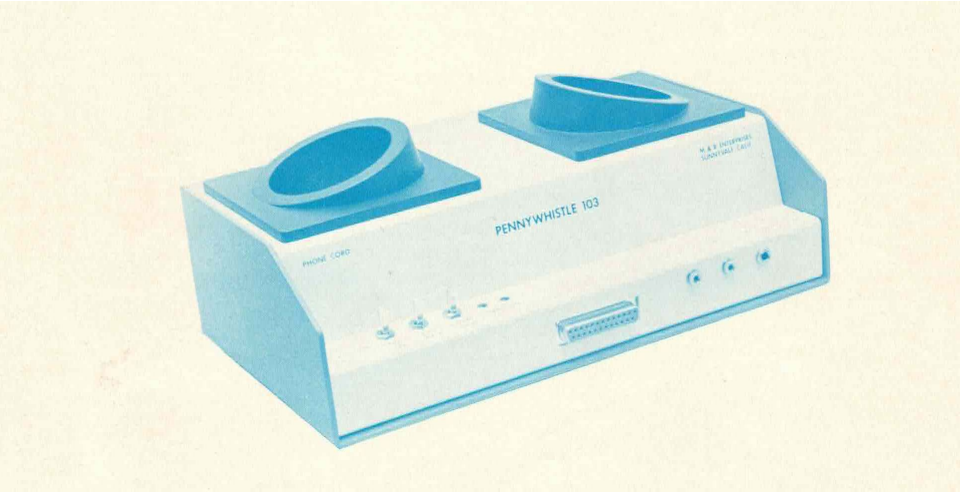
Pennywhistle-103



Lee Felsenstein

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1973

Timesharing

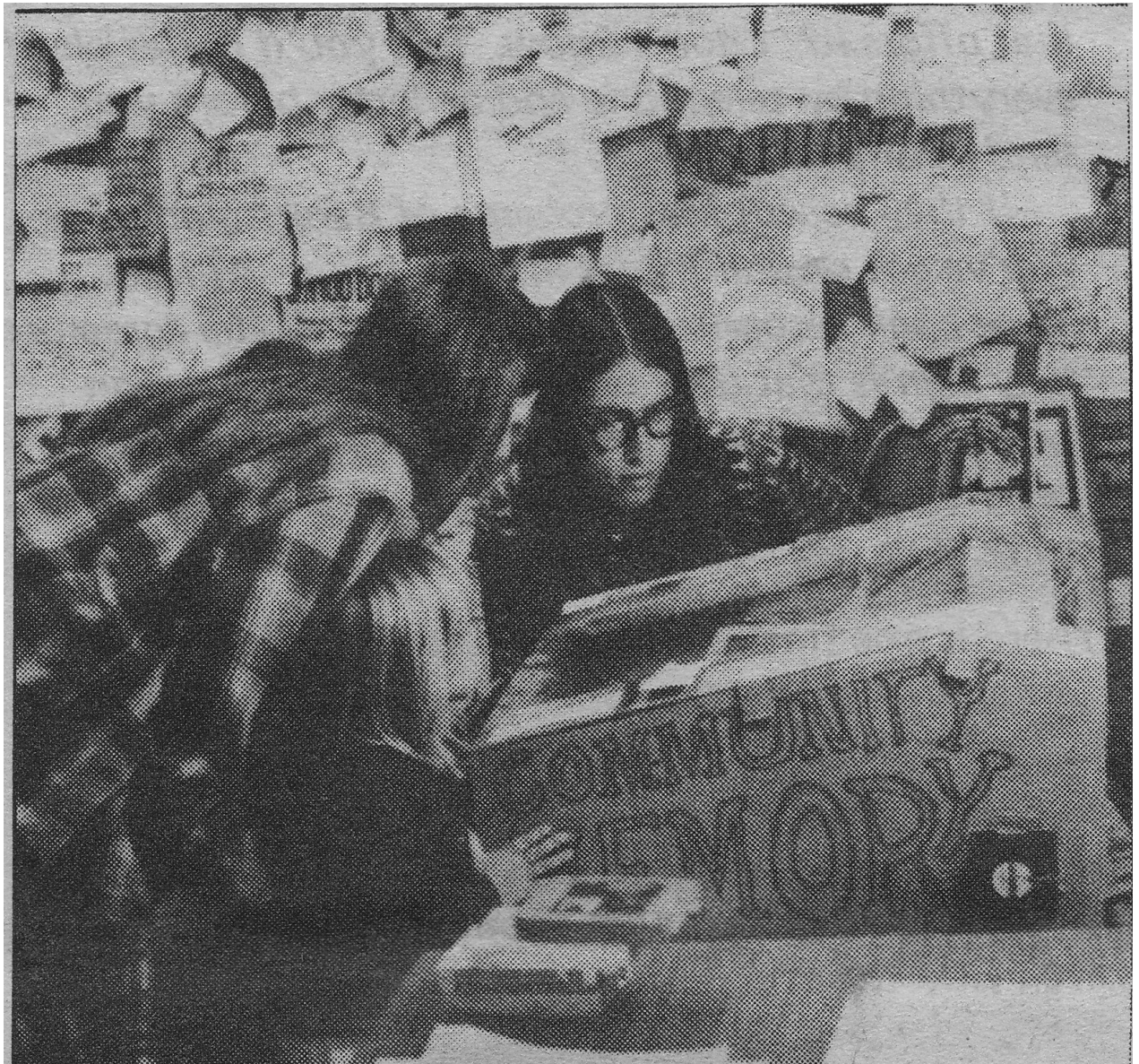
- Only personal use mode – pre-microprocessor
- Remote terminal connected by telephone through modem
- Teletype 33 or 35

