and then check for 208v(ac) at the terminals at the end of tank whose neon fails to light. Check stand-by microswitch under the cover-plate (figure 2-7).
3	Turn short tank STAND-BY POWER on: (1) Supervisory control bell stops ringing. (2) The STAND-BY POWER neon lights. (3) All HEATERS-SHORT TANKS neons light.	If no neon lights, check phase 1L7. If (3) but not (2) occurs, check neon. If one of the short-tank neons does not light, check the neon first, then check at the chassis neon. Check the circuit on the chassis (figure 2-12).
4	Wait until the long tanks have reached a-c equilibrium; that is, until the STAND-BY HEATERS - LONG TANKS neons begin to blink (about 20 minutes).*	
5	Press HEATERS ON button: (1) The green heater-power jewel goes on. (2) Blowers start. (3) Heaters come on dimly; their brightness then increases in three distinct steps. (4) A-C elapsed-time meter starts. (5) Two minutes after the heaters are up to full power, the yellow ready light comes on.	If nothing comes on check all elements in the a-c interlock (figures 2-10 and 2-11). (1) Check jewel-light. (2) Check blower motors. (3) Check the resistors, timer motors, and relays in slow heater-turn on circuit. (4) Check RP8.
6	Check for blown d-c or heater secondary fuses by pushing the FAULT TEST switch down.	Replace any blown fuses.
7	Ring warning bell twice signifying d-c is to be turned on. The button for this bell is under the left side of the supervisory control desk.	
8	Turn d-c lock key clockwise.	
9	Press the D.C. ON button. (1) Red d-c jewel-light goes on. (2) On systems which use RP22, all long-tank heating indicators go off. (3) D-C elapsed-time meter starts.	If nothing occurs, check all elements in the d-c interlock, RP8, RP10A, and RP10B (figures 2-10 and 2-12).
10	Push CU-TSC CLEAR switch down. This clears all four cycling-unit loops and clears the time-selector counters to decimal zero. It is important to start cycling unit as soon as dc is on. This is particularly important in computers that use relay RP22, since this relay removes heating power from the long mercury tanks as soon as dc comes on.	To examine the contents of the cycling-unit loops with the video monitor: (1) Push OSCILLOSCOPE switch down (to Group 2). (2) Push TC/CU button and select loops with SECONDARY SELECTORS 0, 1, 2, 3, and 4. There are no pulses in any of these loops. To check time-selector counters, examine their chassis neons.
11	Push the CU START INTERLOCK switch down and hold it. As long as this switch is held down the input gates to the cycling-unit loops are held open.	
12	Push the CU START switch down and hold it. This sends a single timing pulse into each of the cycling-unit loops.	If a CYC UNIT error neon comes on, repeat steps 10 through 14. If the error persists, one of the cycling-unit loops may not be receiving a pulse or may have an open circuit. Examine the cycling-unit loops with the video monitor. There is one pulse in each loop. If one of the loops has no pulse, repeat steps 10 through 14 while observing the faulty loop on a scope. If none of the loops contains a pulse, check the cycling-unit start circuit. For signal tracing, trigger the circuit repeatedly by plugging the test multivibrator into P8V-V5 socket.

Table 5-25. Power Turn-On and Start Procedure (cont)

