# Using the ASR 33 Teletype

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Vintagecomputer.net/teletype/

# A BRIEF HISTORY …

Teletype Model ASR 33

• Introduced in 1962

• 470,000 produced from 1962 to 1976

• ASR means automatic send-receive

• ASR includes printer unit, keyboard send-receive, and paper tape reader and punch

# Teletype Benefits

It's slow, It's noisy!

- Easy to use – serial port w/ 20 milliamp current loop

- It's 4 devices in one – keyboard for console input, a printer for console display, and line printer, a tape reader for input and papertape punch for output.

- 1977 $850 refurbished unit, $1300 new with everything.

# Teletype Model ASR 33

- Most popular I/O device at dawn of microcomputing age

- All mechanical

- Operates by sending and receiving current impulses, a logic 1 being represented by a flow of current and a logic 0 by no flow.

# PaperTape Storage Benefits

Punched papertape input/output

- "papertape processing" – punching data to tape saves data in hard-copy form.

- "tape reader" – senses and translates the detected holes into electric signals

"..perhaps best meet our criteria for program exchange…" can be read or duplicated and devices made by a dozen manufacturers.

In early 1977 what single device could do all that for less?

# Quote from Kilobaud

"..it's difficult to imagine that even one of you has never seen the media, or doesn't know how paper tape operates…"

-Kilobaud Magazine
(circ. 1/1977 )

Dear Customer:

This letter is to advise you of Teletype Corporation's plans
to discontinue manufacture of the Model 28, 32, 33, 35, DRPE, BRPE and
4210 equipment by year-end 1981.  These plans are being implemented
because of low existing demand for these terminals and the need to
reallocate our facilities and resources for the manufacture of newer
products.

In addition to the referenced equipment, the manufacture of
any options or accessories (e.g. modification kits or set-of-parts)
which are used exclusively with these older product lines will be
discontinued.  Please note however, that all support services for
these products including spare parts support, and documentation, will
be continued for five (5) years from our last scheduled delivery of
December 31, 1981.

Attachment 1 lists all the major apparatus codes affected by
this plan.  Additional information covering options and accessories to
be discontinued will be provided at a later date.

Two key dates should be noted for your planning.  Final orders
for these products must be received at Teletype Corporation no later
than March 30, 1981, and final deliveries are scheduled for
December 31, 1981.

Teletype Corporation realizes that new concepts in data
communications demand more versatile, reliable and economical terminal
equipment.  To help you satisfy your system requirements, we now offer
products such as the Model 42/43 Teleprinter family, the Model 40
Terminals and the Model 4540 Terminals.

# HOW THEY WORK...

# Summary ASR 33

Teletype ASR 33
- 1" tape,
- UPPERCASE ASCII (no lower case)
- 110 baud
- Speed: slow 10 cps – no more no less – a 4K program will take 1 hour to print
- Ease of data recovery – simple
- Volatility – good
- Capacity – good enough
- Transportability – good
- Reliability – fair
- Economy – Good because it's a multi-function device.

# Teletype Model ASR 33

- Current levels for microcomputers usually 20 mA (milliAmps)

- Transmission modes of Half and Full Duplex (full = ability to send and transmit simultaneously)

- 110 baud

- Eleven pulses per ASCII character (8 data bits, plus one start and two stop bits)

# PaperTape Storage Specs

- 950 feet for $2.25 rolls, 1000 feet for fan folded for $4.50 (1977 $$)
- 1" wide, usually oiled
- Stores 100,000 bytes per roll
- Mylar tapes uses for master copies
- Most papertapes can be read 25 times
- Easily copied
- Non-volatile (unless ripped)
- Cannot be edited

# Repairing Ripped Papertape



8-bit repair tape. Oiled on top, adhesive on the bottom.
To apply, peel adhesive stip cover.  Match the outer four corners of the block with damaged tape, centered on tear or rip.  Carefully.

# Teletype Model ASR 33

- Data is transmitted serially, one line for 8 bits = ASCII character
- Tape reader transmits whatever is on the eight levels of the tape in "parallel" because all of the feeler pins in the reader rise at the same time.
- Must be 110 baud or timing fail = gibberish
- Baud not a problem due to the old phone line system.

# Teletype Model ASR 33

- Receiving is independent of the sending making full duplex possible

- Stream of serial pulses arrives at the selector magnet drive that drives the selector cams, which set the desired ASCII code in a series of code bars – totally mechanical.

- System is designed for ASCII code mechanically, but other codes are possible.

HELLO I LOVE TELETYPES

JUST KIDDING.

THE END.............................
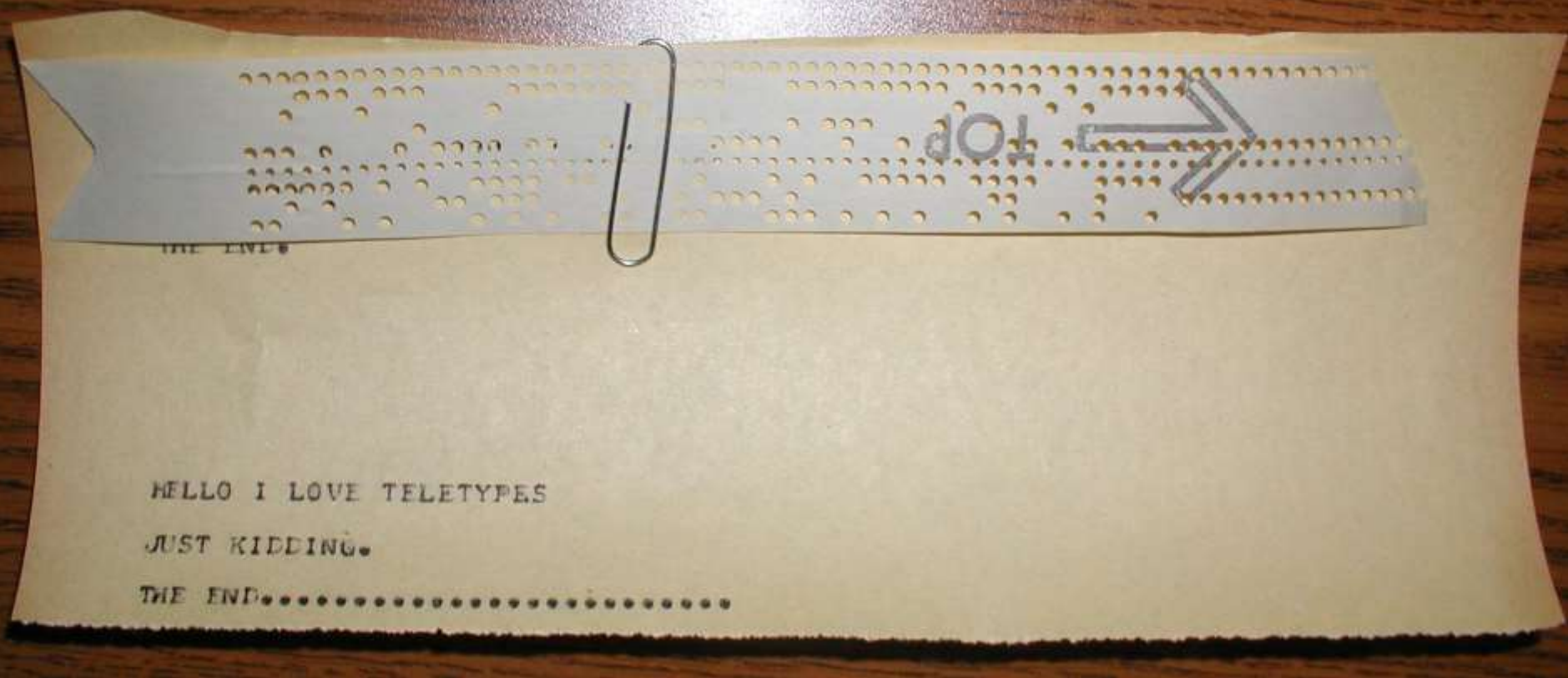
Each letter is represented by an 8-bit ascii character.  The holes represent "open" and the absence of a hole represents "closed".

One set of Three bits, a guide hole, and one set of five bits, per line.