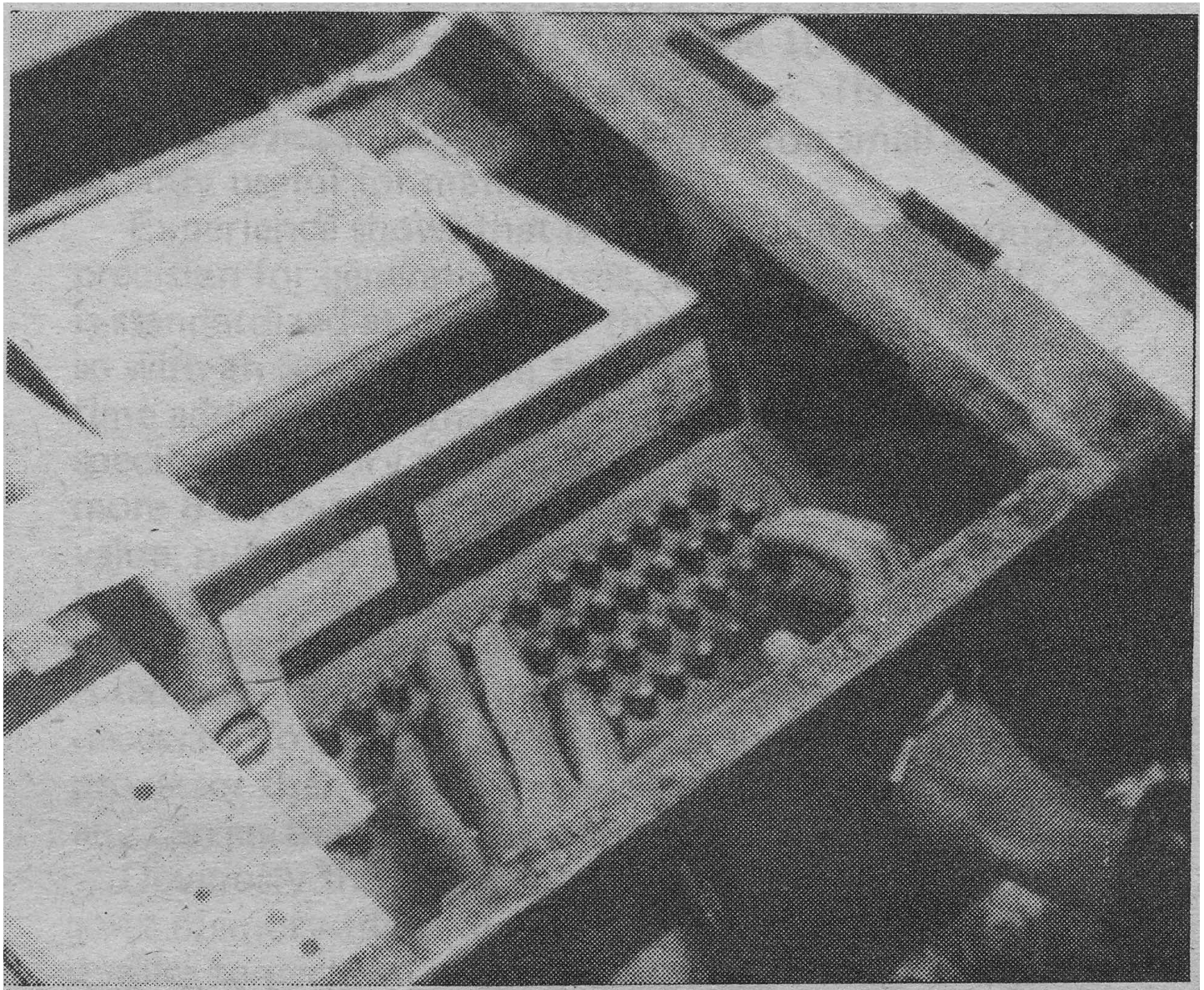
Telco dominates

- Carterfone decision permits DAA direct wire access
- Acoustic coupling is the norm

