BENDIX G-15

SERVICE MANUAL

PR-2 PHOTOELECTRIC TAPE READER

Bendix Computer Division

5630 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA

THE Bendix CORPORATION

MEMORANDUM

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BENDIX COMPUTER DIVISION

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PHOTOELECTRIC TAPE READER

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PR–2
SERVICE MANUAL

1.0 PURPOSE

1.1 Accessory PR–2 associated with the G–15 Computer is a terminal input device which reads punched tape containing an arbitrary code, and translates the information into the G–15 language.

1.2 Tape containing 5, 6, 7 or 8 levels of information, having widths of 11/16 inches, 7/8 inches and 1 inch may be read.

1.3 The PR–2 is a unidirectional device, capable of reading tape at a rate of 43 inches per second, (i.e., 430 characters per second of standard punch tape) and stopping on a character.

1.4 A tape handling system, capable of handling hubless strips of tape up to 500 feet in length, is incorporated in the equipment.

2.0 FUNCTIONAL EXPLANATION

2.1 General

A functional diagram of the PR–2 accessory is shown in Figure 1. A description of the operation, with reference to this diagram, is as follows:

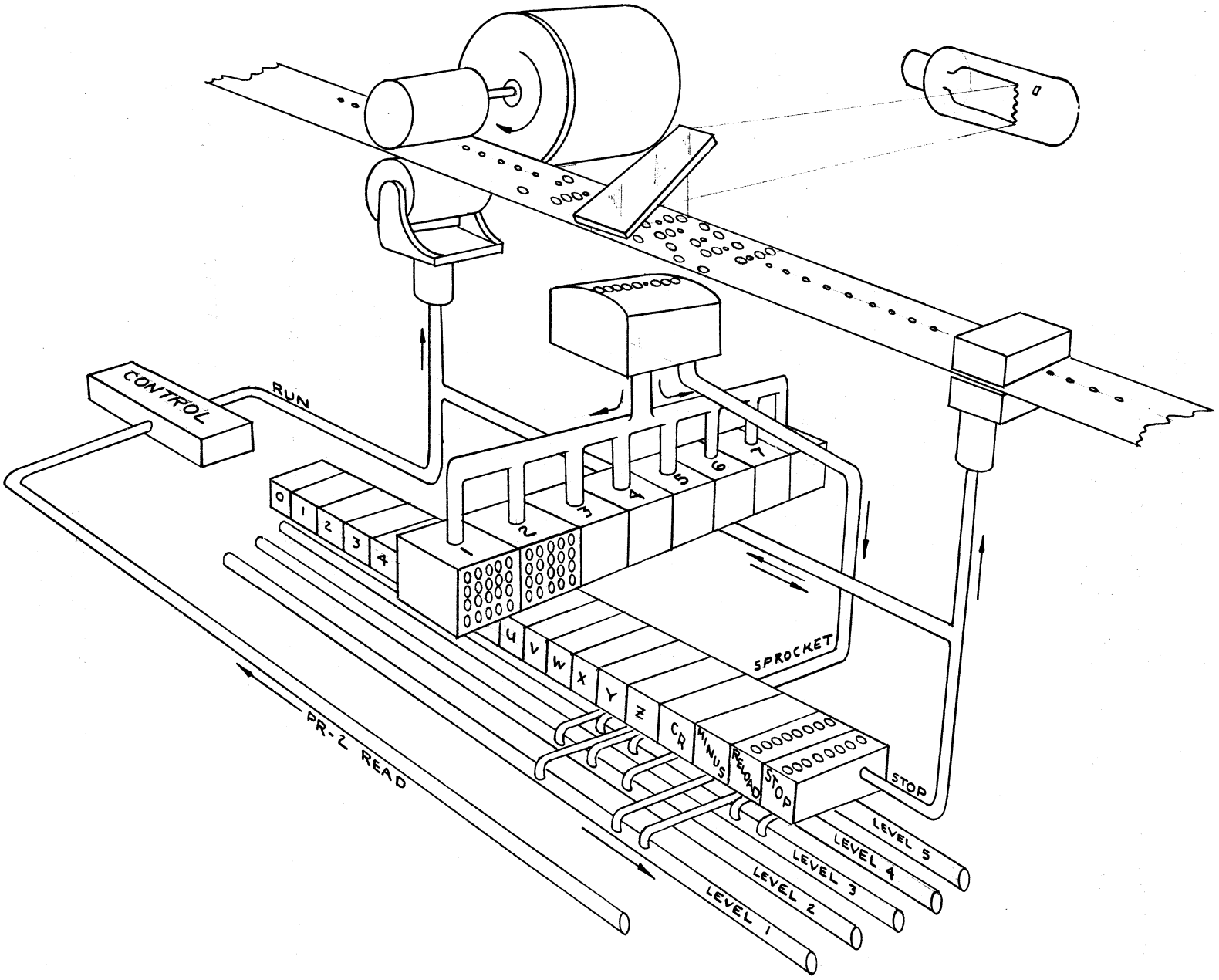


Figure No. 1
PR–2 Functional Diagram

2.1.1 Upon receipt of the "Read Tape" command from the computer, the RUN solenoid is energized, bringing the tape to be read in contact with the capstan.

2.1.2 The tape to be read is drawn through the read head by the capstan mechanism, which is driven continuously by a constant speed motor. The tape will be propelled in this manner until a "Stop" command is issued by the computer or the PR-2 itself. The "Stop" code energizes the STOP solenoid and de-energizes the RUN solenoid. Resumption of tape reading can only be initiated by computer command.

2.1.3 The "Read Head" contains nine photosensitive diodes arranged in line across the path of the tape. Each diode is positioned so that a hole in a particular level will allow light from the light source to strike the photosensitive portion of that diode.

2.1.4 When light strikes one of the photodiodes, a signal is transmitted to the translating matrix where it is transformed into the desired G-15 code.

2.1.5 Each signal is gated in the translating matrix by the "Sprocket" signal. This signal is obtained in the same manner as each of the eight information levels on the tape. The sprocket must be present to allow an output from the translating matrix.

2.1.6 The translating matrix consists of plug-in type packages that

can be patched to allow any code on tape to correspond with any one of the 20 possible G–15 codes.

2.1.7 The output of each of the 20 G–15 codes is amplified and connected to the appropriate input levels of the G–15.

3.0 THEORY OF OPERATION

3.1 General

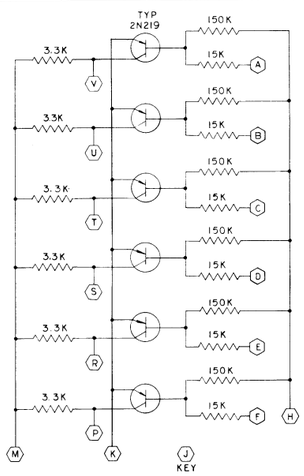
The principal parts of the tape reader are the head assembly, the chassis, front panel, motor assembly, and the translating matrix. Figure 2 is a complete detailed schematic of the entire PR–2 assembly. Figure 2 also indicates, pictorially, all mechanical linkages in the PR–2 system.

3.2 Chassis

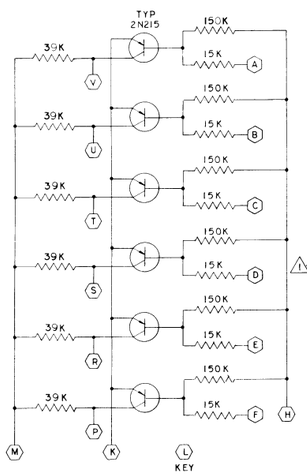
The schematic diagram of the chassis is located in section 1B of Figure 2. It contains the start and stop thyratrons, V101 and V102, a 400–volt d.c. supply, a 35–volt d.c. supply, and the Run relay, K102.

3.2.1 Thyratron Control Circuit

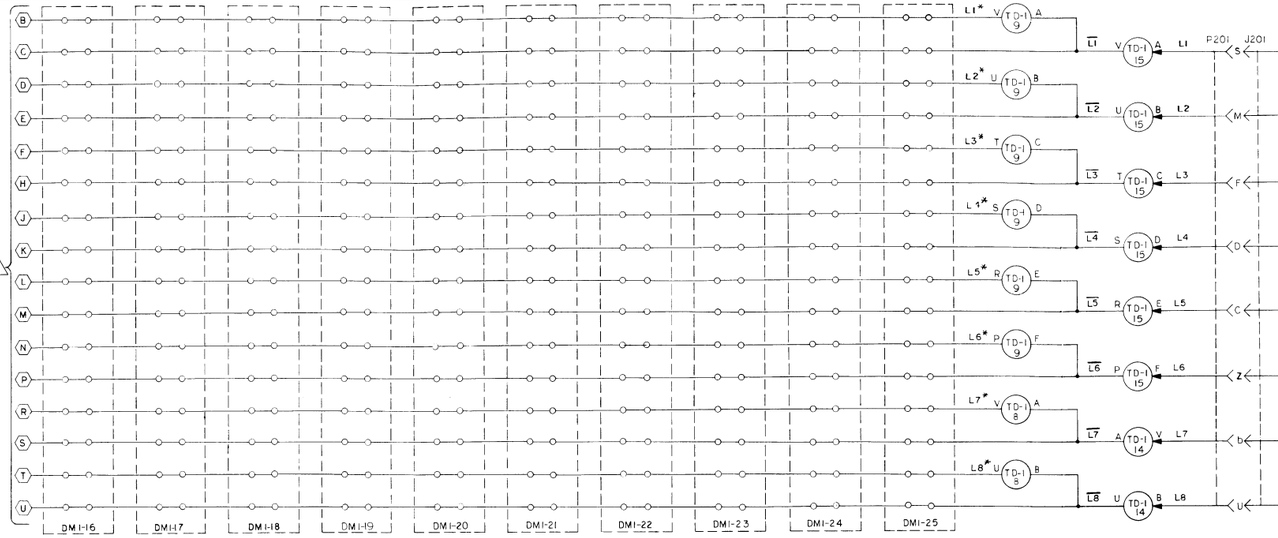
The two thyratrons are connected in a flip–flop circuit so that only one is fired at a time. Power at 400 volts d.c. (in the Run condition) is applied to the thyratron plates via contacts K102B of the Run relay, through current limiting