MITS ALTAIR 680 BASIC

S10400F3FF09
S11300000D7600F37E18F97E033C00004838002C7E
S1130010000000000000000000000000000000000DC
S1130020000000000000000000000000000000000CC
S1130030000000000000000000000000000000000BC
S1130040000000000000000000000000000000000AC
S113005000000000000000000000000000000000009C
S113006000000000000000000000000000000000008C
S113007000000000000000000000000000000000007C
S113008000000000000000000000000000000000006C
S113009000000000000000000000000000000000005C
S11300A000000000000000000000000000000000004C
S11300B00000000000000000000000000000007CC0
... Snip ...
S1131A40AE0D0A005445524D494E414C205749446D
S1131A5054C80020425954455320465245C50D0AE6
S1131A600D0A4D49545320414C544149522203638B3
S1131A703020424153494320564552534949F4E204A
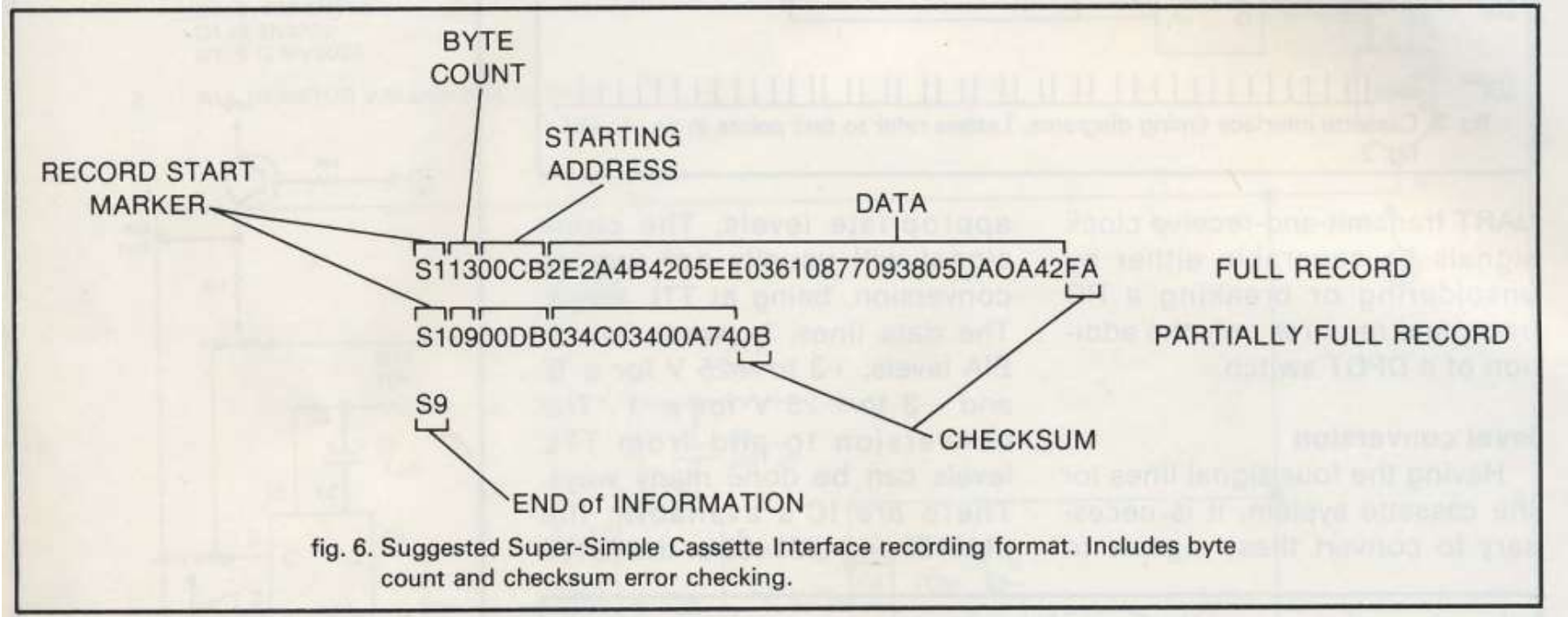S1131A80312E312052455620332EB20D0A434F5089
S1131A9059524947485420313937362042259204D4C
S1131AA04954532049NE43AE0D0A004D454D4F5203
S10B1AB0592053495AC50000F6

(total lines 452, original tape has no S0 line)

# ASCII Teletype Format



fig. 6. Suggested Super-Simple Cassette Interface recording format. Includes byte count and checksum error checking.

See next slide for more details →

# Motorola Teletype Format

<u>S0</u> – leader – lines that start with S0 are not part of the program/data

<u>S1</u> – data

NOTE: The checksum at the end of each line is the one's compliment of the sum of all 8-bit bytes dropping call carries including the byte count, m address, and data.  If the checksum is non-zero, an error is thrown by the monitor.

<u>S9</u> – end of information indicator, stop the loader program

# Intel Papertape

- Same basic principle as Motorola, different order.
- Intel papertape format uses a colon as the start character (:), followed by a two character byte count, then the four-character address, a two-character record type, followed by the two-character data pairs, and ending with a two-character checksum.
- Example Line:
  :10C8A000FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF00

(a line of data starting at address C8A0. Record type = 00 (data), followed by a string of FF instructions, ending with a checksum of 00.

# EVALUATING AN ASR 33...

# Picking out your ASR 33

- Is it complete?
- Is there rust?
- Does it look like it was opened (to scrounge for parts)?
- Did an animal make a nest inside?
- Are the fuses present/blown?
- Are all of the keys aligned correctly?
- Print head ok?

# Useful Stuff for Restoration

1. Basic toolkit, solderkit, wire stripper, electric tape, needle-nose plyers
2. Nut driver – most hardware connections use "nut top" screws
3. Electricity measurement apparatus of choice
4. Various colored wire, 8 alligator chips, and/or a 4 or 6-wire cord that you can splice.  Best Colors: green, white, black, red.
5. spade lugs - "the things that attach to the antenna screws at the end of a RF adapter" - you'll find these useful
6. EIA connect kit of choice if the computer you're attaching the teletype to has a 9-pin or 25-pin port. The little pins that often come in these kits are useful for testing.
7. RS232 to Current Loop converter
8. 7/16 OD - 5/16 ID vinyl tubing (6 inches or more)
9. Cleaning supplies of choice - q-tips, paper towels, soap/water, canned air.
10. Extension cord
11. Notebook / camera to take picture before disassembly.
12. Manuals and Schematics
13. A low-viscocity oil.  Synthetic oil.  (I prefer NYE oil.)
14. Grease for gears only.

# Where do you get parts?

- Greenkeys mailing list
- Ebay / craigslist.com
- Hamfests
- Time capsules from 1970

# RESTORING AN ASR 33…

# Replace Rubber Print Head Pad

- **DO NOT test your teletype until you have replaced the print head pad.** Old print head pads will have turned to mush by now, but that's OK!

1. First remove printer ribbon, but note how it was attached so you can return it into the proper position.

2. Cut out the pad leaving only the hammer's metal striker bar. Replace with a 7/8 inch long piece of 7/16 OD - 5/16 ID vinyl tubing like a sheath over the bar

3. Look between the two ribbon spindles for a clear-plastic pvc tube cut and placed over the print hammer.

4. Every time you replace a printer ribbon, check the tubing. You may need to replace the tube after a lot of use.

# Opening your ASR 33

- There are three screws behind the metal "Teletype" strip in the front. You have to first remove the LINE/OFF/LOCAL knob then slide the strip down.
- There is one screw that holds the cover on the left side by the papertape reader
- There are three knobbed screws in the back
- Remove the printer paper advance knob
- Carefully remove cover, avoid the papertape reader lock.
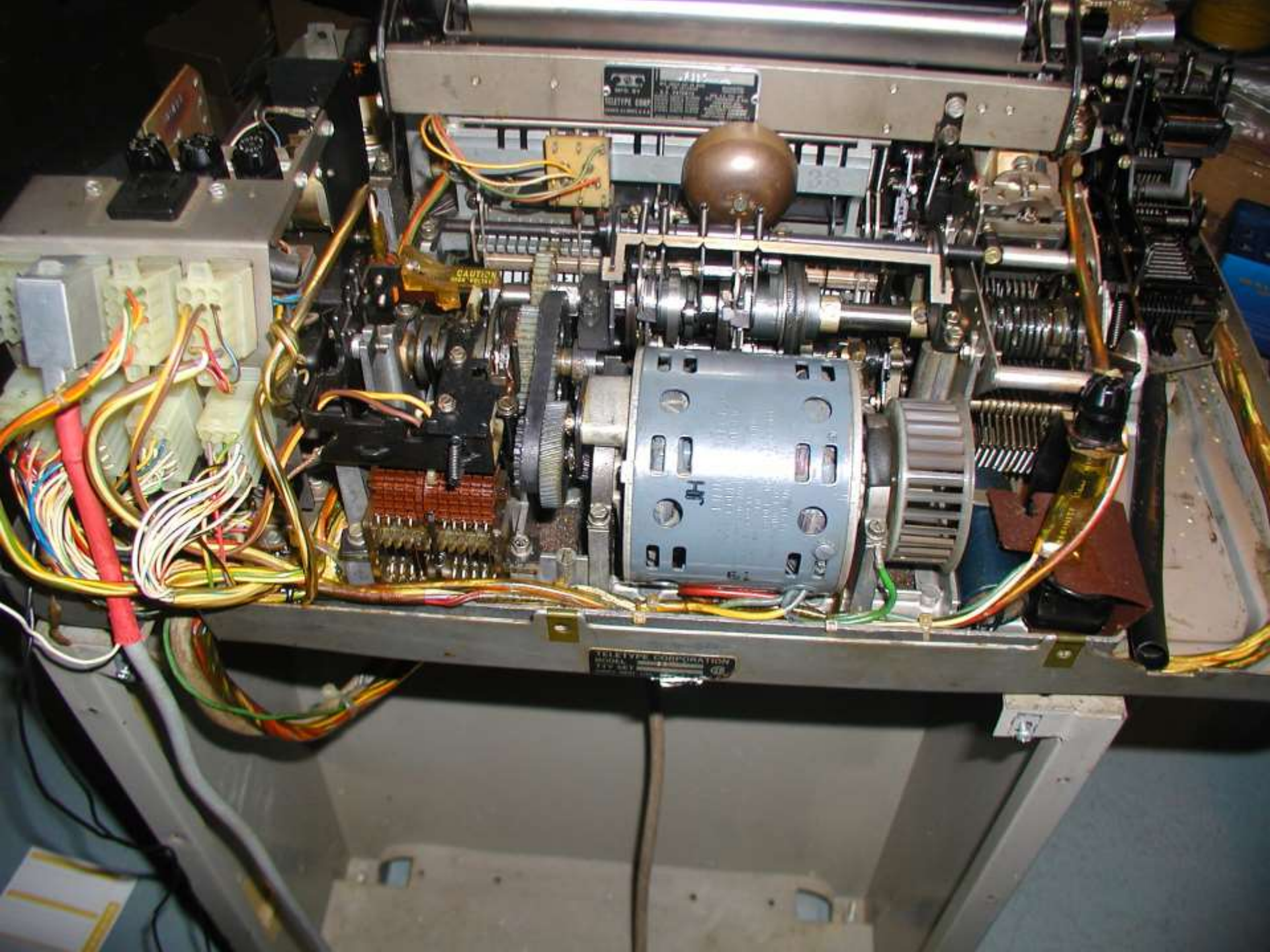
20
mA

# Check the Comm. Settings

Most of the time you want to set your TTY for 20mA current loop and full duplex.

