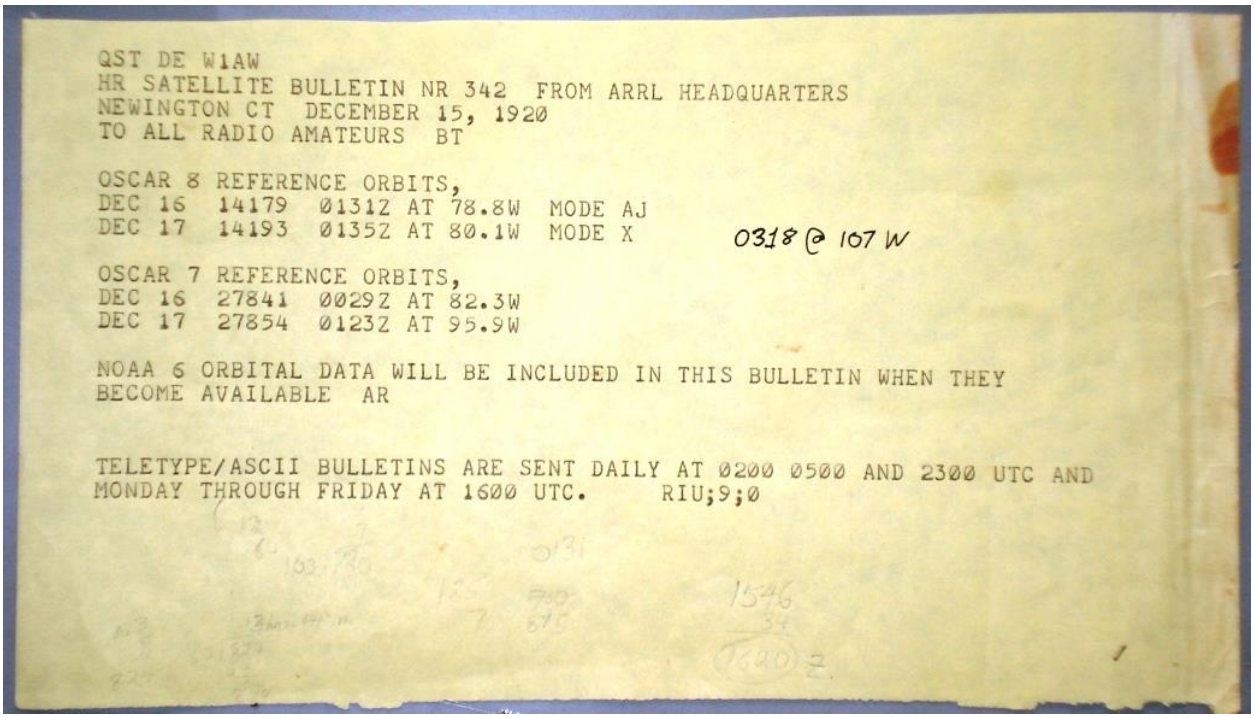
Kleinschmidt AN/FGC-25 Teletypewriter Set
1977 to *On-going*

Modified AN/FGC-25 in AUTODIN Terminal Installation

I bought my AN/FGC-25 in two phases, starting with just the teleprinter and Army technical manual TM11-2246, at a ham radio swap meet in Atlanta Georgia, in 1977. After some weeks I decided I needed the rest of the set, namely the tape reader/reperforator unit and the table. So I wrote to the seller and offered to buy these items also. I drove from my apartment in Marietta, Georgia to Mobile, Alabama to get them, and somehow managed to load both into my 1975 Chevy Monza 2+2 hatchback.

Over several months of 1977 and 1978 I performed a complete disassembly, restoration, and overhaul of this set, including replacement of several missing or broken parts, such as various small springs that had rusted through or were missing. I ordered the proper lubricants, alignment scales, and all needed parts from Mr. Fred Schmidt (Typetronics, P.O. Box 8873, Ft. Lauderdale, Florida, 33310). After I completed the overhaul, testing, and adjustments, the set worked perfectly. I also successfully interfaced the printer to my MEK6800D1-based homebrew microcomputer (see separate report).

In January of 1979 I went back to graduate school. Upon graduation, in early September 1979, I moved to Manhattan Beach, California, to take up my new job at TRW and my new life. In 1980, while living in a duplex apartment on Curtis Avenue, I hooked up the teletype set to a CV89A2 RTTY demodulator unit and shortwave receiver, and successfully received radioteletype messages, such as from the W1AW ham radio station in Newington, Connecticut;



QST DE W1AW
HR SATELLITE BULLETIN NR 342 FROM ARRL HEADQUARTERS
NEWINGTON CT DECEMBER 15, 1920
TO ALL RADIO AMATEURS BT

OSCAR 8 REFERENCE ORBITS,
DEC 16 14179 0131Z AT 78.8W MODE AJ
DEC 17 14193 0135Z AT 80.1W MODE X 0318 @ 107 W

OSCAR 7 REFERENCE ORBITS,
DEC 16 27841 0029Z AT 82.3W
DEC 17 27854 0123Z AT 95.9W

NOAA 6 ORBITAL DATA WILL BE INCLUDED IN THIS BULLETIN WHEN THEY BECOME AVAILABLE AR

TELETYPE/ASCII BULLETINS ARE SENT DAILY AT 0200 0500 AND 2300 UTC AND MONDAY THROUGH FRIDAY AT 1600 UTC. RIU;9;0

Message Received on my Teletype Set, December 15, 1980
(note one character reception error in the date)

The last time I recall operating the set was in early 1990's, at our house in Hermosa Beach. It has been in the basement of our present house for at least the past 15 years, maybe more.

Now I am resurrecting the set from the basement and plan to perform cleaning and lubrication. I also plan to check, and replace if necessary, each of the electrolytic capacitors in the set.

April 26, 2014- I moved the set piecewise to the upstairs den. The complete reperforator unit was too heavy for one person to carry, so I disassembled it into three main parts that I carried up the stairs separately; the tape reader-transmitter sub-unit, the reperforator chassis, and the mounting base.

AN/FGC-25 in Our Upstairs Den, April 2014

The ribbons have dried up, I will have to re-ink them or get new ones somehow. All electrolytic capacitors are suspect, due to their advanced age.

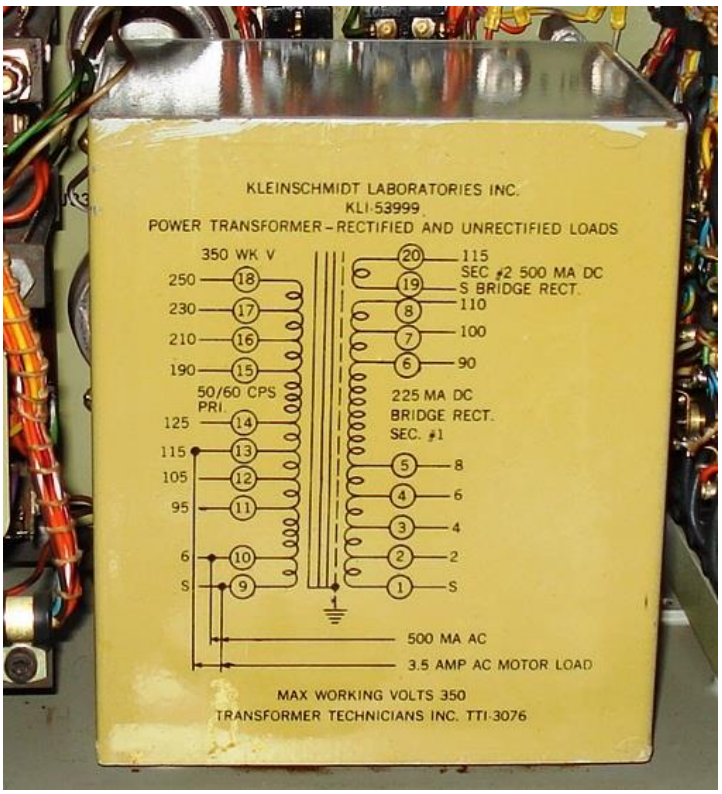
April 27, 2014- I performed some superficial cleaning plus research and study of the TM, and started the lubrication procedure.

May 3, 2014- I completed the lubrication procedure for the reperforator. All of the reperforator mechanisms seem to be working OK when I hand turn the motor shaft, except the multi-solenoid sliding drum clutch does not completely disengage. This may have been the case before, I just don't remember. The normal-speed momentum might be sufficient to complete the disengagement of this clutch.

Next to be lubricated is the tape reader-transmitter sub-unit. You have to remove the front plate and the top of the tape reader before you can remove the right side cover. The procedure in the manual does not describe this detail.

May 4, 2014-

- Completed lubrication of the tape reader sub-unit. I had to use a squirt of WD-40 to un-stick the stop lever on the code-sensing lever shaft. The mechanism seems to be a little stiff. The friction clutch on the drive shaft will not complete the cam shaft rotation when the motor is hand rotated. I do not know if it might be OK at normal speed.
- Changed the AC line input voltage patch to the 125 volt position. It had been in the 115 volt position. I changed the numbered secondary patch from #4 to #3 in accordance with the instructions in the manual.
- Detected a discrepancy between the Technical Manual's schematic tap numberings of the power transformer and the diagram painted onto the transformer itself. I think the diagram on the transformer is more likely to be correct. See the close-up photo on next page.
- Determined that the right side patch panel is set to configuration "A" described in the manual.
- Did a cursory VOM check of two of the electrolytic capacitors, C12 and C13. I observed slowing rising resistance to about 3 or 4 kohms, which is evidence of proper charging.
- Reassembled the reperforator unit.



Power Transformer inside the Reperforator Unit

May 5, 2014- Start Page Printer Lubrication Procedure

I removed the page printer chassis from the base. I removed the keyboard sub-unit from the page printer chassis. The instructions for doing this are deficient. They don't tell you that you have to remove the tab stops cover, a cable clamp, and a bracket before you remove the two big screws that hold the keyboard to the chassis.

May 6, 2014- The power train is very stiff when hand-rotating the motor shaft. I removed the motor so I could check the action of just the motor by itself. The rotor was stiff at first but after several hand rotations it loosened up. After it sits idle for a few minutes the rotor "sets" again, but loosens quickly upon one or two rotations. The manual says all ball bearings are sealed and cannot be lubricated. I suppose it should be OK.

(Gap in activity lasted several months while I devoted effort to resurrecting a Macintosh 512K, my MC6800-based microcomputer, and software development for interfacing with the teletype set)

February 10, 2015- I am resuming the lubrication procedure for the page printer and keyboard.

February 25, 2015- Today I completed the lubrication of the page printer and keyboard.

My new Xcelite R3323 screwdriver was handy for placing oil drops in hard to reach places.

I used a thin wooden coffee stirring stick, dipped in the oil bottle, to reach and oil the working surfaces of the keyboard code bars and stop bar, with the keyboard upside down. I reattached the keyboard sub-unit to the page printer frame.

All mechanisms tried seem to be working now, using manual operations. I haven't tried the letters/figures platen rotation. About a week ago when I tested the ribbon feed mechanism it did not work right. The right side ribbon spindle slip joint was stuck until I oiled it and gently worked it free.

Next is to install the printer frame onto the base and reattach all electrical connections.

