MEMORANDUM

Bendix

Computer • DIVISION OF BENDIX AVIATION CORPORATION

TO: All Field Service Representatives   FROM: M. S. Thomson

SUBJECT: Changes to the G-15 -- Effective   DATE: April 12, 1960
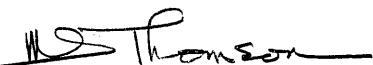Serial #~~309~~ **311**

As you are aware, the G-15 has experienced several changes since #209 came off the line. So far, you have received information outlining the changes imposed by ECO's 970-1053. These became effective on machines with serial #'s 241 and above.

The material you should have received on the subject so far is as follows:

     1. Subject: G-15 ECO's
                    1/7/60, Norman Love to J.R. Campbell (cover memo: 2/4/60, Norman Love to Frank Adair.)

     2. Subject: G-15 ECO's -- Logical Explanation
                    2/16/60, M.S. Thomson to J.R. Campbell

     3. Subject: The OUTPUT "Link"
                    3/23/60, M.S. Thomson to All Customer Engineers

Additional ECO's have been approved since that time, the latest major one being ECO 1096. It is expected that machines starting with serial #~~309~~ **311** will incorporate the latest changes.

In general, ECO 1096 "cleans up" preceding ECO's to yield the same results with less hardware and greater reliability. It is the purpose of the attached to indicate what will be in the #~~309~~**311**+ machines in terms of how they differ from #'s 241-~~308~~**310**.

M.S. THOMSON

mc
encl.

Changes in logic will be discussed in terms of the memo "G-15 ECO's -- Logical Explanation" dated February 16, 1960.

Page 1   This is not a change but an additional note. Item 10, "PHOTO READ, AUTO-RELOAD" will address the built-in photo-reader provided no PR-1's are installed. If PR-1's are installed, CHARACTERISTIC will select the reader, while the S/D bit, if = 1, will call for auto-reload. (CH = 0)·(S/D = 1) must be avoided as it sets OH, resulting in chaos if any MINUS codes exist on a tape on the built-in photo-reader. In general, Item 10 is of academic interest only.

THE FOLLOWING EQUATIONS HAVE BEEN CHANGED:

Pages 2-4

1b   Is now $\langle E \rangle \cdot \langle SA \rangle$ -- improves reliability.

2a,b   Replaced by READY -- reduces hardware, simplifies operating rules.

4c   Is now TYPE·AS·OY·TO -- renders OH inert in numeric type-outs, simplifying logic and reducing hardware.

6c   Is now AUTO·OG·TF·OA3 -- $\overline{OF3}$ was unnecessary.

6d   Is now AUTO·OG·TF·M23 -- OF3 was unnecessary.

6f   Is now SLOW OUT·$\overline{HC}$·$\overline{OS}$·$\overline{OH}$·$\overline{OY}$·TO -- applying $\overline{OH}$·$\overline{OY}$ to this equation in conjunction with the change to eq. 4c permits deletion of equations 8a and 8b, reducing hardware and simplifying logic.

7a   Is now TYPE·$\textcircled{F}$·OY -- hardware reduction.

8a,b   Removed (see 6f).

9a   Is now SLOW OUT·OY·$\textcircled{G}$ as in original G-15 -- the $\overline{OH}$ term was unnecessary.

9b   Is now SLOW OUT·OH·$\textcircled{G}$ -- hardware reduction permitted by change to 4c.

10c   Is now $\overline{OC4} + \overline{OC3} + \overline{AS} + \overline{OY}$, which is still = $\overline{AUTO \cdot OY}$ -- the SLOW IN term was unnecessary.

11a   Is now AUTO·OG·TF·OA3 -- $\overline{OF3}$ was unnecessary.

11b   Is now AUTO·OG·TF·M23 -- OF3 was unnecessary.

11c   The hardware has been re-arranged to save diodes and improve reliability, but the equation remains unchanged.

11d   Is now $\text{\textcircled{M}} \cdot \text{OH} \cdot \overline{\text{OA1}}$ -- hardware reduction; AS is not necessary as a result of change to eq. 4c.

