ALPHANUMERIC TYPEWRITER SYSTEM

The ANC–1 is composed of two couplers in one package, an alphanumeric coupler and a hexadecimal coupler. Although they time–share 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.

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. The alphanumeric typewriter, an integral part of the system, will also be described.

The subject then, is presented in six parts:

1) Automatic Reload
2) Alphanumeric Encoder
3) Hexadecimal Encoder
4) Alphanumeric Typewriter
5) Hexadecimal Decoder
6) Alphanumeric Decoder

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 <u>double</u> <u>precision</u> 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 1.

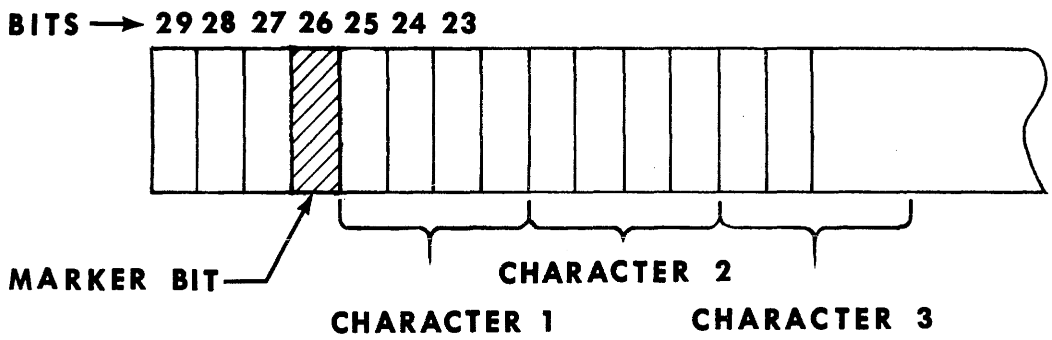


Figure 1

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 T_{29} of the 29th precession, the marker bit appears at the output of OA-3, setting OA-4. 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 ($DS \cdot \overline{CV} \cdot C1$) 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; it stands only for automatic reload, which may be either alphanumeric mode or PR-2. A second flip-flop, the OH flip-flop differentiates between PR-2 and alphanumeric mode.

$AS \cdot \overline{OH}$ = PR-2
$AS \cdot OH$ = Alphanumeric mode

ALPHANUMERIC ENCODER

For alphanumeric operation, the normal 4 bit code does not have enough combinations to cover all the characters. Hence, a 8 bit code was introduced. This 8 bit code parallels the IBM card code.

Each character is put into the computer in two groups of 4 bits each. The groups are identified by the encoder as T_1 group and T_2 group. This T_1 and T_2 has nothing to do with G-15 internal timing. They are gate pulses, generated in the coupler for use in the coupler.

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 1111
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		DELETE
1 1100	0	1	2	3	4	5	6	7	8	9		=				
1 1001		A	B	C	D	E	F	G	H	I	<	?		:	v	
1 1010		J	K	L	M	N	O	P	Q	R						
1 1011			S	T	U	V	W	X	Y	Z		↑				
1 1000		¬		→			≠	[	]							

LOWER* CASE

UPPER CASE

Figure 2

* — INDICATES UPPER CASE CODED AS LOWER CASE (SEE PAGE 4)

Figure 2 charts the output of the encoder during T_1 and T_2 for each character. To see how the chart works, let's take a character — "A", for example, and by looking to the left, we see 11001 as the T_1 group. Directly above "A" we see the T_2 group 10001. The output from the encoder, then, for "A" is 11001 10001.

Now refer to Figure 3. Note that each character energizes two matrices — the T_1 group and the T_2 group. Both matrices feed the 5 level lines to the G–15.

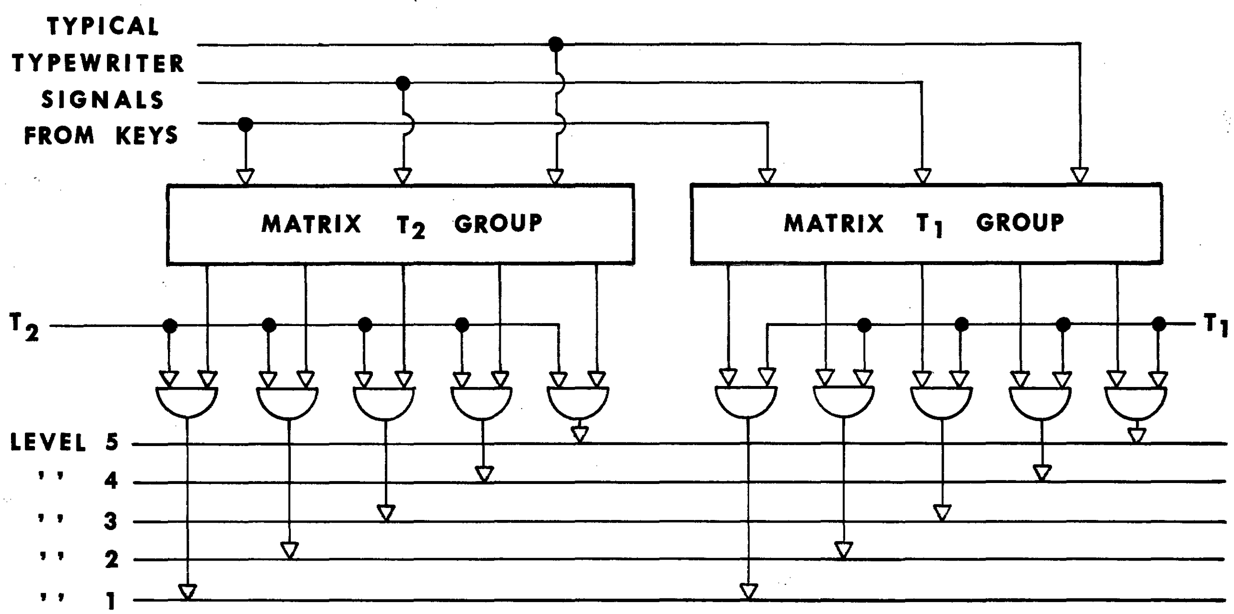
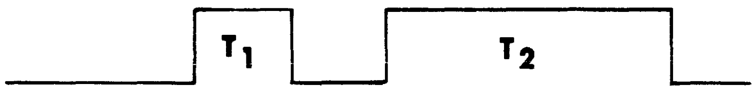


Figure 3

The two groups are separated in time and gated on to the level lines by T_1 and T_2 gate pulses.



	T_1	T_2
A :	1 1 0 0 1	1 0 0 0 1
a :	1 1 1 0 1	1 0 0 0 1

Figure 4

Compare the codes for "A" and "a". Note that the only difference between "A" and "a" is that "a" has a one in level 3 of the T_1 group while "A" has a zero. This is the difference between upper and lower case characters. Upper case characters have a zero in level 3 of the T_1 group while lower case characters have a one in level 3. The T_2 group is exactly the same for both upper case 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. These "special characters" will be discussed in some detail in connection with the decoder.

Look again at the chart of Figure 2. The character "t", for example, is 11111 10011. "t" or "T" is identified by levels 1 and 2 of group 1, and levels 1, 2, 3, and 4 of group 2. That is,

xxx11 x0011 = "t" or "T"

Actually, only six of the ten signals are needed to specify a particular key -- "t" or "T" -- on the typewriter. Level 5 of both groups is forced high. In normal hexadecimal input to the G-15, level 5 gives rise to the signal called "digit in the OB's" meaning that whatever is in the OB's is to go into memory. A zero in level 5 indicates a control code in the OB's that should not go into memory. In alphanumeric, everything goes into memory, and so, level 5 is always forced high -- for both groups. This level 5 is lost between the OB's and M23 in the usual manner. Level 4 of group 1 is not used and is also forced high. With this in mind, we can redraw the simplified schematic of Figure 3 to appear as Figure 5.

