CONSTRUCTION PLANS FOR SIMON

By Edmund C. Berkeley and Robert A. Jensen

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INTRODUCTION

Simon is a small portable mechanical brain, weight 39 lbs. and volume $1\frac{1}{4}$ cu. ft. It was constructed by Edmund C. Berkeley and Associates, in the period November, 1949, to May, 1950, and was modified to become more powerful July, 1950, to September, 1950. The materials cost was about $270. At first, Simon could handle only numbers 0,1,2, and 3, and four operations, addition (without carry), subtraction or negation (without carry), greater than, and selection. After modification, it could take in numbers up to 255, and perform five additional operations,: logical "and", logical "not" or threes complement, logical "or", addition subject to carry, and subtraction or negation subject to carry. It still has a great deal of capacity to grow.

The purpose of Simon is to aid in explaining, lecturing, and teaching in the subject of automatic computing machinery or mechanical brains. It has been used for that purpose in a course "Digital Computers and Techniques" taught by Edmund C. Berkeley in City College of New York in the fall term 1951-1952.

Although Simon started off to be a simple machine, and is a great deal simpler than any other existing complete mechanical brain, its construction is difficult and should not be lightly undertaken. However, Mr. C.J. Carl and Mr. Raymond Lurty, two students at the West Coast College of Engineering in Los Angeles, using a copy of our plans, during 1951 constructed Simon II. They have sent us photographs of their accomplishment.

The following references should be studied before any attempt is made to construct Simon, keeping in mind that Simon has grown and changed from time to time:

(a) Giant Brains or Machines that Think, by Edmund C. Berkeley, published by John Wiley and Sons, 1949, -- Chapter 3, Simon. (Cost: $4.00; Address: 440 4th Ave., New York 16, N.Y.)

(b) "Simple Simon", by Edmund C. Berkeley, in Scientific American, November 1950, cover picture and article pp.40 to 43. (Cost: 50¢; Address: 2 West 45 St., New York 36, N.Y.)

(c) "Constructing Electric Brains", series of thirteen articles by Edmund C. Berkeley and Robert A. Jensen, published in Radio Electronics, October 1950 to October 1951 Reprinted (March 1952) by and available from Edmund C. Berkeley and Associates, (Cost:$2.20: Address: 36 West 11 St., New York 11, N.Y.)

References (b) and (c) contain photographs of the actual physical layout of Simon.

We shall be very glad to try to help anyone who is firmly resolved to try to construct another machine like Simon.

CONTENTS

Memorandum 1

SIMON -- REGISTERS AND OPERATIONS

A list of the registers in Simon, with their codes, entrance relays, and reset relays, follows:

Register	Code	Entrance Relay	Reset Relay
IR1	0000	none	RR1
IR2	0001	none	RR1
SR1	0010	ER3	RR3
SR2	0011	ER4	RR4
SR3	0100	ER5	RR5
SR4	0101	ER6	RR6
SR5	0110	ER7	RR7
SR6	0111	ER8	RR8
CR1	1000	ER9	RR9
CR2	1001	ER10	RR10
CR3	1010	ER11	RR11
CR4	1011	ER12	RR12
CR5	1100	none	RR12
OR1	1101	ER14	RR14
OR2	1110	ER15	RR15
OR3	1111	ER16	RR16

The operations in Simon are as follows:

No.	Code	Operation
1	0000	Add, No Carry;
2	0001	Negate, No Carry; Fours Complement
3	0010	Greater Than
4	0011	Selection
5	0100	Logical AND
6	0101	Logical NOT; Threes Complement
7	0110	Logical OR
8	1000	Add, Subject to Carry from Previous Addition
9	1001	Negate, Subject to Carry from Previous Negation

Operation 1
Addition without carry

c = a + b

b: 0123

a	
0	0123
1	1230
2	2301
3	3012

Operation 2
Subtraction or negation without carry = fours complement

c = 4p - a

p = T(a is 1,2,3)

a	p	c
0	0	0
1	1	3
2	1	2
3	1	1

Operation 3
Greater than

p=T(a is greater than b)

b: 0123

a	
0	0000
1	1000
2	1100
3	1110

Operation 4
Selection

c = ap + b(1 - p)

p: 00001111

b: 01230123

a	
0	01230000
1	01231111
2	01232222
3	01233333

Operation 5
Logical "and"

r = T(P and Q)

q: 01

p	
0	00
1	01

Operation 6
Logical "not"

r = T(not P)

p	r
0	1
1	0

Threes complement

c = 3 - a

a	c
0	3
1	2
2	1
3	0

Operation 7
Logical "or"

$r = T(P \text{ or } Q)$

q: 01

p	
0	01
1	11

Operation 8
Addition, subject to carry

$c = a + b + p$

$p = T(\text{previous addition was } 1+3, \text{ or } 2+2, \text{ or } 3+2, \text{ or } 3+3)$

p: 00001111
b: 01230123

a	
0	01231230
1	12302301
2	23013012
3	30120123

Operation 9
Subtraction or negation subject to carry

$c = 3 - a + q(4p - 3)$

$p = T(a \text{ is } 1,2, \text{ or } 3)$

$q = T(\text{previous negation without carry was of } 0)$

q: 01

a	p	
0	0	30
1	1	23
2	1	12
3	1	01

Note: T(...), where ... is a statement, equals 1 if the statement is true and 0 if the statement is false. Regularly, $T(P) = p$, $T(Q) = q$, and $T(R) = r$.

Memorandum 2

August 21, 1951

SIMON -- CODING CHART

ENTRY 1 (at time 2): Select Receiving Register and Hold Input Registers / Select Receiving Register and Clear Input Registers

REGISTER	CODE	KEY	LIGHTS	REGISTER	CODE	KEY	LIGHTS
Storage 1	00010	2		Storage 1	10010	18	
Storage 2	00011	3		Storage 2	10011	19	
Storage 3	00100	4		Storage 3	10100	20	
Storage 4	00101	5		Storage 4	10101	21	
Storage 5	00110	6		Storage 5	10110	22	
Storage 6	00111	7		Storage 6	10111	23	
Computer 1	01000	8		Computer 1	11000	24	
Computer 2	01001	9		Computer 2	11001	25	
Computer 3	01010	10		Computer 3	11010	26	
Computer 4	01011	11		Computer 4	11011	27	
Output 1	01101	13	16	Output 1	11101	29	16
Output 2	01110	14	8, 4	Output 2	11110	30	8, 4
Output 3	01111	15	2, 1	Output 3	11111	31	2, 1

(Note: In order for the tape to synchronize automatically, there must be no hole 5 in the first row on the tape. Consequently, a signal to clear input must not be given in the first row on the tape.)

ENTRY 2 (at time 5): Number or Operation to be received by Input Registers 1 and 2

NUMBER	OPERATION	CODE	KEY
0	Add, with no previous carry	00000	0
1	Negate, with no previous carry	00001	1
2	Greater Than	00010	2
3	Selection	00011	3
4	Logical AND	00100	4
5	Logical NOT; 3's Complement	00101	5
6	Logical OR	00110	6
7		00111	7
8	Add, with previous carry	01000	8
9	Negate, with previous carry	01001	9
10		01010	10
11		01011	11
12		01100	12
13		01101	13
14		01110	14
15		01111	15
-	Stop for manual inserts	10000	16

(Note: Input Register 1 receives from holes 1 and 2; IR2 receives from holes 3 and 4; an operation read into IR1 and 2 can be transferred as a four binary digit number into Computer Register 4. All other transfers are two binary digit numbers.)

NTRY 3 (at time 8): Sending Register Selected, no machine stop; Sending Register Selected; Machine Stop!

REGISTER	CODE	KEY	REGISTER	CODE	KEY
Input 1	00000	0	Input 1	10000	16
Input 2	00001	1	Input 2	10001	17
Storage 1	00010	2	Storage 1	10010	18
Storage 2	00011	3	Storage 2	10011	19
Storage 3	00100	4	Storage 3	10100	20
Storage 4	00101	5	Storage 4	10101	21
Storage 5	00110	6	Storage 5	10110	22
Storage 6	00111	7	Storage 6	10111	23
Computer 1	01000	8	Computer 1	11000	24
Computer 2	01001	9	Computer 2	11001	25
Computer 3	01010	10	Computer 3	11010	26
Computer 4	01011	11	Computer 4	11011	27
Computer 5	01100	12	Computer 5	11100	28
Output 1	01101	13	Output 1	11101	29
Output 2	01110	14	Output 2	11110	30
Output 3	01111	15	Output 3	11111	31

(Note: Each entry corresponds to one row of holes on tape. Each machine cycle of 10 times contains three entries.)

SIMON — PROBLEM 7 AND TAPE 7

The following problem was the first problem composed for demonstrating Simon. This was before additional circuits were added enabling Simon to handle larger numbers than 3.

Problem 7: Add 2 and 1. Find the negative of 3. If the first result is greater than the second, select 2; if the first result is not greater than the second, select 3.
Solution: $2+1=3$. $-3 \pmod 4 \equiv 1$. $p \equiv T(3>1)=1$. $2p+3(1-p)=2(1)+3(0)=2$.

The sequence of steps for solving the problem, showing the intermediate results, and coding, follows: FIRST: Take 2. Take 1. Add. Store the result. Shine it in lights and stop. SECOND: Take 3. Find the negative (modulo 4). Store the result. Shine it in lights and stop. THIRD: Take the 1st result. Take the 2nd result. Find if the first result is greater than the second. Shine this result in lights and stop. FOURTH: Take 2. Take 3. Take the last result (i.e., yes, 1). Select 2 if that result is yes, select 3, if that result is no. Store the result. Shine it in lights, and stop.

Cycle 1	01000	INTO C1	11	11001	C2
	00010	Two (Number)		00000	Blank
	00000	OUT OF Input 1		00011	S2
Cycle 2	11001	INTO C2	12	11011	C4
	00001	One		00010	Greater Than
	00000	OUT OF Input 1		00000	Input 1
Cycle 3	11011	INTO C4	13	10100	S3
	00000	Addition		00000	Blank
	00000	OUT OF Input 1		01100	C5
Cycle 4	10010	INTO S1	14	11111	O3
	00000	Blank		00000	Blank
	01100	OUT OF C5		10100	S3, & Program Stop
5	11111	Output 3	15	11000	C1
	00000	Blank		00010	Two
	10010	S1, & Program Stop		00000	Input 1
6	11000	C1	16	11001	C2
	00011	Three		00011	Three
	00000	Input 1		00000	Input 1
7	11011	C4	17	11010	C3
	00001	Negation		00000	Blank
	00000	Input 1		00100	S3
8	10011	S2	18	11011	C4
	00000	Blank		00011	Selection
	01100	C5		00000	Input 1
9	11111	O3	19	10110	S5
	00000	Blank		00000	Blank
	10011	S2, & Program Stop		01100	C5
10	11000	C1	20	11111	O3
	00000	Blank		00000	Blank
	00010	S1		10110	S5, & Program Stop

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Memorandum 4

August 21, 1951

SIMON -- TAPE 12, ADDITION

Following is the key punching for Bob Jensen's tape 12, which takes in two numbers A and B from 0 to 15, manually inserted at the first two stops, and reports in lights at the end, the total from 0 to 30.

Cycle	Keys			Meaning
1	7	0	0	Synch.
2	31	0	0	I1*-- C5 (Clear input and check)
3	24	16	0	(Man.) I1 -- C1
4	2	0	1	I2 -- S1
5	25	16	0	(Man.) I1 -- C2
6	3	0	1	I2 -- S2
7	27	0	0	(Adn., no carry) I1 -- C4
8	20	0	12	C5 -- S3
9	24	0	2	S1 -- C1
10	25	0	3	S2 -- C2
11	27	8	0	(Adn., with carry) I1 & 2 -- C4
12	21	0	12	C5 -- S4
13	24	0	0	I1 -- C1
14	25	0	0	I1 -- C2
15	27	8	0	(Adn., with carry) I1 & 2 -- C4
16	29	0	12	C5 -- O1
17	30	0	5	S4 -- O2
18	31	0	20	S3 -- O3 (Program stop)

* This is an abbreviation for Input 1 Register.

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Memorandum 5

August 21, 1951

SIMON -- TAPE 14, LESS-EQUAL-GREATER

Following is the key punching for Bob Jensen's tape 14, which takes in two numbers A and B from 0 to 15, manually inserted at the first two stops, and reports in lights at the end, "Less", "Equal", or "Greater".

Cycle	Keys			Meaning	Cycle	Keys			Meaning
1	12	0	0	Synch.	26	27	3	0	(Sel.) -- C4
2	24	16	1	(Man.) I2 -- C1	27	20	0	12	C5 -- S3
3	2	0	0	I1*-- S1	28	24	0	5	S4 -- C1
4	22	16	1	(Man.) I2 -- S5	29	25	0	3	S2 -- C2
5	3	0	0	I1 -- S2	30	27	3	0	(Sel.) -- C4
6	25	0	6	S5 -- C2	31	21	0	12	C5 -- S4
7	27	2	0	(Gr.) -- C4	32	24	0	10	C3 -- C1
8	20	0	12	C5 -- S3	33	25	0	2	S1 -- C2
9	25	0	8	C1 -- C2	34	27	0	0	(Add) -- C4
10	24	0	6	S5 -- C1	35	24	0	12	C5 -- C1
11	27	2	0	(Gr.) -- C4	36	25	0	3	S2 -- C2
12	21	0	12	C5 -- S4	37	27	0	0	(Add) -- C4
13	24	0	2	S1 -- C1	38	24	0	12	C5 -- C1
14	25	0	3	S2 -- C2	39	25	0	0	(0) -- C2
15	27	2	0	(Gr.) -- C4	40	27	2	0	(Gr.) -- C4
16	18	0	12	C5 -- S1	41	26	0	12	C5 -- C3
17	25	0	8	C1 -- C2	42	24	0	0	(0) -- C1
18	24	0	3	S2 -- C1	43	25	1	0	(1) -- C2
19	27	2	0	(Gr.) -- C4	44	27	3	0	(Sel.) -- C4
20	19	0	12	C5 -- S2	45	30	0	12	C5 -- O2
21	24	0	4	S3 -- C1	46	29	0	5	S4 -- O1
22	25	0	5	S4 -- C2	47	31	0	20	S3 -- O3 Prog. Stop
23	27	0	0	(Add) -- C4					
24	26	0	12	C5 -- C3					
25	25	0	2	S1 -- C2					

* I1 stands for Input 1 Register

Memorandum 6

November 1, 1951

SIMON -- TAPE 18, MULTIPLICATION

Following is the key punching for Bob Jensen's tape 18, which takes in two numbers A and B from 0 to 3, manually inserted at the first two stops, and reports in lights at the end, the total from 0 to 9.

Cycle	Keys			Meaning
1	12	0	0	I1* -- C5
2	18	16	0	I1 -- S1 (Manual Insert A)
3	24	16	0	I1 -- C1 (Manual Insert B)
4	27	2	0	I1 -- C4 (Gr)
5	26	0	12	C5 -- C3
6	25	1	0	I1 -- C2 (1)
7	27	2	0	I1 -- C4 (Gr)
8	19	0	12	C5 -- S2
9	25	2	0	I1 -- C2 (2)
10	27	2	0	I1 -- C4 (Gr)
11	20	0	12	C5 -- S3
12	24	0	2	S1 -- C1
13	25	0	0	I1 -- C2 (0)
14	27	3	0	I1 -- C4 (Sel)
15	21	0	12	C5 -- S4
16	26	0	3	S2 -- C3
17	27	3	0	I1 -- C4 (Sel)
18	22	0	12	C5 -- S5
19	26	0	4	S3 -- C3
20	27	3	0	I1 -- C4 (Sel)
21	24	0	12	C5 -- C1
22	25	0	6	S5 -- C2
23	27	0	0	I1 -- C4 (0)
24	20	0	12	C5 -- S3
25	24	0	0	I1 -- C1 (0)
26	25	0	0	I1 -- C2 (0)
27	27	8	0	I1 & 2 -- C4 (Adn with carry)
28	22	0	12	C5 -- S5'
29	24	0	4	S3' -- C1
30	25	0	5	S4 -- C2
31	27	0	0	I1 -- C4 (Adn, no carry)
32	21	0	12	C5 -- S4'
33	24	0	0	I1 -- C1 (Adn, no carry)
34	25	0	6	S5' -- C2
35	27	8	0	I1 & 2 -- C4 (Adn with carry)
36	30	0	12	C5 -- O2
37	31	0	21	S4' -- O3

* I1 means Input 1 Register

Memorandum 7

SIMON -- DESIGNATION OF RELAYS

Every relay in Simon has two designations; a location and wiring designation, and a functional designation. The location designation is by row (a single letter, CDEFGHJP) and by column, (1 to 19). The functional designation consists of two or more letters, and none, one, or two numbers. The last letter of the functional designation is R, standing for "relay" or "register". The number following further specifies the function of the relay, usually specifying the consecutive number of the register. Finally, in parentheses is the number specifying the position or column of the binary digit regularly stored; for example SR3(2) is the relay for the binary digit in the second place or column of storage register 3.

A summary of the functional designations of relays in Simon is as follows:

Abbreviation	Name of Group	Purpose
ASR	Auxiliary Stepping Relay	Slow down the stepping switch.
BR	Button Register	Temporarily record numbers in instructions from buttons.
CR	Computer Registers	Compute.
ER	Entrance Relays	Allow information to enter registers.
IR	Input Registers	Temporarily record numbers from the tape or the buttons.
OR	Output Registers	Hold answers, to be shone in the output lights.
PR	Program Relays	Record programming information from the tape or from the buttons, and control Simon.
RR	Reset Relays	Reset, release, or clear registers, so that new information may be stored in them.
SPR	Step-Position Output Relay	Allows the position of the stepping switch to be read in the output lights.
SR	Storage Registers	Store information until used.
SYR	Synchronism Relays	Arrange that the tape and the machine cycles shall be automatically in synchronism.