11e,f Are now replaced by $\text{DS} \cdot \text{SO} \cdot \text{\textcircled{U}}$; i.e. the circuit has been returned to its original form for reasons to be discussed later.

13a   Is now $\text{AUTO} \cdot \text{OY} \cdot \text{TE} \cdot \overline{\text{CF}}$ -- OG was unnecessary.

17a   Is now $\text{AUTO} \cdot \text{OG} \cdot \text{TF} \cdot \text{OA3} \cdot \text{OH} \cdot \text{OS}$ -- $\overline{\text{OF3}}$ was unnecessary.

18a   Is now $\text{SLOW IN} \cdot [\overline{\text{STOP}}]_{\text{OB}} \cdot \overline{\text{OF2}} \cdot \overline{\text{OD}}$ -- $\overline{\text{OG}}$ was unnecessary.

18c   Is now $\text{AUTO} \cdot \text{OH} \cdot \text{OF3} \cdot \text{\textcircled{F}}$ -- hardware reduction.

18d   Is now $\text{\textcircled{M}} \cdot \text{OH} \cdot \overline{\text{OA1}}$ -- hardware reduction; AS is not necessary as a result of change to eq. 4c.

19a   Is now $\text{SLOW OUT} \cdot \text{OG} \cdot \overline{\text{AS}} \cdot [\overline{\text{STOP}}]_{\text{OB}}$ -- $[\overline{\text{STOP}}]_{\text{OB}}$ was added for reasons discussed later.

20   Delete -- $\overline{\text{OH}}$ is not necessary and has been removed.

22   Is now $\text{OB5} \cdot \overline{\text{AS}} + \text{OB5} \cdot \text{OH} \cdot \overline{\text{OY}}$ -- AS, in the second term was unnecessary.

23   Is now $\text{<E>} \cdot \text{<SA>}$ -- improves reliability.

24,25 These equations have not been changed, but do warrent further explanation. They are "effective" equations which means that terms which logically "drop out" are not shown. The attached drawing of "PR-2 CONTROL" should clarify this.

Attached you will find three revised TRAINING PRINTS as follows:

45A	ALPHANUMERIC	IN/OUT CONTROL
48A	ALPHANUMERIC	INPUT
52A	ALPHANUMERIC	SLOW OUT

These are supplements to your present drawings #'s 45, 48, and 52. The new prints show the hardware to be found in machines affected by ECO 1096 (presumably starting with machine #309). The three drawings exhibit the hardware forming all of the new IN/OUT equations except 9c, 24, 25.

Your copy of drawing #60 should be marked-up to indicate that $\overline{\text{AS}}$ has been added to the FAST OUT $\cdot$ OD $\cdot$ $\text{\textcircled{G}}$ gate which sets OE -- this will take care of eq. 9c. Eqs. 24 and 25 are handled on the "PR-2 CONTROL" drawing mentioned above.

Essentially the logic write-up, "G-15 ECO's -- Logical Explanation", remains valid although minor items have been changed. Below are some alterations to the text to up-date it:

P5, A-1, line 2 -- ...ECO's 970-<u>1096</u> ...

P5, A-4, line 5 -- ...(e.g. "Eq. 1a" means AS_S includes $DS \cdot \overline{CV} \cdot C1$)...

P5, A-5 -- Add: "SLOW OUT·OH implies ALPHA TYPE-OUT" since OH_S is conditioned by AS in SLOW OUT operations.

P6, B-6, line 2 -- Should read "... $DS \cdot \overline{CV}$, SLOW IN $\cdot \overline{OC1} \cdot \overline{[STOP]}_{OB}$, and ① are ...". The omission of $\overline{[STOP]}_{OB}$ was an error in the text and does not reflect a recent ECO.

P7, B9 -- Additional information: Eq's 13a and 14a are active and control OA1 whether or not they are needed for the "RAPID" case. This is of no conse-quence in the non-"RAPID" case since the state of OA1 while OY is up is of no con-sequence. (A new code will be placed in the OA's prior to the next OA's ←→ M23 precession.)

