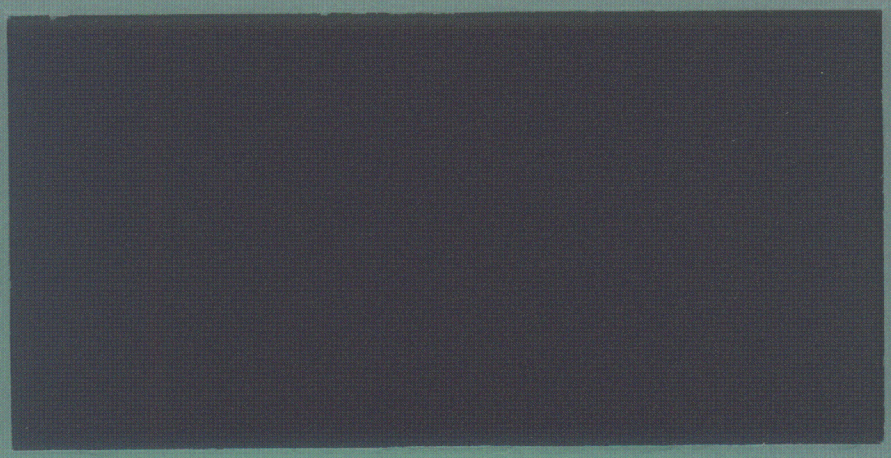
SCTM - 254-61(14)

AUTOMATIC TESTER FOR ELECTRICAL FUSES

C. D. Longerot, 1432

TECHNICAL MEMORANDUM

SC 1004-BK (5-61)



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ABSTRACT

This technical memorandum describes an automatic tester and recorder as it is used in obtaining fusing time information from electrical fuses for subsequent analysis in the IBM 704 Computer. Included is information on tester operation, data recording and handling test equipment, the computer program, and specific recording formats.

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AUTOMATIC TESTER FOR ELECTRICAL FUSES

1 PURPOSE

The purpose of this equipment is to allow testing of electrical fuses with a degree of repeatability and in sufficient numbers to allow statistical and reliability studies of the various fuse characteristics and of the effects of certain variable perameters on these characteristics.

The first use of this equipment is in studying the fusing characteristics of a particular current range and construction of electrical fuses. The fuses are tested under a given set of conditions and in sufficient numbers for the calculation of meaningful statistical information.

Fusing times are measured by the automatic tester and recorded on IBM cards in a format compatible to an IBM 704 program deck for subsequent processing and computation. The data will be tabulated in an output format which will enhance further analysis in the form of visual aids such as bar graphs, distributions, and families of curves indicating the effect of input variables.

Figure 1 presents an operational flow diagram. Figure 2 shows a more detailed diagram of the processing of information after the data is recorded on IBM cards.

2 AUTOMATIC TESTER OPERATION

2.1 General

A block diagram of the automatic tester and a simplified schematic are shown in Figure 3. The tester accepts a test fixture which contains the units to be tested, selects the units one at a time for connection into the test circuit, and applies a preset current. The tester then measures the interval during which current flows in the circuit. The interval timer portion of the tester then displays the reading and through a serial punch converter the information is printed on cards by an IBM 526 Summary Punch.

These punched cards will then be stacked to form a data deck which is subsequently combined with a program object deck. This combined deck of IBM cards is then read into the IBM 704 computer. The data is reduced by the computer and printed out in a comprehensive format.

2.2 Sequence of Events

The sequence of operation is as outlined in the following discussion and as shown in Figure 4. The ON and OFF time of the timing cycle is adjustable by the two plug-in clocks (Timer No. 1 and Timer No. 2) in the Timing and Gating Unit. Timer No. 1 determines the ON time, and Timer No. 2 determines the OFF time. The clocks are set to allow for the fusing time plus the conversion and punch time. The ON time must be at least as long as the fusing time. The combination of the ON and OFF time (one cycle) must be at least as long as the fusing time, conversion time, and punch time, combined. Switching the Timing and Gating Unit on, initiates the rundown of time No. 1, and through a set of contacts applies a DC voltage to the 50-position stepping switch in the Count and Scan Unit. At the same time, a slow-operate relay is energized, applying 24 volts DC through its contacts to a set of contacts on the 50-position stepping switch. (This same slow-operate relay contact also breaks the DC voltage to the stepping switch). As the stepping switch advances, the 24 volts is applied through one of its contact pairs to a relay coil in the Relay Chassis. This selector relay has high-current contacts which complete the circuit in which the test unit is connected. The test circuit parameters are preset before the automatic operation begins. This circuit now remains closed until the test unit opens, thereby breaking the test circuit. When the relay contact closes, completing the circuit, the

