SERVICE MANUAL

ANC-2 ALPHANUMERIC COUPLER

Bendix Computer Division
5630 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA

THE Bendix CORPORATION

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BENDIX COMPUTER DIVISION

A N C - 2

A L P H A N U M E R I C   C O U P L E R

SERVICE MANUAL

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WARNING

Certain modifications are necessary to both the G-15 Computer and Typewriter. These modifications are described in Sections VI and VII of this manual.

The equipment will NOT operate correctly until these modifications are made.

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SECTION I

1.0 GENERAL

1.1 FUNCTION

The ANC-2 acts as a coupler between the typewriter (1D3001) and the G-15D computer. It translates key signals from the typewriter to suitable G-15 codes and receives codes from the G-15 for translation to appropriate typewriter signals.

Codes for entry to the G-15 are generated in a combination relay-diode matrix. Output codes from the G-15 are translated in a relay matrix.

The unit is composed of two couplers in one package; an alphanumeric coupler and a numeric (hexadecimal) coupler. Although they time-share many of the same components, they are logically separate, and are so presented.

Both the hexadecimal and alphanumeric couplers have an encoder to transform typewriter signals into machine language and a decoder to translate machine language to the appropriate typewriter signal.

1.2 PHYSICAL DESCRIPTION:

Height	23 inches
Width	18 1/2 inches
Depth	4 inches
Weight	42 1/2 lbs
Color	Bendix light blue, BCD Spec. 3-2-A

1.3 ELECTRICAL DESCRIPTION

(a) Power: The following voltages are required: -25 volts at 1 amp generated inside the coupler; +160 volts at 0.25 amperes (max) - supplied by G-15; 117 volts ac at 0.125 amperes - supplied by G-15.

(b) Off/On Switch: The unit is wired so that the off-on switch in the typewriter controls +160 volts in the ANC-2.

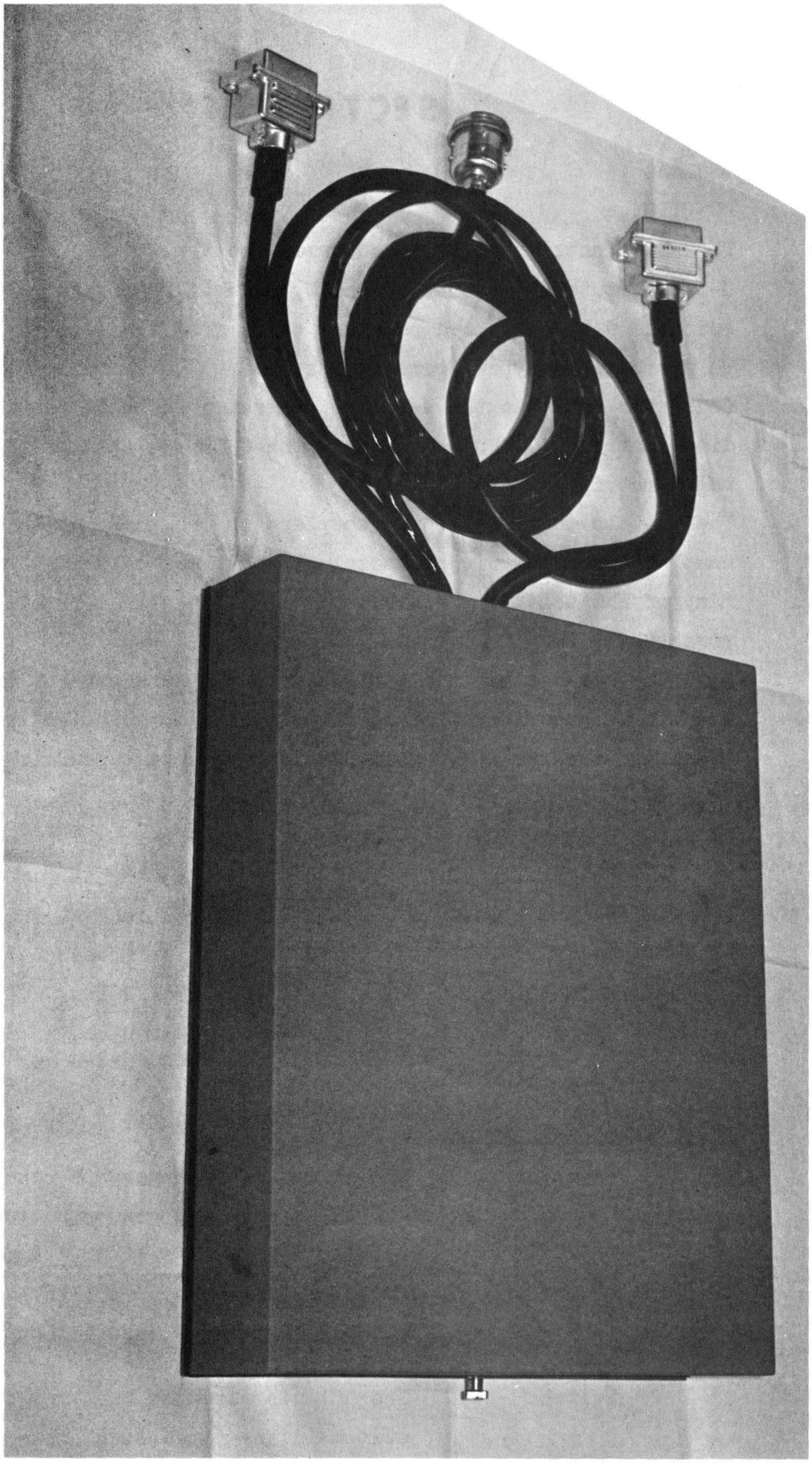


Figure 1-1. ANC-2 Alphanumeric Coupler

(c) Connection to G-15: A single plug with 15 feet of cable to the "typewriter" receptacle at the rear of the computer.

(d) Connection to Typewriter: Two cables, one terminated in a male and one in a female connector. Each cable approximately 4 ft 6 inches long.

(e) Input Signals: From typewriter, 0 volts, generated by closure of mechanical contacts to ground: From G-15: Negative going signals from +160 volts to +80 volts from power amplifiers within the computer. Logical reference voltage (OV_a) is supplied by the computer. Grounding is accomplished with OV_b, the relay power return.

(f) Output: To typewriter: +160 volts in series with a 500 ohm resistor.

To computer: Logical signals of -25 volts or zero. Specifications for these signals are discussed in the particular area in which they apply.

The unit consists, logically of four parts:

1. Numeric Encoder
2. Numeric Decoder
3. Alphanumeric Encoder
4. Alphanumeric Decoder

SECTION II

2.0 CHARACTER CODES

2.1 NUMERIC CODES

2.1.1 The numeric or HEX coupler must encode and decode the sixteen hexadecimal digits, plus the format characters tab, minus, reload, and carriage return. Period and space are not encoded since they are not input functions. However, they are decoded and the typewriter will respond to them during output operations where they are used for editing purposes.

2.1.2 Input codes for the 20 hexadecimal characters to be encoded are listed in Table 2-1.

1 0000	1 0001	1 0010	1 0011	1 0100	1 0101	1 0110	1 0111	1 1000	1 1001	1 1010	1 1011	1 1100	1 1101	1 1110	1 1111	0 0010	0 0001	0 0101	CODE
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TAB CR	MINUS	RELOAD	HEX CHAR.
0	1	2	3	4	5	6	7	8	9	U	V	W	X	Y	Z	TAB CR	–	°	TYPWR. KEY
DIGITS																FORMAT			

Table 2-1. Input Codes, Numeric Coupler

2.1.3 Note that a one bit in level 5 separates digits from format characters. Inside the computer, this level 5 bit gives rise to a signal called "digit in the OB's", meaning that the character is a number and should go into memory. A zero in level 5 indicates a control code in the OB's that should not go into memory.

2.2 ALPHANUMERIC CODES

2.2.1 AUTOMATIC RELOAD

The AN system utilizes the automatic reload feature of the G-15 and any discussion of it must necessarily begin with a brief description of automatic reload.

Normal input to the computer through memory line M23 consists of 4 information words, each made up of seven digits and sign. These 4 words completely fill M23 and a reload code transfers it into the intermediate buffer MZ on the way to M19. This "standard" format of 7 characters and reload is distinctive to the G-15. Thus, punched tapes not especially prepared for the G-15 had to be repunched to include reload codes.

"Automatic Reload" was introduced to eliminate the necessity of repunching tapes by generating a reload signal internally each time M23 is filled. Many tapes not previously readable without rework can now be used. The PR-2, in conjunction with Automatic Reload, allows almost any tape to be read.

Any double precision input-output command will initiate automatic reload by clearing M23 and inserting a marker bit in T_1 or word 00. As characters are precessed into the line, the marker is moved along 4 bits at a time. Finally, after the 28th precession, M23 looks like Figure 2-2.

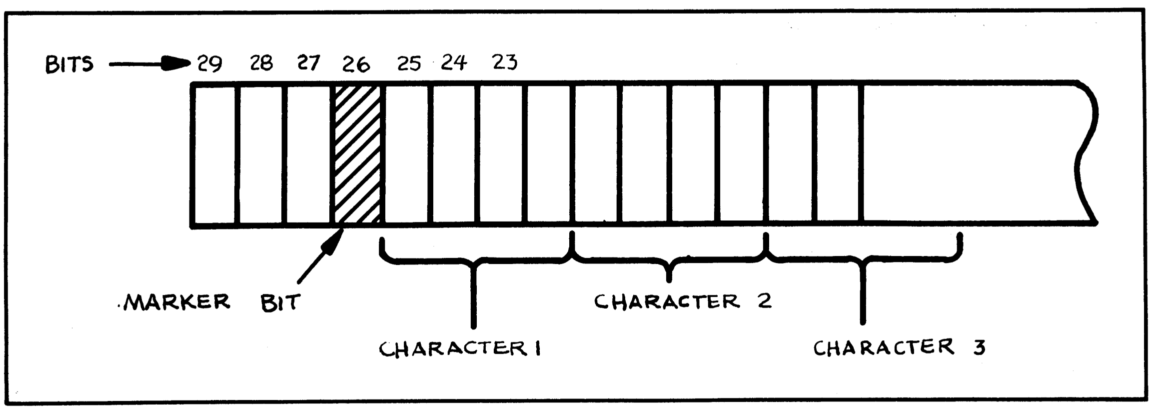


Figure 2-2. Marker Bit, M23

Note that because M23 had been cleared (all zeros) before starting, the OA's had been left reset after each precession. When the 29th precession (which fills M23) starts, a bit -- the marker bit -- will be left in the OA's for the first time. This marker bit is detected in the OA's and caused to generate a reload signal. The TF pulse (T_{29} of word 3 mod 4) is used to interrogate the OA's. At TF of the 29th precession, the marker bit appears at the output of OA-3. Only at the time of the 29th precession (which fills the line) will this coincidence occur between TF and OA-3. This signal is the basis for transferring M23 to MZ.

Again, any double precision input-output command ($DS \cdot \overline{CV} \cdot Cl$) will initiate the action by setting the AS -- automatic/standard -- flip-flop. A light, the "alpha" light on the computer control panel, follows the AS flip-flop. This light, however, does not stand for alphanumeric during input operations; it stands only for automatic reload, which can apply to either alphanumeric type-in or numeric paper tape input. A second flip-flop, the OH flip-flop differentiates between numeric and alphanumeric mode.

$$\left.\begin{array}{l} AS \cdot \overline{OH} = \text{Numeric Mode} \\ AS \cdot OH = \text{Alphanumeric Mode} \end{array}\right\} \text{Automatic Reload}$$

T_1 GROUP	T_2 GROUP														
	1 0000	1 0001	1 0010	1 0011	1 0100	1 0101	1 0110	1 0111	1 1000	1 1001	1 1010	1 1011	1 1100	1 1101	1 1110
1 1101	+	A	B	C	D	E	F	G	H	I	>	.	)	;	^
1 1110	−	J	K	L	M	N	O	P	Q	R	CR	$	*	TAB	
1 1111	°	/	S	T	U	V	W	X	Y	Z		,	(	SPACE	
1 1100	0	1	2	3	4	5	6	7	8	9		=			
1 1001		A	B	C	E	D	F	G	H	I	<	?		:	∨
1 1010		J	K	L	M	N	O	P	Q	R					
1 1011			S	T	U	V	W	X	Y	Z		↑			
1 1000		¬		→			≠	[	]						

Table 2-3. Input Codes, AN Characters

2.2.2 ALPHANUMERIC CODES

The standard G-15 code of 5 bits cannot supply the 53 possible combinations required for alphanumeric encoding. Hence, a 10 bit code was introduced. Only 8 of the 10 bits go into memory; these 8 bits parallel the IBM card code.

Each character is put into the computer in two groups of 5 bits each. The groups are separated in time and are designated the T_1 and T_2 groups. This T_1 and T_2 has nothing to do with G-15 internal timing. They are group designators, generated in the coupler for use in the coupler. Table 2-3 charts the T_1 and T_2 codes for AN characters.

2.2.3 The code for the AN character "A", for example, is found by locating A in the table. Directly to the left of A is seen the T_1 group, 11001. Above A is the T_2 group, 10001. The input code, then, is 11001 10001.

It will be noted that the only difference between "A" and "a" is that the upper case form has a zero in level 3 of the T_1 group, while the lower case form has a one.

A = 11001 10001

a = 11101 10001

The T_2 group is the same for both upper and lower case.

There are seven exceptions to this general rule. In order to maintain compatibility with the IBM card code, the symbols $, +, (,), *, /, and = are coded as lower case, although in typing out, the typewriter carriage must shift up. Special provision is made for these characters in both the encoder and decoder.

Referring again to Table 2-3, the character "t" for example, is encoded as: 11111 10011. The particular key -- that is, "t" or "T" is identified by levels 1 and 2 of group 1, and levels 1, 2, 3, and 4 of group 2.

xxx11 x0011 = "t" or "T"

Only six of the ten signals are needed to specify the particular key "t" or "T" -- on the typewriter. Because there is no standard format in the alphanumeric mode, all characters (including format characters) go into memory. Hence, both groups of every character contain a one bit in level 5. Addition of these bits gives:

"t" or "T" = 1xx11 10011

For the convenience of G-15 internal logic, level 4 of the T_1 group always contains a "1", giving:

"t" or "T" = 11x11 10011

Again, upper case and lower case characters are separated with level 3 of the T_1 group.

"t" = 11111 10011
"T" = 11011 10011

Level 5 of both groups is discarded between the OB flip-flops and line M23 in the usual manner.

2.2.4 If "t" were the first character typed in, examination of M23 would show:

while "T" would appear as:

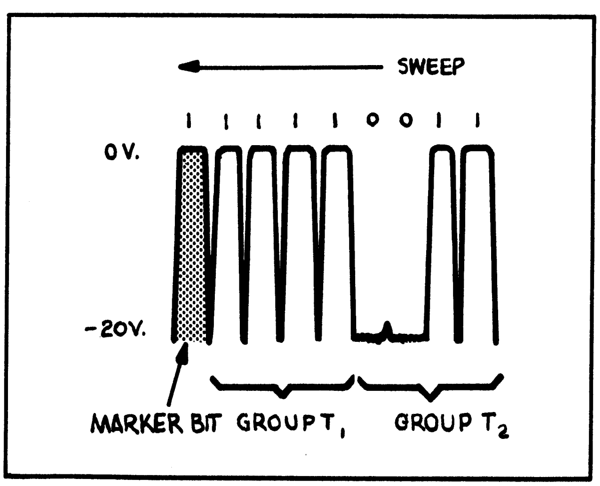


Figure 2-4. Oscilloscope Trace of "t" in M23

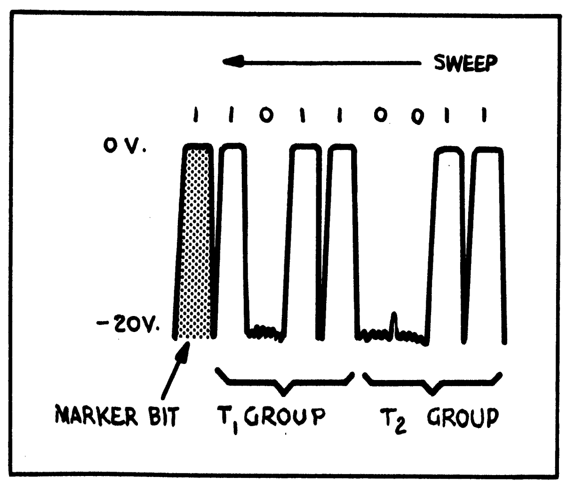


Figure 2-5. Oscilloscope Trace of "T" in M23

SECTION III

3.0 TYPEWRITER

3.1 DESCRIPTION

Before going into the coupler itself, a brief description of the contacts in the typewriter will be helpful. The typewriter is an IBM, alphanumeric input-output writer with 88 characters and the normal typewriter functions of tab, carriage return, space and shift.

3.2 CONTACTS

Each typewriter key, except space, tab and carriage return, has three sets of contacts associated with it.

(a) "key" contact-44 sets total (one set per key).

(b) "character common" contact --1 set shared by all keys.

(c) "character interlock" contact --1 set shared by all keys.

The key contacts are cam driven from the key levers of each individual key. Pressing down on a key button mechanically drives the points of that particular key contact together. One side of each of these 44 switches is brought to a connector on the rear of the typewriter. The other side of each is tied into a common bus.

The character common is a single set of contacts, cam driven by the typewriter ribbon mechanism, each time a key -- any key -- types. When the typing of the character is complete, the contacts open again. Because the tab, space and carriage return functions make no use of the ribbon mechanism, striking them will not effect the character common.

The character interlock is a single set of normally closed points, driven open by the same cam that operates the character common. The space, tab and carriage return will not affect the character interlock.