March 7, 2015- Today I made final checks, installed paper, tape, and the old ribbons. The page printer power plug should <u>always</u> be plugged into the switched outlet on back of the reperforator

chassis. I plugged the page printer cables into the "test" jacks on the reperforator back panel. I started with the initial checkout procedure in the operating manual.

I applied AC power to the set for the first time since the early 1990s. No explosions occurred and no smoke appeared.

I monitored the CR4 output voltage. It rose and settled to about 100 volts. I guess that's OK, but it seems a little low.

Both motors started OK. The page printer motor bearings were very noisy at first, but quieted down in less than a minute.

The test current loop was closed, as evidenced by the standby condition of the printer and the reperforator.
TTY Video Episode 1

Here were the issues;

The simultaneous keyboard mode did not work. There was no response from the reperforator.
The sequential keyboard mode appeared to work OK mechanically but the printing mechanisms did not activate. The reperforator did not respond to the sequential keyboard operation, but I may not have had the control switches set up correctly for it.

The manual tape feed-out lever and mechanisms on the reperforator worked. I had to pull the tape through at first until the just-punched sprocket holes engaged the feed mechanism. I will have to review this later and determine the proper tape loading procedure.

Operating the Line-Break switch (to open the current loop) caused no response from the printer, but the reperforator cycled as expected. I did not try the tape reader, since the printer did not respond to the Break signal.

I let the motors run for several minutes, and then shut it all down.

I checked the 1/16 amp (62mA) fuse in the page printer. It was blown. This fuse protects the printer's bias supply. The bias current is supposed to be about 15mA when the printer is operating in 60mA current loop mode. The blown fuse would explain why the printer did not operate. The purpose of the bias winding in the selector magnet is to pull the armature to the "space" position when the 60mA loop signal is a "space", i.e.,

no current in the 60mA loop. The blown fuse explains why the printer was non-responsive to the Line-Break switch.

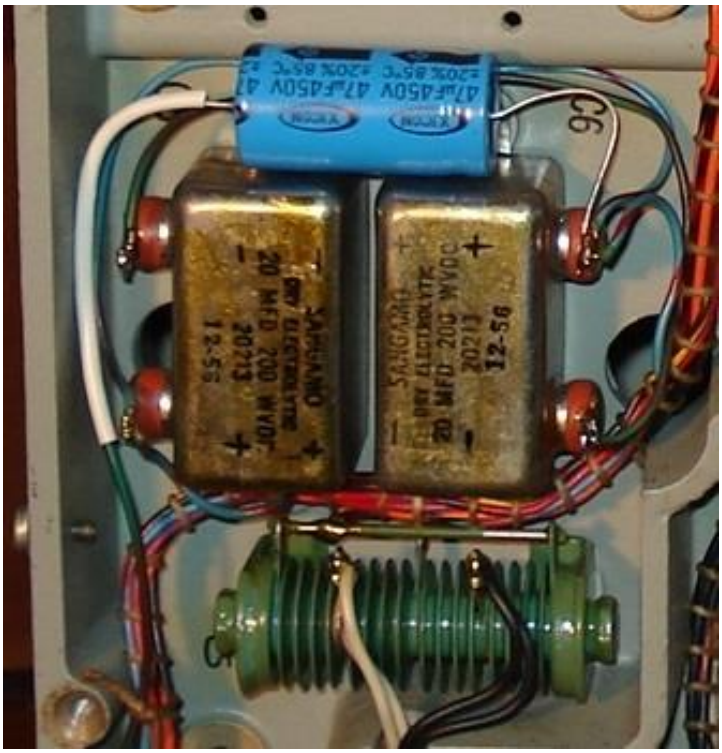
There are two 20uF filter capacitors, C5 and C6, in the printer bias supply. They are the prime suspects for causing the blown fuse. They are wired in parallel to achieve 40uF across the CR1 rectifier output. C5 and C6 are not involved in the simultaneous keyboard mode, so their malfunctions do not explain why that keyboard mode did not work.

I need to install a chad collection bag for the reperforator before any more testing.

March 8, 2015- C5 and C6 are wired in parallel, and each one is rated 20uF and 200 volts. By switching the printer's bias switch to "Polar" position I was able to measure the total capacitance of C5 and C6 in parallel. It should have been about 40uF, but instead measured 105uF. It is quite possible that excessive surge current at turn-on, due to the excessive capacitance, could have blown the fuse. The load resistance of the bias circuit measured about 8.8kohms, which is consistent with the component values given in the schematic diagram. The 5Kohm bias adjustment potentiometer is set to practically zero ohms, but this is probably about right for the 60mA line current mode.

March 14, 2015- Three days ago I determined that C5 and C6 must be replaced by testing them this way; I connected C5 to a B battery while monitoring the voltage across it. The B battery output dropped from 56 volts with no load to steady 35 volts when C5 was connected. It should have quickly risen back to 56 volts, so this is a failure indication. Upon disconnect from the B battery, C5 then discharged very quickly. It should have discharged veeerrry slooowwwly, thus another failure indication. Then I did the same test using a known good 47uF capacitor. The B battery voltage did not drop at all, and upon disconnect the good capacitor discharged very slowly.

I replaced C5 and C6 in the circuit with a single 47uF@450 volt unit, but I did not remove them from the printer;



New 47uF Capacitor Replaces C5 and C6

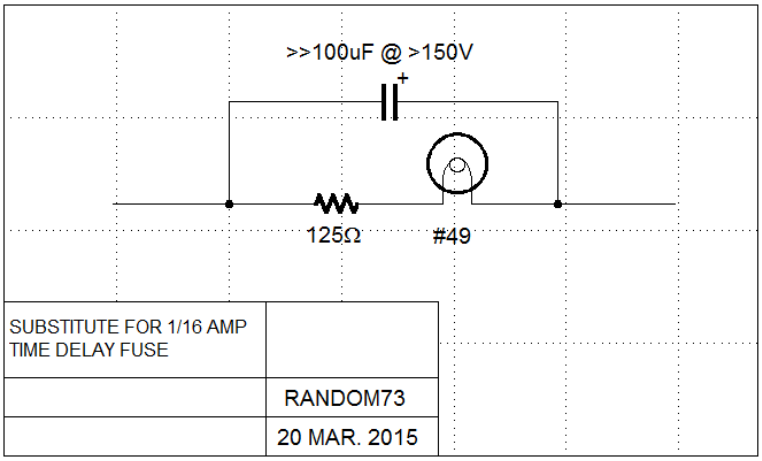
It was necessary to disconnect only one wire from C5/C6 to effect the replacement. Also, you can see that the manufacturing date stamp on each capacitor is 12-56, suggesting that this teletype set was probably manufactured in 1957.

To replace the 1/16 amp fuse, I wired up a pilot lamp socket across the fuse holder terminals and tried using a #49 pilot lamp. The #49 is rated 60mA at 2 volts, so it should blow quickly if the current greatly exceeds 60mA. I have a few #49s on hand.

At power-up the pilot lamp flashed brightly, momentarily, but it did not burn out. I measured the steady-state bias current as 15mA, just as it should be. The printer mechanism now cycles as expected, when the loop current is interrupted using the LINE-BREAK key. I have applied power about five times so far without burning out the lamp, but I am concerned about it.

The Littelfuse catalog shows that the 1/16 amp time-delay fuse #0313.062 has a cold resistance of 120 ohms. I will add a 125 ohm resistor in series with the pilot lamp. I am going to try reducing the transient turn-on current through the pilot lamp by putting a large value bypass capacitor across the series combination of the 125 ohm resistor and the lamp. The voltage rating of this capacitor should be at least 160 volts, so that

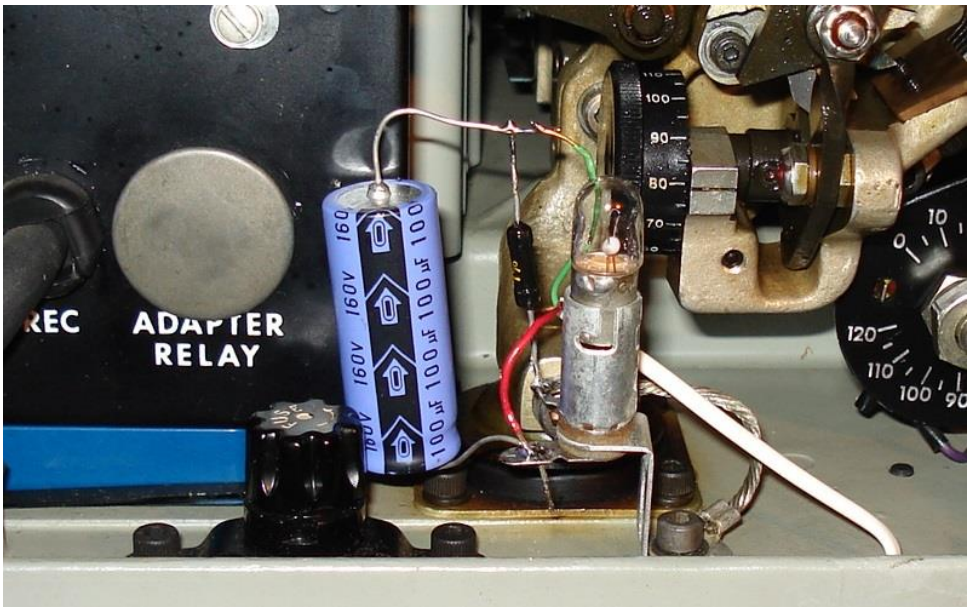
it can withstand a short circuited load if the lamp blows. At the instant of turn-on the bypass capacitor appears as a short circuit and therefore carries the entire initial inrush current. Its current then decreases as the current through the pilot lamp increases. All the while, the total current is decreasing towards the steady state load current of 15ma as the 47uF filter capacitor is charging. The goal is to get the voltage across the 47uF capacitor to rise much faster than the voltage across the lamp bypass capacitor, by using as large a value as practical for the bypass capacitor.



March 20, 2015- With the entire teletype set OFF and unplugged, I tested the keyboard sequential switch contacts using my ohmmeter connected to the black (keyboard) output plug. After some fumbling around I managed to start a sending cycle and then rotated the motor shaft manually while monitoring the ohmmeter. The switch continuity opened and closed OK according to the rotating cam sensing the code bar positions. There is about 15 ohms in the closed position, which sounds reasonable given that there are RF chokes in the circuit.

March 21, 2015- The substitute fuse circuit works great. There is no flash of the pilot lamp at turn-on, and the bias current measures correct, at 16mA.

I measured 129 volts output from the CR3 rectifier circuit, across the manual tape feed-out switch. This is a good reading. Now I have the set of measurements that indicate all three DC power supply circuits CR1, CR3, and CR4, are working. There is no CR2 circuit.



Substitute circuit for 1/16 amp time delay fuse

I measured the test current loop to be 50mA, which is just fine for a "60mA" loop. The reperforator bias current measured 15mA, which is correct. The main problem to tackle now is the keyboard transmitter. Neither the simultaneous nor sequential mode works.

9:00PM March 21, 2015- I don't know what happened, but part way through the "WB4CKM BRAG TAPE" the tape reader and printer suddenly started working great together. I immediately reloaded and read the entire tape with 100% correct copy while filming it for episode 2 of my teletype set chronicle. I made this "brag tape" in 1978 after completing my original restoration and checkout.
TTY Video Episode 2

March 22, 2015- This morning I found the problem with the keyboard sequential mode. The E4 mechanism's armature action is very stiff, probably due to old lubricant. This kept it from moving fast enough to perform the break-make operation of the contacts, such that the line mostly stayed in the mark condition regardless of the key code.