1. The large, green, flat resistor on the TTY base near the call control unit (a flat 4-post resistor with a blue wire on post #4)

2. Set purple wire from resistor to contact 9 of the terminal strip

3. Set brown-yellow wire on terminal strip post 5

4. white-blue wire on terminal strip post 5 also

Terminal input to the teletype to contact 6 for negative line and 7 for the positive line. (printer punch)

Terminal output (keyboard - reader) contacts 3 and 4 (not polarity sensitive)
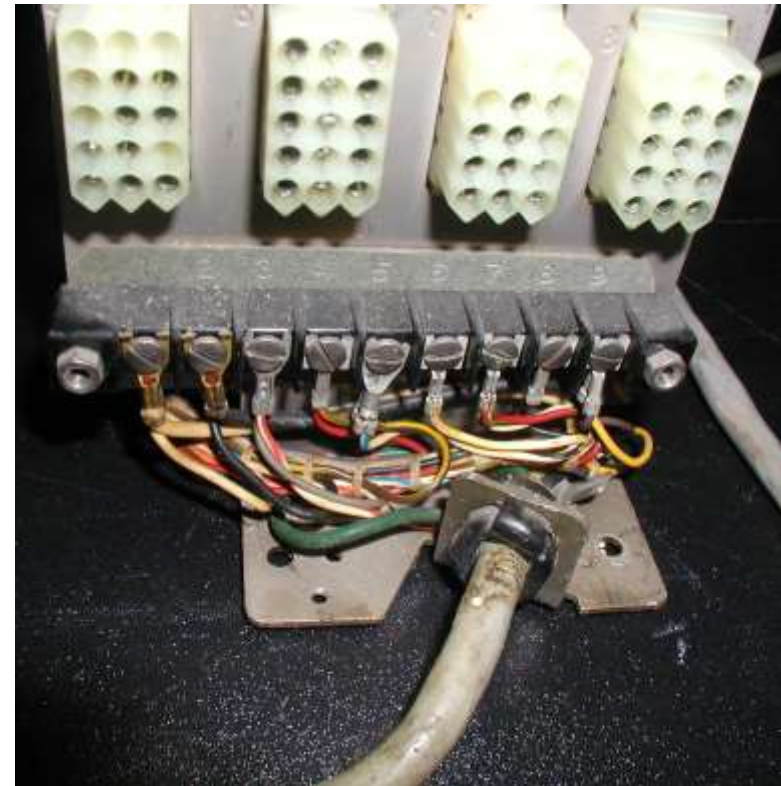
# Two ways to connect to computer

- Plug In connectors (molex)
- Terminal Strip
- You can bypass the connector by attaching the 4 wires from the computer directly to the terminal strip. The terminal strip is located behind/below the connectors.
- If you're making a cable with a special connector to match your particular computer card EITHER the terminal strip or #2 connector can be used. You can have something attached to both, just not at the same time (or you'll get crazy results).
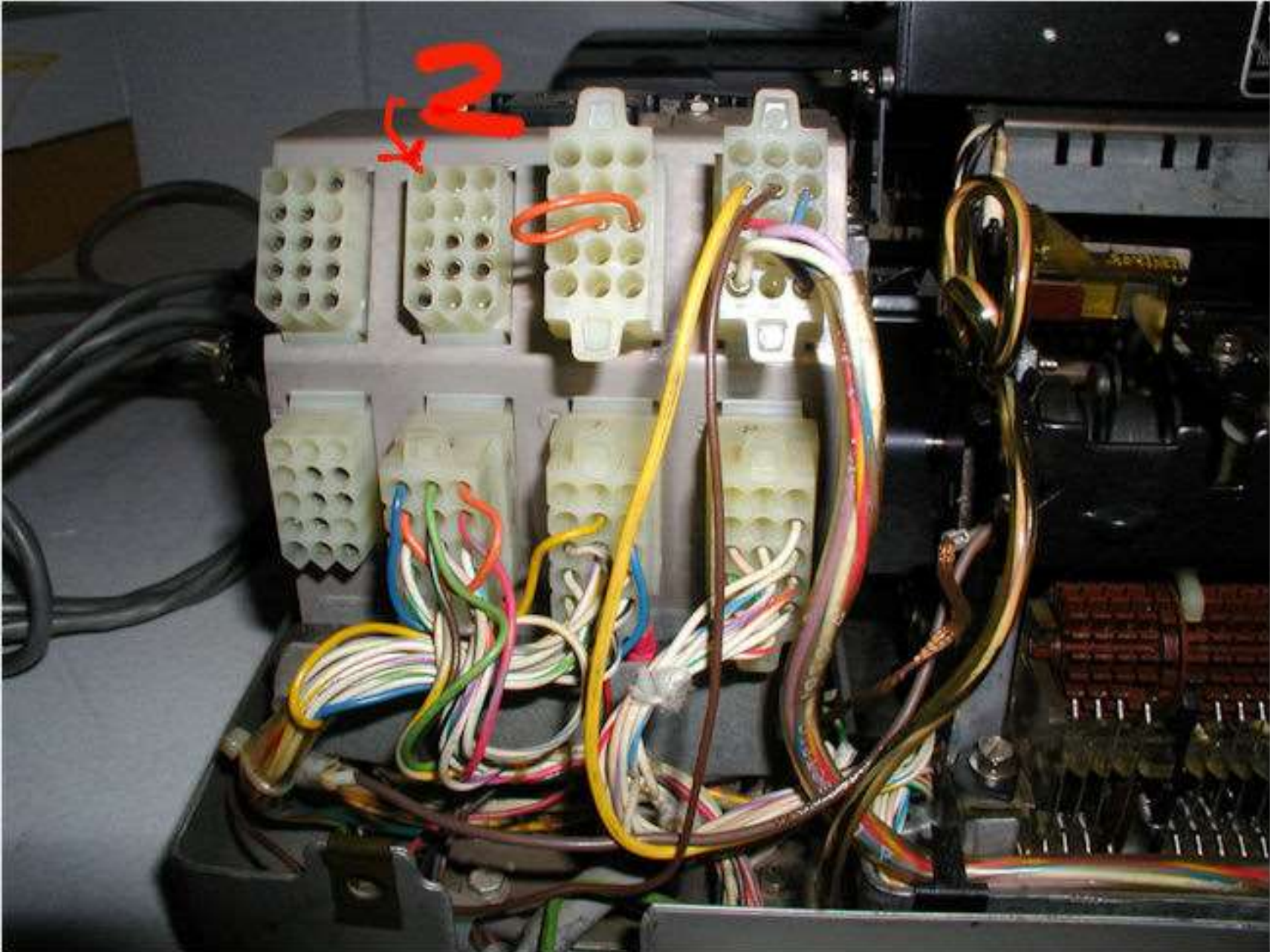
Plug in (molex) connectors.  The computer connects to connector 2, which is second from the top left.

# Plug In Connector Sockets

- An array of 8 connectors, each with a different function, not all used. The top left connector is #1, bottom right is #8. The #2 connector is the one that connects to the computer.
- Each connector socket has 16 pins.   Pin hole one is located at bottom right, see array below:
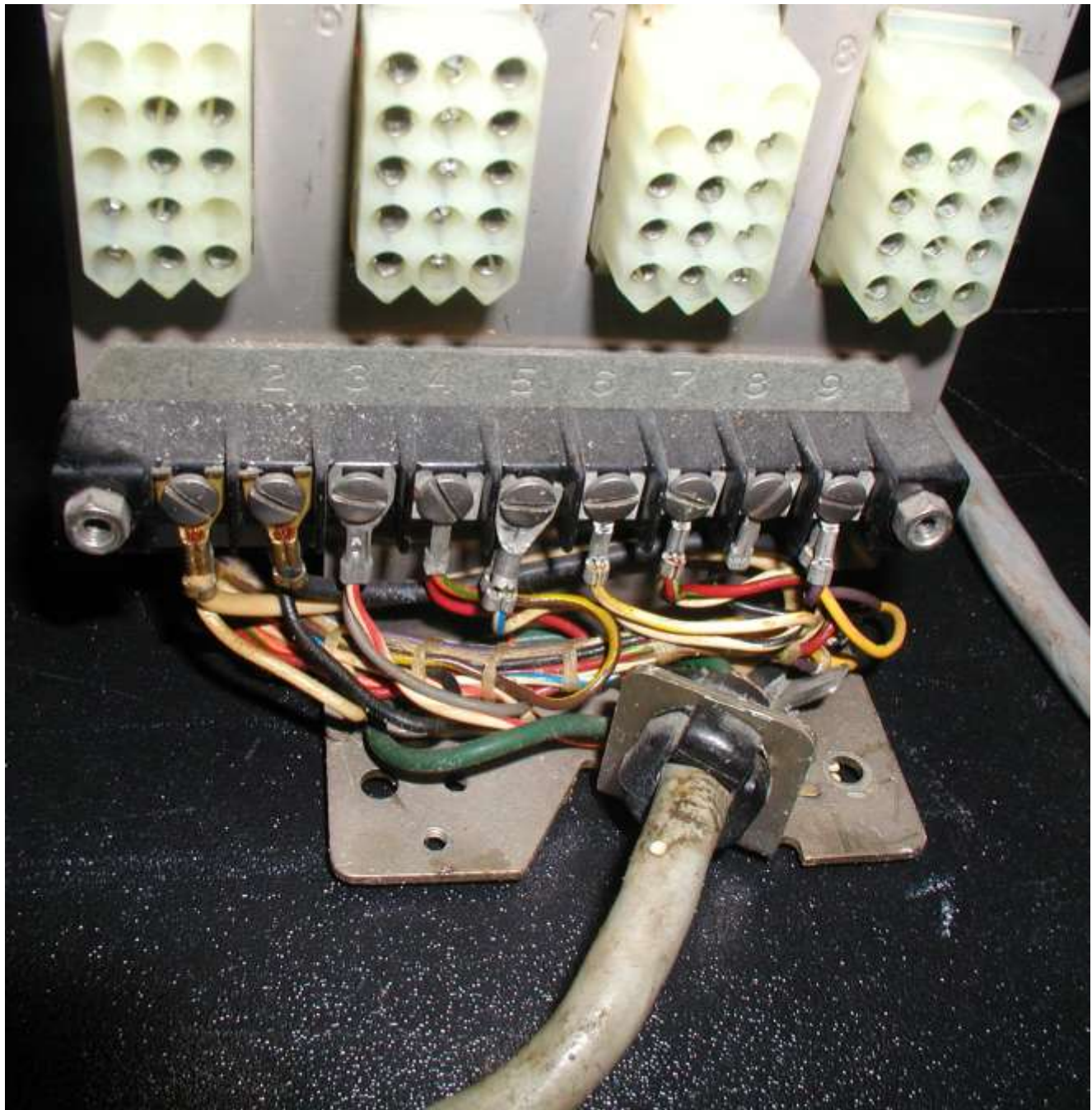
  15-14-13
  12-11-10
  09-**08**-**07**
  **06**-**05**-04
  03-02-01

- Located behind UCC-6

The red cable with the silver cap is connected to plug in "number 2 connector".