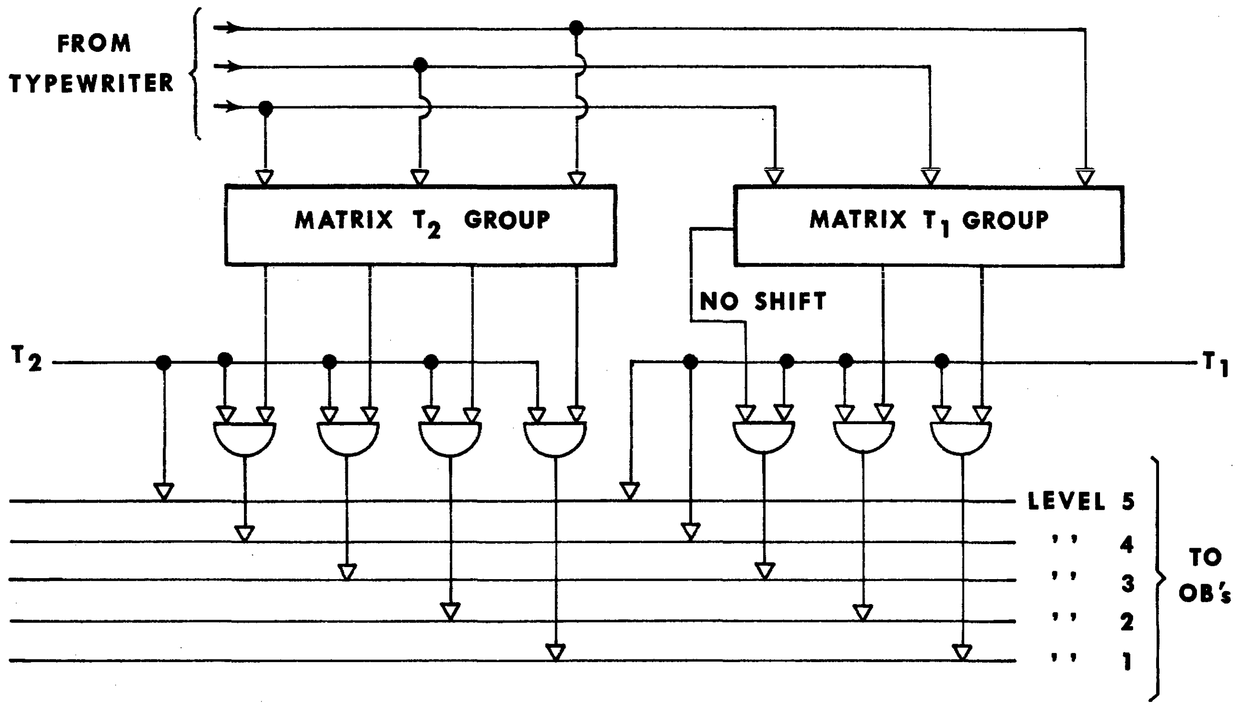


Figure 5

To use the example characters "t" and "T" again, if "t" were the first character typed in, M23 would look like

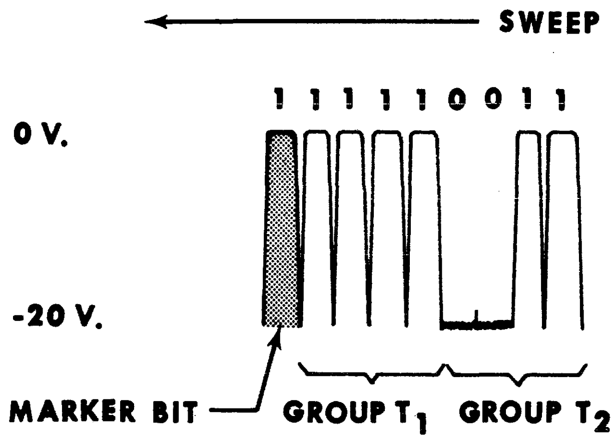


Figure 6

while "T" would show up in M23 as

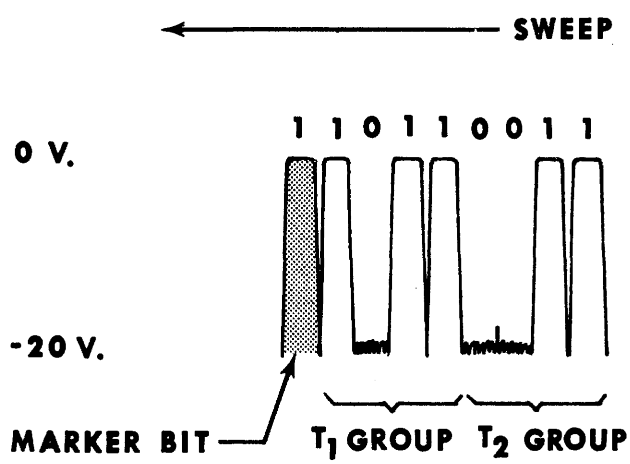


Figure 7

The AN coupler contains a completely separate matrix for hexadecimal input. This matrix generates the standard G–15 hex codes, and since only one group of bits is required per character, the codes are gated with T_1 only.

With two encoders working, the proper code — — alphanumeric or numeric — — is chosen with an appropriate gate signal "AN" or "HEX". The "AN" and "HEX" signals are generated in the computer by the "AS" flip–flop.

AS = AN . . . . $\overline{AS}$ = HEX

The simplified schematic of Figure 4 can now be redrawn as Figure 5 to show the numeric matrix, AN and HEX gates, and the emitter follower amplifiers added to drive the line between coupler and computer.

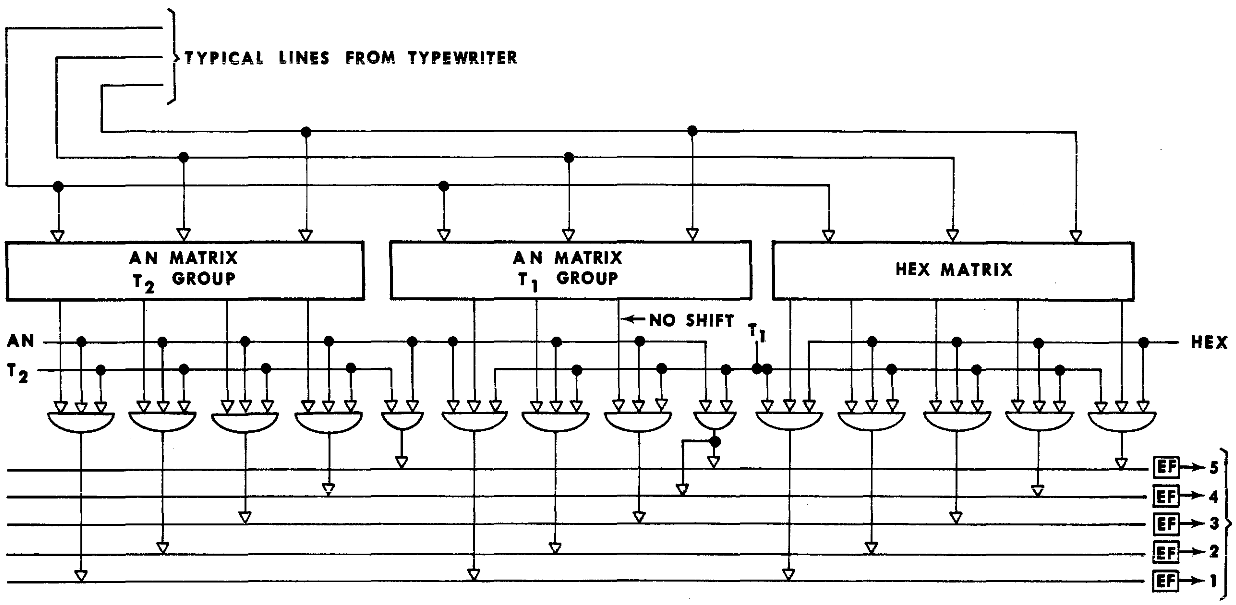


Figure 8

Refer to drawing number 3D643 – "Schematic Coup. Matrix". Compare this drawing to the simplified schematic of Figure 8.

Across the bottom are the five level lines to the emitter followers and thence to the computer.

The left hand half of the page shows the AN matrices, qualified toward the bottom by the signals $AN \cdot \overline{SA} \cdot T_2$ or $AN \cdot \overline{SA} \cdot T_1$.

To the right of center is the numeric matrix, qualified by $HEX \cdot T_1$.

Toward the right hand edge is shown a control signal list and the associated plug connections to the computer.

In the upper right is a schematic of a typical emitter follower package with input connections for the code levels to the left and output connections to the computer on the right.

TYPEWRITER, ELECTRICAL

Before going into the decoder, a description of the AN typewriter will be helpful. The typewriter is an IBM Input—Output Writer, with 88 characters and the normal typewriter functions of tab, carriage return, space and shift.

The typewriter is equipped with 44 "key" or "character" contacts and 4 "function" contacts (carriage return, space, tab, and shift), and interlock contacts for each, all of which are used in various phases of input—output.

Each character on the keyboard has 3 sets of contacts associated with it. These are:

1. Key or character contact (one per key).
2. Character interlock (one switch common to all 44 keys).
3. Input common (one switch common to all 44 keys).

Look at the simplified drawing of Figure 9.