Community Memory

- Public access bulletin board system
  - Walk- up
  - 1973 – 1975, 1984 – 1992
  - Three versions
- TTY and CRT terminals
  - Old 110-baud modems donated (Bell 101 spec)
  - 300 baud modem needed (Bell 103spec) capable of operation from cassette tape (record and playback)


SENIOR



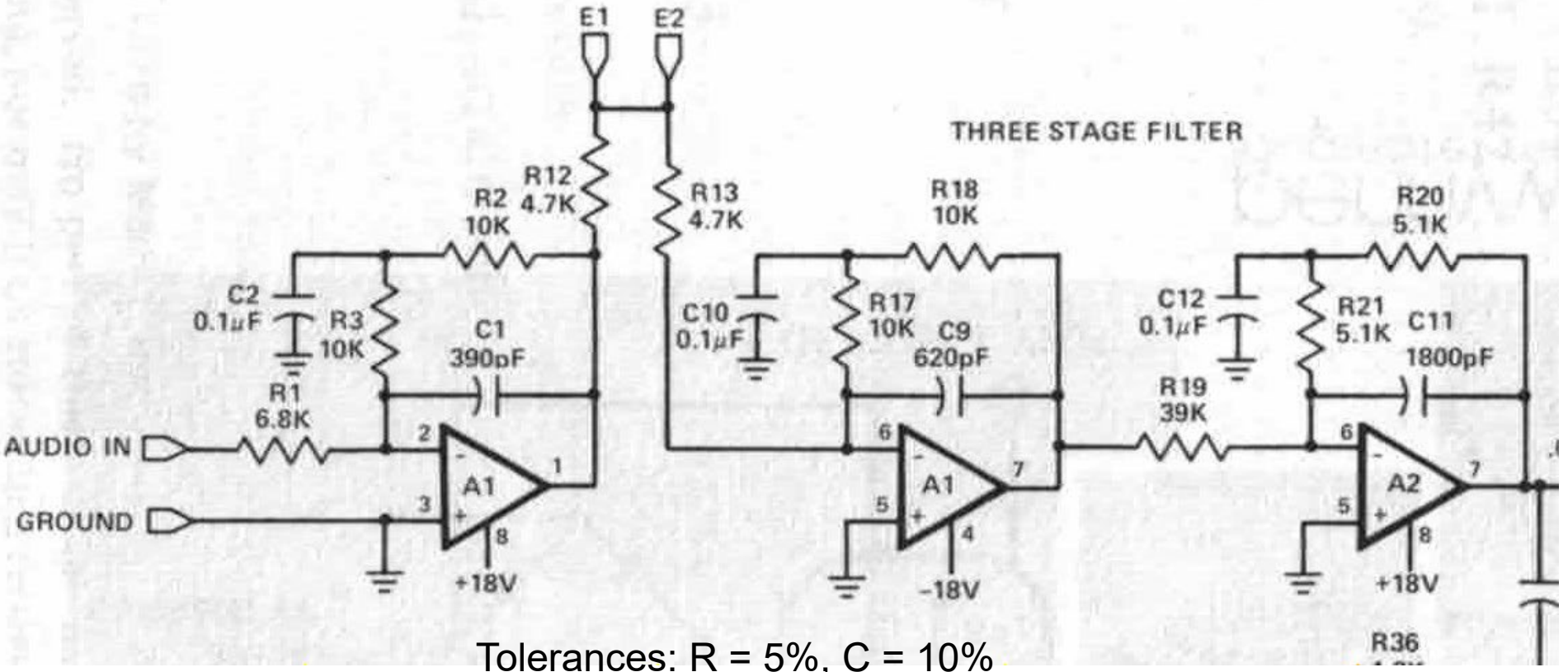
Modem specificatons

- 300 baud
- Acoustic or direct (DAA) connection
- Originate or answer mode
- Record to and play back from cassette tape
- RS-232 or current loop (20 ma – TTY 33)

Active Filter Design

- Otto J. M. Smith, PhD, Prof. UC Berkeley, EE128, 1972
  - Member of 1950 team at North American aviation that developed root-locus (s-plane) stability analysis
  - “Bridged-Tee” active filter circuit designed by L.F. from first principles 1973 using root-locus technique
    - Good stability, high selectivity, gain decoupled from frequency response (unlike Sallen-Key)
    - Easy to calculate
    - Butterworth (maximally flat) response 1070 – 1270 hz.
    - 3 pole pairs => 36 db/octave roll-off