Space, tab and carriage return each have two sets of contacts

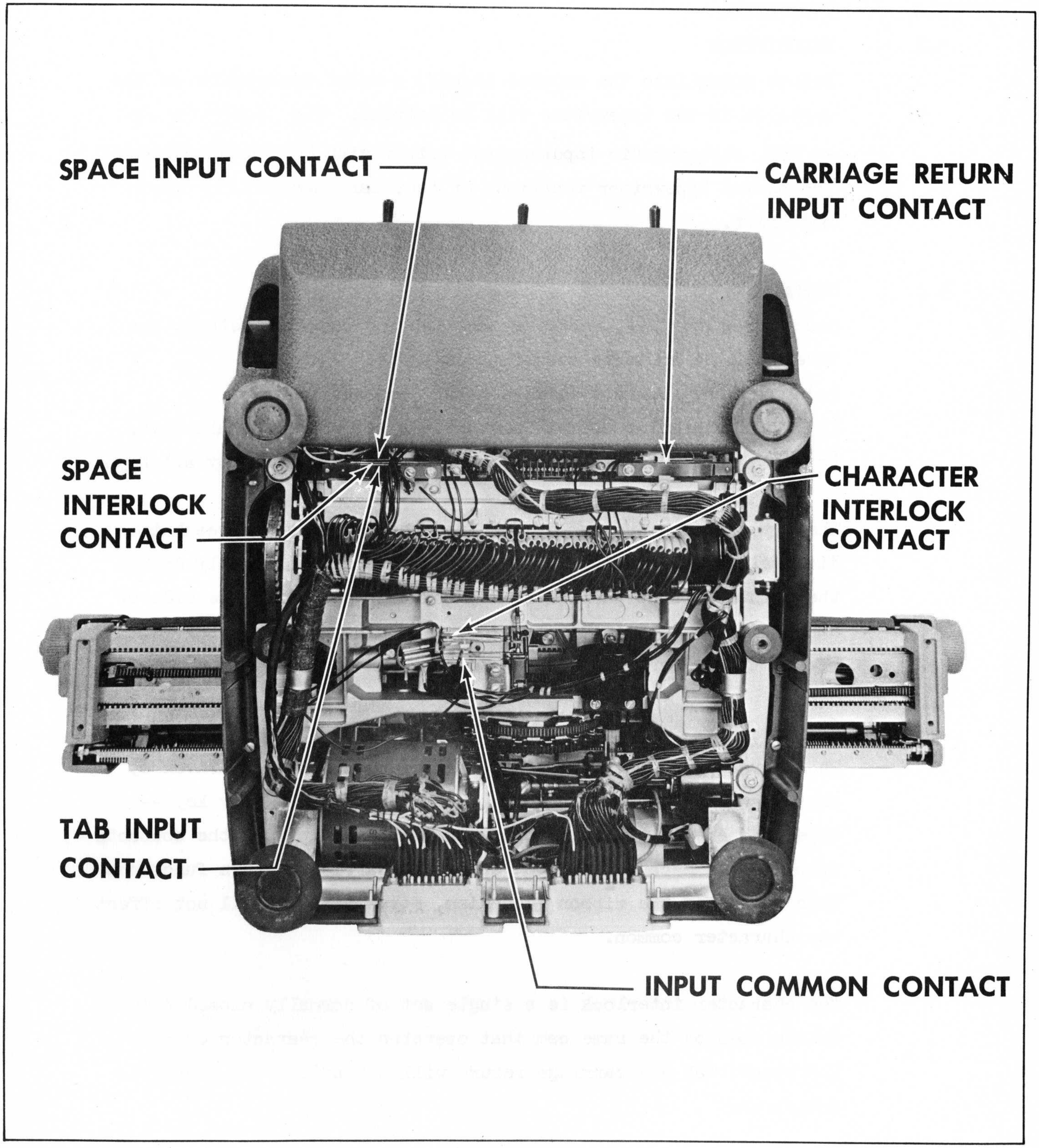


Figure 3-1. Contact Locations, Bottom AN Typewriter

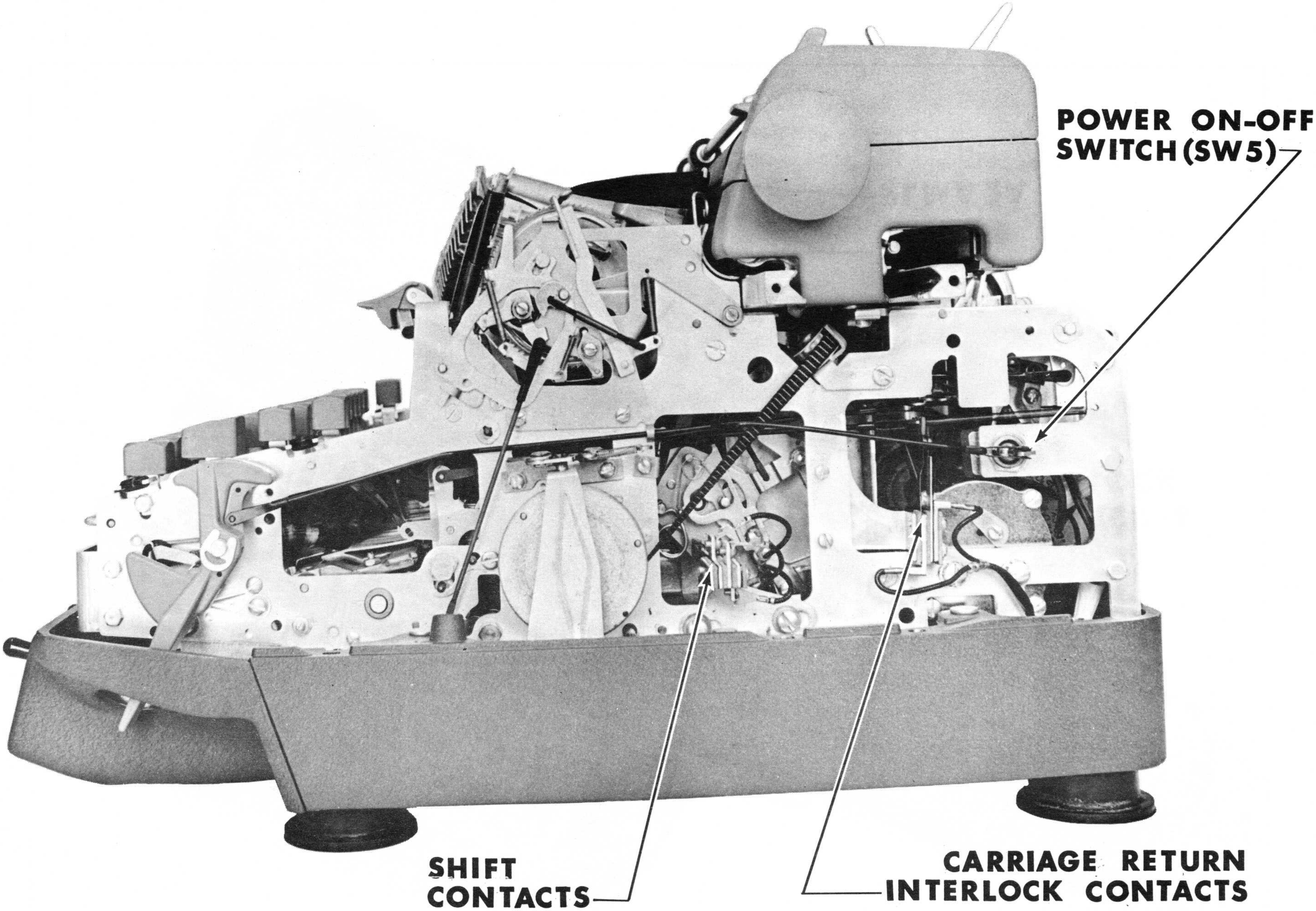


Figure 3-2. Contact and Switch Location, Right Side, AN Typewriter

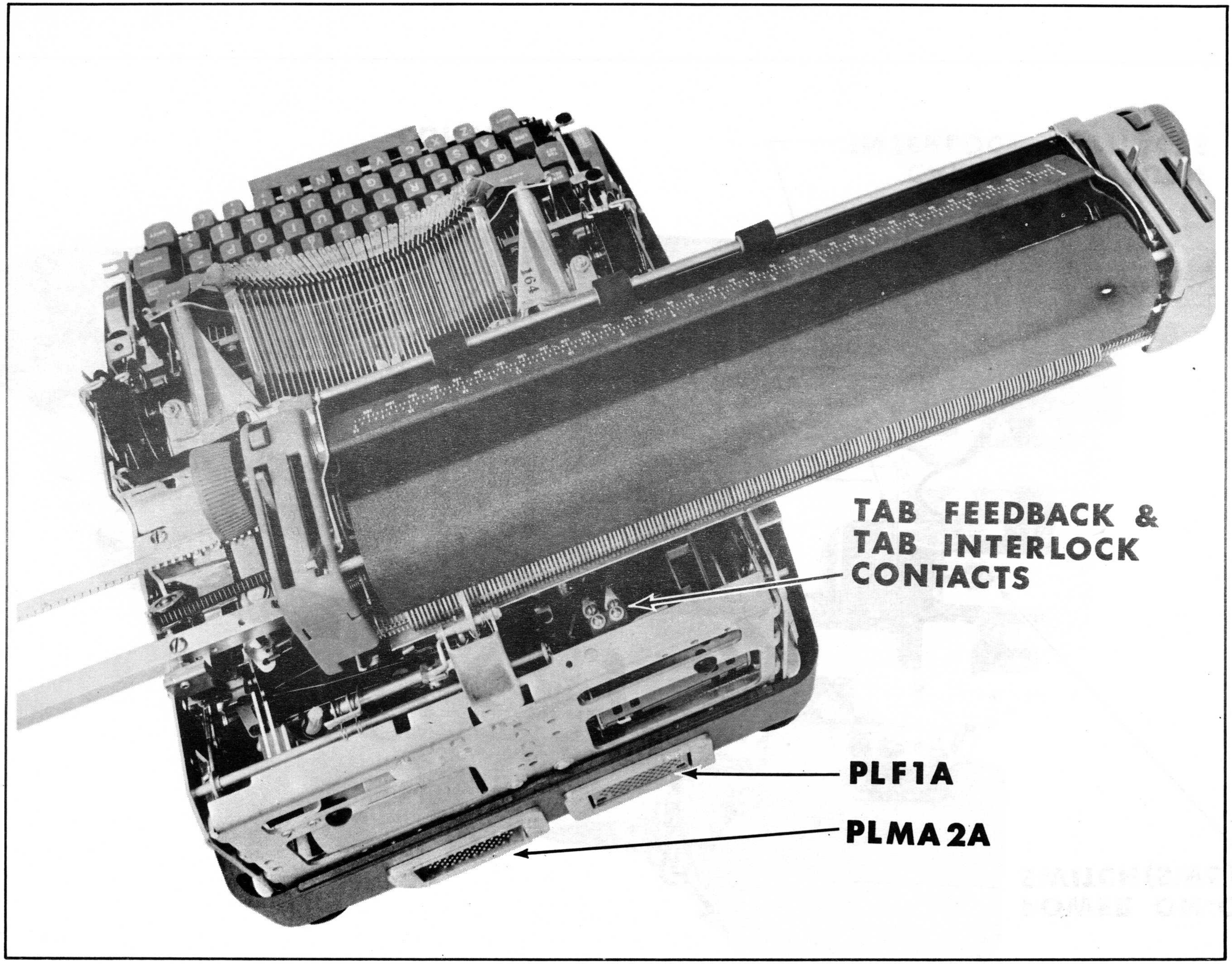


Figure 3-3. Contact Location, Rear, AN Typewriter

associated with them, an input contact and an interlock contact. However, there is no "common" contact involved. Both the tab and carriage return interlocks are constructed so as to stay open during the entire time the carriage is in motion.

Figures 3-1, 3-2 and 3-3 show the locations of various contacts in the typewriter. Figure 3-2 also shows the mechanically operated SHIFT contacts which monitor the carriage position - whether in upper case or lower case position.

The simplified wiring diagram, Figure 3-4, shows how the various contacts are wired inside the typewriter. Appendix Drawing No. 1 shows the complete wiring, together with pin connections to the two plugs on the rear of the typewriter.

3.3 TIMING

When any key is struck, that particular key contact closes. As the key lever moves to strike the paper, it activates the ribbon lift, closing the character common contact. After striking the page, the lever drops back, allowing the common to open before the key contact does. The timing of these two contacts is not critical, the only requirement being that the character common remain closed not less than 30 milliseconds.

Key Contact

Character Common

30 ms. min.

The necessity of this 30 millisecond requirement will be developed in the Section on encoder control.

3.4 RELATION TO COUPLER

The key probe generator is driven from the character common contacts, going through a cycle each time a character is typed. The "key" probe" is returned from the generator to the typewriter, through the key contact and into the encoder matrix. Since space, tab, and CR do not have a common contact, each of them is tied indirectly to the key probe generator as well as the matrix through relays.

The sequence of events, then, is -- as diagrammed in Figure 3-5:

(a) Key contact closes.
(b) Char. common closes, cycling key probe generator.
(c) Key probe is developed and fed back thru key contacts.
(d) Char. common opens, ending key probe.
(e) Key contact opens.

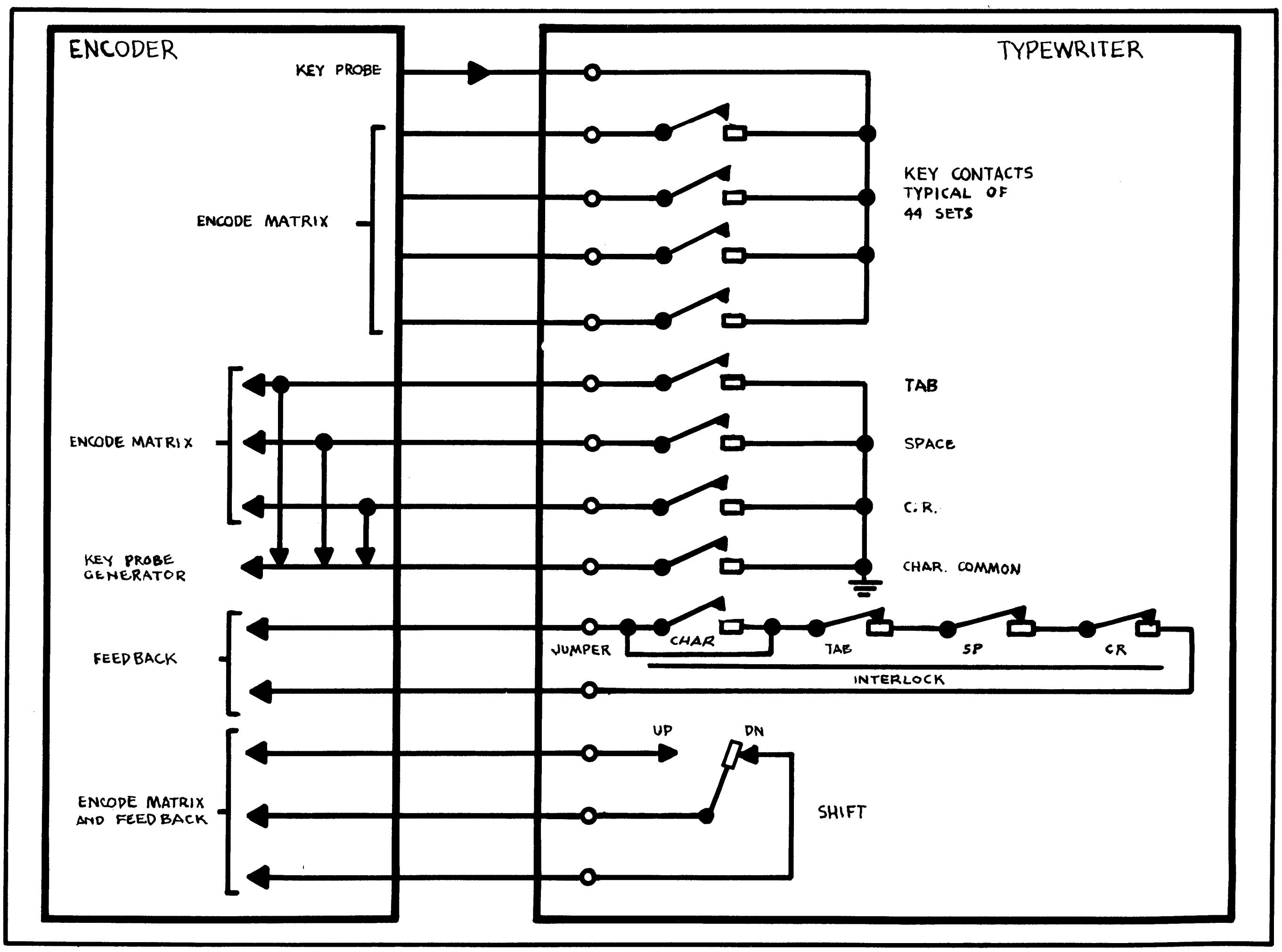


Figure 3-4. Simplified Wiring, AN Typewriter

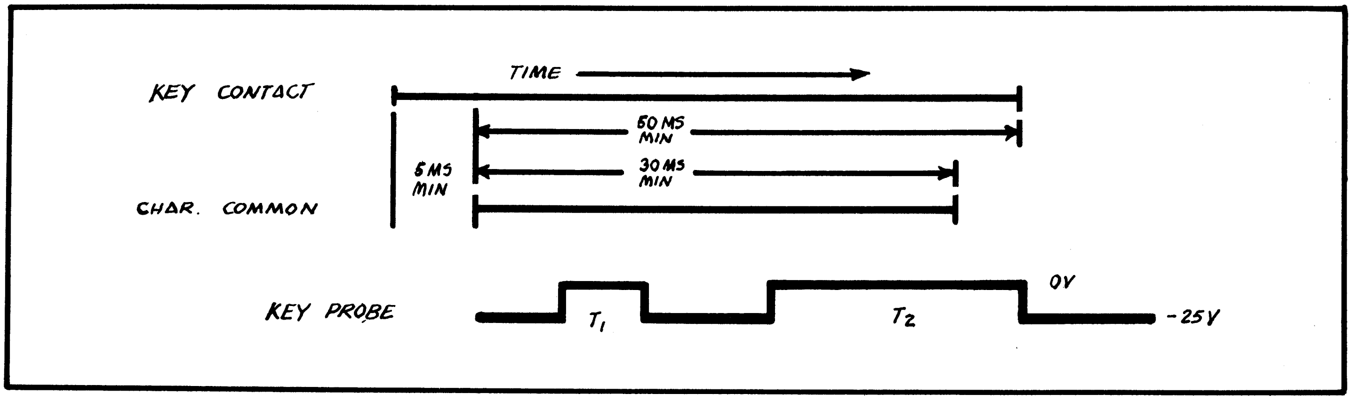


Figure 3-5. Time Sequence, Character Input

SECTION IV

4.0 ENCODING

4.1 GENERAL

There are three general types of information to be fed to the computer.

(a) "Control" information in which the computer is directed to perform certain functions with a single signal rather than a full command. Examples of this type of information are:

M	mark place.
P	read photo tape.
Q	gate numeric type in.
E	gate alphanumeric type in.

(b) "Input" information in which the characters (either letters or numbers) go into memory or are acted upon as commands.

(c) "Feedback" information to tell the computer what is happening to the typewriter. Feedback will be discussed in detail in conjunction with the decoder.

The first type of information to be discussed will be input information. The block diagram of Figure 4-1 shows the general encoding scheme.

The outputs of the encoder rest at -25 volts unless grounded through the typewriter contacts to the zero volt key probe. The probe is a single long pulse of zero volts for HEX, or two, shorter pulses for AN.

The typewriter key contacts are energized through the key probe, and when closed by depressing a keyboard button, ground a series of selection gates which choose appropriate combinations of signals to encode the character. The character is encoded in both hexadecimal and alphanumeric simultaneously. The correct code for the 5 level-lines is chosen by the AN relay, K8, gating either the hexadecimal or alphanumeric lines to the computer. The choice of lines depends on:

$$K8 = AN$$
$$\overline{K8} = HEX$$

Since the alphanumeric characters are encoded in two groups, further separation is supplied by K20. Details of K8 and K20 will be found in paragraph 4.4, Encoder Control.

Level 3 is brought from the encoder through TYPE relay, K10. In an input situation, level 3 is encoded as described under numeric or alphanumeric encoding. In an output mode, it is used as a feedback line.

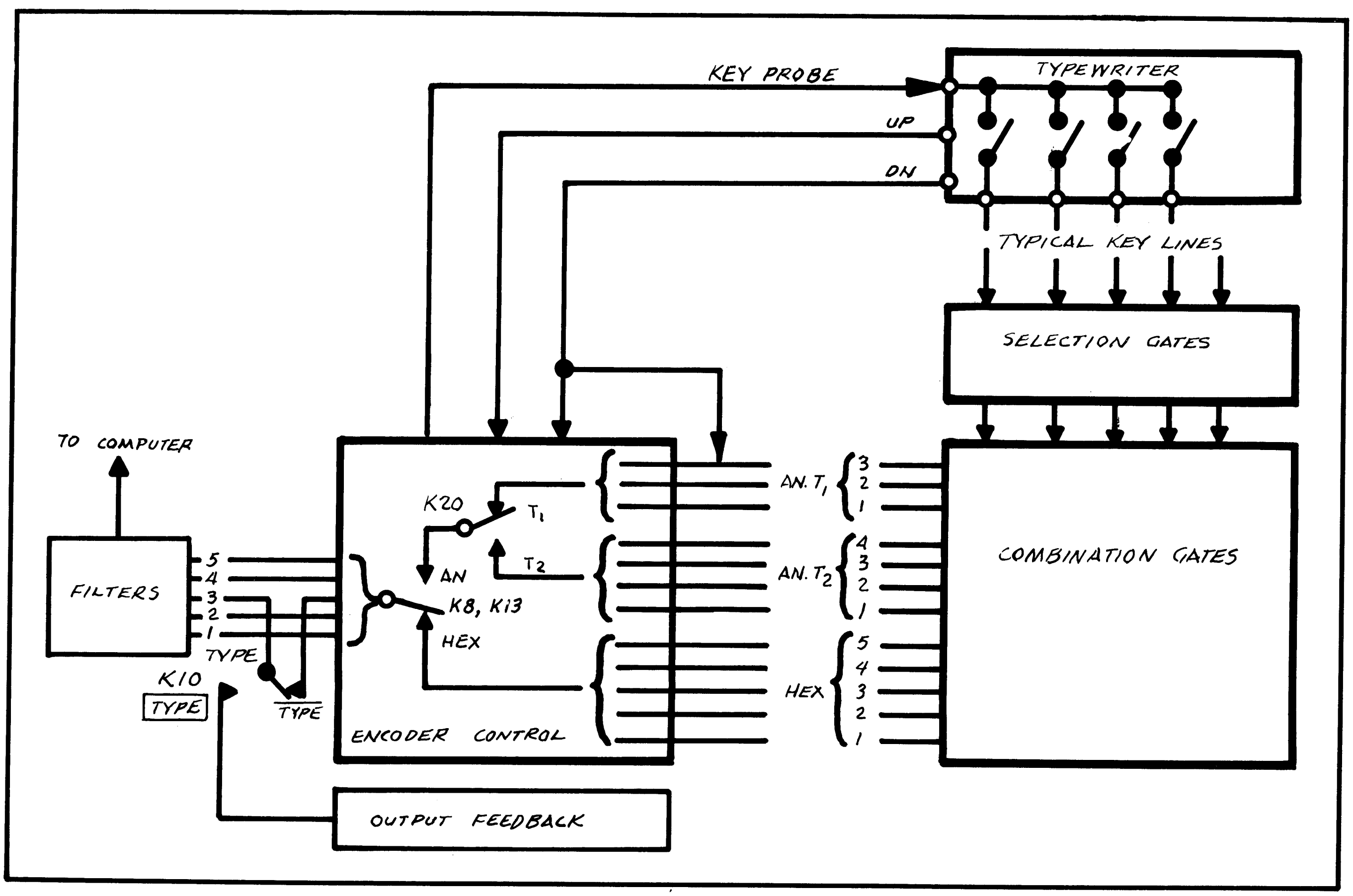


Figure 4-1. Block Diagram, Encoder

4.2 NUMERIC ENCODING

4.2.1 EXAMPLE

When a hexadecimal digit, 7 for example, is struck on the typewriter, the key contacts close, connecting the "7" line to both the key probe line and the matrix. Inside of the matrix, the line goes through a series of selection gates where it chooses the proper combination gates to generate the HEX code 10111. It also generates both the AN, T_1 group and AN, T_2 group at the same time.

The AN relays - K8 and K13 - are not energized, and only the HEX lines are coupled from the encoder to the computer.

Details of the selection and combination gates are found in Appendix Drawing No. 4 - Encoder. Across the top of the drawing are shown some typical typewriter key contacts. With the "7" key contact closed, a circuit is made for the key probe through the selection gates to four combination gates.

AN, T_2 -1	&	HEX-1
AN, T_2 -2	&	HEX-2
AN, T_2 -2	&	HEX-5
AN, T_2 -3	&	HEX-3

These combination gates feed the encoder output lines (both AN and HEX). On the HEX lines, the digit "7" has been encoded (10111). The circuit is then completed through the normally closed side of K8 and K13 to the low pass trash filters and G-15. Level 3 is brought through the normally closed (NOT) contacts of relay K10, the "TYPE" relay. This relay is used in conjunction with feedback in an output situation and will be discussed in some detail with the decoder.

Any other hexadecimal character can be traced through the encoding matrix in the same manner; First, through the selection gates, and then, through the combination gates.

4.3 ALPHANUMERIC ENCODING

In an alphanumeric input, the key probe consists of two pulses, T_1 and T_2 of zero volts, dropping to -25 volts between them. It is evident from the schematic diagram of the encoder that no separation of groups (HEX, T_1 or T_2) is made within the matrix itself. Consequently, during T_1 time, all three codes are generated. The same holds true during T_2 time.

As indicated previously, separation of HEX and AN codes is accomplished with relays K8 and K13. Time separation of the T_1 and T_2 groups is a function of relay K20. K20 is de-energized during T_1 time and couples the T_1 group to the computer through its "Normal" contacts. During the interval between T_1 and T_2, K20 pulls in and during the T_2 key probe couples in the T_2 group to the computer.

4.3.1 EXAMPLE

Using "x" as an example, reference to Drawing No. 66 will show how the required code of 11111 10111 is obtained.

During the closure period of the "x" key contact, selection gates 54, 55, 56, 57 and 58 are utilized as follows:

GATE N		T_1	T_2	HEX
54	Selects the Combination of	00000	00001	00001
55	Selects the Combination of	00000	00100	00100
56	Selects the Combination of	00001	00100	10000
57	Selects the Combination of	00010	00000	01000
58	Selects the Combination of	00010	00010	00000
	Giving a Logical Sum of	00011	00111	11101

It is to be noted that although the encoder is operating in the AN mode, that the code for HEX "x" is actually developed. It is, however, disconnected from the computer input by K8 and K13 as previously described.

The AN code "x" thus far generated is 00011 00111.

Level T_1-3, indicating a lower case character, is taken directly from the T_1 - T_2 generator (K19-1) through $\overline{TYPE}$ (K10 12-10) $\overline{UP}$ (K14A 1-3) to computer input - level 3 through the "Normal" points of transfer relay K20.

During T_1, with K20 in the "Normal" position, computer level 3 is raised to zero volts. During T_2 with K20 in the "Transfer" position, level 3 is directly dependent on what is generated within the encoder. (In this example, also a "1").

The code generated now is: 00111 00111

Level 5 is always forced high for both T_1 and T_2 of <u>all</u> alphanumeric characters. This is accomplished by connecting the output of the T_1 - T_2 generator (K19-1) directly through the "transfer" contact of the AN relay (K13-2-1) to computer input level 5. The result is that level 5 is connected directly to the T_1 - T_2 generator and will be forced high by the generator during alphanumeric input.

Level 4 input is also connected to the generator, but through "Normal" contacts (3-1) of transfer relay K20. Hence, during T_1 it is always high, and during T_2 is dependent on the encoder output.

4.3.2 SPECIAL CHARACTERS

The special characters $, +, (,), *, and =, are upper case characters, coded as lower case. For example: "$", is typed with the combination of shift key and 4 key, that is, "upper case 4". However,

4 = 11100   10100

$ = 11110   11011

the two codes in no way resemble each other, and "$" is not encoded as "upper case 4".

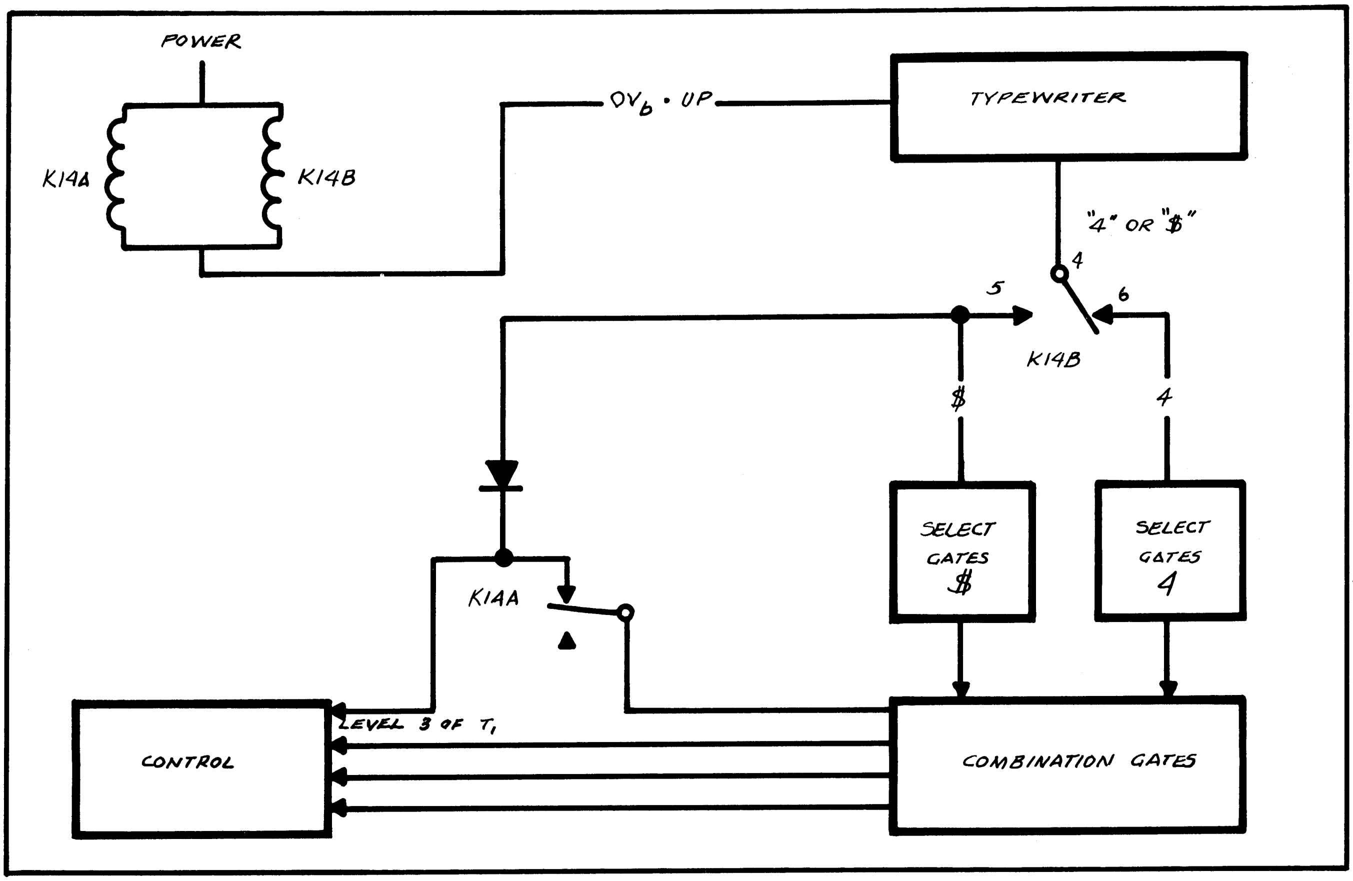


Figure 4-2. Typical Circuit, Special Characters

Since both characters use the "4" key contact and line, provision is made to separate them in the coupler. The circuit of Figure 4-2 accomplishes this separation.

Seven sets of contacts of relays K14A and K14B, following the UP/DN typewriter contacts choose the proper selection gates for the seven special characters.