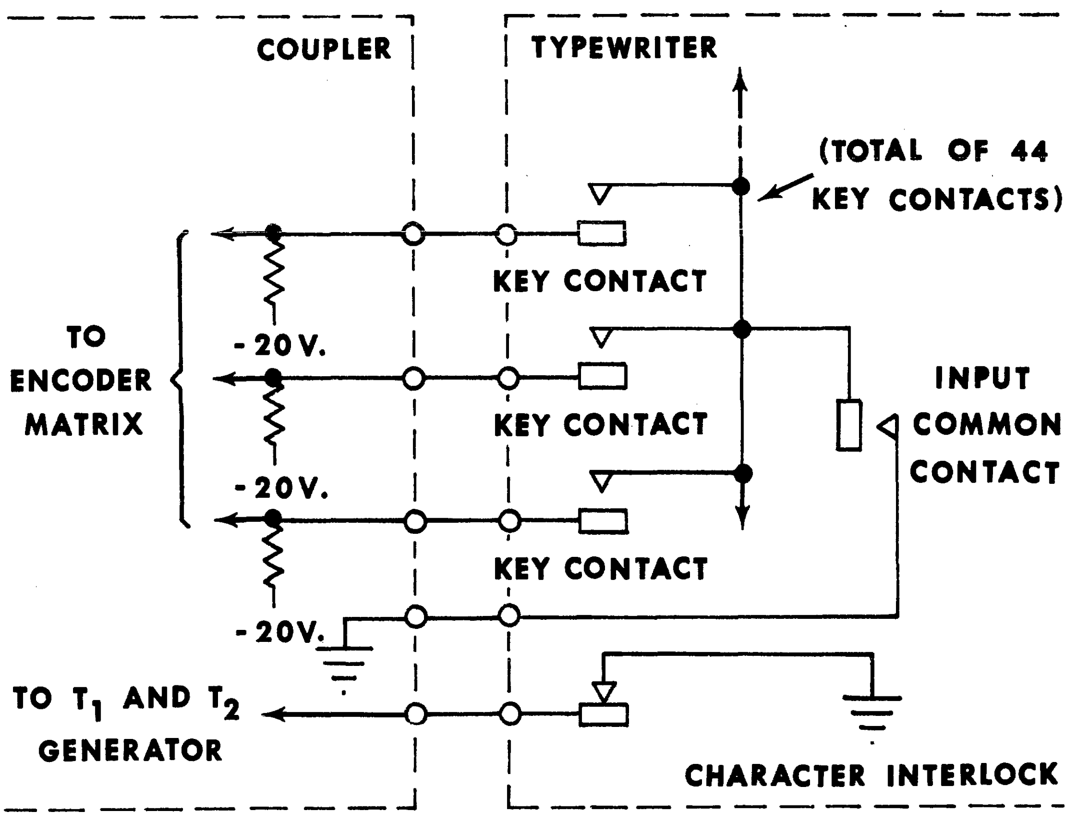


Figure 9

Note that all the key contacts are tied together and float at one end. The other end goes to the encoder matrix and is held at −20 volts. Any key contact plus the Input common contact forms an "and" gate. The key contact closes but the matrix input remains at −20 volts until the input common closes and brings the key line up to zero volts.

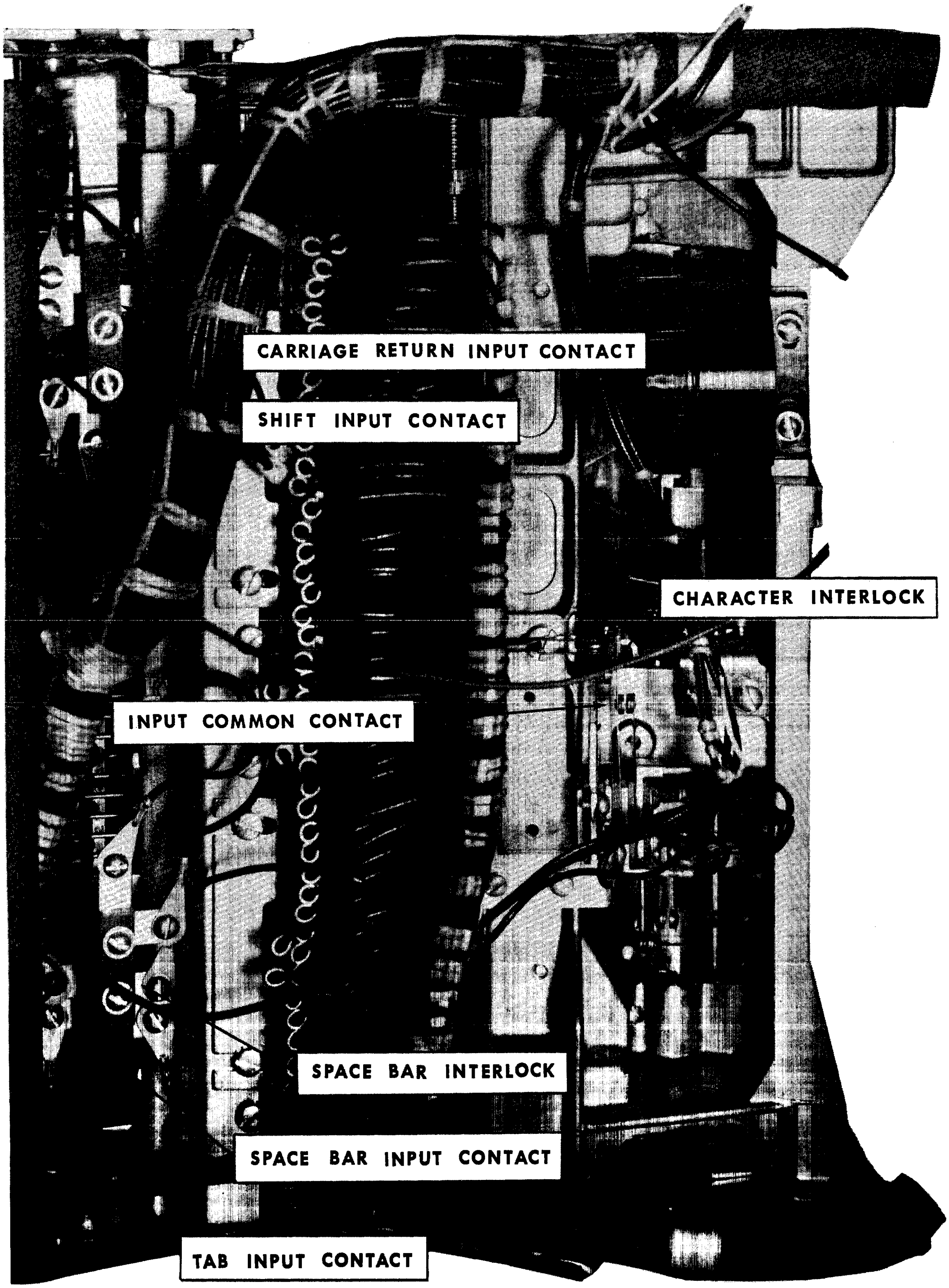

CARRIAGE RETURN INPUT CONTACT
SHIFT INPUT CONTACT
CHARACTER INTERLOCK
INPUT COMMON CONTACT
SPACE BAR INTERLOCK
SPACE BAR INPUT CONTACT
TAB INPUT CONTACT

Figure 10

The character interlock opens, generating the coupler gate pulses T_1 and T_2. The timing of these contacts is shown below.

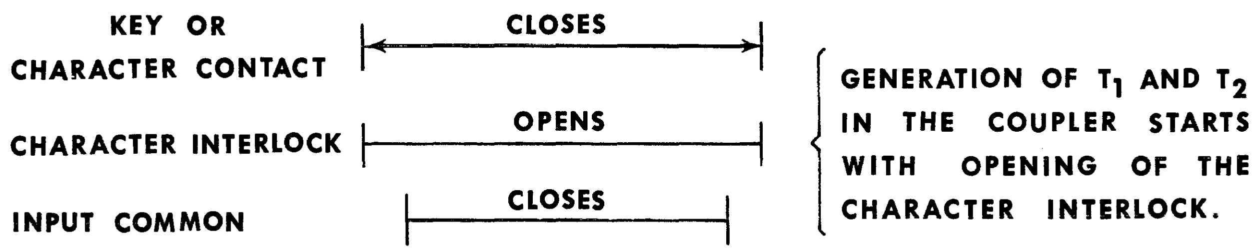


Figure 11

Although separate electrical circuits, the character interlock and input common contacts are operated by the same push rod.

The space bar, tab and carriage return each have two sets of contacts associated with them, the contact itself and an interlock. However, there is no "common contact" involved. The carriage return interlock is built so that it stays open during the entire time that the carriage is in motion. An additional set of contacts, the "tab feedback" contacts have been mounted on the tab interlock switch. Operated by the same cam as the tab interlock, they are normally open but close when the tab is operated. They remain closed during the entire period of tabular movement.

Figure 12 shows these various contacts. Note the "upper case — lower case" contact. This is the "shift" contact. It is a mechanically operated switch such that when the carriage is in the up shift position the upper case contact makes; in the down shift position, the lower case contact makes.