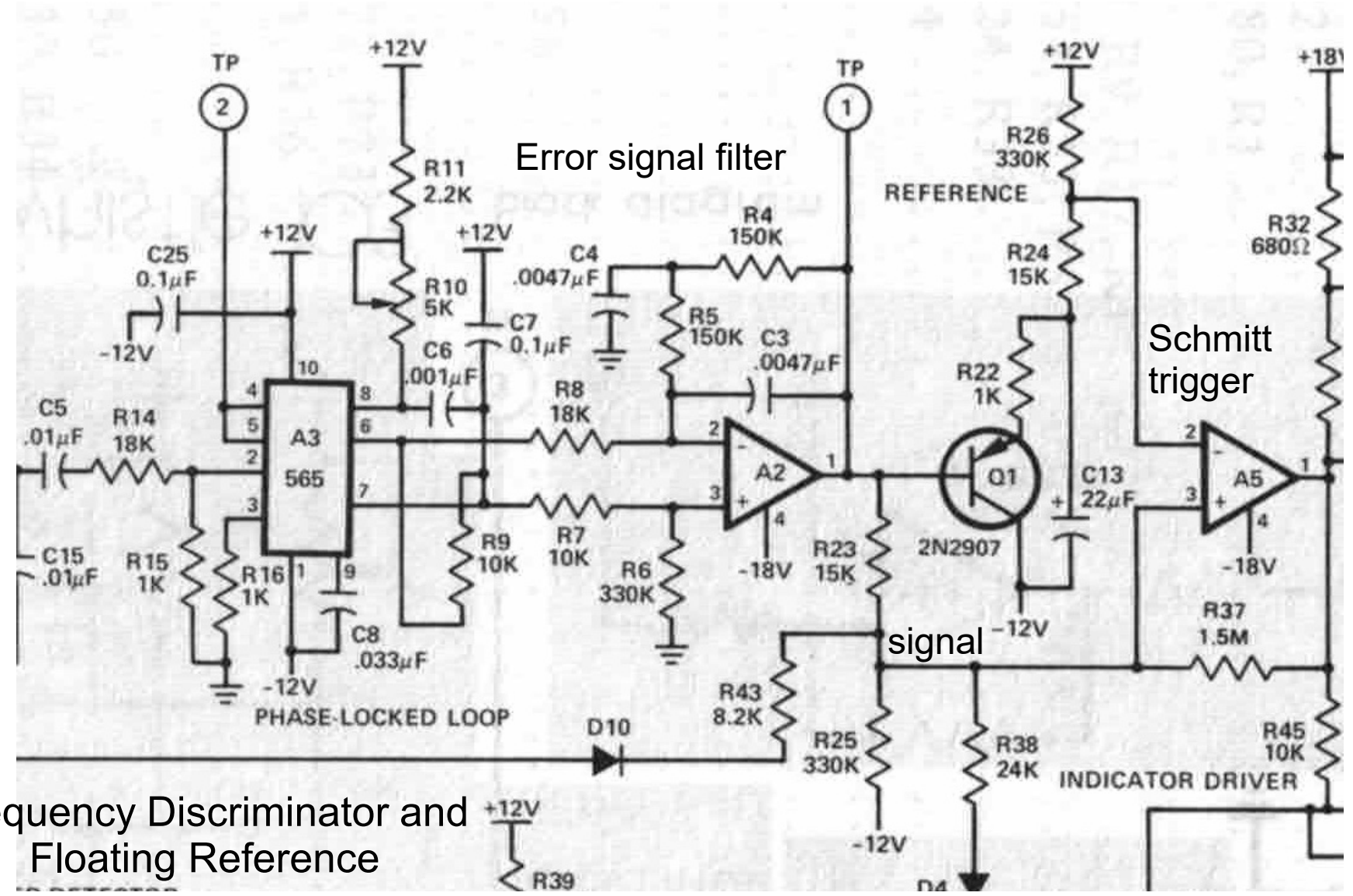
Bridged-Tee Filter



Tolerances: R = 5%, C = 10%
Op Amps: 741

Problem – frequency reference

- Frequency Shift Keying (FSK)
  - Mark = 1 = 1270 Hz, Space = 0 = 1070 Hz
  - Setting trigger point 1 => 0, 0 => 1
    - Previous modems used adjustment potentiometer
- Cassette speed variations imposed additional frequency variations
- Solution: self-adjusting threshold based upon return-to-mark serial data charcteristic