A more detailed list of the relays follows:

(1) Location and Wiring Designation	(2) Description	(3) Functional Designation
C9	Auxiliary stepping relay	ASR
C14	Negation carry relay	CR8
C15	Negation subcarry relay	CR9
C16	Negation carry release relay	RR32
C17 to C19	Spares	--
D12 and D13	Automatic tape synchronization relays	SYR1, SYR2
D14	Extra entrance relay for CR4 register	ER12
D15	Release relay for CR4(8) and CR4(4) relays	RR33
D16	Addition subcarry relay	CR7
D17	Addition subcarry release relay	RR30
D18	Addition carry release relay	RR31
D19	Spare	--
E1 to E5	Program Relay #1 (First binary digit on tape)	PR1
E6 to E9	Program Relay #2 (Second binary digit on tape)	PR2
E10	Tape Synchronization Alarm Relay	
E11 to E19	Entrance Relays	ER3 to 11
F1 to F4	Program Relay #3 (Third binary digit on tape)	PR3
F5	Prevents back circuits in CR5, closes at Time 8 only	RR13
F6 to F10	Program Relay #4 (Fourth binary digit on tape)	PR4
F11 to F19	Release Relays	RR3 to 11
G1 to G2	Input Register 1	IR1
G3 to G4	Input Register 2	IR2
G5 and G6	Storage Register 1	SR1
G7 and G8	Storage Register 2	SR2
G9	Program Relay #5 (Fifth binary digit on tape)	PR5
G10	Input Registers' Release Relay	RR1
G11 to G14	Entrance Relays	ER12 to 16
G15 to G19	Button Input Relays	BR
H1 and H2	Storage Register 3	SR3
H3 and H4	Storage Register 4	SR4
H5 and H6	Storage Register 5	SR5
H7 and H8	Storage Register 6	SR6
H9 and H10	Select-Output-Lights-or-Time-Lights Relays; Operates from TS5	SPR
H11 to H14	Release Relays #12 to #16	RR12, 14 to 16
H15 to H19	Prevent back circuits in release relay circuits	RR17
N1 and N2	Computer Register 5 (Computed answers appear here)	CR5
N3 and N4	Output Register #1 (Output light only on 1st binary digit)	OR1
N5 and N6	Output Register #2	OR2
N7 and N8	Output Register #3	OR3
N9 to N15	Computer Register 1	CR1
N16 to N19	Computer Register 2 (First binary digit)	CR2
P1 and P2	Add carry relay	CR6
P3 and P4	Operation register (Fourth binary digit)	CR4(8)
P5 to P8	Operation register (Third binary digit)	CR4(4)

P9 to P11	Computer Register 2 (Second binary digit)	CR2
P12 to P14	Computer Register 3	CR3
P15 to P19	Computer Register 4 (Operations put in this register)	CR4

Notes: (1) In the wiring diagram: 1, 2, and 3 refer to contacts of the relay; T, O, C mean transfer point, normally open point, normally closed point; PU or P or U refer to the pickup coil leads. (2) For further information, see Drawing 16.

Memorandum 8

SIMON -- COMMENTS AND NOTES

1. Fewer relays may be needed if relays with more contacts than two transfers and one make are currently available.

2. If input by tape is not desired, the Tape Transmitter and associated circuits including tape synchronization may be omitted. The Tape Transmitter (Western Union Type 7C) may be available on the surplus market; if not it may be purchased from Western Union in New York City for about $55.

3. The timing pulses are derived from a stepping switch. Other means are available such as a motor-driven rotary switch. Stepping switches may be available on the surplus market for about $15. Bridging contacts are needed and the coil voltage rating should be the same as the small relays.

4. If the relays are bought on the surplus market, the usual available voltage rating is 24 volts DC. If the relays are bought directly from a manufacturer, other voltage ratings are available if desired. Of course DC relays require a source of DC current of fair size; a selenium bridge rectifier seems to be the most practical.

5. Small pilot lights may be soldered across the coils of the important relays to indicate when they are energised.

6. The relays are arranged in 6 rows of 19 relays each, and two more rows. The rows are lettered C, D, E, F, G, H, N, and P. Many other arrangements may be made to suit different space limitations, etc.

7. Drawings 20 to 25 represent the actual relay contact wiring prior to September 1950. These drawings will not be too useful if relays with other contact configurations are used.

8. The rear terminal plug board J1 to J25 and K1 to K25 and all of rows L and M may be omitted if desired. They are only partially used at present, and were built in for possible future expansion of Simon. If omitted, merely connect all J terminals directly to their corresponding numbered K terminal, i.e., connect J1 to K1, J2 to K2, etc., wherever a J number appears on the circuits. (Drawings 2, 4, and 5 for example.)

9. The rectifiers (Q numbers) used are two-plate 100-milliampere selenium rectifiers. However these are a bit bulky. Experiments with germanium diodes in certain circuits show that a 1N34 for example will be satisfactory if it is used only to pick up a relay and not used to hold it up. However any crystal diode will be seriously over-loaded, and their general use is not recommended in a 24 volt DC system.

10. The circuits allow Simon to operate with the scale-of-four (or tetral) numbers 0, 1, 2, and 3, using their binary equivalents 00, 01, 10, and 11.

11. The fifth hole punched in the tape at Entry 3 (or Time 8) will stop the action of the machine (programmed stop). Push "Step Jog" to start machine again.

12. The input registers IR-1 and IR-2 are so arranged that a four binary digit number can be directly read into both registers at one time from the second entry of the tape (or push buttons). The input registers will hold those numbers until erased so that each group of two binary digits may be operated on in sequence.

13. The fifth hole punched in the tape at entry 2 will reset the input registers, but this hole must not be punched at the start of a tape, or the tape synchronism relays will not operate properly.

14. The fifth hole punched in the tape at entry 5 will stop the tape, turn on the red alarm light, and allow a number to be inserted from the buttons into the button relays.

15. An attempt has been made in the accompanying set of drawings (especially drawings 26 to 33) to give all the essential information for the five new operations added between July, 1950 and September, 1950. Wiring diagrams were not made for these five new operations.

16. Simon uses five-hole paper tape, of the kind that Western Union uses in their telegraph and teletype machines. It uses a tape feed bought from Western Union, 60 Hudson St. New York, for $50. At first, the blank tape was punched by hand, using a hand- made punch and jig. This was very slow. Later, a second-hand typewriter-style tape punch was bought from Western Union for $139. The names of the keys were changed from letters to numbers. The numbers were 0 to 31, corresponding with the pattern of holes in binary. Thus, key 18 produces the pattern 10010, i.e., hole, no hole, no hole, hole, no hole.

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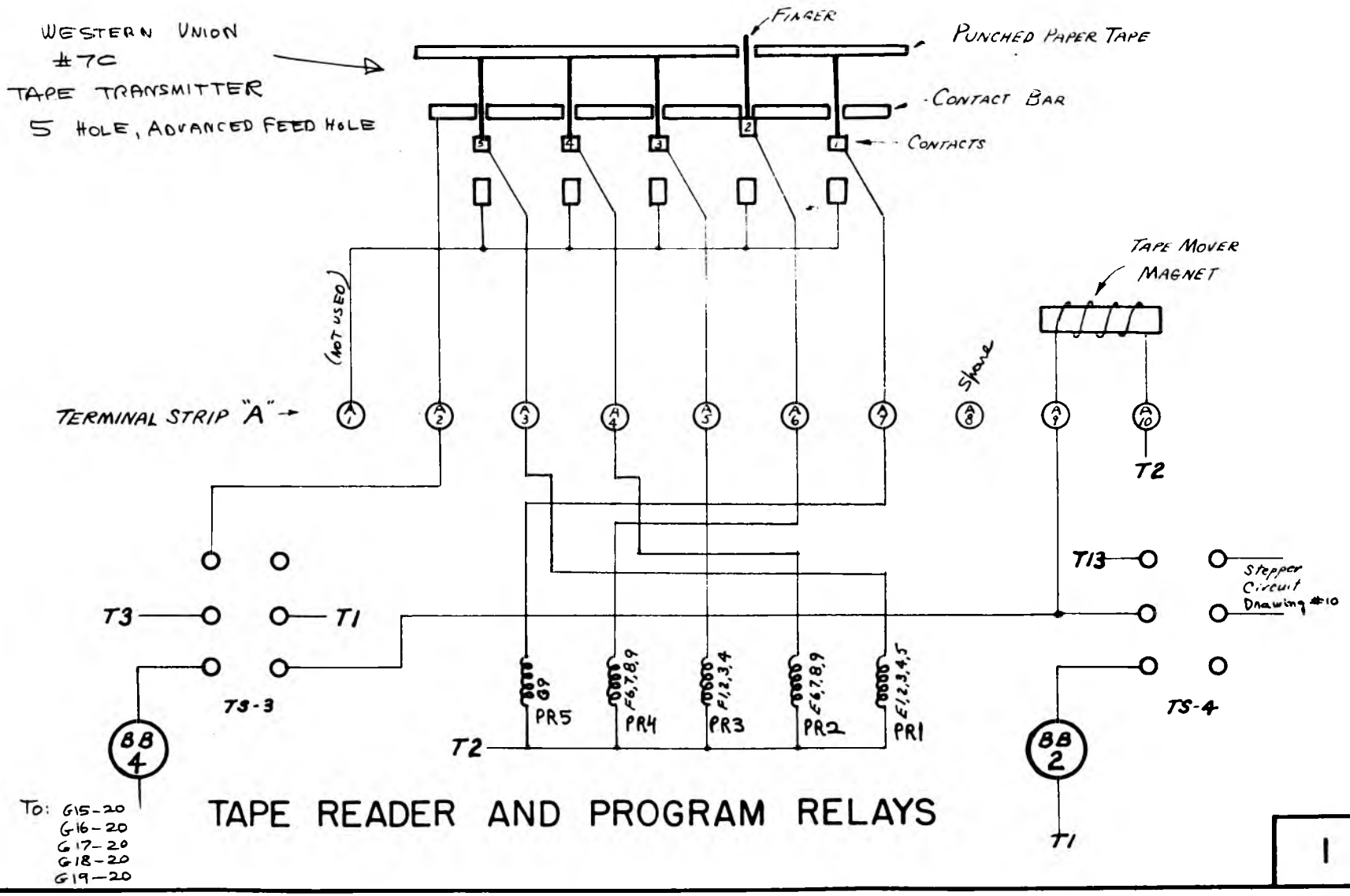
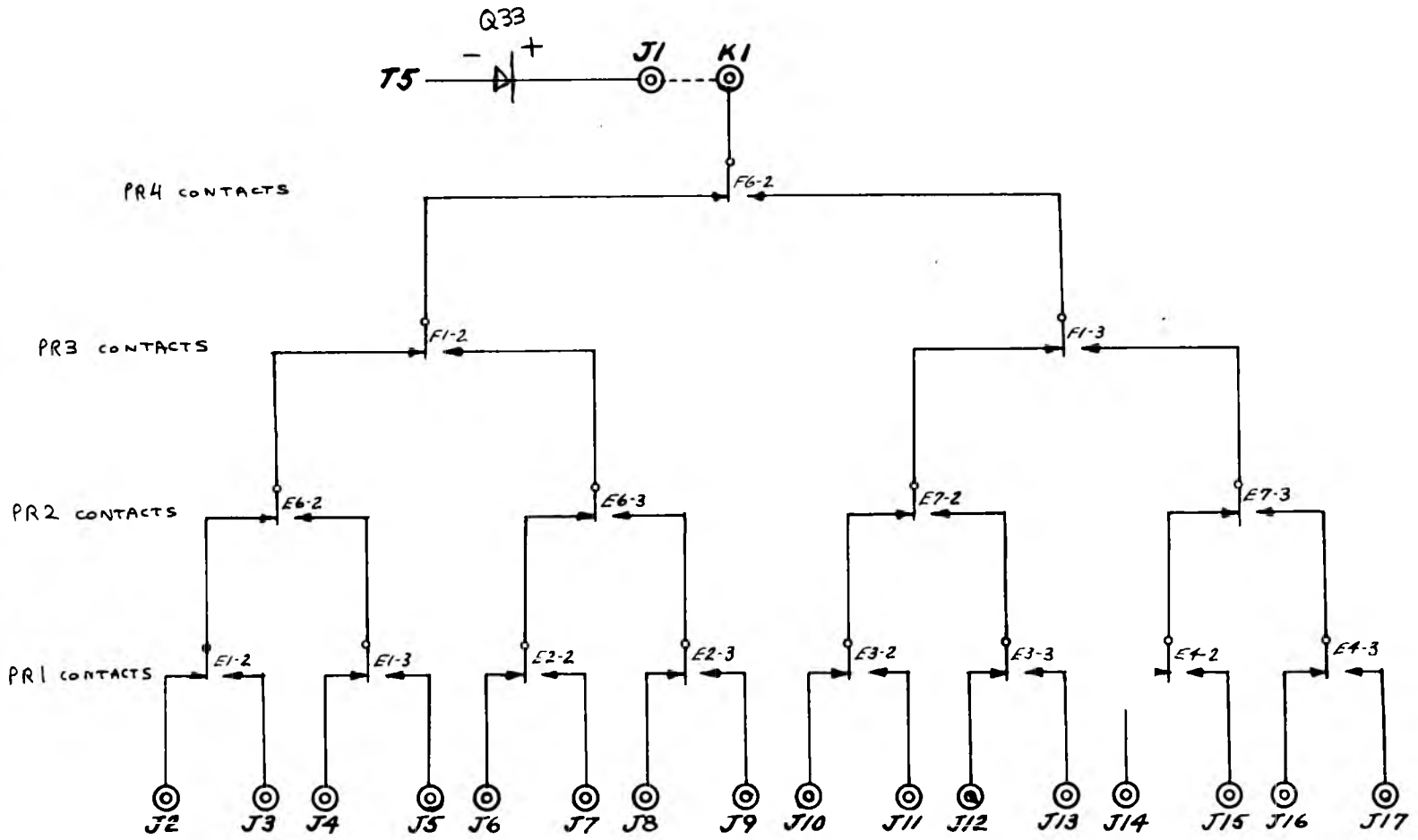
Memorandum 9

PARTS LIST FOR SIMON AS OF JUNE, 1950

7 Double Pole Double Throw Switches
8 Push Buttons - push to make
1 Push Button - push to break
5 Pilot Light Assemblies - white
2 Pilot Light Assemblies - red
2 Fuse Holders - 5 and 15 amps.
2 Polarized 2 contact plug - female, recessed male
1 2 Contact plug set - female, recessed male
1 Standard Line male plug
1 DC Voltmeter: 0 - 100 volts
1 Transformer - 36 volts, 10 amps
16 Selenium Rectifier Disks - 25 volts, 4 amps (Assembled - 50 volt, 8 amp rating)
32 Selenium Rectifier Stacks - 2 25 volt, 100 ma plates per stack
8 10 place Terminal Strip (solder lugs)
3 5 place Terminal Strip (solder lugs)
1 Jack Strip on back panel - 100 jacks
1 Western Union Tape Transmitter, # 7C
1 Clare Stepping relay -- 22 step, 6 deck, bridging wipers, 24 volt coil
131 Relays - 24 volts, 300 ohms, Double Pole Double throw plus single pole normally open.
131 $\frac{1}{2}$" Rubber grommets
262 Mounting screws for relays
1 Steel Chassis - 14"x23"x1$\frac{1}{2}$"
2 Composition Panels - 23"x14$\frac{1}{2}$"x$\frac{1}{4}$"
1 Aluminum Base Panel - 14"x23"
2 Aluminum End Panels - 14"x4"
1 Steel Cabinet & Chassis - 10"x5"x3", with base plate
3 Handles
8 Rubber feet
1 1000 ohm, 20 Watt Resistor
9 200 ohm, $\frac{1}{2}$ Watt Resistors
1 4 µf, 50 volt Electrolytic Capacitor
1 1 µf, 100 volt Paper Capacitor
9 .05 µf, 100 volt Paper Capacitor
24 Plug-in leads - 6" to 12" long
Wire - approx. 400 ft of standard hookup wire
Soldered connections - approximately 1000



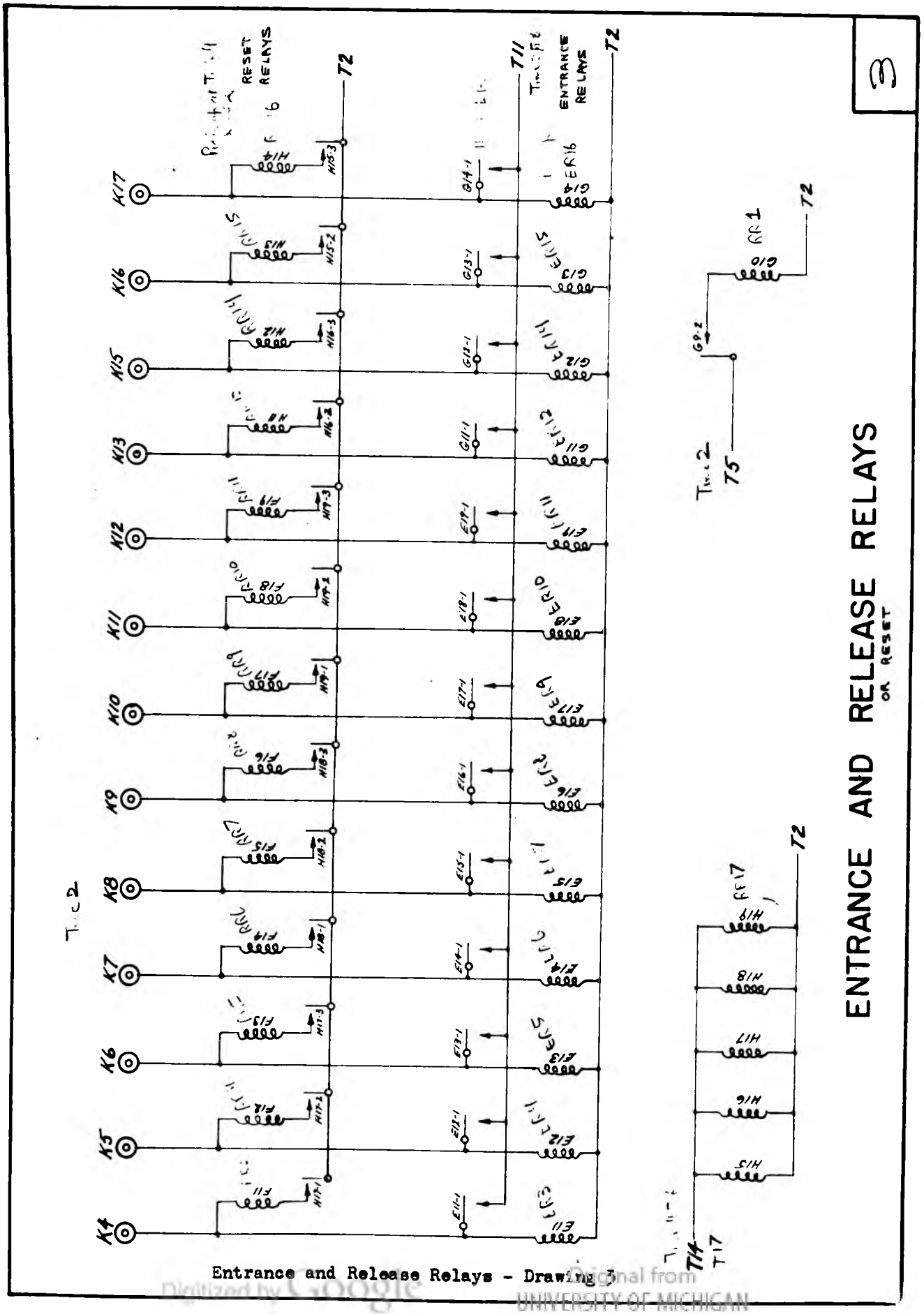
Tape Reader and Program Relays - Drawing 1