# Number Two Connector Cable

- Transmitted data return (-) attaches "number 2 connector" #7

- Received data return (-) attaches to num 2 connector #5

- Transmitted data send (+): #2 connector 8

- Received data send (+): #2 connector #6.

# The Terminal Strip

- If you remove the 8 plug-in connectors and the fiber strip cover, you'll reach the <u>terminal strip</u> of an asr 33.

- The four posts of the terminal strip: 3,4,6,7 have connectors above their respective terminal's screw post. These four wires travel through the reader control and eventually out to the computer.

Terminal Strip is located behind the plug in connectors of the UCC-6

# Wiring the Terminal Strip

- Transmitted data return (-) attaches to terminal strip screw 6

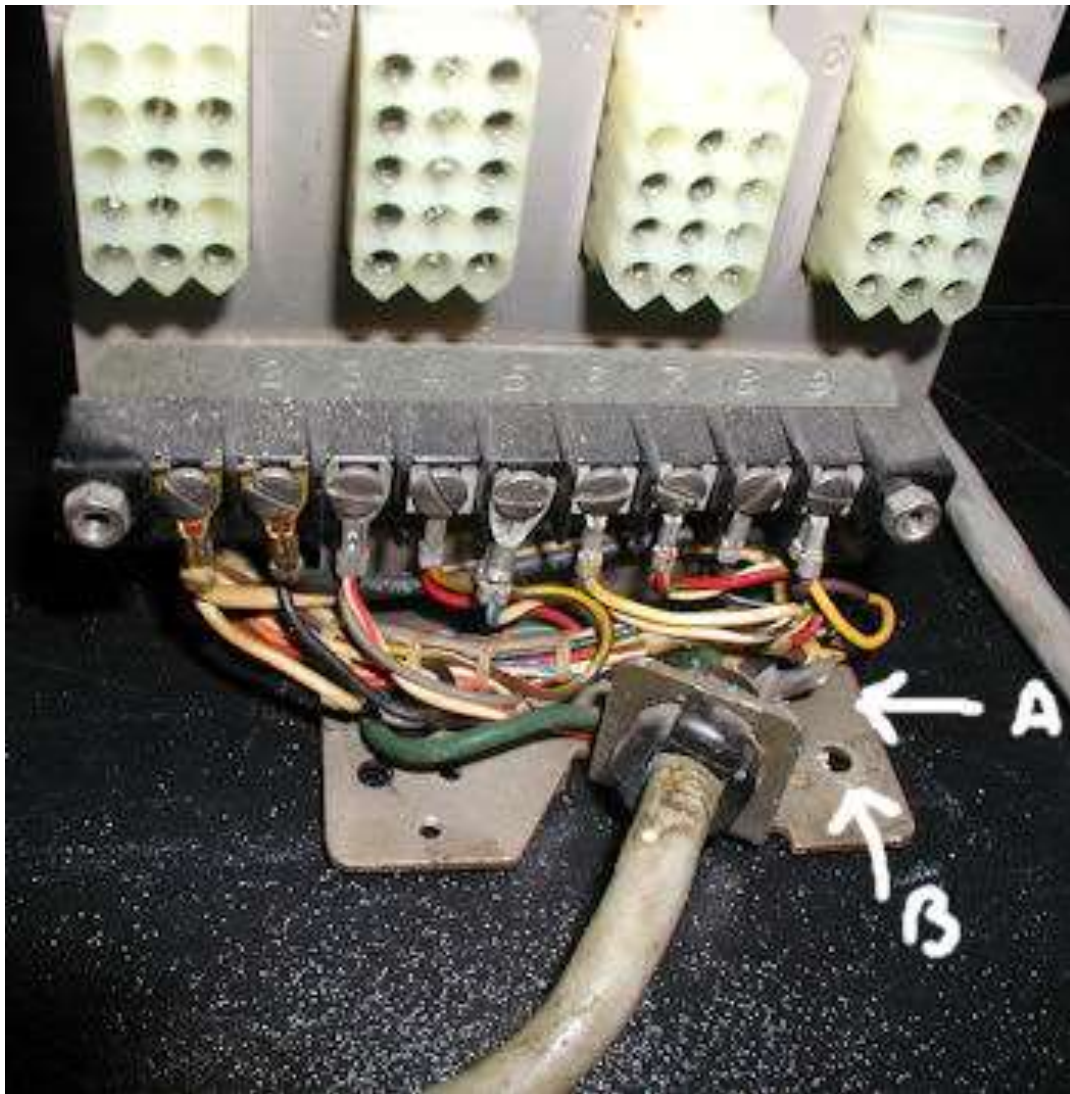  Received data return (-) attaches to terminal strip screw 3

  Transmitted data send (+): Terminal Strip 7

  received data send (+): Term strip 4

# Transplanting ASR 33 Power Supply



UCC-6 "Call control unit" powers everything except the papertape reader

Step 1. Remove the molex plugs attached to the back of the UCC-6. Just leave them hanging so that you can see the terminal strip.

Next remove the ground connector marked "A", leave it attached on the other end.

Remove the screw in position "B" in the photo above using a nut driver, set it aside.