Keyboard Unit, E4 Mark/Space Contactor Mechanism

I had to 1)remove the printer mechanism from the base in order to 2)remove the tabulator mechanism from the keyboard unit, in order to 3)get access to the contact armature for removal, cleaning, and re-lubrication. The armature was so stiff I had to gently pry it off of the pivot using a wooden coffee stirring stick for leverage. It should have slipped off easily.

I shoved a Q-tip soaked in carbon tetrachloride solvent through the inside of the armature shaft to clear out the gummy residue. I swabbed the pivot shaft with solvent using another Q-tip and cloth wipe. I re-lubricated the pivot with fresh oil.

The E4 switch contacts were very dirty with carbonization. They cleaned up nicely with carbon tet solvent swab. I then used extra-fine grit modeler's sandpaper, lightly, and cleaned again with solvent and a cloth wipe.

3:30PM- Mission Accomplished. Upon reassembly and adjustment of the E4 contactor, the keyboard sequential transmitter function is now working fine. I typed several error-free lines of text to both the printer and the reperforator.
For reasons unknown, the keyboard simultaneous mode seems to be working fine now. I made an error-free tape using it, and played back the tape with no printout errors through the tape reader.

March 23, 2015- Started making Teletypemovie3, demonstrating keyboard simultaneous mode.

March 25, 2015- I started following the "Local Testing" checkout procedure, paragraph 24, in TM11-2246.

24a- Keyboard Simultaneous Mode-Passed
Subparagraph 24a(5) contains an incorrect statement relative to simultaneous mode. It says "the carriage should automatically return after the 72nd character has been struck". It is unclear if it means the typing carriage or the character indicator carriage. By design, the printer does not respond to keyboard activity when the keyboard control switch is in the TAPE position. Also by design, the indicator carriage will only return when the carriage return key is pressed, as discussed in paragraph 80. The statement more properly belongs in subparagraph 24d, which has other problems I will discuss when I get to it.

24a(6) Passed. I did not make the tape as described in this step. However, I have already confirmed that the indicator carriage always returns in response to carriage return key.

24a(7) Reperforator bell - Passed after adjustment, March 26, 2015.

24b Tape transmitter-distributor Passed.
All functions performed correctly.

24c Setting the Rangefinders- Skipped.
I am skipping this step because during the recent lubrication process I did not disassemble any mechanisms that would affect the rangefinder settings.

24d Automatic line feed and carriage return- Passed.
The manual does not state that, by design, this function results in a total of three line feeds during the carriage return when printing from tape reader. You can deduce this fact by carefully studying both paragraphs 24d and 74. The test I performed here confirms it.

24e Transmitter distributor to Reperforator sequential mode-
Works OK most of the time, but occasional error.
24f Keyboard to Reperforator sequential mode- Passed March 26, 2015.
TTY Video Episode 3
24g Printer Bell- Passed using my WB4CKM Brag Tape as well as keyboard.

24h Motor Stop- Passed

24i(1) Platen Upper/Lower positions- Passed
24i(2) CAR RTN button- Passed

24i(3) Manual Space- - Passed April 4, 2015
24i(4) Ribbon Movement- Passed
24i(5) 66th Character position- To Be Performed, but has been working
24i(6) Tabulator Mechanism- To Be Performed

I installed a New-Old-Stock ribbon on the reperforator. The ribbon was on spools for an ASR33 machine, but is same width as Smith-Corona, so I wound the dry ribbon onto the empty ASR33 spool, and then wound the new ribbon from the full ASR33 spool onto the Smith-Corona spool. It is printing now, but too heavy on the left side of each character. I need to rotate the typewheel slightly clockwise.

It is time to order a stock of fuses;

Printer		
4	1/16 amp	Littelfuse 0313.062HXP
2	1.6 amp	Littelfuse 031301.6HXP
Reperforator		
3	1/2 amp	Littelfuse 0313.500HXP
2	3/4 amp	Littelfuse 0313.750HXP
4	4 amp	Littelfuse 0313004.HXP

This set of fuses will complete the "running spares" set as well as providing two more of each type.

March 28, 2015- I ordered the set of fuses from Allied Electronics.

April 2, 2015- Last night I successfully sent text from my MEK6800D1 microcomputer to the teletype set for printing. The last time I did this was in 1979, but this time I am using the software ASCII-to-BAUDOT converter and output driver that I completed recently. The output driver is strongly based on the flowcharts and the prototype code that I developed and tested in 1979, and it works great. This was my goal for the past 11 months of effort, to get both my old computer and the teletype set working together again.
There was only one error in the printout of my test file TTY_TEST.OBJ. The double quote character printed as the number 8, due to my data entry error in the assembly language program TTY3.SRC. It is a very easy patch to one memory location, and I can append the patch to TTY3.OBJ loader file. The Excel file in which I developed the lookup table is ASCII_TO_BAUDOT2.xlsx.

I did the patch. It solved the problem, the quote mark prints OK now. However, the printer is sometimes misreading the LTRS code at the beginning of the text output.

After a couple of correct lines of printout it stayed in figures mode from the end of the previous line, so it started printing - ?:$3!& instead of ABCDEFG… . Therefore, when the ABCDE… sequence got to "H", it read it as a motor STOP, but then the letter "I" was immediately transmitted, causing the motor to restart.

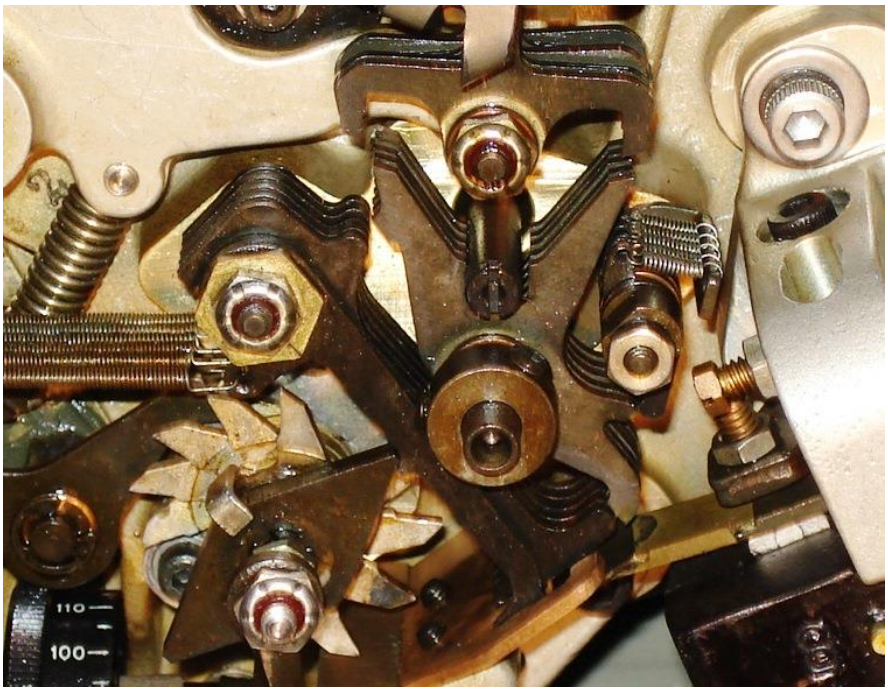
This rapid stop-start event may be the reason one of the 4-amp fuses in the reperforator blew at this very instant, shutting down the teletype set, right after the "&" was printed, so the motor never completed the restart. However, I don't understand why the 1.6 amp fuse in the printer did NOT blow.

Later, I retested the computer's output interface using my LED indicator loop, to make sure it wasn't somehow damaged by this event. It didn't work. Oddly, the 7406 chip now measures failed. The input to it, from the PIA chip on the computer board, is changing state properly, but the output is stuck at about 1 to 1.4 volts. This is the same failure as the original 7406 chip, and both chips are the same brand and may be from the same lot. Fortunately, I happened to order 2 more 7406s the other day, piggybacked onto the fuse order.

But the puzzle is; why did the 7406 chip fail at the same instant when the 4-amp fuse blew?

During this down time I took a closer look at the code sensing levers and Y levers of the printer. Their "action" feels a little bit sticky. This could very well be causing the imperfect printing behavior that I have been observing. I will probably have to disassemble them, clean off the old gummy residue, apply fresh lubricant, and reassemble them. If this solves the problem I will probably do it also for the keyboard, tape reader, and reperforator, as they all have mechanisms similar to these.

April 3, 2015- The fuses arrived today. I am commencing disassembly of the printer's code levers;

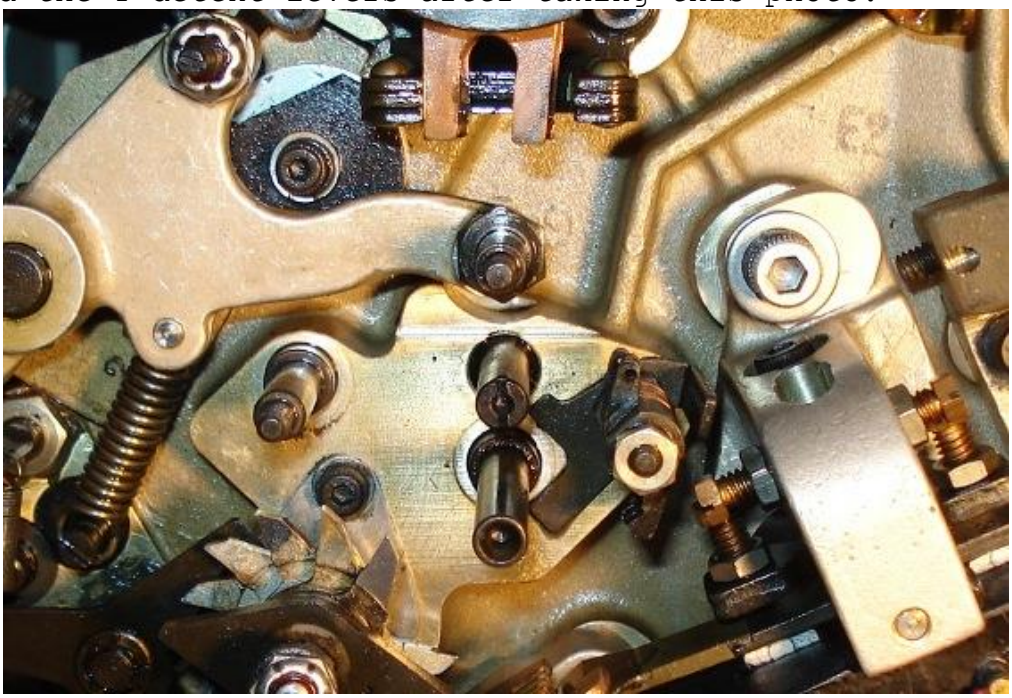


Left-to-Right: Printer Selector Levers, Y levers, and Y Detent Levers.
The T-levers are above the Y-levers.

Here is a close-up of the eccentric bearing, showing the alignment mark position prior to disassembly;

The springs for the Y-detent levers are very tiny and delicate. To remove them with low risk of damage I looped a piece of #30 insulated wire-wrap wire through the right side spring hook. Then while holding the wire ends lightly taut with my right hand, I gently pressed my Xcelite R3323 screwdriver blade against the wire, close to the spring, applying a pulling force towards the right, until the spring unhooked from the spring bracket.

