REVISIONS

LTR	DASH NO.	DESCRIPTION	DATE	APPROVED
A	9001	REL TO PROD PER ECO 000507	8/14/80	
B	9001	REVISED	3/27/81	
C	9001	REV PER ECO 001082	6/16/81	DKD
D	9001	REV PER ECO 001208	8/25/81	
E	9001	REV PER ECO 001249	9-24-81	DKD
F	9001	REV PER ECO 001432	3-8-82	RS.

CHECK PRINT JUN 12 1984
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9001

PRODUCTION
CHANGE BY ECO ONLY

USED ON	NEXT ASSY
	1st APPLICATION

DWG APPROVAL	DATE
DWN W. Davis	8/13/80
CHK L. St. Onge	8/13/80
DR MGR	8/13/80
DES ENG L. St. Onge	8/13/80

DWG RELEASE	DATE
ENG PROG MGR	8/19/80
MFG ENG	
QA	

CENTRONICS data computer corp.
HUDSON, NEW HAMPSHIRE U.S.A.

TITLE
ENG PRODUCT SPEC
HIGH SPEED FF HEAD

SIZE	CODE IDENT	NUMBER	REV
A	50163	80002139	F

SCALE | DO NOT SCALE PRINT | SHEET 1 OF 14

REP 3/78

ENGINEERING PRODUCT SPECIFICATION

CENTRONICS®

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LIST OF FIGURES

1.0 GENERAL

1.1 SCOPE

This specification defines a nine wire "Free Flight" dot matrix impact Print Head Assembly using relay type solenoids of a design intended to improve the performance and extend the life over conventional tractive type plunger solenoids.

2.0 RELATED DOCUMENTS

A.	CDCC 80001003-9001	Paper Specification
B.	CDCC 80001004-9001	Print Quality Specification
C.	CDCC 80002151-9001	Ribbon Specification
D.	CDCC Engineering Standard 001	
E.	CDCC Engineering Standard 014	
F.	CDCC Engineering Standard 011	
G.	CDCC 62001220-5006	Assy Drawing H/S Head

3.0 PRINT HEAD CHARACTERISTICS AND PERFORMANCE

3.1 PRINT HEAD CHARACTERISTICS

A.	Armature Tip Travel	0.015 ± .003
B.	Head to Platen Gap	0.016 ± .001*
C.	Coil Resistance	0.42 ohms ± .02**
D.	Coil Inductance	0.045 MH ± .002**
		0.80 MH approximately***
E.	Drive Voltage	35-40 Volts
F.	Drive Current	6.8 Amps Max 1st Current Pulse
G.	Drive Pulse Form	See Figures 4A, 4B, 4C
H.	Energy Input	4m J Max

*3.1 B Set up without paper or ribbon-typical 1 ply gap. Multi ply paper requires additional gap to maintain print quality and avoid smear and paper jam. Caution: Additional gap adversely affects print quality. See Figures 2A, 2B, 2C.

**3.1 In free air at 1000 Hz.

***3.1 D In operation with gap closing.

3.2 PRINT HEAD PERFORMANCE

A.	Force output (impact on steel)	1.7 Kg. Min.
	Impact on 1 ply paper with ribbon	1.2 Kg. Min.
	Impact on 6 ply paper with ribbon	0.5 Kg. Min.

B.	Frequency (on steel)	1.4 KHz Min.
	On 6 ply paper with ribbon in printer	1.1 KHz Min.
C.	Time to impact	560 us Max.
	Max allow variation	100 us
D.	Rated life (7x9 4 dot characters)	100 Million
	Graphics mode	480 Million Dots
E.	Power dissipation - Frequency X enerty input X duty cycle (%).	

4.0 TEST EQUIPMENT OPERATION

To measure output parameters required by this specification, test the print head on the frequency and impact tester provided and maintained by test equipment engineering following approved operating and recording procedures.