Frequency Discriminator and Floating Reference

Floating Reference

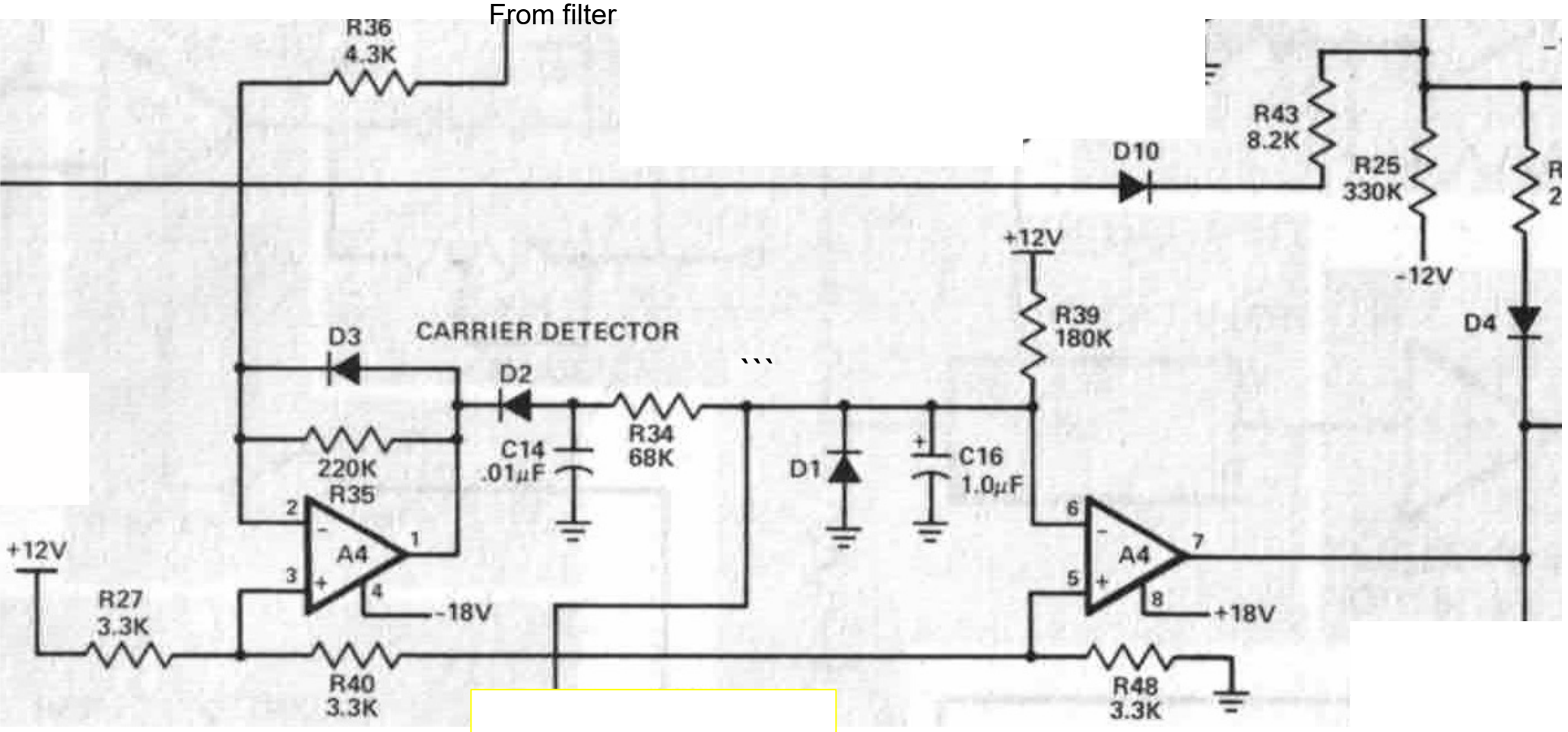
- A3 is 565 Phase Locked Loop – center freq. (1100 Hz) adjusted by R10 (non-critical).
- Average error signal (TP2) tracks with frequency – noisy
- A2 is differential amp and filter – output (TP1 is smoothed and referenced to ground
- Q1 clamps C13 (22uf) to Mark voltage level + 0.43V. Clamp is released by Space voltage level. C13 charges through R26 + R4. RC = 7.9 sec.
- (Reference – signal) = approx. 1.5 V

Line Break Constraint

- Line Break (extended Space) will cause theshold to exceed data level after a delay.
- Result is random data at crossover followed by Mark extending to next Mark level. C13 will then discharge to Mark level.
- NUL character (0x00h) at 110 baud = 9 * 9.09 msec = 82 msec space level. C13 charge will rise by 0.12V = 11% of threshold voltage.