Step	Procedure	Check
13	Release the CU START INTERLOCK switch. This closes the input gates to the cycling-unit loops.	
14	Release the CU START switch to disable single-pulse circuit.	
15	Push both INITIAL CLEAR 1 and INITIAL CLEAR 2 switches up. INITIAL CLEAR 1 blocks all short-register clear gates. INITIAL CLEAR 2 reads gain control pulses into the register.	Examine registers to see if they have been properly cleared.
16	Release INITIAL CLEAR 1.	Gain control pulses are present in all short registers. If any register does not hold pulses, check the temperature-control neon. If it is on, the tank is cold. Determine the cause of any delay in warmup time.
17	Release INITIAL CLEAR 2.	
18	Push the GENERAL CLEAR switch down. This restores most flip-flops and clears the cycle counter and program counter to binary zero. In addition it sets the time-out and stop flip-flops. The following neons should be on: 2 STOP neons, 2 TO neons. STALL neon comes on after 3 seconds. MQC and input-output counter neons may be lighted in random order. No other neons on the center panel light.	Investigate any circuits whose neons do not conform to this pattern.
19	Push memory clear switch down to MEMORY CLEAR.	
20	Push interrupted-operation (I-O) switch up to ONE OPERATION.	
21	Push the CLEAR C switch down.	All error neons go out except the 4TH and 5TH tank selector neons. Delete 4th and 5th tank selector errors and clear C again.
22	Press the start bar several times and look at either the FOURTH or FIFTH INSTRUCTION DIGIT neons of the static register.	If the 4TH and 5TH tank selector neons are not on, ten is added to the static register each time the start bar is pressed.
23	Put the I-O switch on ONE INSTRUCTION. Press the start bar.	
24	Push the MEMORY CLEAR switch up to INHIBIT PMC. Push CLEAR C switch down. Put I-O switch on continuous. Press the start bar. The computer will do a memory check 10 times and stop with the F.T. INTER. neon on.	If the HSB O-E neon lights, repeat steps 19 through 24. Then if the HSB O-E neon is still on, repeat steps 19 through 24 with the RETAIN INSTRUCTION switch down.
25	If no HSB O-E error is present, and the computer completes a memory check successfully, put IOS in ONE INSTRUCTION and push CLEAR C switch down.	
26	Push I.F. BIAS CONTROL switch down to NORMAL. Neon above switch lights.	
27	Computer is ready for an initial read.	

* In later Univac I system computers, this procedure is not necessary.

that produce the signals do not indicate the trouble. Where circuits that develop errors function interdependently, the cause of the error is probably in only one of the circuits. Where circuits use another circuit in common, it is sensible to investigate the common circuit first.

5-36. CAUSING ERROR TO RECUR. One of the first steps in the analysis of the trouble is to try to cause the recurrence of the error by repeating the instruction that initiated it. Ordinarily, the computer stops during the first time-out period following the detection of the error by one of the checking circuits. The exceptions to this generalization are the input-output errors, and the A COMP or X COMP errors if the X÷ ERROR STOP switch is released. Consequently, it is necessary to change either the program-counter reading or the control number. If the program-counter reading is PC-1 (all neons out), the entire instruction that caused the trouble has passed, and the instruction in the static register will follow. The control number must be changed in this way:

(1) Push the interrupted-operation switch left to ONE STEP.

(2) Push the RETAIN C/RETAIN INSTRUCTION switch up to the RETAIN C position.

(3) If the reading of the cycle-counter is delta (all neons lighted), push the statis register clear switch (marked SR) up to DECIMAL ZERO. This substitutes a skip instruction for the delta half of the instruction pair, so that any pulse-train containing an error is held in its register. Press the start bar; the computer will perform the skip and step to alpha.

(4) When the computer is in alpha, press the start bar. When the cycle counter reading is beta, the control number plus one is set up in the static register (fourth, fifth, and sixth digits). Use the static register setup switches on the control panel to decrease the sixth digit by one.

(5) If the computer stops during gamma time out, the error occurred during beta, and must be analyzed in terms of the special conditions of the beta operation.

5-37. When the control number has been changed, press the start bar, and push the RETAIN C/RETAIN INSTRUCTION switch down. The instruction pair is now in the control register and the gamma half is set up in the static register. The instruction is retained, and since the interrupted operation switch is in the ONE STEP position, it can be performed one step at a time.

5-38. If the program-counter reading is not zero, the instruction set up in the static register caused the error. Push the RETAIN C/RETAIN INSTRUCTION switch down, and the interrupted-operation switch to ONE STEP. Then push the CLEAR PC switch down. The instruction remains in the static register, and can be performed one step at a time.

5-39. Analyze the instruction. If it involves a series of 10-word memory transfers, push the interrupted-operation switch up to ONE OPERATION before beginning the instruction. If it is a multiply or divide instruction, push the interrupted-operation switch to ONE ADDITION to give the most minute breakdown of the instruction.