With K14A energized, the "lower case" signal (level 3 of T_1 group) must be supplied by each special character itself through a diode.

All special characters utilize similar circuits.

4.4 ENCODER CONTROL

4.4.1 K8 and K13

Switching of the AN-$\overline{AN}$ relays (K8 and K13) is accomplished with the HEX-AN signal from the G-15. This relay driving signal operates K8, which in turn controls K13 as shown in Figure 4-3.

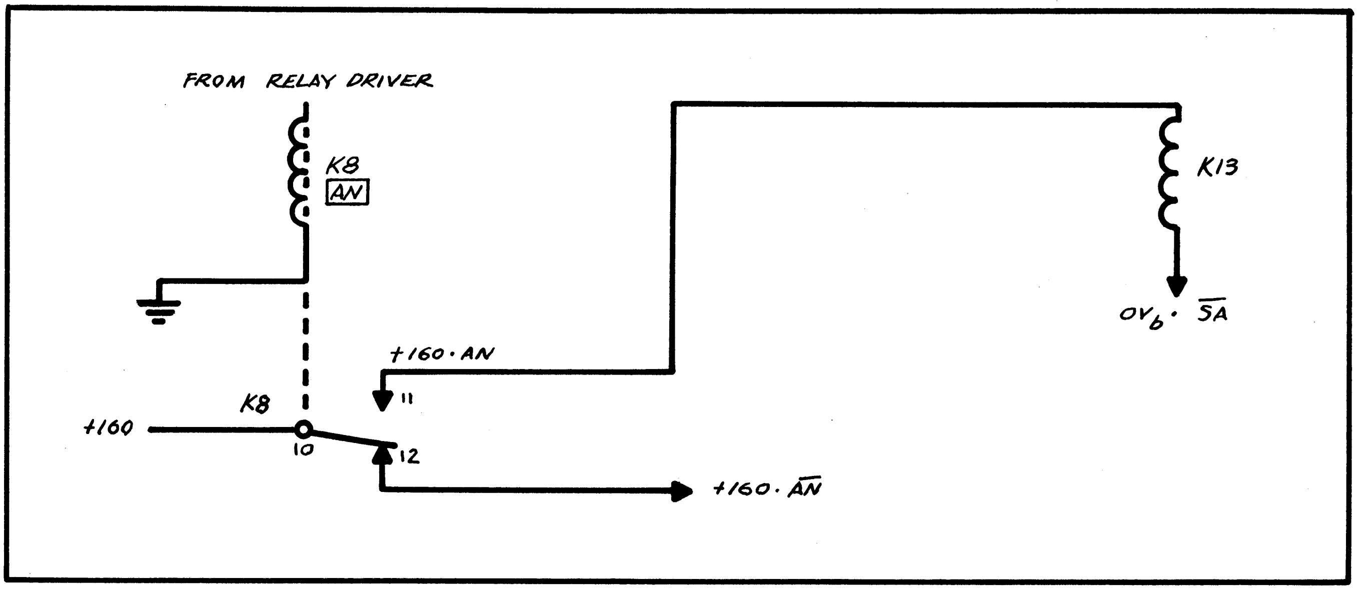


Figure 4-3. AN Relays K8 and K13

K13 is controlled by K8 rather than the signal directly to reduce loading of the tube. It is returned to $OV_b \cdot \overline{SA}$ for reasons that will be discussed in paragraph 4.4.6.

4.4.2 T_1 and T_2 GENERATOR

Generation of T_1 and T_2 and the switching of the AN lines between T_1 and T_2 is a function of relays K18, K19 and K20. The requirements of this circuit are:

(a) The matrix rise to zero volts during T_1.

(b) Drop to -25 volts between T_1 and T_2.

(c) The AN lines be switched between T_1 and T_2.

(d) The matrix rise to zero volts during T_2.

(e) There be a single, long T_1 for HEX input.

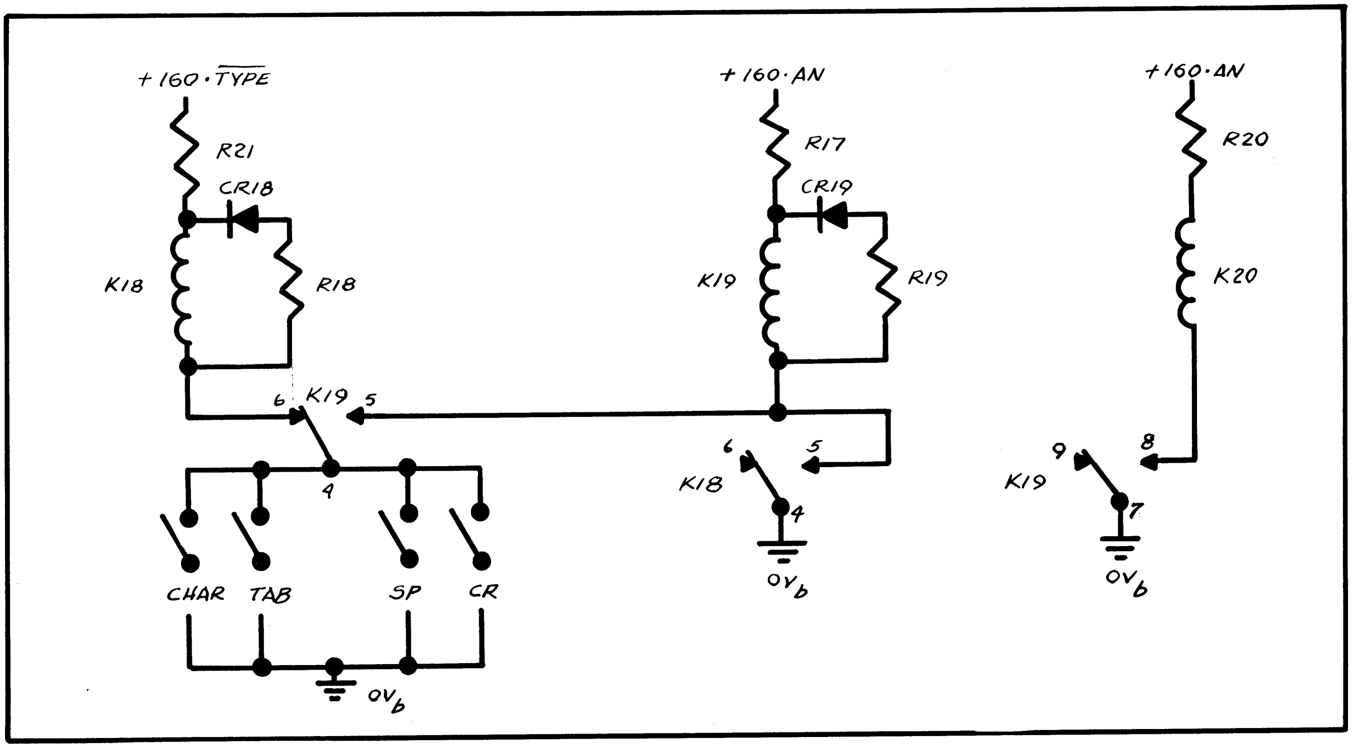


Figure 4-4. T_1, T_2 Generator (Simplified)

The circuit of Figure 4-4 is designed to accomplish these aims. The diode-resistor combination of CR 18, R18 has been chosen to provide a drop out time of at least 15 milliseconds to relay K18. K18 is powered by $+160 \cdot \overline{\text{TYPE}}$ to prevent operation of the circuit during a typeout operation.

When the typewriter contacts of tab, space, carriage return or character common close, K18 is grounded through $\overline{\text{K19}}$-(4-6). K18 pulls in, grounding K19 through K18(4-5). In the HEX mode, this is the end of the operation; K19 and K20, being powered by +160·AN, cannot operate. K18 remains pulled in until the typewriter contacts open again. In the AN mode, K19 pulls in, opening the path of K18, allowing it to drop out, and creating a hold path for itself through its own contacts, K19(4-5).

K19 also grounds the matrix switching relay K20, disconnecting the T_1 lines and connecting the T_2 lines to the G-15. The timing of K18 and K19 is illustrated in Figure 4-5.

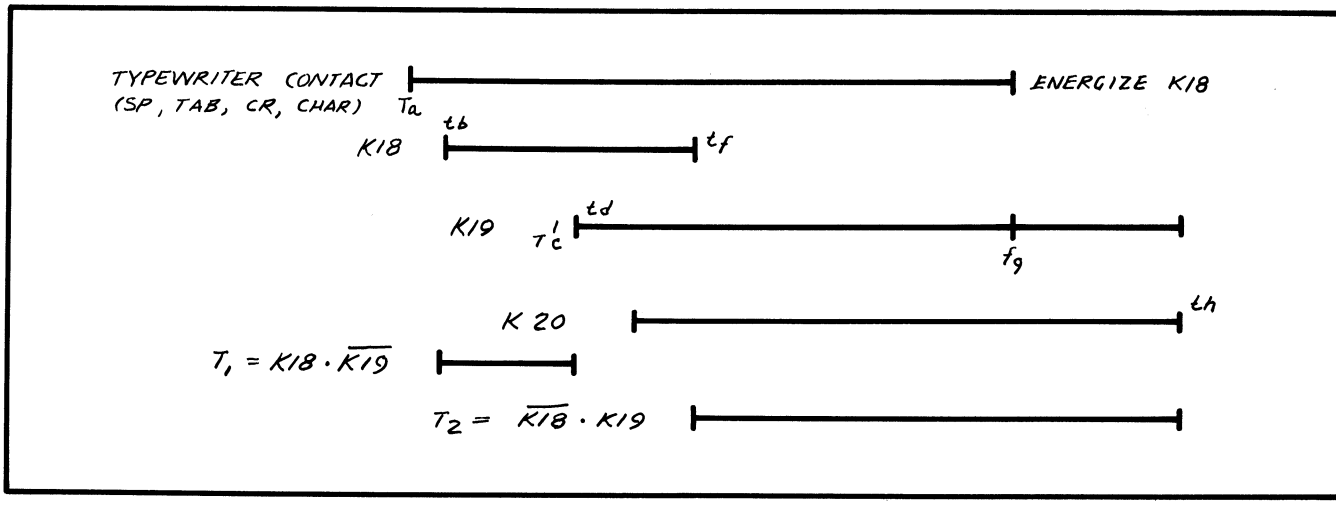


Figure 4-5. Timing T_1, T_2 Generator

(a) At some time, T_a, a typewriter contact closes, energizing K18.

(b) K18 requires a finite time to pull in. Its transfer contacts make at time t_b, completing a path for K19.

(c) K19 normal contacts open at t_c, de-energizing K18. K19 transfer contacts make at t_d, holding the K19 coil.

(d) A finite time later, t_f, K18 contacts drop out.

(e) The typewriter contacts open at t_g, de-energizing K19.

(f) K19 contacts drop at t_h, completing the cycle.

The two groups of AN information are entered into the computer at T_1 and T_2 times, defined as:

$$T_1 = K18 \cdot \overline{K19}$$

$$T_2 = \overline{K18} \cdot K19$$

Relay K20 makes its transition during the period between T_1 and T_2. A detailed timing diagram, including K20 appears in Figure 4-6, which illustrates why the diode-resistor timing circuit is used.

4.4.3 TIMING

The relays have a nominal pull in time of 10 milliseconds. Allowing an additional 50% safety factor gives a maximum pull in time of 15 milliseconds.

A typewriter contact closes at some time, T_a. This closure starts the cycle. Some time later (up to 15 milliseconds), K18 pulls in, making the path for K19. Within 15 milliseconds, at t_d, K19 is pulled in, de-energizing K18, making a circuit for K20, and entering the period between T_1 and T_2 of:

$$\overline{T_1 + T_2} = \text{K18} \cdot \text{K19}$$

K20 is pulled in by t_d +15 milliseconds. And, because of diode-resistor timing combination around K18, the $\overline{T_1 + T_2}$ period will last 15 milliseconds, which is ample time to switch the matrix with K20.

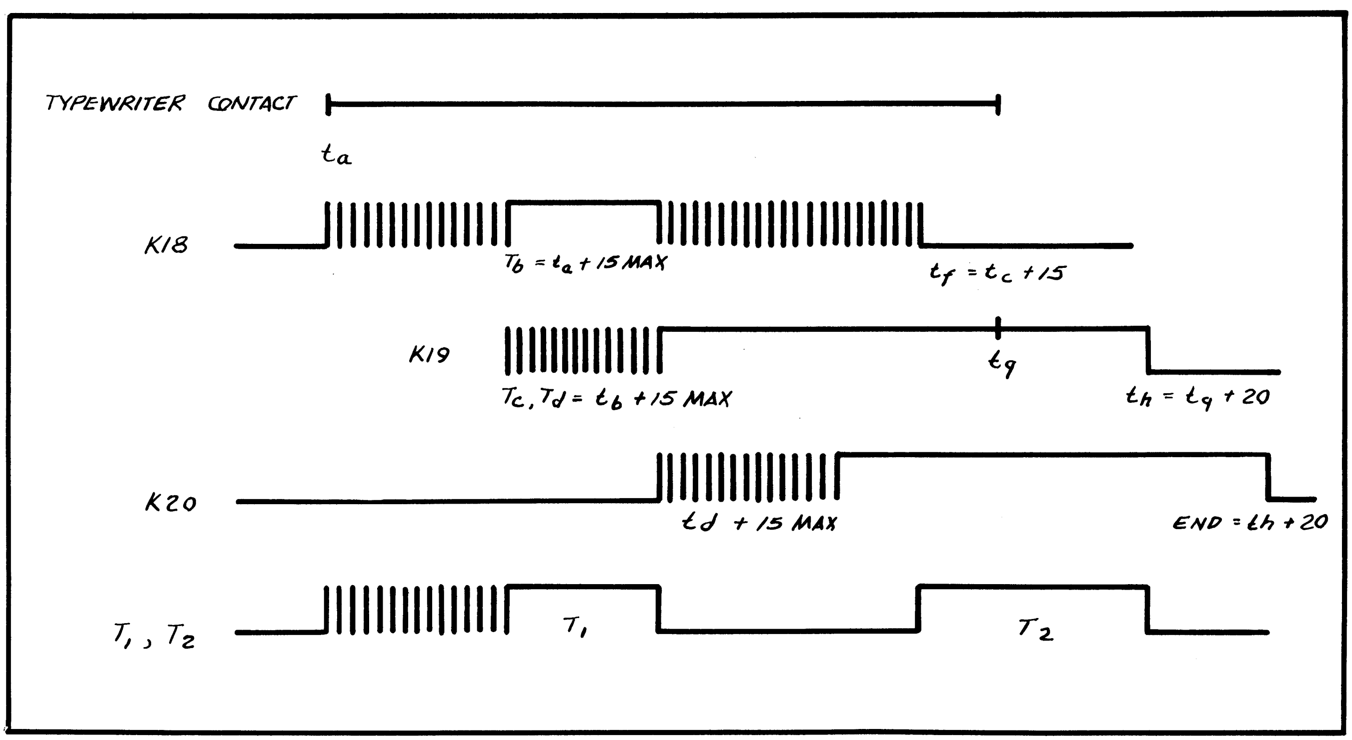


Figure 4-6. Timing Details, T_1 -T_2 Generator and K20 Switch

At the end of T_1 +15, K18 drops out, entering the T_2 period = $\overline{K18} \cdot K19$, which will last until K19 drops out.

The typewriter contacts are required to remain closed long enough for the T_2 lines to be connected to the computer. This time is the summation of three relay pull-in times and could conceivably require 45 milliseconds of contact closure in the typewriter.

The addition of a resistor-diode timing combination around K19, constrains K19 from dropping out until 20 milliseconds after it is de-energized. The typewriter contact, then is not required to be closed for the pull-in time of K20. It can drop out as soon as K19 is pulled in and K20 still has ample time to pull in. The required typewriter closure time, then, is reduced to 30 milliseconds.

30 milliseconds of closure is entirely reasonable to expect of the character common and carriage return contacts.

4.4.4 SPACE, TAB, CARRIAGE RETURN

If tab, space, and carriage return were encoded directly from their typewriter contacts without major rewiring of the typewriter, power ground (OV_b) would be introduced into the encoder, and mixed with logic ground (OV_a). To eliminate this condition and its attendent transient problems, buffer relays K15, K16, and K17 are added.

These relays also offer advantageous possibilities of timing and encoding as discussed below.

The space and tab contacts may not remain closed for 30 milliseconds without special adjustment. To prevent the necessity of adjustment, advantage is taken of buffer relays K15 and K16.

The typewriter space and tab contacts energize K15 and K16 respectively, instead of K18 directly. The K18 connection is made through the transfer contacts of the relays. Both relays are timed with

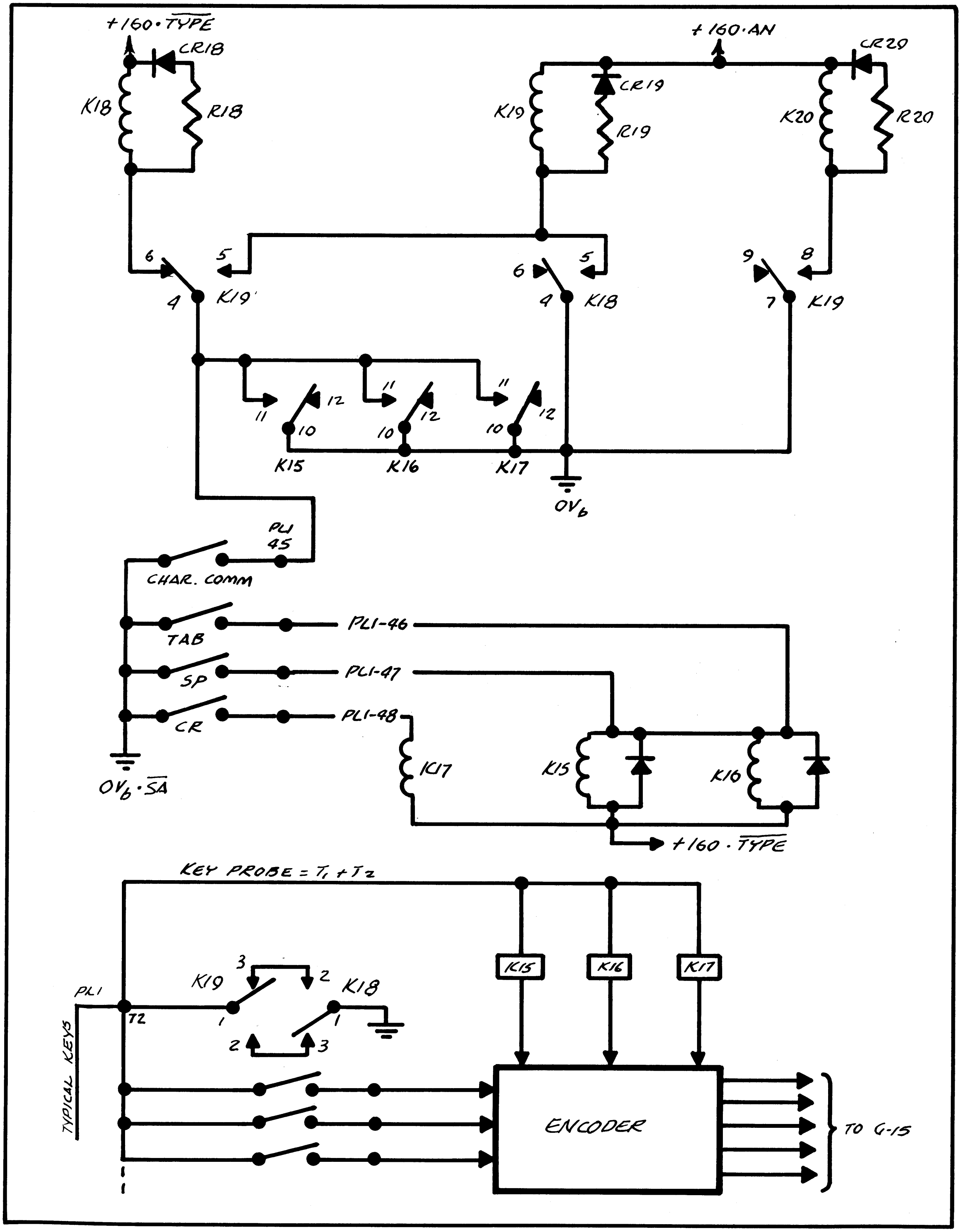


Figure 4-7. Details, T_1, T_2 Generator and Control

diode combinations to remain closed for at least 30 milliseconds which is ample time for T_1 -T_2 generation.

Closure time of the space and tab typewriter contacts is, thus, reduced to 15 milliseconds (maximum pull-in time of K15 or K16), a reasonable figure.

The carriage return contact also energizes a buffer relay, K17. K17 serves as a mechanical filter for carriage return contact bounce. The mechanical inertia of the relay effectively filters out long period bounce, while any bounce introduced by the relay contacts themselves is fast enough to be filtered with RC circuits.

Since only one set of points is required of any of these buffer relays, the spare points are used to encode the characters in place of additional matrix diodes.

Figure 4-7 shows the more detailed form of the T_1, T_2 generator and key probe. Notice that the character common, tab, space, and carriage return ground for K18 is shown as qualified with $\overline{SA}$. The reasoning behind this qualification will be developed in paragraph 4.4.6.

4.4.5 CONTROL KEYS

The keys Ⓢ, F, T, R, Q, M, I, E, C, B, and A are control keys. In conjunction with the enable signal, they cause specific operations to take place in the computer.

In addition to being connected into the encoder, these keys are taken directly to the computer, where they are gated internally by < SA >. The typewriter keys themselves are gated with the key probe, and for the benefit of these twelve control keys is added "SA", giving for the probe:

$$\text{key probe} = (T_1 + T_2) + SA$$

The < SA > signal to the computer has been modified to:

$$< SA > = SA \cdot \overline{TYPE}$$

The result is two different enable signals;

SA (used only in the coupler) = enable

$< SA >$ (used in computer) = $SA \cdot \overline{TYPE}$

which are existant in the coupler. This modification of the signal causes no change whatsoever in the G-15, either in hardware or programming. The reason for modification lies in the habit of many computer operators of using the enable switch to temporarily interrupt a typeout. There is a possibility that if certain characters are being typed when the enable switch was turned ON, the state of the computer would be changed.

For example: in typing out memory line M19, the OC flip-flops have the configuration 1001. If the enable switch is turned ON while a "B" is being typed, the signal $< SA > \cdot B$ would enter the computer, changing the OC configuration to 1111--READ PHOTO TAPE--and the photo reader would turn ON.

If "R" were being typed, a RETURN signal would be sent in, disrupting both AR and the command register. The program would be lost.

By making $< SA > = SA \cdot \overline{TYPE}$, a typeout operation can be interrupted with the enable switch, but the G-15 signal < SA > will remain low. Figure 4-8 shows the gating of the signal.

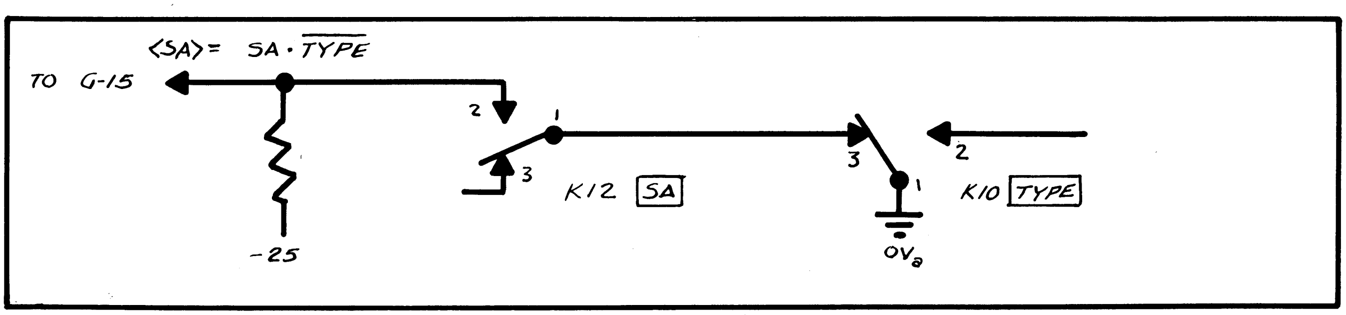


Figure 4-8. Generation of $< SA > = SA \cdot \overline{TYPE}$

4.4.6 SA and $\overline{SA}$

While the SA signal is high, only the twelve control keys should be typed. However, it often happens that an operator will strike the TAB, CR, or SPACE keys with SA, resulting in an unwanted code entered into the computer.

This problem is prevented by grounding the TAB, CR, and SP input contacts to $OV_b \cdot \overline{SA}$ rather than OV_b. It is impossible to energize tab, space, or carriage return buffer relays with the enable switch ON. Hence, the associated codes cannot be generated.