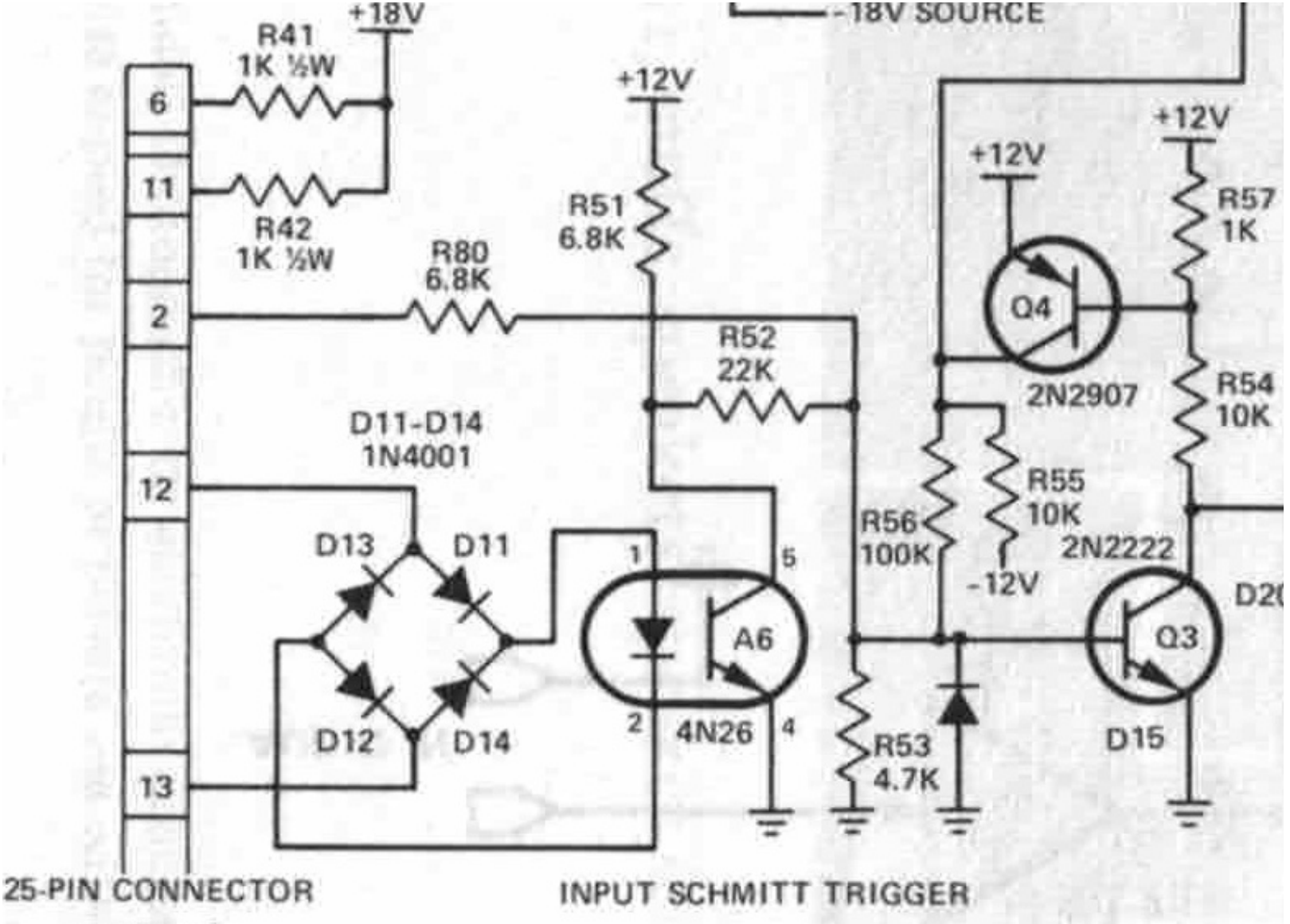
Minimum baud rate is therefore approx 10