5.0 CHARACTER SIZE

The Print Head Assembly is designed to produce a nine dot high character (0.130 inch). The width of the character depends on the matrix column size used in each printer model.

6.0 PHYSICAL CHARACTERISTICS

The nose sub-assembly consists of the plastic nose with integral rearmost wire guides, two plastic intermediate wire guides, a front wire guide and nine printing wires. The wire guides support the print wires in a cluster designed for a uniform transition from a linear array at the printing end to a near oval array at the actuator contact cap molded on one end. The complete sub-assembly includes the coil springs that serve to return the wires from their printing position to their de-energized position.

The pole sub-assembly consists of the coils, the pole cores and a formed pole plate. The cores are firmly inserted into the formed pole plate under sufficient pressure. The coils are wound won a paper bobbin with thermal conductivity so that heat from the coils can readily flow through the yokes to the mounting plate for dissipation into the air. The maximum coil temperatures shall not exceed 140°C (284°F) under any test or printing condition. Because of this construction, the pole sub-assembly cannot be disassembled without irreparable damage.

The actuator components consist of specially heat-treated silicon iron armatures which reduce eddy currents, a multiple finger leaf spring, an anti-residual shim, an energy absorber, and the parasol. The energy absorber is made from special rubber that can stop the armatures from bouncing excessively.

The anti-residual shim is interposed between the armatures and yokes. Its function is twofold: first, to provide bearing surface and, secondly, to prevent the armature from magnetically "sticking" to the yoke. It is made of a plastic that is extremely resistant to mechanical damage. The "parasol" serves to guide the armatures, provide a tip travel adjustment, and holds all the actuator parts in their proper position.

7.0 "FREE FLIGHT" PRINT HEAD OPERATION

The "Free Flight" Print Head provides the dot matrix impact printing of the characters. The Print Head contains nine solenoids that move the tungsten wires against the ribbon to form the column dots on the paper. Solenoid #1 controls the top dot and solenoid #9 controls the bottom dot in a column. The wires from each solenoid are vertically aligned by a jewel bearing located at the front end of the Print Head Assembly.

When a solenoid drive pulse arrives from the electronics, any of one to nine armature coils are strobed. The armature coil creates a magnetic field with a resulting impact pulse force which forces the print wire towards the ribbon, paper, and platen. The final result is a 7x9 dot matrix representing a printed character. After strobing, the armature coil magnetic field decays and becomes de-energized. A coil spring on the print wire, returns the print wire against an energy absorber, where it waits for the next energizing solenoid drive pulse.

8.0 WEIGHT

The Print Head Assembly weighs 6.0 ounces (170 ±10 gm).

9.0 ENVIRONMENTAL REQUIREMENTS

9.1 STORAGE ENVIRONMENT

The Print Head Assembly must be capable of operating reliably after storage as per Centronics Engineering Standard 001.

9.2 OPERATING ENVIRONMENT

The Print Head Assembly must be capable of operating reliably under the following conditions:

A. Temperature/Humidity per Engineering Standard 001, Paragraph 3.1, Class B.

B. Altitude - Per Engineering Standard 001, Paragraph 4.1.

9.3 THERMAL DESIGN

The Print Head Assembly must operate reliably when the maximum coil temperature does not exceed 140°C (284°F).

9.4 SHOCK AND VIBRATION

The print head assembly must meet the requirements of Centronics Engineering Standard 001, Class B.

10.0 RELIABILITY

10.1 DEFINITION OF A FAILURE

A failure is any malfunction of mechanical or electrical hardware which prevents full operation of the Print Head mechanism.

10.2 MEAN TIME TO FAILURE (MTTF)

The MTTF for the Print Head shall be independent of duty cycle. The MTTF is 100 million characters using 7x9 dot matrix format with an USASCII random pattern. Reliability will be tested per Centronics Engineering Standard 014 at a "B10" Life with 90% confidence.