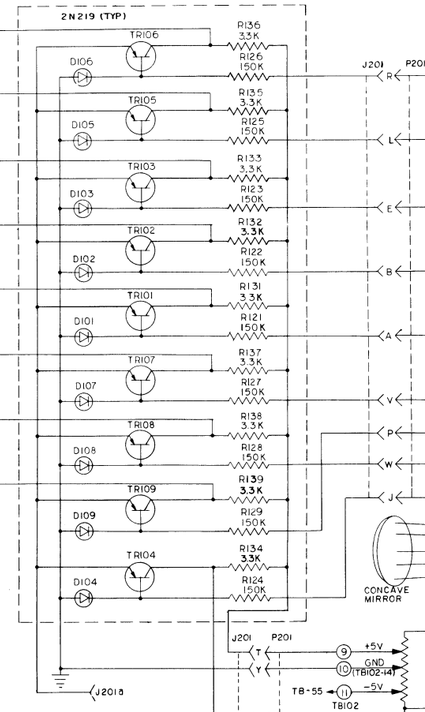


TYPICAL TD-1 PACKAGE INVERTER IC19478

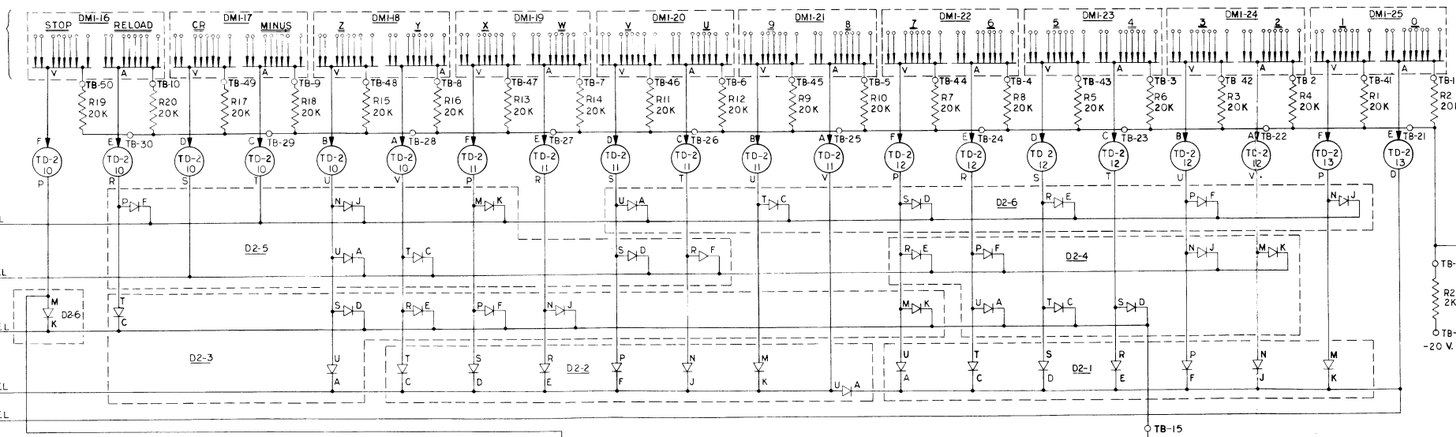


TYPICAL TD-2 PACKAGE INVERTER AMPLIFIER IC19758



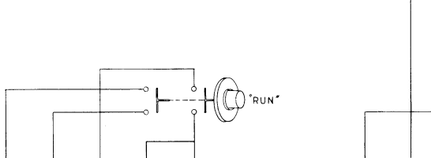


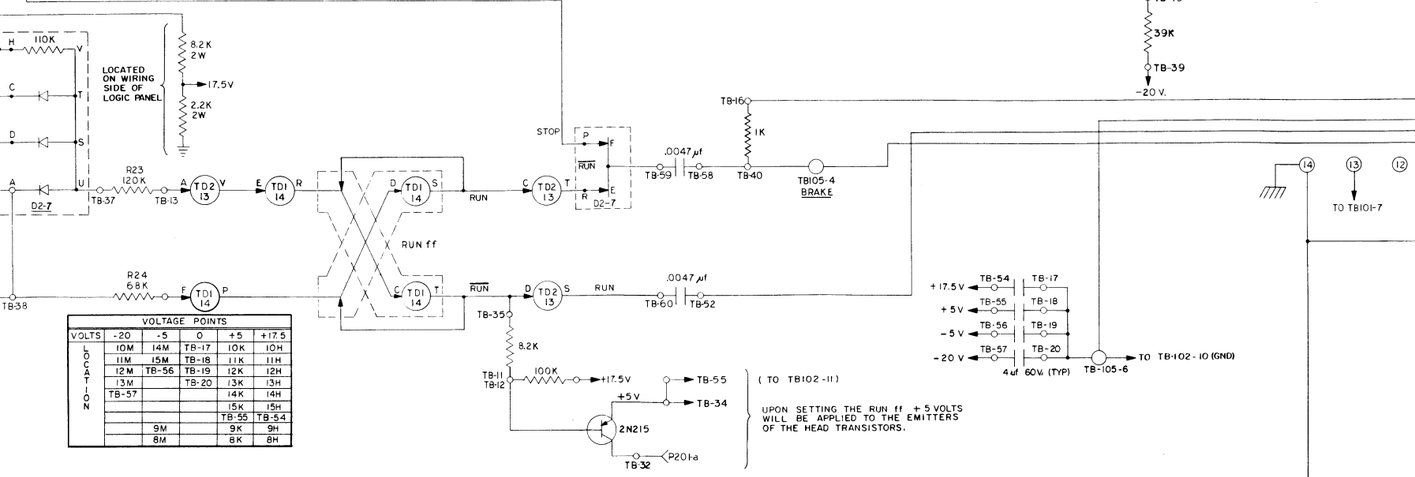
ALL DM-1 MATRIX BOARDS MUST BE PATCHED UP TO CORRESPOND TO THE CUSTOMERS CODE CONFIGURATION AS OUTLINED IN ENGINEERING SPECIFICATION 50-11 REV. B



NORMAL G-15 INPUT: 16 HEX CHARACTERS STOP RELOAD CR MINUS.

TBI03-20 1 LEVEL
TBI03-19 2 LEVEL
TBI03-18 3 LEVEL
TBI03-17 4 LEVEL
TBI03-16 5 LEVEL





VOLTAGE POINTS					
VOLTS	-20	-5	0	+5	+17.5
LOCATION	10M	14M	TB-17	10K	10H
	11M	15M	TB-18	11K	11H
	12M	TB-56	TB-19	12K	12H
	13M		TB-20	13K	13H
	TB-57			14K	14H
				15K	15H
				TB-55	TB-54
		9M		9K	9H
		8M		8K	8H

3. ALL RESISTORS IN ZONE D3&C3 ARE 250K.
2. ALL PHOTO DIODES IN ZONE D4 & D5 ARE TYPE IN77A.

⚠ THESE SYMBOLS ARE PIN NO'S. ON DIODE MATRIX PACKAGES

NOTES:

DMI-19 DMI-20 DMI-21 DMI-22 DMI-23 DMI-24 DMI-25

L1* L2* L3* L4* L5* L6* L7* L8*

TD-1 9 / TD-1 8

L1 L2 L3 L4 L5 L6 L7 L8

TD-1 15 / TD-1 14

P201 J201

2N219 (TYP)

TRI06 TRI05 TRI03 TRI02 TRI01 TRI07 TRI08 TRI09 TRI04

D106 D105 D103 D102 D101 D107 D108 D109 D104

R136 3.3K / R126 150K
R135 3.3K / R125 150K
R133 3.3K / R123 150K
R132 3.3K / R122 150K
R131 3.3K / R121 150K
R137 3.3K / R127 150K
R138 3.3K / R128 150K
R139 3.3K / R129 150K
R134 3.3K / R124 150K

J2018

J201 P201 TB103

R118 R117 R115 R114 R113 R116 R121 R120 R116

PHOTO DIODE SENSITIVITY ADJUSTMENT

TO BASE OF ASSOCIATED TRANSISTOR TRI01 → TRI09

IN77A PHOTO DIODE

PUNCHED PAPER TAPE

PLEXIGLAS FOCUSING LENSE

REFLECTING MIRROR

CONCAVE MIRROR

I101 17V (APPROX)

J201 P201 +5V GND (TBI02-14) -5V TBI02

C105 3000ufd -10V

+25V

D110

T101

FAN J101-1 P101-1 J101-2 P101-2

TOGGLE SWITCH

F101 4A F102 4A TBI01 TBI04 POWER SWITCH 115V

+400V T102

V103 5Y3GT

K102-A (RUN RELAY)

CAPSTAN MOTOR BL RD M 101 YW GN C106

TBI04 (15) (16)

TAPE WINDER SWITCH TAPE WINDER MOTOR

TO TBI02-13

V101 V102 FILAMENT VOLTAGE

TOGGLE SWITCH

R112 22 R109 100K-2 C107 1ufd

R103 5K-55 R106 5K-55 C101 1ufd C102 1ufd C103 1ufd

V101 2D21 V102 2D21

K103 FOWARD SOLENOID K104 STOP SOLENOID

R102 100K R101 100K R105 100K R104 100K

SPROCKET U TD-2 13 B P201 J201 K SPROCKET

TB-31 R27 2K TB-51 -20 V.

TB-15 39K TB-39 -20 V.

"RUN" "STANDBY" TBI04

TBI02 R107 30K-10 K102 RUN RELAY K102-B

R111 1K R108 100K-2 C107 1ufd

TO TBI01-7

TB-16 1K TB-40 TBI05-4 BRAKE

STOP P F RUN C TD2 13 T R E D2-7 .0047 μf TB-59 TB-58

D TD2 13 S RUN .0047 μf TB-60 TB-52

8.2K 100K +17.5V TB-55 +5V TB-34 2N215 TB-32 P201-a

(TO TBI02-11)

UPON SETTING THE RUN ff +5 VOLTS WILL BE APPLIED TO THE EMITTERS OF THE HEAD TRANSISTORS.