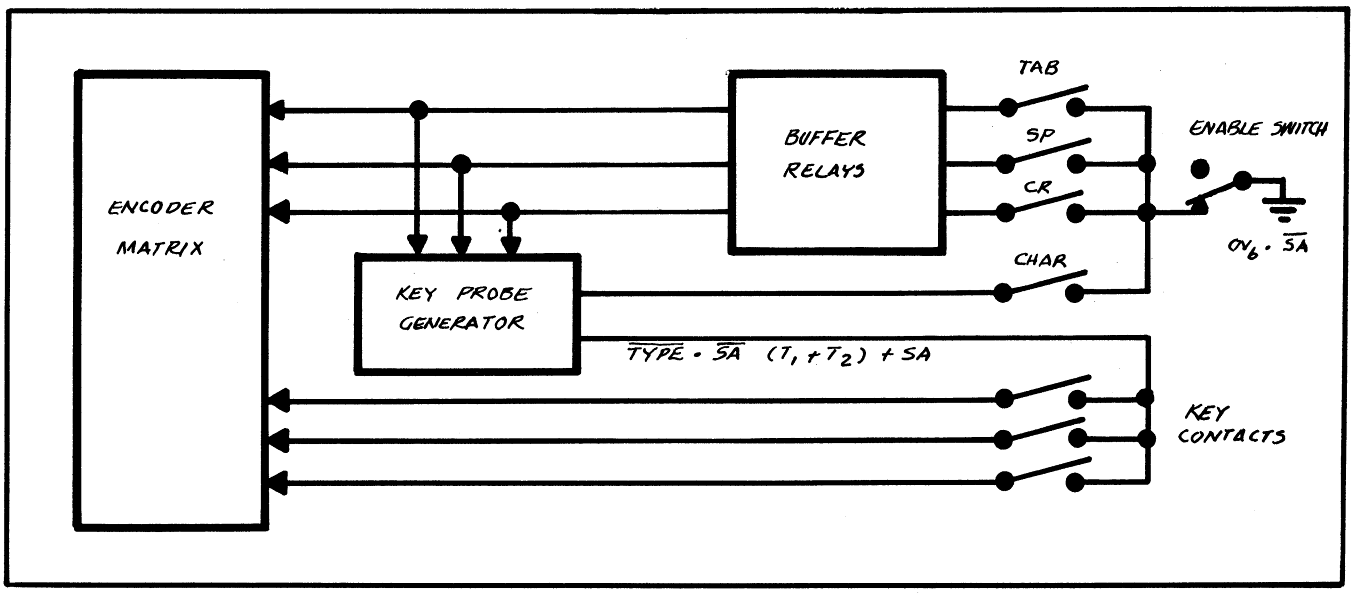


Figure 4-9. Gating of Characters with $\overline{SA}$

The key probe generator is returned to $OV_b \cdot \overline{SA}$ through the input common contact and typewriter enable switch, giving the equation:

$$K18 = +160 \cdot \overline{TYPE} \cdot \overline{SA} \cdot (CHAR + SP + CR + TAB)$$

while the key probe itself is:

$$KEY\ PROBE = \overline{TYPE} \cdot \overline{SA} \cdot (T_1 + T_2) + SA$$

The key probe is developed as shown in Figure 4-10.

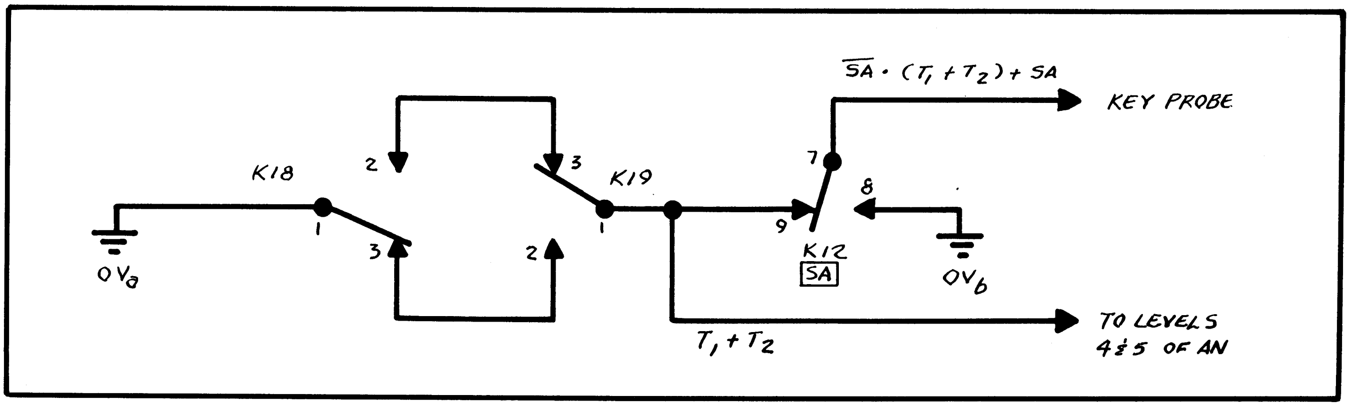


Figure 4-10. Key Probe Signal

Relay K13 is also controlled by $\overline{SA}$, with the equation:

$$K13 = K8 \cdot OV_b \cdot \overline{SA}$$

This is necessitated by the E key being both a control key and a legitimate alphanumeric character. When choosing alpha gate type-in, the E key is struck with enable ON, giving the signal < SA > •< E >. The computer enters the "SLOW IN" state immediately and is receptive to codes, including the E Key whose contacts would still be closed.

Gating K13 with SA eliminates this problem by keeping levels 1, 2, 3, and 5, the encoder output, in the HEX mode until the enable switch is returned to OFF. Since there is no E code in HEX and there is no level 4 in T_1 of the AN code, the output remains at -25. By the time the physical motion required to return the enable switch to OFF is complete, the E key contacts are open again.

4.4.7 HC BUFFER INVERTER

If the encoder output lines drive HC directly, any bounce or trash on them could cause multiple codes to enter the computer. To eliminate that possibility, the output lines are heavily filtered with low pass filters and final control of HC is taken from them and given to the T_1, T_2 generator. The $(T_1 + T_2)$ key probe supplies the drive signal. This signal is operated on so that it rises to zero volts before the input lines, and falls back to -25 volts after the input lines. The circuit appears in Figure 4-11.

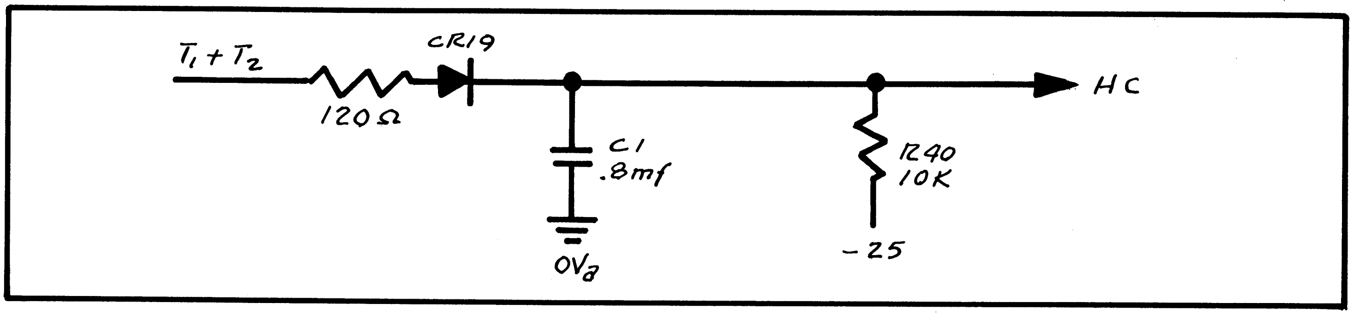


Figure 4-11. Fast Rise, Slow Fall Circuit

In the quiescent state, C_1 is charged to -25 volts. When T_1 or T_2 goes to zero volts, C_1 is discharged very rapidly by a current flow through diode CR_{19}. With only 120 ohms of series resistance, the time constant of this discharge is:

$$T = RC = 120 \times .8 = 96 \text{ microseconds}$$

If contact bounce exists in the T_1, T_2 generator, the input to the circuit floats during the bounce. Deprived on the ground signal, the output charges again toward -25 volts. However, the charge path is through R_{40}, 10 kilohms, in parallel with the high input resistance of HC. The resulting charge time constant is almost 10,000 microseconds.

The circuit, then, is a fast rise, slow fall circuit and overrides contact bounce in the T_1, T_2 generator. Figure 4-12 illustrates this filtering action.

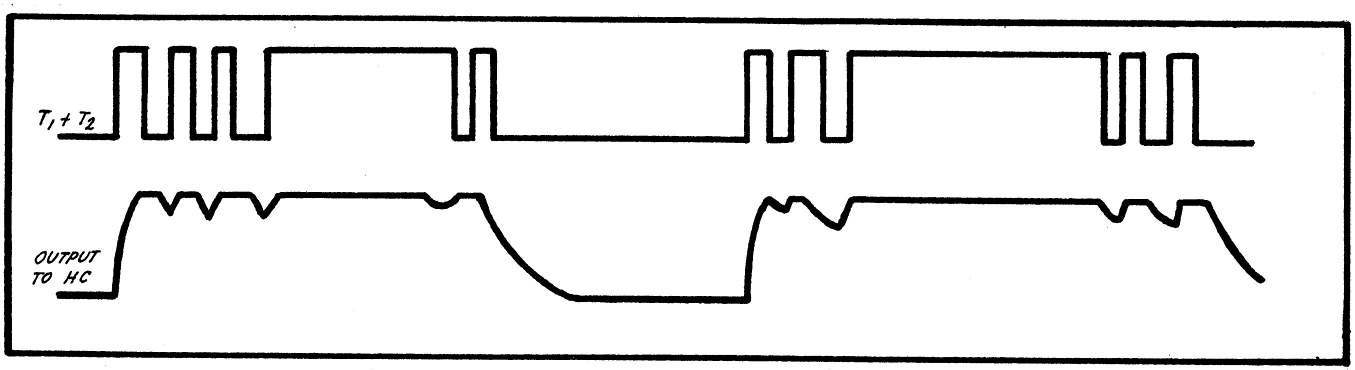


Figure 4-12. Output, Fast Rise, Slow Fall Circuit

A refinement is made to the circuit of Figure 4-11 to further increase the fall time during T_1 and T_2.

While it is desirable to lengthen the fall time as much as possible, a limit is reached when the OB reset term becomes marginal between T_1 and T_2.

To lengthen this time constant <u>during</u> T_1 and T_2 but not <u>between</u> T_1 and T_2. resistor R40 is carried to -25 volts through a relay configuration representing $\overline{T_1 + T_2}$.

$$T_1 = K18 \cdot \overline{K19}$$

$$T_2 = \overline{K18} \cdot K19$$

$$\overline{T_1 + T_2} = K18 \cdot K19 + \overline{K18} \cdot \overline{K19}$$

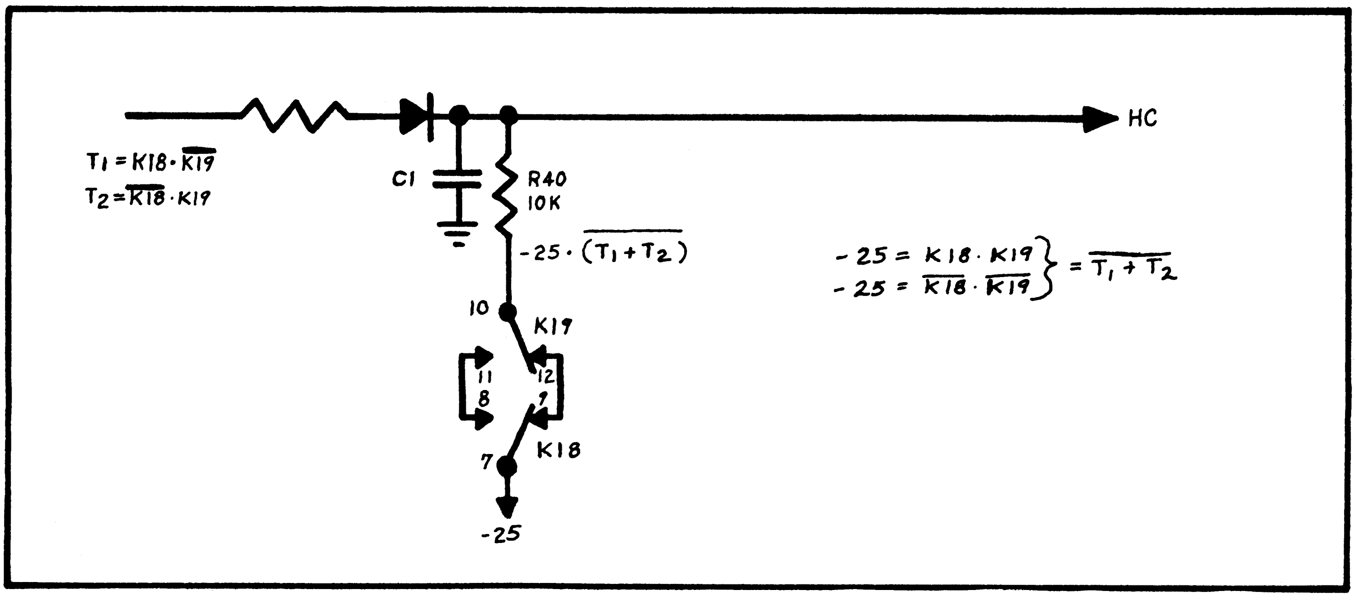


Figure 4-13. Refined, Fast Rise, Slow Fall Circuit

In Figure 4-13, it is seen that resistor R40 is carried to -25 volts as a function of the $\overline{T_1 + T_2}$ equation.

During $T_1 + T_2$, R40 is disconnected from -25 volts and the charge path of C_1 is through the high input resistance of the HC buffer inverter. This circuit will allow C_1 to charge approximately 1/3 volt for each millisecond of bounce.

4.5 ENCODER - DESIGN CRITERIA

In examining the encoder it will be noted that many redundancies exist. For example, the "C" key raises level T_1 -1 in TWO WAYS:

A9PF ⟶ A20TC T_1-1
A9NJ ⟶ A20RE T_1-1

These redundancies are deliberate; they afford component economy and reduce the forward current requirement of many diodes.

It will also be noted that no more than two diodes will exist in series with ground and a level-line output to the computer.

In many cases (e.g. the H key) no diodes were needed since isolation is obtained by virtue of open contacts.

In the numeric encoder TAB and CARRIAGE RETURN generate the same code (00010) since their input control functions are identical and the extra hardware required for different codes would be useless.

Four major design criteria were used:

1. Circuit should operate with diode reverse resistances reduced to 100 kilohms.
2. Maximum forward voltage drop in any diode may reach one volt.
3. A "logical absence" signal should not rise above -15 volts at any time.
4. A "zero" volt signal should not fall below -2 volts at any time.

These considerations constrict the design of the encoder matrix by:

(a) Combining (2) and (4) specifies that not more than two forward conducting diodes may be in series with a zero volt signal.

(b) Combining (1) and (3) specifies the maximum number of diode reverse resistances that may be connected to any line.

When any output line is raised to zero volts, all other lines connected to it through a reverse biased diode will tend to rise also. Figure 4-14 shows a line with N diodes connected between it and another line. The zero signal applied should raise output #1 to zero volts, while output #2 remains at -20. The resistance of 4.7 kilohms represents the pull down resistor for that line as found in the trash filter circuits.

Figure 4-15 shows the equivalent circuit when SW-1 is closed and SW-2 is open. R_b is the parallel reverse resistance of all the diodes between the two lines.

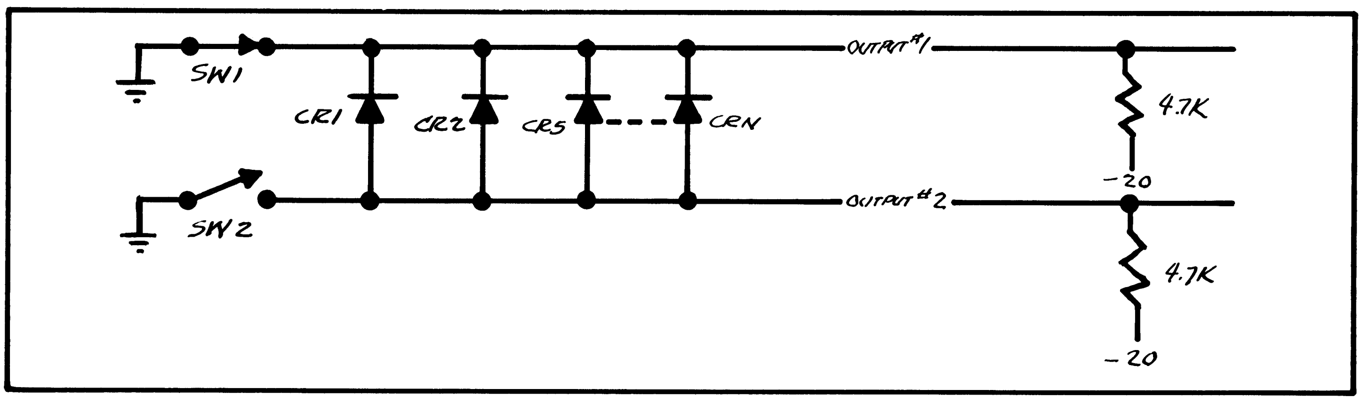


Figure 4-14. Schematic, Two Output Lines

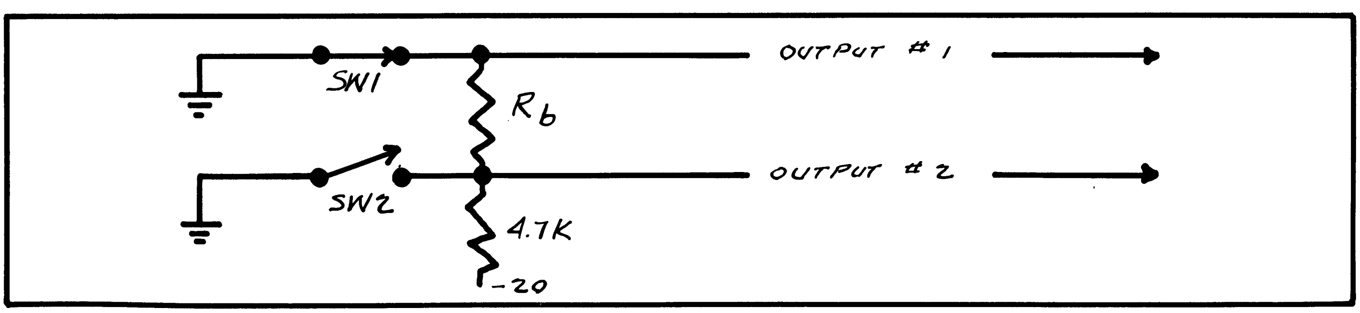


Figure 4-15. Equivalent Circuit of Figure 4-14

The paralleled reverse resistances of N diodes forms a voltage divider with the 4.7 K resistor to -20 volts. The output voltage of line #2 will be:

$$Eo_2 = \frac{-20\ R_b}{4.7K + R_b}$$

From criterion #3, Eo_2 may not exceed -15 volts.

$$-15 = \frac{-20\ R_b}{4.7K} + R_b$$

$$R_b = 14.1\ K.$$

From criterion #1, if each diode reverse resistance = 100 K, and N = the maximum allowable number of reverse resistances between lines 1 and 2, then,

$$N = \left[\frac{100K}{14.1\ K}\right] = 7.$$

Hence, not more than 7 diode back resistance are allowed to load any output line.

Although the matrix could have been designed with fewer diodes, the restrictions of 7 back resistances and 2 forward voltage drops results in increased reliability.

SECTION V

5.0 DECODER

5.1 GENERAL

The decoder portion of the ANC-2 is composed of three relay decoders; one for numeric, one for alphanumeric, and one for special characters.

The AN relay (K8), under the control of the AS flip-flop, chooses either the AN or numeric decoder. The special character decoder is a special case of alphanumeric decoding where the characters are coded as lower case, but still cause the typewriter to shift before typing. Figure 5-1 shows a Block Diagram of the three decoders.

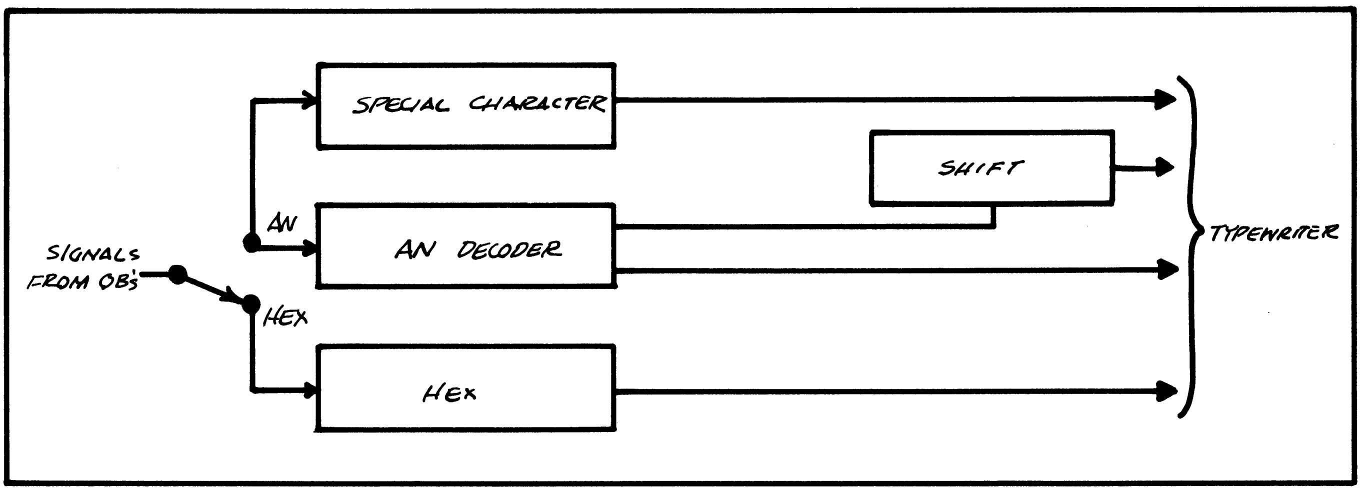


Figure 5-1. Block Diagram, Decoder System

Signals from the G-15 are brought to the coupler through relay driver tubes to a series of relays, the K1 through K5 series, corresponding to the five output levels of the computer. As shown in Figure 5-2, the relays are carried to +160·TYPE. Gating them with TYPE precludes their chattering needlessly during an input operation.

The TYPE relay, K10, follows the G-15 TYPE signal. This is not to be confused with the TYPE PULSE which drives the EXECUTE relay K9. The TYPE signal is a configuration of the OC flip-flops and remains steady for the entire duration of a typeout operation.

The TYPE PULSE is an execute pulse that finally energizes the appropriate typewriter solenoid.

The relays of Figure 5-2 are set up and held by the OB flip-flops, creating a path through the contact matrix. The TYPE PULSE, operating EXC relay K9 energizes the chosen typewriter through this path.

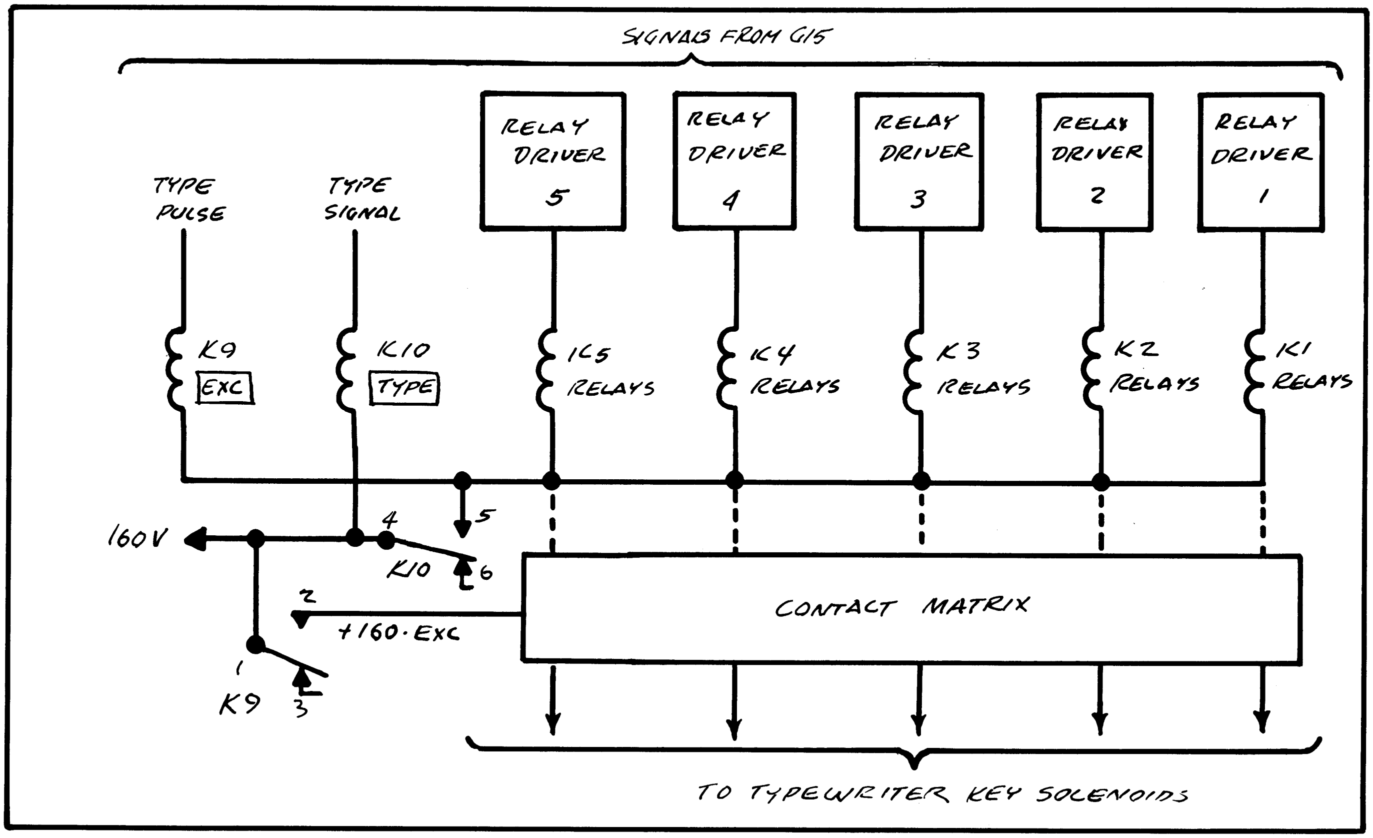


Figure 5-2. Character Signal Relays, ANC-2

5.2 NUMERIC DECODING

Table 5-3 charts the required output codes for a numeric type-out. The decoder is designed to respond to these codes with a straight-forward relay tree.