11.0 SAFETY

Print Head Assembly must meet the safety standards of Centronics Engineering Standard 011.

12.0 OPERATING PROFILES

The following profiles show the results of varying one or more conditions while holding the remaining conditions per Section 3. They should be used as a guide depending on driver characteristics, magnetic and tolerance conditions.

12.1 ATT PROFILES

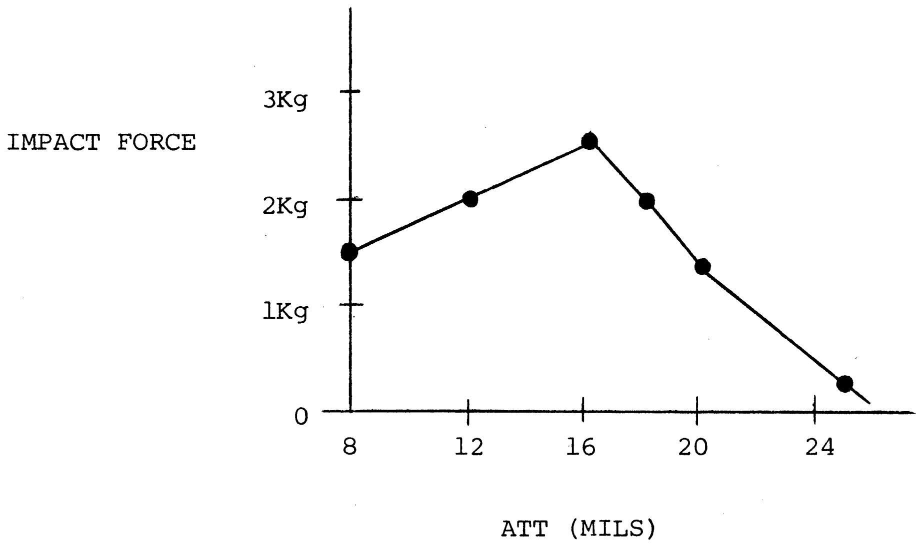


FIGURE 1A