+17.5 V TB-54 TB-17
+5 V TB-55 TB-18
-5 V TB-56 TB-19
-20 V TB-57 TB-20
4 uf 60 W (TYP)

TB-105-6 TO TB-102-10 (GND)

D2-6 D2-4 D2-2 D2-1

TB-47 TB-7 TB-46 TB-6 TB-45 TB-5 TB-44 TB-4 TB-43 TB-3 TB 42 TB-2 TB-41 TB-1

R13 20K R14 20K R11 20K R12 20K R9 20K R10 20K R7 20K R8 20K R5 20K R6 20K R3 20K R4 20K R1 20K R2 20K

TD-2 11 / TD-2 12 / TD-2 13

TB-27 TB-26 TB-25 TB-24 TB-23 TB-22 TB-21

TB-15 39K TB-39 -20 V.

Figure No. 2
PR-2 Schematic

3E

resistors R103 and R106, and through their respective solenoids. Thyratron grids are biased to −10 volts d. c., and neither thyratron is fired until its control grid is triggered.

3.2.1.1 When V101 is triggered, for example, current flows through R103, through the Forward Solenoid (connected to terminals 11 and 12 of Terminal Strip TB101) to the plate of V101. Capacitor C101 discharges through solenoid and thyratron to provide additional energy for rapid solenoid travel.

3.2.1.2 If V102 is conducting at the time V101 is fired, it is extinguished by the large negative–going pulse appearing at its plate via the commutating capacitor C102. Thus either thyratron, when triggered, will turn off the other.

3.2.2 Low Voltage Supply

This supply, using a full–wave selenium bridge rectifier, develops a nominal 35–volt d. c. output. From this supply, the following voltages are obtained:

−10v for biasing grids of thyratrons
− 5v for read amplifiers and matrix inverters
5v for read amplifiers and matrix inverters
20v for exciter lamp I101

3.2.3 High Voltage Supply

This conventional power supply provides a nominal 400 volts d.c. at 100 ma for operating the drive and brake solenoids and the relays K101 and K102. A 6.3-volt rms winding on transformer T102 powers the heaters of the 2D21 thyratrons. Rectifier is a type 5Y3GT.

3.2.4 Light Source

The exciter lamp and its reflector are mounted on the chassis. The spherical mirror focuses the light from the lamp into a circular beam of parallel rays. Light passes through holes in the chassis and panel and is reflected onto the reading head by a 45-degree inclined mirror. Between the inclined mirror and the reading head is a cylindrical plastic lens, which focuses the parallel light beam into a bright line on the head surface.

3.3 Drive Motor Assembly

3.3.1 Motor

Constant average tape speed is provided by a hysteresis synchronous drive motor. As this type of motor has a smooth rotor without rotor windings or slots, it provides uniform motion.

3.3.2 Capacitor

The capacitor of the hysteresis motor is mounted on a bracket attached directly to the motor.

3.3.3 Motor Connections

Motor and relay connections to the chassis are to terminal strip TB101, at the right of the chassis.

3.4 Read Head Assembly

3.4.1 Photodiodes

As indicated in Section 3D of the schematic, Figure 2, photodiodes are Sylvania type 1N77A. These diodes are of the hermetically sealed germanium junction type. A built-in glass lens is allowed to protrude slightly from the mounting block thus making it possible to avoid the use of a dust collecting hole in the block. D. c. voltage (25v) is applied to the diodes, via potentiometers, with polarity to produce reverse biasing. In the dark, a small reverse current of a few microamperes flows; when the cell is illuminated, several hundred microamperes of reverse current flow.

3.4.2 Transistor Amplifiers

As shown on Figure 2, each photodiode is connected to a single-stage, grounded-emitter transistor amplifier.

Transistors are PNP type 2N219; emitters are connected to plus 5 volts d. c. In the "no-hole" condition of the photodiode, the diode current is low and the voltage drop in the diode load resistor is small. Since the base of the transistor is more positive than the emitter, the transistor is cut off. As the collector is returned to the -5-volt d. c. supply, collector potential is -5 volts.

3. 4. 3 When light passing through a hole in the tape strikes the photodiode, the much higher current passed by the photodiode drops the base voltage below the emitter voltage, and emitter-to-base current flows. This base current is sufficient to produce saturation current in the collector and the resultant drop in the collector load resistor produces a collector potential of nearly plus 5 volts d. c. Outputs of the transistor amplifiers are brought to a connector (P201) at the rear of the head assembly. D. c. supply voltages are brought into the head assembly by leads to terminals 9-12 on TB102. Individual adjustment potentiometers are provided.

3. 5 Panel Mounted Components

3. 5. 1 Drive solenoids are mounted inside blocks on the front panel; connections to these are at terminals 11-14 on terminal strip TB101.

3. 5. 2 The drive capstan is driven by the hysteresis motor through a seamless woven belt which is kept tight by a spring-loaded idler pulley at the panel rear.

3.6 Translating Matrix

Figure 2 also contains the schematic of the logic for the translating matrix.

3.6.1 Section 4D of Figure 2 shows 16 inverter units. Eight of these units are driven directly by the eight signals from the read head amplifiers. The outputs of the first eight inverters are the inverted level signals and are indicated as $\overline{L1}$ through $\overline{L8}$.

3.6.2 $\overline{L1}$ through $\overline{L8}$ form the inputs to eight more inverters. The outputs of the second group of eight inverters are the true level signals and are designated as $L1^*$ through $L8^*$.

3.6.3 Section 5 and 6D of Figure 2 represents the translating matrix of the PR–2. Each of the 16 inverters previously described is connected to 20 common points. Each point is associated with some particular G–15 code, of which there are a total of 20.

3.6.4 Twenty inverters are located in Sections 4, 5, and 6D of Figure 2. The code which is to represent a particular G–15 code is "patched" in as the inputs to the associated G–15 code inverters. When the input conditions to the G–15 code inverter are satisfied, its output will be high (+5v). The output of this inverter drives the appropriate G–15 input lines, thus entering the desired code into the G–15.

3.6.5 Each code inverter has nine inputs, eight levels representing the code on tape plus sprocket. The nine inputs to the inverters form an OR–gate. Thus, if the output of any inverter is to be high, all of its inputs must be low.

3.6.6 The sprocket signal is used to gate all 20 of the G–15 codes. This inverter is located in Section 3B of Figure 2. If the sprocket signal is low, it is impossible for any information to enter the G–15 since the $\overline{\text{sprocket}}$ input to all 20 inverters will be held high, thus forcing the output of all G–15 code inverters to be low.

3.6.7 When all the inputs to a single G–15 code inverter are low, the output will be high and coincident with the sprocket signal. This indicates that a code has been read from tape which is to correspond to some G–15 code. Which code on tape is to correspond to which G–15 code is entirely arbitrary, and depends upon how the PR–2 is to be "patched".

3.7 Diode Matrix Boards

3.7.1 The plug–in jumper wires on diode matrix boards must be arranged so as to conform with the coding on the tape to be read by the PR–2.

3.7.2 The diode matrix boards are all located in the lower row of the PR–2 logic chassis.

3.7.3 A single plug–in unit contains 16 diodes arranged in two

rows of eight. Each diode in a row corresponds to one of the eight tape channels. Each row of eight diodes translates, from tape, a specific character of the external code. As there are ten plug–in units and each unit has two rows of diodes, 20 external characters are translated into the 20 G–15 codes.

3.7.4 The G–15 characters are:

0	U
1	V
2	W
3	X
4	Y
5	Z
6	End (Tab or Carriage Return)
7	Stop
8	Reload
9	Minus Sign

3.7.5 There are two groups of terminals called "zero" and "one" terminals. Each terminal group consists of two rows of eight terminals, one for each diode, as shown in Figure 3.

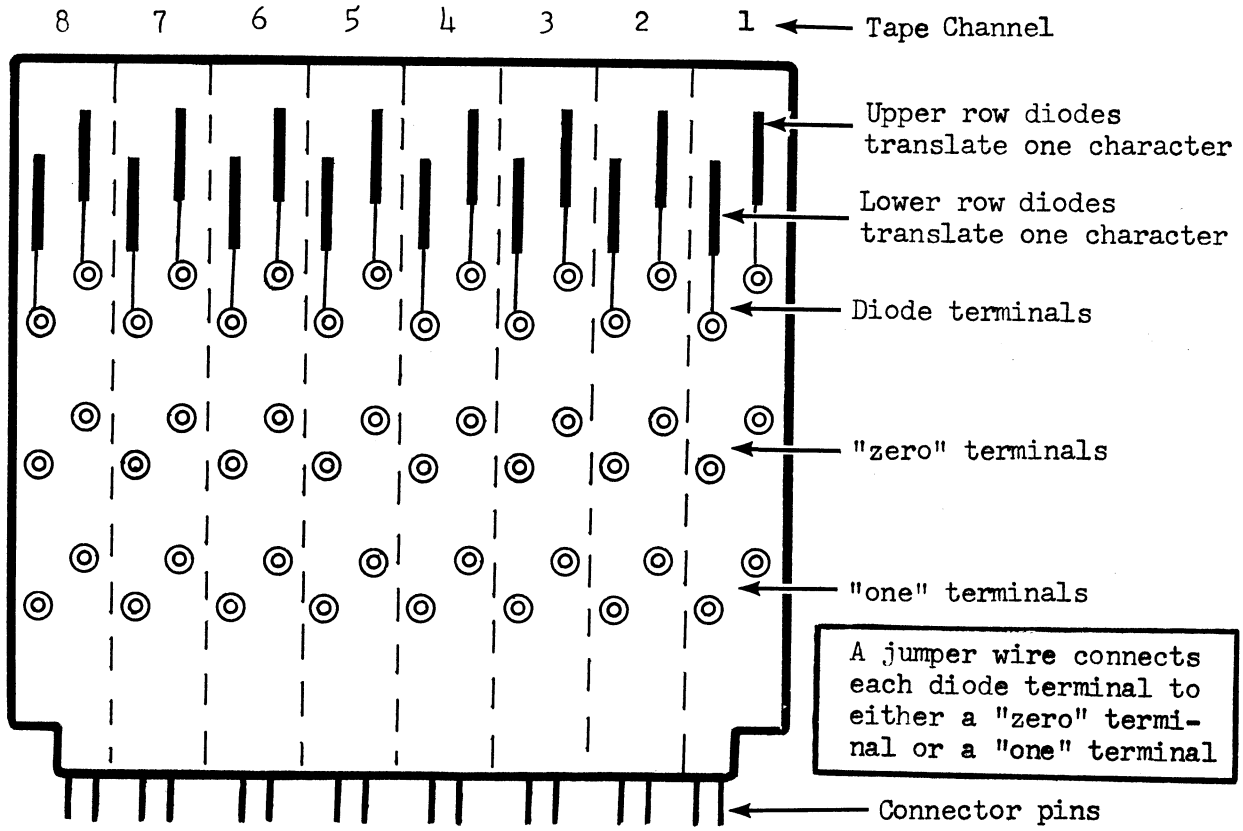


Figure No. 3
Diode Matrix Board

3.7.6 By inserting jumper wires, two character codes from tape are translated into two internal G–15 codes for each plug–in unit. The two internal G–15 codes which correspond to the position of each plug–in unit are printed above the plug–in connector in the PR–2 as shown in Figure 4.