P8, B-15, line 2 -- "... (SLOW IN <u>appears</u> inverted in the PR-2 <u>stop equation</u> and is ..." This is not a new change but a correction.

P12, D-3 -- Substitute the following for the entire paragraph:

"In the ALPHA mode, OY and OH may be thought of in terms of <u>a counter</u> having four states. The relaxed state is $\overline{OY} \cdot OH$ (#4 or #5). In order to advance to the #1 state, $OY \cdot \overline{OH}$, OY must be set. The OY_S equation is:

SLOW OUT·TO·$\overline{OY} \cdot \overline{OH} \cdot \overline{HC} \cdot \overline{OS}$

The $\overline{OY} \cdot \overline{OH}$ terms in the equations allow the #1 state of this counter to <u>arise</u> only after the #4 or #5 state, while the $\overline{HC} \cdot \overline{OS}$ portion can prevent advance-ment as a function of external control. HC stops advancement as a function of typewriter feedback, while OS is used for a special purpose outlined in sec. D-15."

P14, D-8 -- Substitute the following for the entire paragraph:

"The TYPE PULSE is generated during the #1 state ($OY \cdot \overline{OH} \cdot \overline{OE}$). The maximum rate at which the OY-OH counter can cycle is once every 4 drum cycles, or approximately 8 times per second, hence the maximum ALPHA type-out rate is limited to approximately 8 characters per second. This will be slowed down by (1) Typewriter feedback via HC and (2) OS.

During the course of the #4 cycle $(\overline{OY}\cdot\overline{OH})$, OE will be
high for the sake of the second extraction. This, as a
by product, enables a ONE in M19.107's sign position to
set OS at T1·CN time of the #4 cycle; if set, OS will
then be reset at T1 of the following word 00. There <u>will</u>
be a ONE in the sign position of M19.107 at this time
until M19 is almost exhausted of compacted ALPHA charac-
ters, with the result that until an M19 ALPHA type-out
is almost concluded OS will prevent the #1 state from
directly following the #4 state, slowing down ALPHA
type-outs from M19 to a maximum of one character every 5
drum cycles regardless of feedback.

This slow-down could be eliminated by applying [SIGN]$_{OF}$
to the (T)·T1·CN·M19 gate which sets OS; however, feed-
back from the typewriter usually slows the type-out rate
to one character per 5 drum cycles anyway and the OS
slow-down feature merely keeps the rate consistant from
key to key.

Typewriter feedback will slow type-out down considerably
more in the event of a TAB or CARRIAGE RETURN. "CARRIAGE"
SHIFT will not slow the type-out down except when assoc-
iated with special characters discussed in the next para-
graph (D-9)."

<u>P15, D-13</u> -- Substitute the following for the entire paragraph:

"There is practically no change to original NUMERIC type-
out system; the ALPHA circuits which were added will simply
be inert since AS will be low. If anything, NUMERIC type-
out is simpler than it was in the earlier G-15's since the
"phoney feedback" circuit involving OF3 has been removed.
(The new typewriter is faster than the old one and one
character per 3 drum cycles can be tolerated.) The cycle
is now as follows:

#1	OY·$\overline{OE}$	(send TYPE pulse for previous character to ANC-1)
#2	OY·OE	M19 $\longleftrightarrow$ OA's (the only extraction)
#3	$\overline{OY}$·OE	code placed in OB's
(#4	$\overline{OY}$·$\overline{OE}$	kill time in case of feedback)
#1	OY·$\overline{OE}$	send TYPE pulse to ANC-1 for code just obtained

Feedback from the typewriter can only exist when TAB, CAR-
RIAGE RETURN, or SPACE functions are performed. In such
cases advancement from #3 state to #1 is delayed and the in-
active #4 state will exist until feedback is over. The OH
and OS terms will have no effect on delaying OY$_S$ since OH
remains reset all through a NUMERIC type-out and OS cannot
be high at the end of the #3 drum cycle.