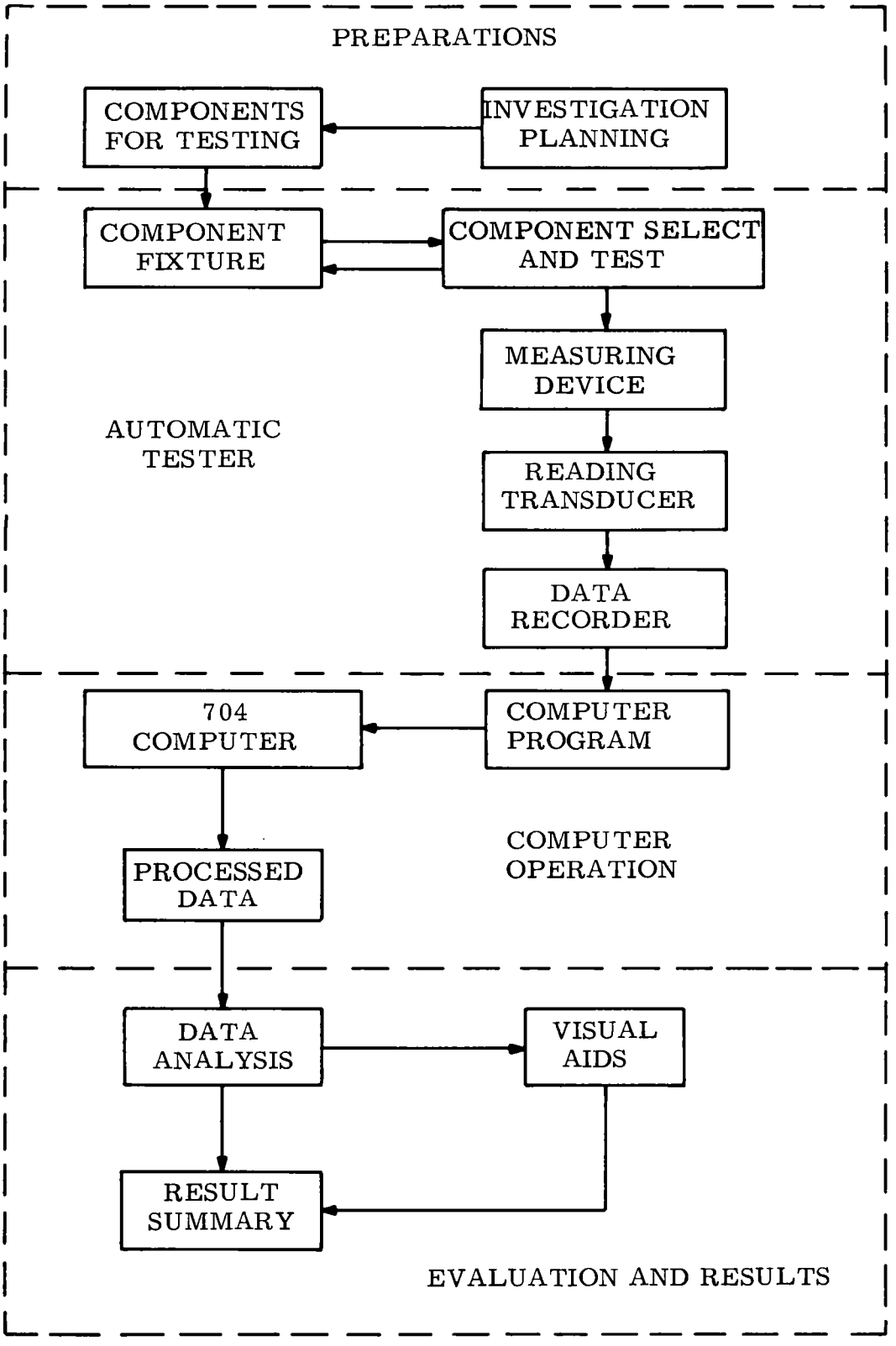


Figure 1. Operational Flow Diagram

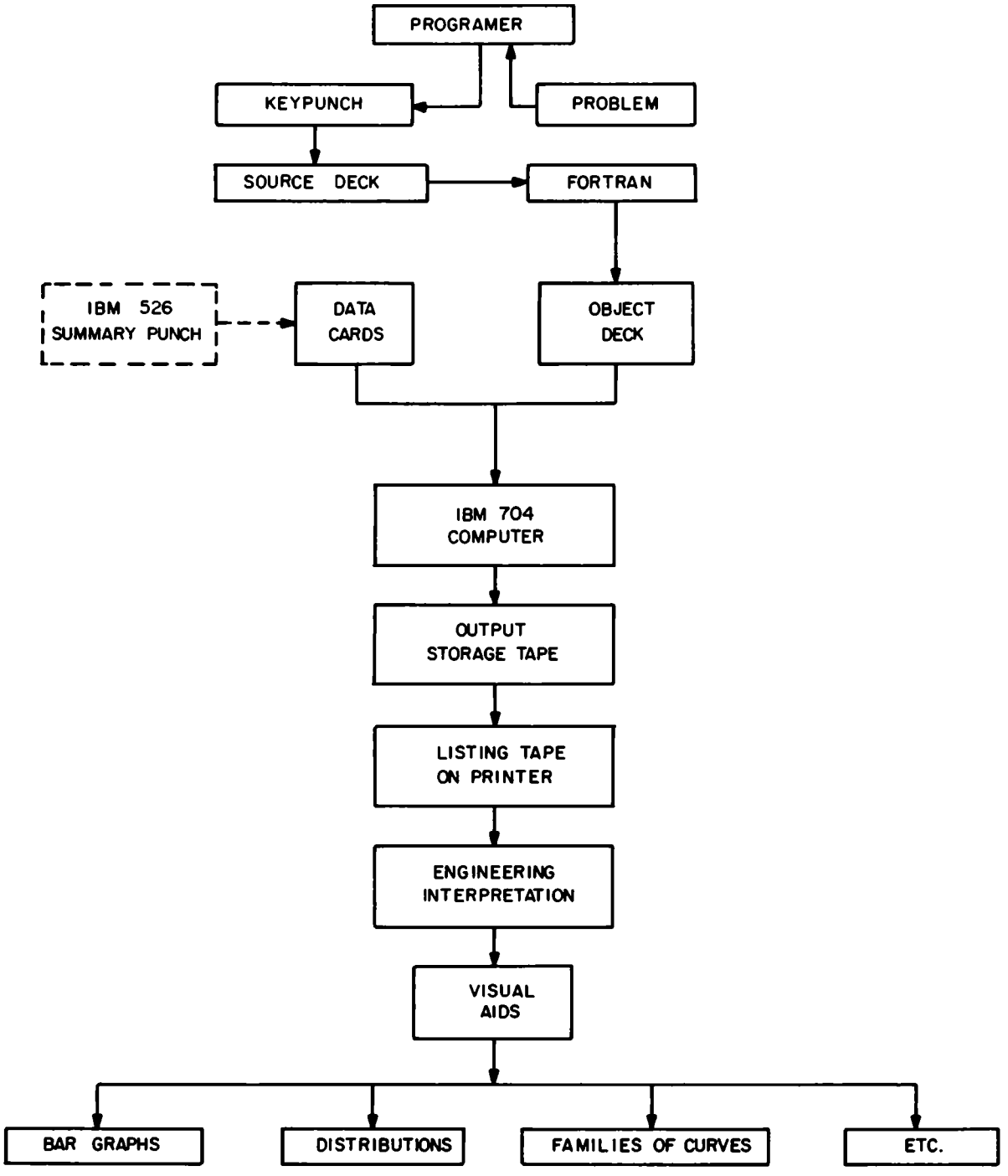
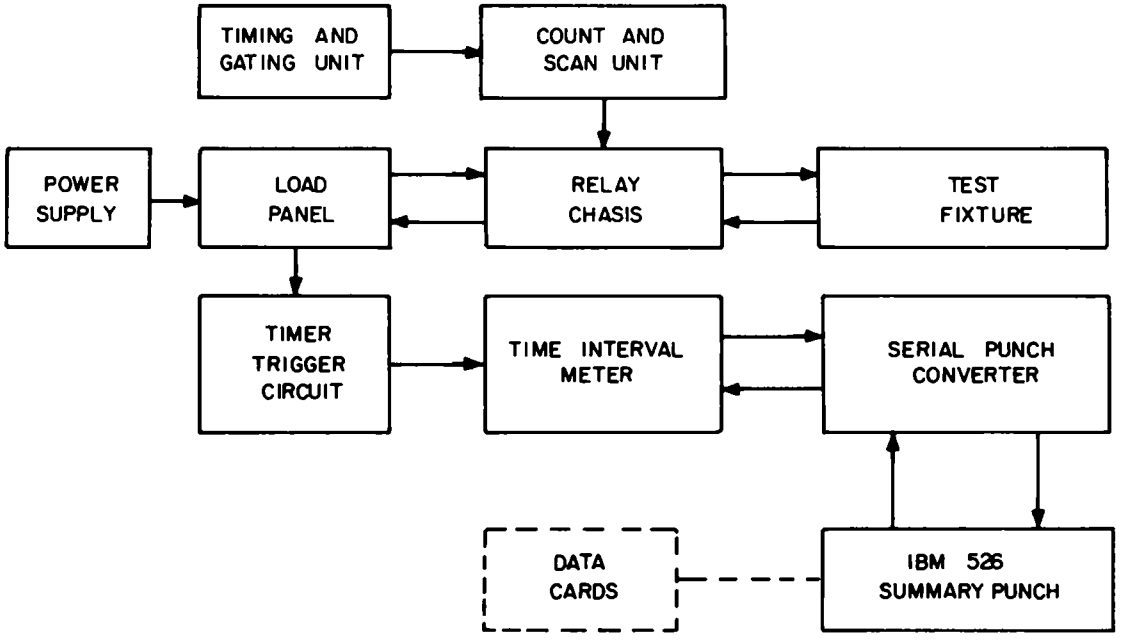
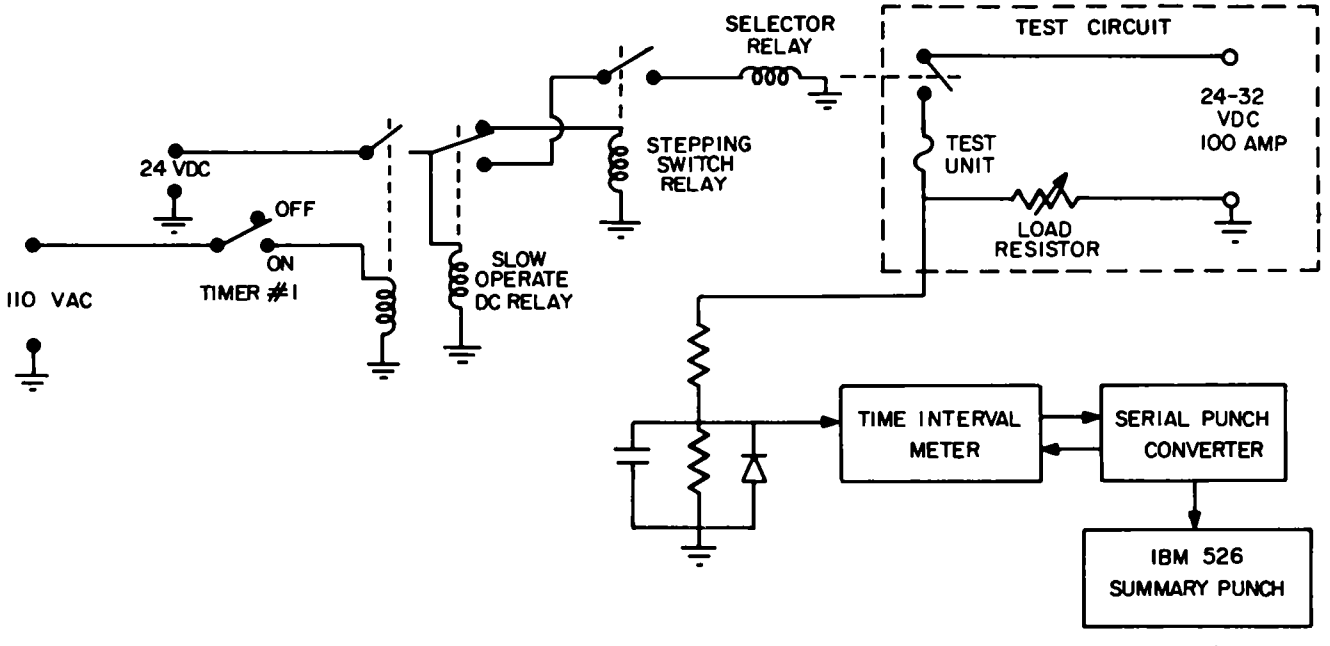


Figure 2. Information Processing



(a) BLOCK DIAGRAM



(b) SIMPLIFIED SCHEMATIC

Figure 3. Automatic Tester

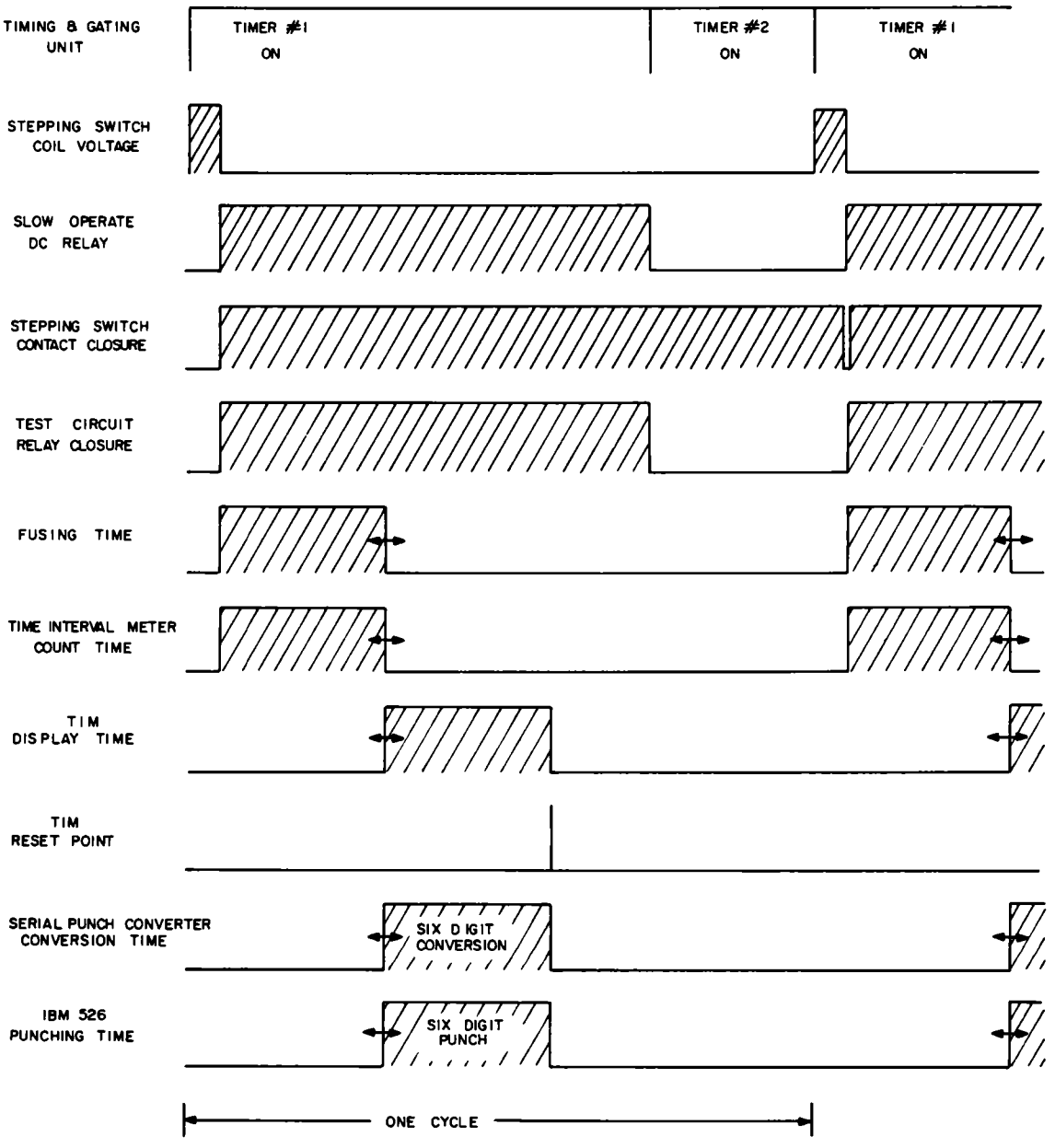


Figure 4. Timing Sequence

initial current produces a signal which is applied through a reference diode and charging circuit (for wave shaping) to a time interval meter to initiate measurement of the fusing time. As the test unit then opens, the test circuit is broken and a signal is developed which stops the Time Interval Meter. The Time Interval Meter now holds its reading of the fusing time (the time during which the unit maintained the closed test circuit) and signals the Serial Punch Converter that it is ready for readout. The Converter then selects one digit at a time from the Time Interval Meter and converts the four-line binary output into a digital output (causing a contact closure in one of ten lines). This contact closure in the Converter completes the punch solenoid circuit in the IBM 526 Summary Punch. The operation of this punch results in the punching of the digit in one of the card columns. Card control within the Summary Punch is achieved by a program card which controls the position of the card to insure that the data is punched in the proper columns. The subsequent digits appearing on the Time Interval Meter are likewise converted and punched in a serial sequence. Timer No. 1 will run down and automatically reset. As the time elapses on Timer No. 1, the slow-operate relay is de-energized, removing the voltage from the coil of the relay in the Relay Chassis, and thereby opening the test circuit at another point. Timer No. 2 begins to run down as Timer No. 1 is reset. When the time set on Timer No. 2 elapses, Timer No. 1 begins the second cycle and Timer No. 2 is automatically reset. This is a brief description of the sequence of events as they occur during operation. There are many additional controls in both the tester and the IBM 526, and these will be shown and discussed in the equipment and operating procedures sections.

2.3 Special Circuits

There is a simulator circuit which simulates the test fixture and cable load. This circuit allows for current and Time Interval Meter trigger adjustment under a condition simulating the attachment of the cable and test fixture.