Carrier Detector



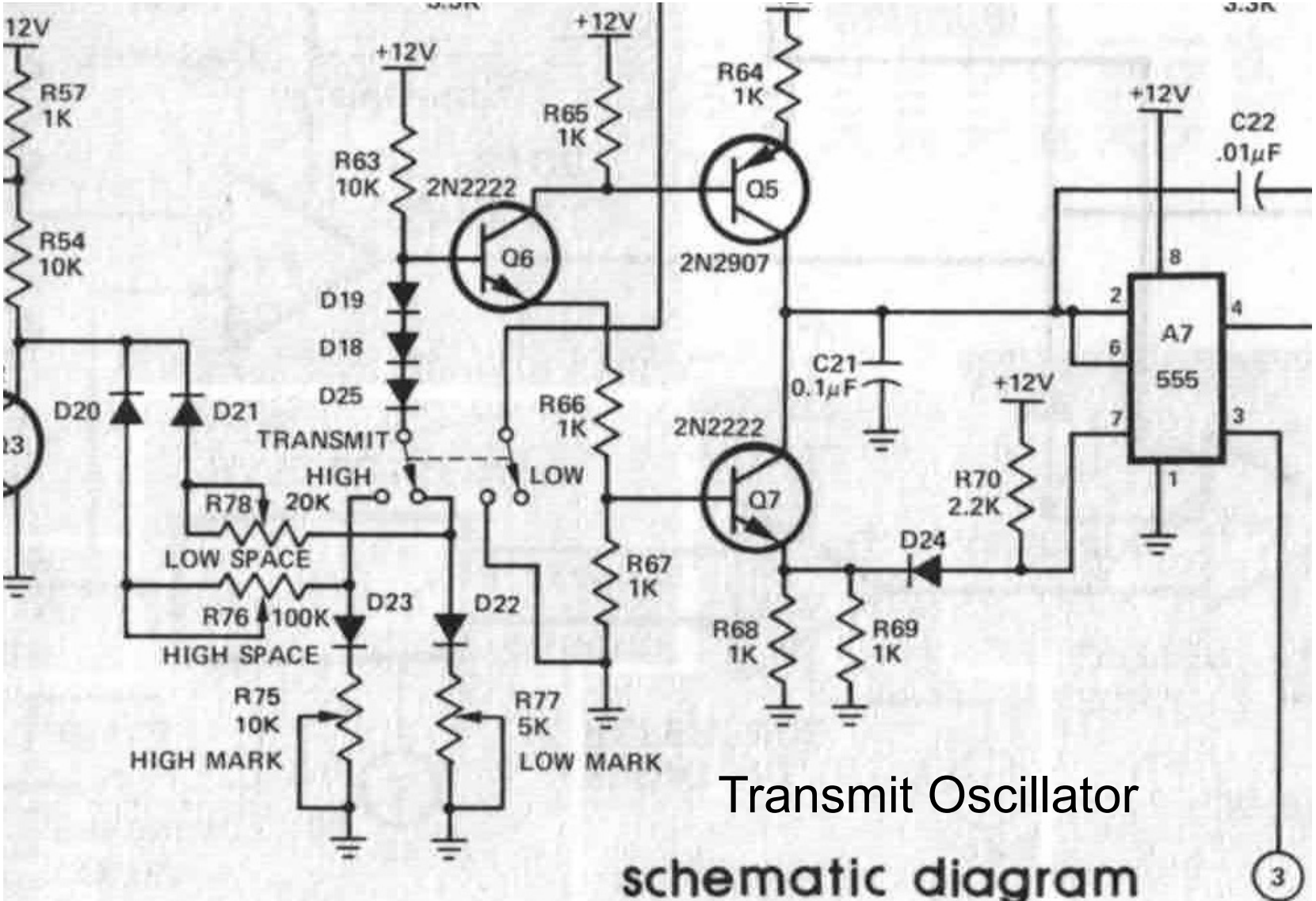
Carrier Detector

- Resistor divider R27 / R40 / R48 produces +9V and +3V at the taps.
- Input stage (A4A) output will be at +9V when quiescent. Amplification of 51 will produce negative-going peaks of amplified filter output at C14.
- C16 will be discharged by these peaks until D1 conducts.
- A4 operates as a comparator, producing Carrier Dertect output when C16 voltage falls below 3 V.


-18V SOURCE
+18V
R41
1K ½W
6
11
R42
1K ½W
+12V
R51
6.8K
R80
6.8K
2
R52
22K
+12V
+12V
R57
1K
Q4
2N2907
R54
10K
D11-D14
1N4001
12
R56
100K
R55
10K
-12V
2N2222
D13
D11
1
5
A6
D12
D14
2
4N26
4
R53
4.7K
Q3
D15
13
25-PIN CONNECTOR
INPUT SCHMITT TRIGGER

Data Input

- Q3 and Q4 form a Schmitt trigger circuit
- RS232 input is through R80
- Current loop input is through optical isolator A6 and diode bridge D11 – D14