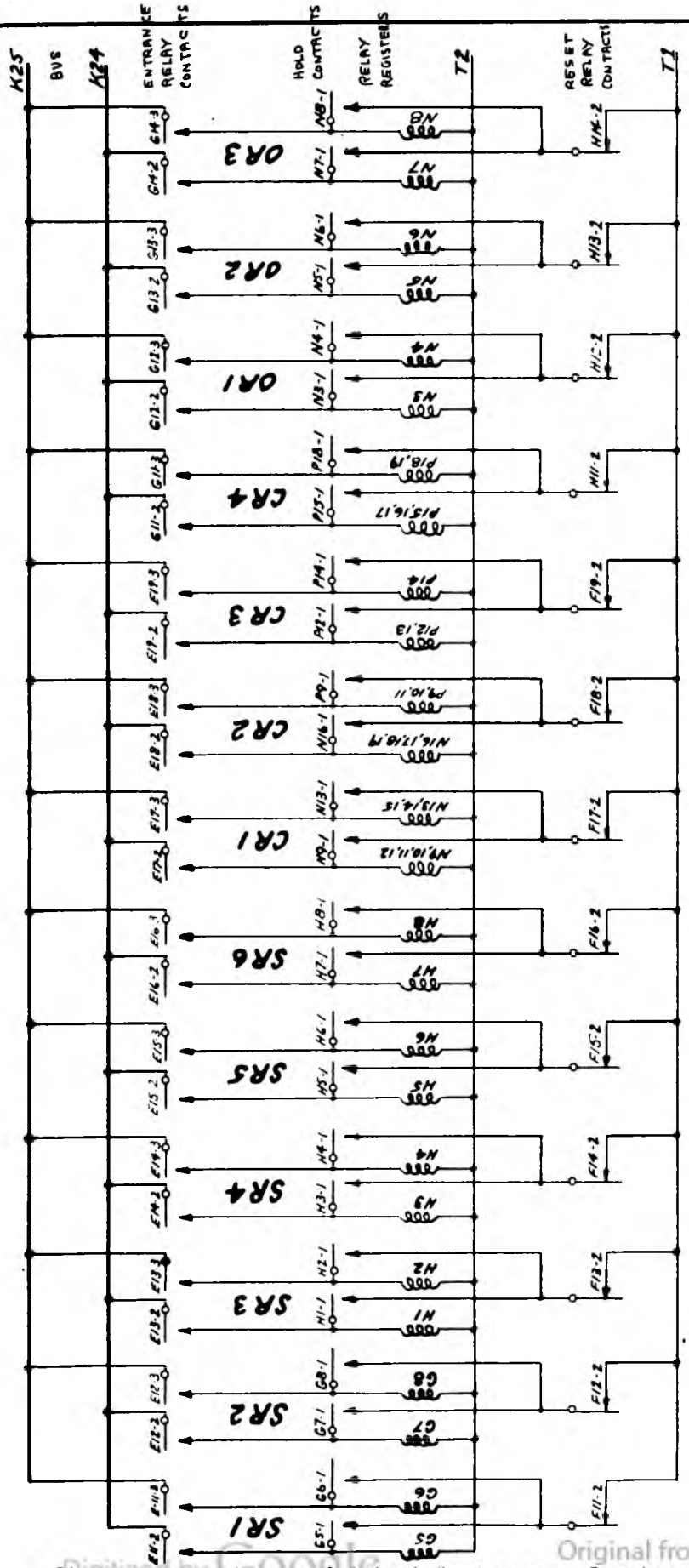
SELECT READ-INTO-REGISTER CIRCUITS

2

Select Read Into Register Circuits - Drawing 2



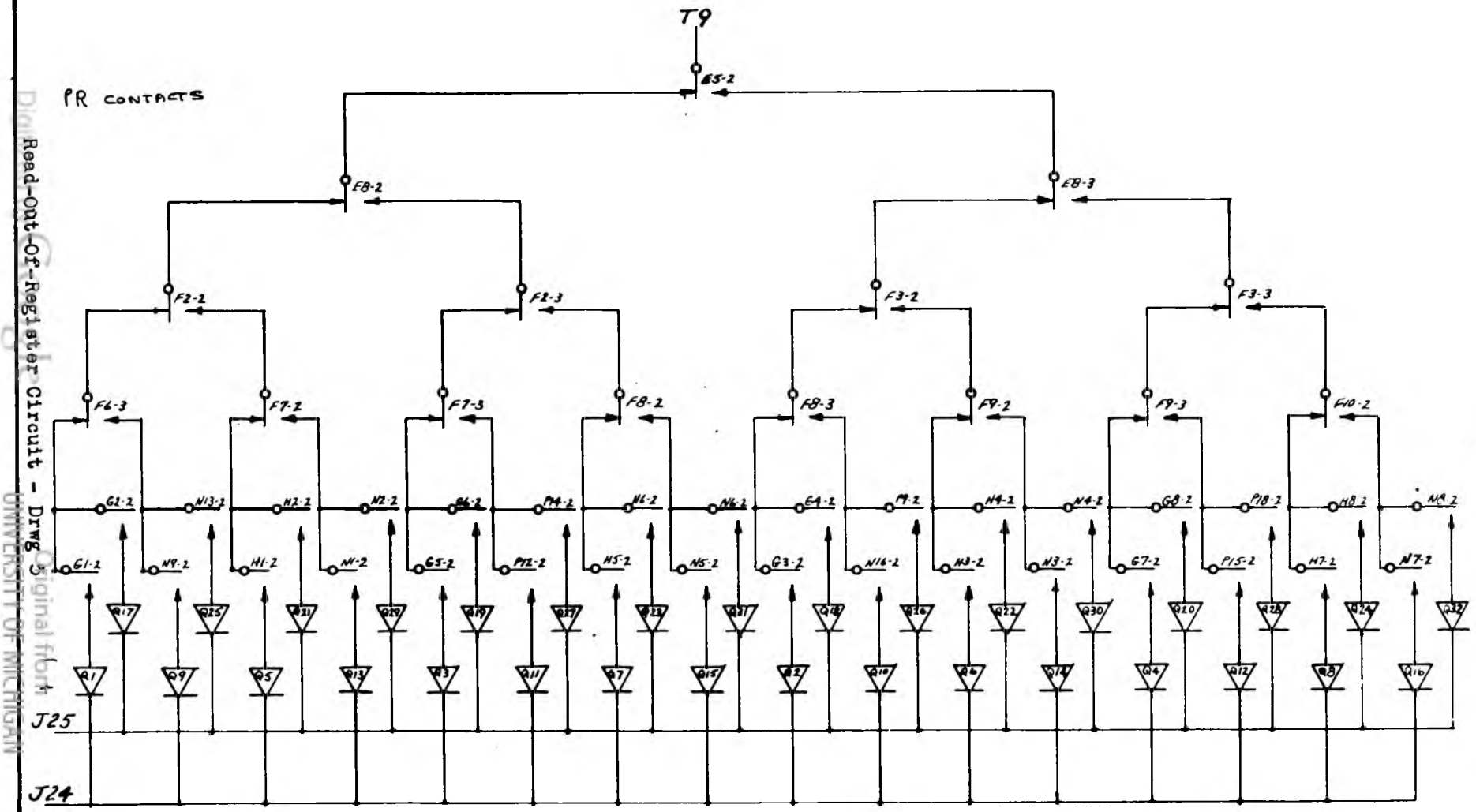
Entrance and Release Relays - Drawing 3



STORAGE, COMPUTER, AND OUTPUT REGISTERS

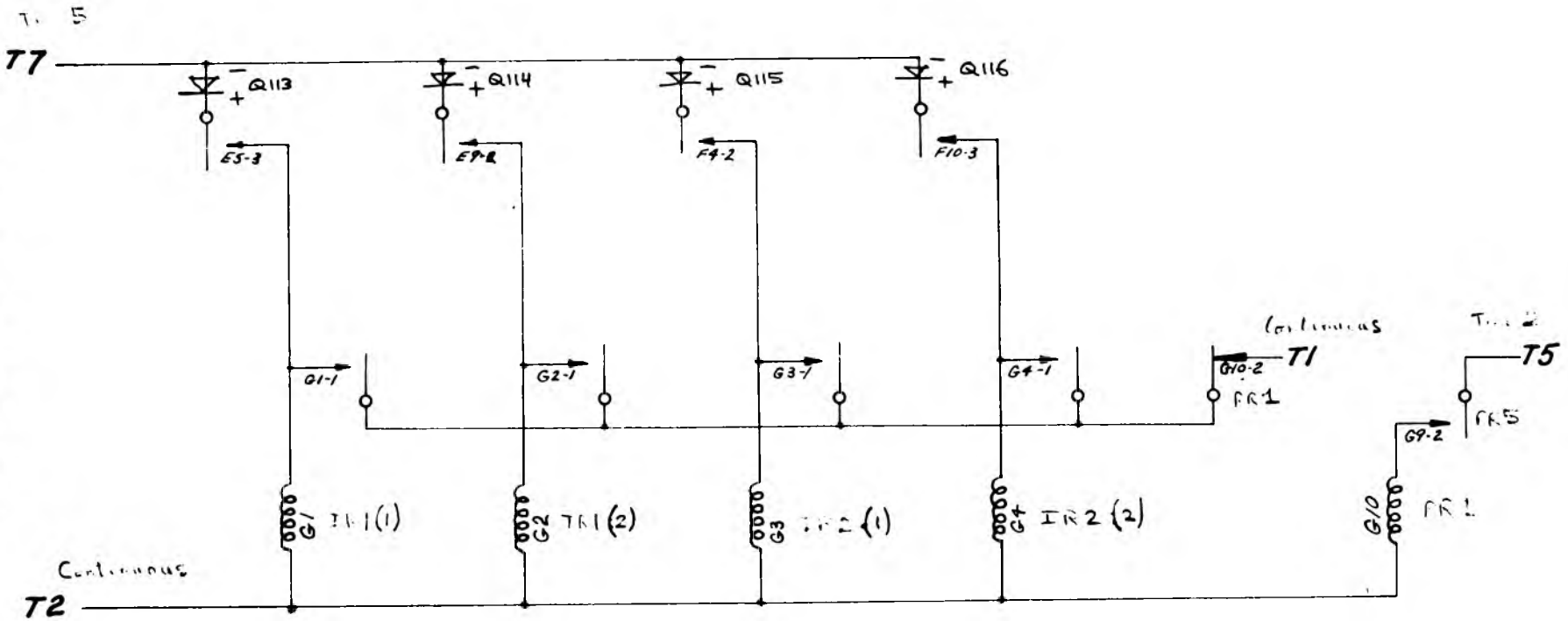
4

Storage, Computer, and Output Registers - Drawing 4



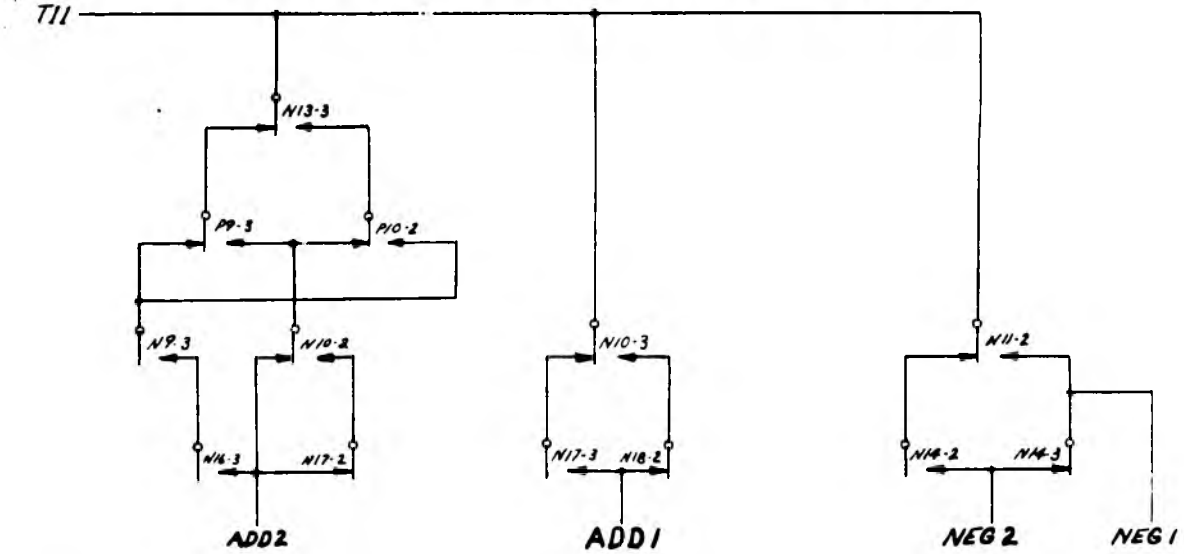
READ-OUT-OF-REGISTER CIRCUIT

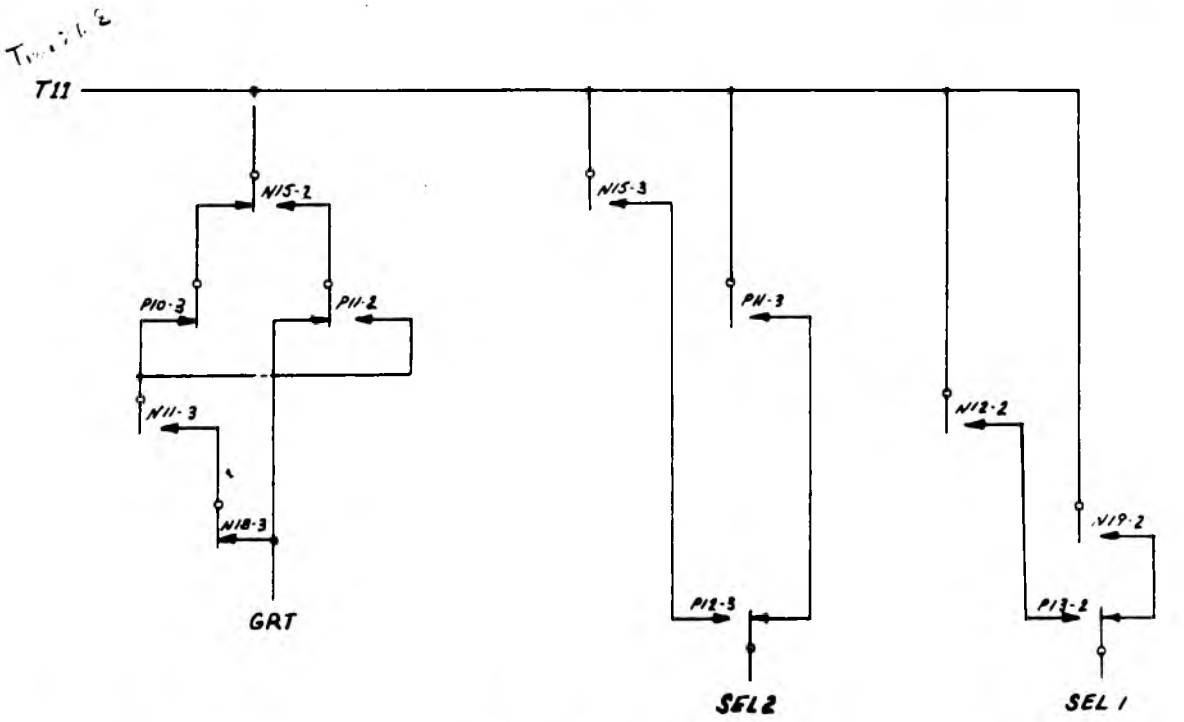
Input Registers - Drawing 6

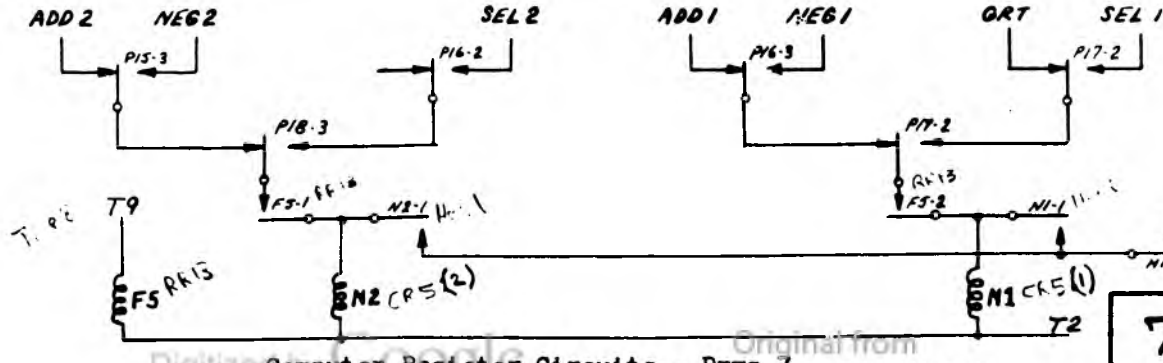


INPUT REGISTERS

COMPUTER REGISTER CIRCUITS



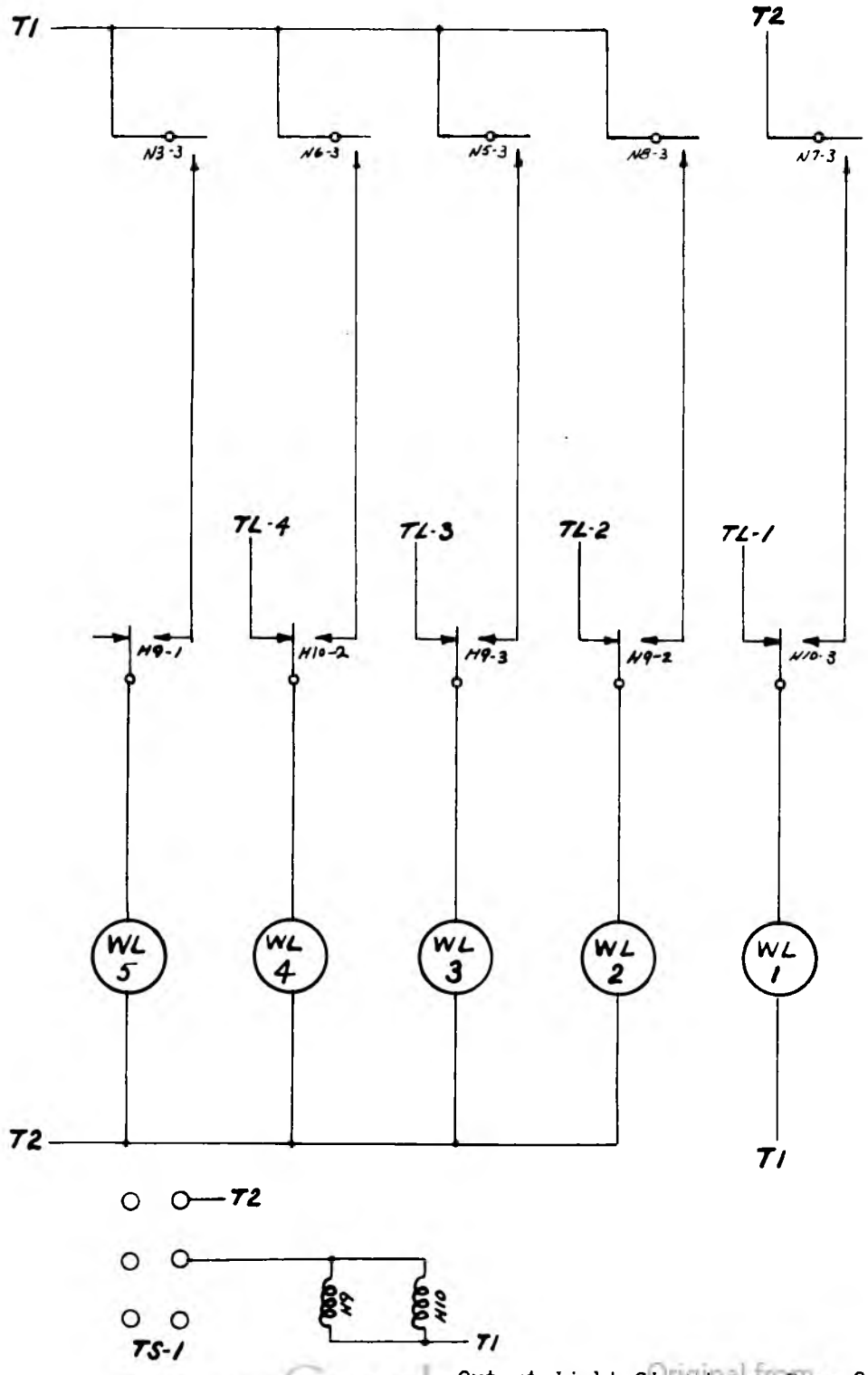




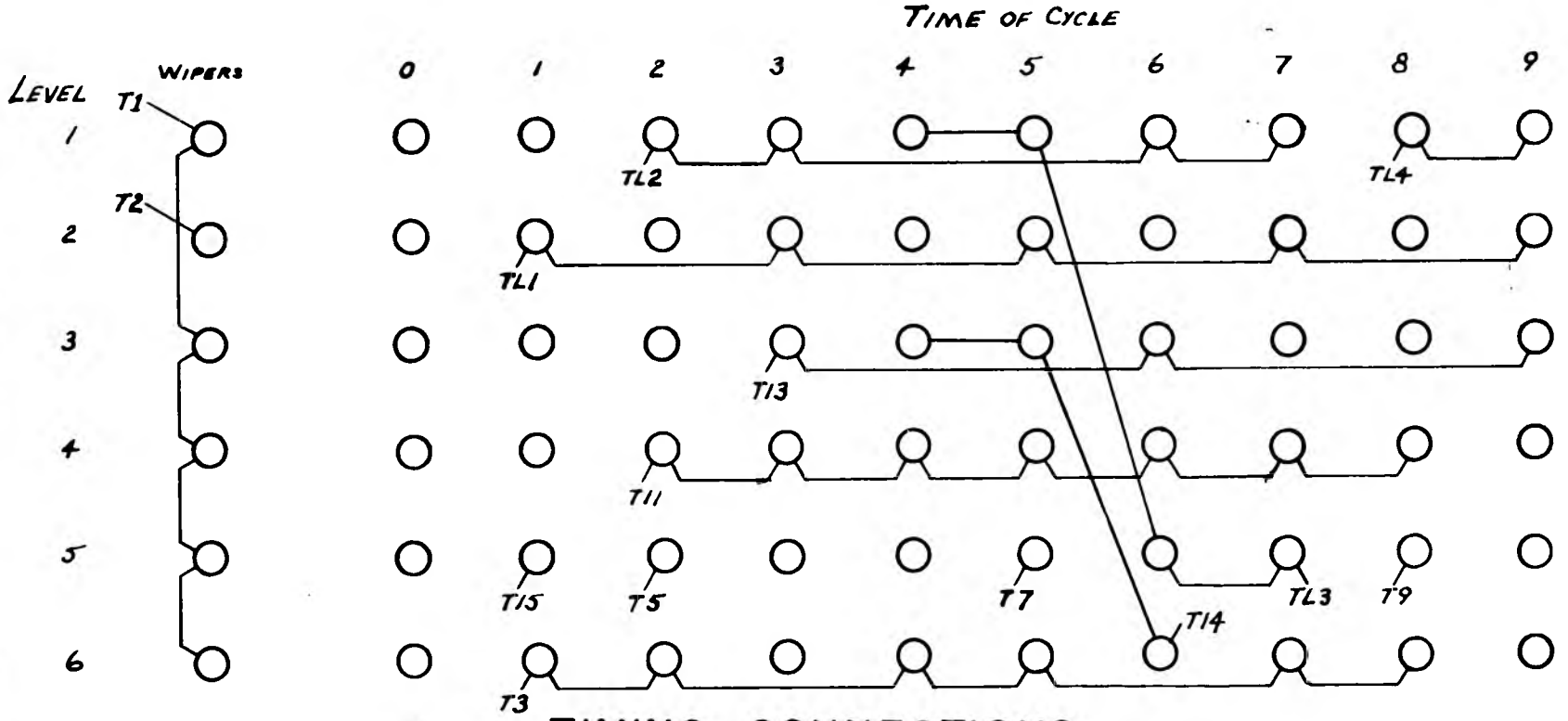