The Fail circuit in cabinet No. 2 monitors the 48 volts DC from the IBM 526 punch. A jammed or missing card at the read station of the IBM 526 will cause a failure of the 48 volts DC (causing the light to go out). Failure to have the Interlock of the Serial Punch Converter in the ON position also breaks the 48 volts DC to the lamp. In all of these instances the test equipment is shut down automatically and remains so until the necessary corrective action is taken.

3 PROGRAMMING AND PROCESSING

The Object Deck indicated at the top of Figure 5 is obtained from the Fortran Statement Deck which appears in Appendix A. The IBM 704 computer with the aid of a Fortran compile tape converts the FORTRAN statements into machine language. This deck of IBM cards which contains the FORTRAN Statements in the form of machine language is called the Object Deck.

This Object Deck, once obtained, may be used and re-used until cards become damaged owing to repeated handling. A fresh object deck may be obtained by again compiling from the FORTRAN statement deck or, if not too badly damaged, they may be duplicated on an IBM card punch.

To obtain information computed on the IBM 704 computer, a data deck (containing the information to be analyzed) must be added to the Object Deck.

The data is punched on cards by the IBM 526 Summary Punch. A program card mounted on a drum within the IBM 526 machine provides a means of recording the data on cards in a format compatible to the 704 computer program.

Once the data is recorded on cards in the proper format, the cards are assembled with control and identification cards according to the sequence shown in Figure 5. This deck of IBM cards forms what is called the data deck.

The formats for the individual Data Deck cards are shown in Appendix B along with more detailed information on forming the data deck.

NOTE: It is <u>necessary</u> that the Data Deck cards be punched as shown in the formats appearing in Appendix B. Failure to do this will result in erroneous information or no information at all from the computer.

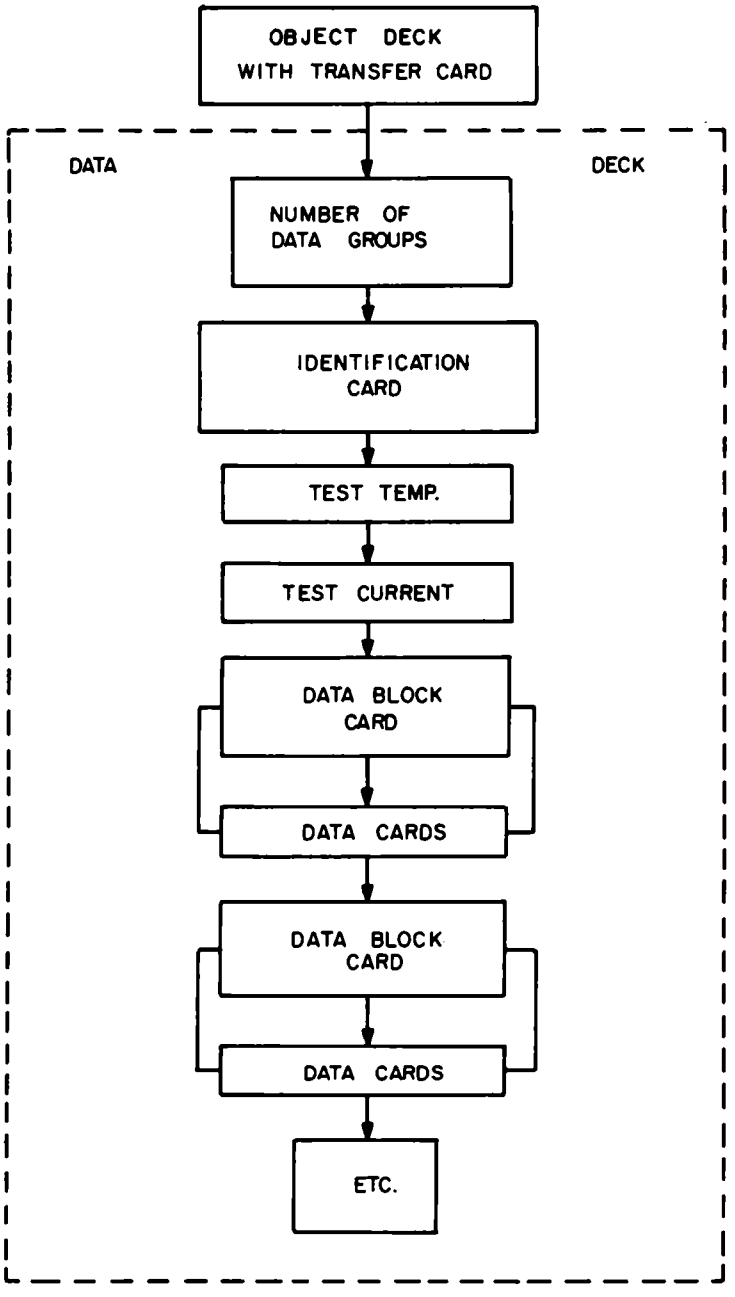


Figure 5. Card Deck Assembly for IBM 704

The steps in the procedure for processing data are outlined below:

1. Record data on cards in the proper format.

2. Add the control and identification cards in accordance with Figure 5 (see Appendix B for more detailed information.)

3. Place this data deck directly following the transfer card which immediately follows the object deck.

4. This over-all assembled deck is then ready for the computer.

5. The IBM 704 Computer operator will run the deck through the computer. The computed information will be recorded on an output tape (No. 2) by the computer. This tape will be listed on an off-line printer by computer center personnel.

6. Computed and tabulated data may then be picked up at the center in this listed form for interpretation.

7. This information may then be displayed in various forms (curves and tables) to accentuate the different computed values.

4 OPERATING PROCEDURE

The following steps outline the procedure for setting up the equipment and operating to obtain recorded data.

4.1 Interconnection of Equipment

(1) Connect the Snake Head Cable between the IBM 526 Summary Punch and Cabinet No. 2.

(2) Two high-current lead conductors are to be connected between Cabinet No. 1 (two red terminals marked "Test Fuse") and Cabinet No. 2 (two red terminals on side of cabinet). Terminals are marked H and L for high and low side of voltage when fuse is open circuited.

(3) Connect a BNC coaxial cable between the connector marked "Trigger Circuit" on Cabinet No. 1 and the connector in Channel B on the Time Interval Meter in Cabinet No. 2.

(4) Connect the test fixture cable to the receptacle on the Relay Chassis.

(5) Connect the IBM 526 and Cabinet No. 2 to 110 vAC/60 cycle.

(6) Connect the power supply in Cabinet No. 1 to 3 phase 208 vAC/60 cycle.

4.2 Test Current Setup

(1) Switch the three power switches on the Power Panel of Cabinet No. 2 to the ON position, the Simulator Circuit and Fail switches to the OFF position.

(2) Set Timer No. 1 to full scale on Timing and Gating Unit.

(3) Depress the Manual Zero button on the Count and Scan Unit.

(4) Set the Time Interval Meter power switch to the OFF position.

(5) Set switches on the Serial Punch Converter to POWER OFF, STANDBY, and INTERLOCK OFF.

(6) Rotate all rheostat knobs on the Load Panel fully CCW.

(7) Set Parallel-Series switch to center position, power switch to OFF, and all other switches to OUT position.

(8) Set power switch to ON on Power Panel of Cabinet No. 1.

(9) Depress START button on power supply of Cabinet No. 1.

step Disable switch to the down position and set Tens and Units preset knobs to 2 and 6,
re . . This will automatically stop the tester after 25 units are tested.

(1₁. ᵗch to ON position on Timing and Gating Unit and immediately disengage Timer No. 1 from its plug-in unit (this holds the Count and Scan Unit in position one - the Nixie indicators on the Count and Scan Unit should indicate position one at this time).

(12) Insert a shorting rod in fuse block No. 1 of the test fixture.

(13) Set the power switch on the Load Panel to the ON position.

(14) Adjust the required Load Panel current by selecting the appropriate load resistors and adjusting the rheostat knobs and power supply voltage.

(15) Set the power switch on the Load Panel to the OFF position and proceed to the Time Interval Meter Trigger Adjust section.

4.3 Time Interval Meter Trigger Adjust

(1) After setting up the test current in accordance with 4.2, proceed as follows:

(2) Set the Time Interval Meter power switch to the ON position and allow a five-minute warmup.

(3) Set the Function switch of the Time Interval Meter to Per B.

(4) Set both attenuator switches to 10.

(5) Set Slope switch in channel B to positive.

(6) Set Slope switch in channel A to negative.

(7) Set Time-Seconds switch to 10^{-3}.

(8) Pulses may be obtained by switching the power switch on the Load Panel to ON and then to OFF.

(9) Adjust the Channel B Trigger Voltage knob until the Time Interval Meter starts counting when the power switch of the Load Panel is turned ON and stops counting when the power switch is turned OFF. Once this state is obtained, it should be checked several times to insure that the setting is not marginal.

(10) Turn the display knob on the Time Interval Meter fully counterclockwise. (This sets minimum display time.)

(11) Set the switch on the Timing and Gating Unit to OFF and engage Timer No. 1 in its plug-in unit.

(12) With the power switch on the Load Panel in the OFF position, depress the Reset button on the Count and Scan Unit.

(13) Proceed to the Data Recording Section.

4.4 Data Recording

(1) After adjusting the Time Interval Meter trigger in accordance with 4.3, proceed as follows:

(2) Removing the shorting rod from fuse block No. 1 of the test fixture.

(3) Load the test fixture with the fuses to be checked.

(4) Allow the fixture and fuses to stabilize at the desired test temperature.

CAUTION: Owing to the length of time between the test current setup and actual testing of the fuses, a check should be made of the test current value and the reliable triggering of the Time Interval Meter, as follows:

(a) Set the Simulator Circuit switch to the ON position
(b) The current value and triggering of the Time Interval meter can now be checked by the power switch on the Load Panel. (Adjust the Load Panel and Time Interval meter controls as necessary.)
(c) Return the Load Panel power switch and the Simulator Circuit Switch to the OFF position. Check that the Display knob on the Time Interval Meter is fully counterclockwise.

(5) Check that the card feed hopper on the IBM has a sufficient supply of cards.

(6) Turn the power switch on the IBM 526 to the ON position.

(7) Check for the presence of the program card on the program drum of the IBM 526 and that the program control lever is on.

(8) Depress the FEED key on the IBM 526 keyboard twice and turn on the function switches - Auto Feed, Auto Skip and Duplicate, and Print.

(9) Set the power switch on the Serial Punch Converter to the ON position and set the select switch to A.

(10) Set the Tens and Units Preset knobs on the Count and Scan Unit to the desired position. Check that the Nixie lights indicate position zero. (If they do not, depress the Manual Zero button).

(11) Adjust Timer No. 1 and Timer No. 2 settings to accommodate the fuse under test and its test conditions.

(12) Set the Load Panel power switch to the ON position.

(13) Set the switches on the Serial Punch Converter to Interlock ON and Operate.

(14) Turn the Fail switch to the ON position (the lamp should come on).

(15) Set the switch on the Timing and Gating Unit to the ON position. Testing and data recording on the fuses in the test fixture should progress until the equipment is automatically stopped.

NOTE: The Step Disable switch on the Count and Scan Unit should be in the down position and the Nixie lamps should indicate zero before the switch on the Timing and Gating Unit is switched to the ON position.

4.5 Data Handling

(1) The cards of data in the punched card hopper should be removed and combined with the identification cards (see Section 3).

(2) The cards should then be stored until a complete set of data for a computer run is obtained at which time the cards may be combined to form a data deck as stated in Section 3 and shown in Figure 5.

5. EQUIPMENT

A list and brief description of the equipment used in the automatic tester are contained in the following paragraphs. Schematics and photographs appear on the pages following.