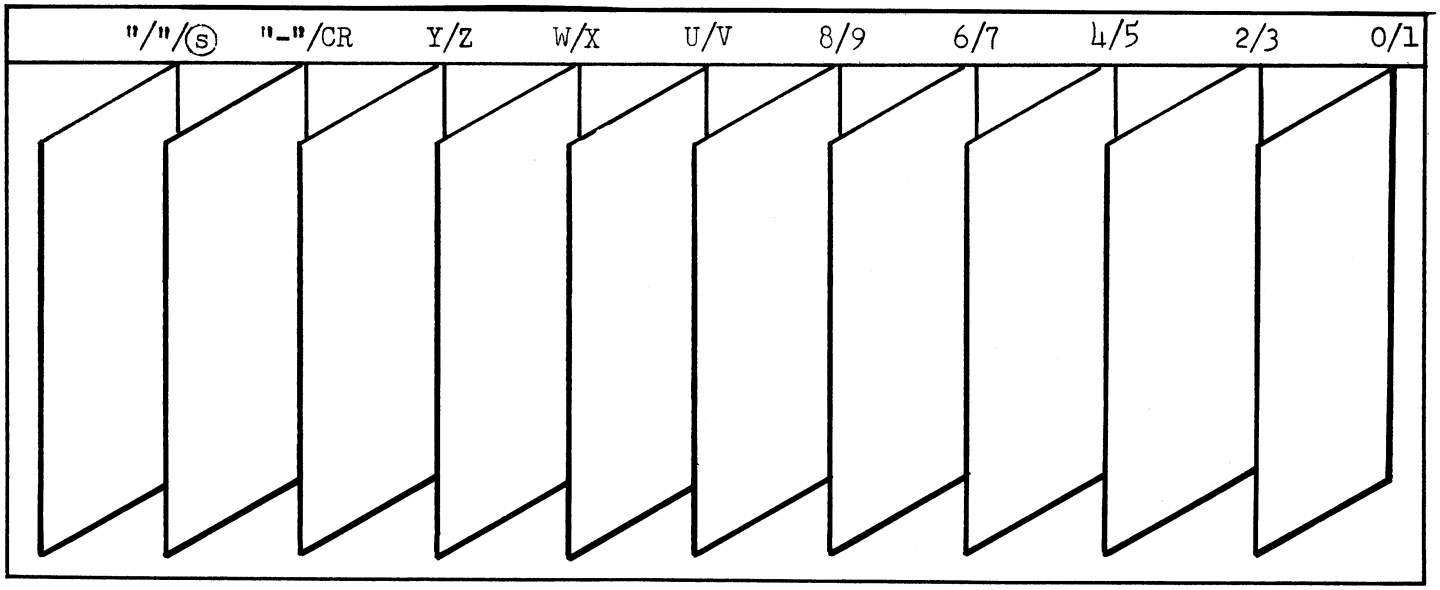


Figure No. 4
Diode Matrix Boards and Corresponding G–15 Codes

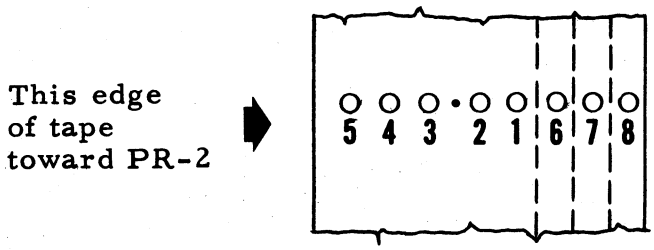


Figure No. 5
Numbering of Tape Channels

3.7.7 If a jumper wire is left out of any position, this position in the code to be translated will be disregarded. For example, if two codes differ by only one bit, and the jumper wire representing this position is omitted, then when either of these codes is read the same G–15 code will be generated.

3.7.8 If any width of tape less than 1 inch wide (at some level lower than 8) is to be read, all the jumper wires associated with the unused levels should be removed from the diode matrix boards.

4.0 CONTROL SECTION

4.1 Located in Section 6A of Figure 2 is the PR–2 control circuitry. A flip–flop comprised of four inverters is set by the coincidence of the signals SLOW IN, (1) and DS · $\overline{CV}$ from the computer. This flip–flop, which is

designated as the RUN flip–flop, will remain set until reset by $\overline{\text{SLOW IN}}$.

4.1.1 The output of the RUN flip–flop is differentiated and applied to the grid of the RUN thyratron, thus energizing the RUN solenoid and moving the tape past the read head.

4.1.2 Upon setting the RUN flip–flop, the transistor located at 5A in Figure 2 is driven into conduction and applies +5 volts to the emitters of the "Read Head" amplifiers.

4.1.3 When a "Stop" code is read, it is differentiated and applied to the STOP thyratron, which energizes the STOP solenoid and de–energizes the RUN solenoid.

4.2 Electrical Maintenance

4.2.1 All normal electrical maintenance is described in detail in Engineering Specification No. 50–11B, a copy of which is included in the Appendix.

4.3 Mechanical Maintenance

4.3.1 Lubrication

All bearings, including those of the drive motor, are permanently lubricated and require no further attention. Double–shielded ball–bearings are used throughout the tape transport to prevent entry of dust. When a bearing

shows signs of sticking it should be replaced.

4.3.2 Cleaning

It is recommended that dirt deposited from the tape be removed, using a cotton swab dipped in alcohol, at least once a week. Dirt particles should be removed from the read head, tape rollers, guide posts, and capstans.

4.3.3 Pressure Roller and Brake Adjustment

Clearance between the pressure roller and drive capstans has been set at the factory to 0.018". A similar clearance has been set between the brake shoe and the braking capstan. Normally this adjustment will remain set. If, however, readjustment is required after a long period of use, or if one of the solenoid mounting blocks has been removed, the correct adjustment is easily re-established. Remove the cover plate by taking out the two mounting screws under the solenoid blocks. Blocks are held to the panel by No. 10 socket-head screws; by loosening these screws the blocks may be positioned to adjust the clearance to the capstans. Use a feeler gauge to establish the correct setting within .001", and tighten socket-head screws securely.

4.4 Clutch Adjustment

4.4.1 The clutch must be lubricated and adjusted properly in order

for the winder and brake to function correctly. The felt pads on either side of the clutch pulley must contain enough oil to allow the clutch to operate smoothly. Approximately twenty drops of oil should be applied to the surface of each felt pad about every four months. The oil supplied in the PR–2 maintenance kit, L0–17 oil, is recommended.

4.4.2 Adjust the torque transmitted to the take–up reel by using the locknut on the clutch shaft. When the take–up reel is fully loaded with tape, the tape should not loop past the take–up arm at the time the capstan drive starts and the winder brake releases. There should be no slack tape between the capstan drive and the take–up reel when the PR–2 is operating. Tighten the locknut to the point where the winder operates just within the above condition.

4.5 Take–Up Reel Brake Adjustment

4.5.1 The brake mechanism and the adjusting screw are located directly behind the take–up reel.

4.5.2 When the take–up tension arm is in its rest position, the brake must be sufficiently free from the brake drum to prevent any self–application of the brake when the reel rotates in a clockwise direction.

4.5.3 Connect the brake spring to the brake arm with the spring adjusting screw so that there is no tension on the brake

spring when the take-up tension arm is in the rest position.