<u>P17, E-1</u> -- This entire change is being removed, reverting the circuit to its original form for the sake of standardization. Programmers have learned to live with the old system while the new one, though cleaner, could cause incompatibility between old programs and new machines.

<u>P18, E-4</u> -- In addition to the features outlined here, provisions for two additional commands are contemplated as follows:

LOWER PEN:	DS·S5·SX· ①	(1 23 31)
RAISE PEN:	DS·S5·SX· ②	(2 23 31)

It is not expected that these commands will be built into all new machines. Certain machines might be modified in the field to include the feature for the sake of expanding the capabilities of the PA-3 accessory. (At this time the feature is outlined in ENGINEERING MEMORANDUM #693.)

<u>THE FOLLOWING CONSTITUTES AN ADDENDUM TO SECTION E</u>

<u>E-5</u>   <u>"Logical Sum" command -- ECO 1074</u>

DS·S7·SX· ② ·M18 has been added to M20w

This creates a command in the Form:

$$M18 + M20 \longrightarrow M20$$

which is programmed as a "2 31 31" during the desired word time or series of word times.

The purpose of the command is to permit easy logical summing of input data received from a CA-2 when multiple-formatting is employed. (A companion modification to the CA-2 is desirable to further reduce programming complexities in connection with multiple-format input operations -- this would only be of concern to CA-2 installations employing 402's as card readers.)

<u>E-6</u>   <u>Application of $[\overline{STOP}]_{OB}$ to ⓠ -- ECO 1096</u>

This has been indicated earlier in this write-up as a change to eq. 19. Addition of this term has nothing to do with the ALPHA feature of SLOW OUT, but constitutes the correction of a logical flaw which has always existed in the G-15 SLOW OUT system.

In brief, the three bits which follow an END code in an output format (NUMERIC) are not ignored. They are of no consequence in the case of an M19 output since the only effect they can have is that of shifting M19 left after it is empty. However, should a 101 configuration follow the END code of an AR format, an M19 $\longleftrightarrow$ MZ precession will occur after AR is typed out. This would resemble a machine trouble, but is actually a design flaw. $\overline{[STOP]}_{OB}$ "locks" the END code in the OF's so that the following three bits will never be interrogated. (Note: This disorder has no connection with the TYPE AR - SET READY sequence used by programmers to purposely cause a M19 $\longleftrightarrow$ MZ precession.)

E-7   <u><P> Key Interlock -- ECO 1096</u>

The TAPE START signal is now:

<P>·<SA>·$\overline{AS}$ + AUTO TAPE START

instead of:

<P><SA> + AUTO TAPE START

Application of $\overline{AS}$ to the <P>·<SA> combination renders <P> key initiation of a PHOTO-TAPE READ impossible if the INPUT system is set up for ALPHA input. For instance, should the operator fail to strike the <S> key after an ALPHA TYPE-IN, he will obtain no reaction if he strikes the <P> key.

Should an ALPHA TYPE-IN followed by a manually initiated PHOTO-TAPE READ be desired, the operator should follow this sequence:

    1. <E>·<SA> -- set up for ALPHA TYPE-IN.

    2. TYPE-IN the ALPHA information.

    3. Option (A) <S>·<SA> -- set READY <u>without</u> terminal
                 M23 normalizing, etc.

        Option (B) <S>·<$\overline{SA}$> -- set READY <u>with</u> terminal M23
                 normalizing, etc.

    4. <P>·<SA> -- start PHOTO-TAPE READ (numeric).

If step (3) is skipped, step (4) will cause no reaction.

Historical information: Machines starting with #241 had the <P>·<SA> + AUTO TAPE START combination applied to AS$_r$ to shut off the ALPHA circuits in case

step (3) was skipped in the above sequence. This, however, did not assure reset of OH. With OH set, numeric inputs would lose control when the first MINUS code reached the input system. Hence $\langle P \rangle \cdot \langle SA \rangle$ + AUTO TAPE START was applied to OH_r. (TECO #146 - Change 2 applied this combination to OH_r; ECO #1084 made the change permanent. ECO #1096 removes it from both OH_r and AS_r since the $\overline{AS}$ qualifier on the $\langle P \rangle \cdot \langle SA \rangle$ gate renders it unnecessary.)