CODE	1 0000	1 0001	1 0010	1 0011	1 0100	1 0101	1 0110	1 0111	1 1000	1 1001	1 1010	1 1011	1 1100	1 1101	1 1110	1 1111	0 0000	0 0001	0 0010	0 0011	0 0110
	0	1	2	3	4	5	6	7	8	9	U	V	W	X	Y	Z	SP	-	CR	TAB	.

DIGITS (0 – Z) FORMAT (SP – .)

Table 5-3. Output Codes, Numeric Mode

In Figure 5-4, diodes are added to the K1, 2, 3, and 4 relay series, while capacitors suppress the inductive transients of K8, K9 and K10. The diodes serve both as transient suppressors and timing control.

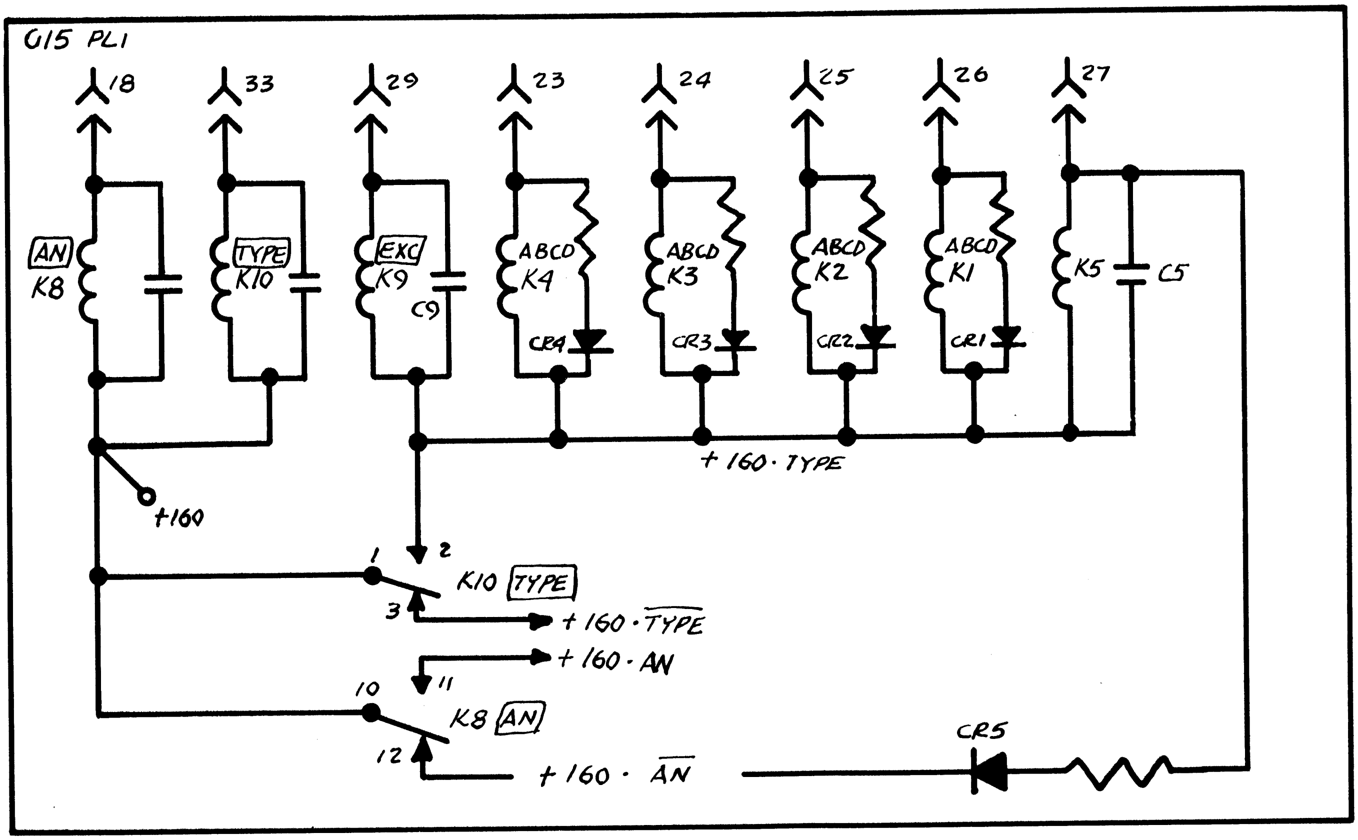


Figure 5-4. Decoder Control, Numeric Decoder

It is desirable that only the heavy duty contacts of EXC relay K9 break the inductive load of a typewriter solenoid. Since all relays are de-energized simultaneously, without timing control, the fastest relay would break the load. Introduction of a diode around the coils, holds up drop out time approximately 20 milli-seconds; ample for K9 to drop out first.

For reasons to be developed in Paragraph 5.3.2, it is necessary to remove the diode around K5 during an alphanumeric typeout. Hence, CR5 is connected to +160·$\overline{AN}$ instead of +160·TYPE. It is seen that the diode will float during an alphanumeric typeout, with the coil being suppressed with C5 only.

Refer to Appendix Drawing No. 2, Decoding Tree. A numeric character, 5, for example, can be traced through the tree. From Table 5-3., the code for the digit 5 is seen to be 10101, indicating that relay series K1, K3 and relay K5 are energized. In the numeric mode, K8 is de-energized.

A circuit is made at EXC time through K9(4-5) = $\overline{\text{K8}}$(4-6) = K5(1-2) =K3B(7-8) = $\overline{\text{K2C}}$(4-6) = K1D(1-2) = $\overline{\text{K4C}}$(7-9) and into the typewriter solenoid through PL2A-37.

Any other numeric character may be traced the same way.

5.2.1 NUMERIC FEEDBACK

Feedback is restricted to the tab, space, and carriage return functions. In Figure 3-4 is seen the series connection of typewriter interlocks. These interlocks are carried through typewriter plug PL2A-54 and PL2A-57 into the coupler feedback circuit of Figure 5-5.

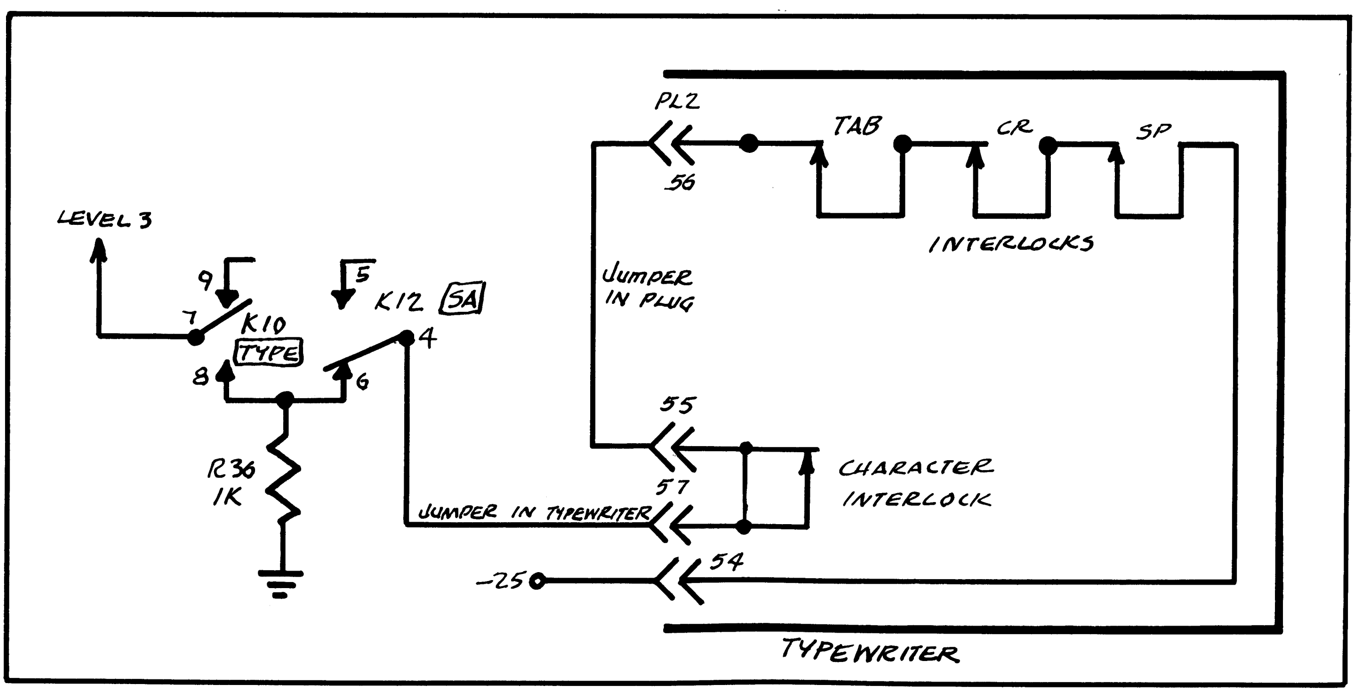


Figure 5-5. Numeric Feedback

As mentioned previously, level 3 is used as the feedback line. During an output operation, it is held at -25 volts through enable relay $\overline{\text{K12}}$, and the interlocks. The opening of any interlock or the turning ON of the enable switch removes the -25 volts, allowing level 3 to be pulled up to nearly zero volts through the 1 kilohm resistor.

Level 3 will raise HC (but cannot reset OY), preventing further output until the interlock closes again or the enable switch is returned to OFF. It should be noted that the character interlock in the typewriter is shorted out, preventing feedback. It may be removed where a slower type-out rate is desired.

5.3 ALPHANUMERIC DECODING

5.3.1 GENERAL

Just as alphanumeric information enters the computer in two groups, it is extracted in two groups termed the <u>first</u> and <u>second</u> extraction. Table 5-6 charts the output codes for the two extractions.

1ST EXTR.	2ND EXTRACTION														
	0 0000	0 0001	0 0010	0 0011	0 0100	0 0101	0 0110	0 0111	0 1000	0 1001	0 1010	0 1011	0 1100	0 1101	0 1110
1 1101	+	A	B	C	D	E	F	G	H	I	>	.	)	;	∧
1 1110	–	J	K	L	M	N	O	P	Q	R	CR	$	*	TAB	
1 1111	°	/	S	T	U	V	W	X	Y	Z		,	(	SPACE	
1 1100	0	1	2	3	4	5	6	7	8	9		=			
1 1001		A	B	C	D	E	F	G	H	I	<	?		:	∨
1 1010		J	K	L	M	N	O	P	Q	R					
1 1011			S	T	U	V	W	X	Y	Z		↑			
1 1000		¬		→			≠	[	]						

Table 5-6. Output Codes, Alphanumeric Characters

5.3.2 LOGIC

The OB flip-flops, as shown in Figure 5-7, receive the first extraction from the OA's, transfer it to the coupler, clear, receive the second extraction from the OA's and transfer that information to the coupler.

Recall that the relay series K1's through K5 follow the OB flip-flops. Since the OB's reset between extractions, the first extraction information must be remembered by the coupler until it can be combined with the second extraction to completely identify the character.

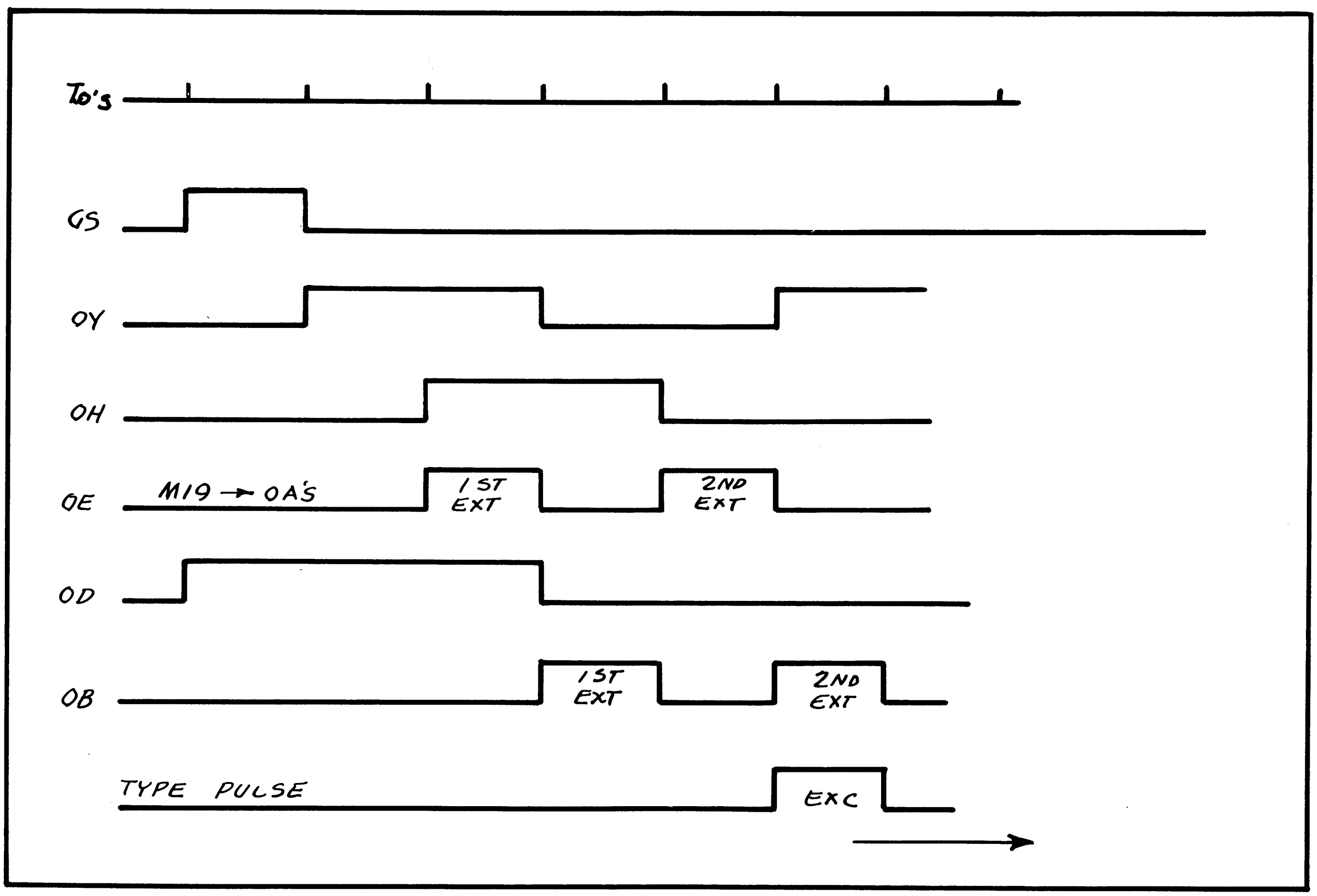


Figure 5-7. Basic Computer Timing, Alphanumeric Output

As an example, from Figure 5-6, the output code for "a" is seen to be:

11101 00001.
(first ext) (second ext)

Recalling that "a" or "A" is identified by:

xxx01 x0001,

and specifically lower case by:

xx1xx xxxxx.

levels 1, 2, and 3 of the first extraction must be examined by the decoder. If level 3 is a zero, the shift solenoid of the typewriter must be energized and held until the type pulse arrives. The shift circuit will be discussed in detail later.

The three levels are to be remembered by the coupler only if they occur during first extraction. Hence, a method of identifying first extraction is necessary. This is done with level 5.

LEVEL 5 = first extraction

$\overline{\text{LEVEL 5}}$ = second extraction.

This identification is confirmed in Table 5-6. In all alphanumeric codes, first extraction has level 5, while second extraction does not. To the coupler, then,

LEVEL 1 • LEVEL 5 = remember
LEVEL 2 • LEVEL 5 = remember
LEVEL 3 • LEVEL 5 = shift and hold.

Refer to Figure 5-8. K6A, B, and C remember level 1 of first extraction. K7 remembers level 2 of first extraction.

$K6_{(pick)}$ = LEVEL 1 • LEVEL 5
$K7_{(pick)}$ = LEVEL 2 • LEVEL 5.

If level 1 is present during first extraction, a circuit is made for K6 through K1D(10-11) --K5 (8-7) and the 1 Kilohm, current limiting resistor.

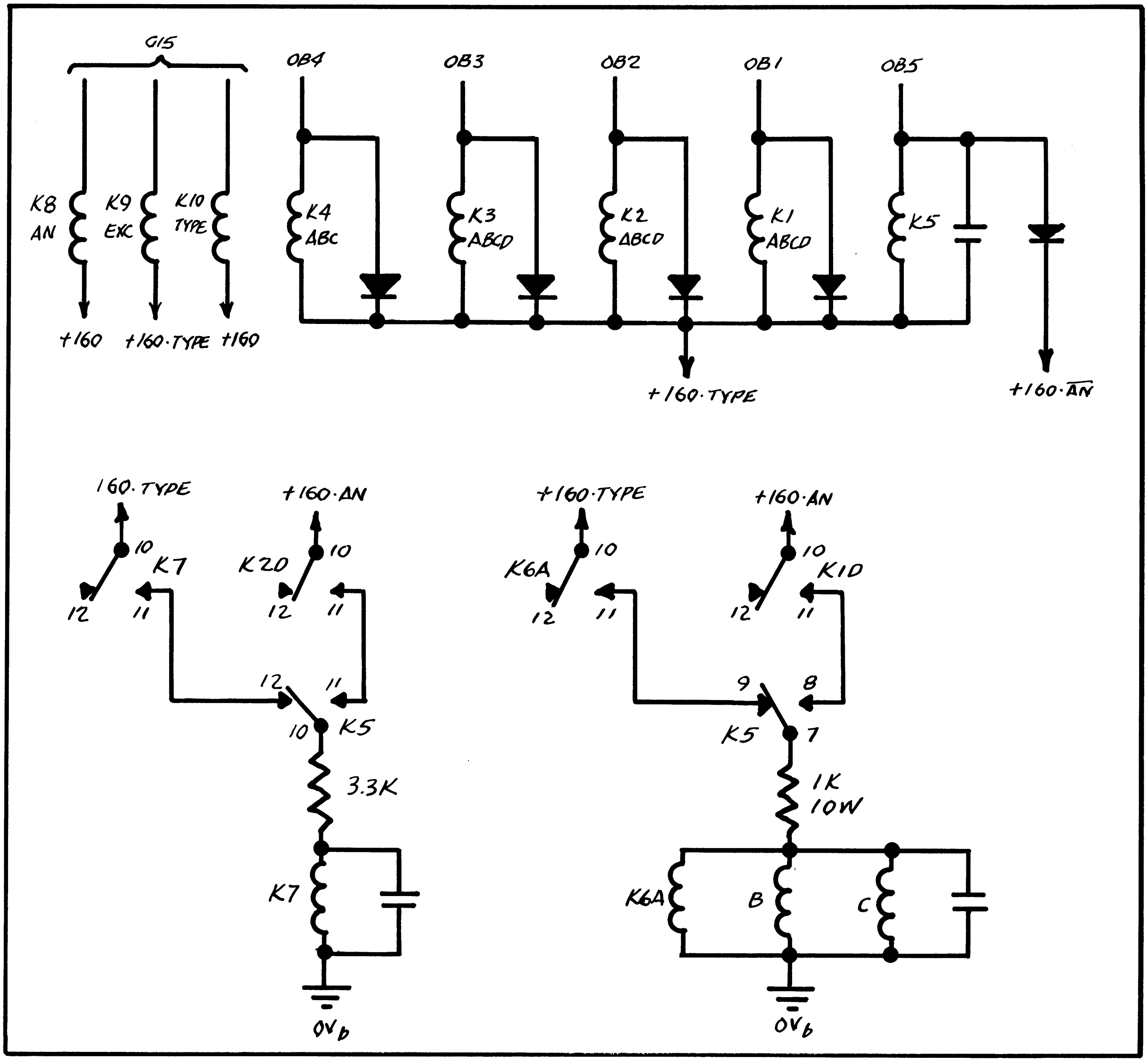


Figure 5-8. K6 and K7, Pick and Hold Circuits

Level 2 and level 5 energize K7 through K2D(10-11) and K5(10-11).

Examination of the K7 circuit indicates that when the OB flip-flops reset, all relays following them, including K2D and K5 will be de-energized, open, and in turn de-energize the memory relay. However, K7 will not be de-energized until either K2D or K5 transfer contacts actually move from the transfer side. Following that, there is an additional delay in K7 itself (due to collapse of the magnetic field) before the K7 transfer points move.

If the K5 transfer contacts have returned to their normal position before K7 transfer contacts (10-11) open, the relay is re-energized through $\overline{K5}$(10-12) and K7(10-11).

Here then, is the reason for capacitor suppression of K5 in the alphanumeric mode as mentioned in paragraph 5.1. The drop out time of K5 should be as low as possible. The timing diagram of Figure 5-9 illustrates the described action.

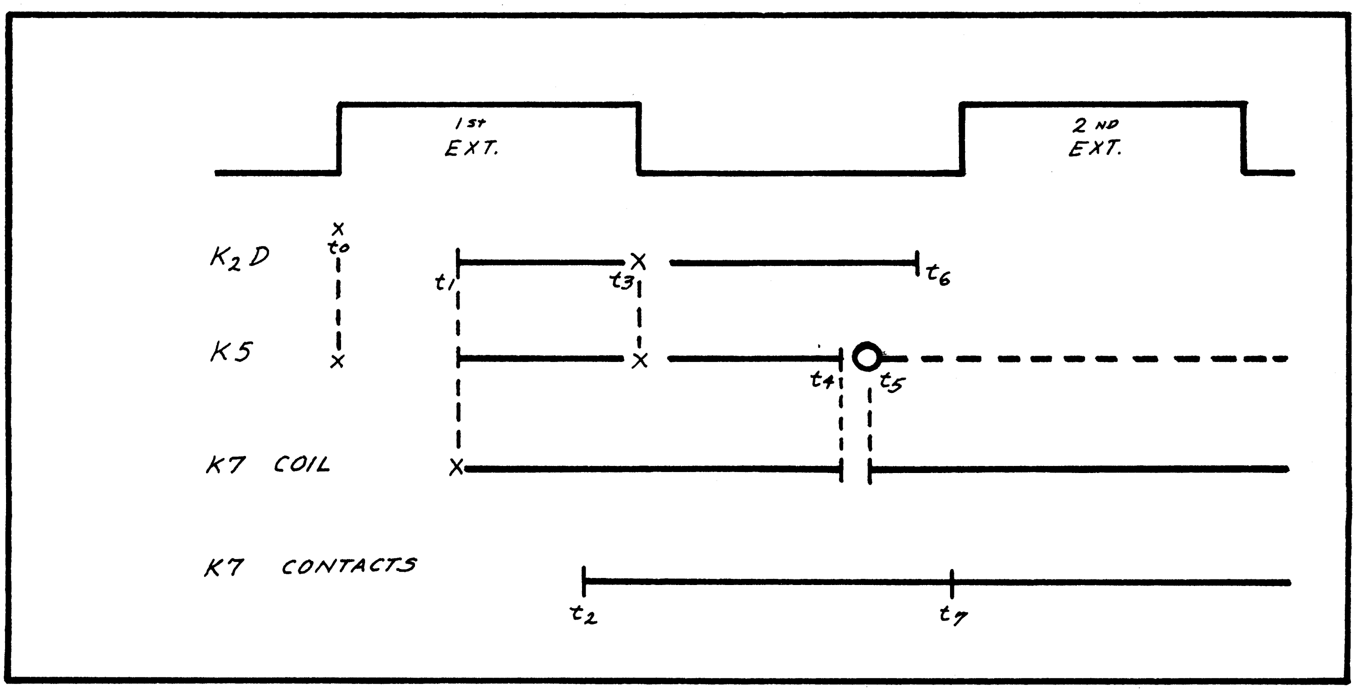


Figure 5-9. Qualitative Timing, K7 Pick and Hold

At time t_0, when the first extraction (calling for a level 2), appears in the OB's, K2D and K5 are energized. They are pulled in by t_1, energizing K7, which in turn is transferred by t_2. At t_3 -- the end of first extraction -- K2D and K5 are both de-energized. K2D drop out is delayed until time t_6 by its suppressor diode. K5 opens more quickly, its transfer contacts moving at t_4, de-energizing K7 coil, but re-energizing it at t_5, through $\overline{K5}$ contacts. If not re-energized, K7 contacts would have opened at t_7, but through $\overline{K5}$, they are held on through second extraction.