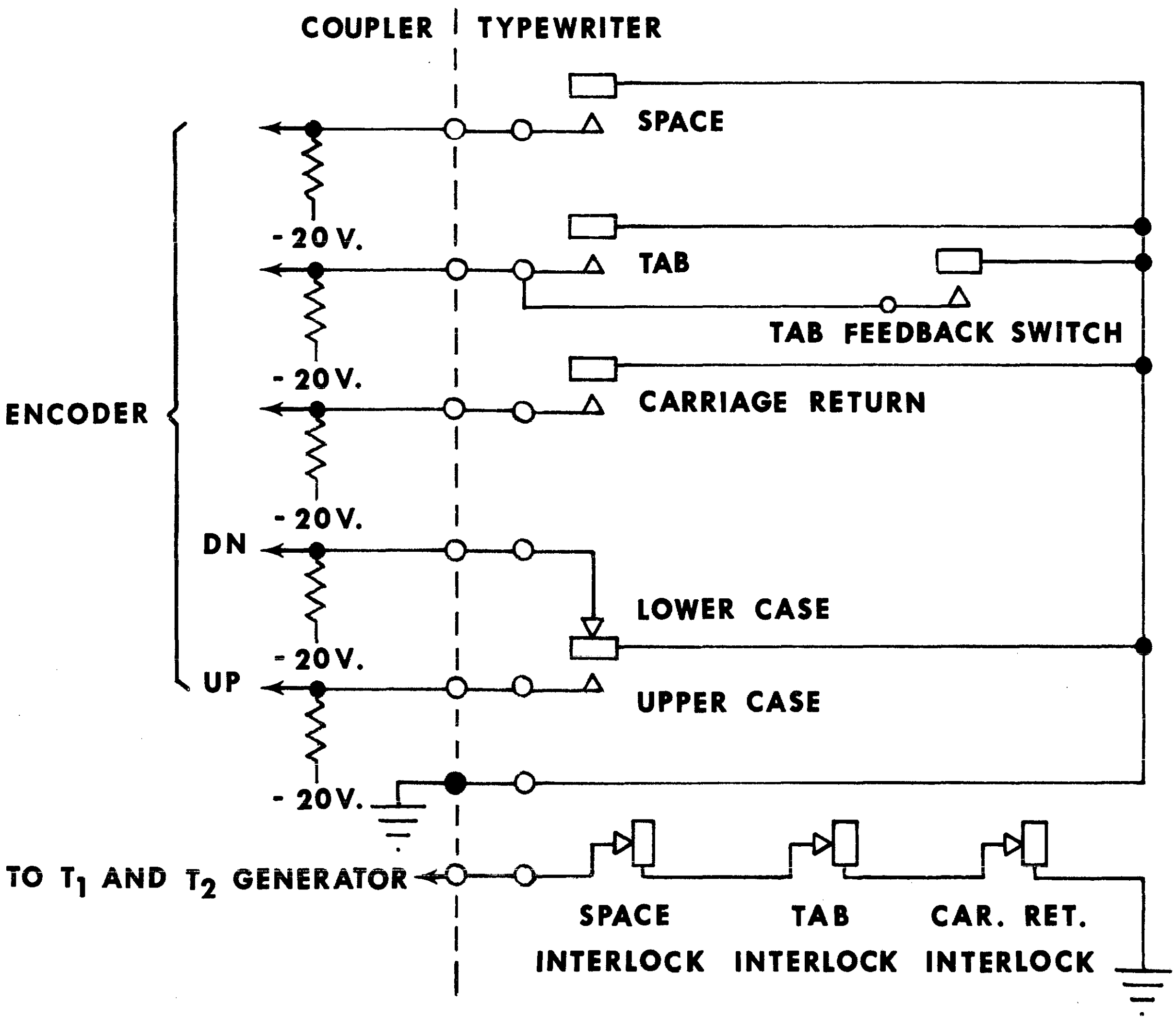


Figure 12

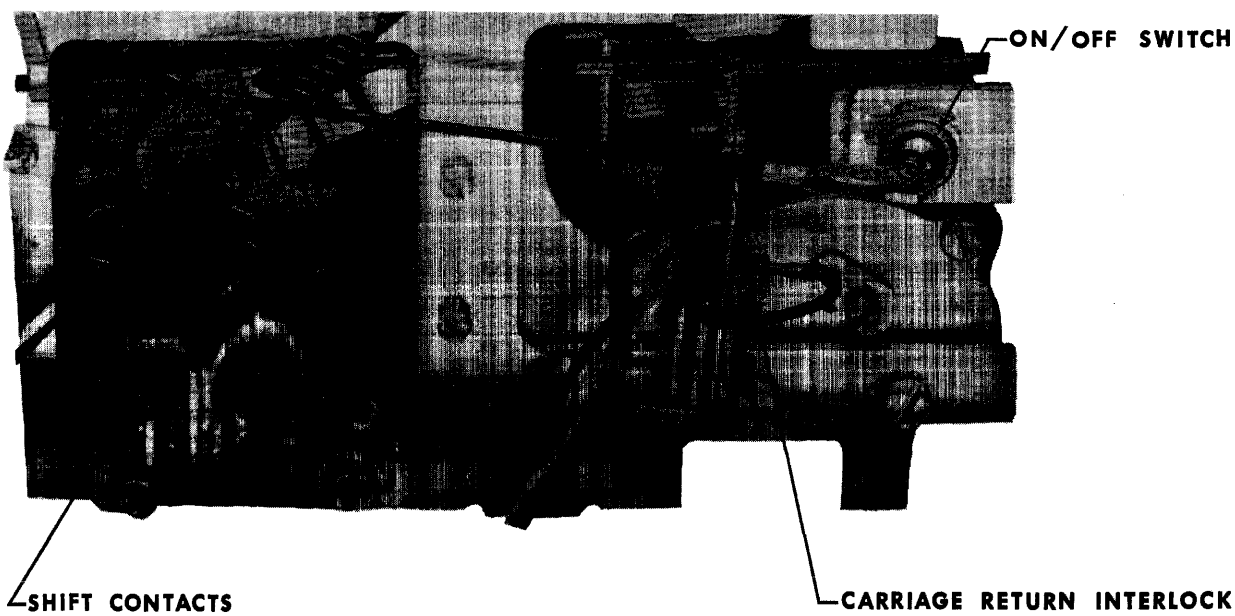


Figure 13

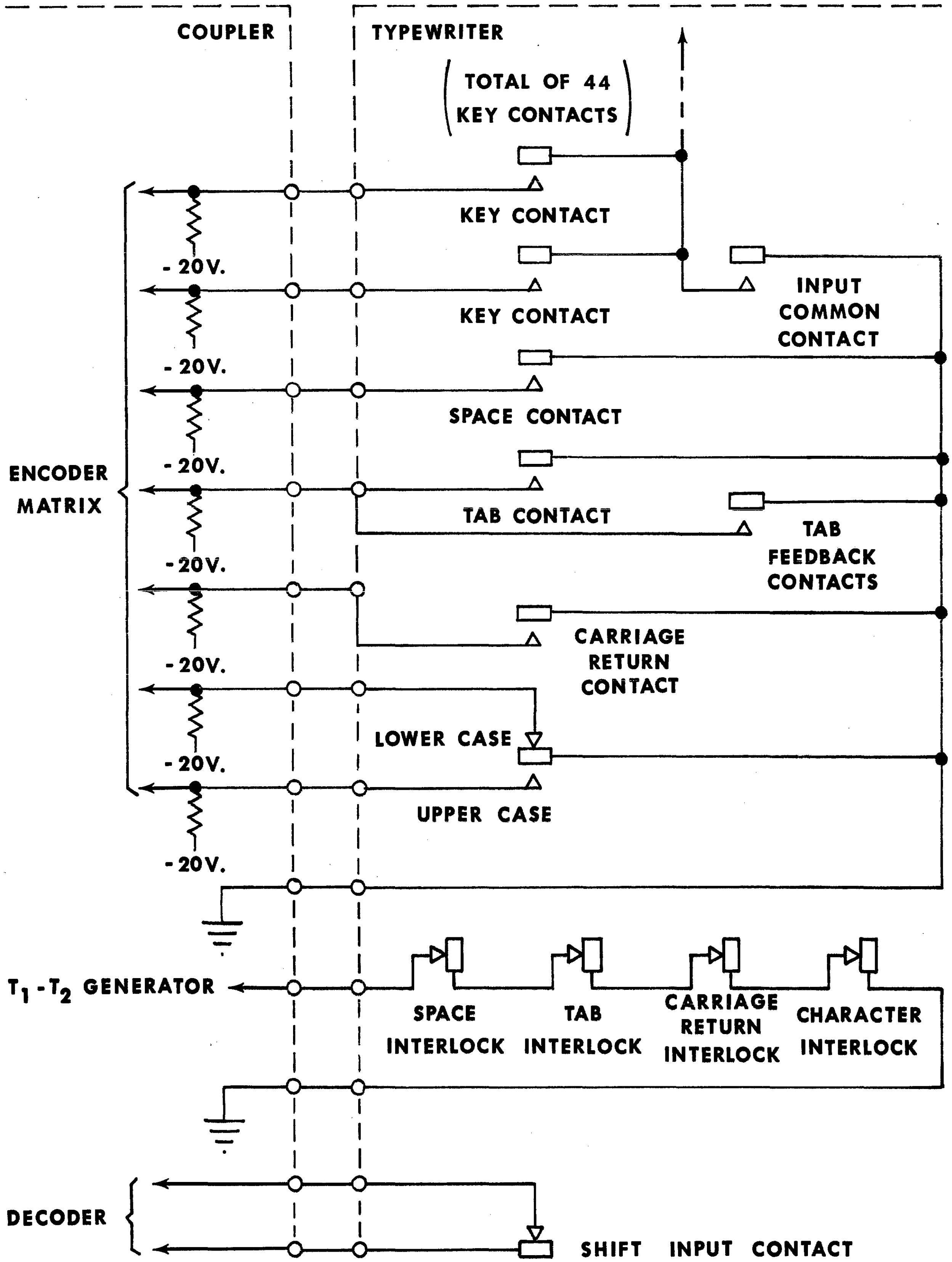

COUPLER
TYPEWRITER
TOTAL OF 44 KEY CONTACTS
KEY CONTACT
KEY CONTACT
INPUT COMMON CONTACT
SPACE CONTACT
TAB CONTACT
TAB FEEDBACK CONTACTS
CARRIAGE RETURN CONTACT
LOWER CASE
UPPER CASE
ENCODER MATRIX
- 20V.
T_1 - T_2 GENERATOR
SPACE INTERLOCK
TAB INTERLOCK
CARRIAGE RETURN INTERLOCK
CHARACTER INTERLOCK
DECODER
SHIFT INPUT CONTACT