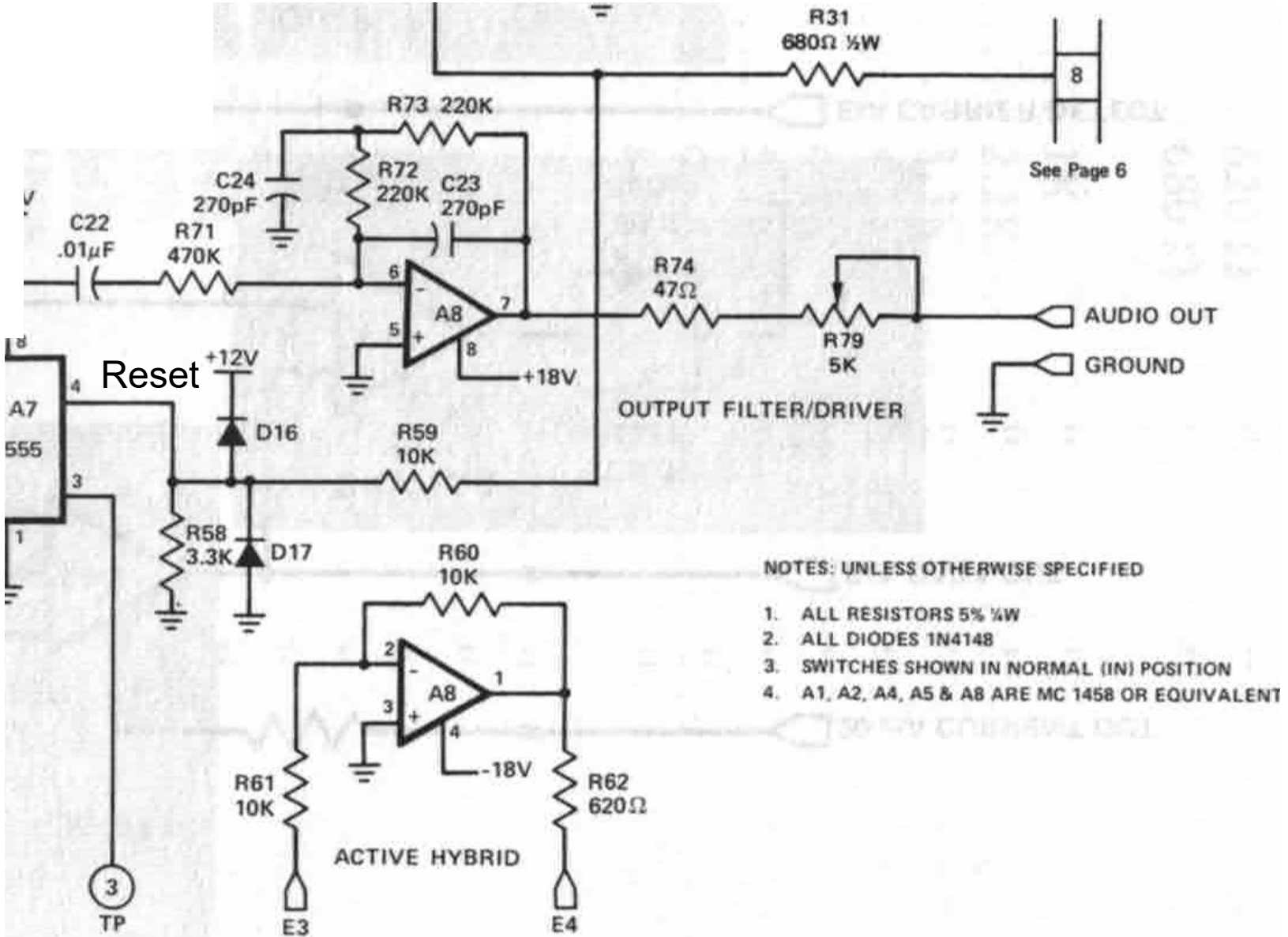


Triangle Wave

Transmit Oscillator

- Data input through D20, D21
  - High = marking
- A7 is 555
  - C21 charges and discharges between 8V and 4 V internal thresholds. Discharge pin pulls low when high threshold is crossed
  - Q6 current flows through identical resistors R65, R67
  - Identical voltages are impressed across R64 and R68, R69
  - Discharge pin (7) turns off Q7 when high
  - When low, Q7 turns on
    - 2x current absorbs Q5 current and draws identical current from C21
    - Voltage on C21 is triangular wave
    - Frequency is determined by Q6 base voltage.

Triangle Wave



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS 5% ¼W
2. ALL DIODES 1N4148
3. SWITCHES SHOWN IN NORMAL (IN) POSITION
4. A1, A2, A4, A5 & A8 ARE MC 1458 OR EQUIVALENT

Audio Output

- Triangle wave coupled through C22
- A8 is smoothing filter, speaker driver
- Oscillator is turned off by low Carrier Detect

Economic Impact

- 1973 prices: $350 for 110 baud modem
- Pennywhistle 103 marketed in 1976
  - $99 price for kit
  - raised to $139 later
  - new price point for modems
  - sold until 1979.