5.0 TABLE OF NOMINAL CIRCUIT VOLTAGES

5.1 Measurements made with 20,000 ohms/volt d. c. meter, at 115 volts 60 cps line voltage.

TERMINAL	VOLTAGE	TEST CONDITION
TB102-4	0	STANDBY
TB102-4	400	RUN
TB102-5	425	STANDBY
TB102-5	400	RUN
TB102-9	-5	ON
TB102-10	0	
TB102-11	+5	ON
TB102-13	400	LOW SPEED
TB102-13	0	HIGH SPEED
TB101-12	400	STOP OR STANDBY
TB101-12	10	FORWARD
TB101-14	400	FORWARD OR STANDBY
TB101-14	10	STOP
I101	17	ACROSS LAMP TERMINALS
TB103-1 thru 9	10 - 25 adj.	BIAS VOLTAGE

6.0 TABLE OF REPLACEABLE PARTS

6.1

Circuit Symbol	Description	Digitronics Stock No.	Mfr. Part No.
C101	Capacitor, Oil, 1 uf, 600v	A1121-1	Pyramid
C102	Capacitor, Oil, 0.1 uf, 600v	A1122-2	Pyramid
C103	Same as C101		
C104	Capacitor, electrolytic, 20 uf, 500v	AA447-1	Pyramid
C105	Capacitor, electrolytic, 3000 uf, 30v	AA389-1	Pyramid
C106	See table below	A1348	GE 1130
D101	Photodiode, 1N77A	AA470-1	Sylvania
D101-109	Same as D101		
D110	Rectifier, full-wave bridge, 36v 1A	AA387-1	Tabtron
F101	Fuse, 115v 3 A	A1126-3	Buss
F102	Same as F101		
I101	Lamp, 22v, 1 A	S130-1	GE 1936
K101	Relay, DPDT, 10,000 ohms	A1081	Guardian
K102	Same as K101		
M101	See table below		
R101	Resistor, comp, 1/2 w 10 pct., 100K	1-100K	Ohmite
R102	Same as R101		
R103	Resistor, wire, 55w, 5K	A1116-1	Ward-Leonard
R104	Resistor, comp, 1/2 w 10 pct., 100K	1-100K	Ohmite
R105	Same as R104		
R106	Resistor, wire, 55 w, 5K	A1116-1	Ward-Leonard
R107	Resistor, wire, 10 w, 30K	A1130-1	Ohmite
R108	Resistor, comp, 2 w, 100K	3-100K	Ohmite
R109	Same as R108		
R110	Resistor, wire, adj., 50 w 25 ohm	AA392-3	Ohmite

Circuit Symbol	Description	Digitronics Stock No.	Mfr. Part No.
R111	Resistor, comp, 1/2 w, 10 pct., 1K	1–1K	Ohmite
R112	Resistor, comp, 1/2 w, 10 pct. 22 ohms	1–22	Ohmite
R113–R121	Potentiometer, comp, 2 w, 250K	S250–2	Ohmite
R114–R120	Omitted		
R121	Resistor, comp, 1/2 w, 10 pct. 100K	1–100K	Ohmite
R122–129	Same as R121		
R130	Omitted		
R131	Resistor, comp, 1/2w, 10pct., 4.7K	1–4.7K	Ohmite
R132–139	Same as R131		
R140	Resistor, wire, 10 w, 30K	A1130–1	Ohmite
T101	Transformer, 32v, 1 A	AA390–2	Crest.
T102	Transformer, power	AA434–1	UTC
TR101	Transistor, type 2N219		RCA
TR102–109	Same as TR101		
V101	Tube, thyratron, 2D21	7–2D21	
V102	Same as V101		
V103	Tube, rectifier, type 5Y3GT		
	Bearing, 1/8 ID x 5/16 OD	A1072–2	N.H. Ball
	used on tape rollers		Bearing
	Bearing, 3/8 ID x 7/8 OD	A1073–1	Fafnir
J201	Connector assy, for head		
P201	Connector, chassis	A1133	Amphenol
	used on head assy.		
	Photoelectric Head Assy.	DB44–1	
	Solenoid	A1076	Leland
	Belt, Endless	A1223–7	Tilton

7.0 PROGRAMMING

7.1 Automatic Mode

7.1.1 The command which instructs the PR–2 to read tape in the automatic mode is as follows:

Command	Code
Read Tape	L5 N 5 12 31

The command should not be placed in address u7.

7.1.2 On receipt of this command, the computer clears Line 23 and inserts a marker bit in its least significant bit. Then, as information is stored in Line 23, the marker bit is moved toward the most significant bit position.

7.1.3 When four groups of 7 hex characters have entered Line 23, the marker bit is recognized and the contents of Line 23 are transferred to Line 19. The four groups of numbers may or may not be separated by an End code. After the transfer, Line 23 is cleared and the marker bit again enters the least significant bit position.

7.1.4 Observe these rules in punching tape: The number of digits per number is 7; zeros must be punched in unused digit positions.

7.1.5 Each 7–digit number may or may not be followed by an End of Number character. However, if used, the End of Number

character must be used after every 7–digit number.

7.1.6 For information to be entered into the G–15 memory, there must be a "Stop" code at least every 108 seven–digit numbers.

7.2 Standard Mode

7.2.1 The command which causes the PR–2 to read tape in the standard mode is:

Command	Code
Read Tape	T N 1 12 31

7.2.2 The standard mode input operation is exactly like input to the G–15 through the standard photo–reader; the TRANSFER–23–to–19 signals are read from tape. The G–15 does not automatically generate the transfer of the contents of Line 23 to 19 code in the standard mode. When the "transfer–23–to–19" code is read, the contents of Line 23 are copied into Line 19.

7.2.3 A minimum of 26 characters must appear on tape between any two of these codes. A TRANSFER–23–to–19 signal must occur before 117 bits of information have been entered into the computer; otherwise, information will be lost.

7.2.4 The use of a "Stop" code in the standard mode halts the tape before the next character is read and, in addition, causes the contents of Line 23 to be copied into Line 19. "Stop" codes may occur as often as desired provided there are at least six characters between "Stop" codes.

7.3 Timing

In writing a program that uses either of the PR–2 commands, allow a delay of at least four drum revolutions after a tape read has halted before re–executing the command.

7.4 Physical Description

7.4.1 The PR–2 is designed to be used without reels. Tape winding and unwinding equipment capable of handling 500 feet of tape is associated with the accessory. The winder and unwinder are designed to handle a reel–less roll of tape from a standard winder such as is found on National Cash Register, Clary Cash Register, or Friden Flexowriter equipment.

7.4.2 The PR–2 is 22 inches high, 24 inches wide and 19 inches deep. It weighs about 120 pounds.

7.5 Installation

7.5.1 Connect the PR–2 cable to the receptacle at the rear of the G–15 computer labeled "Punched Tape". Power for the PR–2 is supplied from the G–15.

7.6 Operating Instructions

7.6.1 To turn on the PR–2:

1 Put the Power switch in the ON position.

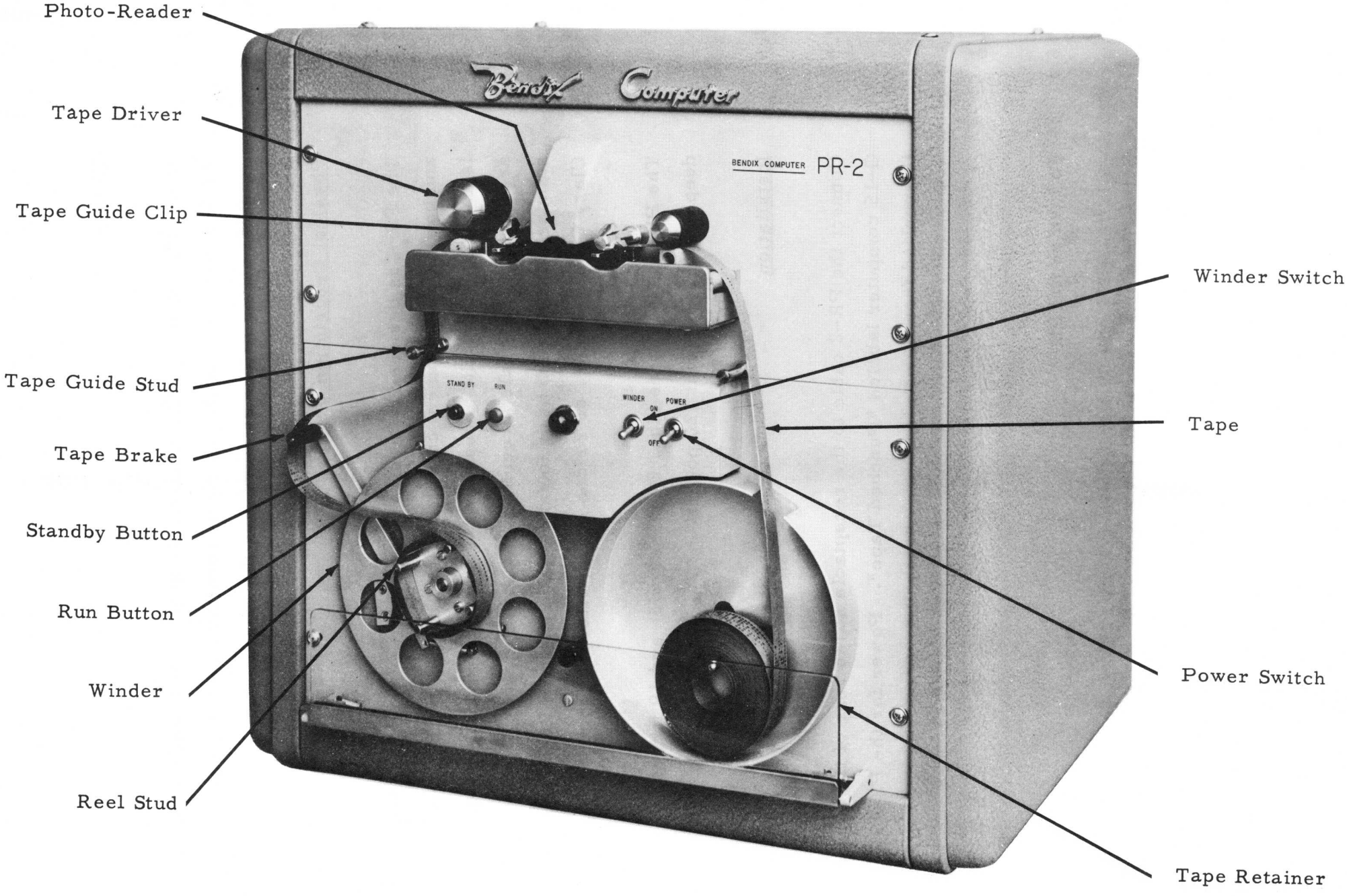


Figure No. 6
PR–2 Front Panel

2 Insert tape to be read in the reader and thread through the winder as shown in Figure 6. The two clips on either side of the photo–reader permit the operator to easily slide the tape under the photo–reader.

3 Wait for at least 60 seconds after the Power switch is turned ON. Then press the Run button. The tape is now firmly held in place.

7.6.2 To insert tape in the reader or remove tape from it, press the Standby button.

7.6.3 To use large rolls of tape:

1 Put the tape roll in the container and run the tape through the photo–reader, around the tape brake and around the reel studs of the tape reel.