Computer Register Circuits - Drwg 7

7

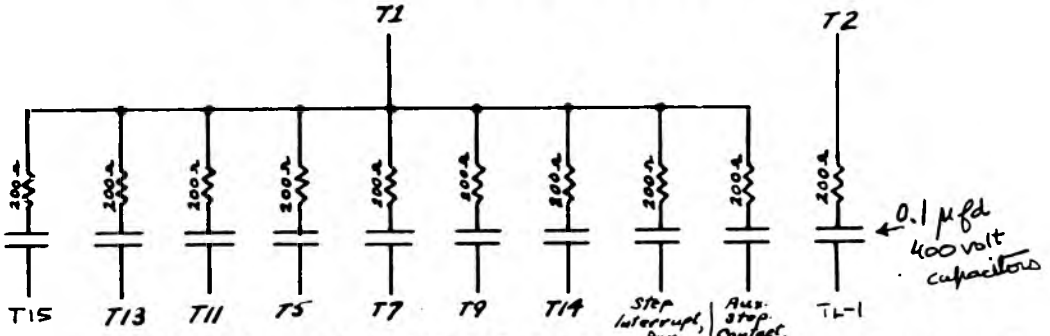
OUTPUT LIGHT CIRCUITS



Output Light Circuits - Drwg 8



TIMING CONNECTIONS

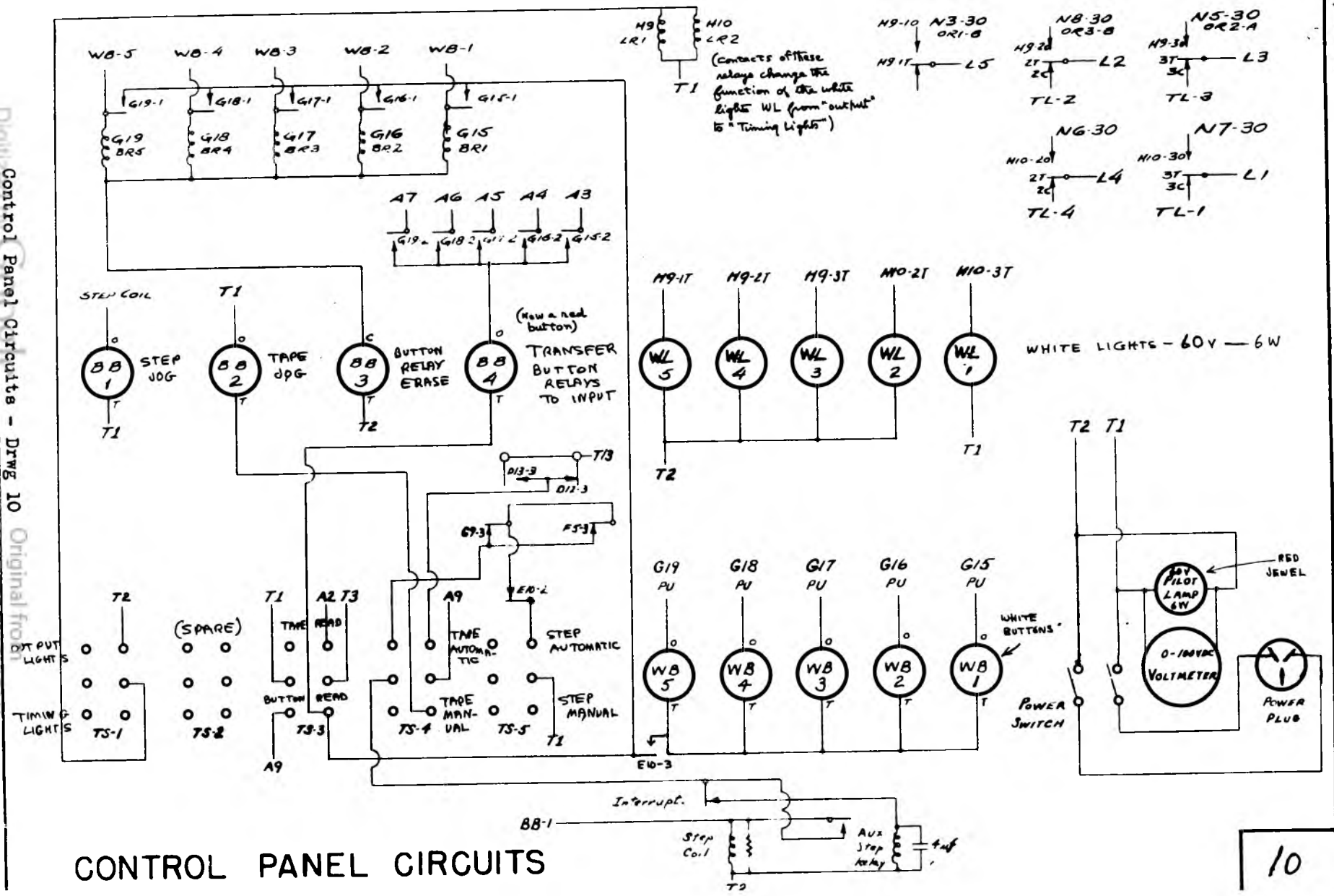


SPARK SUPPRESSORS

Coil (side not connected to T2)

Timing Connections and Spark Suppressors - Drwg 9

9



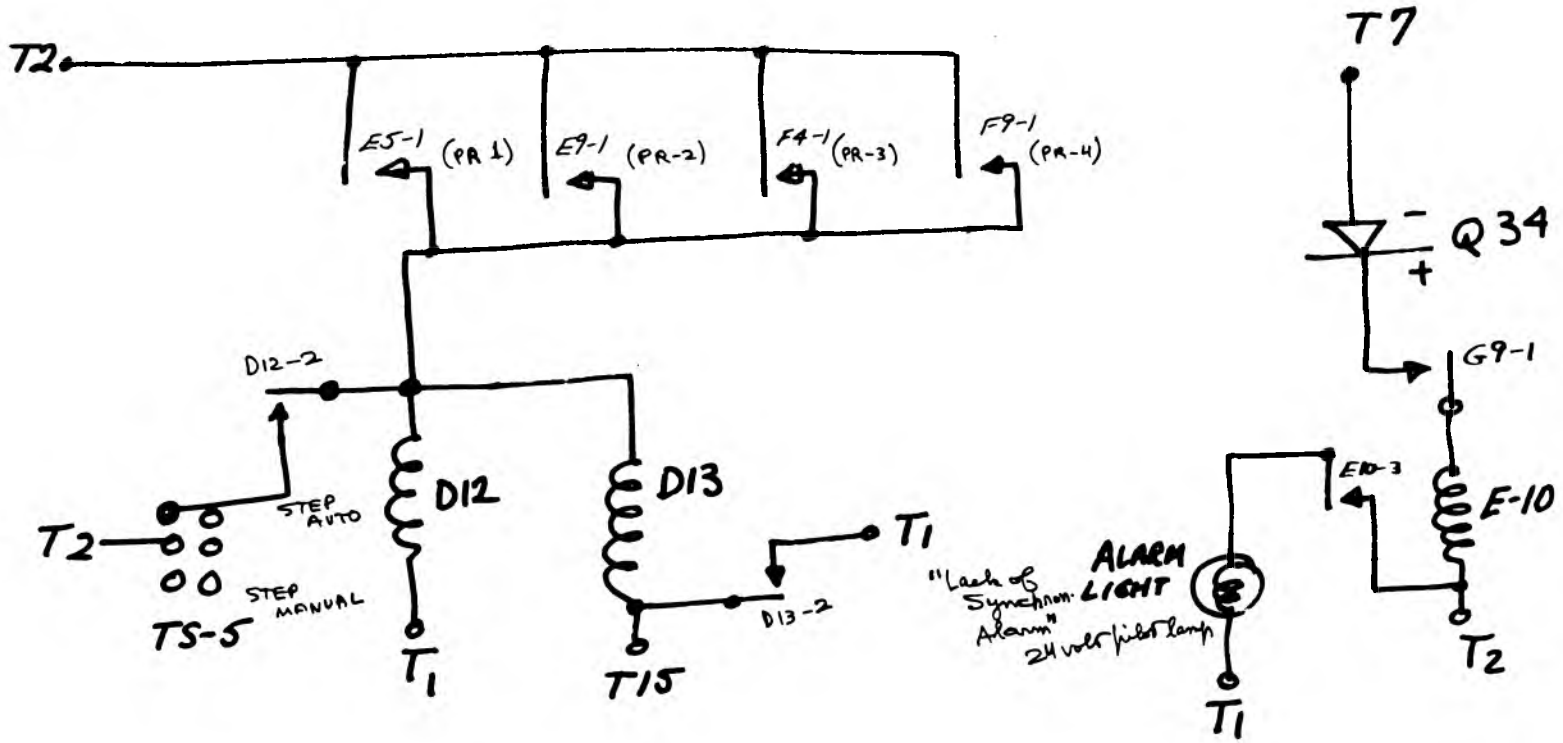
CONTROL PANEL CIRCUITS

Control Panel Circuits - Drwg 10

10

AUTOMATIC TAPE SYNCHRONIZATION CIRCUIT AND LACK OF SYNCHRONIZATION ALARM CIRCUIT

JUL 1950

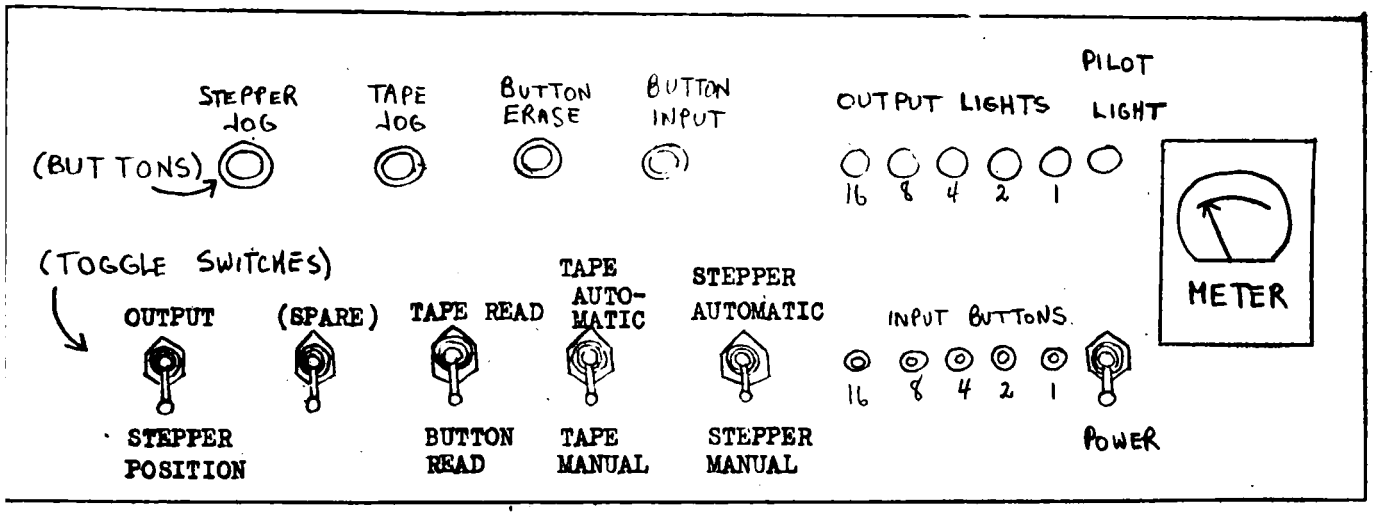


(Other contacts of this circuit appear on Drawing # 10 "CONTROL PANEL CIRCUITS")