5-40. Certain types of errors are caused by the absence of function signals. Check the function-table neon bank in DE corner to see that the neons for the correct function-table signals are lighted.

5-41. If anaylsis of the instruction gives no clue, press the start bar. The computer will start the instruction. If it is a one-step instruction the computer will finish it. If the error indications remain the same, the trouble is probably systemic, and isolating procedures must be used to find it (paragraphs 5-45 and 5-52). If the error indications are different, the trouble may be caused by certain marginal signal conditions, or by a partial intermittent trouble. If error indications do not develop, the cause of the error was a true intermittent trouble, one caused by loose connections, partial breaks, or faulty solder joints, as distinguished from true faults, caused by faulty components, blown fuses, or circuit failures.

5-42. As a further test, retain the program-counter reading in which the error seemed to develop, or the instruction, if the step that produced the error is unknown, and set the interrupted-operation switch in the continuous (center) position. Press the start bar. The computer will repeat the same instruction or step. This procedure may cause the error to develop when interrupted operation would not. If the error does develop, the cause is probably an overloading a-c coupling circuit, or a faulty d-c restoration at some point along the line.

5-43. If the error does not develop under these conditions, record the symptoms in the logbook, and release the computer to the operator. If there is any possibility that information in the computer was invalidated by the error or the maintenance procedure, notify the programmer as well, so that the operation can proceed under his guidance.

5-44. At each point in this procedure, the important aspect is the analysis of the various results of each test: of the initial symptoms as they appeared; of the instruction and step in which they appeared; of any secondary symptoms; and of whether the trouble was systemic or intermittent.

5-45. ISOLATING TROUBLE TO A CIRCUIT. If the symptoms of a trouble recur each time the instruction is set up, then the trouble is a true one. To determine what it is, and to correct it, the trouble must be isolated. Analytic isolation of a trouble to a major unit must precede electronic isolation and signal tracing.

5-46. First, analyze the type of instruction that is causing the error, and the error symptoms. If there is only one error symptom, isolation is fairly simple. Probably, the circuit in which the single error develops is at fault. For example, an X COMP error, which occurs during any instruction using the accumulator circuits, indicates a trouble in one of the X-registers. To check this:

(1) Inspect the X-register on the video monitor, or set up a 50 + BREAKPOINT, and push OUTPUT SELECTOR X.

(2) Read out of the X register with $\overline{\text{HSB}}$ TO SYO switch in both positions, or set up a Jm instruction, using an empty address, and observe whether a HSB O-E or HSB COMP error develops.

5-47. Any of these procedures will detect a faulty pulse-train in register X. To determine at what point in register X the pulse-train develops the trouble, set up and retain an L instruction. Put the interrupted-operation switch in the continuous (center) position and check signals in register X.

5-48. If there is more than one error-symptom, isolation becomes a problem of determining what common circuit or common signal causes the error. Sometimes this procedure can be simplified by using the interrupted-operation switch to obtain the smallest possible breakdown of an instruction. For example, comparison errors may develop in one accumulator register during an MNP or X instruction, and be passed into another register or adder later when either register or adder is used. If a ONE ADDITION instruction is performed the source of the trouble may be detected.

5-49. The symptoms themselves sometime provide clues. When HSB COMP, L COMP, and X COMP errors develop during an L instruction, the trouble is in one of the duplicated high-speed bus paths. When HSB O-E and ADDER SUB erorrs occur on an A, S, or X instruction, the trouble is in register X, because it is used by all three instructions. HSB O-E errors on the first step of any arithmetic instruction indicate a faulty pulse train from the memory (or a faulty high-speed bus).