Figure 14

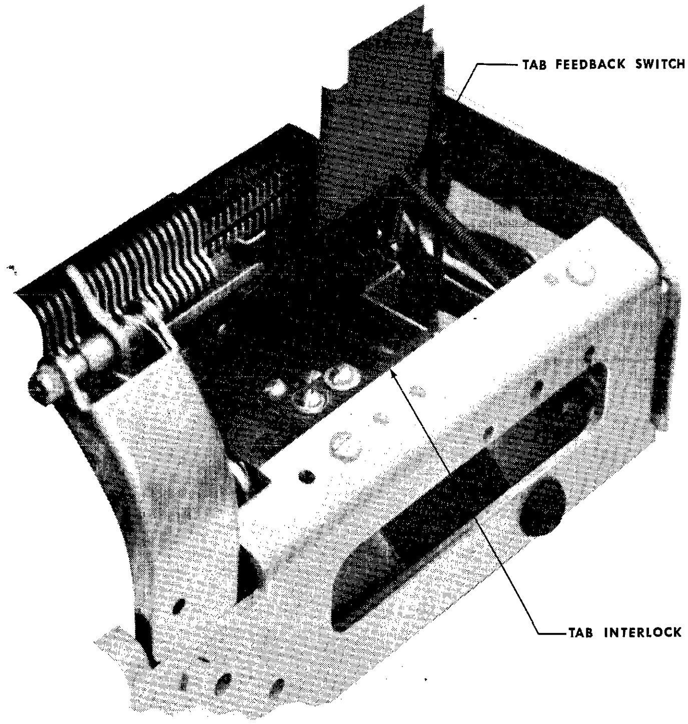


Figure 15

The shift key does not have an interlock named as such. It does have a set of contacts called the "shift input " contact that are used to provide something similar to interlock action. This switch will be discussed in detail in the Decoder Section.

The various interlock contacts all accomplish the same job in the same way. When the interlocks open, they initiate the T_1 and T_2 gating pulses. Because of this, they are all connected in series and a single line brought out to the coupler.

The simplified drawing of Figure 14 ties up Figure 9 and 12.

Compare drawing 3D640 – Schematic, Typewriter – with Figure 14. All the contacts shown in Figure 14 are repeated together with the pin connections in the two plugs on the rear of the typewriter.

Pins 55 and 56 of PLM 2A are jumpered in the plug, giving the series connection of interlocks shown in Figure 14.

PLM 2A–57 connects the interlocks to the T_1–T_2 generator while PLM 2A–54, 60 and PLF 1A–45 go to ground in the coupler.

PLM 2A–58 is the "lower case" contact while PLM 2A–59 is the "upper case" contact.

The "Ribbon Interlock" connected to PLM 2A is not used.

T_1–T_2 GENERATOR

The generator is used to supply two gating pulses, T_1 and T_2 when any one of the typewriter interlocks open.

Refer to Figure 17, recall that all interlocks are wired in series and that the relay K12A is grounded at the lower end through K12B (3–1).

At first glance, it would appear that the K12A relay should be pulled in at all times. It isn't. The 4K and 390 Ohm resistor form a voltage divider between +160 V and ground (through the typewriter interlocks). The voltage at point (a) is approximately

$$\frac{160 \times 390}{4000 + 390} = 14 \text{ volts}$$

This, of course, is not enough to pull in the relay.

However, when any interlock on the typewriter opens, the voltage divider is lifted off ground and 160 volts appear at point (a). K12A pulls in.

The voltage wave form at point (a) is shown

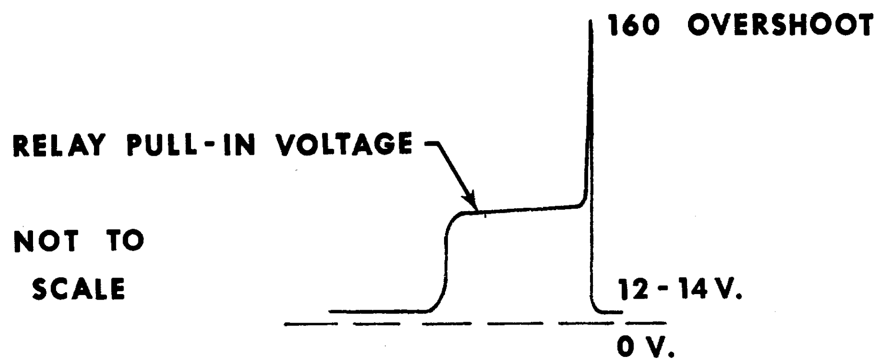


Figure 16

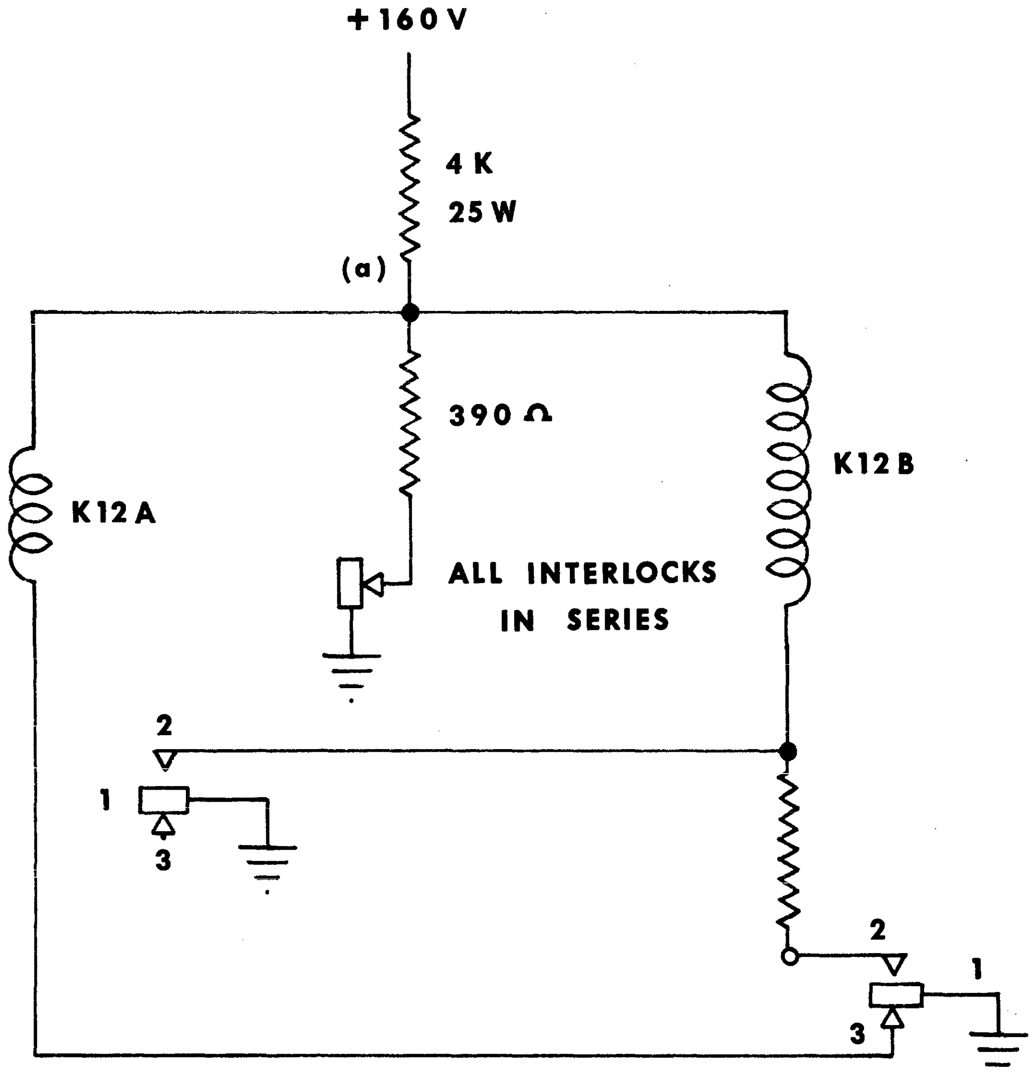


Figure 17

Keeping this simplified drawing in mind, look at drawing 3D646 or 3D661 – "Schematic, Decoder, AN Coupler".

In the lower left hand corner, are the K12A and K12B relays. The voltage divider and connection through PL2A–57 to the typewriter interlocks. The action of contacts 123 has been discussed.

When K12A pulls in, it puts ground on K12B, allowing K12B to energize, K12B pulls in, breaking the path of K12A.