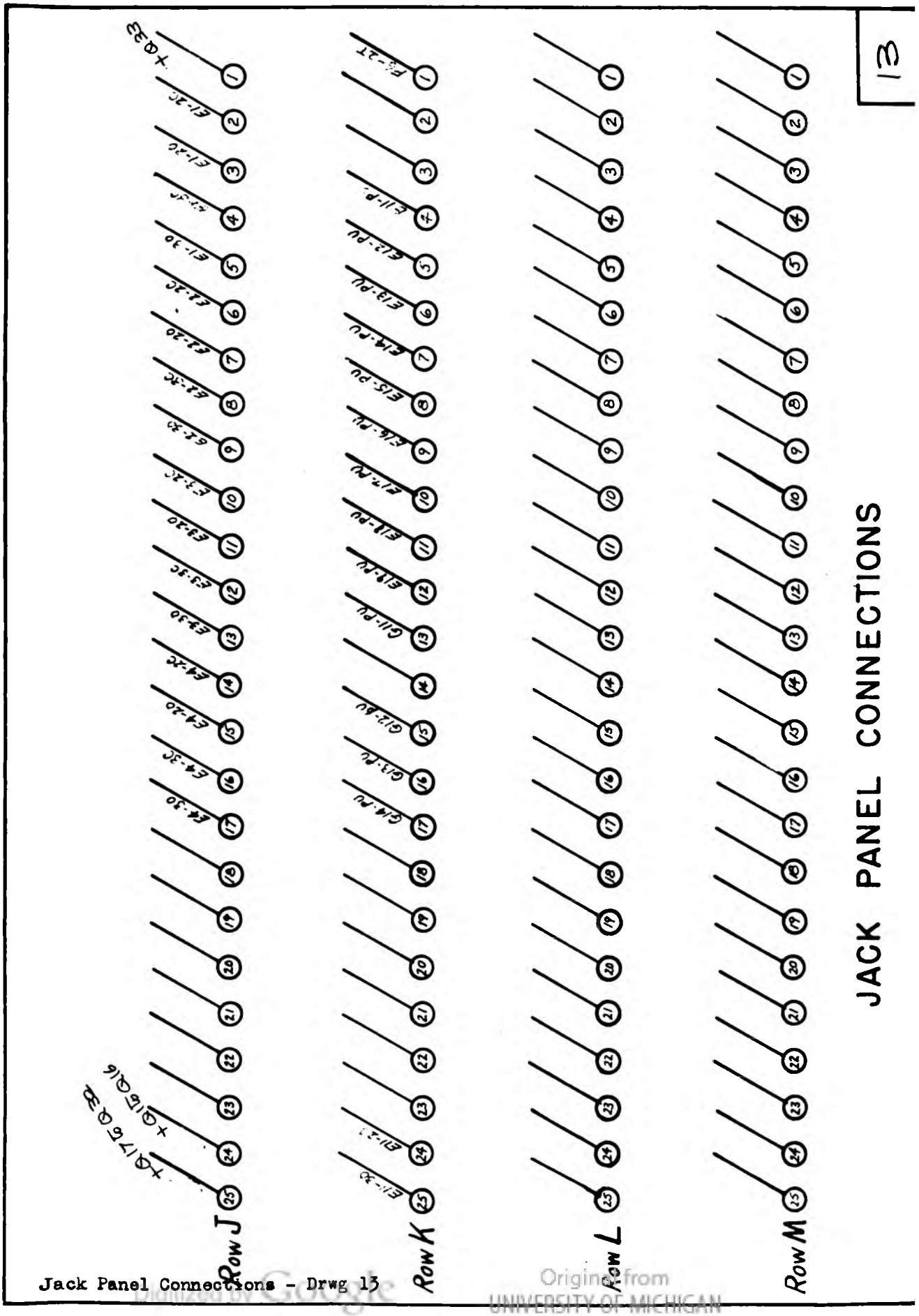
Note (Instead of adding Relays D12 and D13 can use spares P1 and P2 for example.

SYNCHRONIZES TAPE WITH STEPPING RELAY AS FIRST ROW OF HOLES IS READ. ALARM LIGHTS IF FIFTH HOLE IS PUNCHED IN ENTRY TWO., OR IF TAPE SLIPS.

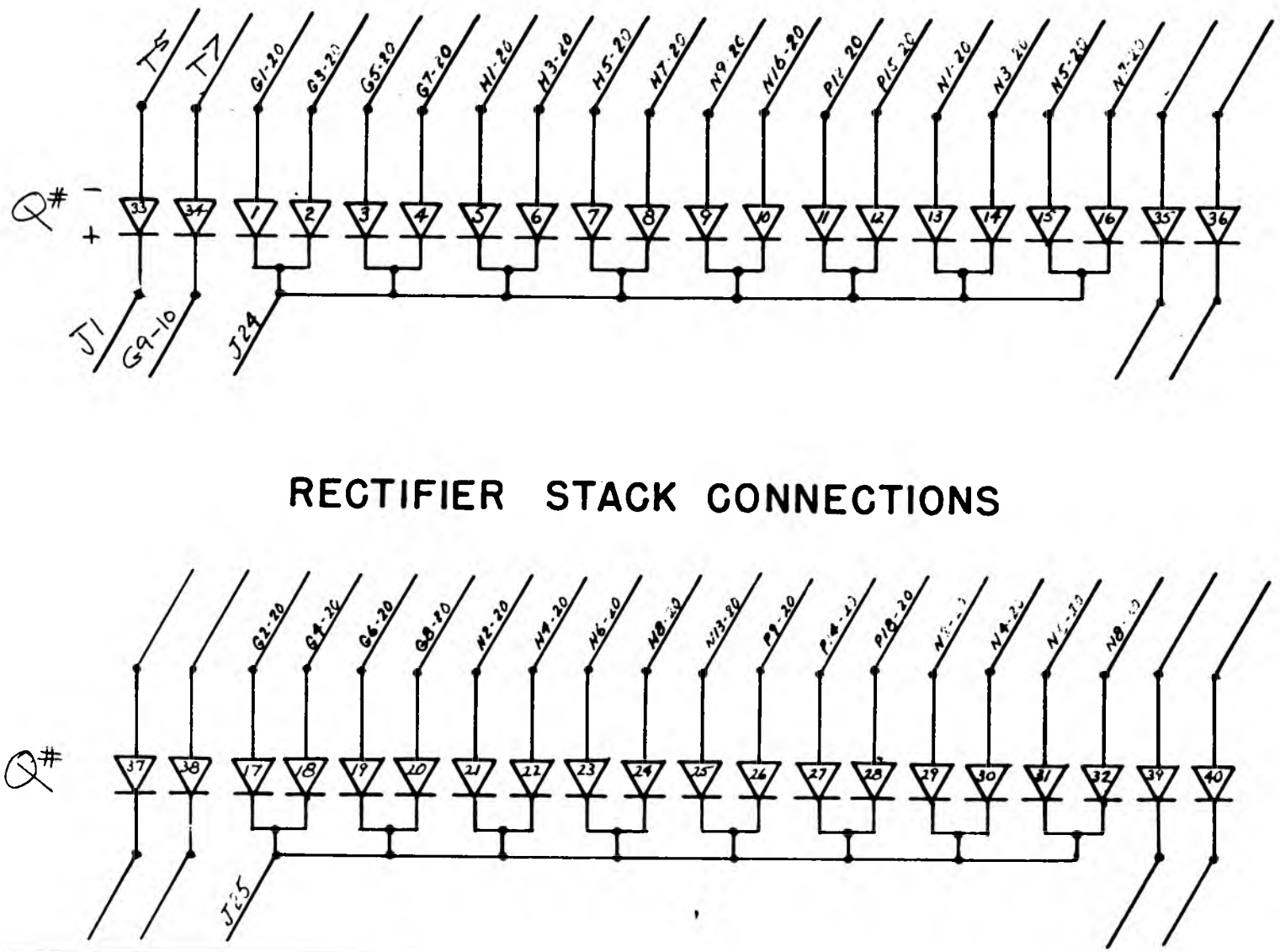
11



Layout of the Front Panel or Control Panel -- Drawing 12

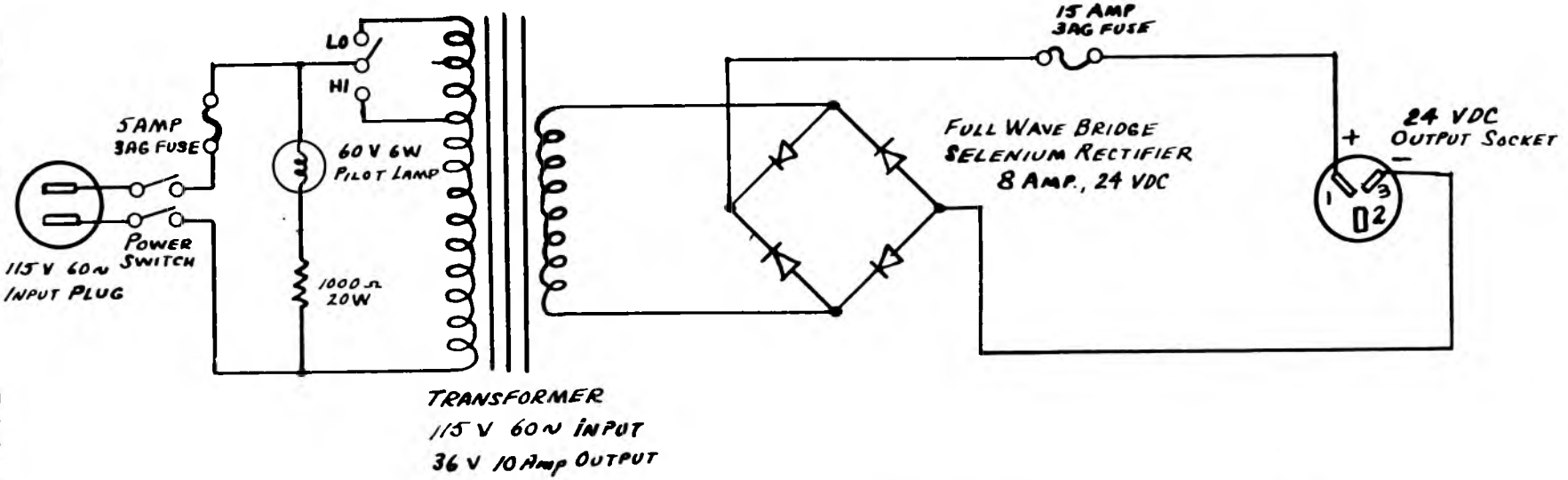


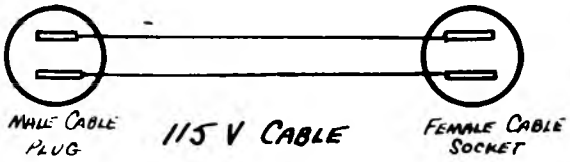
Jack Panel Connections - Drwg 13



RECTIFIER STACK CONNECTIONS

Power Supply and Cables - Drwg 15





POWER SUPPLY AND CABLES

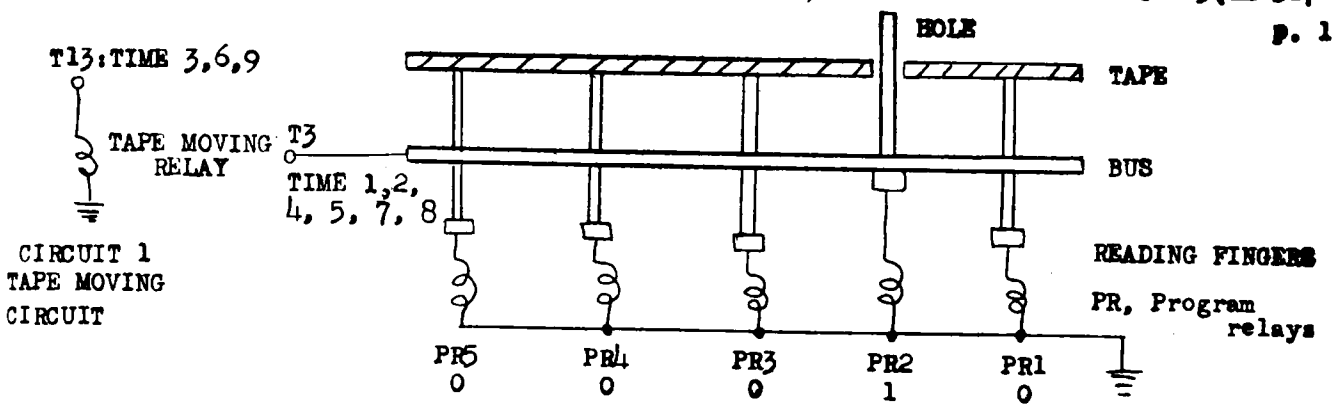
15

The Location Designation of Relays is shown at the sides, rows C to H,N,P, and columns 1 to 19. Functional Designation of Relays is shown in the boxes. The number in parentheses denotes the column or place in the binary number.

	C	D	E	F	G	H	N	P	
19	Spare	Spare	ER11	RR11	BR(16)	RR17	CR2(1)	CR4(2)	19
18	Spare	RR31	ER10	RR10	BR(8)	RR17	CR2(1)	CR4(2)	18
17	Spare	RR30	ER9	RR9	BR(4)	RR17	CR2(1)	CR4(1)	17
16	RR32	CR7	ER8	RR8	BR(2)	RR17	CR2(1)	CR4(1)	16
15	CR9	RR33	ER7	RR7	BR(1)	RR17	CR1(2)	CR4(1)	15
14	CR8	ER12	ER6	RR6	ER16	RR16	CR1(2)	CR3(2)	14
	C 13	SYR2	ER5	RR5	ER15	RR15	CR1(2)	CR3(1)	13
	12	SYR1	ER4	RR4	ER14	RR14	CR1(1)	CR3(1)	12
	D 11		ER3	RR3	ER12	RR12	CR1(1)	CR2(2)	11
	C 10		SYR3	PR4	RR1	SPR	CR1(1)	CR2(2)	10
9	ASR 9		PR2	PR4	PR5	SPR	CR1(1)	CR2(2)	9
	C 8		PR2	PR4	SR2(2)	SR6(2)	OR3(2)	CR4(4)	8
	STEPPER	7	PR2	PR4	SR2(1)	SR6(1)	OR3(1)	CR4(4)	7
		6	PR2	PR4	SR1(2)	SR5(2)	OR2(2)	CR4(4)	6
		5	PR1	RR13	SR1(1)	SR5(1)	OR2(1)	CR4(4)	5
	TAPE FEED	4	PR1	PR3	IR2(2)	SR4(2)	OR1(2)	CR4(8)	4
		3	PR1	PR3	IR2(1)	SR4(1)	OR1(1)	CR4(8)	3
		2	PR1	PR3	IR1(2)	SR3(2)	CR5(2)	CR6	2
		1	PR1	PR3	IR1(1)	SR3(1)	CR5(1)	CR6	1
			E	F	G	H	N	P	