The circuit operation of the K6 series of relays is exactly the same as K7.

K6 and K7 will remain held in until the first extraction of the following character when K5 is again energized. If that character does not call for a level 1 or 2 in first extraction, they will be open and remain de-energized. If they are called for, they will remain pulled in.

5.3.3 ALPHANUMERIC DECODING TREE

Returning to the example of paragraph 5.3.2, refer to Appendix Drawing No. 2. At the end of the first extraction for "a", the decoder contains the information:

(a) TYPE (K10)
(b) AN (K8)
(c) LEVEL 1 (K6)
(d) $\overline{\text{LEVEL 2}}$ ($\overline{K7}$)
(e) LEVEL 3 (no shift)

With the arrival of second extraction, the K1 relays again pull in, giving the overall decoder set up as:

$$K8 \quad K9 \quad K10 \quad \overline{K7} \quad K6 \quad \overline{K5} \quad \overline{K4} \quad \overline{K3} \quad \overline{K2} \quad K1.$$

With this information, the circuit for the "a" solenoid can be traced through,

PL2A-21-$\overline{K4B}$(3-1)--$\overline{K2B}$(9-7)--$\overline{K3B}$(3-1)--K1A(8-7)--
K6C(8-7)--$\overline{K7}$(6-4)--K8(5-4)--K9(2-1) R22 and +160 volts.

Exactly the same path energizes the key solenoid in upper case. The only difference being that during first extraction, an <u>additional</u> path is set up to energize the shift solenoid.

Any alphanumeric character except the "special" characters +, (,), *, /, =, and $ may be traced through the tree in the same manner.

5.3.4 SHIFT CIRCUIT

Relay K11A energizes the shift solenoid when called for by $\overline{\text{LEVEL 3}} \cdot \text{LEVEL 5}$.

In Figure 5-10, the shift circuit is isolated. During a first extraction calling for $\overline{\text{LEVEL 3}}$ = SHIFT, a circuit is made for K11A through K5(4-5) and $\overline{\text{K3D}}$(10-12).

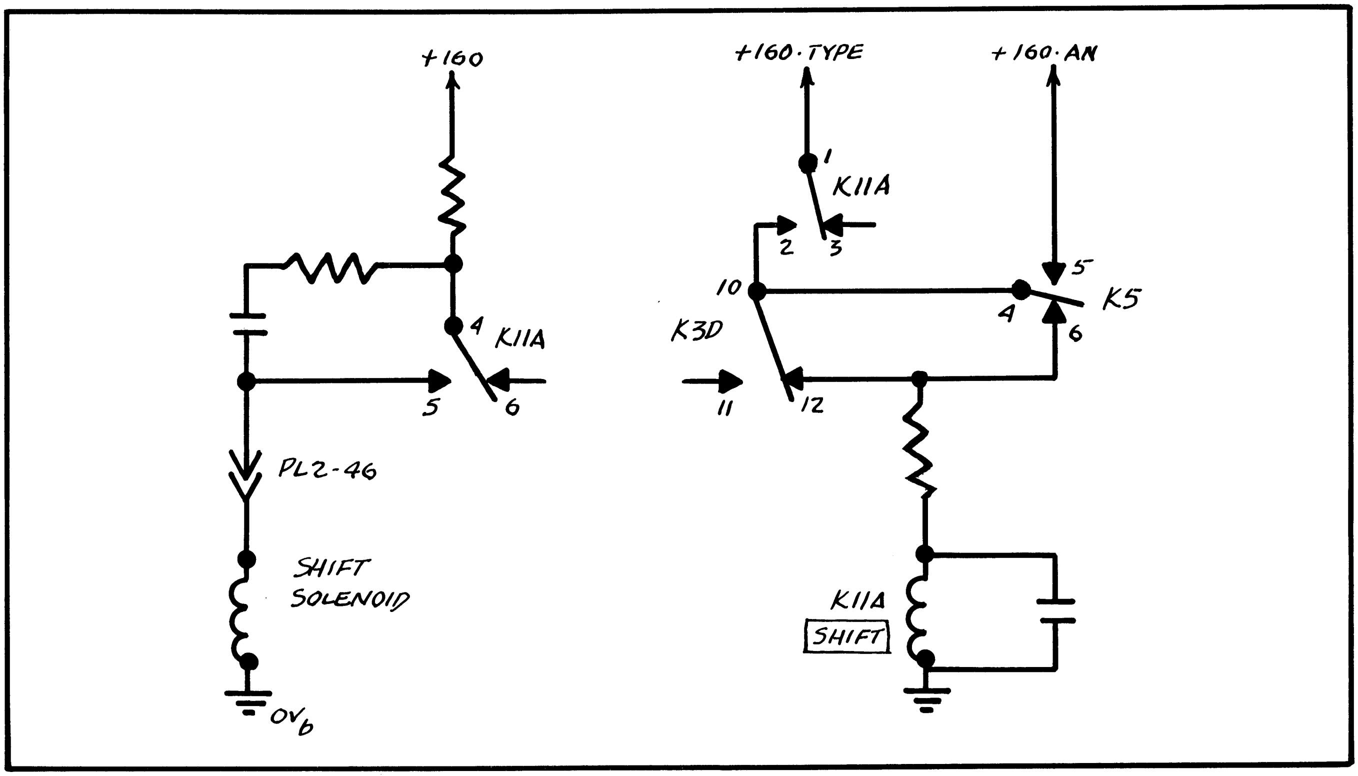


Figure 5-10. Shift Circuit, AN Decoder

K11A pulls in, completing a path for the shift solenoid and closing its own hold contacts K11A(1-2).

At the end of first extraction, K5 drops out, completing the hold circuit.

$$K11A_{hold} = K11A \cdot \overline{K5}.$$

The total hold equation is:

$$K11A_{hold} = K11A \cdot (\overline{K5 \cdot K3})$$

For K11A to drop out and release the shift solenoid, both K5 and K3 must pull in. This happens only during the first extraction of a lower case character. Hence, once energized by K11A, the typewriter will stay in upper case position until the next lower case character or the end of the typeout operation. This prevents the typewriter carriage from beating up and down during a long series of upper case characters.

5.3.5 AN FEEDBACK

AN tab, carriage return, space feedback and typeout interrupt with SA in exactly the same manner as described in paragraph 5.2.1, for the numeric mode. In the AN mode, additional feedback is provided for the carriage shift, either up or down.

Operating through the FB line to raise HC, its action is shown in Figure 5-11.

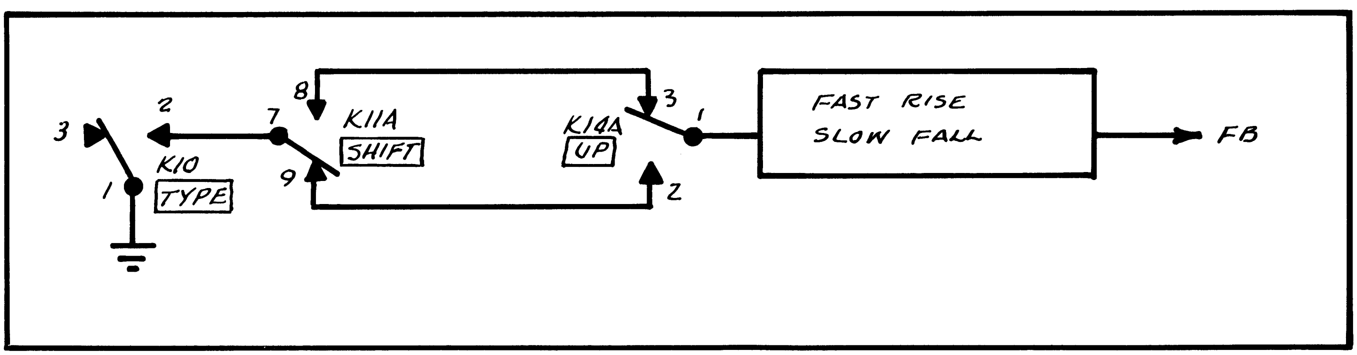


Figure 5-11. Shift Feedback

K14A follows the UP/DN typewriter contact, being energized in the UP position. During first extraction of an upper case character with the carriage in lower case position, K11A pulls in, completing a ground path for the FB line to HC.

$$FB = K10(1\text{-}2) \cdot K11A(7\text{-}8) \cdot \overline{K14A}(3\text{-}1)$$

The FB line is carried through the fast rise, slow fall circuit of paragraph 4.4.7 as a convenient filter. The FB signal raises, HC, preventing second extraction until K14A pulls in, releasing the ground path.

When shifting down from upper case, K11A is de-energized during first extraction and drops out to its normal position. K14A, however, being grounded through the UP contacts of the typewriter is still pulled in. When calling for lower case while the carriage is in the upper case position, FB follows the equation:

$$FB = K10(1-2) \cdot \overline{K11A}(7-9) \cdot K14A(2-1).$$

Second extraction is held up until the carriage moves to its lower case position, opening its own UP contacts and releasing K14A.

5.3.6 SPECIAL CHARACTER DECODING

With a normal upper case character, the shift solenoid is energized during first extraction and begins shifting. Second extraction, with the accompanying type pulse, is delayed through feedback until the shift is complete.

A special character, however, is not recognized until the entire character is decoded, at second extraction time, coincident with type pulse. At this, the shift must be energized and the type pulse kept out of the typewriter until the shift is complete. Then, without changing the OB configuration (which would destroy the character), the type pulse must be repeated to print the character.

Requirements of the circuit at second extraction time are:

(a) Prevent the EXC pulse from reaching the typewriter.

(b) Energize the shift solenoid.

(c) Supply feedback to repeat the type pulse after feedback is gone.

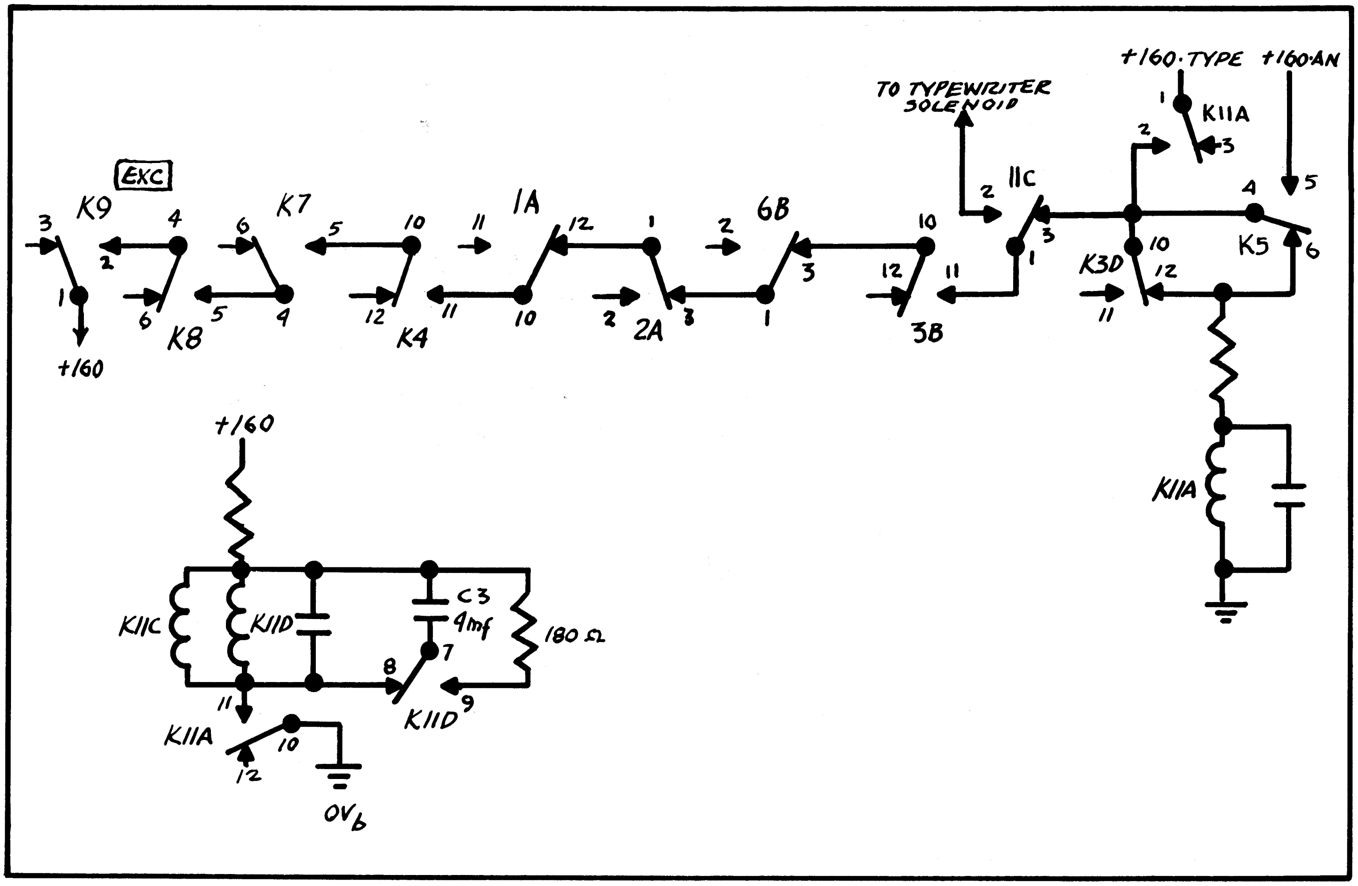


Figure 5-12. Special Character Shift

Requirements (a) and (b) are met through the simplified circuit of Figure 5-12. While using "*" as an example, it should be remembered that all seven special characters are treated in the same manner.

The typeout code for "*" is:

* = 11110 01011,

which configuration gives a path for EXC to the common contact of relay K11C. The final connection to the typewriter key is made through transfer contact K11C(1-2). The normal contact of K11C is connected to SHIFT relay, K11A.

During second extraction, then, a path is made through EXC relay K9, not to the typewriter, but to SHIFT, K11A. The EXC shot energizes K11A, starting the shift as previously described and completing a path for K11C and K11D through K11A(11-10).

When K11C and K11D pull in, they break the K11A circuit and connect the EXC relay through to the typewriter. Since K11A supplies its own hold circuit, the EXC pulse may be safely removed.

K11C and K11D are not allowed to pull in immediately. If they did, the EXC pulse -- which may still be existant -- would be connected to the typewriter with no guarantee that the carriage had completed its shift. The delay is caused by placing capacitor C3 and resistor R2 in parallel with K11C and K11D coils. C3 and R2 prevent the coil voltage from rising rapidly. Hence, K11C and K11D's pull-in time is extended.

This time delay is long enough for the EXC relay to drop out before K11C and K11D complete the path to the typewriter.

After completion of typing the particular special character C_1 is discharged through K11D(7-8) as soon as the relays pull in.

If the carriage shift is complete, the type pulse reappears one drum cycle later, energizing K9 again, and completing the circuit for the typewriter solenoid.

5.3.7 SPECIAL CHARACTER FEEDBACK

Special character feedback utilizes the same hardware as normal shift feedback. That is,

$$FB = K11A \cdot \overline{K14A}$$

but has a different effect inside the computer.

From G-15 logic, it is recalled that;

$$\text{TYPE PULSE} = OY \cdot \overline{OE} \cdot \text{Other Terms}$$

and from Figure 5-7, M19 to OA precession for first extraction implies: $OY \cdot OH$.

Through the simplified G-15 gating of Figure 5-13, it is seen that if feedback is raised during second extraction ($\overline{OH}$), OY is immediately reset. Without OY, the TYPE PULSE is killed. The difference then, is that if feedback goes high during second extraction, type pulse is killed and OY is held low until FB is gone. At the first T_o after FB is gone, OY comes high again, allowing type pulse to be generated and M19 to begin precessing out the bits for first extraction of the following character.

The term "AS" on the OY reset gate constricts this action to occur only during alphanumeric output.

The timing diagram of Figure 5-14 illustrates the special character FB in terms of G-15 drum cycles.

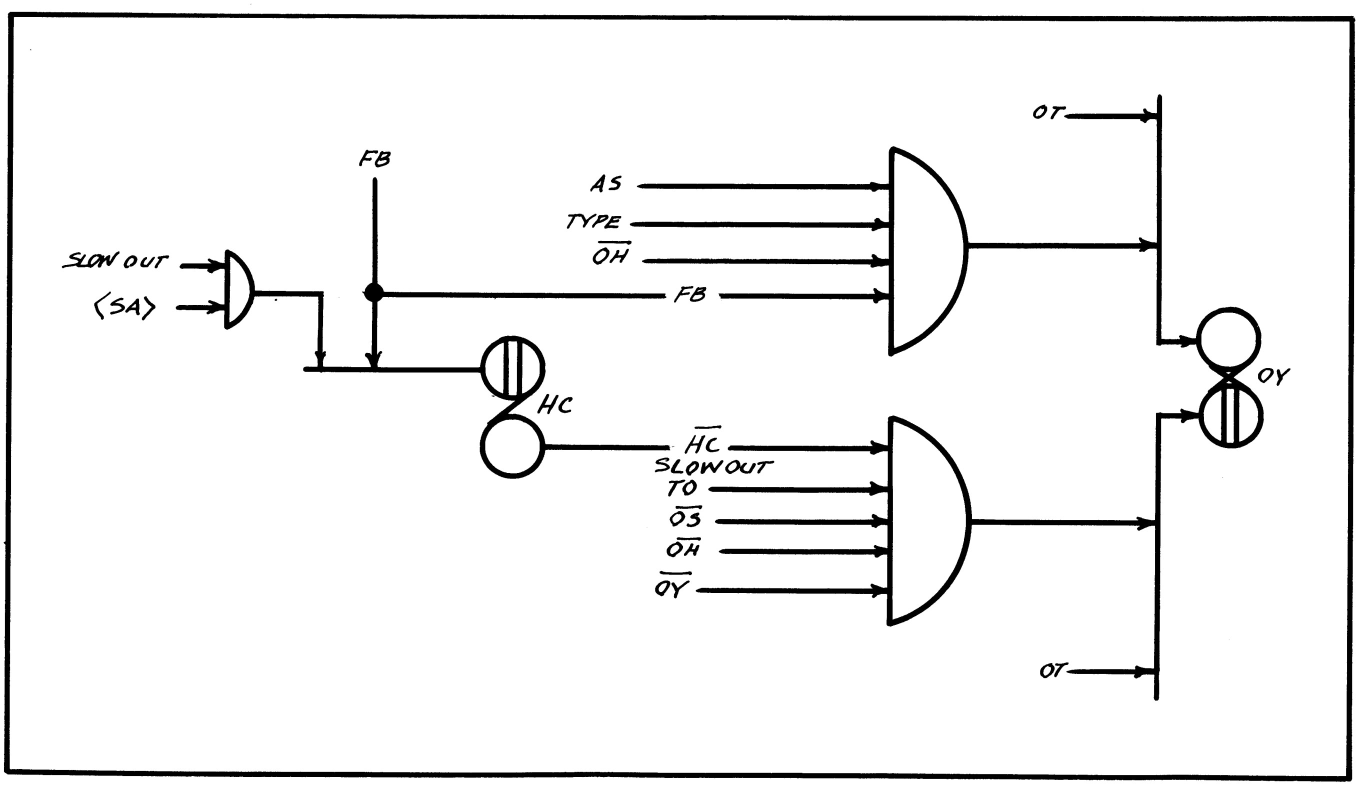


Figure 5-13. G-15 Internal Gating for Special Characters

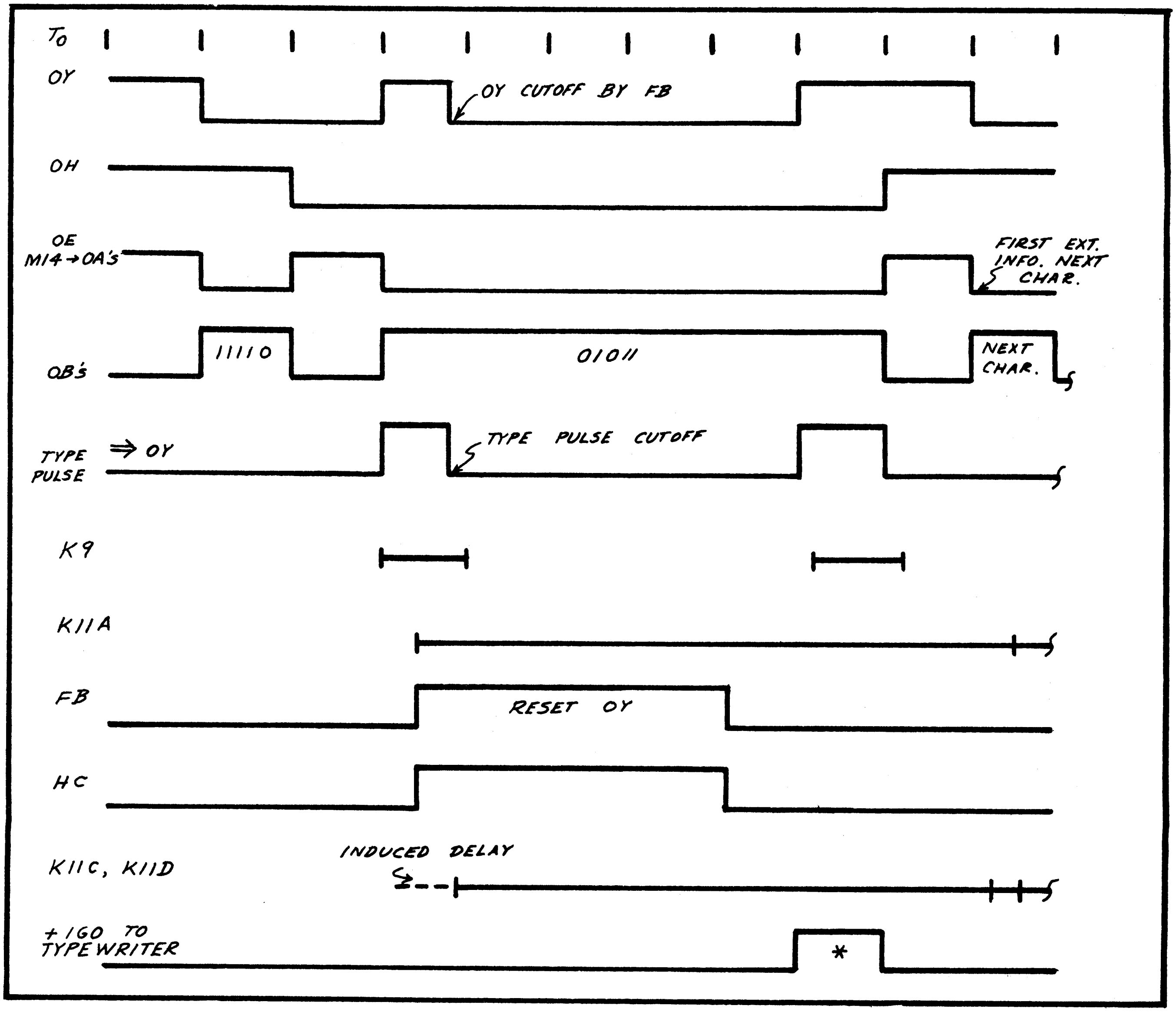


Figure 5-14. Timing of Special Character, "*"

SECTION VI

6.0 MODIFICATIONS TO G-15

6.1 GENERAL

Certain minor modifications are necessary to both the existing typewriter and G-15 to incorporate the ANC-2. None of these changes affect programming or operating rules in any manner.

6.2 G-15 WIRE CHANGES

6.2.1 Because the ANC-2 uses only the typewriter plug on the rear panel of the computer, all signals must be brought to this plug. The "AN" signal must be transferred from PL-14-32 to PL-1. Pin 18 is cleared for it by developing the -20 volt logic voltage for the coupler inside of the coupler. The changes are:

$TS1_a$-9 to PL-1-18 (remove -20 V not brought out)

$TB1_a$-CF to PL-14-32 is now
$TB1_a$-CF to PL-1-18 ("AN" signal).

6.2.2 The OC_r term $\circledS \cdot (\langle SA \rangle + \overline{OH} \cdot \overline{OC_1} \cdot \overline{OC_2})$, has been simplified to:

$$OC_r = \circledS \cdot (\langle SA \rangle + \overline{OH}.)$$

Without this change, alpha typeout of line 19 may not be terminated at the typewriter. Since M19 typeout involves source 9, the

$$\circledS \cdot OH \cdot \overline{OC_1} \cdot \overline{OC_2}$$ term cannot reset the OC's.