E-8   Special provisions for MTA-2 control -- ECO 1096

There has been a demand for the following features in programming MTA-2's:

(1) REVERSE-SEARCH (7 1/2 ips) for STOP code.

$$L \; : \quad L_{50} \quad L_{50} \quad C \quad 4 \quad 31$$
$$L_{50} : \quad L_{52} \quad N \quad C \quad 12 \quad 31 \qquad N.G.$$

(2) FORWARD-SEARCH (7 1/2 ips) for STOP code.

$$L \; : \quad L_{50} \quad L_{50} \quad C \quad 5 \quad 31$$
$$L_{50} : \quad L_{52} \quad N \quad C \quad 13 \quad 31 \qquad N.G.$$

Sequences similar to the above have been used on unmodified G-15's with marginal results. The following changes have been introduced to render the operations "solid":

(A)   Ⓚ, which resets the OB's, now includes FAST IN· Ⓔ as a substitute for PHOTO-TAPE REVERSE· $[STOP]_{OB}$· Ⓔ. See Dwg. 48A - bottom.

(B)   MAG TAPE STOP is now $[STOP]_{OB}$· Ⓢ· OCI + READY instead of $[STOP]_{OB}$· Ⓢ + READY. This should be noted on your copy of Dwg. 47 - lower right.

Item (A), in conjunction with the recommended command sequences, eliminates the "false STOP code" problem associated with starting tape in the midst of data. (This has been previously referred to as "Hugh Bell's problem".)

Item (B) delays tape stop by 30-60 ms. when reverse-reading for STOP codes in order to allow a minimum of 2/10" of tape "overshoot" for the sake of a subsequent "FORWARD-SEARCH (7 1/2 ips) for STOP code" sequence. (The problem introduced by insufficient "overshoot" has previously been referred to as the "'C.D.C.' or 'Mac Haufe' problem".)

This ECO renders two TEMPORARY ECO's (TECO #146 and TECO #147) permanent. TECO #146 deals with the ALPHANUMERIC INPUT system while TECO #147 deals with the PR-1 and PTP-1 accessories.

(Item 1) TECO #146, change 1:

This portion of ECO 1084 inserts the B28CF-S cathode-follower in series with the $[AUTO \cdot OG \cdot TF \cdot (OA3 \cdot \overline{OF3} + M23 \cdot OF3)]$ combination (found on |LOOP|) which is applied to both OD_s and OY_s.

ECO 1096 will still apply the output of this cathode-follower to OD_s and OY_s, but the combination feeding it will be changed to $[AUTO \cdot OG \cdot TF \cdot OA3 + AUTO \cdot OG \cdot TF \cdot M23 + \overline{OB5} \cdot OB3 \cdot \overline{OB2} \cdot \text{(S)} \cdot \overline{AS}]$. This constitutes no change in logic -- just a re-arrangement of hardware which releases several diodes and the D28DE-UV cathode follower.

(Item 2) TECO #146, change 2:

This portion of ECO 1084 connects the $<P> \cdot <SA> +$ AUTO TAPE START combination (found on K13J) to OH_r via the C17R-E diode. (For discussion see sec. E-7). ECO 1096 will remove it.

(Item 3) TECO #147, changes for PR-1:

This changes the control of the built-in PHOTO-TAPE READER such that an external signal can inhibit its activity if a PHOTO-TAPE operation is initiated by a command containing a non-zero CHARAC-TERISTIC. The inhibiting action will only be effective if a PR-1 is installed.

Two "and" gates have been installed in series with the signals which control the relay puller tube in the PHOTO-TAPE READER as follows:

(PHOTO TAPE FORWARD) $\cdot (\overline{OC6 \cdot OC5})$ feeds the FORWARD triode.