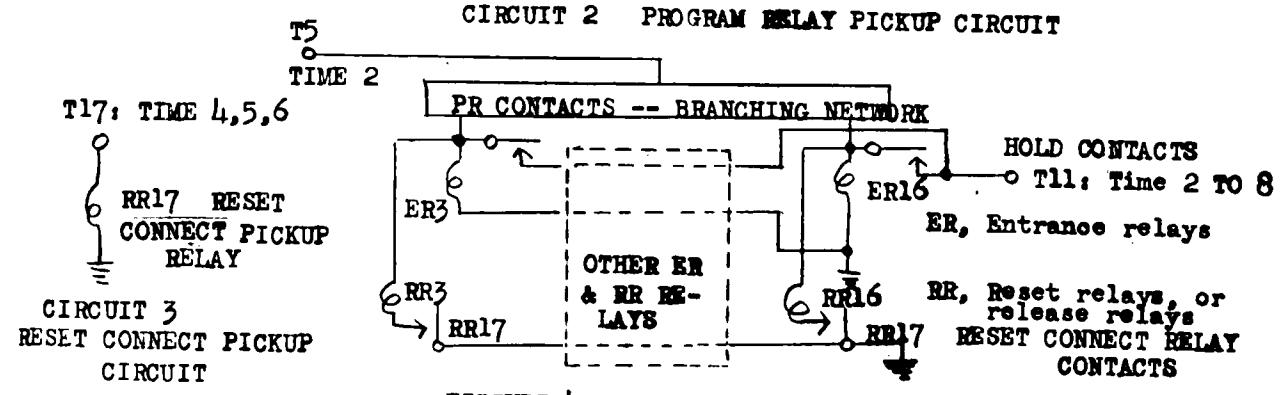
RELAYS

The Lay-out of the top of Simon -- Drawing 16



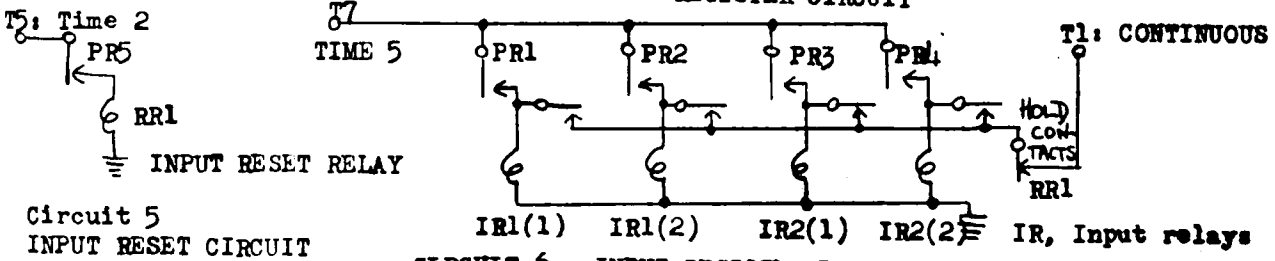
CIRCUIT 1 TAPE MOVING CIRCUIT

CIRCUIT 2 PROGRAM RELAY PICKUP CIRCUIT



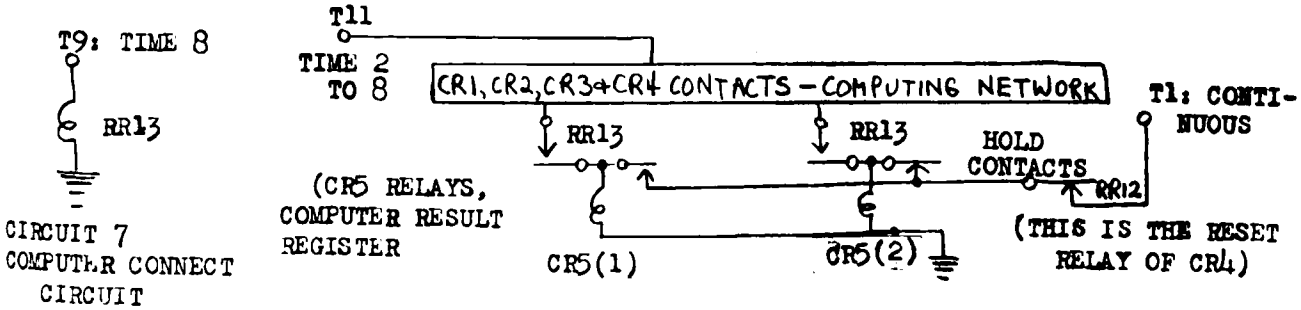
CIRCUIT 3 RESET CONNECT PICKUP CIRCUIT

CIRCUIT 4 SELECT (AND RESET) RECEIVING REGISTER CIRCUIT



Circuit 5 INPUT RESET CIRCUIT

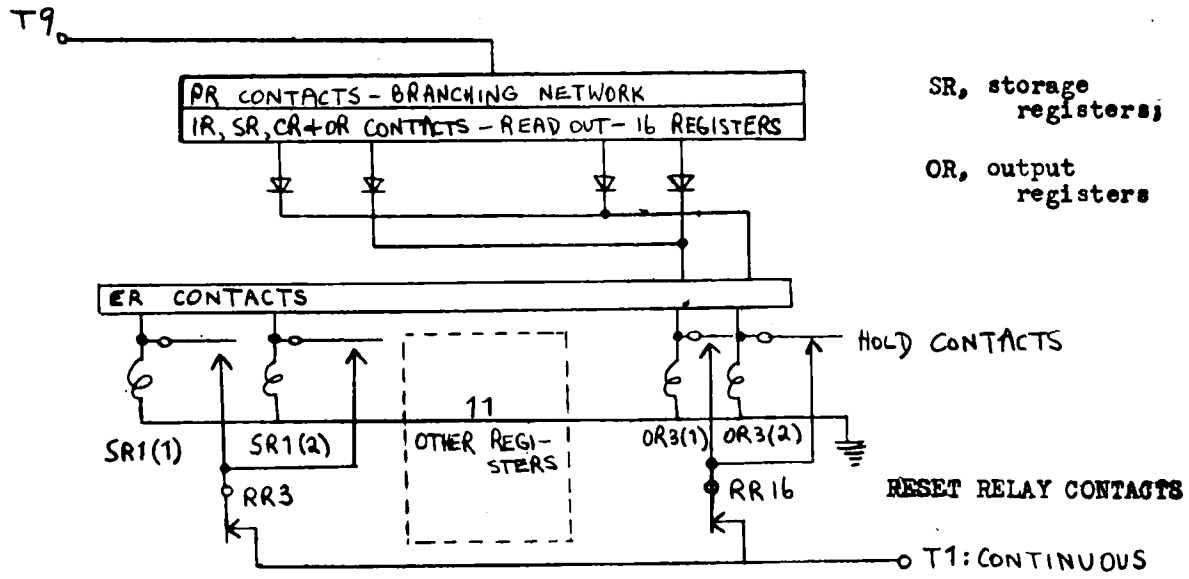
CIRCUIT 6 INPUT REGISTER PICKUP CIRCUIT (2 INPUT REGISTERS)



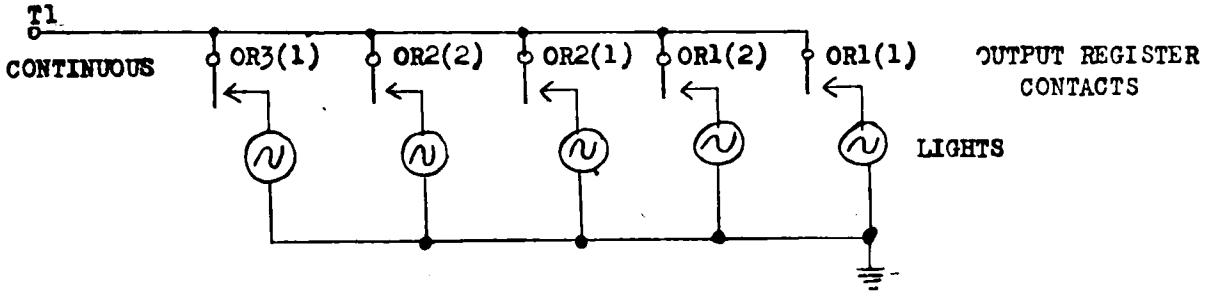
CIRCUIT 7 COMPUTER CONNECT CIRCUIT

CIRCUIT 8 COMPUTING CIRCUIT

(CR1,2,3, NUMBER REGISTERS; CR4, OPERATION REGISTER)



CIRCUIT 9 SELECT-SENDING-REGISTER AND TRANSFER CIRCUIT



CIRCUIT 10 OUTPUT READOUT CIRCUIT

General Scheme of the Ten Essential Circuits of Simon, showing the operational sequence and the connections to the terminals of the stepping switch -- Drawing 17

Relays energized	Number of Time Interval in Machine Cycle									Terminal
	1	2	3	4	5	6	7	8	9	
Tape Coil -- moves tape										T13
PR, Program Relays, energized through tape										T3
ER, Entrance Relays picked up										T5
ER, Entrance Relays, held up until receiving register is read into; also, read through computing network of CR contacts										T11
RR, Reset Relays, (except RR1), reset Receiving Register										T17
IR, Input Register, energized through tape and program relays										T7
SR, Storage Registers, CR 1 to 4, Computer Registers 1 to 4, and OR, Output Registers -- picked up through bus										T9
Hold current for SR, CR 1 to 4, and OR; interrupted when specified								OR		T1
Hold current for IR interrupted when specified										T1
RR1, Reset for IR1 or 2, energized through 5th hole in tape and program relays										T5

Main Part of Timing Chart -- Drwg 18

Simon -- Operating Instructions

A. Running automatically with Tape

1. Turn all switches up except the power switch.
2. Insert tape in the tape feed with at least one inch of blank tape before the first row of punched holes.
3. Turn power switch up. Machine will start and tape will synchronize with stepper automatically.
4. If any "manual inserts" are in the tape, machine will stop at time 5 in the cycle, and shine alarm light, waiting for the manual inserts from the buttons. Press the appropriate buttons to insert the desired numbers. Then press "button input". Then press "step jog" twice.

5. If any "programmed stops" are in the tape, machine will stop at time 8 in the cycle. To restart the machine, push "Step Jog" button twice. Do not move any switches.

6. Tape stops at end of tape, and answer appears in the white lights of the output.

7. It is advisable to turn off the power switch between tapes to clear all information out of the relays.

B. Running Manually Without Tape -- One Cycle of the Machine

1. Turn all switches down. The output lights will show the time position of the stepper in binary.

2. Jog the stepper to time 2; select receiving register by pushing the appropriate white buttons expressing the code of the register. Then press "Button Input" (to transfer from button relays into the program relays).

3. Then jog stepper to time 5. Select the number or process and press the appropriate buttons. Press "Button Input" to transfer from the button relays into the input register. Note that time 5 may be blank, with no insert, when transferring a number from one register to another inside the machine.

4. Then jog stepper to time 8. Select sending register, and push the appropriate white buttons expressing its code. Press button input. Note that time 8 may be blank if inserting a number or operation into input register 1.

Notes. (1) If running with tape but step jogging manually , the automatic synchronizing is not in circuit.

(2) If a mistake is made inserting information into the buttons, the mistake can be erased by pressing "button erase".

Wiring Diagram, Row E -- Drwg 20

Relay: / Terminal:	E1	E2	E3	E4	E5	E6	E7
30	J5	J9	J13	J17	G1-PU	E2-3T	E4-3T
3T	E6-20	E6-30	E7-20	E7-30	Q113+	F1-20	F1-30
3C	J4	J8	J12	J16		E2-2T	E4-2T
20	J3	J7	J11	J15	E8-3T	E1-3T	
2T	E6-2C	E6-3C	E7-2C	E7-3C	T9	F1-2C	F1-3C
2C	J2	J6	J10	J14	E8-2T	E1-2T	E3-2T
1T					E4-PU		
10					]		
P	A3	A3	A3	A			A4
U	T2	T2	T2	T (E5-1T)			T2

	E8	E9	E10	E11	E12	E13
30	F3-3T			K25	K25	K25
3T	E5-20			G6-PU	G8-PU	H2-PU
3C	F3-2T					
20	F2-3T	G2-PU		K24	K24	K24
2T	E5-2C	Q114+		G5-PU	G7-PU	H1-PU
2C	F2-2T					
1T		T2	T2	K4	K5	K6
10		D12-PU	Sync Alarm	T11	T11	T11
P	A4	A4	T2	K4	K5	K6
U	T2	T2	G9-1T	T2	T2	T2

	E14	E15	E16	E17	E18	E19
30	K25	K25	K25	K25	K25	K25
3T	H4-PU	H6-PU	H8-PU	N13-PU	P9-PU	P14-PU
3C						
20	K24	K24	K24	K24	K24	K24
2T	H3-PU	H5-PU	H7-PU	N9-PU	N16-PU	P12-PU
2C						
1T	K7	K8	K9	K10	K11	K12
10	T11	T11	T11	T11	T11	T11
P	K7	K8	K9	K10	K11	K12
U	T2	T2	T2	T2	T2	T2

Wiring Diagram, Row E -- Drwg 20

Wiring Diagram, Row F -- Drwg 21

Relay: Terminal	F1	F2	F3	F4	F5	F6	F7
30	E7-3T	F8-2T	F10-2T			N13-2T;N9-2T	P12-2T
3T	F6-20	E8-20	E8-30			F2-2C	F2-3C
3C	E7-2T	F7-3T	F9-3T			G1-2T	G5-2T
20	E6-3T	F7-2T	F9-2T	G3-PU		F1-3T	N1-2T
2T	F6-2C	E8-2C	E8-3C	Q115+		K1	F2-20
2C	E6-2T	F6-3T	F8-3T			F1-2T	H1-2T;H2-2T
1T				T2			
10				D12-PU			
P	A5	A5	A5	A5		A6	A6
U	T2	T2	T2	T2		T2	T2

	F8	F9	F10	F11	F12	F13	F14
30	N16-2T;P9-2T	P15-2T	Q4-PU				
3T	F3-2C	F3-3C	Q116+				
3C	G3-2T	G7-2T					
20	N5-2T	N3-2T	N7-2T				
2T	F2-30	F3-20	F3-30	G5-1T	G7-1T	H1-1T	H3-1T
2C	H5-2T	H3-2T	H7-2T	T1	T1	T1	T1
1T		T2					
10		D12-PU					
P	A6	A6	A6	K4	K5	K6	K7
U	T2	T2	T2	H17-10	H17-20	H17-30	H18-10

	F15	F16	F17	F18	F19
30					
3T					
3C					
20					
2T	H5-1T	H7-1T	N9-1T	N16-1T;P9-1T	P12-10
2C	T1	T1	T1	T1	T1
1T					
10					
P	K8	K9	K10	K11	K12
U	H18-20	H18-30	H19-10	H19-20	H19-30

Wiring Diagram, Row F -- Drwg 21

Wiring Diagram, Row G -- Drwg 22

Relay:	G1	G2	G3	G4	G5	G6	G7
Terminal:							
30							
3T							
3C							
20	Q1	Q17	Q2	Q18	Q3	Q19	Q4
2T	F6-3C;G2-2T	G1-2T	F8-3C;G4-2T	G3-2T	F7-3C;G6-2T	G5-2T	F9-3C;G8-2T
2C							
1T	G2-1T	G1-1T;G3-1T	{G2-1T; G4-1T}	{G3-1T; G10-2T}	{F11-2T; G6-1T}	G5-1T	{F12-2T; G8-1T}
10	G1-PU	G2-PU	G3-PU	G4-PU	G5-PU	G6-PU	G7-PU
P	{E5-30; G1-10}	{E9-20; G2-10}	{F4-20; G3-10}	{F10-30; G4-10}	E11-2T	E11-3T	E12-2T
U	T2	T2	T2	T2	T2	T2	T2

	G8	G9	G10	G11	G12	G13
30				K25	K25	K25
3T				P18-PU	N4-PU	N6-PU
3C						
20	Q20	G10-PU		K24	K24	K24
2T	G7-2T	T5	G4-1T	P15-PU	N3-PU	N5-PU
2C			T1			
1T	G7-1T	Q34+		G11-PU	G12-PU	G13-PU
10	G8-PU	E10-PU		T11	T11	T11
P	E12-3T	A7	G9-20	G11-1T;K13	K15;G12-1T	K16;G13-1T
U	T2	T2	T2	T2	T2	T2

	G14	G15	G16	G17	G18	G19
30	K25					
3T	N8-PU					
3C						
20	K24	BB-40;G16-20	G15-20;G17-20	{G16-20; G18-20}	G17-20;G19-20	G18-20
2T	N7-PU	A3	A4	A5	A6	A7
2C						
1T	G14-PU	G15-P	G16-P	G17-P	G18-P	G19-P
10	T11	TS-3CR;G16-10	G15-10;G17-10	G16-10;G18-10	{G17-10; G19-10}	G18-10
P	K17;G14-1T	WB-10;G15-1T	WB-20;G16-1T	WB-30;G17-1T	WB-40;G18-1T	WB-50;G19-1T
U	T2	BB-3C;G16-U	G15-U;G17-U	G16-U;G18-U	G17-U;G19-U	G18-U

Wiring Diagram, Row G -- Drwg 22

Wiring Diagram, Row H -- Drwg 23

Relay:	H1	H2	H3	H4	H5	H6	H7
Terminal:							
30							
3T							
3C							
20	Q5	Q21	Q6	Q22	Q7	Q23	Q8
2T	F7-2C;H2-2T	H1-2T	F9-2C;H4-2T	H3-2T	F8-2C;H6-2T	H5-2T	F10-2C;H8-2T
2C							
1T	F13-2T;H2-1T	H1-1T	F14-2T;H4-1T	H3-1T	F15-2T;H6-1T	H5-1T	F16-2T;H8-1T
10	H1-PU	H2-PU	H3-PU	H4-PU	H5-PU	H6-PU	H7-PU
P	E13-2T;H1-10	{E13-3T; H2-10}	{E14-2T; H3-10}	{E14-3T; H4-10}	{E15-2T; H5-10}	{E15-3T; H6-10}	{E16-2T; H7-10}
U	T2	T2	T2	T2	T2	T2	T2

	H8	H9	H10	H11	H12	H13
30		N5-30	N7-30			
3T		WL-3	WL-1	N1-10		
3C		TL-3	TL-1	T1		
20	Q24	N6-30	N8-30			
2T	H7-2T	WL-4	WL-2	P15-10	N3-10	N5-10
2C		TL-4	TL-2	T1	T1	T1
1T	H7-1T	WL-5				
10	H8-PU	N4-30				
P	E16-3T;H8-10	{TS-1TR; H10-P}	H9-P	K13	K15	K16
U	T2	T1	T1	H16-20	H16-30	H15-20

	H14	H15	H16	H17	H18	H19
30		H14-PU	H12-PU	F13-PU	F16-PU	F19-PU
3T		T2	T2	T2	T2	T2
3C						
20		H13-PU	H11-PU	F12-PU	F15-PU	F18-PU
2T	N7-10	T2	T2	T2	T2	T2
2C	T1					
1T				T2	T2	T2
10				F11-PU	F14-PU	F17-PU
P	K17	T14	T14	T14	T14	T14
U	H15-30	T2	T2	T2	T2	T2