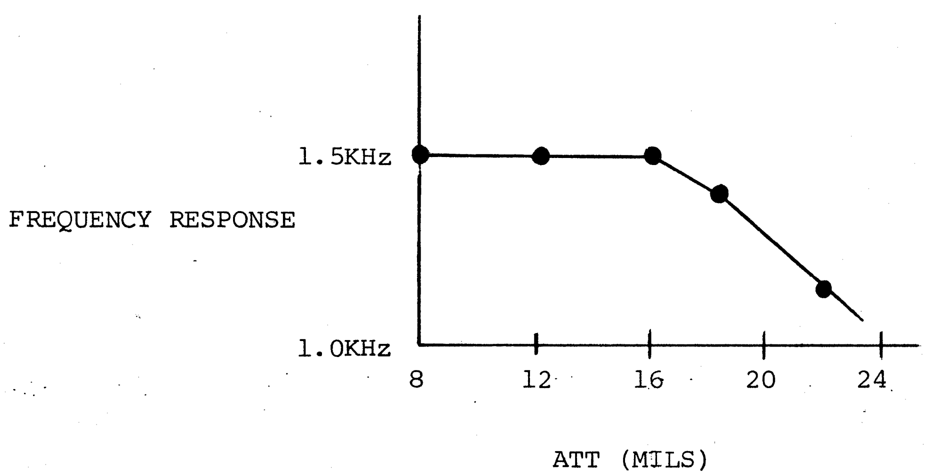


FIGURE 1B

12.2 WIRE TRAVEL (GAP) PROFILE

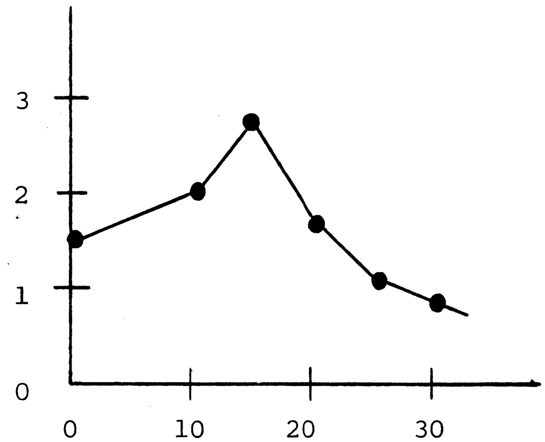


FIGURE 2A

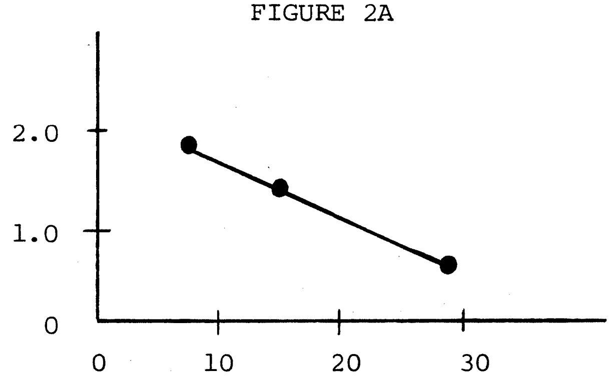


FIGURE 2B

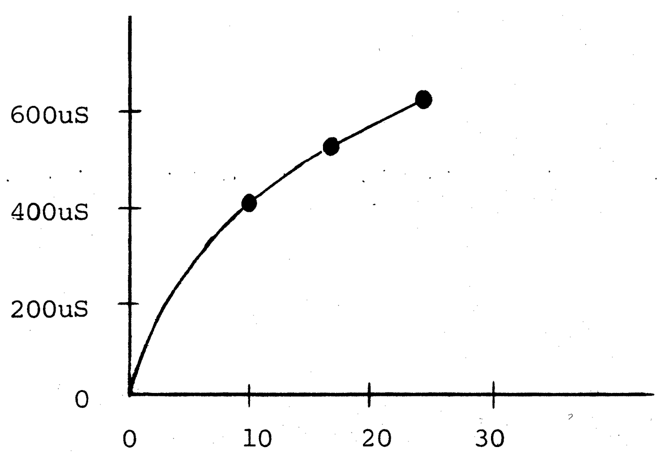


FIGURE 2C

12.3 VOLTAGE PROFILES

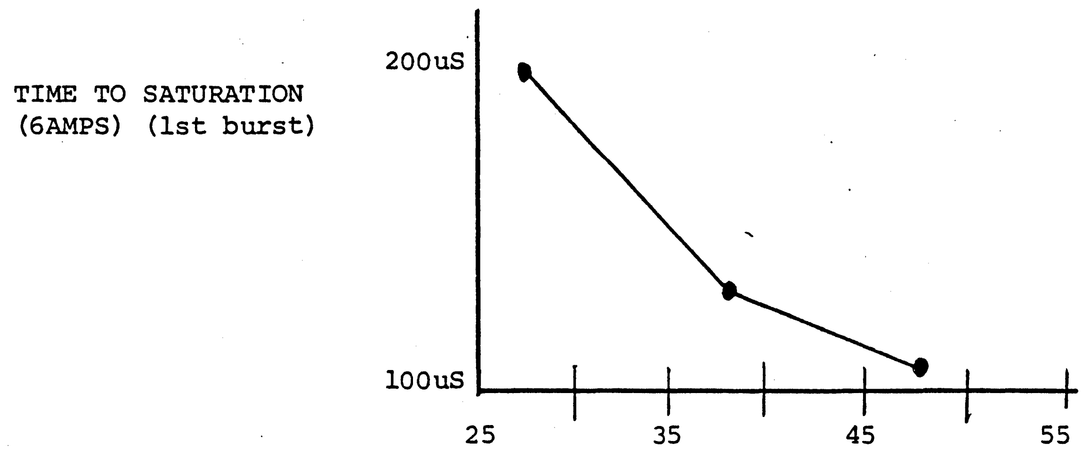


FIGURE 3

12.4 CURRENT PROFILES

Current profiles using various drive techniques based on parameters in Section 3. Only 1st burst conditions shows.