If there is an external cable attached to the terminal strip, make note of the colors/posts used and remove the external cable ONLY.  Leave the terminal strip wiring alone otherwise.
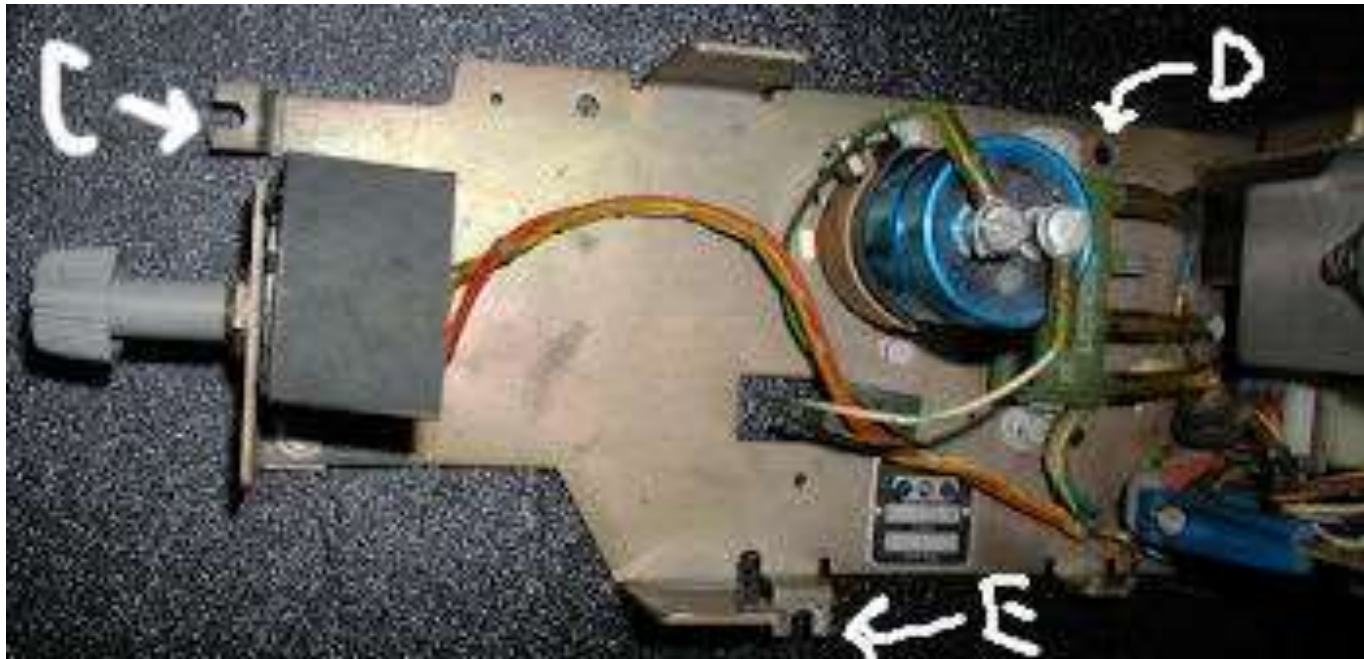
Next remove the screws in positions C, D, and E using a nut driver.
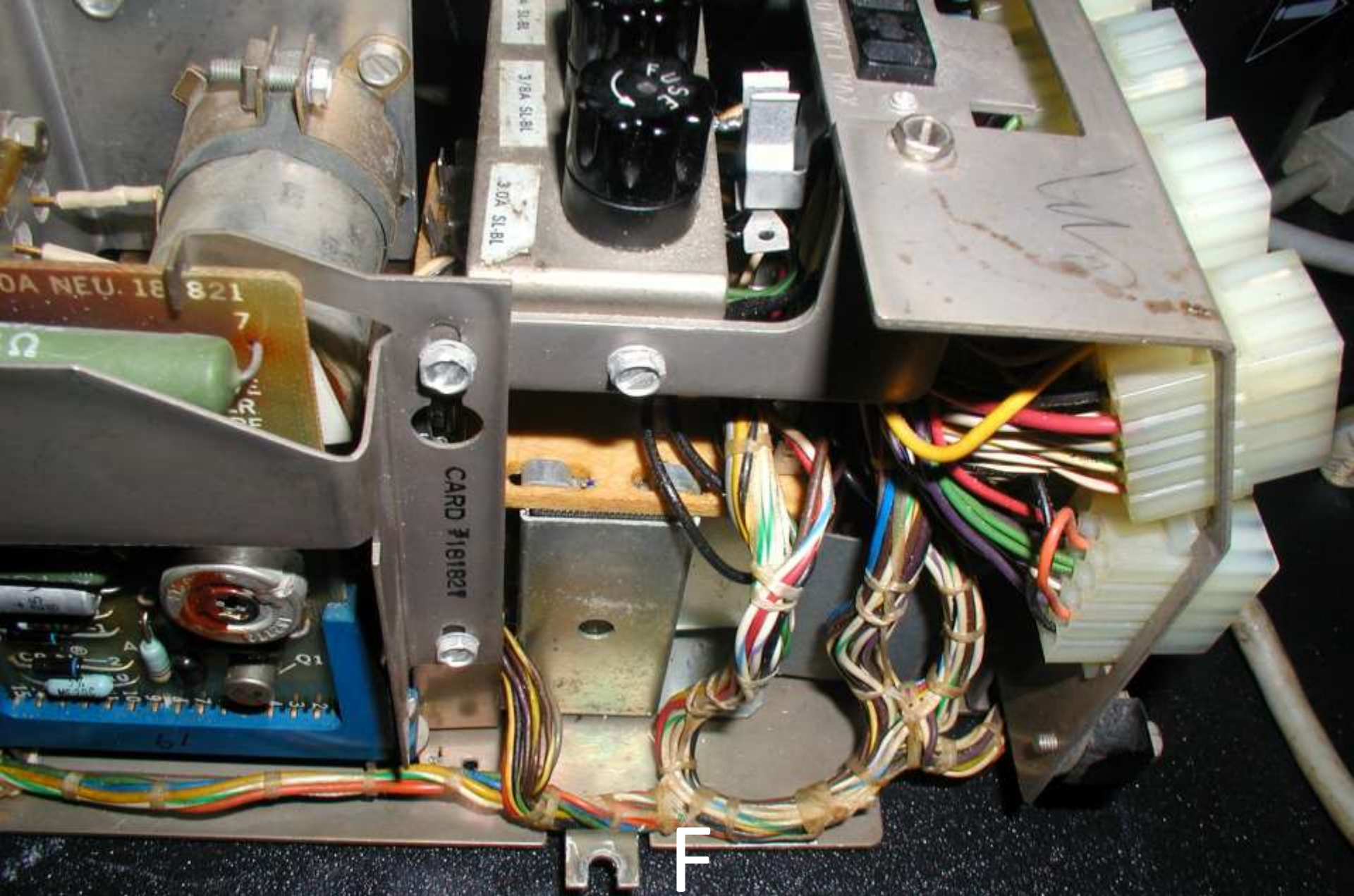
Lastly remove screw holding F into place

# QUICK FIXES...

# Incorrect characters?

SITUATION:
Characters that use the 6th channel/cam to print characters from the keyboard was being switched with channel/cam 7.

For example, if you hit the "4" key, the printer prints a T instead.

The Model 33 typewheel code chart says that the 4 is printed using channel 3-5-6-8. A "T" is printed by using channels 3-5-7-8.

WHY?

There are 4 gold-colored double pins coming from the left front of reader and 8 wires to the right.
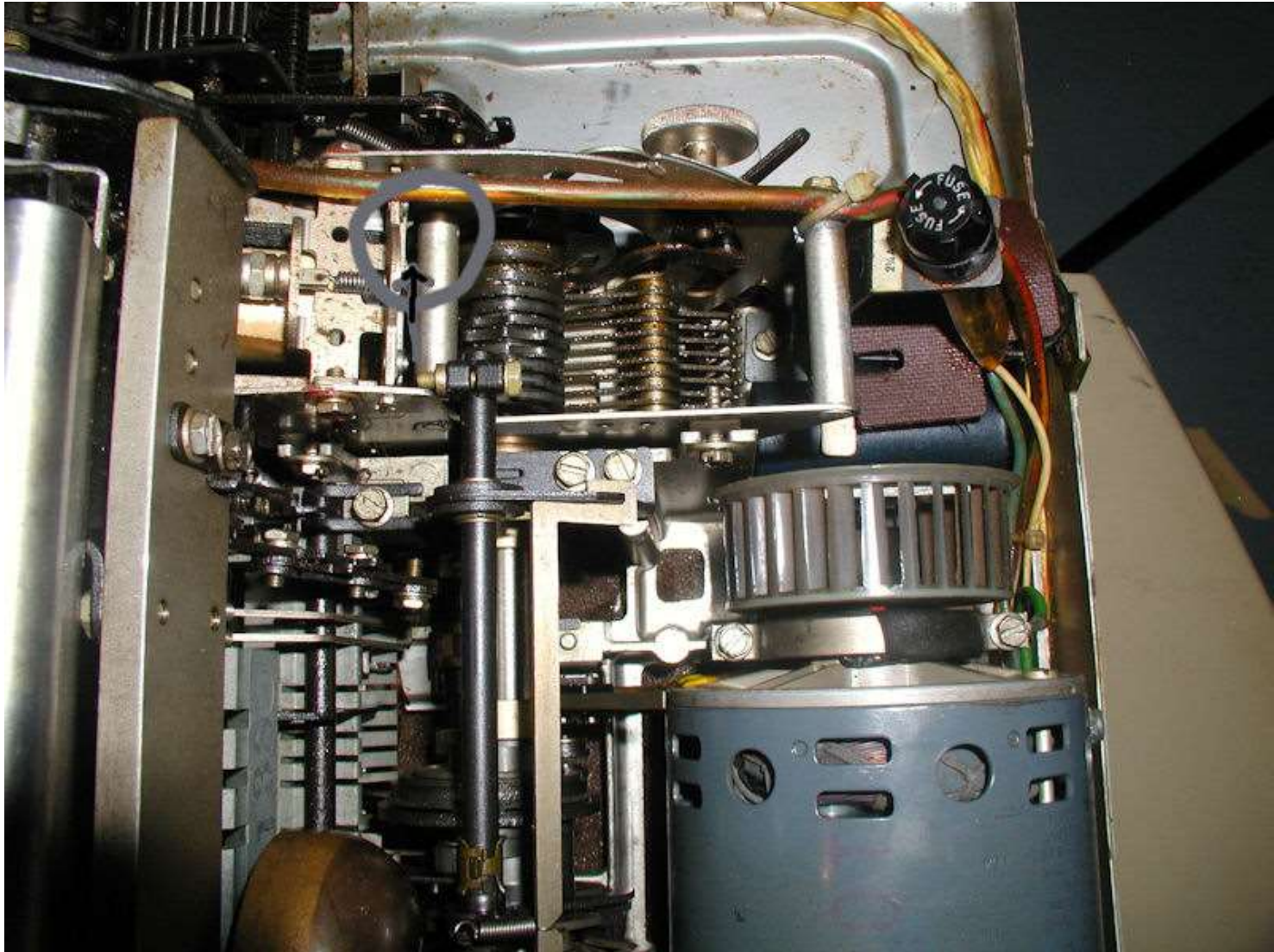
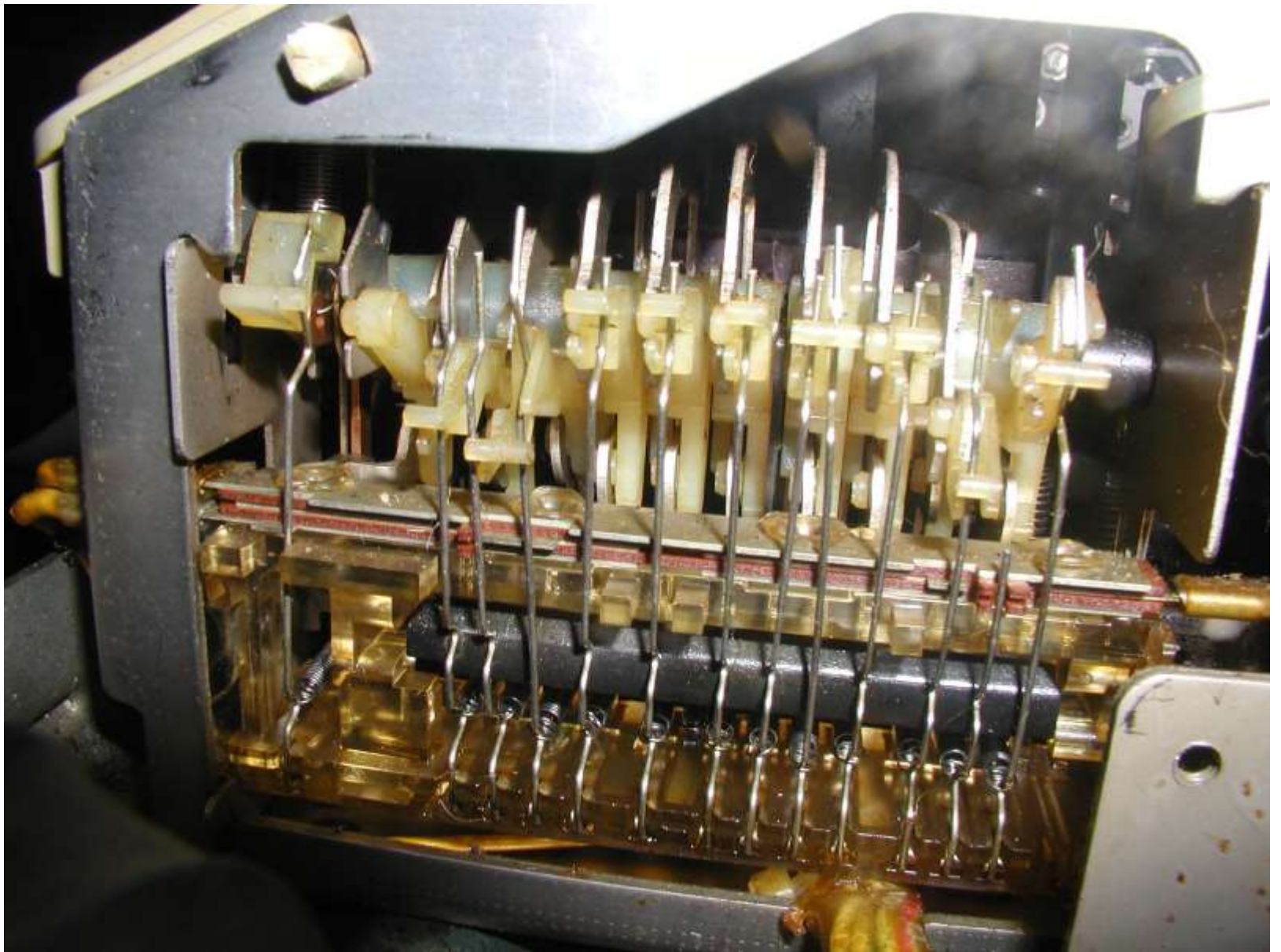Each of these 8 wires also connect to long golden-colored pins.