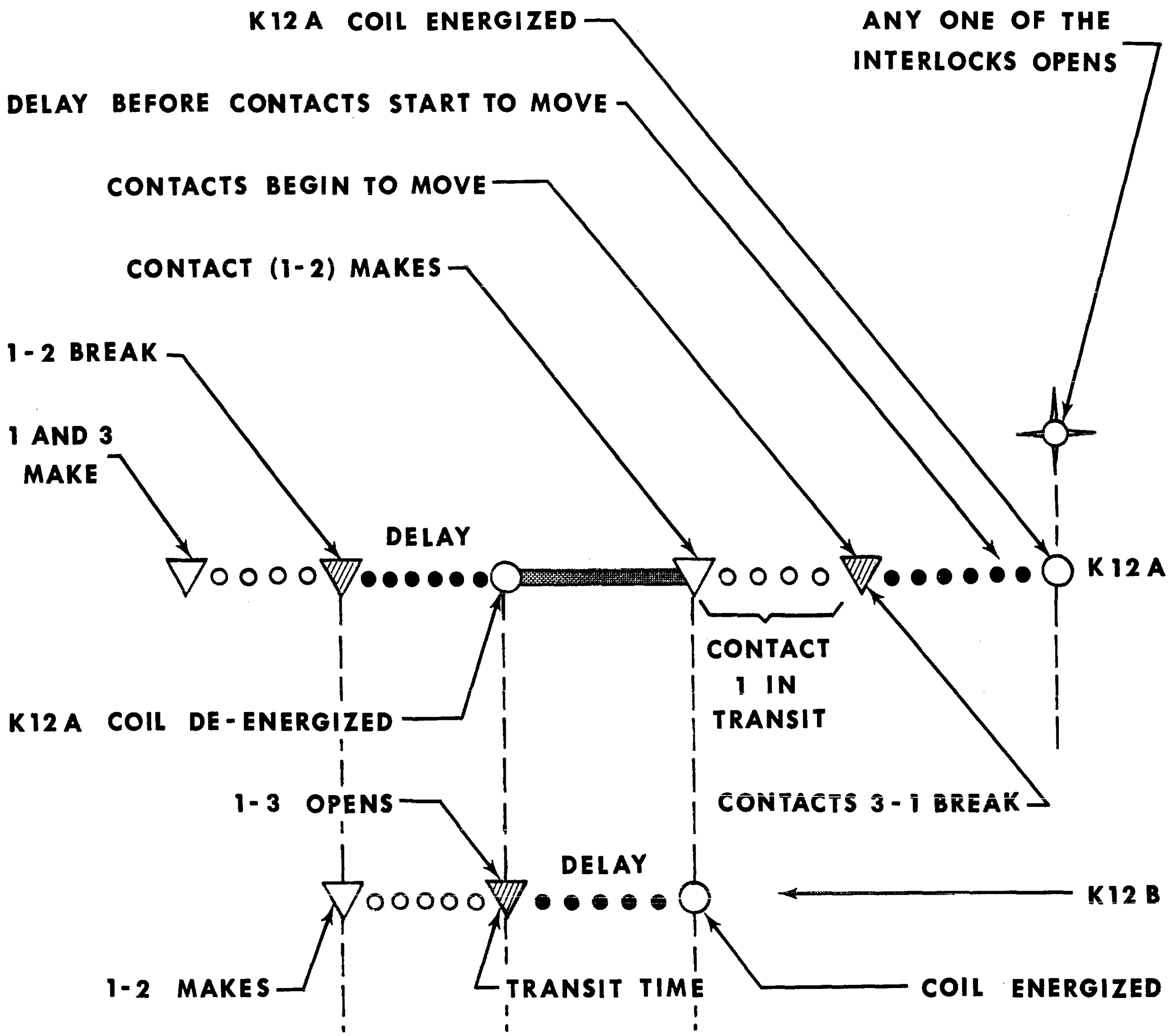


Figure 18

K12B, then has held itself on and will remain pulled in until the interlocks close again and pull the voltage at point (a) so low that K12B drops out. To diagram the timing of the coils:

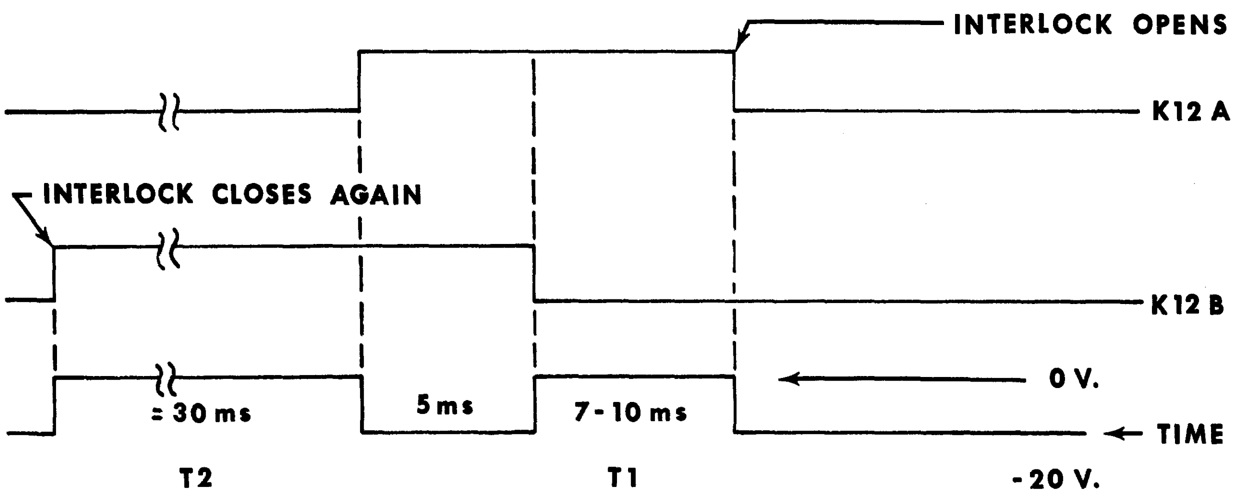


Figure 19

When K12A pulls in, the −20 volts circuit holding T_1 down through K12A (10–12) is broken. The zero volt circuit is made from 0 volts (A) through K12B (4–6) and K12A (4–5) through the intergrator to remove contact bounce and out.

At the same time this pulse rises, K12B is energized and begins to break the path of T_1. Recall the timing of Figure 19. After K12B is energized, there is a delay before the contacts move. Hence, the T_1 line remains at zero volts for a period of time before K12B (4–6) opens, removing it from ground and K12B (10–11) closes, pulling it back to −20 volts.

Simultaneously, T_2 is disconnected from −20 when K12B (10–12) opens. K12A has been de–energized but again there exists a delay before the contacts resume their normal position.

When K12A does finish dropping out, a path is made for T_2 from 0 volts – – K12B (4–5) – – K12A (7–9) and out.

T_2 will remain at 0 volts until the interlocks close again, shutting off K12B.

Algebraically:

$$T_1 = K12A \cdot \overline{K12B}$$

$$T_2 = \overline{K12A} \cdot K12B$$

DECODER:

The decoder portion of the coupler is made up of 3 relay decoders, one for numeric, one for alphanumeric and one for special characters.

A relay, K8, under control of the AS flip–flop chooses either the AN or numeric (hex) decoder. The special character decoder is a special case of alphanumeric coding where the characters are coded as lower case but still cause the typewriter to shift up.

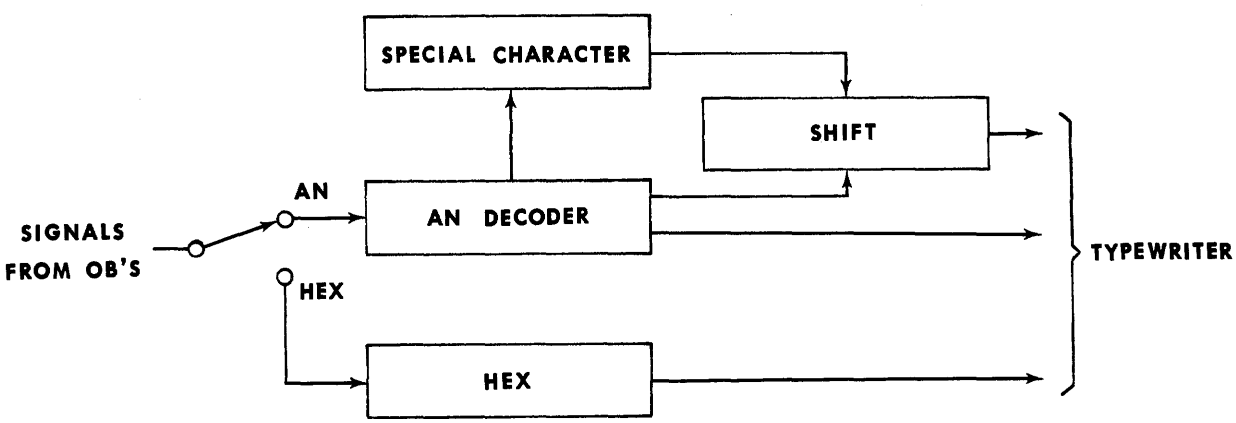


Figure 20

The numeric portion will be discussed first, the alphanumeric added and finally the special characters brought in.

First, let's look at the signals from the G-15 to the coupler.