2 Put the Winder switch in the ON position.

7.6.4 To rewind the tape:

1 Remove the roll of tape from the reel.

2 Put the tape in the tape holder and over the tape guide studs as illustrated in Figure 6.

3 Press the run button and put the Winder switch ON.

7.6.5 To turn off the PR–2:

1 Press the Standby button.

2 Put the Power switch in the OFF position.

The PR–2 need not be disconnected from the G–15 computer.

8.0 ENGINEERING SPECIFICATION

NO. 50-11, REVISION B

THE Bendix CORPORATION — BENDIX COMPUTER DIVISION

APPROVED	ENGINEERING SPECIFICATION	NO. 50-11	REV. B
MECH. ENGR.		PREPARED BY Norman Love	
ELECT ENGR.	TITLE PR-2 TEST ROUTINE #2	CHECKED BY	
PROJ. ENGR.		DATE January 26, 1961	

1. This test routine was written to accomplish the following:

   1.1 Thoroughly test all components in the PR-2.

   1.2 Provide a meaningful error typeout of what was read in and not merely a check sum.

   1.3 Provides a method for adjusting the PR-2 without returning to the typewriter. (This was very often necessary with previous routines if stray signals are stopping the PR-2 and not setting "ready" in the G-15.)

   1.4 Provides a method for preparing PR-2 number loops.

2. The following is a summary of this test routine operation.

   2.1 The computer is assumed on and the number track read in.

   2.2 Read in one block and throw "compute" to "go" or "BP".

      2.2.1 GO: A loop containing 8 word blocks is assumed on the PR-2 and the PR-2 turned on.

      8 words of information are read in. If this block contains the correct check sum and no error has been made, 8 more words are immediately read in. If this block does not contain the correct check sum, or an error has been made, a typeout of the information read will occur providing the punch switch is "off". If the punch switch is "on", one bell will ring and the next block of 8 words is read in.

2.2.2 BP: After the tape is read in, throw compute to go in order to enter the test described in 2.2.1. "SC1F" will enter the routine described in 2.3.

2.2.3 If for any reason the PR-2 should fail to set "ready" in the G-15, a count in the routine will force a set "ready" and ring the bell 4 times.

2.3 Line one contains a routine for preparing test loops which are compatible to this routine; i.e., eight word blocks, where all words are separated by carriage returns. This information may be typed in or read from tape. If the punch switch is off, the routine will gate type in. If the punch switch is on, the information will be read from tape. If it is desired to continue punching the same 8 word block, have the compute to "go". If it is desired to punch all different blocks, have compute to "BP". This will punch out only one time block and halt.

Enable "F" will return to start of routine and compute to "BP" will gate type or read tape depending on punch switch setting.

3. Recommended operating procedure for final test or field debugging. The following tapes are necessary:

1. PR-2 test routine No. 2.
2. "Z" loop. This loop should contain nothing but Z's.
* 3. "Correct check sum" loop.
* 4. Number loop.

3.1 Adjust all signals.

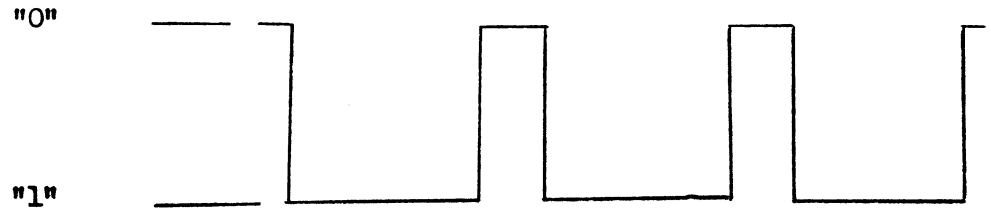
3.1.1 Place the "Z" loop on the PR-2 and turn on.

* For correct matrix coding - see Sec. 4.

3.1.2 Read in test routine as described in 2.

3.1.3 The "Z" loop will run continuously. The computer will indicate a forced "set ready" periodically. During this time the PR-2 signals will vanish. Ignore this and continue adjusting the levels, since they will be coming through most of the time.

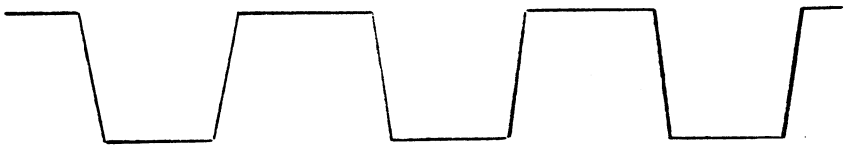
3.1.4 Adjust all 5 information signals to maximum width that is reliable. They should appear similar to Figure 1.



(Inverted Level Signals)

Figure 1

3.1.5 Adjust sprocket as narrow as is reliable. It should appear similar to Figure 2.



(Inverted Sprocket, 13u)

Figure 2

3.1.6 If available, a dual trace scope should be used. Have sprocket always on one channel. Trigger on sprocket and put the other channel on the level signal to be adjusted.

by combining Figures 1 and 2, Figure 3 should be observed on the scope as the ultimate adjustment for all levels.

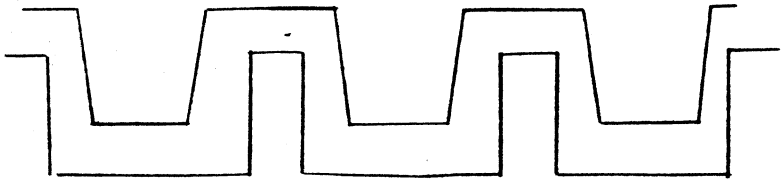


Figure 3

3.2 Check all characters issued from the PR-2.

3.2.1 After insuring that sprocket is probing all levels correctly, place the number loop on the PR-2. Leave the punch switch off in order to observe the typeout. This loop should contain 8 word blocks where all eight words are the same number. There are as many blocks as there are numbers plus 2 additional blocks. One of these blocks consists of 8 words of ZOZOZOZ, the other will appear as follows:

1234567 89UVWXY -ZO12345 6789UVW
-1234567 89UVWXY -ZO12345 6789UVW

This test is designed to expose any bad components that might be associated with any one character. Should any one character fail, use the punch routine to prepare a number loop containing only the character that failed and repeat test,and observe where the signals are failing.

3.3 After successfully completing 3.3.2, place the "check sum" loop on the PR-2 and throw compute to go with the punch switch off in order to observe any possible error typeout. Assuming Steps 3.1 and 3.2 have been completed satisfactorily, this test should run continuously without any error typeouts. (See Section 5.0)

3.3.1 In order to check marginal operation of the PR-2, leave the "check sum" loop on and running as described in 3.3.2. Put the punch switch in the "on" position in order to avoid waiting for the typeout should an error occur. The most critical margins associated with the PR-2 are the +100 and -20 volts.

APPROVED	ENGINEERING SPECIFICATION	NO. 50-11	REV. B
MECH. ENGR.		PREPARED BY Norman Love	
ELECT ENGR.	TITLE PR-2 TEST ROUTINE #2	CHECKED BY	
PROJ ENGR.		DATE January 26, 1961	

4. Matrix Coding for PR-2 Test Routine No. 2.

4.1 PR-2 test tapes, as described in Sec. 3.0, are available in either standard G-15 code or teletype code. If standard G-15 code is used refer to Table 1 for the jumper wire connections or if teletype code is used refer to Table 2.

4.2 A jumper connection is made from each of the diodes to either the "1" row, or the "0" row (see Figure 4), according to Table 1 or Table 2. It is not necessary to make a connection between diodes 6, 7, 8, 14, 15 and 16, since only 5 level tape is being read.

4.3 The PR-2 should be tested, as outlined in Section 3, using both G-15 and teletype coded matricies and their respective test loops.

5. "Correct Check Sum" Loop

5.1 The "Correct Check Sum" loop used with this test routine must have the following check sum =

OUVWXZO

5.2 All test loops used with this routine must have a 7 digit carriage return format.

5.3 An error typeout when using the "correct check sum" loop provided with this test routine will be some deviation of the following

0112233 -4556677 899UUVV -OUVWXYZ

1579VXZ -0112233 455667 -899UUVV

STANDARD G-15 CODE

Package No.		25	24	23	22	21	20	19	18	17	16
G-15 Character		0/1	2/3	4/5	6/7	8/9	u/v	w/x	y/z	-/CR	R/S
Diode Conn.	1	0	0	0	0	0	0	0	0	1	1
	2	0	1	0	1	0	1	0	1	0	0
	3	0	0	1	1	0	0	1	1	0	1
	4	0	0	0	0	1	1	1	1	0	0
	5	1	1	1	1	1	1	1	1	0	0
	6										
	7										
	8										
	9	1	1	1	1	1	1	1	1	0	0
	10	0	1	0	1	0	1	0	1	1	0
	11	0	0	1	1	0	0	1	1	0	1
	12	0	0	0	0	1	1	1	1	0	0
	13	1	1	1	1	1	1	1	1	0	0
	14										
	15										
	16										

Table 1

TELETYPE CODE

Package No.		25	24	23	22	21	20	19	18	17	16
G-15 Character		0/1	2/3	4/5	6/7	8/9	u/v	w/x	y/z	-/CR	R/S
Diode Conn.	1	0	1	0	1	0	1	1	0	0	0
	2	1	1	1	0	1	1	1	1	0	1
	3	1	0	0	1	1	0	0	1	1	1
	4	0	0	1	0	0	1	0	1	0	1
	5	1	1	0	1	0	1	0	0	1	1
	6										
	7										
	8										
	9	1	1	0	1	0	1	1	0	0	0
	10	1	0	0	1	0	1	0	1	0	0
	11	1	0	0	1	0	1	0	0	0	1
	12	0	0	0	0	1	1	1	1	1	1
	13	1	0	1	0	1	1	0	1	0	0
	14										
	15										
	16										

Table 2

APPROVED		ENGINEERING SPECIFICATION	NO. 50-11	REV B
MECH. ENGR.			PREPARED BY N. Love	
ELECT. ENGR.	R. Smith	TITLE	CHECKED BY	
PROJ. ENGR.	W. Gibson	PR-2 TEST SPECIFICATION	DATE Jan. 26, 1961	