This leaves only the $\langle \circledS \rangle$ $\langle SA \rangle$ term, and since $\langle SA \rangle =$

$SA \cdot \overline{TYPE}$, it cannot exist during a typeout operation. Removal of the $\overline{OC}$ qualifiers allows M19 to be terminated with $\langle \circledS \rangle \cdot \overline{OH}$. This change does not affect programming of the computer in any way. The wiring changes are:

E45P	Disconnect both wires, splice together.
E44J to A39D	Remove.
E44N to E44M	Remove.
E44M to E44R	Remove.
E44K	Transfer to E45P

6.2.3 In a type configuration, feedback is provided by the interlock chain. The T_1, T_2 generator is deliberately innactivated during typeout to (1), save wear and tear on the points and relays, and (2) prevent undesirable feedback from character keys.

When an alphanumeric typeout terminates, the TYPE relay (K10) drops out when the OC's reset at the end of the first M19 to OA precession, ending interlock FB.

"Encoder" FB must be substituted before the first TO signal and be continuous until the final mechanical operation is complete. Otherwise OD will be reset and READY will arise before the typeout is actually finished.

To fulfill the "encoder" FB requirement, the T_1, T_2 generator must be made to function in the numeric mode (single, extended, T_1). To facilitate this, the AN relay (K8) must be de-energized at the same time as the TYPE relay (K10). This requires minor modification to the G-15.

(a) Change AS reset from READY to OC_r.

Remove D9A - B3A (removes READY)
Add E45K - L00E (pick up OC_r).
Add L0E - B3A (OC_r to AS reset).

(b) Substitute OH for AS in the OD reset term $AS \cdot \overline{HC} \cdot TO \cdot \overline{OC_4}$

Remove A16E - C12R (removes AS)
Add A16E - C11R (adds OH).

(c) Substitute $\overline{OH}$ for $\overline{AS}$ in the OE set term $\overline{AS}$•FAST OUT • Ⓖ •OD

Remove B10J - D10T (removes $\overline{AS}$)
Add B10J - C12D (adds $\overline{OH}$)

6.2.4 A 25% increase in the speed of an AN typeout of M19 can be obtained by adding $[\text{sign}]_{of}$ to the OS set term, T_1·CN·Ⓣ·M19.

For all alphanumeric characters except the last four, this term interprets M19 as containing a minus, setting OS, which holds up OY an additional drum revolution. Adding $[\text{sign}]_{of}$ (which does not exist in AN) will disable the term during an AN typeout, but still allow proper operation in the numeric mode.

Field modification of machines NOT having ECO 1096 in them is:

Add C34S - B39V (pick up $[\text{sign}]_{of}$)

Add B39K - H35K ($[\text{sign}]_{of}$ to OS_{set}).

For machines which HAVE 1096 in them;

Add F45S - D38A (pick up $[\text{sign}]_{of}$)

Add D38U - H35K ($[\text{sign}]_{of}$ to OS_{set}).

SECTION VII

7.0 TYPEWRITER MODIFICATIONS

7.1 GENERAL (Refer to Appendix Drawing No. 3).

Because of the method of handling of certain signals, some modifications to typewriter wiring are necessary.

7.2 Locate the wire from the character common contact to the key contacts. Disconnect this wire from the character common contact, and connect it to PLF1A-72.

7.3 Add a new wire from the side of the character common contact which was freed in step 7.2 to PLF1A-70.

7.4 In the typewriter base, locate the wire from:

SW1 (enable)-2 to SW2 (Rewind)-2,

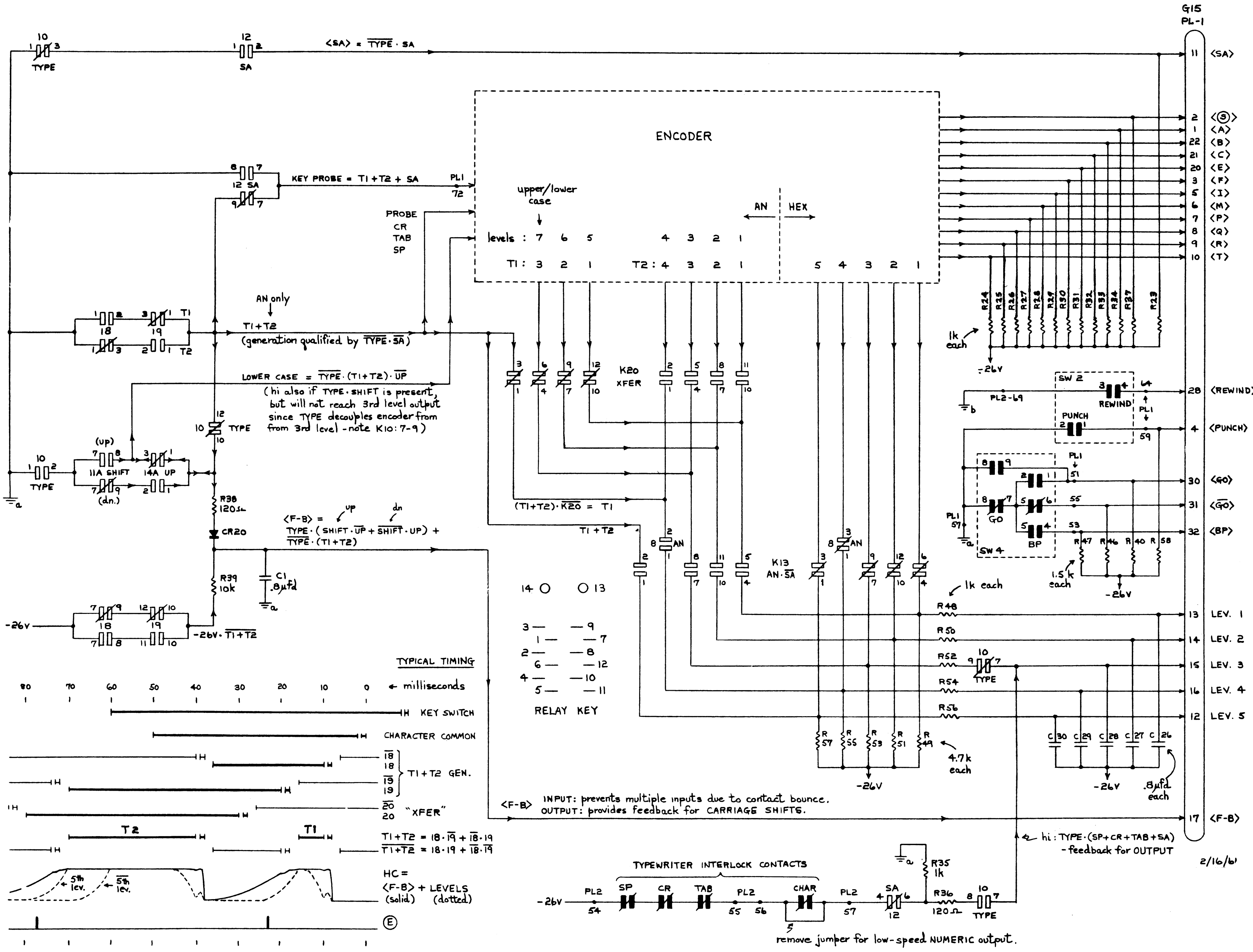
and change it to:

SW 1-2 to SW 2 (punch)-3.

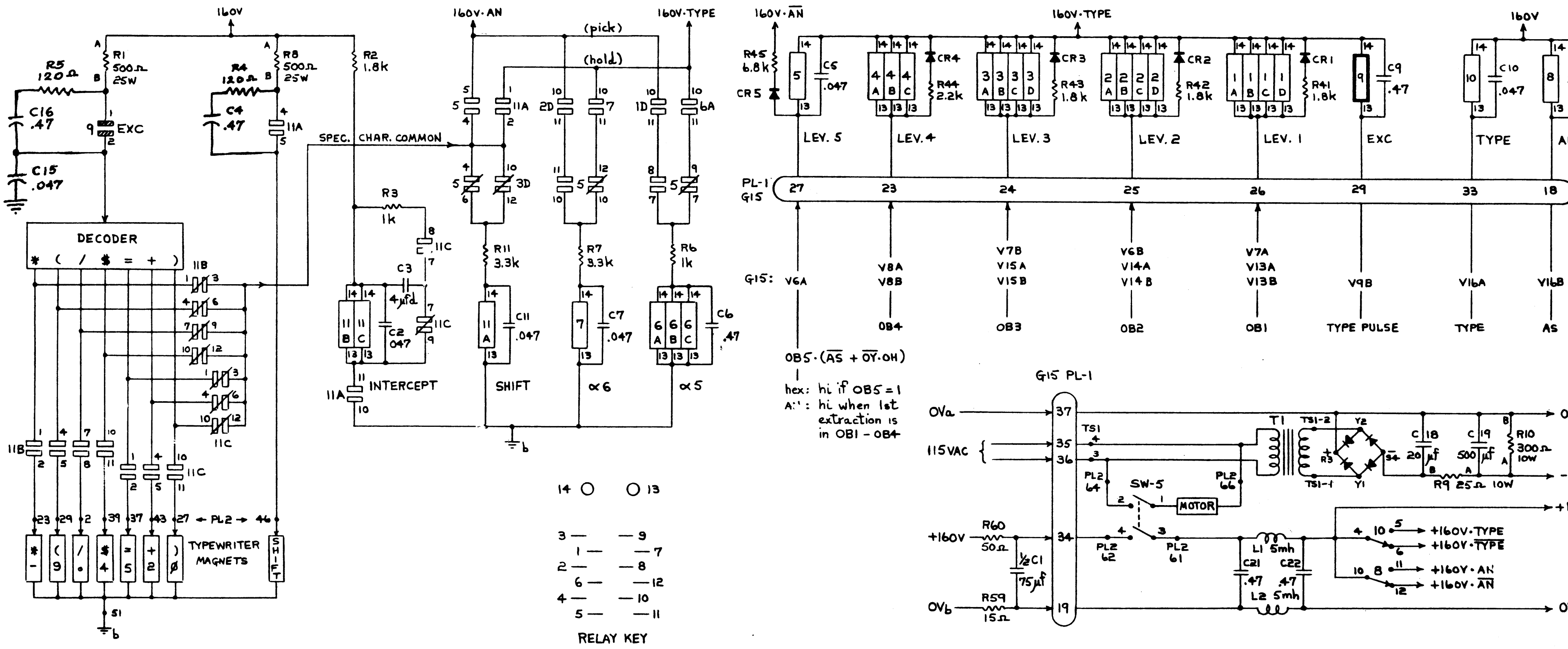
7.5 Add a jumper wire around the character interlock contact.

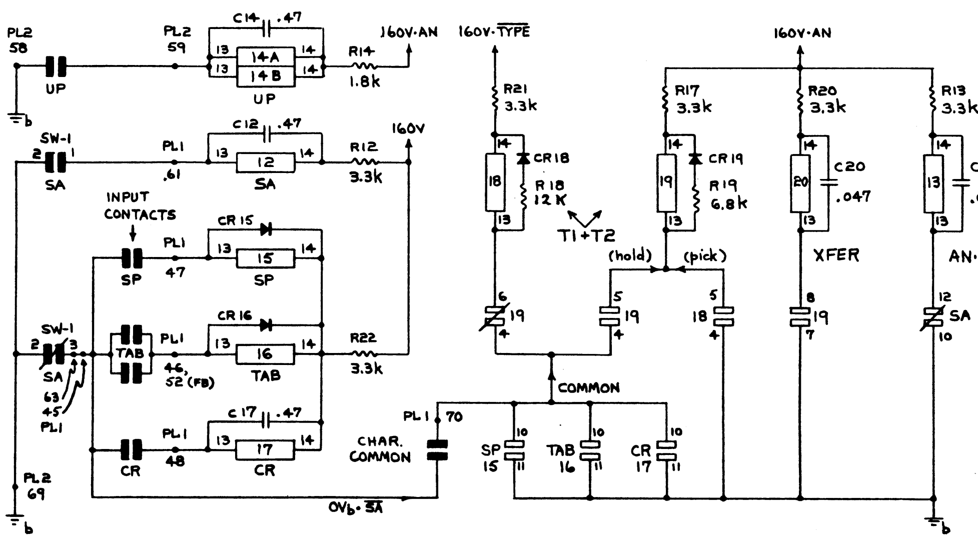
7.6 Add the adhesive-backed identification tag to the bottom of the typewriter base.

ANC-2 Circuits Controlling G-15



ANC-2 Relay Control





			IN		OUT	
K#		FUNCTION	HEX	AN	HEX	AN
1	ABCD	lev. 1	—	—	OB1	OB1
2	ABCD	lev. 2	—	—	OB2	OB2
3	ABCD	lev. 3	—	—	OB3	OB3
4	ABC	lev. 4	—	—	OB4	OB4
5		lev. 5	—	—	OB5	OB5·$\overline{OY}$·OH
6	ABC	∝5	—	—	—	5·1 + [$\overline{5}$·6]
7		∝6	—	—	—	5·2 + [$\overline{5}$·7]
8		AN	—	AS	—	AS
9		EXC.	—	—	EXC.	EXC.
10		TYPE	—	—	TYPE	TYPE
11	A	SHIFT	—	—	—	5·$\overline{3}$+SPEC.CHAR.+[$\overline{5}$·$\overline{3}$·11A]
11	BC	INT.	—	—	—	11A
12		SA	SA*	SA*	SA*	SA*
13		AN·$\overline{SA}$	—	AN·$\overline{SA}$	—	/AN·$\overline{SA}$/
14	AB	UP	—	UP*	—	UP*
15		SP	SP*·$\overline{SA*}$	SP*·$\overline{SA*}$	/SP*·$\overline{SA*}$/	SP*·$\overline{SA*}$
16		TAB	TAB*·$\overline{SA*}$	TAB*·$\overline{SA*}$	/TAB*·$\overline{SA*}$/	TAB*·$\overline{SA*}$
17		CR	CR*·$\overline{SA*}$	CR*·$\overline{SA*}$	/CR*·$\overline{SA*}$/	CR*·$\overline{SA*}$
18		} T1+T2	COMM·$\overline{SA*}$	COMM·$\overline{SA*}$·$\overline{19}$	—	—
19			—	18 + [COMM·$\overline{SA*}$·19]	—	—
20		XFER	—	19	—	—
		T1	18	18·$\overline{19}$	—	—
		T2	—	$\overline{18}$·19	—	—

* means SWITCH

[xxx] means HOLD

/xxx/ means PRESENCE NOT REQUIRED

COMM = CHAR. COMMON* + SP+TAB+CR

SPEC. CHAR. = 9·$\overline{11BC}$·*(/$=+)

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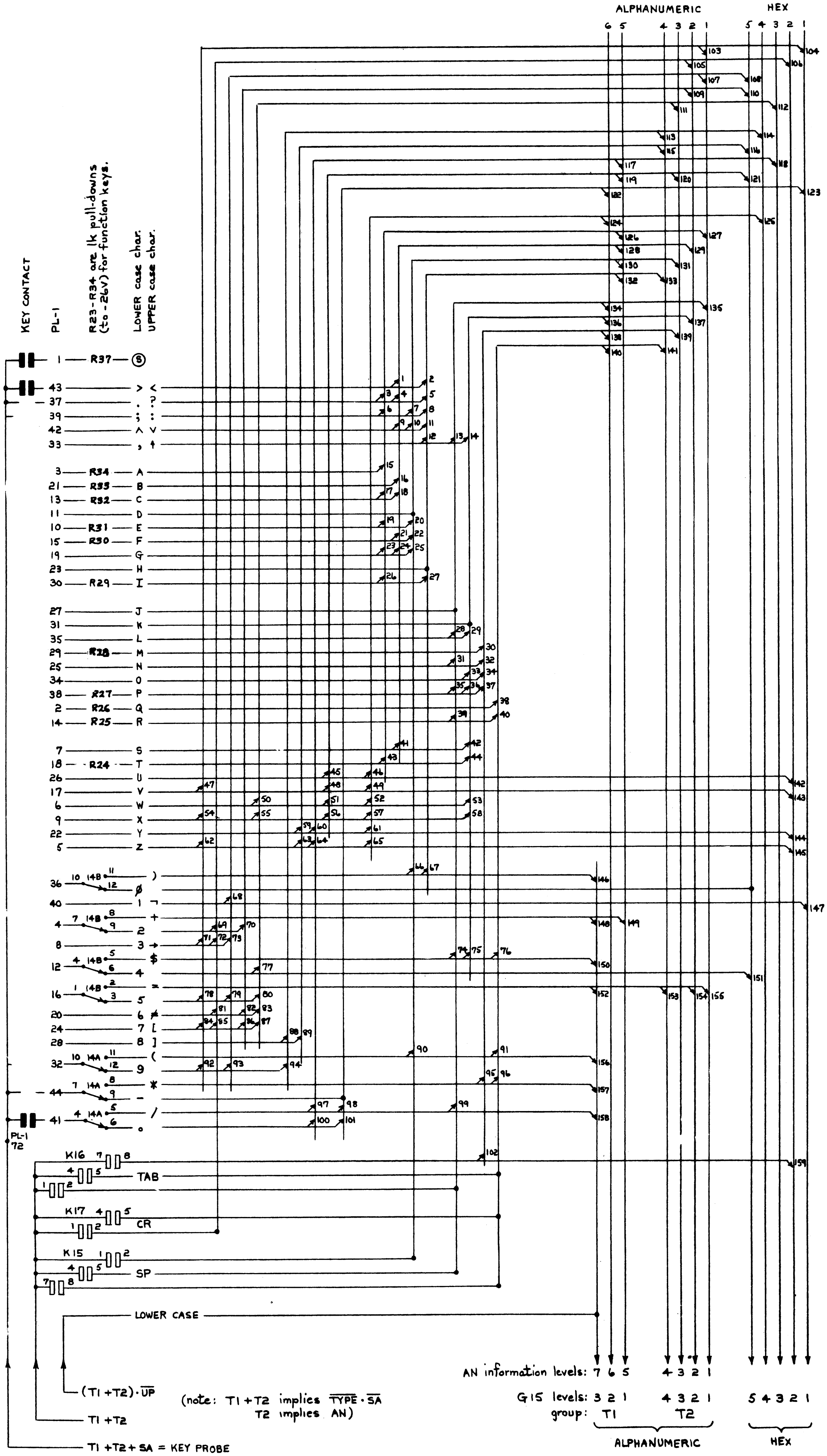

DIODE LOCATIONS

#	pkg.	⊣◁⊢	#	pkg.	⊣◁⊢
			80	16	PF
1	12	UA	81	1	PF
2	12	TC	82	1	NJ
3	11	PF	83	1	MK
4	11	NJ	84	1	UA
5	11	MK	85	1	TC
6	11	UA	86	1	SD
7	11	Tc	87	1	RE
8	11	SD	88	15	RE
9	10	PF	89	15	SD
10	10	NJ	90	14	RE
11	10	MK	91	14	SD
12	10	TC	92	15	MK
13	10	SD	93	15	NJ
14	10	RE	94	15	PF
15	10	UA	95	14	MK
16	9	MK	96	14	NJ
17	9	PF	97	13	MK
18	9	NJ	98	13	NJ
19	9	SD	99	13	PF
20	9	RE	100	13	TC
21	9	UA	101	13	UA
22	9	Tc	102	13	SD
23	6	PF	103	23	SD
24	6	NJ	104	23	TC
25	6	MK	105	23	RE
26	8	NJ	106	23	NJ
27	8	MK	107	22	PF
28	8	RE	108	22	RE
29	8	PF	109	22	NJ
30	8	SD	110	22	SD
31	8	UA	111	14	UA
32	8	TC	112	23	PF
33	7	NJ	113	12	SD
34	7	MK	114	22	MK
35	5	PF	115	12	RE
36	5	NJ	116	22	TC
37	5	MK	117	20	MK
38	7	PF	118	21	UA
39	7	SD	119	20	SD
40	7	RE	120	19	PF
41	7	UA	121	22	UA
42	7	Tc	122	21	TC
43	4	NJ	123	23	UA
44	4	MK	124	21	SD
45	3	PF	125	20	UA
46	3	NJ	126	20	Tc
47	6	UA	127	19	Tc
48	6	Tc	128	20	RE
49	6	SD	129	19	RE
50	5	UA	130	20	NJ
51	5	Tc	131	19	NJ
52	5	SD	132	20	PF
63	5	RE	133	12	PF
54	4	UA	134	21	RE
55	4	Tc	135	19	UA
56	4	SD	136	21	PF
57	4	RE	137	19	SD
58	4	PF	138	21	NJ
59	3	UA	139	19	MK
60	3	TC	140	21	MK
61	3	SD	141	12	NJ
62	2	SD	142	3	MK
63	2	RE	143	6	RE
64	2	PF	144	3	RE
65	2	NJ	145	2	MK
66	17	SD	146	17	UA
67	17	TC	147	2	TC
68	2	UA	148	17	PF
69	15	TC	149	17	RE
70	15	UA	150	18	UA
71	18	MK	151	17	NJ
72	18	NJ	152	16	RE
73	18	PF	153	16	SD
74	18	RE	154	16	TC
75	18	SD	155	16	UA
76	18	TC	156	14	TC
77	17	MK	157	14	PF
78	16	MK	158	13	RE
79	16	NJ	159	23	MK