Here is a photo of the same area after I removed the selector levers, Y-levers, and T-levers and their related parts. I removed the Y-detent levers after taking this photo.



The spacing collar and the first Y-lever were quite difficult to remove due to the gummy film on the pivot stud. This gives me hope that this little cleaning exercise should yield much better printer performance.

April 4, 2015- I used Goof-Off to clean the various parts. I put it all back together and only made one adjustment; the Y-detent levers centering sleeve (Para. 315). I replaced the 4-amp fuse that blew the other day.

I typed several lines with no errors in the printout. I tested the motor stop function to make sure it still works OK, and it does. However, the printer still occasionally mistypes, from either the keyboard or the transmitter-distributor (tape reader) or the computer.

April 6, 2015- I fixed the computer output interface yesterday. I had to replace not only the 7406 chip, but also the 2N2222A transistor that drives the MJE340 high voltage NPN transistor.

I finally figured out how to use the Automatic Line Return function. It works, and it is pretty useful, as it turns out. I measured the Line 1 closed circuit (mark condition) current as 57mA. The open circuit (space condition) Line 1 voltage measured 116 volts. Both values are good.

I lightly lubricated the four control switch lever mechanisms on the front of the reperforator. They operate much more smoothly now.

I finally figured out how to extend the sprocket pins on the platen. I replaced the canary paper roll with sprocket fed fan-fold paper (I can't remember when or where I got it). The canary paper rolls are no longer available, so I am saving them for history.

I defined a modification to my ASCII-to-BAUDOT software to enable explicit sending of LTRS or FIGS codes. I mapped the ASCII control code DC2 to LTRS and DC4 to FIGS. The software details are documented in a separate report.

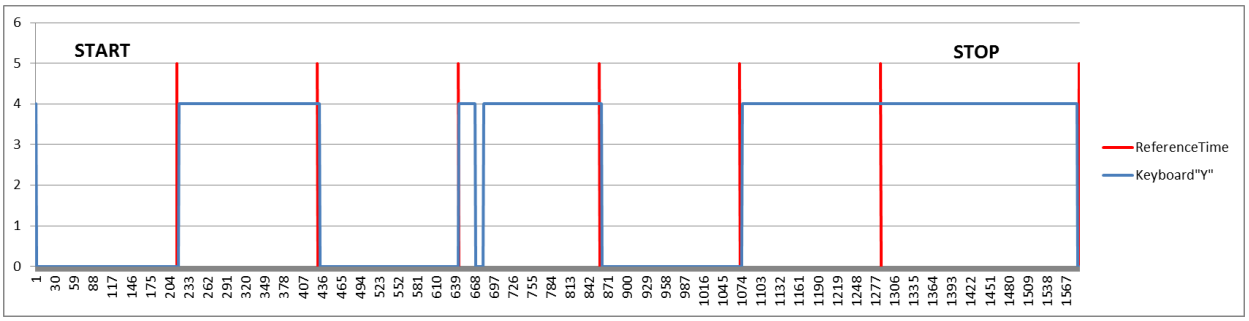
April 11, 2015- On April 8 I accomplished my goal. I successfully printed, error-free, text files that I transmitted from the Macintosh to the M6800 microcomputer and on to the teletype set, using all the equipment and software that I repaired, wrote, debugged, and integrated over the past 11 months.
TTY video episode 4

April 18, 2015- New printer ribbon installed yesterday is a big improvement. I think I have pinpointed the keyboard's sequential mode problem. The code sensing levers might be sticky. I will have to remove the printer chassis from the base yet again, in order to get access to, disassemble, and clean the code sensing levers and their related mechanisms.

July 1, 2015- Since my last log entry here, I completed an upgrade to the teletype interface card in the microcomputer. I can now receive data from the teletype set as well as send data to the set, as demonstrated in TTY Data Reception Video. This new capability enabled design and implementation of a software-intensive distortion tester. I wrote a separate report about the tester and about the testing results.

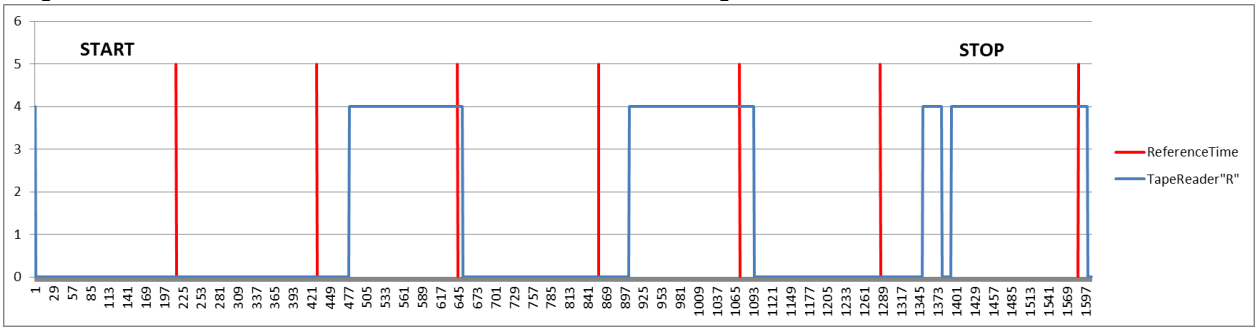
In summary, the distortion testing results indicated that the keyboard and tape reader transmitters are always sending the correct code, but there is a frequent occurrence of a glitch about 1 to 2 milliseconds after a space-to-mark transition.

I made the two data captures on the next page after fiddling with the keying contacts of both keyboard and tape reader. There are many more signal plots in the other report.
Keyboard June 26, 1st character compared to reference markers



The keyboard timing/bias performance looks great!

Tape Reader June 26, 1st character compared to reference markers



The tape reader's "spacing bias" is clearly evident. There is also some slight "marking end" distortion.

I am wondering if the tape reader's spacing bias might be partly due to heavily worn cam lobes. Perhaps the tape reader was used extensively in this set's previous life, and is showing a sign of the wear and tear?

I plan to revise this report as events warrant. I want to solve the mystery of the glitching effect, and I hope I can reduce the spacing bias of the tape reader.

August 25, 2015- I am beginning to suspect that the occasional mistype by the printer could be caused by momentary slipping of the typing sequence clutch at the start of a typing cycle. I noticed that the letter "T", code 00001, is sometimes typed when a null, code 00000, is received. The null code mistype is usually a "T" (possibly always, but I need to confirm this). If the code sensing shaft is slightly late getting started due to a clutch slip, then the stop bit would present as the 5th code bit. If the mistypes of other codes can be similarly explained, then this would be strong supporting evidence of a slipping clutch. I need to analyze the other mistypes to see if they fit this hypothesis.

September 6, 2015- Today I fixed the mis-type problem. The selector cam friction clutch tension was too high. It measured more than 70 oz., while the spec is 48 to 56 oz. The stop cam was pressing too hard on the stop lever which in turn was pressing too hard on the selector magnet armature blade. There have not been any more mistypes after reducing the tension to about 56 oz, per paragraph 329 of TM11-2246.

I have no memory as to what I did to adjust this clutch in my original restoration in 1979. The procedure in paragraph 329 is awkward. It does not say that the motor is supposed to be running during the tension measurement. It does not say that you have to remove the chassis from the base for access to the clutch so that you can adjust the tension. I modified the procedure to get reliable measurements of the clutch tension while the motor is running. I do not have to put the selector magnet in the space position for the measurement.

September 7, 2015- There is one mistype after cold power-up (machine has been off for several hours). No mistype has been observed after warm motor restart (motor off for 5 minutes). I will now try to determine a demarcation time between cold and warm.

September 8, 2015- I determined that the one-time cold start mistype may occur after the motor has been off at least 1.5 hours. I logged the testing on the printout. I am going to try reducing the clutch tension a little more.

I learned last week that the motor STOP function, <FIGS>H, was not used by the DoD Communications Centers;

Don:

In military CommCenters, the Motor Stop (upper case H) was NEVER used. There was just too much message traffic to ever really allow a teletype to "stop" operating. Matter of fact, most TTY maintainers disconnected the motor stop function entirely, since we didn't need it, and never used it. These machines ran continuously, even when not receiving traffic (the motors always kept running).

Hope this helps,

Dave
DE RUMLNHA
....
Don,

I agree with Dave, Motor Stop was rarely (if ever used) in military comm centers.

It was a feature for early email, where the printer could turn on, print out a message, and then turn off. But most military communications were busy all the time. Also (as

you found) it can cause problems when it tries to shut down when it's not supposed to. So I doubt it was ever used with RTTY/RATT operation.

Duncan, K2OEQ
SP6 31J30/33F30

USASESCS, Ft Gordon, GA '66

To disable the motor STOP I need to do two things;

1. Unplug P2 from J2
2. Install a wire jumper from pin J2-B to J2-C.

The <FIGS>H sequence will then result in a no-op, same as the NULL key.

September 19, 2015- Today I disabled the motor STOP function as described above. For the jumper I used a cut piece of a paper clip inserted into pins B and C of socket J2. I verified the printer's response to <FIGS>H is now the same as the NULL key response.

I also added some more oil to the selector cam shaft clutch and back off the clutch tension a little bit more. It didn't make any difference to the mis-type of the first received codeword after the printer has been off for at least an hour.

October 25, 2015- THE FOLLOWING PROCEDURE AVOIDS MISTYPES AFTER THE PRINTER HAS BEEN OFF A WHILE;

~~1. CONFIGURE LINE-TEST SWITCH BEFORE POWER UP.~~
~~2. TURN ON THE SET~~
~~3. IF CONFIGURED TO A LINE, VERIFY LINE IS IN MARK STATE.~~
~~4. TURN ON THE PRINTER MOTOR. PRINTER SHOULD BE IDLE.~~
~~5. WAIT FOR MOTOR BEARINGS TO QUIET DOWN.~~
~~6. TYPE LTRS KEY ONCE.~~
~~7. IF THE PRINTER CYCLES, IT IS READY. EXIT THIS PROCEDURE NOW.~~
~~8. ELSE TYPE THE LETTER KEY "V" ONCE. THE PRINTER MAY OR MAY NOT CYCLE.~~
~~9. IN EITHER CASE, GO BACK TO STEP 6.~~

<no longer recommended- see ahead April 10, 2016 procedures>
Here are the BAUDOT codes for LTRS and V keys (S=space, M=mark)

Start bit plus LTRS = SMMMMM
Start bit plus V = SSMMMM

If LTRS code doesn't cycle the printer, then the double length space pulse of the V code will eventually "unstick" the offending printer mechanism such that it will cycle, but without a mistype. Of course, once it is unstuck, typing the V key again will cause a "V" to be printed. You must pay attention to the printer's response to each key strike.

October 30, 2015- My teletype set is working well now. Today I made Movie 7, which is just a fun demo of some post-season baseball game reports that I used to establish that I can effectively manage the mis-type issue.

I also did something useful today with the teletype set. I printed a letter containing a list of my mom's current medications, for her to give to her doctor and to the Merrill Gardens nurse. The Canon inkjet printer ran out of ink, so the teletype set did the job instead, perfectly.