DIODE MATRIX BOARD

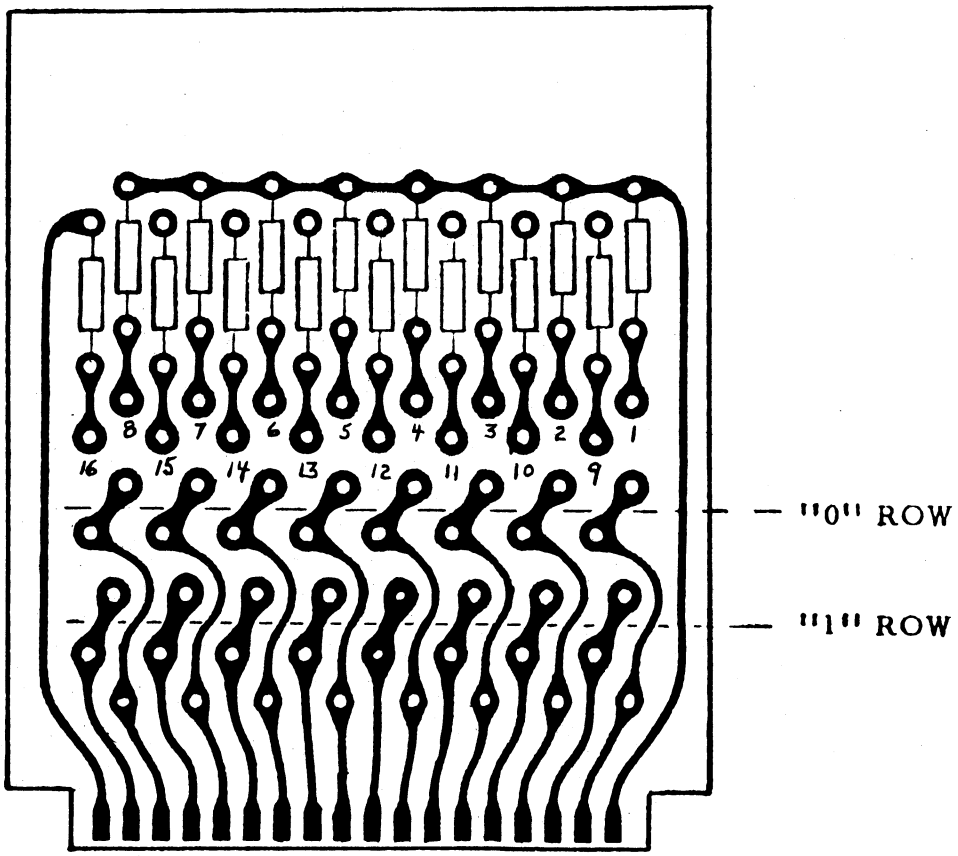
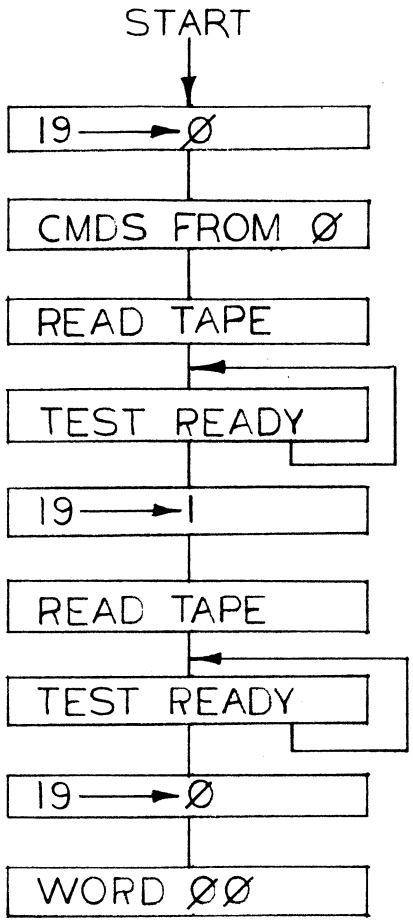
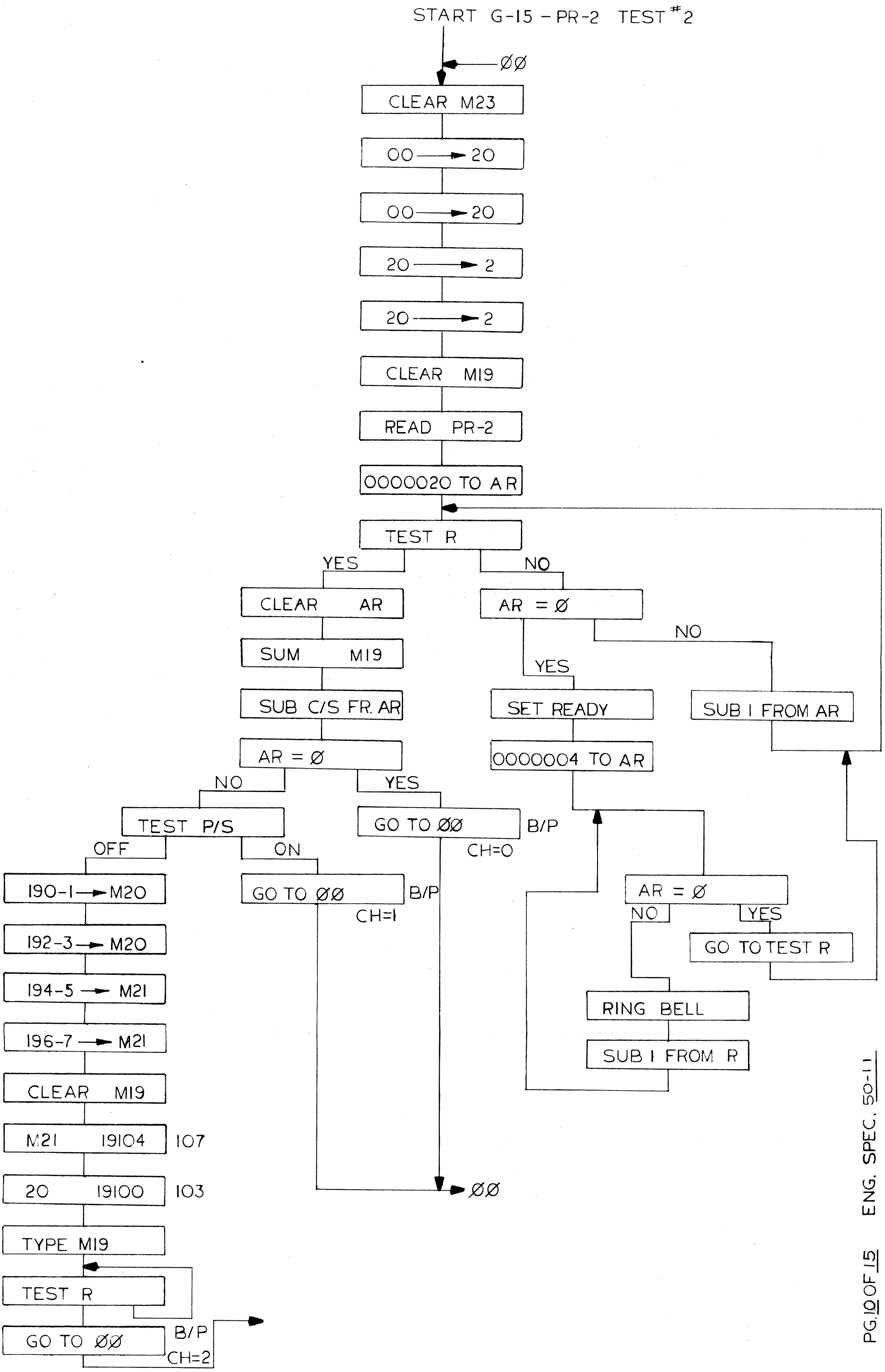