5-50. When many apparently unrelated errors occur, a control, sequencing, function or operating signal may be at fault, or a cycling-unit signal may be missing. The arithmetic-sequencing signals and most of the control signals are represented by neons on the control panel. (Refer to tables 5-1 through 5-24 and see figure 5-1.) The function signals are all represented in the function-signal neon bank. The cycling-unit signals are more difficult to trace, but an error should cause at least one of the two CYC UNIT error neons to light. It is important to remember that the neons on the control panel are usually connected to amplifiers close to the generating circuits. Many of these controlling signals go through many stages of amplification before they arrive at their destination. Failure of any of these amplifiers might cause the error indication on the panel.

5-51. After the symptoms are analyzed, verify any preliminary conclusions. If one particular circuit or group of circuits is suspected, set up an instruction that uses part or all of that circuit. For example:

(1) If errors are produced on 5n or 7n instructions, exempt all the tape-control circuits, the counters, and rSYO1 if a 50 or an EMPTY does not produce errors.

(2) If an input-synchronizer odd-even error develops while a routine containing more than one tape instruction is in progress, try reading the block by itself. If no error develops, the initial trouble was probably due to crosstalk.

(3) If an output-synchronizer odd-even error develops, read the block that caused it. An I. S. O-E error on read-back indicates trouble in the output circuits. To check the output-synchronizer registers in this case, set up a 30 instruction and then EMPTY from memory. Trouble in rSYO1 will cause an incomplete second word and in rSYO2, a incomplete first word.

(4) Errors occurring on 3n or 4n instructions may be due to faulty channels in register I, or to the synchronizer circuits. With the interrupted-operation switch in the ONE OPERATION position, determine if the error always recurs on the transfer from the same channel. If so, that channel is probably at fault. If not, type out from the memory to examine the information. Consistent errors in alternate words indicate trouble in the rSYI1 or rSYI2. To determine which of the registers contains the trouble, try type-in instructions. When either the SYI1 or SYI2 neon is lit, the output gate of the associated register is open. Random errors indicate a faulty path between rSYI1 and rSYI2, and the input register.

5-52. ISOLATING TROUBLES IN A CIRCUIT. After the operational analysis of the computer, analyze the conditions in a selected circuit. If the symptoms that have developed during operational analysis indicate a missing or intermittent control signal, check the source and distribution of that signal. If a voltage deviation is suspected, use the voltage monitor.

5-53. Errors that result from a deviating voltage, or from a drop in tube emission, are errors of still another kind. The amplitude of a signal may drop too low to operate one circuit, but still be sufficient to operate another. Sporadic HSB COMP or HSB O-E error indications in one circuit and not in its duplicate frequently can be traced to this source. If the trouble can be traced to a single location, normal signal-tracing techniques can be efficiently used.

5-54. INTERMITTENT TROUBLES. Intermittent troubles should be traced only after alternate explanations are thoroughly considered. Do not disturb the condition of the computer. Do not turn off dc, remove tubes or chasses, change duty cycles or make any other change that will alter or erase the symptom. If the trouble stops the computer but cannot be made to recur (paragraph 5-36), record the indications at the control panel before attempting to make it recur as suggested in paragraph 5-55.

5-55. An intermittent trouble sometimes may be made to recur by changing the duty cycle or repetition rate of the operation with the test multivibrator or the interrupted-operation switch.

5-56. Brute-force techniques are sometimes useful for tracing intermittent troubles. For example:

(1) Substitute spare chasses in the memory.

(2) Interchange chasses in the duplicate circuits to see if the trouble moves with a chassis.

(3) Substitute tubes one at a time.

(4) Tap tubes, chasses, and backboards while the routine is running.

(5) Pull a normally nonconducting tube to open a signal path. Short the grid to the cathode to turn a tube fully on.

(6) When a tube is pulled, monitor the faulty circuit to see if the trouble is corrected.

CAUTION

Some tubes may be removed while dc is on. However, this should never be done without first refering to the schematic diagrams of the circuit to determine if any damage will result. Generally, never remove a chassis or tube without turning off dc, and always check the circuit on a schematic before pulling a tube with dc on.

5-57. An oscilloscope is much more sensitive than the error circuits. It may, therefore, interpret marginal signals, which are detected as intermittent by the error circuits, as consistent faults.