5.1 Cabinet No. 1

Power Supply - The high-current supply for fusing tests is supplied by a Perkins DC Power Supply. Input: 208 volts, 60 cycle, 3 phase, 13-1/2 amperes. Output: 24 to 32 volts DC, up to 100 amperes.

Power Panel No. 1 - This panel contains a power switch which passes the output of the power supply to two terminals mounted on the Power Panel and also to the power switch on the Load Panel.

Load Panel - The panel contains several 500-watt Ohmite power rheostats, switches, and 1 percent Weston, bakelite case, ammeters. All load current wiring is of No. 12 AWG teflon insulated wire. The panel also contains a trigger circuit for furnishing the time gate to the Time Interval Meter.

Timer Panel - This panel contains two Standard type timers with a 60-second range and 0.01-second divisions. The timer input is 110 volts AC to the timing motor and 28 volts DC to operate the clutch.

5.2 Cabinet No. 2

Power Panel No. 2 - This panel contains three switches which apply 110 volts AC to a bus strip inside the cabinet, 300 volts DC and 24 volts DC to the Count and Scan Unit and the Timing and Gating Unit.

Timing and Gating Unit - Two plug-in timers which make up a Tandum Recycling Timer produced by the Industrial Timer Corporation allow for presetting the test unit time. The two timers cycle continuously, causing a Count and Scan Unit switch to step at the beginning of each cycle until interrupted by the Count and Scan Unit preset circuit.

Time Interval Meter - This is a Berkeley/Beckman, six-decade, Model 7250-14 meter. The counter is triggered by the pulse from the load panel. The leading edge, which starts the timer, occurs at the time the appropriate relay operates in the Relay Panel. The timer is stopped by the trailing edge of the pulse which occurs when the test component opens the circuit. At the end of the timing period, the timer signals the converter that the reading is being held for readout. After the reading on the Time Interval Meter is converted and punched on cards by the IBM Summary Punch, the Timer is Reset. Meanwhile, the timing cycle is running and when the preset time has elapsed another cycle is begun.

Count and Scan Unit - This panel contains a stepping switch to operate the test unit selection relays, interconnect a test unit to the Digital Volt Ohmmeter, and provide position-indicate circuitry (to supply power and ground to Nixie filaments). The panel also contains a manual step and reset provision with an additional provision for presetting an inhibit to the timer cycle by the setting of two panel selectors.

Relay Chassis - The relay panel contains 50 high-current switching and carrying capacity relays. Each relay coil is associated with a position of the Count and Scan Unit stepping switch, and the relay contacts are in series with a test unit mounted in the test fixture when the interconnecting cable is installed.

Digit Volt Ohmmeter - This meter is a three-decade Berkeley/Beckman Model 5350R. This meter is connected across the test unit to measure voltage drop when the proper test fixture and cables are connected to Cabinet No. 2.

Serial Punch Converter - A Berkeley/Beckman Model 3100-1 converter is used to convert the four-line binary code output of the timer decades into a decimal line output. The decimal output is a relay closure which operates the proper punch magnet in the IBM 526 Summary Punch. The converter sequentially converts the decade readings until all have been converted and punched. The converter then resets the timer, making it ready for the next cycle.

5.3 Test Fixture and Cable

The test fixture contains provisions for mounting 25 components for testing, and a connector and cable arrangement for connecting the test fixture to the relay panel.

5.4 IBM 526 Summary Punch

The IBM 526 provides a method of punching data in an IBM card in the format determined by a program card mounted on its program drum. The IBM 526 punches the data in the proper columns as it receives a series of punch signals from the Serial Punch Converter.