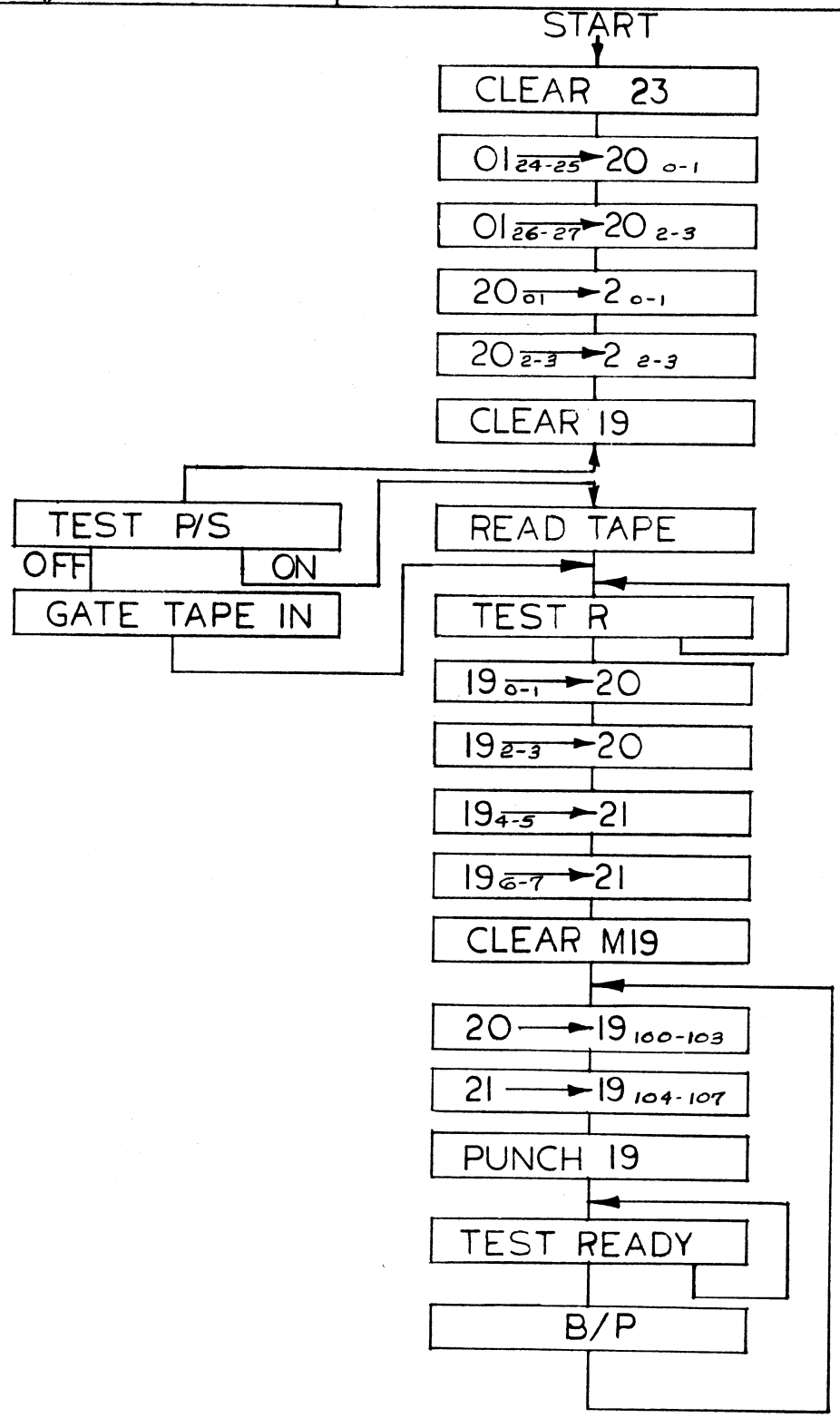
Figure 4

APPROVED	ENGINEERING SPECIFICATION	NO. 50-11	REV. B
MECH. ENGR.		PREPARED BY Norman Love	
ELECT. ENGR.	TITLE PR-2 TEST ROUTINE #2 LOADER	CHECKED BY	
PROJ. ENGR.		DATE January 26, 1961	




START G-15 – PR-2 TEST # 2
ØØ
CLEAR M23
00 → 20
00 → 20
20 → 2
20 → 2
CLEAR MI9
READ PR-2
0000020 TO AR
TEST R
YES
NO
CLEAR AR
SUM MI9
SUB C/S FR. AR
AR = Ø
NO
YES
TEST P/S
OFF
ON
190-1 → M20
192-3 → M20
194-5 → M21
196-7 → M21
CLEAR MI9
M21 19104 107
20 19100 103
TYPE MI9
TEST R
GO TO ØØ
B/P
CH=2
GO TO ØØ
B/P
CH=1
GO TO ØØ
B/P
CH=0
AR = Ø
NO
YES
SET READY
0000004 TO AR
SUB I FROM AR
AR = Ø
NO
YES
GO TO TEST R
RING BELL
SUB I FROM R

APPROVED	ENGINEERING SPECIFICATION	NO. 50-11	REV. B
MECH. ENGR.		PREPARED BY Norman Love	
ELECT. ENGR.	TITLE PR-2 PUNCH ROUTINE	CHECKED BY	
PROJ ENGR.		DATE January 26, 1961	



Bendix Computer — Los Angeles 45, California

G-15D

PROGRAM PROBLEM: PR-2 Test Routine No. 2 - Loader

Prepared by Renfeldt & Love

Date: 1/26/61

Line

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15
16	17	18	19
20	21	22	23
24	25	26	27
28	29	30	31
32	33	34	35
36	37	38	39
40	41	42	43
44	45	46	47
48	49	50	51
52	53	54	55
56	57	58	59
60	61	62	63
64	65	66	67
68	69	70	71
72	73	74	75
76	77	78	79
80	81	82	83
84	85	86	87
88	89	90	91
92	93	94	95
96	97	98	99
u0	u1	u2	u3
u4	u5	u6	

L	P	T or L_k	N	C	S	D	BP	NOTES
00	U	01	01	0	19	00		M19 → M0
01	W	02	02	0	21	31		Cmds from 0
02		04	05	0	15	31		read tape
05		05	05	0	28	31		Test ready
06	U	07	08	0	19	01		M19 → M1
08		10	11	0	15	31		Read tape
11		11	11	0	28	31		Test ready
12	U	13	00	0	19	00		M19 → M0

Bendix Computer — Los Angeles 45, California

G-15D

Prepared by Renfeldt & Love

Date:

PROGRAM PROBLEM: Punch Routine - PR-2 Test Tapes

Line 01

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15
16	17	18	19
20	21	22	23
24	25	26	27
28	29	30	31
32	33	34	35
36	37	38	39
40	41	42	43
44	45	46	47
48	49	50	51
52	53	54	55
56	57	58	59
60	61	62	63
64	65	66	67
68	69	70	71
72	73	74	75
76	77	78	79
80	81	82	83
84	85	86	87
88	89	90	91
92	93	94	95
96	97	98	99
u0	u1	u2	u3
u4	u5	u6	

L	P	T or L_k	N	C	S	D	BP	NOTES
00	U	05	28	0	29	23		Clear M23
01	U	02	15	0	29	19		Clear M19
03		05	06	0	15	31		Read tape
06		06	06	0	28	31		Test ready
07		00	08	4	19	20		M19 0-1 → 20
08		02	09	4	19	20		19 2-3 → 20
09		04	10	4	19	21		19 4-5 → 21
10		06	11	4	19	21		19 6-7 → 21
11	U	12	99	0	29	19		Clear M19
99	U	U4	U3	0	20	19		20 → 19 100-103
U3	U	00	12	0	21	19		21 → 19 104-107
12		14	13	0	10	31		Punch M19
13		13	13	0	28	31		Test ready
14		15	99	0	00	00		Return to 99
15		16	16	1	17	31		Test PS
16		18	06	0	12	31		(Off) gate type in
17		18	03	0	00	00		(On) do nothing
24	U	00	00	0	08	16		)
25	U	00	00	0	02	16		) M 19 format
26	U	00	00	0	00	20		)
27		00	00	0	00	05		)
28		25	29	4	01	20		M01 24-25 → M20 0-1
29		26	30	4	01	20		M01 26-27 → M20 2-3
30		00	31	4	20	02		M20 0-1 → M2 0-1
31		02	01	4	20	02		M20 2-3 → M2 2-3

Bendix Computer — Los Angeles 45, California

G-15D
PROGRAM PROBLEM: PR-2 Test Routine No. 2

Prepared by Renfeldt & Love

Date: 1/26/61
Line 00

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15
16	17	18	19
20	21	22	23
24	25	26	27
28	29	30	31
32	33	34	35
36	37	38	39
40	41	42	43
44	45	46	47
48	49	50	51
52	53	54	55
56	57	58	59
60	61	62	63
64	65	66	67
68	69	70	71
72	73	74	75
76	77	78	79
80	81	82	83
84	85	86	87
88	89	90	91
92	93	94	95
96	97	98	99
u0	u1	u2	u3
u4	u5	u6	

L	P	T or L_k	N	C	S	D	BP	NOTES
00	U	05	52	0	29	23		Clear M23
01	U	02	02	0	29	19		Clear M19
02		04	25	1	12	31		Read PR-2 manual mode
06		08	24	0	29	28		Clear AR
08		09	10	3	00	29		Subt. check sum from A.R.
09	U	10	60	3	15	16		Check sum
10		11	12	0	28	27		Test AR = 0
12		13	00	0	00	00		Yes go to 00
13		14	16	1	17	31		No Test PS
16		00	11	4	19	20		Off M 190-1→M20
17		37	00	1	00	00		On go to 00
11		02	14	4	19	20		M192-3→20
14		04	20	4	19	21		M194-5→21
20		06	18	4	19	21		M196-7→21
18	U	19	U3	0	29	19		Clear M19
U3	U	00	99	0	21	19		M21→M19104-107
99	u	U4	19	0	20	19		M20→M19100-103
19		21	22	0	09	31		Type M19
22		22	22	0	28	31		Test R
23		38	00	2	00	00		Go to 00
24	U	25	08	1	19	29		Sum M19
48	U	00	00	0	08	16		) Standard
49	U	00	00	0	06	16		) M 19
50	U	00	00	0	01	20		) Format
51		00	00	0	00	13		)
25		26	27	0	00	28		Timing no. to AR

Bendix Computer — Los Angeles 45, California

Date: 1/26/61

G-15D

PROGRAM PROBLEM: PR-2 Test Routine No. 2

Prepared by Renfeldt & Love

Line 00

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15
16	17	18	19
20	21	22	23
24	25	26	27
28	29	30	31
32	33	34	35
36	37	38	39
40	41	42	43
44	45	46	47
48	49	50	51
52	53	54	55
56	57	58	59
60	61	62	63
64	65	66	67
68	69	70	71
72	73	74	75
76	77	78	79
80	81	82	83
84	85	86	87
88	89	90	91
92	93	94	95
96	97	98	99
u0	u1	u2	u3
u4	u5	u6	

L	P	T or L_k	N	C	S	D	BP	NOTES
26	<						>	Timing No. 1=(0000020)
27		27	28	0	28	31		Test ready
28		29	31	0	28	27		TN no AR = 0
29		30	24	0	29	28		TN + 1 yes clear AR
31		33	27	0	00	31		TN yes set ready
32		33	27	3	00	29		TN + 1 no subt. 1 from AR
33	<						>	(0000001)
52		48	53	4	00	20		M00 48-49 → M20 0-1
53		50	54	4	00	20		M00 50-51 → M20 2-3
54		00	55	4	20	02		M20 0-1 → 02 0-1
55		02	01	4	20	02		M20 2-3 → 02 2-3
31		33	34	0	00	31		set ready
34		35	58	0	00	28		Timing no. #2 to AR
35	<						>	Timing No. 2=(0000004)
58		57	59	0	28	27		AR = 0
59		60	27	0	00	00		(Yes) go to 27
60		61	57	0	17	31		(No) ring bell
57		33	05	3	00	29		Subt. 1 from AR
05		60	58	0	00	00		Return to 58

Bendix Computer Division
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