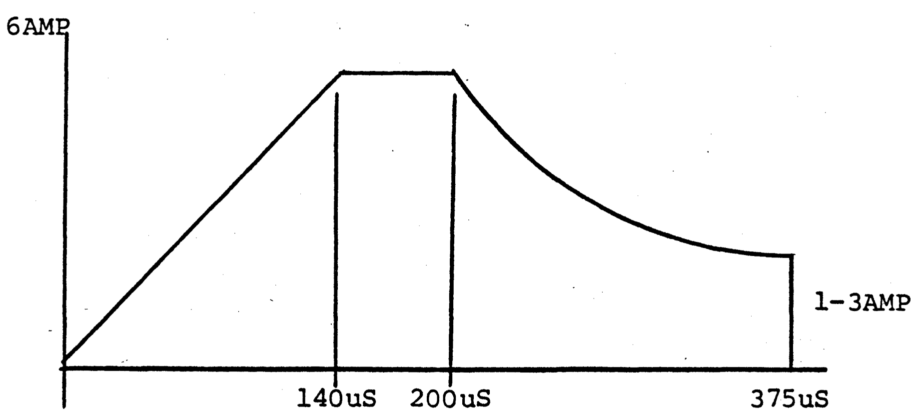


FIGURE 4A
CURRENT LIMIT WITH RECIRCULATE

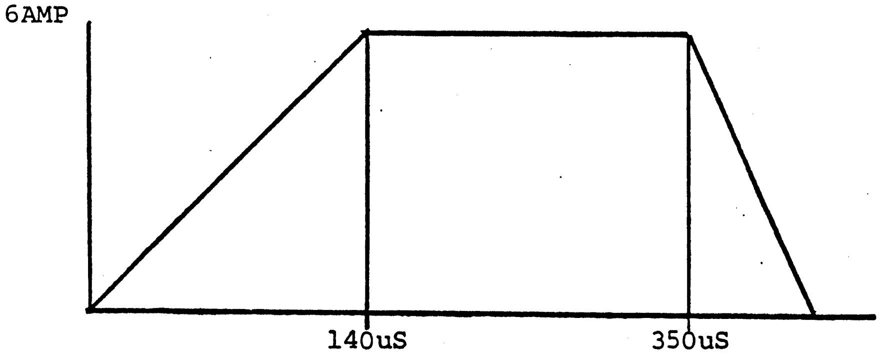


FIGURE 4B
CURRENT LIMIT

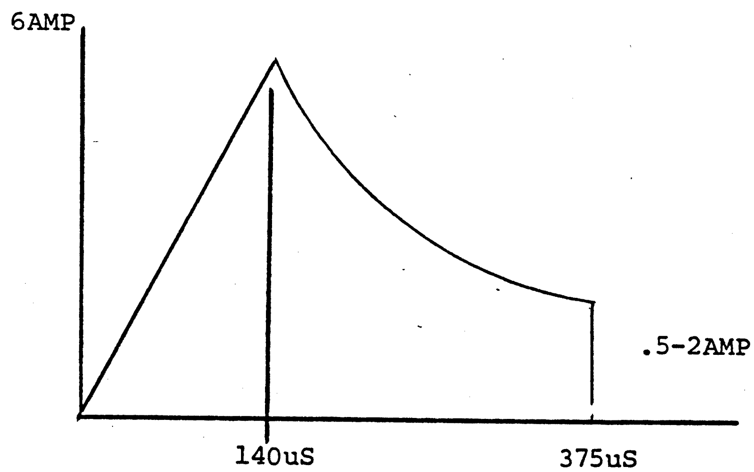
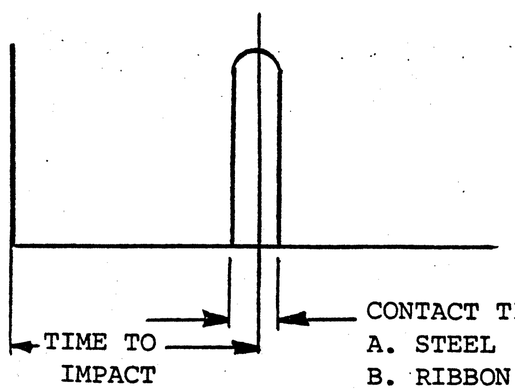