The end of these pins is supposed to fit into little notches.
**Check to see if any of these are out of their notch**.
If so, carefully pul on the spring holding the pin and let it fall back naturally into the correct slot.

# Wont' Stop Chattering? – Clothespin Trick

View from side of keyboard…These wires/pins must be aligned properly.

# Check the keyboard bars and alignment

Example – If the BREAK key pin is out of its joint under the keyboard, just slightly, but enough to be constantly "on" you can disrupt the current loop.  Once I caused mis-alignment when I vacuumed the insides of the TTY after running a long punch job without a chad catch cover on the punch pins.!   Lesson learned – **find a way to catch chads.**

By re-aligning the pin into its slot, the TTY now closes in LOCAL mode or when engaged by a computer system sending a current loop.

If you're brave, remove the keyboard cover and check for bent/mis-aligned pins.

You can check the underside without removing the cover, those pins can jump their holders.

The fuse in the back can often get missed...check this, and the 108 mfd 125v cap too.  A bad fuse will cause uncontrolled chattering
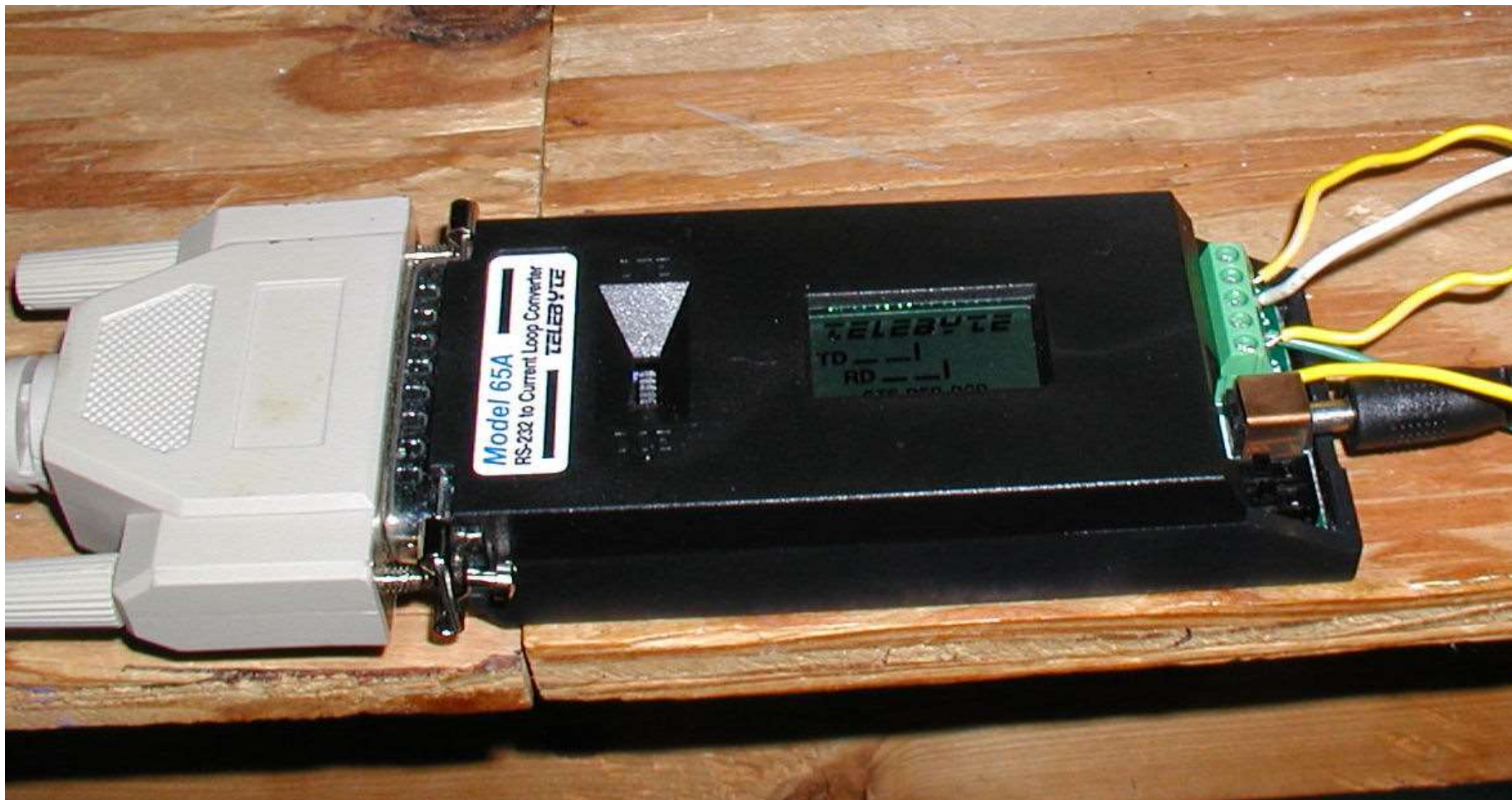
# RS232 TO CURRENT LOOP CONVERTERS ARE YOUR FRIEND…

Altair 680 set for 110b, no Baudout, 2 stop bits RS232 (not current loop)

Multi-Tech Systems MT25 EIA-CCITT Breakout / Monitor tester. This device allows me to see what signals are being sent through the serial cable.

Telebyte Model 65A RS232 to Current Loop Converter.

- This is what converts RS232 signals to current loop signals.
- To the left is the cable coming from the computer.
- To the right are wires that attach to the terminal strip of the teletype

## How to attach a teletype to a PC serial port using the Telebyte 65A (Teletype is a passive current loop device):

1. Connect serial straight-through cable to computer serial port and on other end to the RS232 end of the 65A.

2. Set DTE/DCE to DTE

3. Set SW2, SW3, SW4 to 1-2

4. See photo above, the wires coming from the 65A current loop posts are connected directly to the Teletype's terminal strip.

Wiring as follows:
65A post K- to Teletype terminal strip 7
65A post K+ (not needed)
65A post G to wires attached to terminal strip pins 6 and 4
65A post C- to terminal strip pin 3
65A post C+ (not needed)

5. Once wiring complete turn on the 65A, and then turn on teletype. If everything is working correctly you'll get a ready TTY in LINE mode.   If the teletype is chattering then you did something wrong or the teletype is not working correctly.

6. Turn on your favorite machine set to 8 bits / no (or mark) parity / 2 stop bits for keyboard and ASCII tape interaction. It may work just fine with 1 stop bit. Experiment.