Wiring Diagram, Row N -- Drwg 24

Relay: / Terminal:	N1	N2	N3	N4	N5	N6	N7
30			H9-10		H9-30	H9-20	H10-30
3T			T1		T1	T1	T2
3C							
20	Q13	Q29	Q14	Q30	Q15	Q31	Q16
2T	F7-20;N2-2T	N1-2T	F9-20;N4-2T	N3-2T	F8-20;N6-2T	N5-2T	F10-20; N8-2T
2C							
1T	N1-PU	N2-PU	{H12-2T; N4-1T}	N3-1T	{H13-2T; N6-1T}	N5-1T	H14-2T;N8-1T
10	N2-10;H11-3T	N1-10	N3-PU	N4-PU	N5-PU	N6-PU	N7-PU
P	{P19-2T; N1-1T}	{P18-3T; N2-1T}	{G12-2T; N3-10}	{G12-3T; N4-10}	{G13-2T; N5-10}	{G13-3T; N6-10}	{G14-2T; N7-10}
U	T2	T2	T2	T2	T2	T2	T2

	N8	N9	N10	N11	N12	N13
30	H10-20	N16-3T	N18-2T	N18-3T		P10-2T
3T	T1	P9-3C;P10-20	T11	P10-3C;P11-20		T11
3C			N17-3T			P9-3T
20	Q32	Q9	N17-2T	N14-3T;P16-30	P13-20	Q25
2T	N7-2T	F6-30;N13-2T	{P9-30; P10-2C}	T11	T11	N9-2T
2C			N16-30	N14-2T		
1T	N7-1T	{F17-2T; N10-1T}	{N9-1T; N11-1T}	{N10-1T; N12-1T}	{N11-1T; N13-1T}	{N12-1T; N14-1T}
10	N8-PU	N9-PU	N10-PU	N11-PU	N12-PU	N13-PU
P	{G14-3T; N8-10}	{E17-2T; N10-PU}	{N9-PU; N11-PU}	{N10-PU; N12-PU}	N11-PU	{E17-3T; N14-PU}
U	T2	T2	T2	T2	T2	T2

	N14	N15	N16	N17	N18	N19
30		P12-30	N17-2C	N18-2C;P16-3C		
3T	N11-20	T11	N10-2C	N10-3C	N11-30	
3C	N14-20		N9-30		P11-2C;P17-2C	
20	N14-3C;P15-30	P11-2T	Q10			P13-2C
2T	N11-2C	T11	F8-30	N10-20	N10-30	T11
2C		P10-3T		N16-30;P15-3C	N17-30	
1T	N13-1T;N15-1T	N14-1T	F18-2T;N17-1T	{N16-1T; N18-1T}	{N17-1T; N19-1T}	N18-1T
10	N14-PU	N15-PU	N16-PU	N17-PU	N18-PU	N19-PU
P	{N13-PU; N15-PU}	N14-PU	{E18-2T; N17-PU}	{N16-PU; N18-PU}	{N17-PU; N19-PU}	N18-PU
U	T2	T2	T2	T2	T2	T2

Wiring Diagram, Row N -- Drwg 24

Wiring Diagram, Row P -- Drwg 25

lay: / rminal:	P1	P2	P3	P4	P5	P6	P7
30							
3T							
3C							
20							
2T							
2C							
1T							
10							
P							
U							

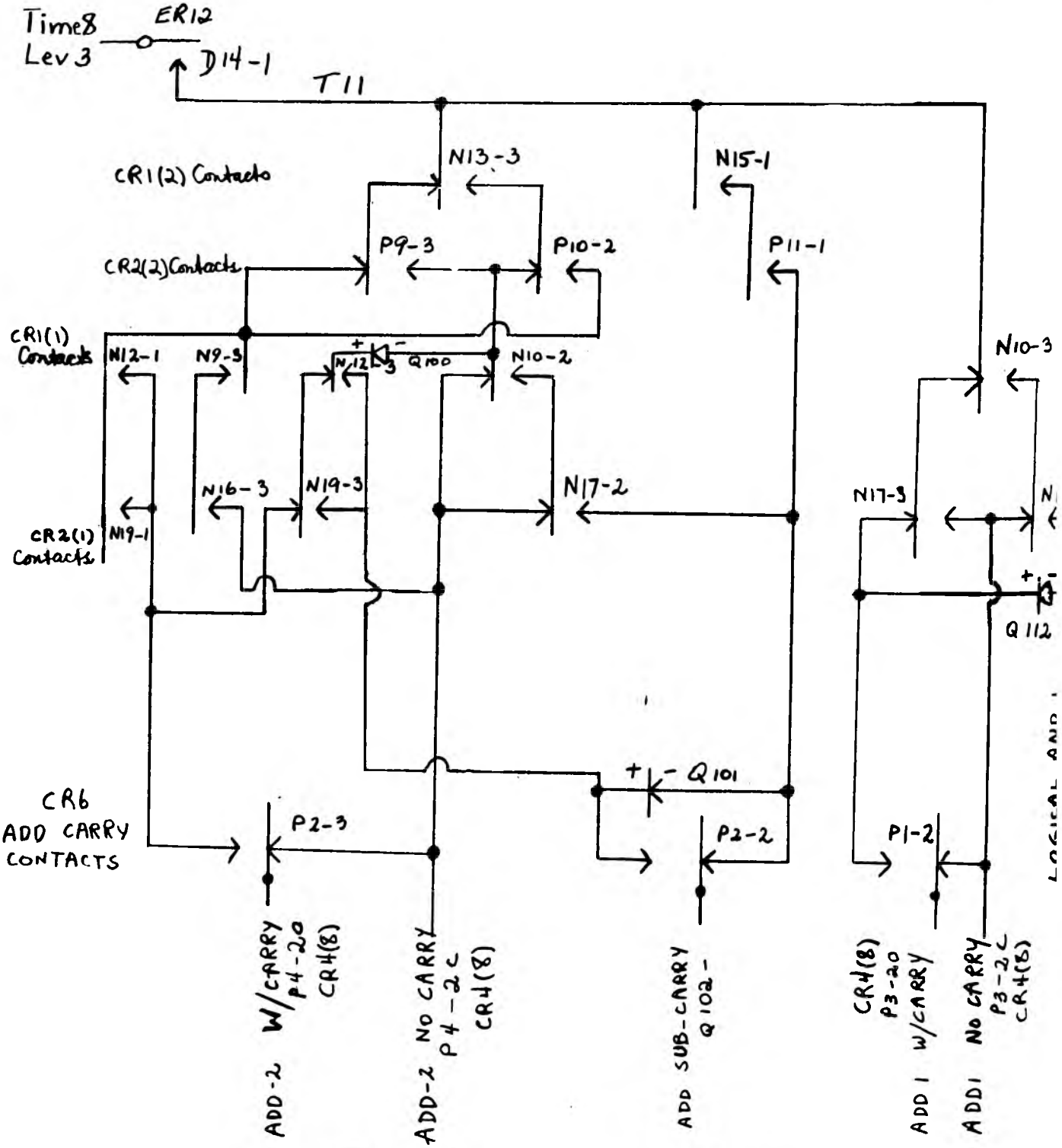
	P8	P9	P10	P11	P12	P13
30		N10-2T;P10-2C		P12-3C	N15-30	
3T		N13-3C	N15-2C	T11	P16-20	
3C		N9-3T;P10-20	{N11-3T; P11-20}		P11-30	
20		Q26	P9-3C	P10-3C;N11-3T	Q11	N12-20
2T		F8-30	N13-30	N15-20	P14-2T	P17-20
2C			P9-30;N10-2T	N18-3C		N19-20
1T		F18-2T;P10-1T	{P9-1T; P11-1T}	P10-1T	F9-2T;P13-1T	P12-1T;P14-1T
10		P9-PU	P10-PU	P11-PU	P12-PU	P13-PU
P		{E18-3T; P10-PU}	{P9-PU; P11-PU}	P10-PU	{E19-2T; P13-PU}	P12-PU
U		T2	T2	T2	T2	T2

	P14	P15	P16	P17	P18	P19
30		N14-20	N11-20		P16-2T	
3T		P18-3C	P19-2C		N2-PU	
3C		N17-2C	N17-30		P15-3T	
20	Q27	Q2	P12-3T	P13-2T	Q28	P17-2T
2T	P12-2T;F7-30	{F9-30; P18-2T}	P18-30	P19-20	P15-2T	N1-PU
2C				N18-3C		P16-3T
1T	P13-1T	H11-2T;P16-1T	{P15-1T; P17-1T}	{P16-1T; P18-1T}	{P17-1T; P19-1T}	P18-1T
10	P14-PU	P15-PU	P16-PU	P17-PU	P18-PU	P19-PU
P	E19-3T	G11-2T;P16-PU	{P15-PU; P17-PU}	P16-PU	G11-3T;P19-PU	P18-PU
U	T2	T2	T2	T2	T2	T2

ADDITION COMPUTER WITH CARRY

PROPOSED LOGICAL AND - 1(1st binary place)

September 16, 1950

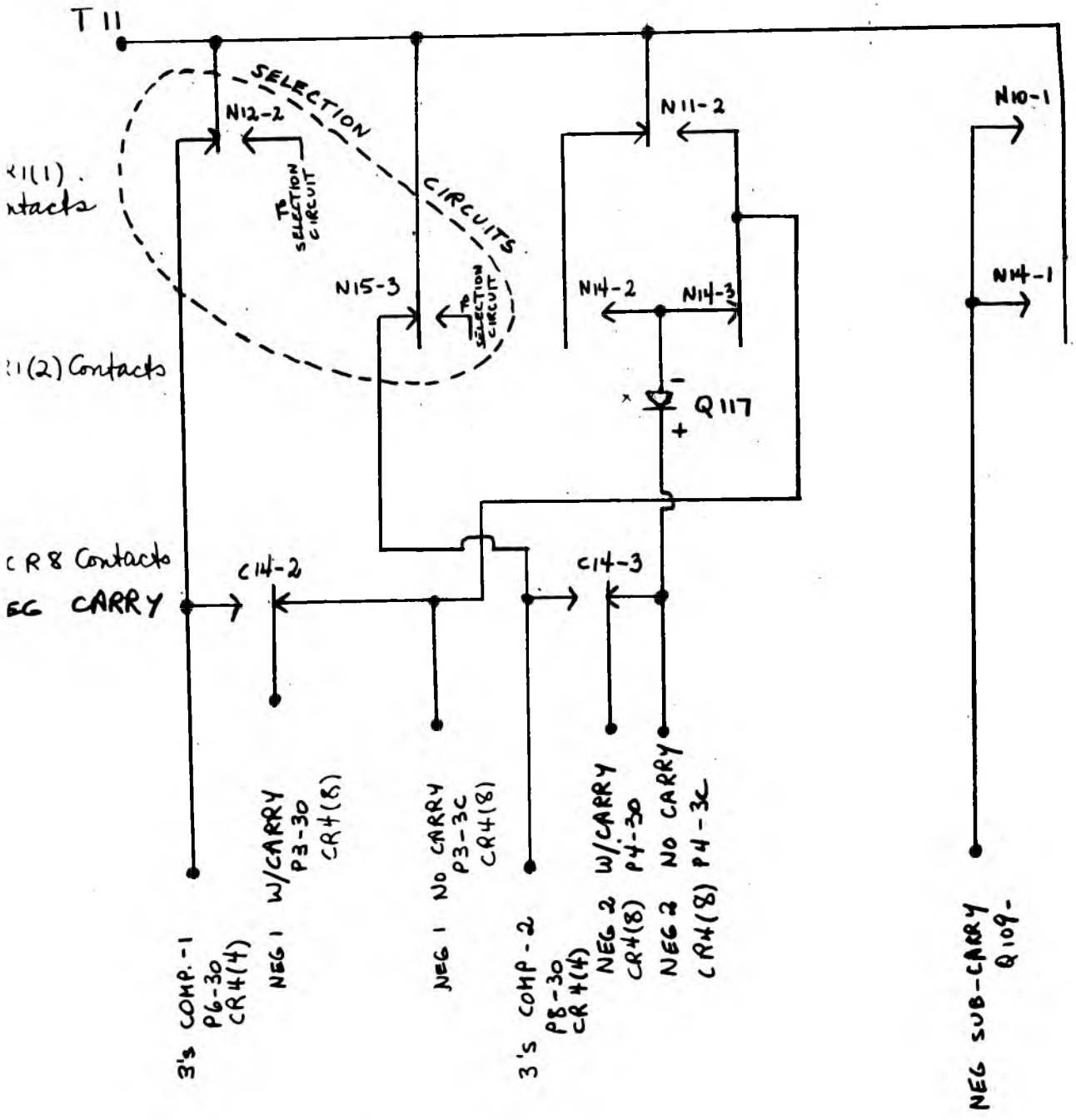


8-105(21-2
(22-D27

NEGATION COMPUTER WITH CARRY

(ALSO 3'S COMPLEMENT AND LOGICAL NOT)

September 16, 1950



Negation is 4's complement
Negation with carry is 3's complement
Negation with carry is also brought out as 3's complement with code 00100; this is also LOGICAL NOT in each of 1st and 2nd digits

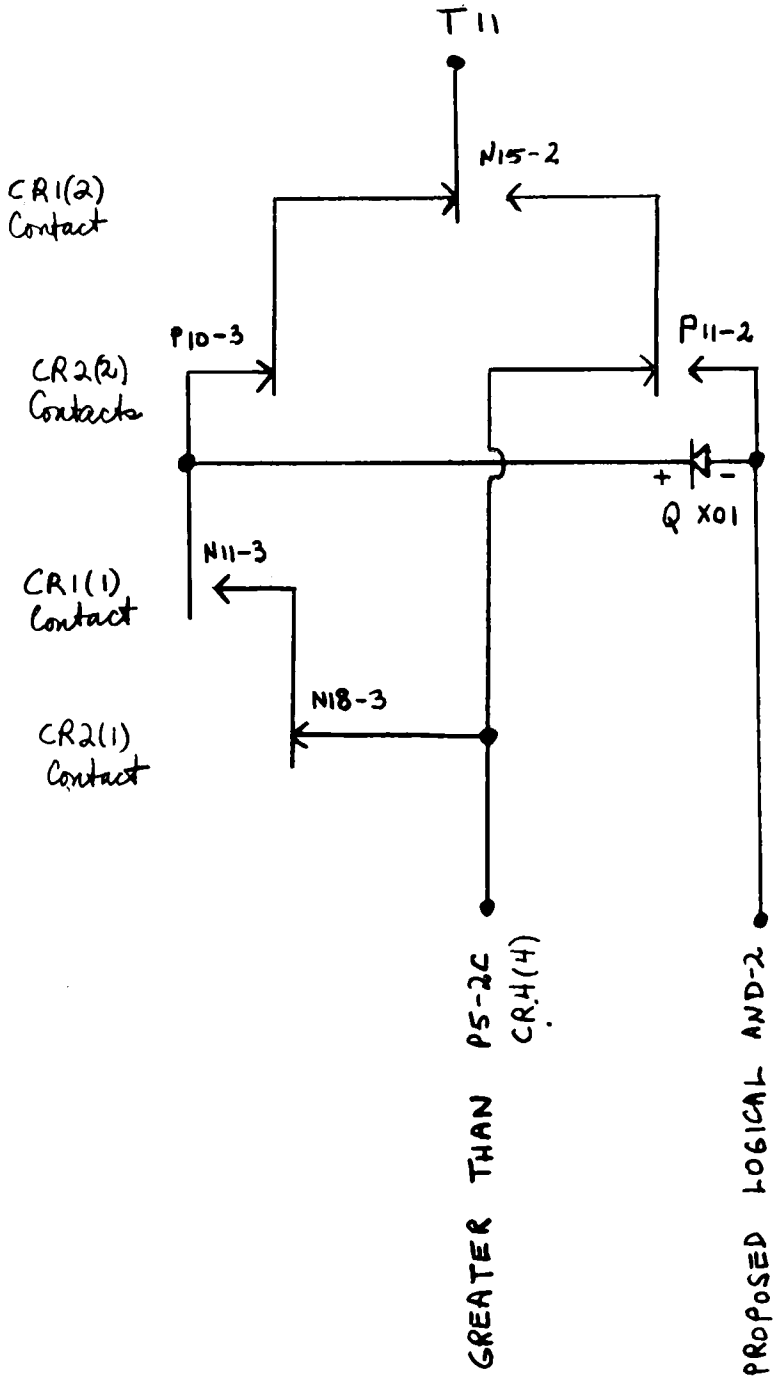
Drawing 27

8-105(21-3
(22-D28

GREATER THAN COMPUTER

PROPOSED LOGICAL AND (2nd binary place)