FIGURE 4C
VOLTAGE SWITCH WITH RECIRCULATE
FIRST BURST CONDITION

12.5 IMPACT PROFILE

FIGURE 5



CONTACT TIME
A. STEEL 50uS
B. RIBBON & 1 PLY PAPER 70uS
C. RIBBON & 6 PLY PAPER 200uS

12.6 DISPLACEMENT ERROR PROFILE

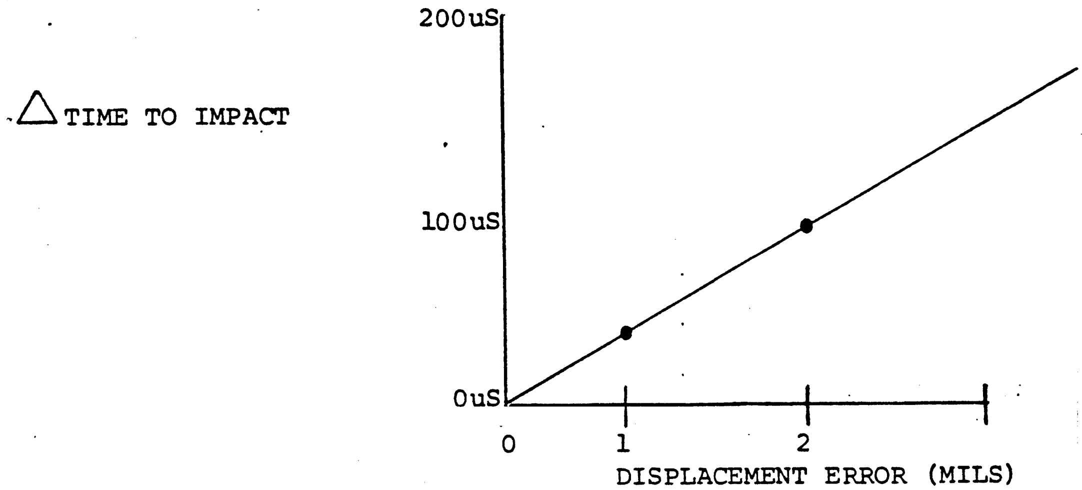


FIGURE 6

BASED ON CARRIAGE VELOCITY OF 20ips

12.7 RATED LIFE

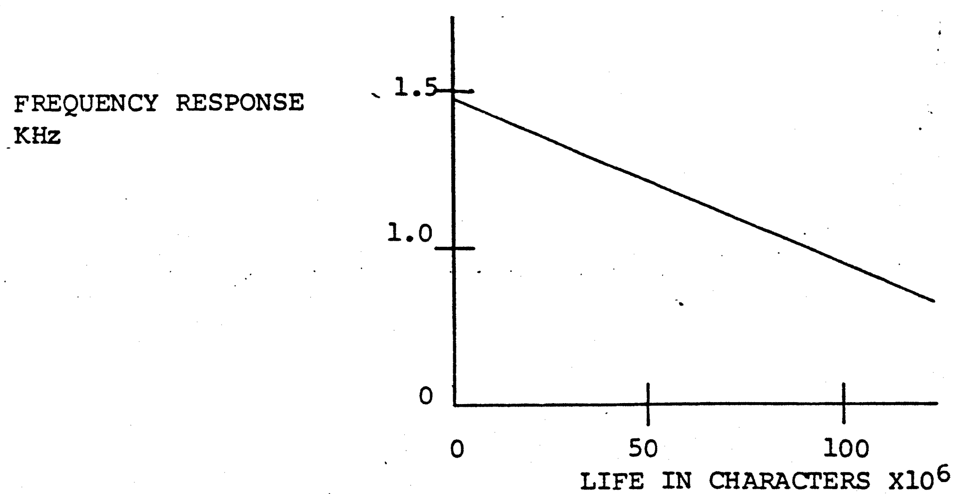


FIGURE 7

APPENDIX

Two different print head/driver combinations were analyzed and quantized for energy content as relates to heat. A piecewise-linear integration of actual scope waveforms was performed on the following two systems:

1. Standard 310 turn bifilar FMPP print head; standard Phoenix driver set to production strobes of 150 and 375 us.

2. Same print head, but modified driver with current sense and base clamp, set to clamp at 5 amps. The upper strobe was chosen to produce equivalent 6-ply print to the standard driver. The strobes were 180 us and 375 us.

The results number-crunch down to Amp-squared microseconds and, if this is multiplied by resistance of the print head wire, the result is microjoules (an energy quantum). Microjoules per dot times dots per second yields (micro) watts of heat that has to be dissipated in the print head or driver transistors. Table 1 compares the combinations for the first pulse energy, energy in subsequent pulses of a character and the average energy per pulse in a burst of 4 pulses. The final column shows energy per dot using a resistance of 0.5 ohms for the standard head.

TABLE 1

	SATURATED DRIVE 310T #28AWG 150 us/375 us	CURRENT LIMIT 310T #28AWG 180 us/375 us
1st Pulse A^2us	4,804	5,421
Nth Pulse A^2us	12,466	6,000