November 9, 2015- I may try using trichloroethane to clean the selector cam shaft stop bar and the stop lever where they touch. It is possible that old oil on them is gummy enough to stick after having been in contact for a while.

November 19, 2015- I printed the "Happy Anniversary" message while Pam watched it print out.

January 5, 2016- I tried Goof-Off followed by a tiny drop of 3-in-1 oil. It did not make much difference. While I had the cover off the printer I checked the roller ball bearing on the right side of the type-bar selector shaft. It rolls OK when I manually rotate the motor shaft. I was concerned that it might not be rolling, but it seems fine.

February 21, 2016- A few days ago I revisited the subject of the STOP function, whereby the printer motor shuts off if the code for the letter H is received while the printer is in uppercase <FIGS> mode. Other teletype machines, such as model 15 or model 19, map <FIGS>H to the hashtag character #. My current version of UTMGR, UTMGR4, maps the ASCII # character to Baudot null, because I did not want to accidentally shut off the motor. Going the other direction, UTMGR4 maps Baudot <FIGS>H to ASCII null.

If the STOP function is operational in the AN/FGC-25, then;
Rule 1: Do not allow <FIGS>H to appear on paper tape.
Rule 2: Do not allow # character in any message traffic to be sent from ASCII console to the AN/FGC-25.

February 28, 2016- Programs UTMGR5_TTY5_READTTY600 and UTMGR5_TTY5_READTTY300 include conversion of ASCII # to <FIGS>H, and <FIGS>H to ASCII #. I tested and confirmed that the conversions are correct. The reperforator unit printed # on the paper tape upon receipt of <FIGS>H. The printer cycled as expected, equivalent to receipt of the NULL code.

March 10, 2016- It has been just over a year since I first powered up my AN/FGC-25 after the 11 months long resurrection effort. It has been working well and reliably these days, along with my M6800 microcomputer and my various console terminals (both Toshiba laptops and the Mac 512K). I am now in a phase of routine occasional operation to ensure all functions continue to work properly. I have allocated approximately one page of printout per month, at the rate of about one operating session per week. I also operate the reperforator at least twice a month, alternating between the sequential and simultaneous keyboard modes to produce short tapes usually not exceeding one printed line of text. Last week I did sequential mode with no errors and no mistypes. Today I did simultaneous mode with no errors and no printer mistypes. I plan to operate the tape reader at least once a month using any one of my test tapes that I already made. I usually use the M6800 console terminal as the receiver of the paper tape reader signals so that I can leave the teletype set's printer motor off and save paper.

March 30, 2016- K8ARY704.860.6589 Jim Plummer k8ary at yahoo.com, posted to the GreenKeys forum that he needs a 600opm main shaft driven gear for testing/restoring his TT-482/UGC set. I can loan him my extra one until he finds a 368.1 opm gear set.

April 8, 2016- I mailed my extra 600opm gear set to Mr. Plummer, but it might not fit his set. The 1970 Kleinschmidt catalog parts tables seem to indicate that the TT-482/UGC does not take the 600opm gear set.

I should clarify that my set consists of the TT-117/FG printer, serial no. 183, and the TT-179/FG reperforator, serial no. 133, and the table FN-65/FG (serial no. is blank). The 1970 catalog lists the TT-117C/FG and TT-179B/FG as comprising the AN/FGC-25. I do not know what is different about these later versions, maybe the motors. I am happy to have the original versions.

The line break switch is used to terminate input to the M6800-based UTILITY MANAGER program (documented separately). To avoid mistypes due to an intentional line break, do this;
1. After text has been input from keyboard or the paper tape reader, turn OFF the printer motor. The reperforator motor must be OFF also.
2. Operate the line break switch momentarily and confirm UTMGR responds with "OPERATION COMPLETE" on the M6800 console terminal.
3. Press and release the LTRS key. This is most important.
4. Turn ON the printer motor. The printer should cycle but there should not be any mistype.

April 10, 2016- Verified Procedures for Avoiding Mistypes

Procedure 1- Alternate AN/FGC-25 Cold Start;
1. Verify or set the switches on perforator front panel, in order from left to right;

1.	Keyboard control	KEYBD or KYBD&TAPE
2.	Perforator control	OFF
3.	MOTOR	OFF
4.	LINE-TEST	LINE 1, or TEST if local loop only
5.	A.L.R. MONITOR	OFF

2. If LINE 1 was selected, Turn on the M6800 system first, load and start UTILITY MANAGER as documented in separate report.
3. Turn ON perforator main power (switch on rear of perforator unit).
4. Check: Red LED on TTY interface card should be on.
5. Operate the LINE-BREAK switch (on printer) momentarily.
6. Make sure the SEND-LOCK switch is set to "SEND", then press and ~~release~~ hold the LTRS key. <updated April 2018>
7. Turn ON the printer motor. The printer should cycle once, but no mistype should occur. Release LTRS key.
[This worked like a charm- 10April2016]

~~Procedure 2- Anytime after cold start, and when switching from keyboard sequential mode (on-line) to simultaneous mode (for the purpose of punching a tape while the printer remains on-line);~~

~~1. Turn ON the perforator motor.~~
~~2. Set the keyboard control switch on the perforator to "TAPE".~~
~~3. Press and release hold the LTRS key. The printer should cycle once and no mistype should occur. Release LTRS key.~~
~~4. (optional) Turn OFF the printer motor.~~
~~5. Set the perforator control switch to the "KEYBD" position.~~
~~6. Proceed to prepare message tape as desired.~~
~~7. Set the perforator control switch to the "OFF" position.~~
[This worked like a charm- 10April2016]

~~Procedure 3- After procedure 2, to return the keyboard to the line and reactivate the printer, without a mistype;~~
~~1. (Optional) Turn OFF the perforator motor.~~
~~2. If the printer motor is ON, turn it OFF.~~
~~3. Set the keyboard control switch to "KEYBD" or "KYBD&TAPE".~~
~~4. Press and release the LTRS key.~~
~~5. Turn ON the printer motor. The printer should cycle once and no mistype should occur.~~
[This worked like a charm- 10April2016]

Procedure 4- AN/FGC-25 Shutdown to avoid mistypes

If the teletype set is configured to Line 1, do not turn off the M6800 computer before performing the following steps, in order;

1. Turn off printer motor
2. Turn off printer copy lamps
3. Turn off perforator motor
4. Turn off perforator main power

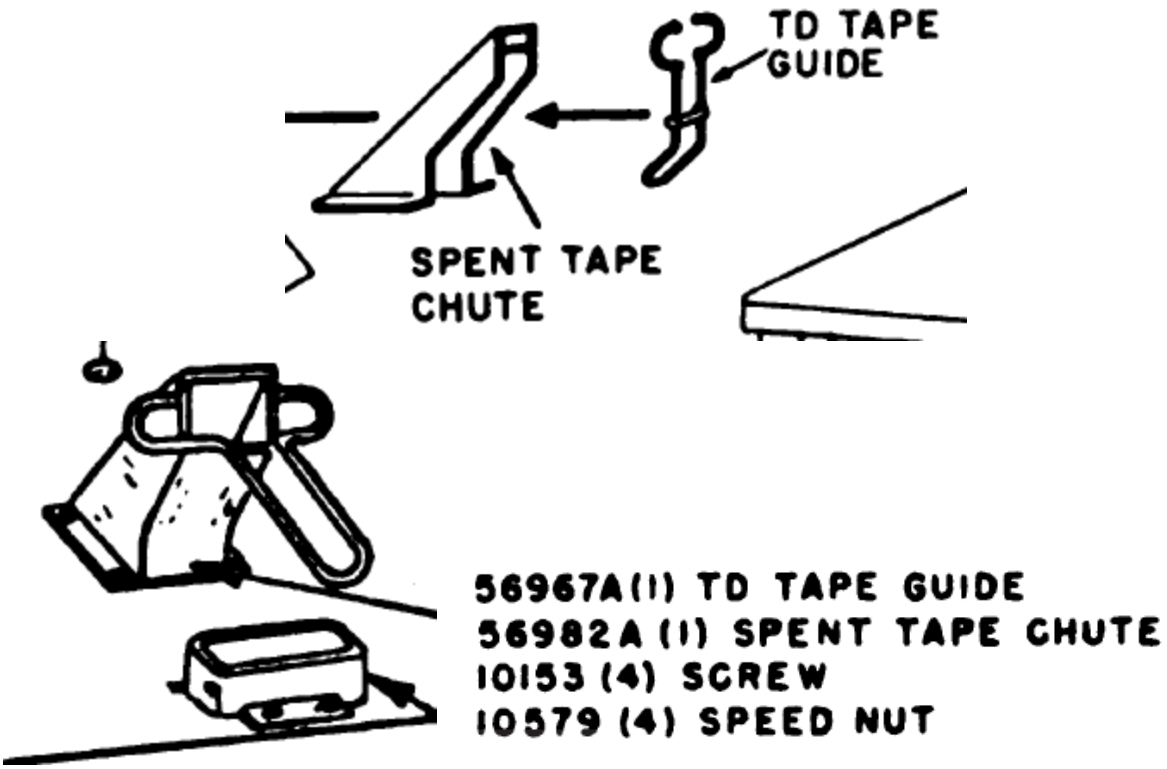
April 12, 2016- Alternate Procedure 2- Anytime after cold start, and when switching from keyboard sequential mode (on-line) to simultaneous mode (for the purpose of punching a tape while the printer remains on-line);

1. Turn ON the perforator motor.
2. Set the keyboard control switch on the perforator to "TAPE".
3. Set the SEND-LOCK switch on printer to "LOCK".
4. Press and release any key. The keyboard mechanism should cycle once but the printer should remain idle.
5. (optional) Turn OFF the printer motor.
6. Set the perforator control switch to the "KEYBD" position.
7. Proceed to prepare message tape as desired.
8. Set the perforator control switch to the "OFF" position.
~~[Untested]~~