(PHOTO TAPE REVERSE) $\cdot (\overline{OC6 \cdot OC5})$ feeds the REVERSE triode.

The $(\overline{OC6 \cdot OC5})$ combination originates in the "MASTER PR-1" and indi-cates a PHOTO-TAPE operation with CHARACTERISTIC = 0. If no PR-1

is installed the ($\overline{OC6} \cdot \overline{OC5}$) combination will be "floating" and cannot disqualify the above-mentioned "and" gates.

The above is not a complete description of the PR-1 change; its purpose is to indicate what has been done to original G-15 internal logic. More details on the PR-1 facilities should be mentioned in literature on the subject of the PR-1 itself.
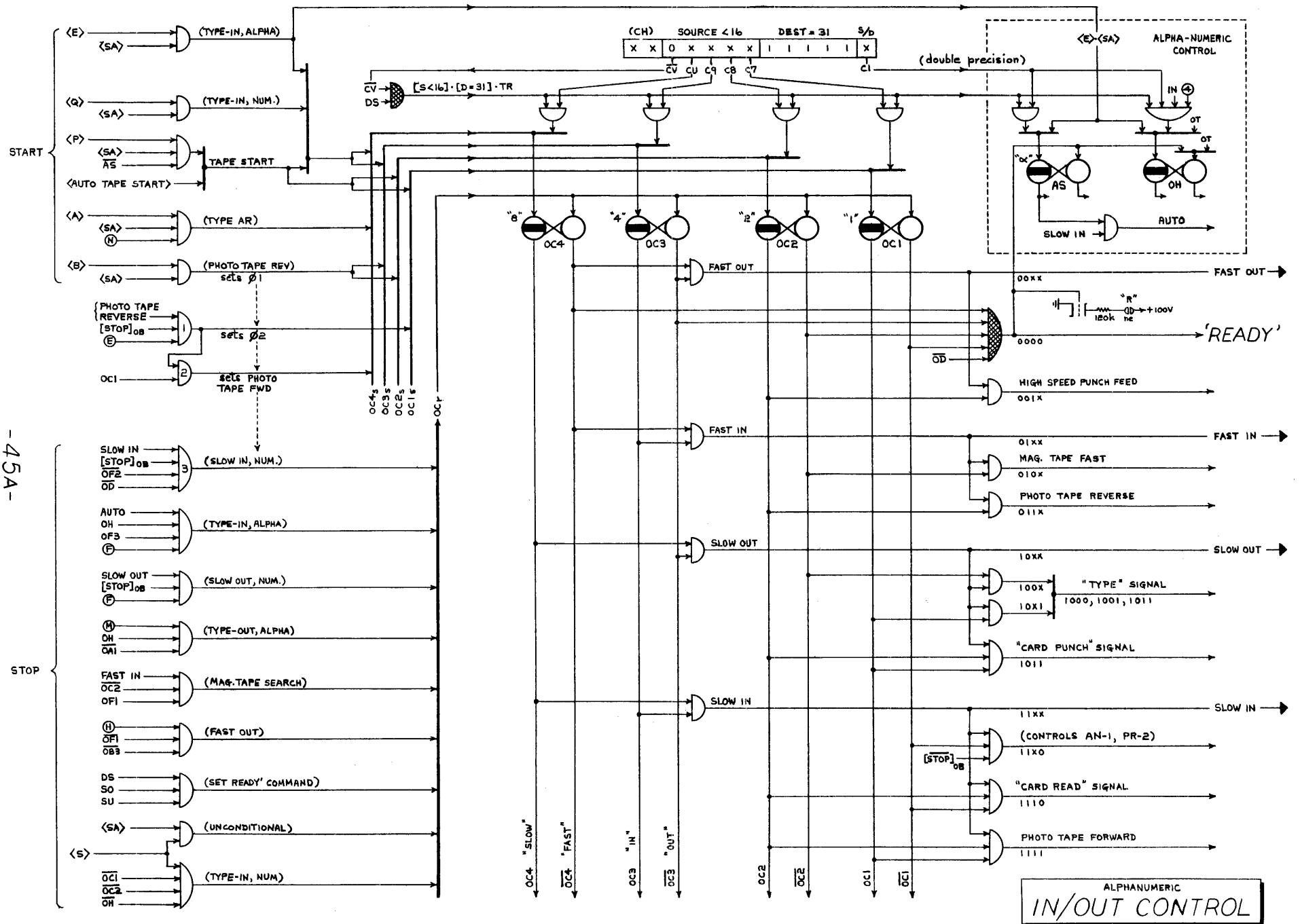
(Item 4) TECO #147, changes for PTP-1:

This deals with the installation of wiring and logic to control the PTP-1. Such wiring and logic is only of interest in connection with the PTP-1 accessory and should be documented in literature dealing with the PTP-1.

SUGGESTION

It is suggested that you place the attached copies of Dwgs. 45A, 48A, and 52A in your copy of TECHNICAL MANUAL - REV. #1 following Dwgs. 45, 48, and 52. It is also suggested that you place your copy of "THE OUTPUT LINK" (which you should already have) in the manual directly after Dwg. 62. A detailed version of "THE OUTPUT LINK" is being prepared and will be known as Dwg. 63A; it will be sent to you later.

ALPHANUMERIC IN/OUT CONTROL

-45A-

ALPHANUMERIC

-INPUT-

TO OUTPUT MEDIA

PUNCH PULSE = SLOW OUT·(OC2·$\overline{OC1}$ + $\overline{OC2}$·(MAN PUNCH))·OG
TYPE PULSE = TYPE·$\overline{OC2}$ · OD · $\overline{OE}$ · OY
CARD PUNCH PULSE = SLOW OUT·OC2·OC1 · OD · $\overline{OE}$ · OY

ALPHANUMERIC

SLOW OUT

Color key: TIMING   FORMAT { M19 / AR }   DATA EXTRACTION   OUTPUT BUFFER
(ALPHA.)

-52A-

PR-2 CONTROL CIRCUIT

TURN ON 2N215 WHEN LOW

DS·$\overline{CV}$

①

SLOW IN · $\overline{OC1}$ · $\overline{(STOP)}_{OB}$

1 → INV 2 → INV 3 → INV 4 $\overline{X}$ → INV 5 → RUN THY. → 6

7 → INV 8 → INV 9 X → INV 10 → BRAKE THY. → 12

$(STOP)_{TAPE}$ 11

EQUIVALENT CIRCUIT (G-15 TYPE OF NOTATION)

DS·$\overline{CV}$

①

SLOW IN · $\overline{OC1}$ · $\overline{(STOP)}_{OB}$

OC'S = 12 OR 14

1 → X   9,5,3 → RUN THY. → 6

$\overline{7,2}$ → X $\overline{X}$ 4,10,8 → BRAKE THY. → 12

7

$(STOP)_{TAPE}$ 11

SET 'READY' COMMAND OR ⟨S⟩ KEY - - - → $\overline{SLOW\ IN + OC1 + (STOP)_{OB}}$ (USED IN LIEU OF 'READY')

EXAMPLE (—TIME→)

1

7

$\overline{7,2}$

X (9,5,3)