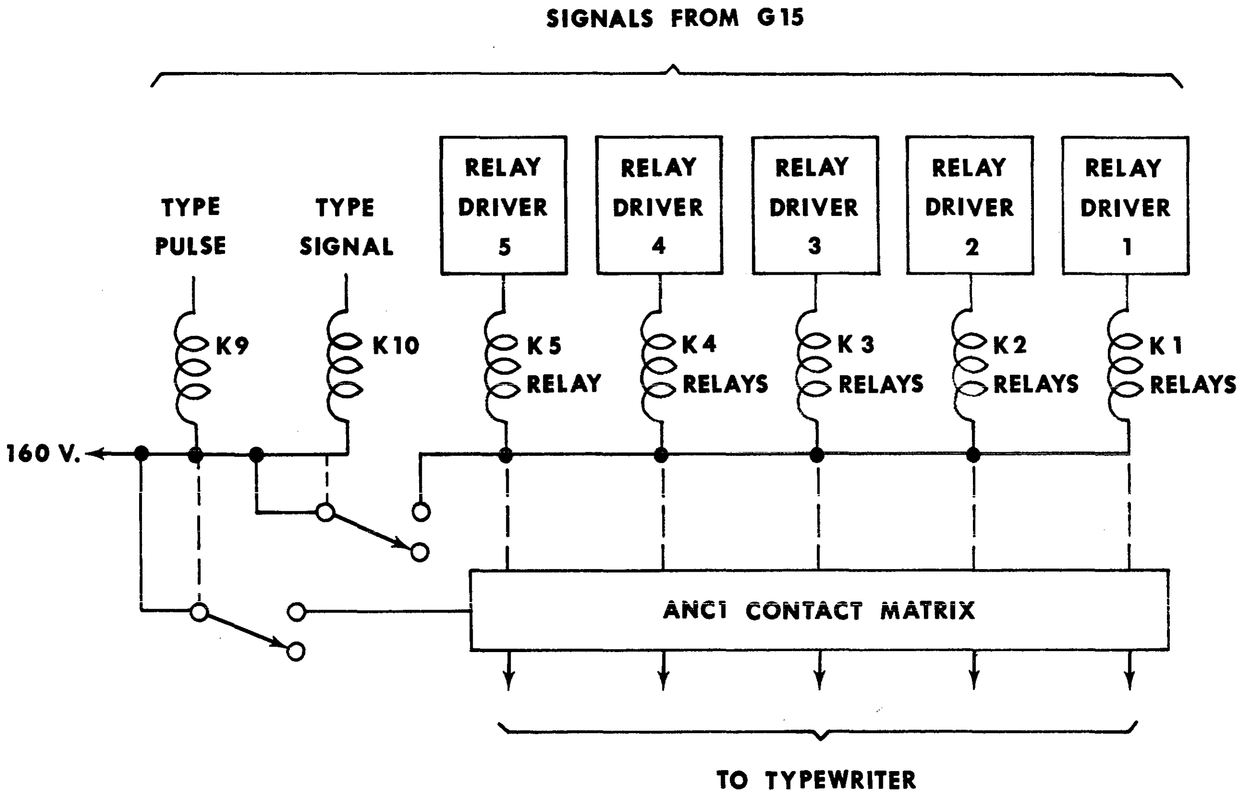


Figure 21

The type signal relay follows the G-15 "TYPE" signal and applies +160 volts to one end of the matrix relay coils. The other ends of the coils are tied to relay driver tubes following the OB flip-flops.

The relays are set up and held by the OB's, their contacts creating a path to one of the typewriter solenoids. The "TYPE PULSE", through relay K9 energizes the typewriter solenoids through this path.

DECODER NUMERIC

Refer to simplified schematic number 1 — — "Numeric Decoder — — ANC–1". The numeric decoder is a straightforward relay matrix to decode the standard G–15 hexadecimal output codes.

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 through z) **FORMAT** (SP through .)

Figure 22

The driving signals appear across the top of the drawing. K10 follows the G–15 "TYPE" signal — — not the "type pulse", but the steady "TYPE" signal as set up by the OC's K9 is the "type pulse" (execute) relay. Through its contacts (4–5), power is applied to the relay contacts that finally energize the proper typewriter solenoid.

K8 is the "AN" relay that follows the AS flip–flop. In alphanumeric, this relay is energized, in numeric as now, it is de–energized.

K5, K4's, K3, K2's, and K1's are the five information levels from relay drivers (RD's) 1 through 5. The relay driver tubes themselves follow the OB flip–flops.

A pin diagram of the relays appears in the lower right corner of the drawing.

In the upper left of the drawing is a signal list, exit points and routing to the typewriter. For example, the signal for the digit "5" is decoded in the matrix, leaves the matrix at K4C–9, goes through Terminal Block TB3–L, through the connecting cable and into the typewriter through plug P1–2A–37.

Again using "5" as an example, let's trace through the matrix. Figure 22 gives the code for 5 as:

10101

and the signal list shows that "5" exits from the decoder at K4C–9. The energizing path through the matrix from + 160 volts to K4C–9 is:

K9 (4–5) – – $\overline{\text{K8}}$ (4–6) – – K5 (2–1) – – K3B (7–8) – – $\overline{\text{K2C}}$ (4–6) – –

K1D (1–2) – – $\overline{\text{K4C}}$ (7–9) – – TB (3–L) – – PL2A–37 and to the

typewriter solenoid.

Any other numeric character may be traced through the matrix in the same manner.

DECODER, ALPHANUMERIC

Information comes from the computer in two groups – – the first and second extractions – – from the OB flip–flops.

The OB's load up and transfer the first extraction to the coupler, clear, load and transfer the second extraction.

The information in the first extraction must be remembered by the coupler until it is combined with second extraction information to identify the character.

T_1 GROUP	T_2 GROUP															
	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	0 1111
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		DELETE
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		-		-			≠	[	]							

Figure 23

As an example, let's look at the letter "a". From Figure 23 the output code is:

11101 00001

first extraction second extraction

Recall that "a" or "A" is identified by

xxx01 x0001

and specifically lower case by:

xx1xx xxxxx

With this in mind let's see how this letter is decoded. Levels 1, 2, and 3 of the first extraction must be looked at by the matrix. If 3 level is low, the shift must start up immediately and remain up until the second extraction and type pulse arrives. The shift circuit remembers that it has been told to shift by a circuit made up of two relays (K11A and K11B) which will be discussed in detail later.

These 3 levels are 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

Confirm this by looking again at Figure 23. Note that for all alphanumeric characters, first extraction has level 5 while second extraction has no level 5.

1.5 = remember

2.5 = remember

3.5 = shift and hold the shift

To see how the relay matrix is set up during the first extraction, look at simplified decoder schematic number 2.

The K6 series relays detect and remember level 1 of first extraction.

$K6_{(set)}$ = Level 1 · level 5

The $K7_{(set)}$ = level 2 · level 5.

The K3A relay detects level 3 of first extraction and uses the combination of K11B and K11A to initiate and hold the shift.

At the end of the first extraction for the character "a", we have:

1) "type" (K10)
2) "AN" (K8)
3) level 1 · level 5 (K6)
4) level 2 · level 5 (K7)
5) "no shift" (K11A)

Now the second extraction arrives from the computer. Figure 13 shows

00001

for "a".

The K1 relays pull in for the second time, and K9 pulls in with the type pulse giving the overall matrix set up as:

$$K10 \cdot K8 \cdot \overline{K7} \cdot K6 \cdot \overline{K5} \cdot \overline{K4} \cdot \overline{K3} \cdot \overline{K2} \cdot K1 \cdot \overline{K11A} \cdot \overline{K11B} \cdot K9$$

With this, we can trace the path of power from the "a" key solenoid of the typewriter back to +160 volts.

At the left edge of the drawing is a chart showing each character, its exit point from the matrix and its routing to the typewriter.

Upper case and lower case are not separated as they exit from the same point.

"a" exits from K4B–3 and the object of the game is to get from this point to +160 volts through the relays as set and reset by the character code.

$\overline{K4B}$ (3–1) – – $\overline{K2B}$ (9–7) – – $\overline{K3B}$ (3–1) – – K1A (8–7) – –

K6C (8–7) – – $\overline{K7}$ (6–4) – – K8 (5–4) – – K9 (5)

The type pulse closes K9 – completing the circuit to +160 volts.

Exactly the same path energizes the key solenoid in upper case. The only difference being that during the first extraction an additional path was set up that energized the shift solenoid.

Any alphanumeric character except the "special" characters +, (,), *, /, =, and $ may be traced out the same way.

CIRCUIT DETAILS – AN

Look at Simplified Schematic number 2 — — "AN Decoder, ANC–1". The setting of K6 and K7 is done through their ground paths. Look at the wire runs around K6 and K7. Their top ends are connected to + 160 volts as soon as the "type" signal comes high and pulls in K10. Recall that,

K6 = level 1 · level 5 = level 1 of first extraction

K7 = level 2 · level 5 = level 2 of first extraction

Remembering that + 160 is already ties to K6, its ground comes from K6 (13) – K1D (11–10) — — K5 (11–10) — — K8 (11–10) — — OV_B. The K6 series are energized and pull in. K6A (11–10) bypass K1 contacts to K5 (12). At the end of the first extraction, K1 and K5 levels disappear; K1 and K5 drop out and a ground circuit is made for K6 from K6A (13) — — K6A (11–10) — — K5 (12–10) K8 (11–10) — — OV_B. K6 is now held in and has remembered level 1 of the first extraction.