7. Regardless of whether the tape is ASCII or binary you have to change the computer to 8 bits 2 stop bits no parity.

# Teletype Faulty Linefeed Analysis using RS232 converter
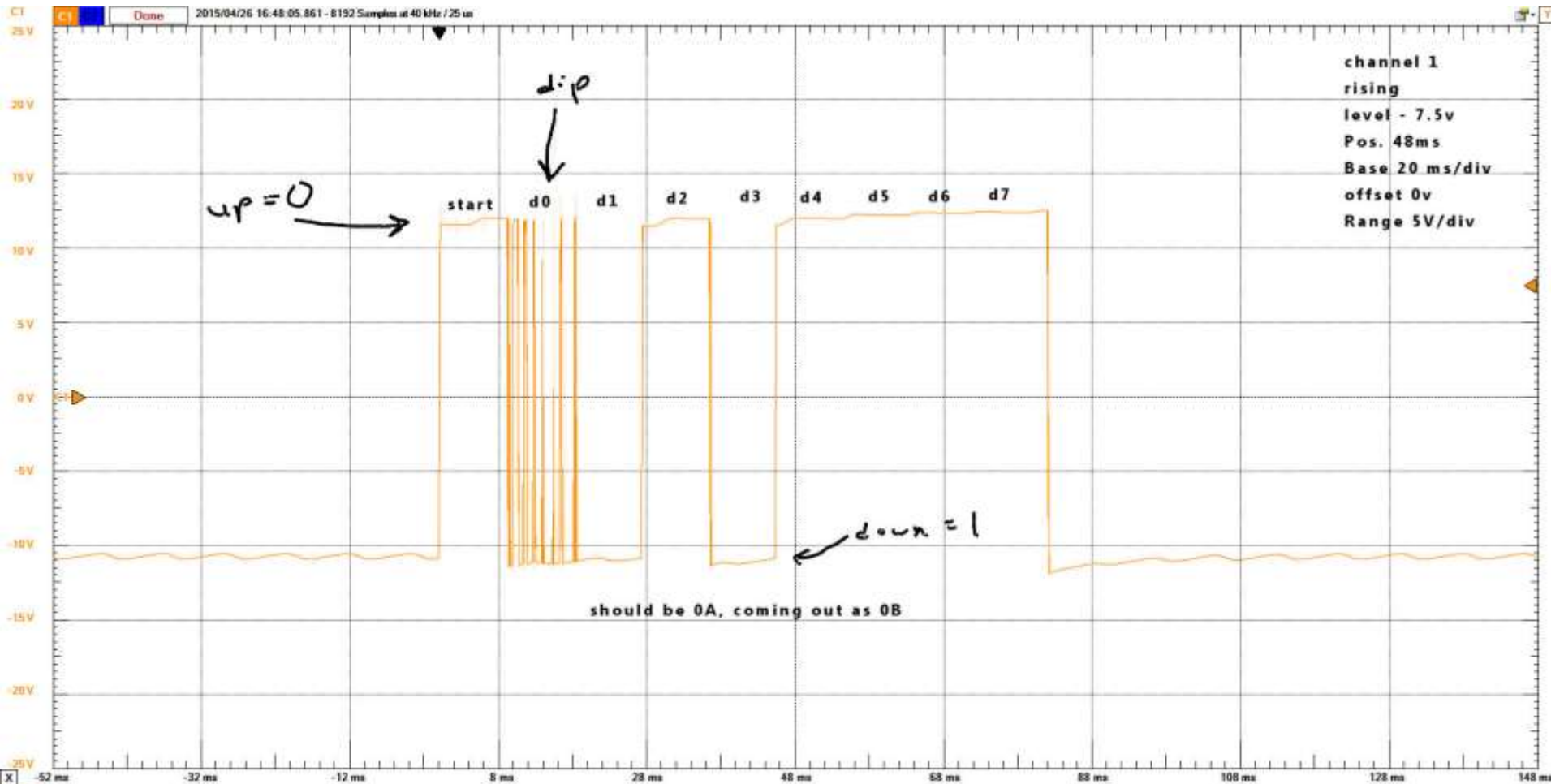


Attach RS232 output pins 2&3 to positive, pin 7 to the return. Type a key on the keyboard (or advance the reader) while the Teletype is in LINE mode. With 2 and 3 connected on the RS232 end, you'll get the characters echoed back to the Teletype printer AND the signal will appear on your oscilloscope.

# PUNCHING TAPES (USING RS232 CONVERTER)

**You can punch tapes from any serial port if you have an RS232 to current loop converter**

Change the Telebyte 65A to a "partial" Active Loop.  It will be a one-way communication, PC→TTY

C- to terminal strip 3
C+ to terminal strip 4
K+ to terminal strip 6
K- to terminal strip 7.
SW3 2/3
SW4 1/2



Set the terminal program (i.e. Windows 3.1 Terminal) communication settings to 110 baud, N / 8 / 2.

In the terminal preferences section choose TTY as the type.

Five Bolts Hold Reader in Place

It is vital that the tape reader is properly adjusted and aligned. Carefully adjust the 5 screws underneath the reader to be sure the tape feeds in straight and with minimal vibration. Use a low viscosity oil on the reader. Set tape to feed with minimal pull/tension.

## Punching Tapes from PC Serial Port:

You're sending the actual tape text file. You might see lines that start with S0..S1..S9 - it's still an ASCII transmission regardless of the tape contents (binary or ASCII program tape does not matter).

In terminal settings turn on screen echo , terminal type – TTY. 8/N/2 110b

Add a delay per character to slow down the transmission and make sure every bit was transmitted correctly. (try 1,2,3 or 4/10 sec).

When sending the ASCII papertape file uncheck "strip LF" if necessary. Also don't "append CR".

# Using ASR 33 as IBM PC Current Loop Console



Current Loop Pos.

Pictured: Shunt module on the bottom right of the original IBM async board (serial bd)

Pull it out and re-insert upside down (so the dot is pointing down) for current loop. If you're going to use slot 8 of an IBM PC or XT a jumper is required on connector J13.

# Using ASR 33 as IBM PC Console

Plug a regular-old EIA connector into the serial card in the back. The serial connector pins you need to connect to the teletype are are:

pin 9 = + transmit current loop data
pin 11 = - transmit current loop data

pin 18 = + receive current loop data
pin 25 = - receive current loop data

[pin 25 is the bottom right (bottom = row of 12 pins)]

the PC still pays attention to DSR, DTR, RTS and CTS. So you still have to jumper 4-5 and 6-8-20 on the PC DB25. ..

Request-to-send -> Clear-to-send (pin 4 to pin 5)
Data Set Ready -> Carrier detect -> Data terminal ready (pin 6 to 8 to 20)

# Using ASR 33 as IBM PC Console

Connect to ASR 33:

Transmitted data return (-) attaches to terminal strip screw 6 or "number 2 connector" #7

Received data return (-) attaches to terminal strip screw 3 or num 2 connector #5

Transmitted data send (+): Terminal Strip 7, #2 connector 8

received data send (+): Term strip 4, #2 connector #6.

If the tty stops chattering you at least have a current loop. You'll need some sort of terminal program just like you'd use with an RS232 terminal connection, and you will need to use 110b, etc.

Source - Paraphrase from IBM Technical Reference Manual volume 2

# Using ASR 33 as IBM PC Console

If you have an IBM Asynchronous Communications Adapter configured for current loop, then set the OS at the DOS prompt:

MODE COM1:110,N,8,1
CTTY COM1

Use the software that came with the IBM Asynchronous Communications adapter
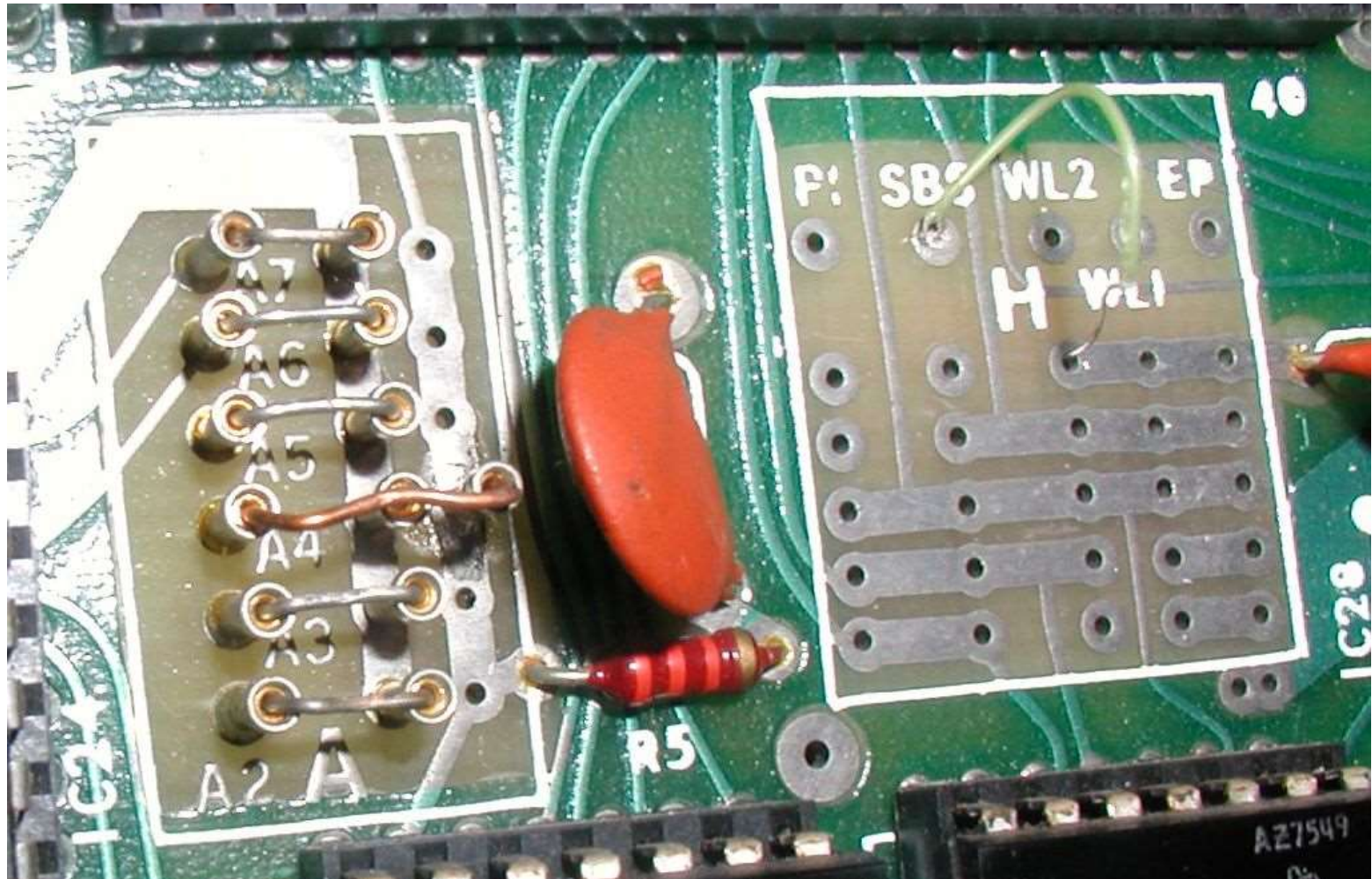
WHY DO THIS?
• Archive or create papertapes
• ASCII art printouts
• Obscure use of IBM PC kitch
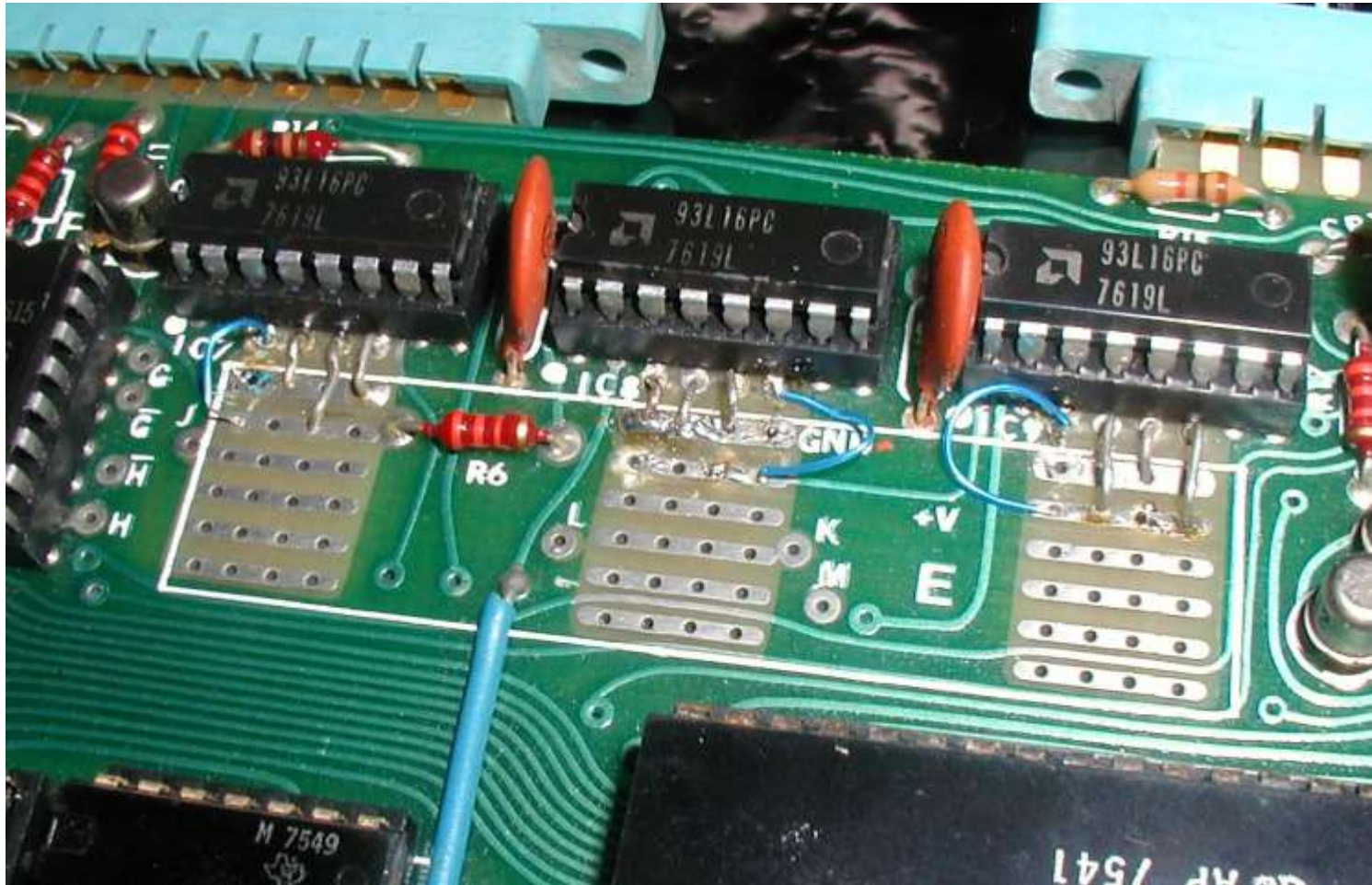
# Processor Technologies 3P+S

# Processor Technologies 3P+S to mimic MITS 2SIO

Assign address 20 (decimal) – see A4
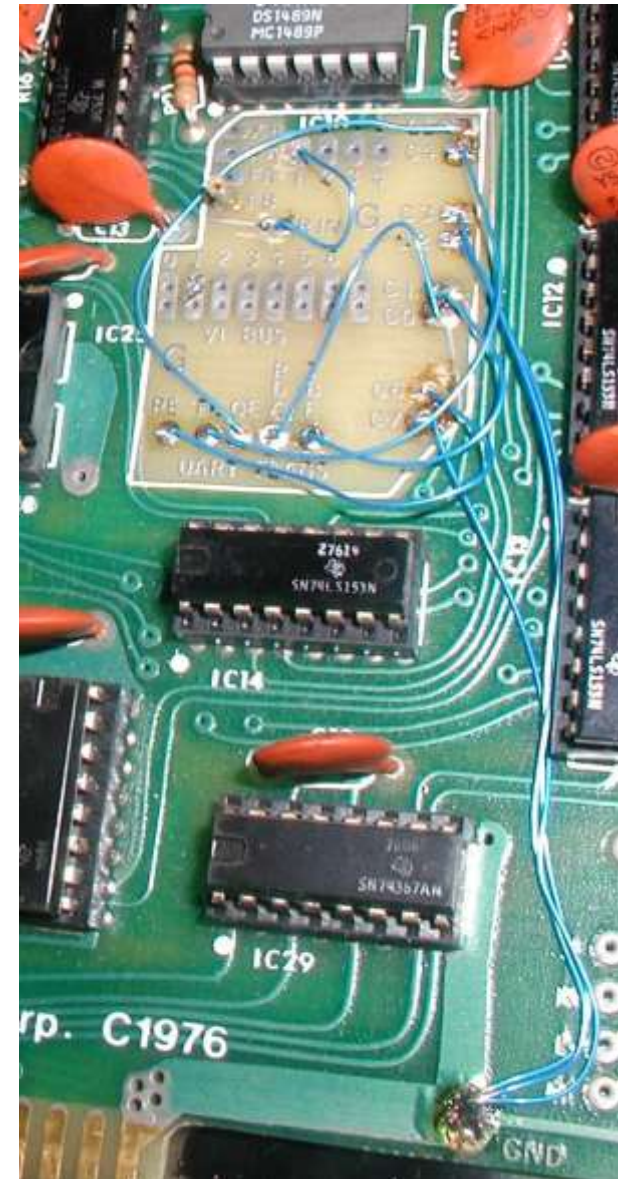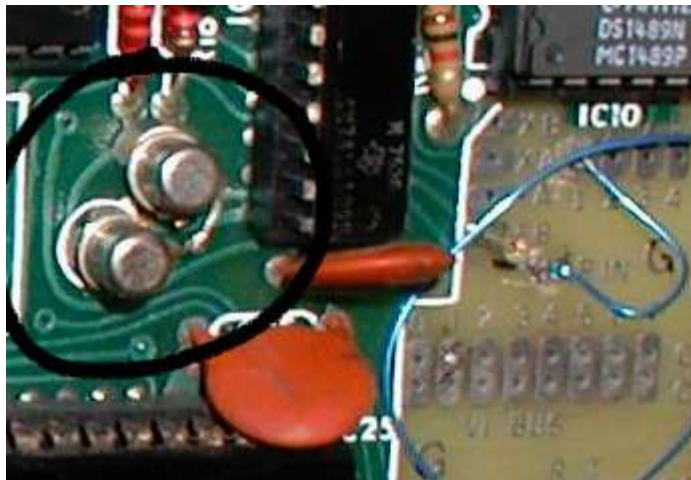
# Processor Technologies 3P+S to mimic MITS 2SIO

Section E is set for 110b current loop

# Processor Technologies 3P+S to mimic MITS 2SIO

Connect RDA (receiver data available) and TBE (transmiter buffer empty) to two of the C0 through C7 control bits.

To the left of area G, connect the current loop input to the UART RCV IN input by placing a jumper between the terminal to the immediate right of the transistor Q4 and the terminal to the immediate right of Q5.

# Processor Technologies 3P+S to mimic MITS 2SIO
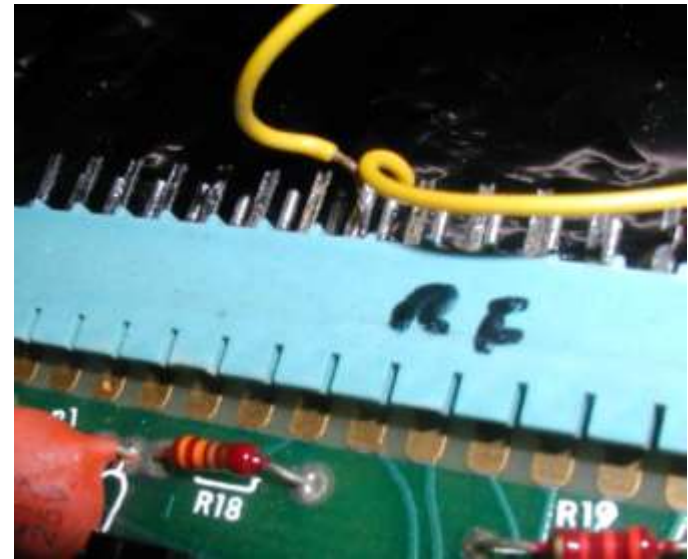




J1 (left) and J2 (right)
J1-15 terminal 7 on teletype
J1-S to terminal 6
J2-8 to terminal 4
J2-J to terminal 3

# THANKS…
# VINTAGECOMPUTER.NET/TELETYPE