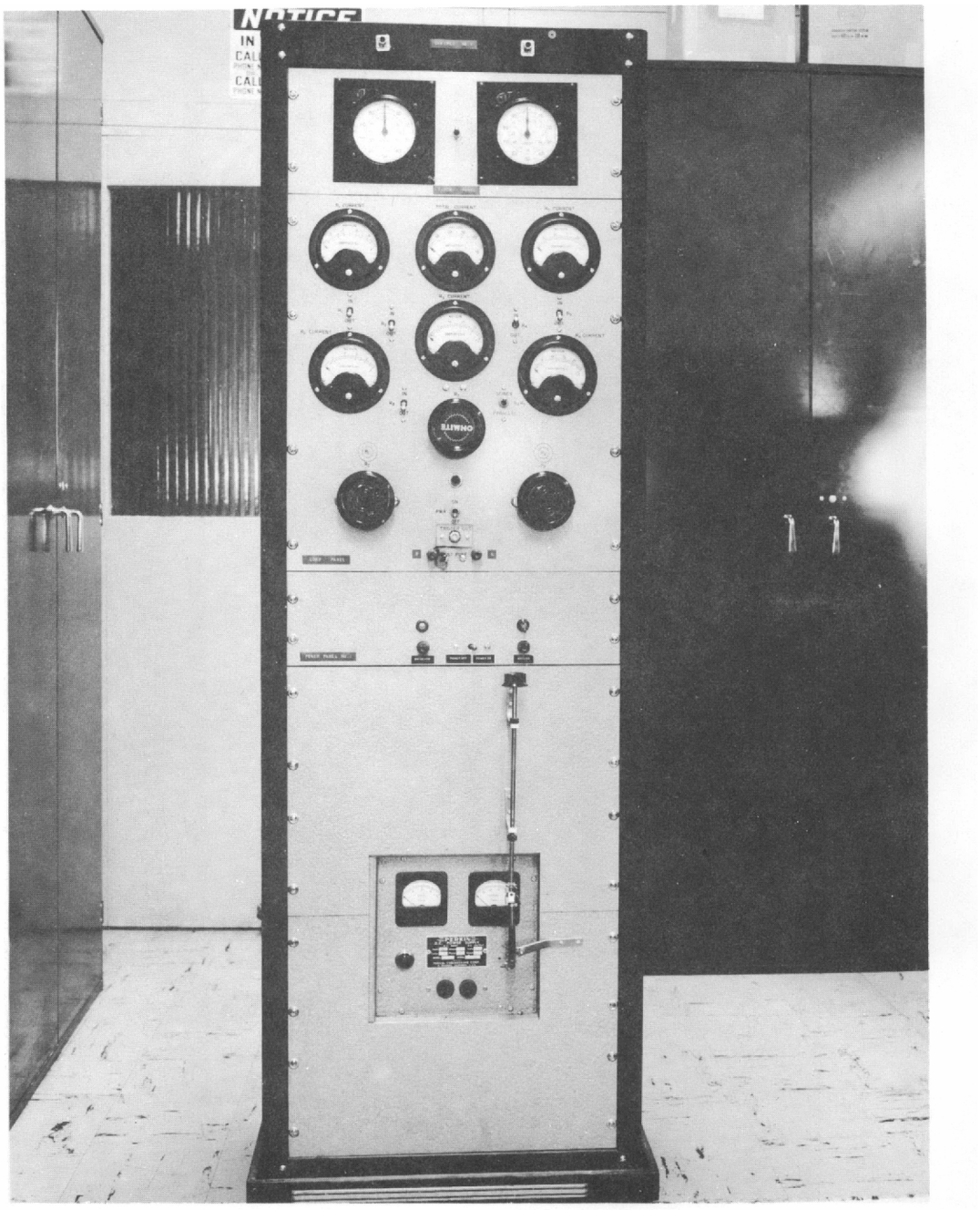


Figure 6. Cabinet No. 1

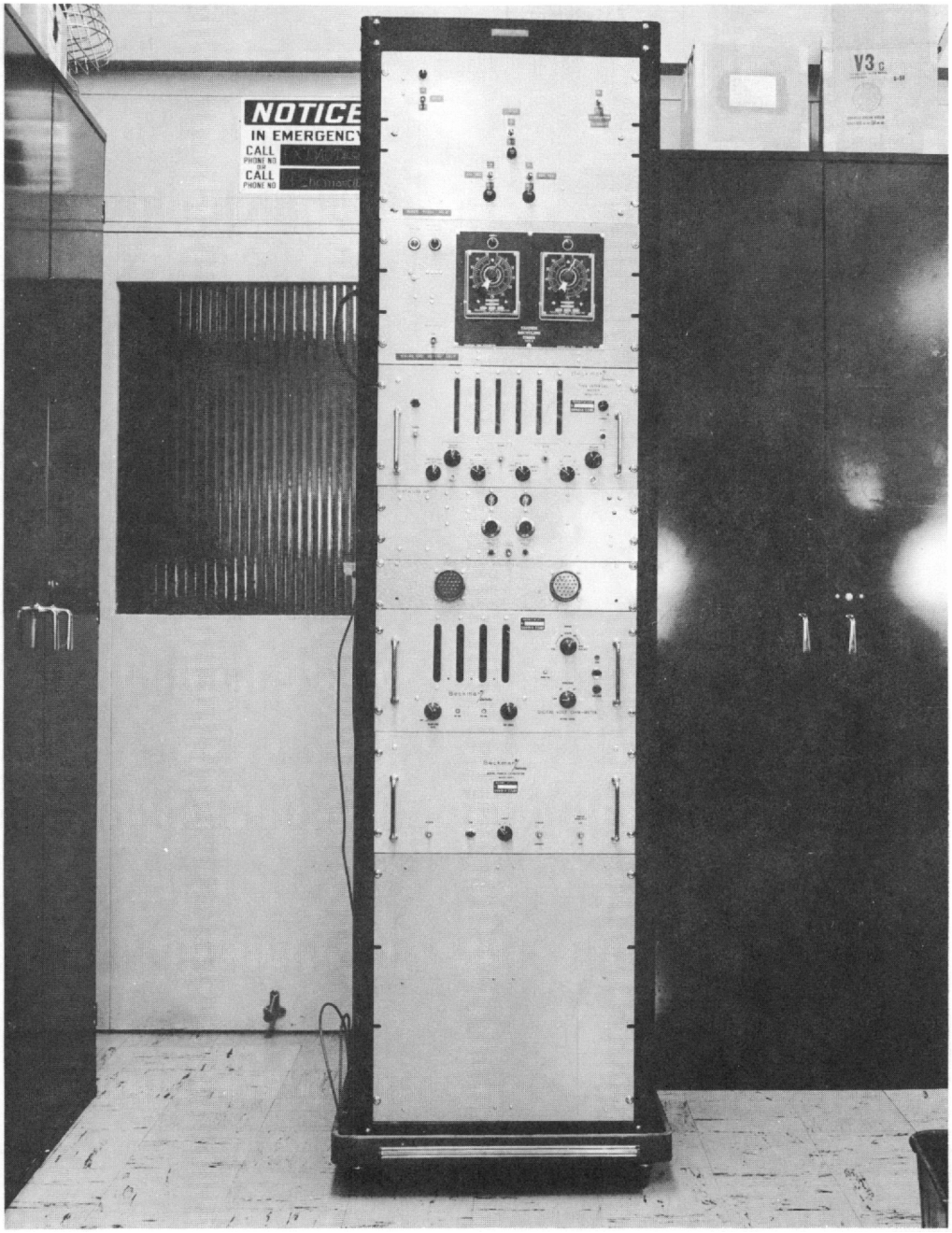


Figure 7. Cabinet No. 2

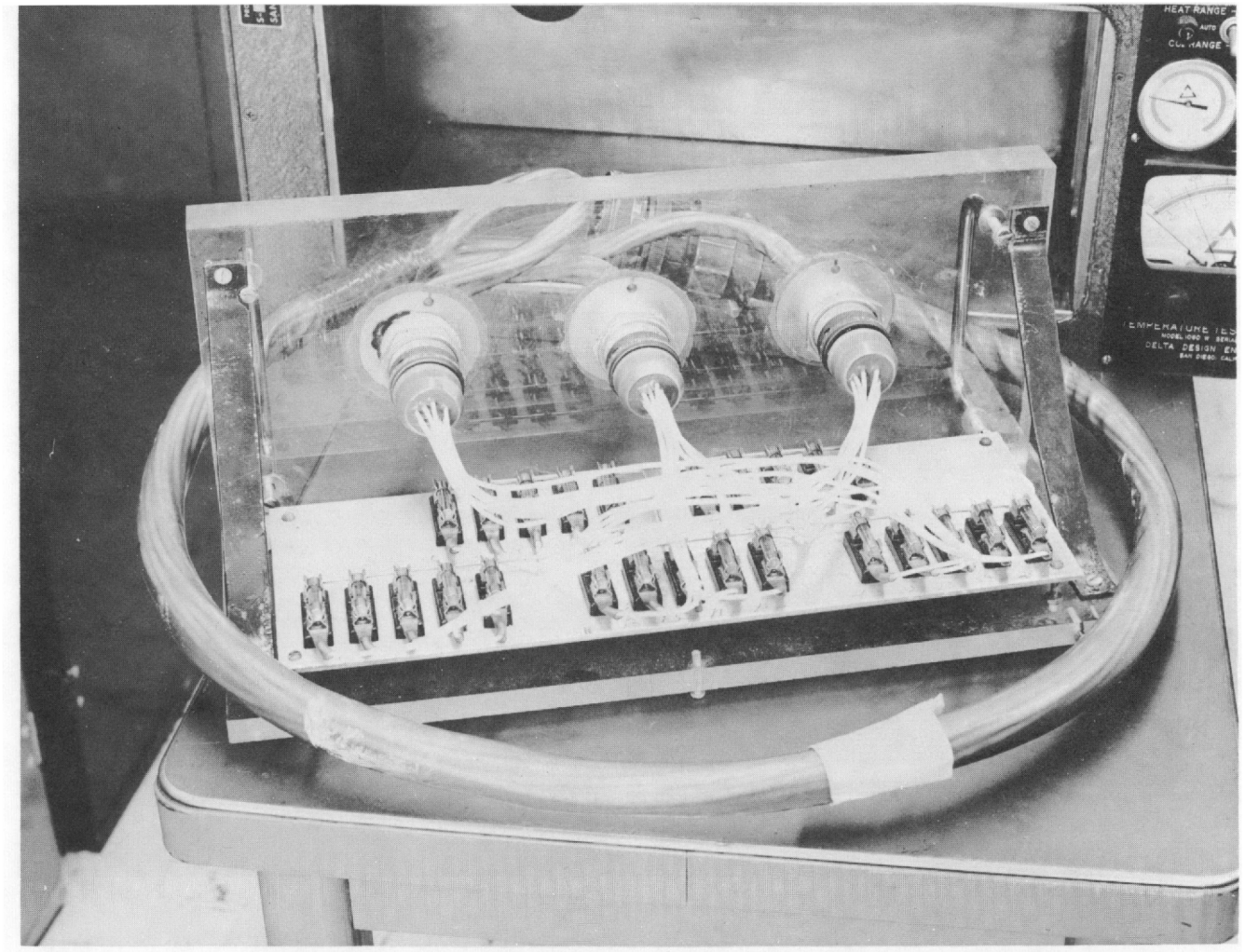


Figure 8. Test Fixture and Cable

Figure 9. IBM 526

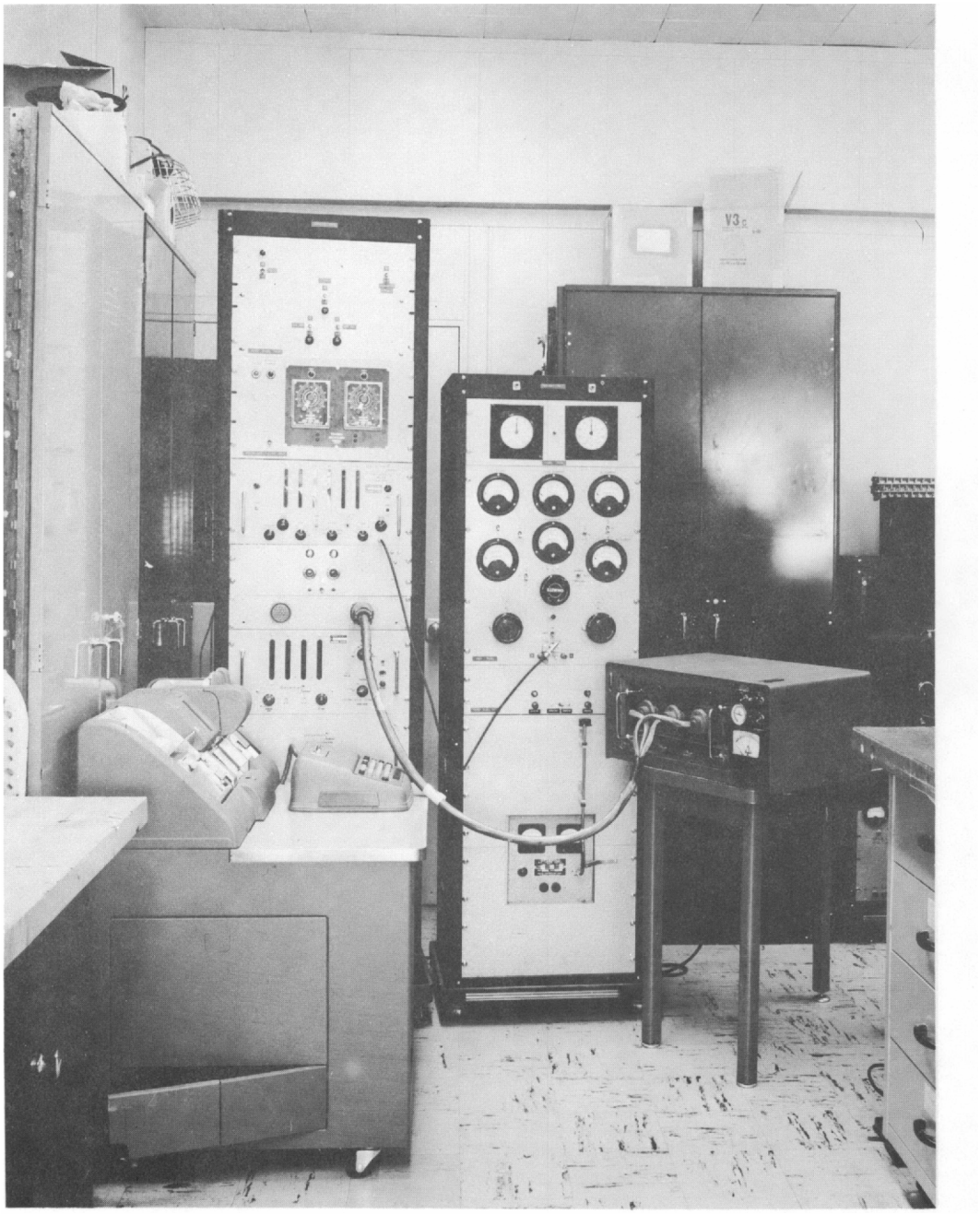


Figure 10. Complete Setup

APPENDIX A

FORTRAN STATEMENT PROGRAM AND TYPICAL COMPUTER OUTPUT

FORTRAN STATEMENT PROGRAM

```
C       CARL D LONGEROT 1432 EXT 47254 FUSE DATA ANALYSIS
        DIMENSION HEAD(15), COND(30), DATA(300), HI(10), CEN(10), SMA(10),
       1A(10), V(10), D(10), SEQ(300, 5), SQRD(300), DIFTH(300), DIFFO(300),
       2SKEW(10), PEAK(10), TORQ(10), PRC(30), JAP(10)
        READ68, NOOP
        NOPA=0
5       NOPA=NOPA+1
        IF(NOOP-NOPA)6, 8, 8
6       WRITEOUTPUTTAPE2, 67
        ENDFILE2
        STOP 757
8       WRITEOUTPUTTAPE2, 50
        READ51, (HEAD(I), I=1, 14)
        WRITE OUTPUT TAPE 2, 52, (HEAD( I), I=1, 14)
        WRITEOUTPUTTAPE2, 53
        READ 54, (COND(I), I=1, 6)
        WRITE OUTPUT TAPE 2, 55, (COND(I), I=1, 6)
        READ51, (PRC(I), I=1, 20)
        WRITEOUTPUTTAPE2, 57, (PRC(I), I=1, 20)
        M=0
9       M=M+1
        IF(5-M)25, 10, 10
10      READ70, N, IT, IP
        EN=N
        KK=(N+1)/2
        JAP(M)=N
        READ73, (DATA(I), I=1, N)
        C=0
        DO 11 I=1, N
11      C=C+DATA(I)
        AVG=C/EN
        DO 12 I=1, N
12      SQRD(I)=DATA(I)*DATA(I)
        R=0
        DO 13 I=1, N
13      R=R+SQRD(I)
        TORQ(M)=R/EN
        AVGS=AVG*AVG
        VAR=TORQ(M)-AVGS
        DEV=SQRTF(VAR)
14      L=1
15      K=L
        BIG=DATA(K)
16      J=K+1
        IF(BIG-DATA(J))17, 18, 18
17      SWI=DATA(J)
        DATA(J)=BIG
        BIG=SWI
18      K=K+1
        IF(N-J)30, 19, 16
19      SEQ(L, M)=BIG
        L=L+1
        IF(N-L)31, 20, 15
```

```
20      SEQ(L, M)=DATA(L)
        HI(M)=SEQ(1, M)
        CEN(M)=SEQ(KK, M)
        SMA(M)=SEQ(N, M)
        A(M)=AVG
        V(M)=VAR
        D(M)=DEV
        DO 21 I=1, N
        DIFTH(I)=(SEQ(I, M)-A(M))**3
21      DIFFO(I)=(SEQ (I, M)-A(M))**4
        R=0
        S=0
        DO 22 I=1, N
        R=R+DIFTH(I)
22      S=S+DIFFO(I)
        SKEW(M)=R/(EN*(D(M)**3))
        PEAK(M)=S/(EN*(D(M)**4))
        GOTO9
25      JJ=XMAXOF(JAP(1), JAP(2), JAP(3), JAP(4), JAP(5))
        WRITEOUTPUTTAPE2, 60, ((SEQ(L, M), M=1, 5), L=1, JJ)
        WRITEOUTPUTTAPE2, 74
        WRITEOUTPUTTAPE2, 61, (HI(M), M=1, 5)
        WRITEOUTPUTTAPE2, 62, (CEN(M), M=1, 5)
        WRITEOUTPUTTAPE2, 63, (SMA(M), M=1, 5)
        WRITEOUTPUTTAPE2, 64, (A(M), M=1, 5)
        WRITEOUTPUTTAPE2, 65, (V(M), M=1, 5)
        WRITEOUTPUTTAPE2, 66, (D(M), M=1, 5)
        WRITEOUTPUTTAPE2, 75, (SKEW(M), M=1, 5)
        WRITEOUTPUTTAPE2, 76, (PEAK(M), M=1, 5)
        WRITEOUTPUTTAPE2, 69, (NOPA)
        DO 26 I=1, 1500
26      SEQ(I)=0.0
        GOTO5
30      PRINT71
        STOP
31      PRINT72
        STOP
50      FORMAT(1H1, 46x, 27HFUSING TIME INVESTIGATION///19x76HSUPPLIER
       1 PO NUMBER SIZE TYPE RATED CURRENT TEST DATE//
       2)
51      FORMAT(12AG)
52      FORMAT(19x14A6////)
53      FORMAT(59x26HOPENING TIME IN SECONDS///)
54      FORMAT(6A6)
55      FORMAT(55x6A6///)
57      FORMAT(20A6///)
60      FORMAT(15x5F20.3)
61      FORMAT(1H , 7HMAXIMUM7X(5F20.3)//)
62      FORMAT(1X6HMEDIAN8X(5F20.3)//)
63      FORMAT(1X7HMINIMUM7H(5F20.3)//)
64      FORMAT(1X4HMEAN10X(5F20.3)//)
65      FORMAT(1X8HVARIANCE11X(5F20.8)//)
66      FORMAT(1X19HSTANDARD DEVIATION(5F20.8)//)
67      FORMAT(41X34HCARL D LONGEROT 1432 47254)
68      FORMAT(112)
69      FORMAT(60X12)
70      FORMAT(3110)
71      FORMAT(10X25HERROR AT NJ COMPARISON)
72      FORMAT(10X25HERROR AT NL COMPARISON)
73      FORMAT(8F9.6)
74      FORMAT(1HO)
75      FORMAT(1X8HSKEWNESS11X(5F20.8)//)
76      FORMAT(1X10HPEAKEDNESS9X(5F20.8)//)
        END(0, 1, 0, 1, 0)
```