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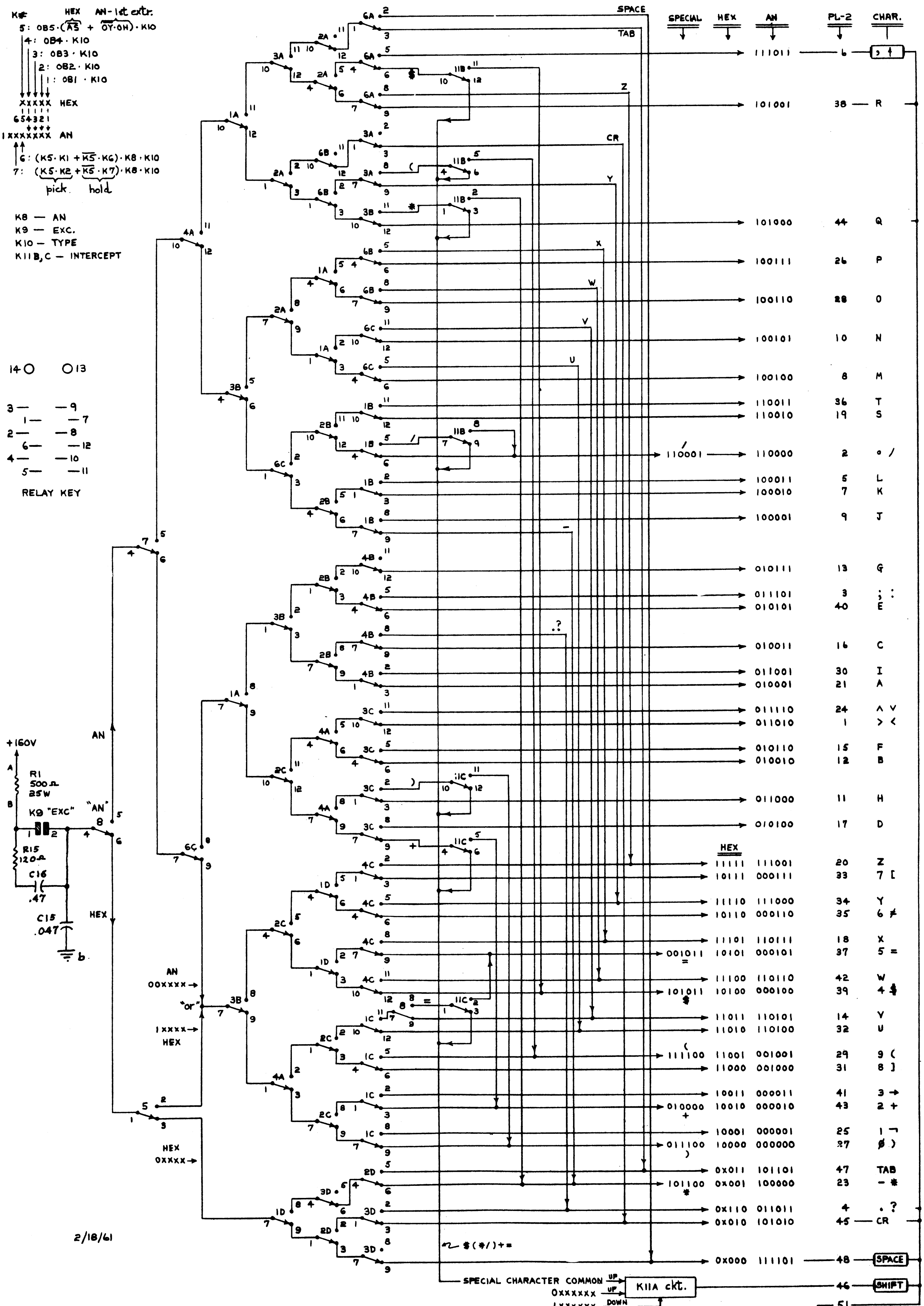
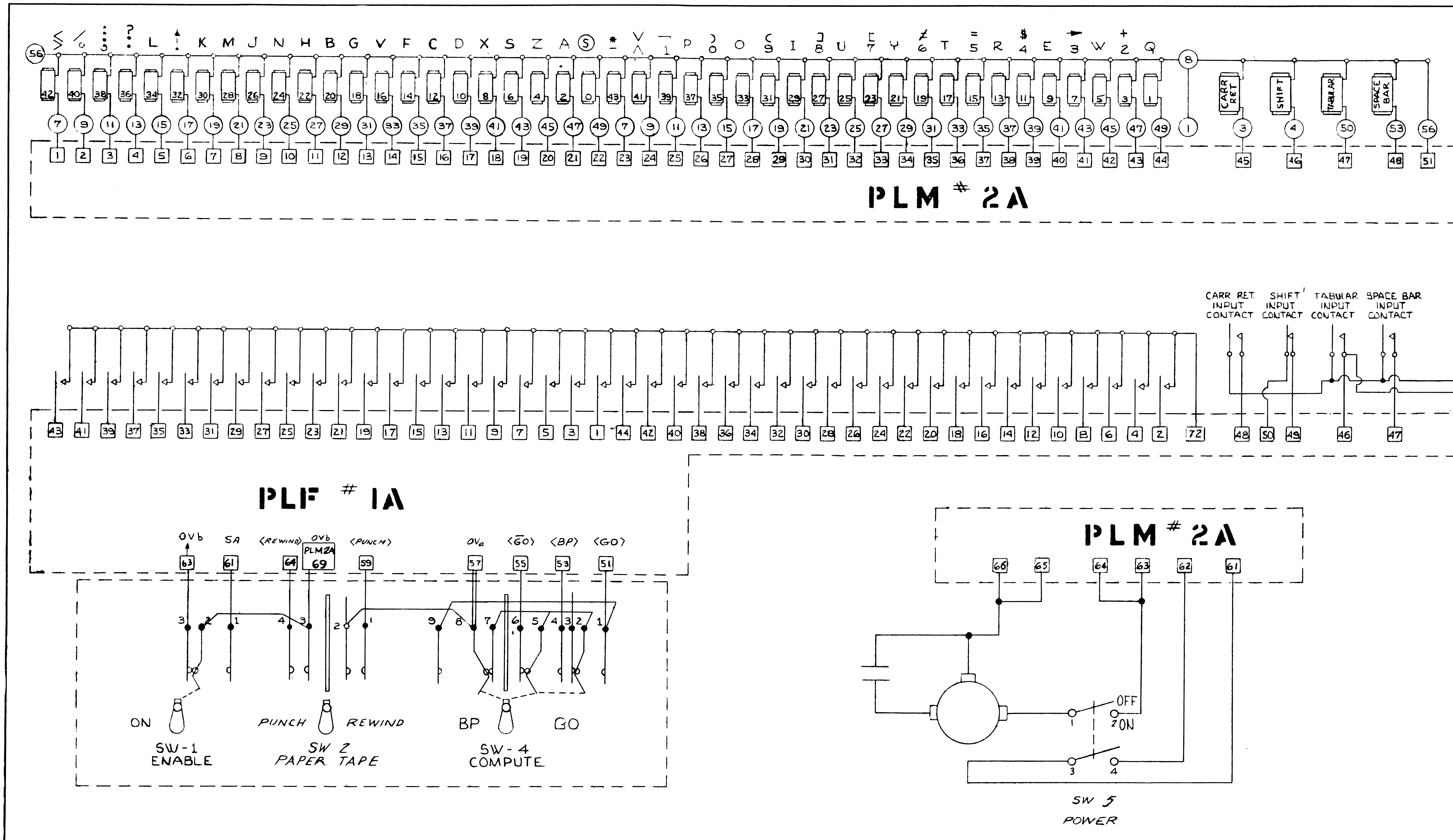
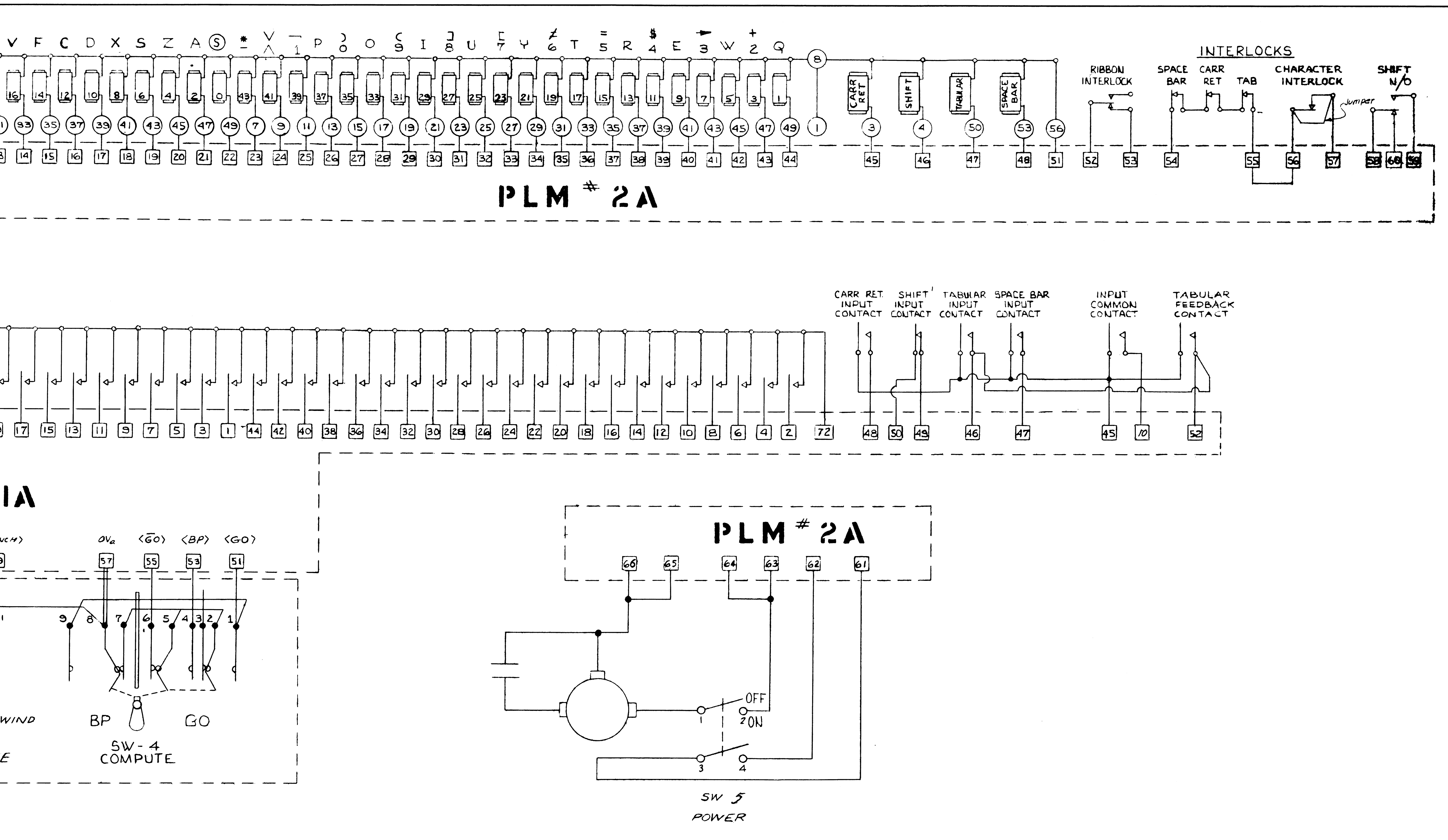
ANC-2 Encoder



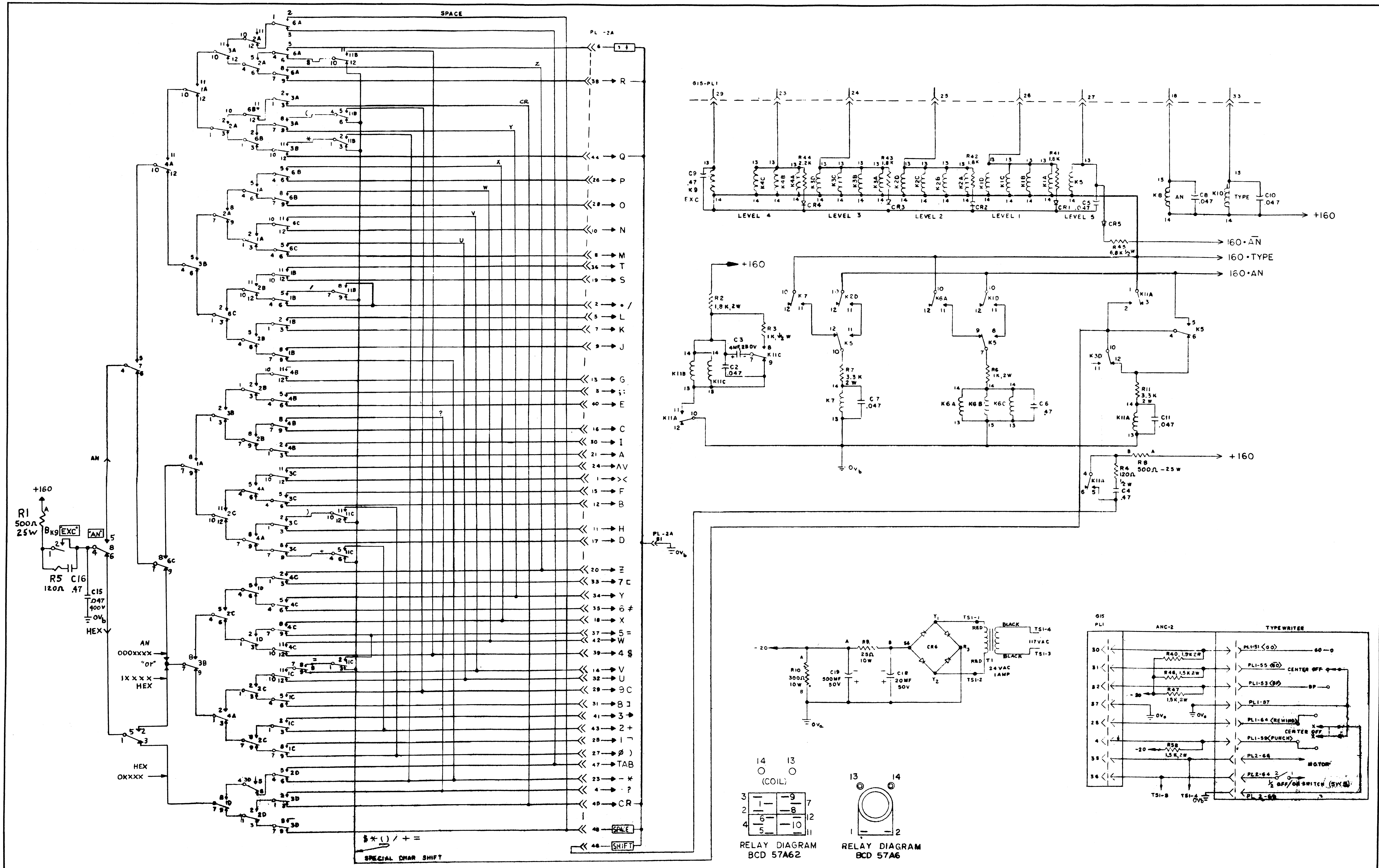
ANC-2 Decoder

APPENDIX

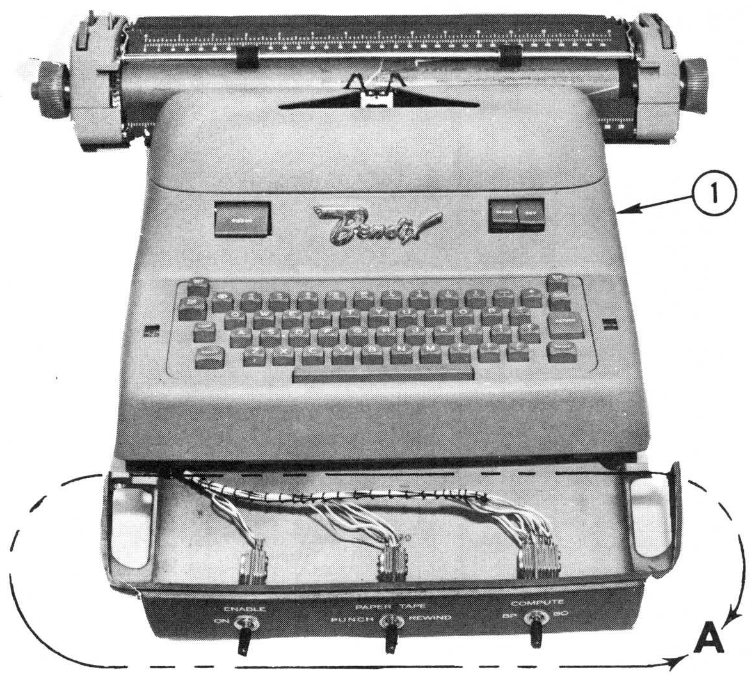

PLM # 2A
CARR RET
SHIFT
TABULAR
SPACE BAR
CARR RET INPUT CONTACT
SHIFT INPUT CONTACT
TABULAR INPUT CONTACT
SPACE BAR INPUT CONTACT
PLF # 1A
OVb
SA
(REWIND)
OVb PLM2A
(PUNCH)
OVa
<GO>
<BP>
<GO>
ON
SW-1 ENABLE
PUNCH
REWIND
SW 2 PAPER TAPE
BP
GO
SW-4 COMPUTE
PLM # 2A
OFF
ON
SW 5 POWER



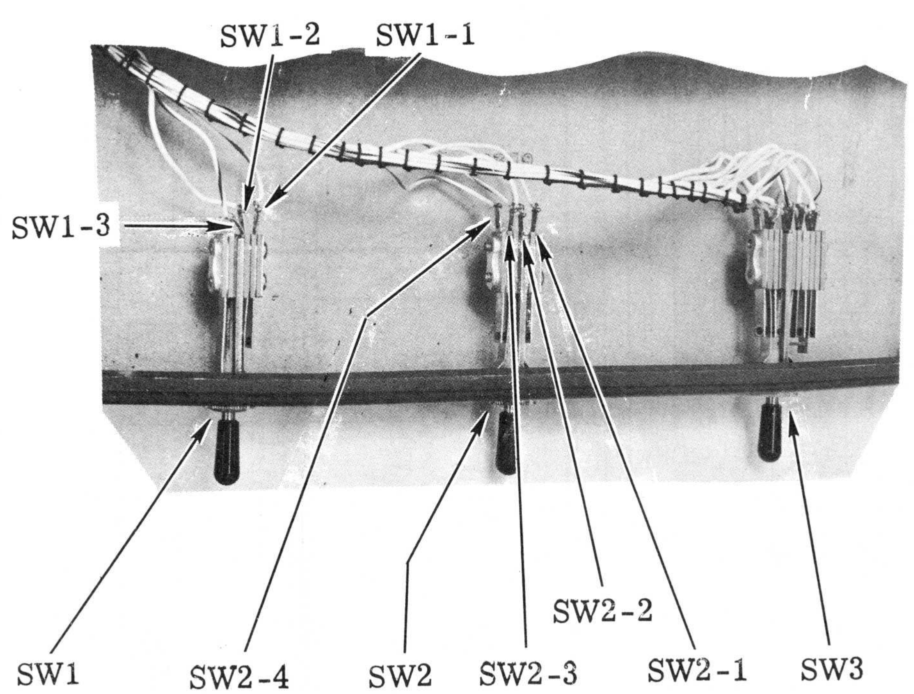
Appendix No. 1. ANC-2 Typewriter, Schematic



B Appendix No. 2. ANC-2 Typewriter, Decoder



TYPEWRITER BEFORE MODIFICATION

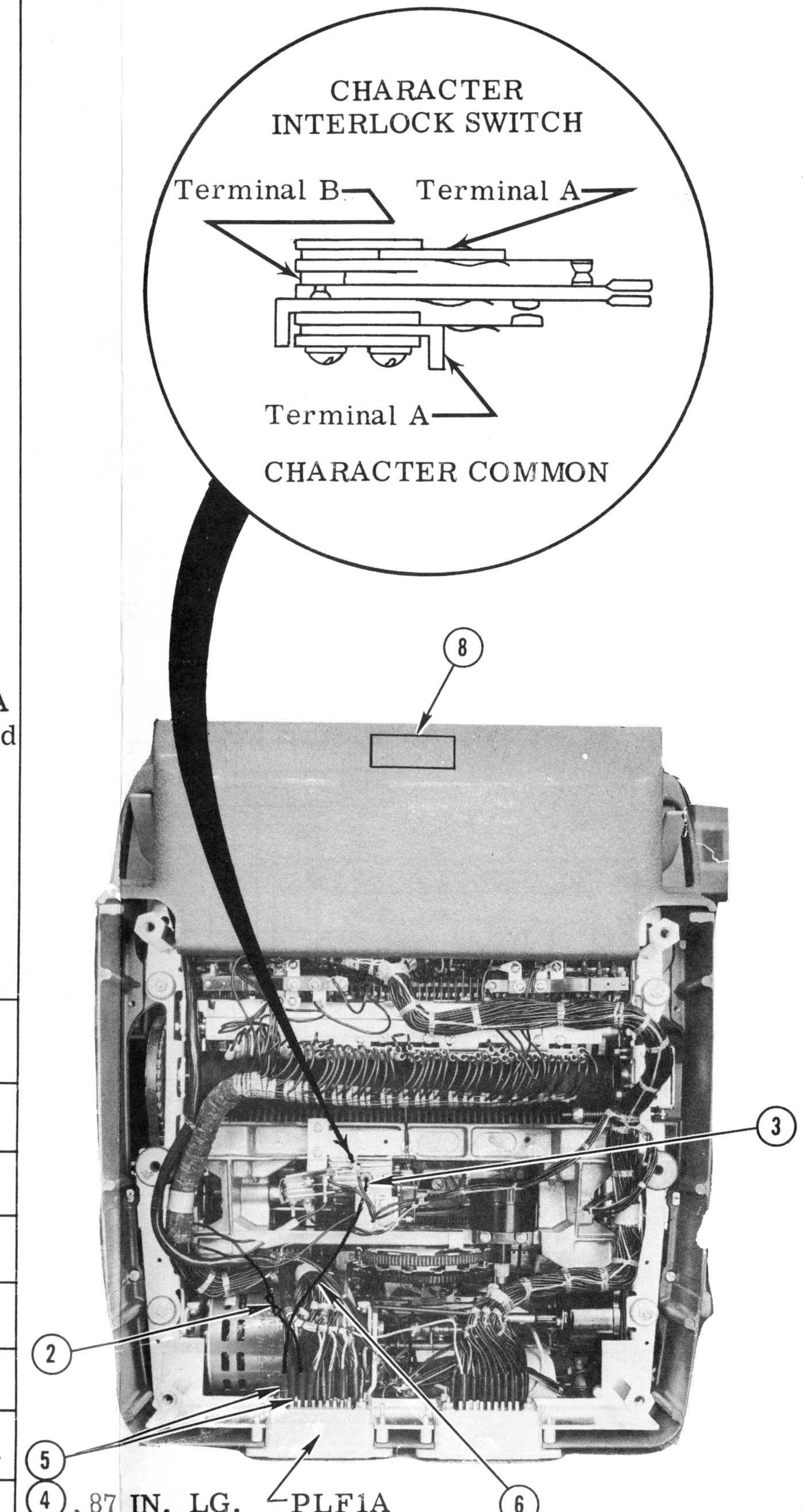


DETAIL **A**

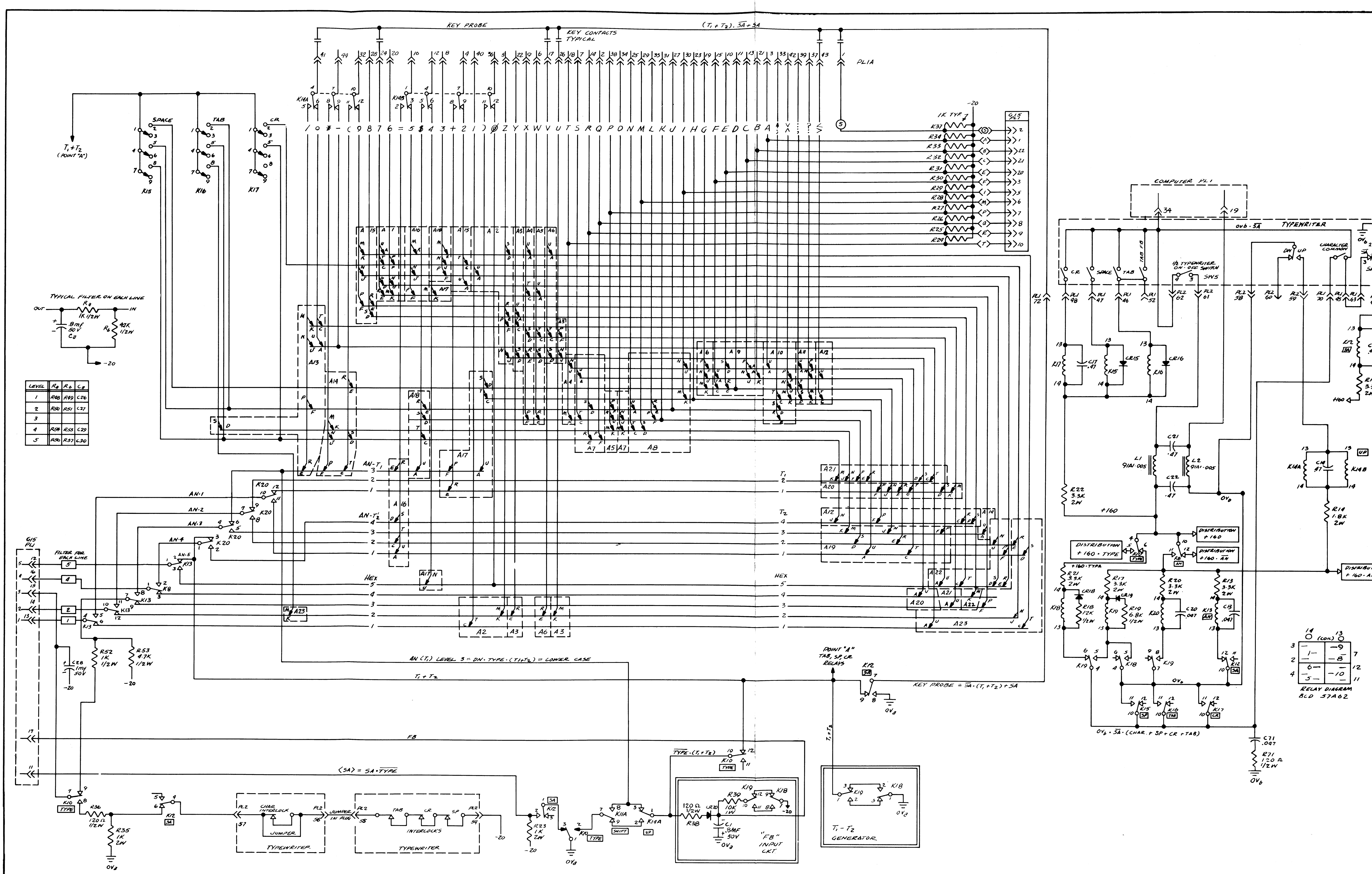
THE FOLLOWING MODIFICATIONS ARE REQUIRED.
Refer to Appendix No. 1

1. Locate wire from SW1-2 to SW2-2.
2. Disconnect end from SW2-2 and solder to SW-3.
3. Remove wire from Character Common Switch, terminal A.
4. Connect this wire to PLF1A-72. Use extruded tubing (Item 4)-.87 inches long to insulate the taper pin. If the wire won't reach PLF1A-72, cut off the taper pin and splice an extra piece of wire (Item 6). Use a butt connector (Item 2) to make the splice. Use taper pin (Item 5) and extruded tubing (Item 4) to connect PLF1A-72.
5. Cut a piece of wire approximately one inch long. Terminate each end of this wire with a ring tongue terminal (Item 7). Connect the wire between terminal A and terminal B of the Character Interlock Switch, shorting out the contact.
6. Add a wire from Character Common Switch, terminal A to PLF1A-70. Use a 16A56 taper pin (Item 3) to connect to terminal A and a 16A19-001 taper pin (Item 5) for the PLF1A connection. At PLF1A, insulate the connection with extruded tubing.
7. Place the nameplate stick-on (Item 8) as shown.
8. Wire the tab feedback contact in parallel with the tab input contact.

ITEM NO.	NO. REQ.	PART NUMBER	DESCRIPTION
1	1	1E2182	ASSY. TYPEWRITER
2	1	61A198-001A	CONNECTOR BUTT
3	1	16A56A	PIN, TAPER
4		66S9-010	TUBING, EXTRUDED
5	2	16A19-001B	TAPER PIN
6		67C60-022C	WIRE ELECT. STRD. INSUL.
7	4	11C8-004B	TERMINAL, RING TONGUE
8	1	40C112A	NAMEPLATE, STICK-ON



TYPEWRITER AFTER MODIFICATION



D Appendix No. 4. ANC-2 Typewriter, Encoder