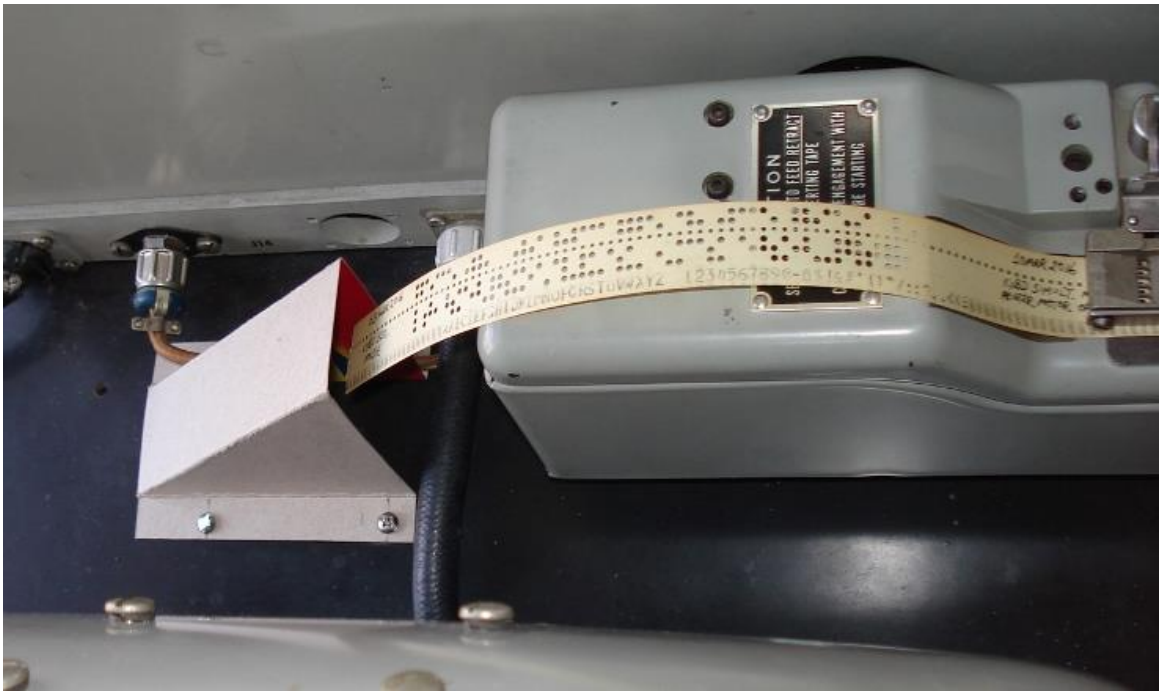
Alternate Procedure 3- After alternate procedure 2, to return the keyboard to the line and reactivate the printer, without a mistype;
1. (Optional) Turn OFF the perforator motor.
~~2. If the printer motor is ON, turn it OFF.~~
3. Set the keyboard control switch to "KEYBD" or "KYBD&TAPE".
4. Set the SEND-LOCK switch to "SEND"
5. Turn ON the printer motor. The printer should remain idle.
~~[Untested]~~

I found out last July, from the CommCenter-1 group on Yahoo, that the teletype set in the picture on page 1 of this report is actually a highly modified version of the AN/FGC-25, and called AN/FGC-161. Its keyboard is not even functional.

April 24, 2016- My table did not have the "spent tape chute", so I fashioned a rather crude substitute out of a piece of a Ritz Crackers box. I cannot figure out exactly how the part called "TD Tape Guide" is supposed to work, so I haven't tried to make something for it yet. Below are snips from TM11-5815-244-12;



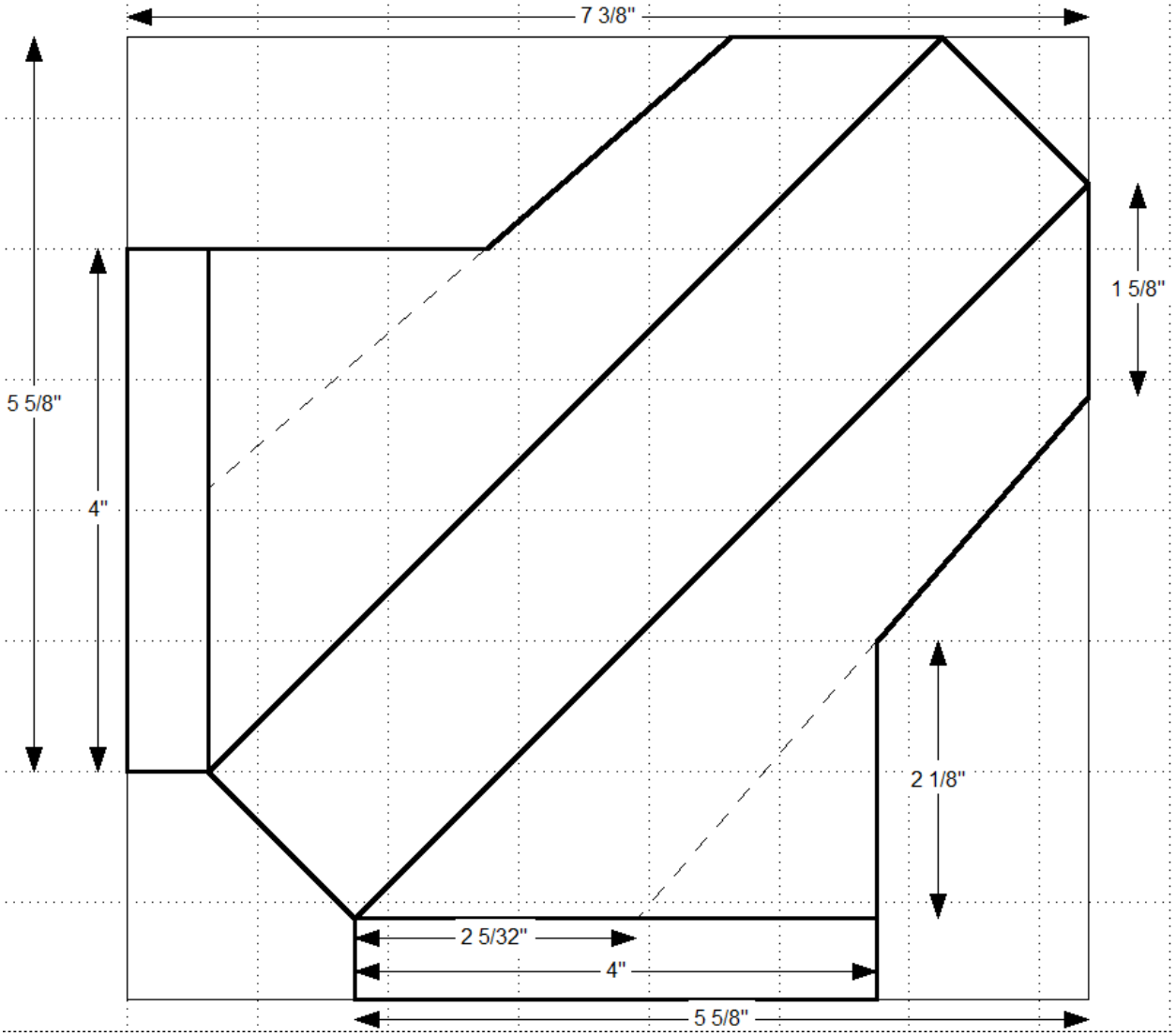
The parts look different in the two different figures. It looks like maybe the looped end of the "TD Tape Guide" is supposed to rest on top of the tape reader?



April 27, 2016- I think I just figured out how the "TD Tape Guide" works. It rests on top of the spent tape chute when not in use. After loading a tape, you flip the tape guide up and over, such that it rests on top of the tape reader.

My spent tape chute is not long enough. I need to extend it towards the tape reader about two inches and install a sloping "shelf" for the tape to rest on after it enters the chute.

May 8, 2016- Drawing for spent-tape chute to be made by folding a piece of cardboard;



June 23, 2016- Today I made an RYRY... tape, using keyboard sequential mode, for testing the tape reader. Then I tested the keyboard simultaneous mode. It seemed a little "stiff" or sluggish in responding to each keystroke. It worked OK (full speed) when using the repeat key. A keyboard mechanism involved in simultaneous mode is probably a little sticky or gummy. We have had very hot weather the past week. The temperature in the upstairs den (where the teletype set is located) reached 100 degrees a few days ago.

July 10, 2016- After some investigation, I suspect that the keyboard reader switch, S11, may need cleaning of its contacts. To do this I will have to remove the keyboard assembly. I will wait until the next time I do a maintenance lubrication of the entire printer.

July 24, 2016- Switch S18 in the perforator is involved in both sequential and simultaneous modes, and sequential mode seems to be working OK, so S18 is not as suspect as S11 of the printer. UPDATE 11DEC2022: Switch S18 is NOT involved in simultaneous mode. The manual text and chart on page 64 are wrong, should be referring to S20. I made notations on page 64. See also page 120. I made a drawing for a "TD Tape Guide" to be fabricated from a thin piece of steel rod. I will need to develop some tooling in order to shape it properly.

April 19, 2017- Two years on, and my teletype set is still working well, except for keyboard simultaneous mode as mentioned in my 23 June log entry. I will address it during next regular lubrication event. I operate the set about every two weeks or so. April 26 will be the third anniversary of exhuming the set from the basement. So far I have not discovered anyone else who has a working AN/FGC-25 set.

June 17, 2017 (Saturday)- This past Thursday afternoon I tried some things to explore the problem with keyboard simultaneous mode.

I set the SEND-LOCK switch to LOCK. The LOCK position prevents the keyboard sequential mode from keying the current loop, so the printer will remain idle during this test.

I set keyboard control switch to KEYBD&TAPE, and the reperforator control switch to KEYBD. These settings cause the reperforator to respond to just the simultaneous mode signaling from the keyboard, while the sequential mode signaling from the

keyboard is also operating (but prevented from keying the loop by the LOCK setting).

In this configuration the simultaneous mode operation of the reperforator works just fine.

However, when I set the keyboard control switch to TAPE, then the simultaneous mode operation becomes erratic, with a noticeable delay occurring between the pressing of a key and the punching operation. In this mode the keyboard sequential signaling is disabled while operating the simultaneous mode. The tape punching operation is supposed to be faster in this mode than in KEYBD&TAPE mode, because it is not limited by the sequential mode operation time.

These results indicate that the simultaneous mode circuits in the printer are working fine, and that perhaps there is a problem with the keyboard control switch in the reperforator unit.

June 23, 2017- I studied the schematics in the back of TM 11-2246. In KEYBD&TAPE mode, the perforator punch solenoids are activated by a signal from keyboard "counter" switch S12. In TAPE mode the punch solenoids are activated by a signal from the keyboard "reader" switch S11. Otherwise, all the circuitry to control the punches is the same for both modes. So the suspects are as follows;

Perforator Switch S23 contacts TL2 and TL3, or
Keyboard Switch S11 contacts P3 and P4.

I can check and clean S11 at next lubrication event for the printer unit. Getting to S23 will be harder, as I will have to lift the extremely heavy reperforator unit from the table and turn it on its side to get to S23.

April 1, 2018- Today is the 3 year anniversary of successful transmission from Mac512K to M6800 computer to the teletype set printer. Now I mostly use the Toshiba Win98 laptop instead of the Mac. All working well, except simultaneous mode still to be fixed next time I have to do printer lubrication. I edited some of the procedures on earlier pages, including use of strikethroughs.

April 17, 2019- 4 year anniversary, still working same as last year.

August 24, 2019- Reperforator malfunctioned during routine exercise 11 May. See the printout. Tape not advancing properly after punch. On 4 August I performed step 485 in TM 11-2246, "Feed Pawl and Ratchet Wheel Clearance Adjustment". The tape reader is getting "sticky" about starting up after several days idle, but OK once it starts. Time to do lubrication, as it has been over 5 years since I did the lubrication procedure on the reperforator unit in April-May of 2014. Despite all this, I successfully duplicated the reader test tape this morning, with no problems.

June 23, 2021- Almost 2 years since I last updated this report, due to various other priorities and some health issues. The tape reader issue gradually got worse, eventually causing garbled printout. I finally suspected that the tape reader friction clutch might be slipping. I tested it per paragraph 520 of TM-11-2246. Indeed, the spring pressure was around 20 oz., out-of-spec low by quite a bit. I adjusted the spring pressure to spec 35-to-40 oz. Now the tape reader works OK.

July 3, 2021- The tape reader is working fine now, but when I turn off the printer motor the clutch squeaks as it slows to a stop. I might try backing off the tension a little bit.

July 18, 2021- keyboard sequential signaling contacts may be noisy. UTMGR5 gets errors from keyboard, but the printer does not. Reperforator doesn't start punching tape until after several attempts, then its OK. Something might be getting gummy since it has not been lubricated since 2014.