There does exist a short period of time when the K6 relays are de–energized. This happens during the transition time of the K5 relay contacts when they leave 11 and are traveling to 12 — — there is no ground for K6.

Obviously the transit time of K5 must be less than the drop out time of K6. It normally would be, but for additional insurance, timing resistors have been put across the coils.

Relay K7 is set exactly the same as K6, through K2D (11–10) — — K5 (8–7) — — K8 (11–10) — — OV_B.

Both relays will continue to hold themselves on until the following first extraction time. Then K5 energizes, breaking their ground paths and if K1 and/or K2 is not energized to remake the ground – K6 and K7 will drop out.

SHIFT CIRCUIT

With the exception of the special characters, the command to shift is given by a level 3 in the first extraction. Recalling that first extraction is characterized by a level 5,

$$\text{SHIFT} = \overline{\text{level 3}} \cdot \text{level 5}$$

To prevent needless bouncing of the carriage, the shift, once up, will stay up until it receives a down shift command in the form of level 3 of the first extraction. If a series of upper case characters come in, the carriage shifts on the first one, and stays up until all are typed; it will remain up until the next lower case character is decoded. The shift circuit, then, is governed not only by the character being decoded but also by the last previously decoded character.

Refer to simplified schematic number 3 "Normal Shift–ANC–1". Relay K11B (at the far right) is a trigger and gate used to set and reset K11A. Relay K11A is the actual switch, through K11A (4–5), that applies power to the shift solenoid.

Assume that the last character typed was lower case and the present one is upper case. That is, we call for an "up shift". K11B is turned on by the first extraction code,

$$\text{AN} \cdot \text{level 5} \cdot \overline{\text{level 3}}$$

and sets K11A. The path to K11B is:

$$\text{K5 (4–5) – – K8 (1–2) – – } \overline{\text{K3A}} \text{ (4–6) – – } \overline{\text{K11A}} \text{ (10–12) – – K11B (14–13).}$$

K11B closes and:

1) Gives "feedback" through K11B (2–1)
2) Holds itself on through K11B (7–8)
3) Turns on K11A through K11B (10–11)
4) To be discussed in "down shift".

Now, K11A closes and:

1) Puts power to the up solenoid through K11A (4–5)
2) Holds itself on through K11A (1–2)
3) Opens original path through K11A (10–12) that triggered K11B with level 3 · level 5.
4) Establishes a new path through K11A (7–8) so that K11B will be triggered with level 3· level 5.

When the carriage begins to move, the normally closed "shift input" contact in the typewriter opens and stays open during the time of actual carriage motion. It opens the K11B circuit and allows K11B to drop out.

When K11A completes actions 3 and 4, it has reversed the sensitivities of K11B. Now, it can be energized only by level 3 · level 5 – – that is "lower case" – – calling for a down shift.

The carriage now up. will stay up until the next character calling for a down shift. Then it will come down and stay down until an up shift is again called for.

When the next down shift is called for by level 3 $\cdot$ level 5, power is removed from the shift solenoid by turning "off" relay K11A.

This can be done by opening the K11A ground path.

Look closely at K11A ground—paths out of K11A pin (13). There are three paths from pin 13 to ground:

1) Through K11B (6–4) – – K8 (11–10) = $\overline{K11B} \cdot AN$

2) K3D (12–10) – – K8 (11–10) = $\overline{K3D} \cdot AN$

3) K5 (9–7) – – K8 (11–10) = $\overline{K5} \cdot AN$

Looking at the equations,

$$K11A_{ground} = AN \cdot (\overline{K11B} + \overline{K3D} + \overline{K5})$$

This equation implies that when calling for a down shift with level 3 $\cdot$ level 5, only K11B must be energized and the ground will be removed from K11A.

K11B, then, is energized through K11A by level 3 $\cdot$ level 5.

The ground path of K11A is opened, K11A drops out and power is removed from the shift solenoid.

SPECIAL CHARACTERS:

As has been mentioned, special characters are upper case characters coded as lower case. In decoding, the matrix must recognize the fact that this is a special character and energize the shift solenoid. Normally, the shift is energized during the first extraction of a character and the carriage has ample time to move before the second extraction completes identification of the character and the "Type" pulse comes in to type it.

With special characters, however, the matrix doesn't know it's dealing with a special case until the character is completely identified – – that is, until some time during the second extraction – – after the slowest matrix relay is set up.

The decoder, then, must recognize the special character, start the typewriter shifting and kill the type pulse until the carriage can get moved.

The type pulse occurs simultaneously with the second extraction so that as soon as the matrix is set up, power is normally applied to the key solenoid. However, with special characters power to the key solenoids must be delayed until the carriage completes its motion. This can be done in two ways:

1) By killing the type pulse until the carriage is moved,
2) By inserting a gate qualified by upper carriage position and type pulse.

The first method is used as well as a delay inserted in the key solenoid line to allow the type pulse to be killed.

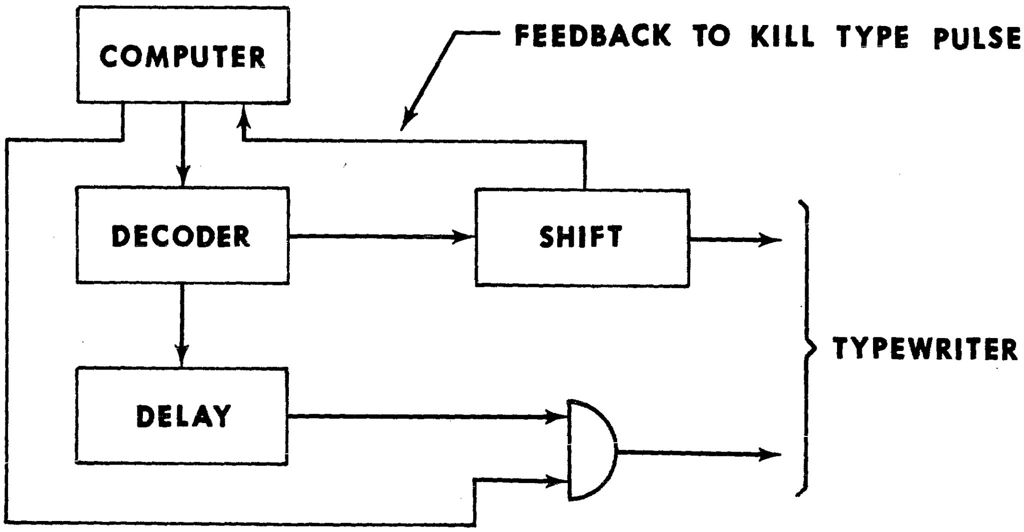


Figure 24

Refer to Simplified Schematic number 4 – "Special Characters ANC–1".

Note that the ends of relays K6 and K7 have been left dangling –– completing the ground circuits would have complicated the drawing without helping to explain special characters.

Using "$" for an example, let's trace through the decoder matrix. The code for $ is:

11110 01011

first extraction second extraction

Giving a path, at the time of second extraction through,

K9 (4–5) ––K8 (4–5) –– K7 (4–5) –– K4 (10–11) –– K1A (10–11) ––

$\overline{\text{K5}}$ (10–12) –– K2A (4–5) –– $\overline{\text{K6A}}$ (4–6) –– CR11 and K11C (10)

The pulse passes through CR11, CR10 and energizes K11A through K5 (9–7) and K8 (11–10).

Simultaneously, the pulse energizes K11B through CR18 and the shift input contacts.

K11B closes, and

1) Opens up K11A ground through K11B (6–4).
2) Applies its own "hold" through K11B (8–7).
3) Supplies a feedback signal to kill the type pulse.

K11A, closing at the same time,

1) Holds itself through K11A (1–2) and CR9.
2) Applies power to K11C and K11D through K11A (1–2).
3) Applies power to the up solenoid through K11A (4–5).

K11C and K11D make the final connection from the decoder to the typewriter solenoid lines.

Refer again to Simplified Schematic number 4. The feedback comes from K11B (2–1). The shift command from K11A (4–5). The "delay" is the time lag between the closing of K11A contacts and K11C and K11D contacts.

The type pulse, killed by the feedback to the HC buffer inverter which resets the OY flip–flop, comes high again one drum revolution (30 milliseconds) later, which is enough time for the carriage to complete its motion to the upper case position.

As the carriage moves to upper case position, the "shift input" contacts open by cam action and turn off K11B. When K11B comes down, the feedback is turned off and the type pulse comes through at the next G–15 T_0 time.

Having reviewed the 4 simplified schematics, look again at 3D661/3D646.

All the information on the 4 simplified drawings has been brought together in one schematic.

There are a few things that should be mentioned to eliminate possible confusion.

Look at K7. Between K7 (13) and K7 (11) is a diode, CR5. To the right and below it is another, CR6, and at 7 o'clock from it is still another, CR7. These are isolation diodes and do not enter into the logic of the decoder.

There are other isolation diodes scattered around as well as some RC arc suppressors and timing resistors and diodes across relay coils.

In several cases there are different exit paths for the same typewriter solenoid. The character "4", for example, has one exit point for numeric, one for alphanumeric and a third for the upper case "4" – "$". These points are merely wired together and a single line brought out to the typewriter solenoid.