5-58. POWER TROUBLES. Check for power faults in the following circumstances:

(1) If neons on the control panel light, or if random fuses blow in various parts of the computer. One complete rectifier circuit may have failed, or a single phase of input power may be low. Check voltages with a 2-percent meter, but turn power on for a short time only. If random fuses blow after voltages have been adjusted, check voltages at supply points. Half-voltage or no voltage may indicate defective percentage switches.

(2) If a fuse fault is not due to fuse fatigue, remove the fuse and measure the resistance in both directions between the load side (terminal W) and ground.

(3) If the resistance is high, turn on dc and measure current. If the current increases as time passes, the trouble is probably a defective crystal.

(4) If the resistance is low in either direction, check schematics to determine the value of the voltage, and what resistance it should encounter.

(5) If a direct short appears, remove chasses one at a time until the short indication disappears.

(6) If a signal wire is shorted to a power point, the power surge can cause serious damage to crystals. Trace out both lines and check all crystal diodes connected to them. Use an ohmmeter (R x 100 scale).

5-59. Reject a crystal if the forward resistance is greater than 1 kilohm and if the backward resistance is less than 20 kilohms. Do not unsolder leads unless a diode is suspected.

5-60. Check the resistance of wire-wound resistors as quickly as possible after turning off dc, since a break in the resistor may reconnect as the wire cools.

5-61. Tubes, crystal diodes or capacitors, may pass static tests, but fail under dynamic conditions. If there is any doubt, replace the component.

5-62. Errors occurring during PMC, initial read, or beta may be easier to find on program instructions such as A or B. PMC can be terminated by jamming 990 into the 4th, 5th and 6th digits of the static register. For troubleshooting tape errors, refer to section VI of the Uniservo I maintenance manual.

5-63. SAMPLE TROUBLES

5-64. GENERAL. This section gives examples of the methods of analysis and isolation discussed in the preceding sections. In almost all cases of systemic trouble, there are many possible approaches. The solutions of the cases cited here are not the only solutions, but they illustrate the analytical approach.

5-65. ADDER. In a sample trouble for the adder, the symptoms are:

(1) Computer stops.

(2) STALL neon lights.

(3) ADDER COMP. and A COMP. neons light.

(4) Cycle counter is at alpha and cycle counter neons are not lighted.

5-66. Push the STOP switch down and push the interrupted-operation switch down to ONE INSTRUCTION to analyze the symptoms. Since the ADDER COMP. and A COMP. neons both are lighted, the trouble is either in the adder or in register A. Assume the error occurred in the previous instruction (delta stage).

5-67. Set up the previous instruction:

(1) Push RETAIN C/RETAIN INSTRUCTION switch up to RETAIN C.

(2) Delete the A COMP. and ADDER COMP. error indications by pushing down the switches.

(3) Press the start bar. This reads the control number from the control counter into the static register, steps the cycle counter to beta, and resets the ADDER COMP. neon. The static register neons indicate 00 087, the control number for the next two instructions.

(4) Change the sixth instruction digit to a 6 by operating the appropriate static-register switches. This enables the computer to select the address that contains the instruction which caused the error. Press the start bar, stepping the cycle counter to gamma.

(5) Execute the B500 instruction indicated by the static register neons. The information in registers A and X is now the same and the A COMP. neon goes out. The cycle counter is now in delta stage. The static register now contains instruction A0 112. Press the start bar. If the ADDER COMP. and the A COMP. neons do not light, an intermittent fault or an overloaded a-c coupling may have caused the original error. If both neons light, indicating a repetition of the original error, determine which A-register contains the error.

(6) Push the interrupted-operation switch down to ONE INSTRUCTION. Press start bar twice to advance to gamma stage.

(7) Set up a 50m instruction in the static register.

(8) Press OUTPUT SELECTOR A.

(9) Press the start bar twice to advance the program counter to 3. The computer will print the word held in register A.

(10) Push the CLEAR PC switch down and release it.

(11) Push the $\overline{\text{HSB}}$ TO SYO switch down and press the start bar twice. The computer will print the word held in register $\bar{A}$.