September 16, 1950



Drawing 28

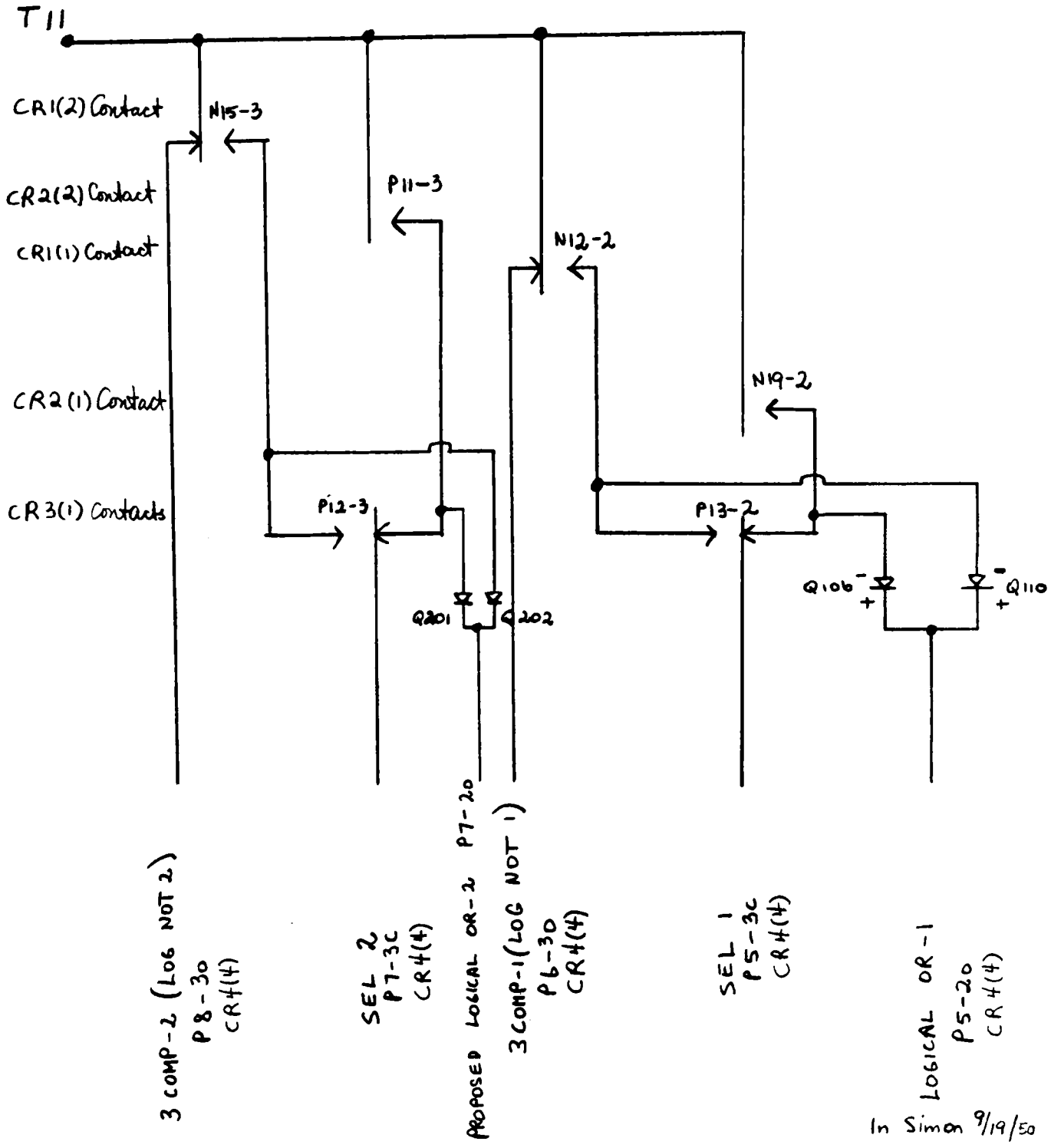
8-105(21-4
(22-D29

SELECTION COMPUTER

ALSO 3'S COMPLEMENT AND LOGICAL NOT

LOGICAL OR

September 16, 1950



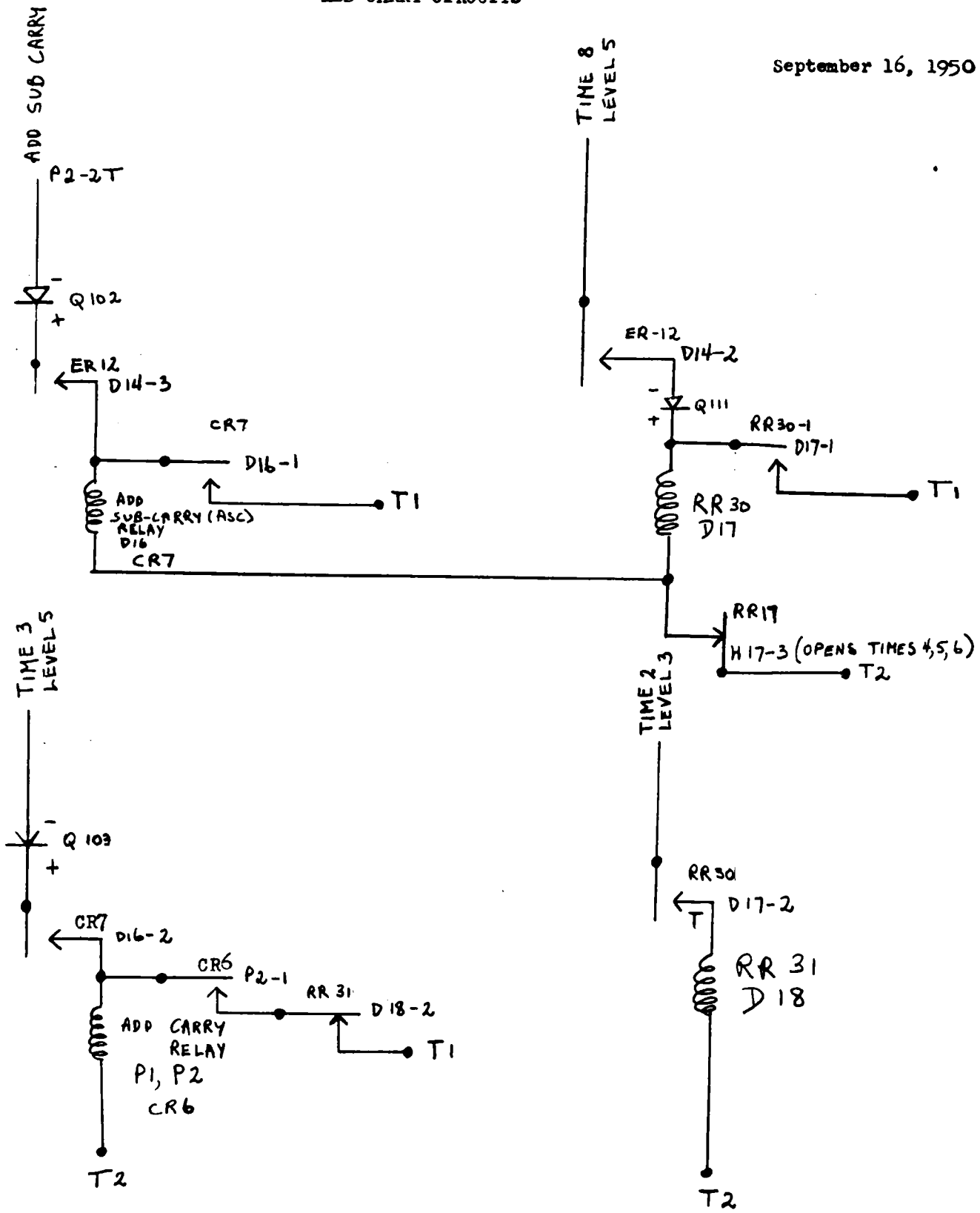
In Simon 9/19/50

Drawing 29

8-105(21-5
(22-D30

ADD CARRY CIRCUITS

September 16, 1950

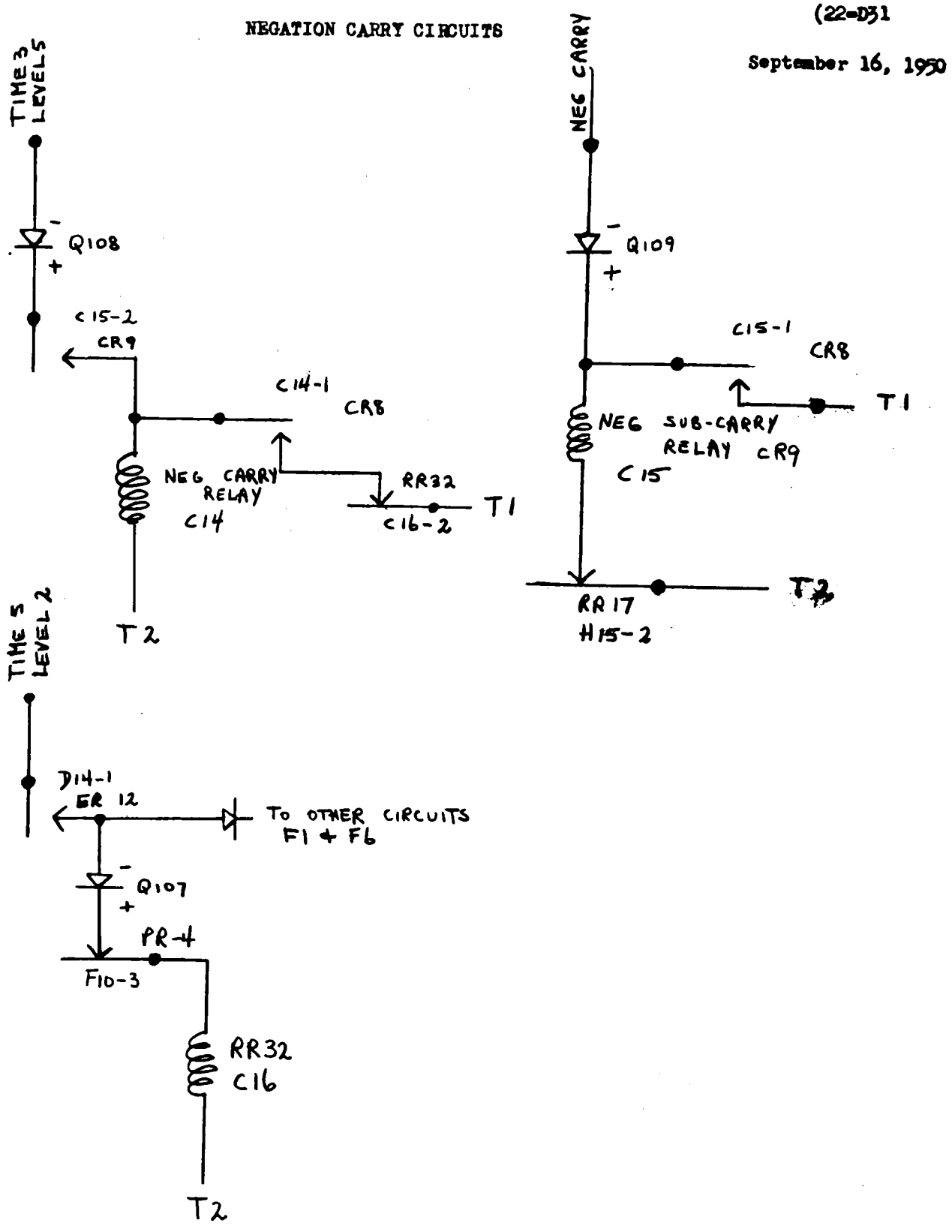


Drawing 30

8-105(21-6
(22-D31

September 16, 1950

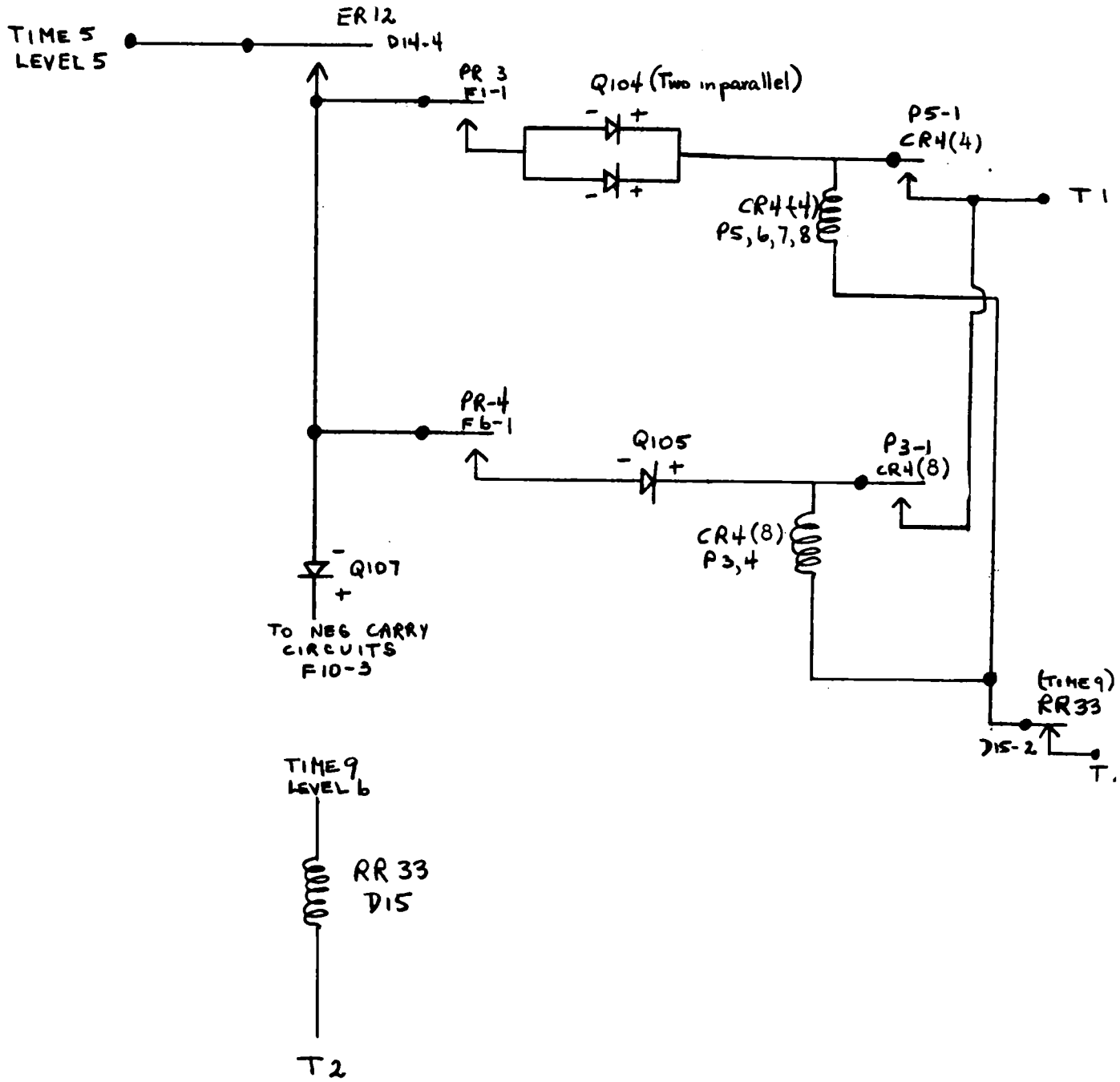
NEGATION CARRY CIRCUITS



Drawing 31

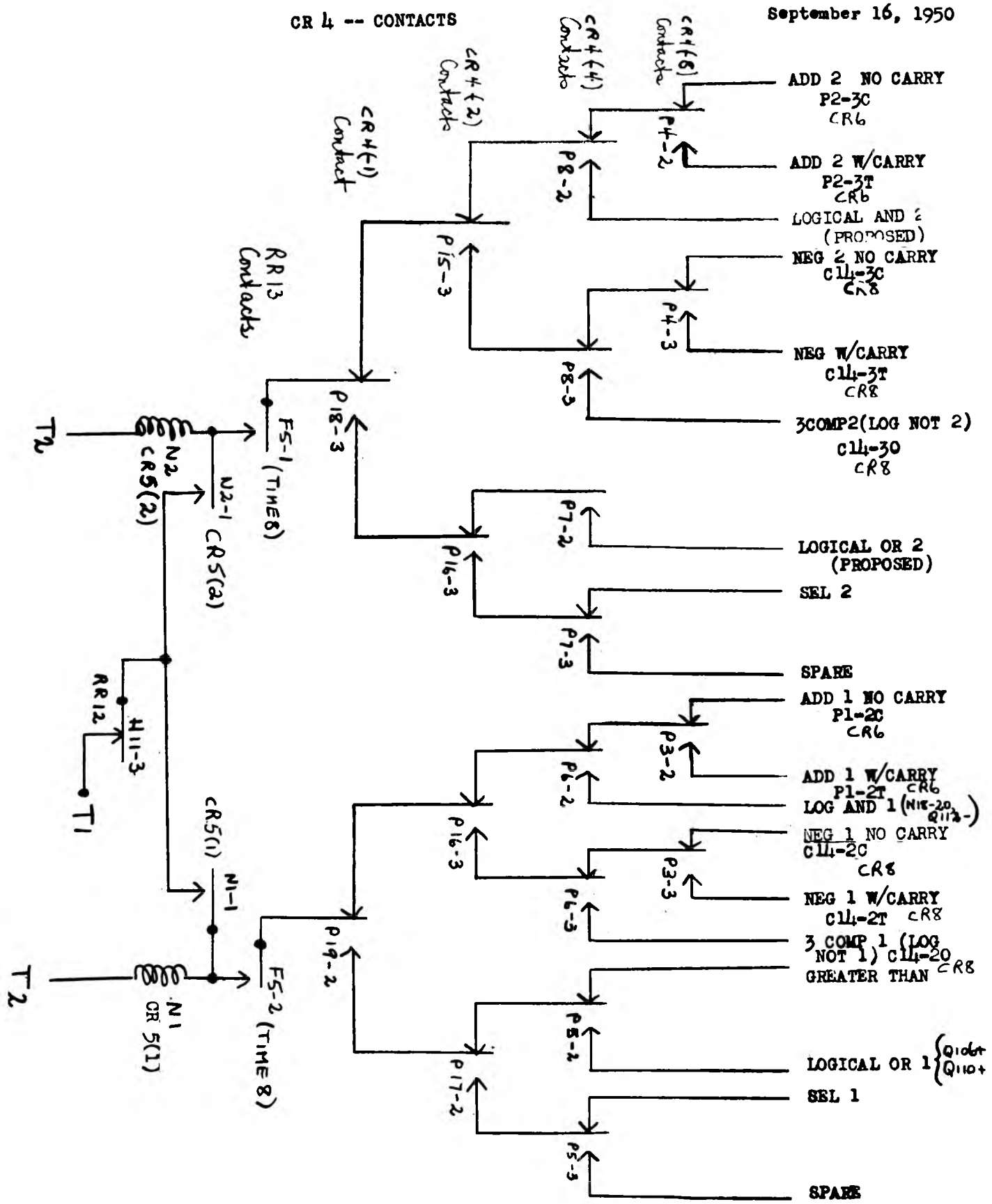
CR 4(4)AND CR 4(8)CIRCUITS

September 16, 1950



Drawing 32

8-105(21-8
(22-D33
September 16, 1950



Drawing 33