FUSING TIME INVESTIGATION

SUPPLIER	PO NUMBER	SIZE	TYPE	RATED CURRENT	TEST DATE
BUSSMAN	14-0872-1	8AG	AGX 1	1 AMPERES	JUNE 1, 1961

OPENING TIME IN SECONDS

AMBIENT TEMP OF 77 DEGREES F

TEST AMPERAGE	2	3	4	5	6
	0.611	0.222	0.129	0.077	0.058
	0.598	0.220	0.129	0.077	0.058
	0.585	0.220	0.128	0.077	0.057
	0.563	0.220	0.128	0.077	0.057
	0.562	0.219	0.128	0.077	0.057
	0.553	0.219	0.128	0.077	0.057
	0.550	0.218	0.127	0.077	0.057
	0.546	0.218	0.127	0.076	0.057
	0.546	0.218	0.127	0.076	0.057
	0.543	0.217	0.127	0.076	0.057
	0.537	0.217	0.127	0.076	0.056
	0.537	0.216	0.127	0.076	0.056
	0.532	0.215	0.126	0.075	0.056
	0.521	0.215	0.126	0.075	0.055
	0.519	0.214	0.126	0.075	0.054
	0.515	0.213	0.126	0.075	0.054
	0.512	0.213	0.126	0.074	0.054
	0.511	0.212	0.126	0.074	0.054
	0.508	0.212	0.125	0.074	0.053
	0.504	0.210	0.125	0.073	0.052
	0.502	0.210	0.124	0.073	0.052
	0.501	0.209	0.124	0.072	0.052
	0.500	0.208	0.123	0.072	0.051
	0.417	0.201	0.122	0.070	0.051
	0.365	0.200	0.115	0.068	0.051
MAXIMUM	0.611	0.222	0.129	0.077	0.058
MEDIAN	0.532	0.215	0.126	0.075	0.056
MINIMUM	0.365	0.200	0.115	0.068	0.051
MEAN	0.526	0.214	0.126	0.075	0.055
VARIANCE	0.00249299	0.00003042	0.00000781	0.00000538	0.00000543
STANDARD DEVIATION	0.04992981	0.00551579	0.00279556	0.00232006	0.00233104
SKEWNESS	-1.31838143	-1.02731873	-2.29609367	-1.22601914	-0.41490658
PEAKEDNESS	5.81022280	3.60841495	9.43807888	4.03948992	1.72965129

Figure A-1. Typical Computer Output

APPENDIX B

DATA DECK CARD FORMATS AND DATA DECK FORMATION

DATA DECK FORMATION

The data deck is made up of several properly ordered IBM cards. The order in which the cards are arranged and the format in which they are punched are particularly critical in obtaining the desired information from the IBM 704 computer.

An example of each type of card appears in the photograph in this Appendix. Following is a brief description of the purpose of the cards in the data deck.

Number of Data Groups - A single card with a number from 1 to 99 punched in the first two columns. This card tells the computer the number (quantity) of groups of data that will be processed in this operation. This number is necessary to let the computer know when it is through processing data. This card is the top card of the data deck and immediately follows the transfer card at the end of the object deck.

Identification Cards - Two cards are necessary to identify the test units and provide a space for the date on which the testing was performed. The information obtained on these two cards is typed out at the top of the output page as it is listed from the computer output tape.

Test Temperature - This card provides the table heading for the output data obtained from the computer output tape. This card indicates the temperature at which the units were tested.

Test Amperage - Two cards are necessary to list the test currents used in obtaining the first group of data. These test currents form column headings for the information as it is obtained from the computer output tape.

Data Block Card - This card has two functions: (1) it provides the computer with the value to be assigned to N in the program (in this case the number 25), which is the actual number of readings which will appear on the data cards immediately following; (2) it contains the test temperature and amperage at which the immediately following data was obtained (this information is for the card handlers use only, for data identification).

Data Card - This card contains the actual readings upon which the computer operates. The card is set up to contain up to eight each six-digit readings per card with three-column spaces between readings (in the case of 25 readings, 4 cards are required - eight readings on each of the first three cards and one reading on the fourth card).

Following is an ordered list of the cards required to make up a single group of data (one page of computer information):

Two identification cards
One test temperature card
Two test amperage cards
One data block card (with first test amperage)
Four data cards
One data block card (with second test amperage)
Four data cards
One data block card (with third test amperage)
Four data cards
One data block card (with fourth test amperage)
Four data cards
One data block card (with fifth test amperage)
Four data cards

The cards listed on page 28 are repeated for each group of data. A group of data consists of 25 readings at each of 5 test amperages taken at a single temperature. For each test temperature and each fuse type (current rating and physical dimensions) combination there will be a group of data. A single card punched with the number of total groups to be in the data deck is placed on top of the stack of card groups, thus forming the data deck.

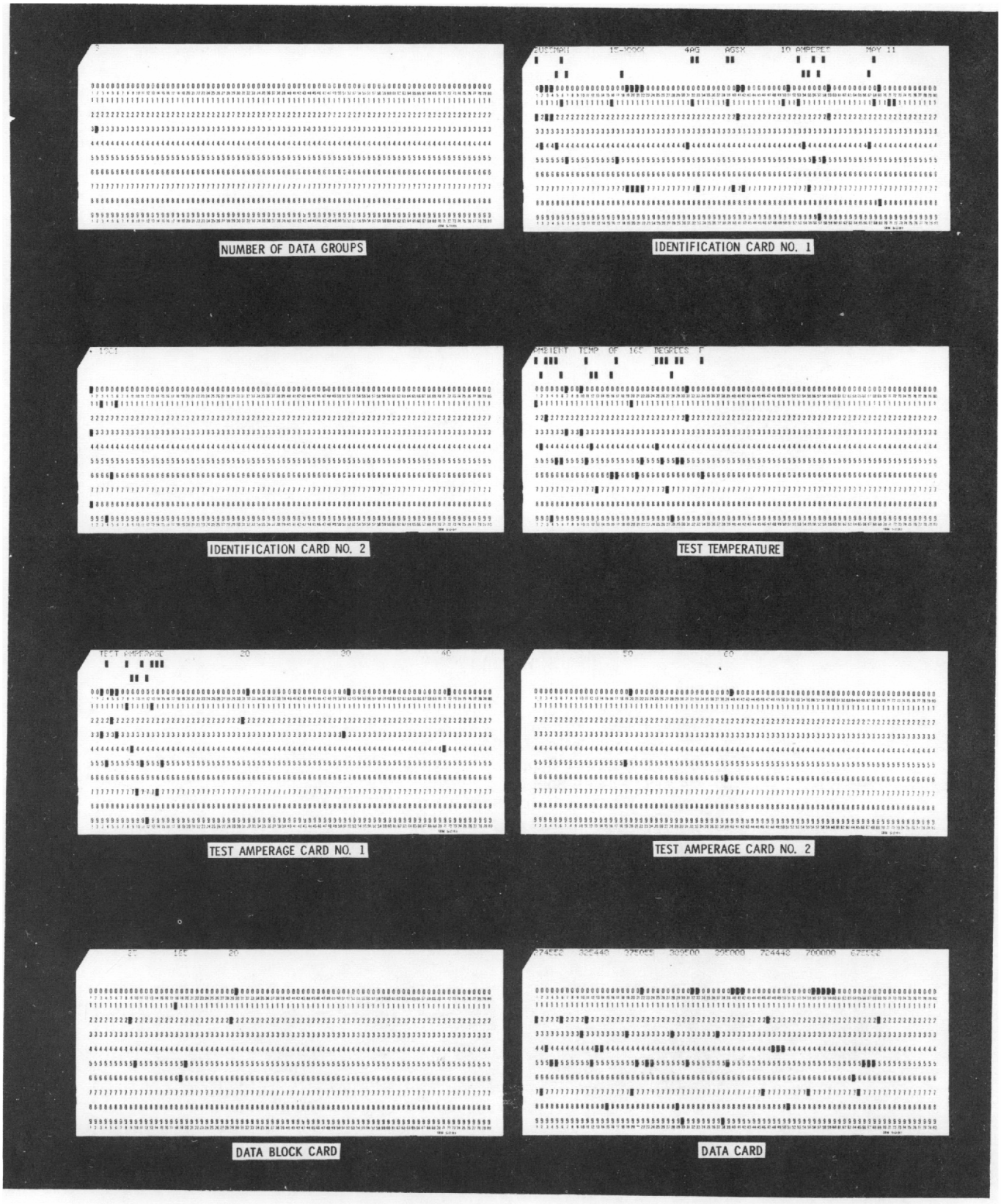
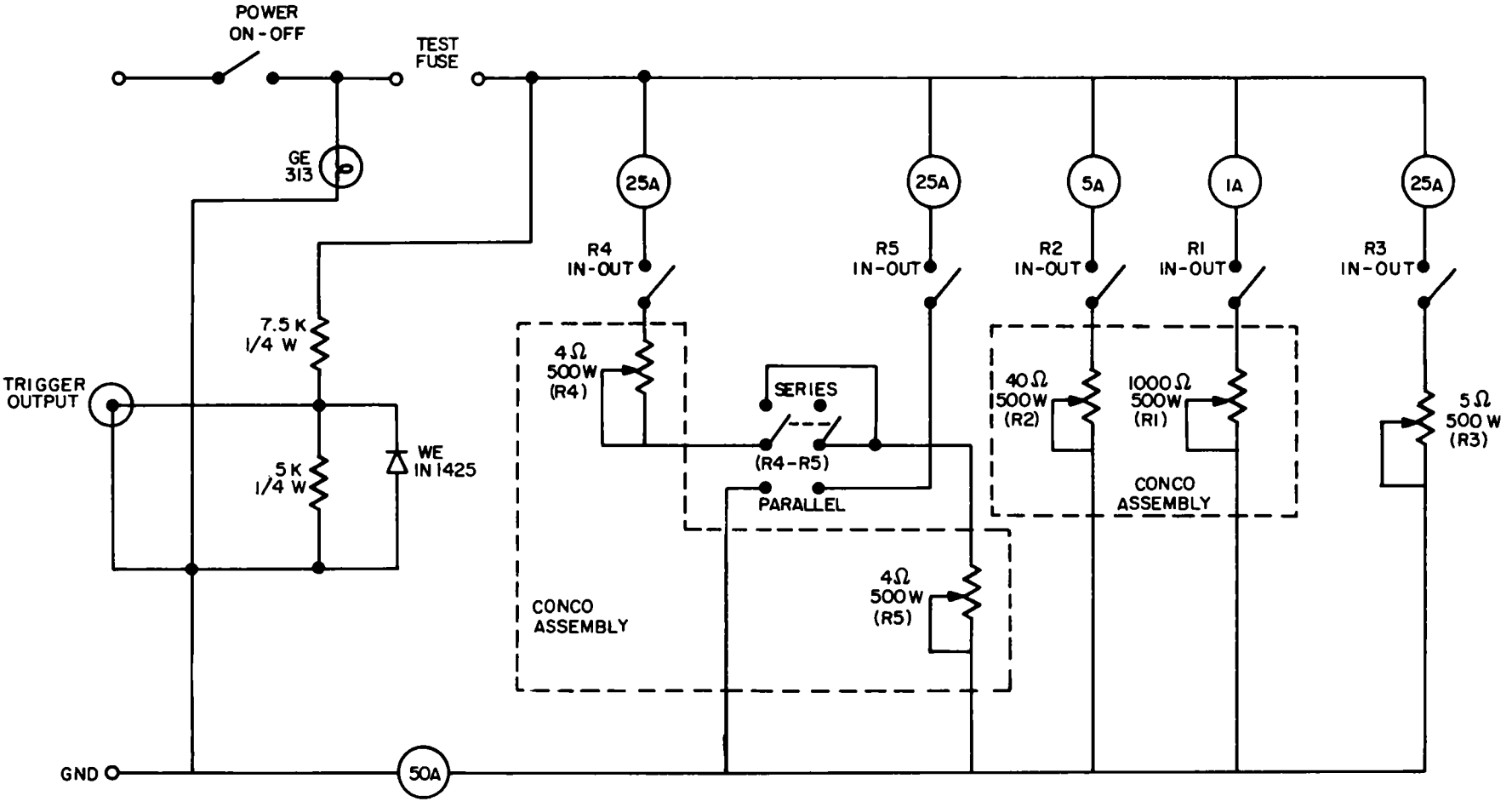