5-68. Result: the type-out of registers A and $\bar{A}$ indicates which register is faulty. Therefore, the error is in the adder associated with that register.

5-69. The following routine, applicable to an 11-place addition, allows the operator to examine the adder with an oscilloscope, with the 0p0 signal as synchronizing voltage, and to see the particular minor cycle during which the addition takes place. The routine is as follows:

(1) Set up a 10 003 instruction in the static register and type in instruction B0 005 and A0 007.

(2) Set up a 10 005 instruction and type in the word 055 555 555 555.

(3) Set up a 10 007 instruction and type in the word 033 333 333 333.

(4) Release the RETAIN INSTRUCTION switch.

(5) Push the SCICR switch down and release it. Type in instruction 000 000 U00 003.

(6) Retain C and release the I-O switch to the continuous position. Press the start bar to execute the instruction in memory location 003. This will produce an ADDER COMP., A COMP. error if the circuitry is at fault. To locate the faulty adder, type out of register A and register $\bar{A}$. The register holding the word 088 888 888 888 is not faulty.

(7) Put the computer in continuous operation. Using an oscilloscope with 0p0 as synchronizing voltage, check the adder and proceed to locate the trouble.

(8) If it is not obvious which adder is faulty, it will be necessary to use two other words that will produce a long carry, such as 077 777 777 777 and 004 444 444 444.

5-70. MEMORY. In a sample trouble for the memory, the symptoms are:

(1) Computer stops.

(2) STALL neon lights.

(3) HSB O-E and PMC neons light.

(4) Instruction set up in the static register is 00 550 (skip).

(5) The cycle counter reading is at alpha. (All cycle-counter neons out.)

5-71. Push the STOP switch down to analyze the symptoms. Since the error occurred during PMC, the fault is probably in memory channel 540 to 549. Put the interrupted-operation switch in ONE INSTRUCTION position and the RETAIN C/RETAIN INSTRUCTION switch at RETAIN C.

5-72. Examine channel 540 with the video monitor:

(1) Push REGISTER SELECTOR M.

(2) Push hundreds-selector 50.

(3) Push tens-selector 4.

(4) Push SYNC switch up to 0p0.

5-73. Result: no pulses are seen on the monitor oscilloscope because information is not entering or recirculating in the channel.

5-74. Determine which condition prevails:

(1) Push the HSB O-E switch down to delete the error indication.

(2) Press the start bar twice to step the cycle counter to gamma. This prevents PMC from causing additional errors.

(3) Set up the instruction H0 540 in the static register.

(4) Release the interrupted-operation switch to the continuous position.

(5) Push the RETAIN INSTRUCTION switch down.

(6) Press the start bar to cause a word to appear on the scope.

5-75. Push the interrupted-operation switch down to ONE INSTRUCTION. This causes the word to disappear.

5-76. Conclusion: channel 540 is functioning properly. A probable cause of the trouble is the cathode follower. Channel 540 is in chassis G6V. Therefore, check V14 in G6V.

5-77. TEMPERATURE CONTROL. In a sample temperature-control trouble, the symptoms are:

(1) Computer stops.
(2) STALL neon lights.
(3) HSB O-E and PMC neons light.
(4) Cycle counter reading is at alpha.
(5) Instruction set up in the static register is 00 630.

5-78. Push the STOP switch down to analyze the symptoms. The error occurred during PMC. As each memory channel is checked, the MQ13 flip-flop signal sets the time-out flip-flop, clears the static register, and sets up in the static register the address of the next memory channel to be checked. Therefore, the error must have occurred while channel 620 was checked.

5-79. Examine channel 620 with the video monitor:

(1) Push REGISTER SELECTOR M.
(2) Push hundreds-selector 60.
(3) Push tens-selector 2.
(4) Push the SYNC switch up to 0p0.

5-80. Result: a blurred pulse-train moves across the face of the oscilloscope. This indicates a fault in the temperature-control channel. (Channel 620 is located on tank NX.)