August 31, 2021- still getting erratic copy in UTMGR5 from keyboard signaling. Tape reader signaling works OK. Need to play around with the sample timing patch in UTMGR5 to see if I can find a sweet spot.

November 18, 2022- The keyboard signaling issue seems to have fixed itself in the past 2 or 3 months. Solid copy to UTMGR5 lately. The reperforator startup issue is getting worse.

December 2, 2022- The reperforator clutch release lever needs adjustment. I will do step 459, located on page 446 of TM-11-2246. Since I have to remove the chassis from the base I will also do the complete lubrication procedure (it has been 8 years since last lube job on reperforator). I am also documenting this effort in a video. I performed the adjustment in step 459. The gap is now slightly greater than .012, that's the best I could do.

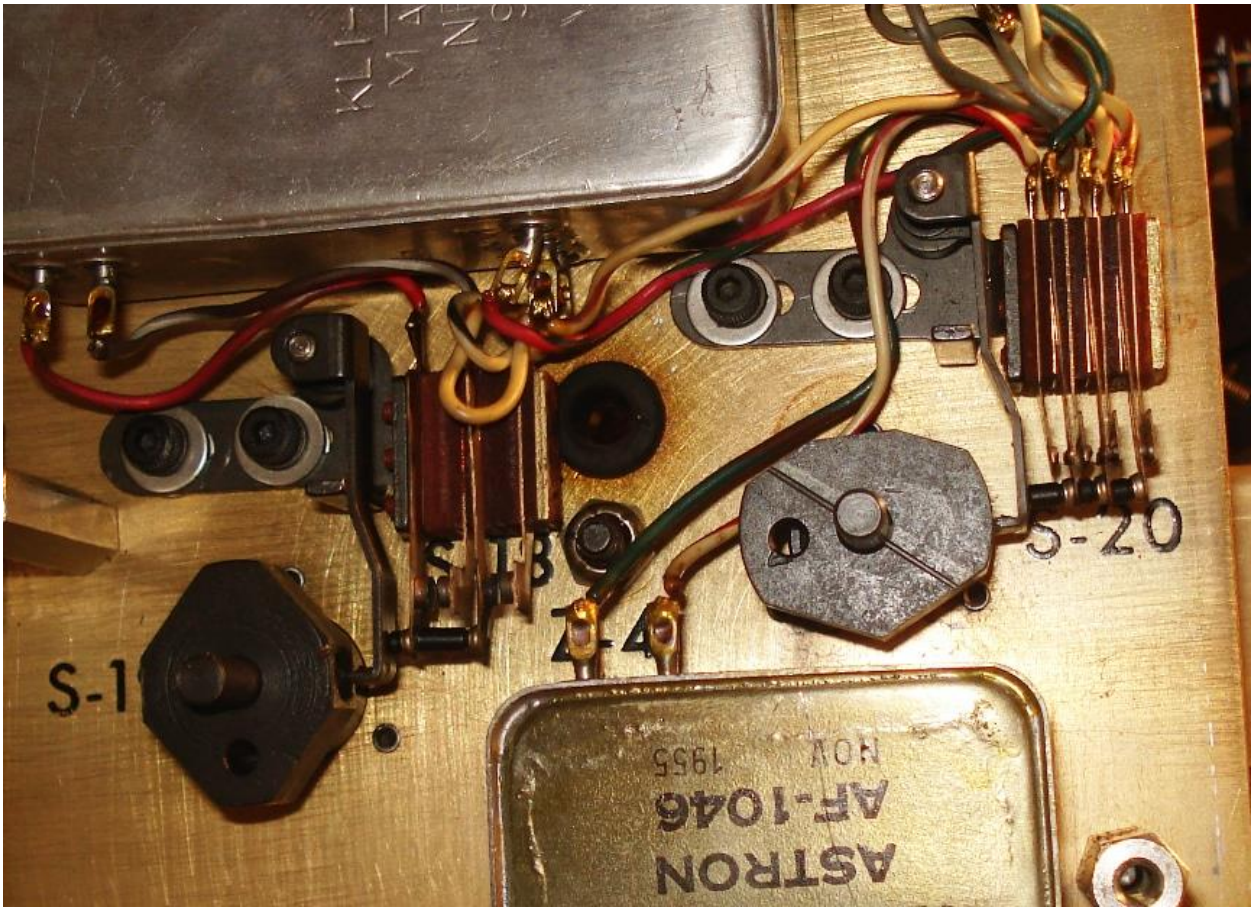
Notes: Procedure in manual for removing reperforator chassis from base is missing three steps; 1) unplug the two wires going to S34, 2) Squeeze to unsnap the cable retainer that is mounted to one of the tape guide mounting posts and move the brown cable outside of the retainer, and 3) be aware of the small cable that goes from the tape reel sensing switch to the base when you unscrew all four fasteners that attach the tape reel mounting bracket, and shift the bracket slightly rearwards. This added step provides clearance for the S18/S20 switch cover on back side of the reperforator chassis, when you lift the chassis off of the vibration mounts.

December 7, 2022- Now on to the "simultaneous mode" issue. All roads lead to S11, located on the back side of the keyboard chassis, after much studying, cleaning of switches S18 and S20, and testing of S20. S11 has two N-O SPST switches. The switch on terms 1 and 2 shorts out 500 ohm resistor R6, which is in the power line to restoring solenoid L1. This enables restoring solenoid L1 to be operated by a short pulse transmitted from switch S20. the other switch on terminals 3 and 4 operates the perforator latch coil L3, which in turn started the ½ turn rotation of the multi-solenoid function shaft. The manual has an error in its description, on page 64, of the restoring solenoid L1 control when in simultaneous mode. It says there, in two places, that switch S18 on the code actuating shaft operates L1. But on page 120, it says that switch S20's N-O contacts close to operate L1 when the multi-solenoid shaft rotates. S20 is correct.

So the first thing that happens when a key is pressed (S11 operates to ON) is that latch coil L3 energizes and releases the clutch. The shaft turns. The attached cam rotates, causing S20 N-O contacts to close, which completes circuit to restoring solenoid L1 in the keyboard. L1 causes switch S11 to go back to OFF, which puts the 500 ohm resistor back into the L1 circuit, effectively disabling L1. Since S11 is now OFF, voltage is removed from L3, thereby disabling L3, so that the latch lever will engage the clutch to stop the rotating shaft when ½ turn is reached. In the meantime, the rotating cam returns the S20 switch contacts back to open.

Somewhere in the TAPE-KEYBD mode there must be some dirty switch contacts. I am pretty sure S18 and S20 are OK now that I have cleaned them and tested S20. If the dirty contacts are S11 3 and 4, then the sequence described above either 1)cannot get started or 2)is intermittent. That is indeed what seems to be happening. The most revealing symptom is the occurrence of 1)no action at all, or 2)a random delay, sometimes very long, between pressing

a key and the activation of L1. If and when L1 finally activates there are also a character printed and code punched onto the tape, which means that the multi-solenoid shaft rotated ½ turn at that same time.



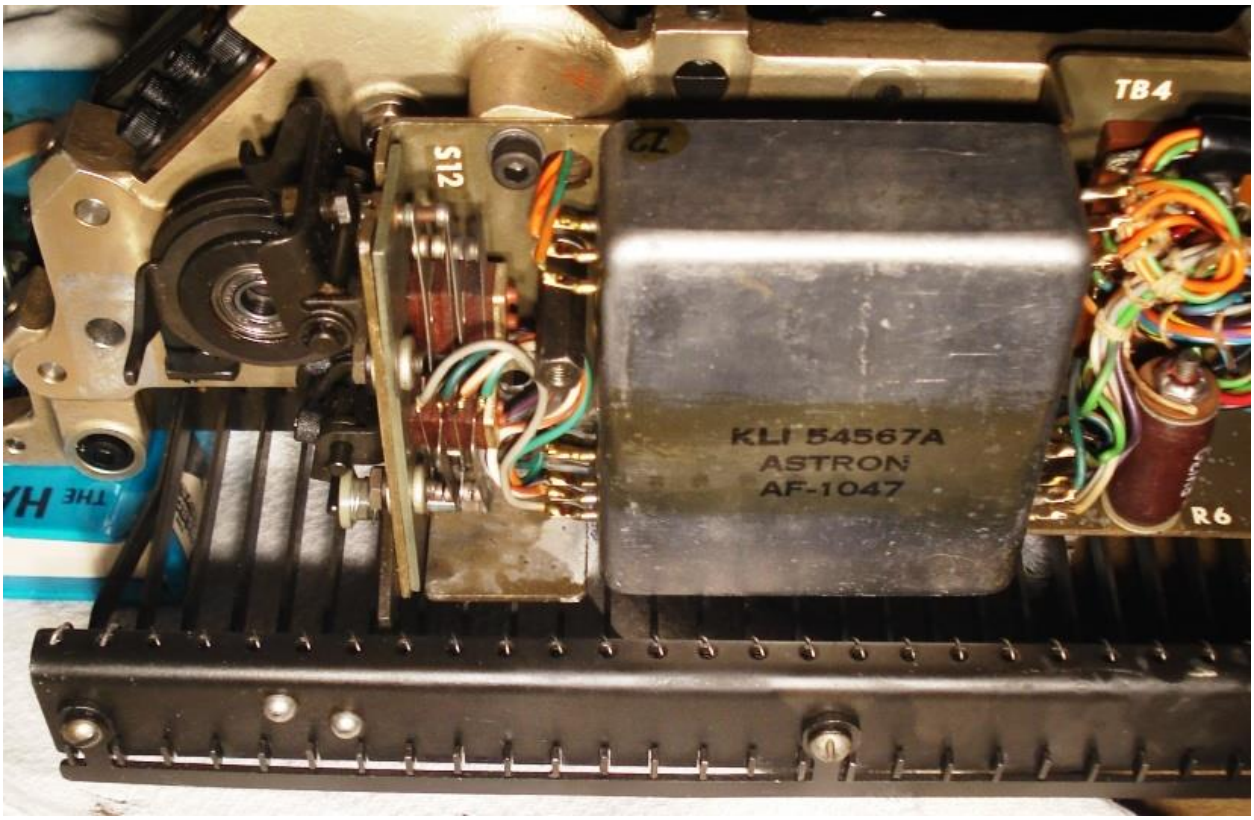
OK – I cleaned all the switch contacts for S18 and S20 and tested the N-O contacts on S20 (the ones that operate restoring solenoid L1 when in simultaneous mode) and they seem to be fine.

Then I turned my attention to the keyboard assembly and switch S11. I determined that I could check S11 operation manually by attaching an ohmmeter to pins G and H of the printer side of the giant connectors below the printer base and table-top. When I pressed any key the S11 switch resistance was anywhere from 1.8 to 3.5 megohms, when it should have been not more than a handful of ohms. (there are two RF filter chokes in the lines to the cable). I did this test several time by manually operating the L1 solenoid lever. I also had to manually rotate the motor shaft after operating L1, to reset the keyboard so I could press another key. S11 contacts 3 and 4 are very suspect now.