Figure B-1. Data Deck Card Formats

APPENDIX C

SCHEMATICS

1. Load Panel
2. Timing and Gating Unit
3. 300 vDC Power Supply
4. 24 vDC Power Supply
5. Count and Scan Unit (Relay Chassis)
6. Serial Punch Converter
7. Special Circuits (Simulator and Fail Circuits)



METERS - WESTON MODEL 643 (1%)
RHEOSTATS - OHMITE/8 INCH, 500 WATT
WIRE - NO. 12 AWG. (TEFLON)

Figure C-1. Load Panel

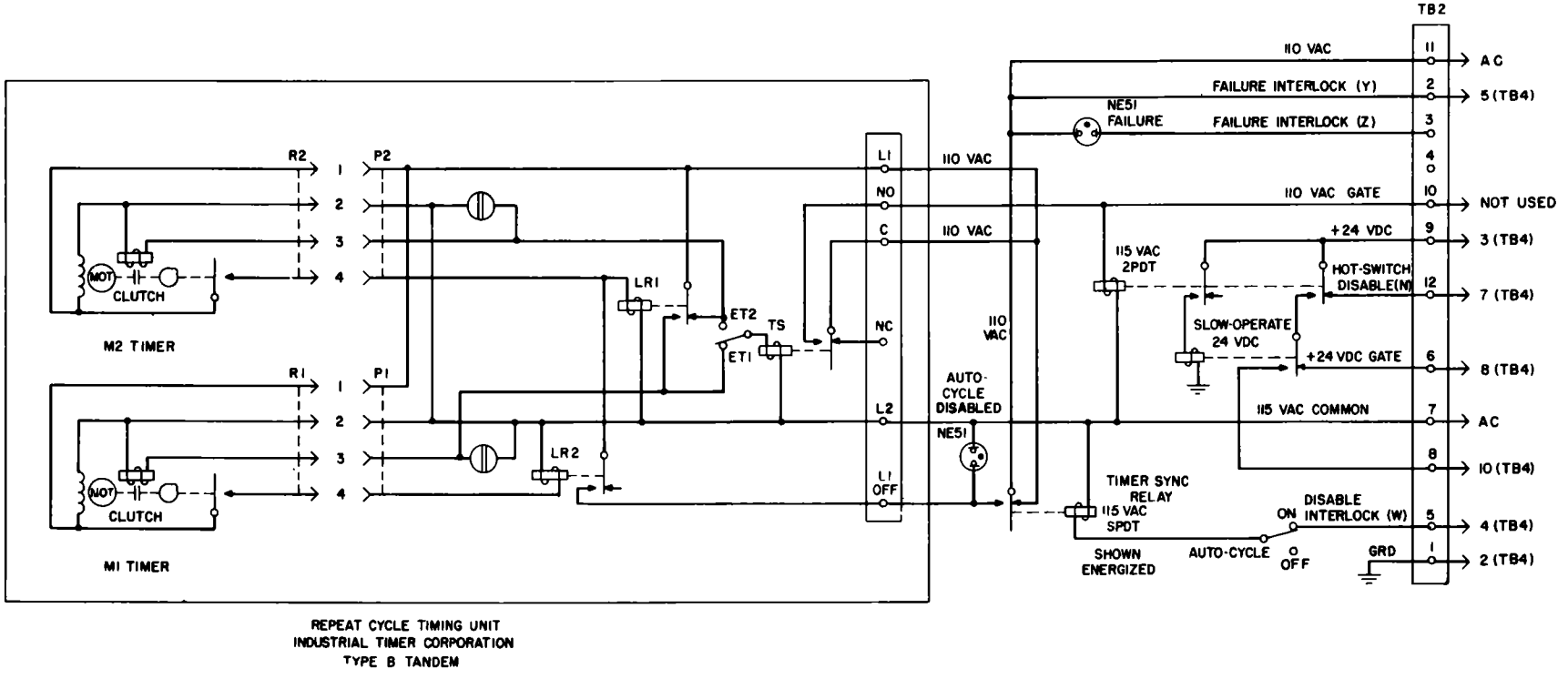


Figure C-2. Timing and Gating Unit

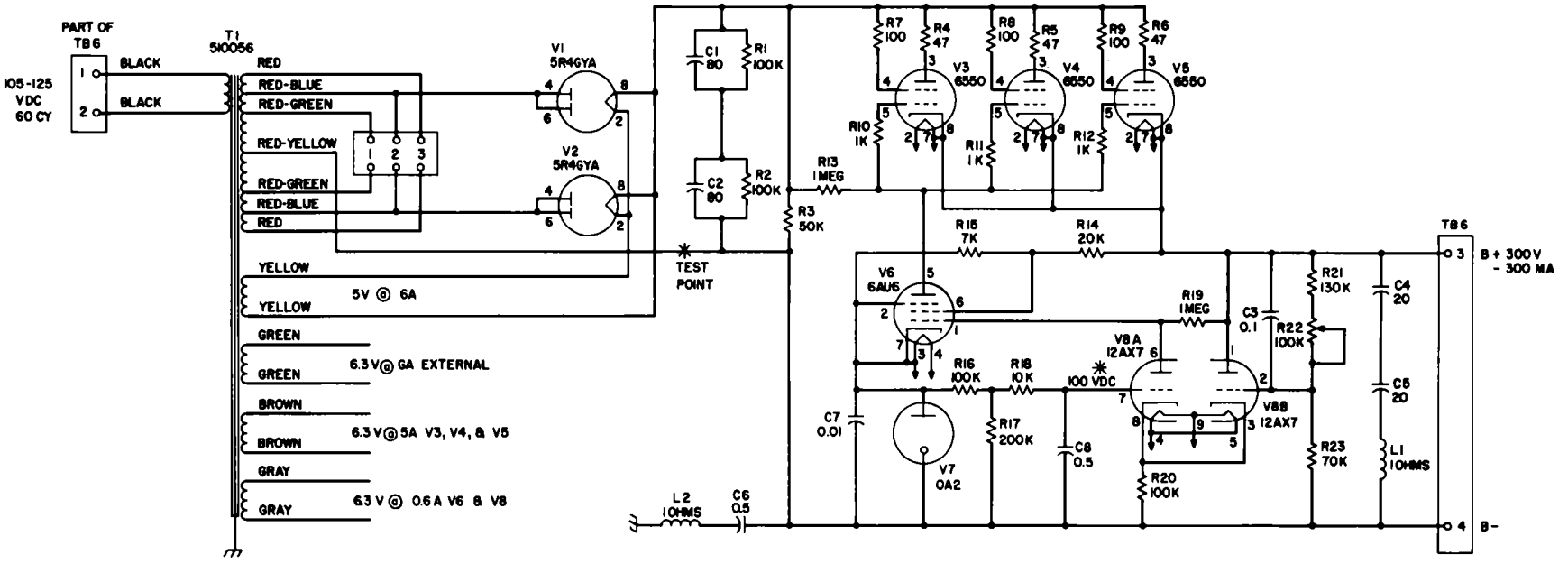
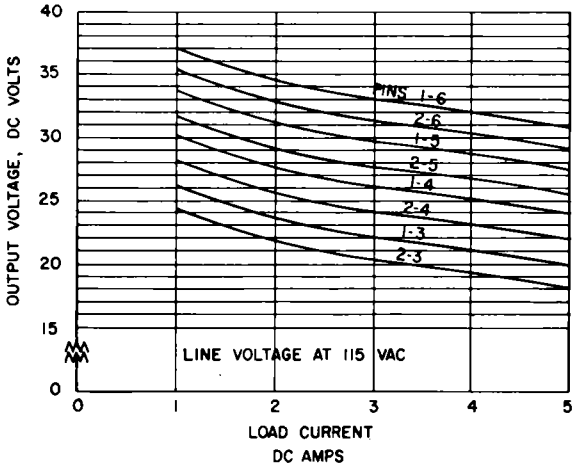
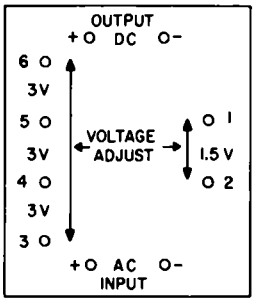