Average A^2us	10,550	5,855
Energy/Dot @ 75^oC	5,275 uj	2,928 uj

The first pulse in a standard head with standard saturated driver produces the least amount of heat. It's the subsequent pulses that almost triple the energy per pulse. The current limit driver prevents excessive magnetic saturation currents and consequently presents the lowest average energy per dot but as will be seen, has to dissipate this heat at the other end - in the driver.

The following discussion pertains to the upper PNP Darlington Transistor. In the standard driver, approximately 80% of the heat is created during the current build-up of the drive pulse (I-head X V_{ce}). The other 20% is generated during turn off, with the Vce rising to 38V before the current has totally decayed. In the current limit driver, there are three phases: Ramp-up, Linear Current Limit, and Turn-off. Only 5% of heat is generated during ramp-up and about 1-1/2% during turn-off. The linear portion creates the rest.

TABLE II

	STANDARD DRIVE STANDARD HEAD	CURRENT LIMIT STANDARD HEAD
Ramp Up	798 uj	324 uj
Turn Off	225 uj	100 uj
Current Limit	-	6300 uj
Total 1st Pulse	1023 uj	6724 uj
Ramp Up	1491 uj	350 uj
Turn Off	420 uj	120 uj
Current Limit	-	6400 uj
Total Subsequent Pulse	1911 uj	6870 uj

So, at 20 ips and 10 cpi and adding in turn around, actual thorughput for 132 character line is 176 characters per second. Printing solid "E's" generates the following wattage in the head and driver:

	STD HEAD/DRIVER	STD HEAD/I-LIMIT DRIVER
Pin 1 Only	3.71 Watts	2.06 Watts
Total Head	11.74 Watts	7.56 Watts
Driver	3.95 Watts	17.96 Watts

Localized heating about Pin 1 may cause a problem in 1.