December 8, 2022- Back to reperforator: I have to wrap up the perforator lube job before I can work on keyboard assembly. I could not reach all 64 spots of code ring bars (32 bars). Did all of the 16 outer ring bars but only about half inner ring. The rollers for the perforator ribbon were stiff due to gummed old oil. I removed both rollers and cleaned the shaft. I got tired, so I decided to use WD-40 sparingly to both clean and lightly lubricate most of the remaining mechanisms of the perforator main chassis. I declared victory on lube job even though I did not exactly follow the manual. Around mid-day today I reinstalled the reperforator chassis onto its base and tried it out. The reperforator worked fine right away.

Around 3 p.m. I turned my attention back to the keyboard sub-unit, to deal with the "simultaneous mode" issue regarding switch S11. You have to remove the printer chassis from its base in order to remove the keyboard sub-unit from the chassis. Removing the keyboard sub-unit is more involved than what it says in the manual. The entire printer unit must be unfastened from the table (4 bolts at the base corners) and shifted a couple of inches to the right, so that the connector on the end of the thick black keyboard cable can pass through the hole in the table. The cable clamp must be unfastened from the main chassis, but you can leave the clamp loose on the cable. A support bracket on the main chassis, for the big black LTRS button on the printer cover, has to be unfastened (2 screws) and repositioned, to make clearance for the thick keyboard cable. The printer chassis must be elevated at least 2 inches above the workbench using blocks at the four vibration-mount points, so that you can use your hand to support the keyboard subunit while removing its two attachment screws. You have to remove the grey keyboard tab levers cover (2 screws on top) in order to engage the 2 keyboard mounting screws with the Allen wrench. The "Cannon connector" that the manual refers to is for the motor, and is located towards the right side of the base, even though it says to lift up the left side of the base to get to that connector to unscrew it. By 5 p.m. I had the printer chassis and the keyboard sub-unit separated and on the bench.

December 9, 2020- Morning- 8 a.m. I was finally able to inspect, clean and test S11. I used contact cleaner, paper towel strips, and a burnishing tool to clean not only S11 contacts but also S12, since this was a convenient time to do so, even though S12 has been working OK. I was able to achieve 1.4 ohms continuity, at the end of the cable, for the previously bad S11 contacts at pins 3 and 4. This is a very reasonable value since there are two R.F. chokes in the circuit, one going and one coming.



S11 on the bottom, S12 on top, RFI filter module to their right

By 10:40 a.m. the printer was all back together and back on the table. "Simultaneous Mode" worked great right away, and the clutch latch arm has been working fine, so far. The video clip demonstration of success is timestamped 10:44 a.m.

December 11, 2022- After some diagnostic effort this morning I determined that the reperforator's tape advance feed pawl had slowed down due to gummy oil on its pivot shaft (last lubricated in 2014). Because of this it would work when rotating the motor by hand, but was too slow to reliably engage the ratchet wheel, when it was supposed to, at normal operating speed. I first reported this issue in 2019 (August 24 log entry above) but I did not correctly diagnose it. To fix this I;

1)unhooked the tiny spring that pulls back the feed pawl, and set it aside,
2) removed the snap ring retainer at the front end of the shaft,
3) worked the feed pawl back and forth (it was very stiff, worse than I even thought) while pulling forward enough to expose some of the shaft (you can't take it all the way out),

4) applied very small dose of WD-40 to both ends of the shaft, and
5) worked the feed pawl back and forth on the shaft, plus back and forth rotation, until the feed pawl loosened up very nicely.

Then I reinstalled the spring and snap ring. The spring is easily reinstalled by ;
1)place one hook onto the feed pawl post. While it hangs there,
2)threaded one end of a piece of dental floss through the free hook, and
3)pull on both ends of the dental floss (held together between thumb and forefinger) to lift the hook over and onto the stationary post.

The floss is waxy so it pulls out easily, and I'm done. I did not have to take the chassis off the base to do all this. The tape advance is working great again. I expect I will be having more gummy oil problems in the coming weeks and years. You can't really fix them by applying more oil. We're talking major disassembly, cleaning, and rebuild like I did in 1977-78. I don't think I could do it all again. The WD-40 trick will just have to do, for now.

Summary of past week of accomplishments, 2DEC2022 to 11DEC2022:
1. Adjusted reperforator Clutch Latch Arm gap for reliable engagement of clutch, to drive multi-solenoid function shaft.
2. Cleaned keyboard sub-unit S11, S12 switch contacts, and reperforator S18, S20 switch contacts. Simultaneous mode is restored due to S11 contacts 3 and 4 now having good continuity. They were essentially open circuit prior to cleaning and burnishing.
3. Cleaned reperforator ribbon rollers' shaft of gummy oil and used WD-40 to loosen up their spin.
4. Used WD-40 to dissolve gummy oil on reperforator tape feed pawl pivot shaft, and loosen it up, to correct tape feed issue.

Here is link to the video I made during this effort;
Troubleshoot/Fix

December 12, 2022- The reperforator's ribbon needs replacing. When I installed it in 2015 it was New-Old-Stock (NOS) and still in its unopened wrapper, but already at least 35 years old,.

Here are the ribbon saga notes, from April 2015, that I just today rediscovered on the Win7 laptop, along with some more messages that I never got around to sending to the teletype set;

17 APRIL 2015 1614 HRS PDST
BULLETIN NO. 1 FROM RANDOM73
RIBBON SPOOLS ROUNDABOUT

PHASE 1 - REPLACED REPERFORATOR RIBBON 25 MARCH 2015
1. THE BLUE AND WHITE CARTER'S BOX CONTAINED AN "ORIGINAL" RIBBON THAT I PUT THERE IN 1978, WHEN I INSTALLED A NEW RIBBON. I DON'T REMEMBER WHAT HAPPENED TO THE OTHER "ORIGINAL" RIBBON, OR EVEN IF THERE WAS ONE.
2. I OPENED THE NEW-OLD-STOCK ASR33 RIBBON SET (TWO SPOOLS, ONE EMPTY).
3. I WOUND THE "ORIGINAL" RIBBON ONTO THE EMPTY ASR33 SPOOL.
4. I WOUND THE NOS ASR33 RIBBON ONTO THE "ORIGINAL" SPOOL.
5. I STORED THE ASR33 SPOOL SET, NOW WITH THE "ORIGINAL" RIBBON.
5. I PULLED THE 1978-INSTALLED RIBBON AND SPOOL FROM THE REPERFORATOR.
6. I INSTALLED THE "ORIGINAL" SPOOL, W/ THE NOS ASR33 RIBBON, INTO THE REPERFORATOR.
7. I PUT THE 1978 RIBBON & SPOOL INTO THE CARTER'S BOX.
THE REPERFORATOR IS PRINTING MUCH BETTER NOW.

PHASE 2 - REPLACED PRINTER RIBBON 17 APRIL 2015

8. I ORDERED TWO NEW SCM "STANDARD" RIBBONS. THEY EACH CAME AS A TWO SPOOL SET, ONE EMPTY, ONE FULL, LIKE THE ASR33 SET. THE SPOOLS ARE THE WRONG TYPE (2" INSTEAD OF 2 1/8", ALSO CHEAP PLASTIC).
9. I WOUND THE 1978-REPERFORATOR RIBBON FROM THE CARTER'S BOX ONTO THE EMPTY 2" SPOOL.
10. I WOUND THE NEW RIBBON ONTO THAT 1978-RIBBON SPOOL.
11. I INSTALLED THE 1978-SPOOL WITH THE NEW RIBBON INTO THE PRINTER.
12. I PUT THE PRINTER 1978-SPOOL AND RIBBON INTO THE CARTER'S BOX AND PUT A POST-IT NOTE ON THE BOX.

THE NEW PRINTER RIBBON WORKS GREAT.
-END MESSAGE-

17 APRIL 2015 1855 HRS PDST
BULLETIN NO. 2 FROM RANDOM73
ACCOMPLISHMENTS TODAY;
1. REMOVED SUBSTITUTE FUSE CIRCUIT, INSTALLED 1/16 AMP TIME DELAY FUSE IN PRINTER.
2. INSTALLED NEW RIBBON IN PRINTER, WORKS GREAT.
3. INSTALLED TRENDNET SOFTWARE DRIVER, FROM CD-ROM, ONTO THE TOSHIBA LAPTOP (USB-TO-RS232 SERIAL PORT ADAPTER).
-END-

18 APRIL 2015 2033 HRS PDST
BULLETIN NO. 3 FROM RANDOM73
ACCOMPLISHMENTS TODAY;
1. WIRED RS-232 JUMPERS IN M6800 COMPUTER,
2. PROTO-BOARDED H11D1/DF04M OPTOISOLATOR/BRIDGE CIRCUIT WORKED FINE, AS EXPECTED.
3. PINPOINTED KEYBOARD PROBLEM- STICKY CODE SENSING LEVERS
4. FILMED FOR MOVIE5, MAC512K-TO-REPERFORATOR DEMO.
-END-

19 APRIL 2015 1854 HRS PDST
BULLETIN NO. 4 FROM RANDOM73
ACCOMPLISHMENTS TODAY;

1. UPGRADED THE TTY INTERFACE CARD PER THE NEW DESIGN USING H11D1 OPTOISOLATORS AND DF04M BRIDGE CIRCUIT. I ALSO INCLUDED AN LED TO INDICATE SPACE CONDITION ON THE DATA INPUT LINE TO COMPUTER.
2. INSTALLED DB-15 MATING CONNECTORS ON THE CURRENT LOOP LINES THAT GO BETWEEN THE TELETYPE SET AND THE COMPUTER INTERFACE CARD. I FOUND THE CONNECTORS THIS MORNING IN A JUNK BOX IN THE GARAGE.

-END-

20 APRIL 2015 2057 HRS PDST
BULLETIN NO. 5 FROM RANDOM73
LOCATION: HERMOSA BEACH HOUSE
ACCOMPLISHMENTS TODAY;

1. GOOD PROGRESS ON SOFTWARE DESIGN FOR INPUT FROM TELETYPE, CONVERTING BAUDOT TO ASCII, AND OUTPUT TO MIKBUG CONSOLE (MACTERMINAL 2.0).
2. COMPLETED CABLE DRAWING FOR EXISTING FASTMAC V.34 MODEM-TO-MAC512K CABLE.
3. COMPLETED MOVIE5 EDITING, READY TO PUBLISH.

-END-

22 APRIL 2015 1723 HRS PDST
BULLETIN NO. 6 FROM RANDOM73
LOCATION: MAIN HOUSE
ACCOMPLISHMENTS YESTERDAY AND TODAY;

1. CONTINUED GOOD PROGRESS ON SOFTWARE DESIGN
2. CHECKED OUT MODIFIED TTY INTERFACE. SEEMS TO WORK USING 5MA LOOP, BUT H11D1 OUTPUT DRIVER IS OVERHEATING WITH 60MA LOOP.
3. WIRED UP RS-232 CABLE FOR FASTMAC MODEM (OR M6800 COMPUTER) TO TRENDNET USB-RS232 ADAPTER FOR LAPTOP. SUCCESSFULLY QUERIED MODEM FROM LAPTOP WINDOWS 7 CONTROL PANEL "PHONE AND MODEM". NEED TO INSTALL TERMINAL EMULATOR, SUCH AS PUTTY.
4. RE-FABRICATED MAC512K-TO-MODEM CABLE USING 2 FT LONG PHONE COMPANY CABLE. WORKS FINE.

-END-

So the 2nd SCM "standard" ribbon-and-spool set that I ordered in 2015 is still unopened today, but is already 7½ years old.