Figure C-3. 300 Volts DC Power Supply





TERMINAL BOARD
SHOWING PIN NUMBERS

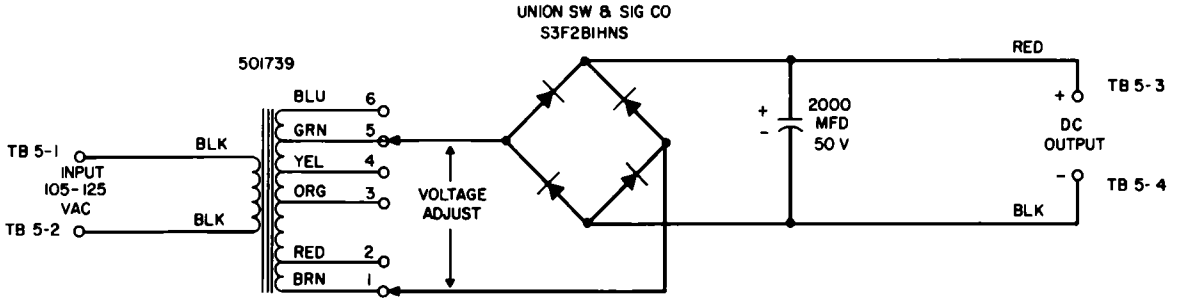


Figure C-4. 24 Volts DC Power Supply

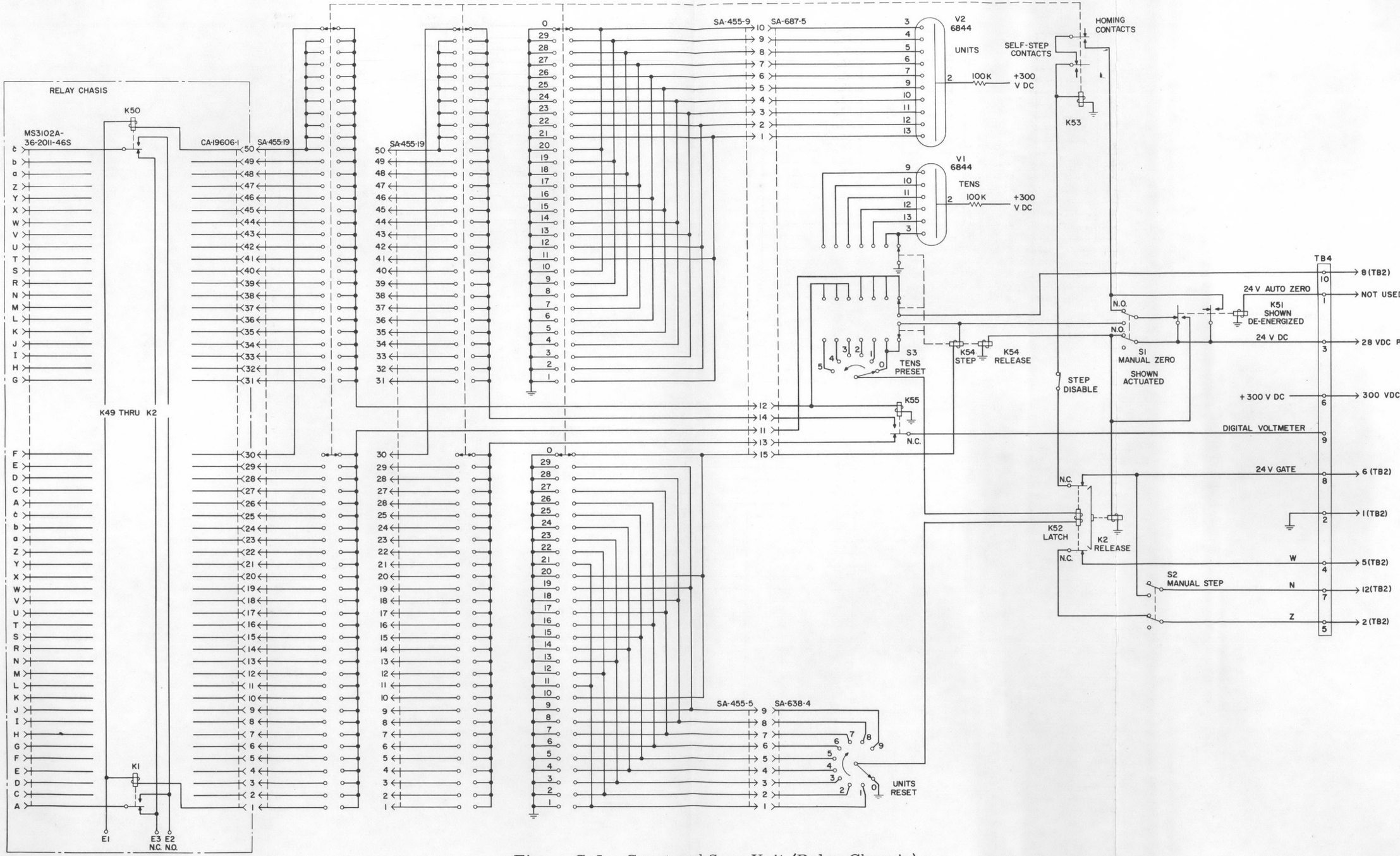
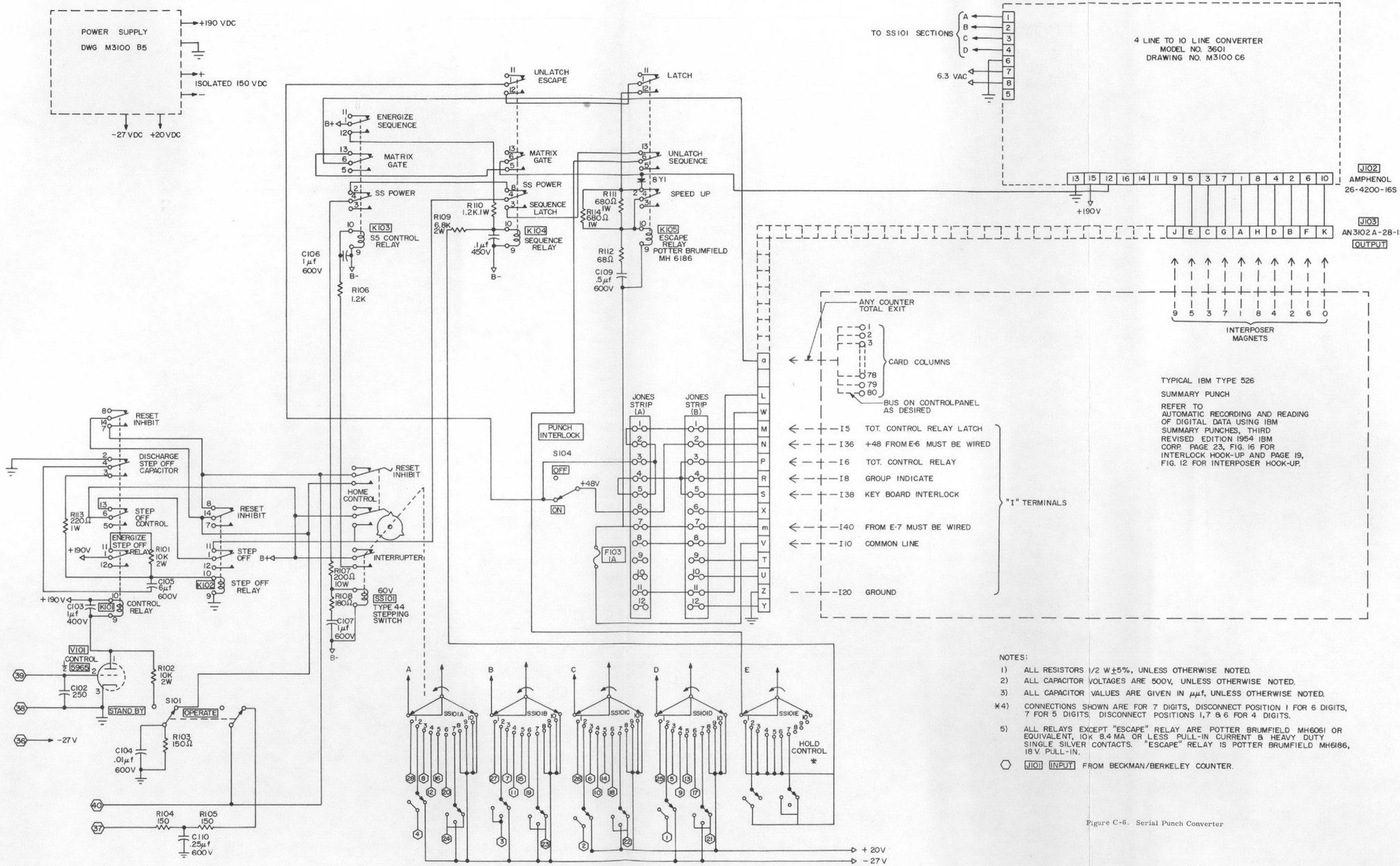


Figure C-5. Count and Scan Unit (Relay Chassis)

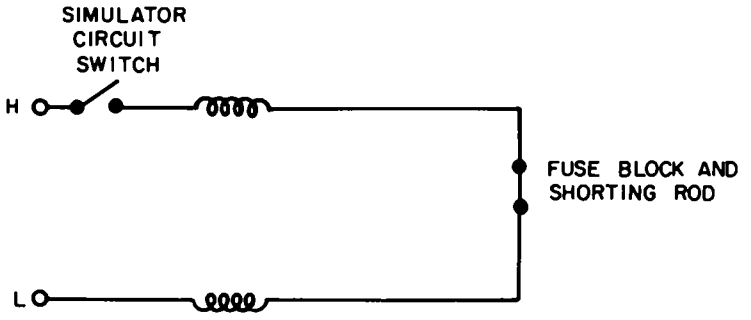


NOTES:

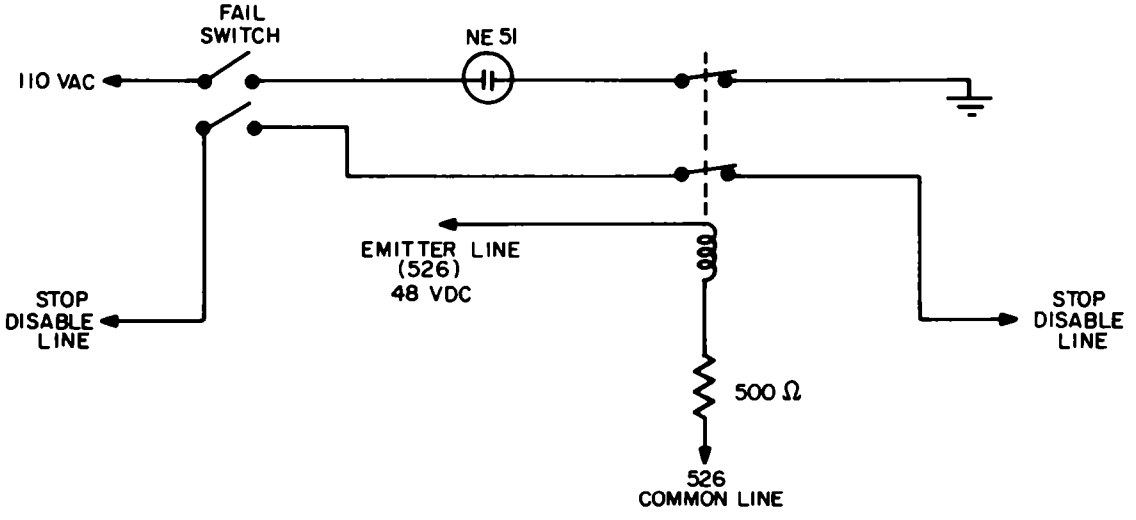
1) ALL RESISTORS 1/2 W ±5%, UNLESS OTHERWISE NOTED.
2) ALL CAPACITOR VOLTAGES ARE 500V, UNLESS OTHERWISE NOTED.
3) ALL CAPACITOR VALUES ARE GIVEN IN μμf, UNLESS OTHERWISE NOTED.
*4) CONNECTIONS SHOWN ARE FOR 7 DIGITS, DISCONNECT POSITION 1 FOR 6 DIGITS, 7 FOR 5 DIGITS, DISCONNECT POSITIONS 1, 7 & 6 FOR 4 DIGITS.
5) ALL RELAYS EXCEPT "ESCAPE" RELAY ARE POTTER BRUMFIELD MH6061 OR EQUIVALENT, 10K 8.4 MA OR LESS PULL-IN CURRENT & HEAVY DUTY SINGLE SILVER CONTACTS. "ESCAPE" RELAY IS POTTER BRUMFIELD MH6186, 18 V. PULL-IN.

⬡ J101 INPUT FROM BECKMAN/BERKELEY COUNTER.

Figure C-6. Serial Punch Converter



(a) SIMULATOR CIRCUIT



(b) FAIL CIRCUIT

Figure C-7. Special Circuits