5-81. Examine the temperature-control channel of tank NX with the video monitor:

(1) Push the OSCILLOSCOPE switch up to GROUP 1.
(2) Push REGISTER SELECTOR TC/CU.
(3) Push SECONDARY SELECTOR 4.

5-82. Result: no pulses appear on the screen. There should be ten pulses, one for each minor cycle.

5-83. Conclusion: since the temperature-control channels for the other tanks are functioning, the t16's from the cycling unit are entering the memory sections. The trouble is in the channel itself. Troubleshoot chassis N2X and its associated amplifier chassis (tank-mounted chassis 18). Check for t16 pulses at test terminals G12, G13, A17 (figure 2-8), and at the input to the chassis on terminal T59, chassis N2X. If the location of the trouble is not apparent, isolate the trouble in the bay-mounted temperature-control chassis, the amplifier chassis on the tank, and the mercury channel itself.

5-84. OUTPUT-SYNCHRONIZER ODD-EVEN CHECKER. In a sample trouble, the symptoms are:

(1) Computer stops.
(2) STALL neon lights.
(3) O. S. O-E neon lights.
(4) Cycle counter is at delta (all cycle counter neons on).
(5) Instruction set up in the static register is 51.
(6) WRITE lamp on Uniservo 2 lights.

5-85. Push the STOP switch down to analyze the symptoms. The error occurred during the writing of the last block on tape 2. It is caused by a checker malfunction or an error on the tape.

5-86. To determine whether the trouble is in the checker:

(1) Push the RETAIN INSTRUCTION switch down.
(2) Push the O. S. O-E switch down to cancel the effect on both output-synchronizer odd-even checkers.
(3) Set up a 22 instruction in the static register.
(4) Press the start bar.

If an input-synchronizer odd-even error does not occur, the trouble is in the output-synchronizer checker. If an input-synchronizer odd-even error does occur, an error developed during the write instruction.

5-87. To isolate the faulty write channel:

(1) Set up a 10m instruction in the static register, using the first of at least seven unused memory locations.
(2) Set the PRINT SELECTOR switch on the control printer to COMPUTER DIGIT.
(3) Press each of the following keys 12 times:
Ignore = 100 0000
Tabulator (TAB) = 010 0000
Carriage Return (C.R.) = 001 0000
Five = 000 1000
One = 000 0100
Hyphen = 000 0010
Space = 000 0001

(The code for each of these characters contains only one pulse.)

(4) Type out the successive words that were typed in. Change the address after each typeout. That is, set up a 50m instruction. (If desired, perform an SCI CR operation to the address of the first word and then initiate an empty.)

5-88. Result: the computer will print out the seven words that were just typed in. When the error occurs, the printer will stop. Since each character has only one pulse, the faulty channel is indicated by the character that cannot be printed. Therefore, check the head-driver tube for that channel.

5-89. POWER FAILURE. In a typical trouble, the symptoms are:

(1) DC goes off.

(2) Primary fault indicators and the thermostat fault indicator do not light.

5-90. Push the FAULT TEST switch down. The upper BAY C neon lights. Fuse CT14-6, which protects the +120 line in bay C, has blown because of fuse fatigue or overload. Replace the faulty fuse and turn on dc.

5-91. If the fuse blows again, check the power wiring print for section CT and measure the resistance between point 14W6 and ground in both directions. The print shows that +120 volts is supplied to terminals 2T7, 3T3, 5T8, 8T8, 10T8, and 12T7. If a direct short-circuit is found while measuring the resistance, remove the faulty chassis.

5-92. If no direct short-circuit is located:

(1) Compute the resistance, using the following equation: Resistance equals voltage divided by 60 percent of the current rating of the fuse.

(2) If a partial short is indicated, locate and remove the faulty chassis.

5-93. If no partial short is found:

(1) Remove half of the chasses that receive the voltage.

(2) Turn on dc.

(3) If the fuse blows, remove the remaining chasses and repeat steps (1) and (2).

(4) Repeat the preceding steps until the fault has been located and corrected in the chassis.