$\overline{X}$ (4,10,8)   WHEN LOW, ENABLES PHOTO-READING CIRCUITS BY 2N215

11

6   FIRE RUN THY.

12   FIRE BRAKE THY.
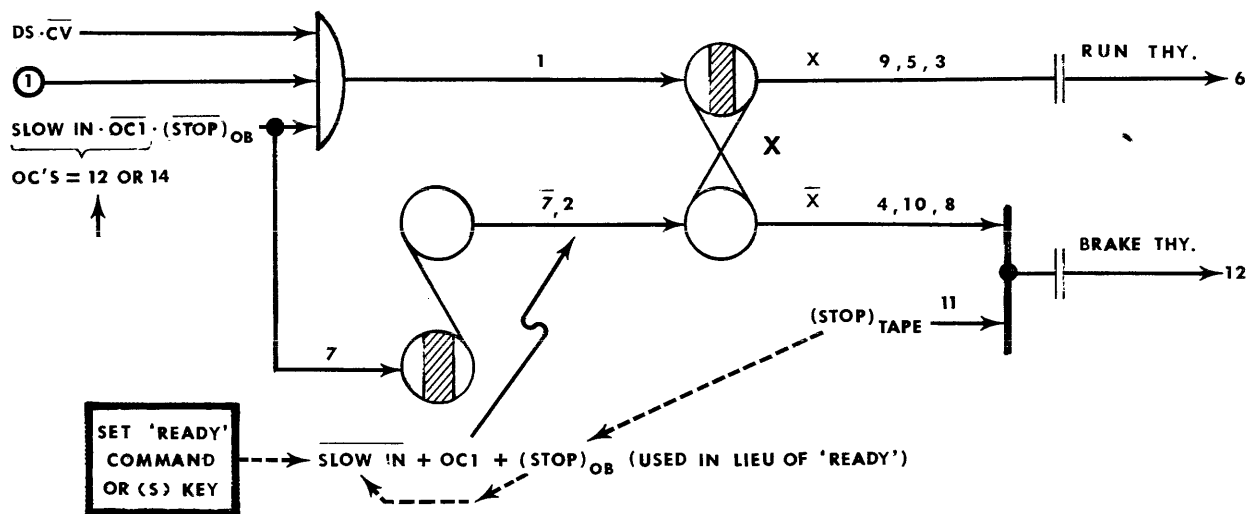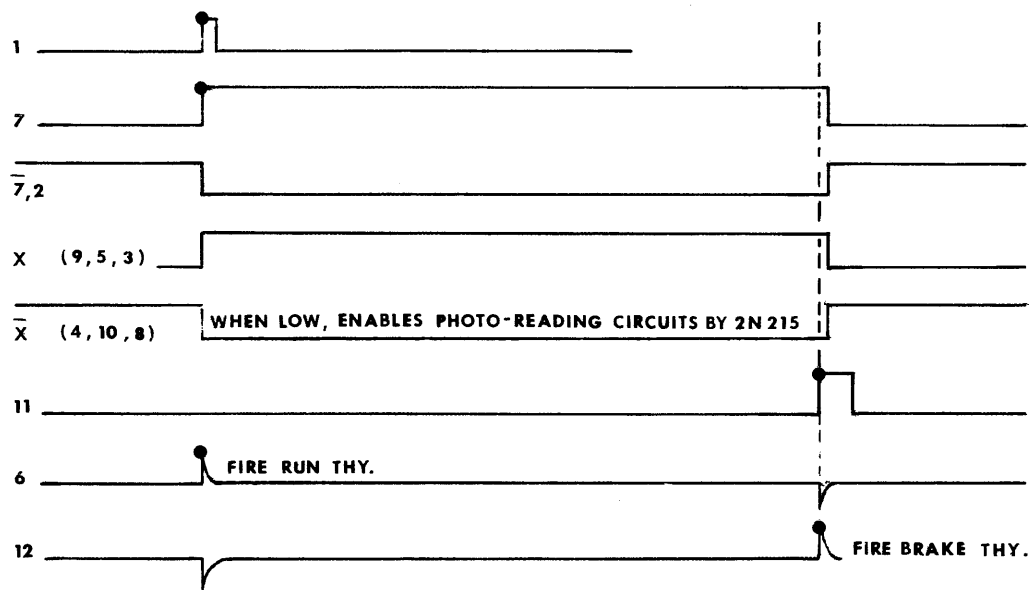
EFFECTIVE START:

L_5 N 5 12 31 COMMAND

EFFECTIVE STOP:

$(STOP)_{TAPE}$

OR

L_2 N 0 00 31 (SET READY COMMAND)

OR

⟨S⟩ KEY

PR-2 CONTROL