The Detonation Electric Effect
As
Applied to the MC-2453 Driver Subassembly

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DEVELOPMENT DIVISION

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MASTER

Normal Process Development
Endeavor No. 232

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The purpose of this project is the use of shock-generated signals to measure events in HE/laminate systems.

Section S

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ABSTRACT

The detonation electric effect has been used for the purpose of measuring the change in transit time through the temperature range of -45 to +165 F, in the MC-2453 driver subassembly. Ionization switches were applied to an additional sample of subassemblies in order to compare the transit time as measured by the detonation electric effect and the ionization switches. Results of these tests are included in this report.

DISCUSSION

Fourteen MC-2453 driver subassemblies (Fig. 1) were fired at three temperatures in order to establish the change in transit time as a function of temperature. The test fire assembly (Fig. 2) was basically the same as described in a previous report.[1] The differences were that the aluminized Mylar was omitted from the PETN/PMMA interfaces, and the assembly was immersed in L-45 silicone fluid[2] instead of mineral oil as was done with previous test firings.

The transit times and temperatures, obtained from a copper-constantan thermocouple reading prior to each shot, are listed in Table I for each assembly. The "Student's t" test was used to find the average transit time and the standard deviation of each temperature group.

A plot of the average transit time and the range of the data at the three average temperatures are shown in Fig. 3. A line drawn to connect the average time at -32 F and +85 F reveals a slope of +0.21 nsec/F. A larger slope is apparent between +85 F and +170 F and is calculated to be +0.34 nsec/F. An average change in transit time due to a change in temperature, calculated to be +0.24 nsec/F, was obtained by averaging the slopes of the lines connecting the transit times at the temperature extremes, with the slope connecting the cold and ambient temperatures. The slope of the line connecting the ambient and hot averages was not used because an extrapolation of this line does not intercept the range of data observed at the cold temperatures. The average sloped line was then used to obtain the transit times at the three temperatures of interest. (Fig. 3).

Six driver subassemblies incorporating ionization switches (Fig. 4) were then fired at ambient temperature in order to compare the transit times obtained by this method to the times obtained by the detonation electric effect. The transit times obtained from the ionization switches are listed in Table II. It should be noted that one

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(1) MHSMP-71-46, Section R
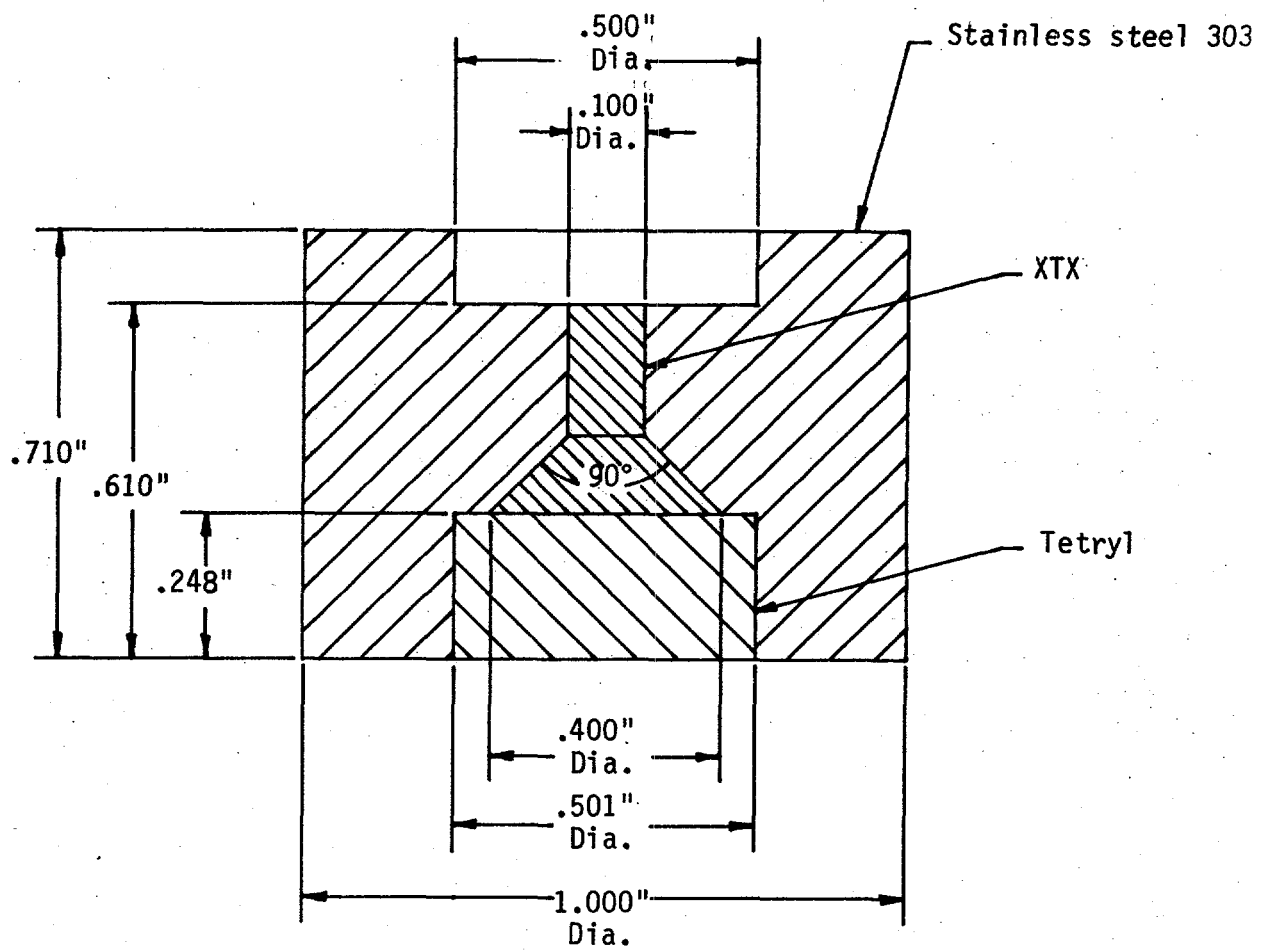(2) A dimethylpolysiloxane marketed by Union Carbide

Fig. 1.   An MC-2453 Driver Subassembly

#22 Solid Copper Wire (4" length)

Brass Antenna
.005" x 1.00"
Dia

Antenna Stand-Off
PMMA - .25" x 1.50" Dia

Adiprene

Driver Subassembly

PETN Booster Pellet
.100" x .101" Dia
ρ = 1.6 g/cc

Adiprene

Adiprene

MDF/Driver Adapter
PMMA - 1.00" x .487" Dia

10 g/ft MDF (10 cm length)

SE-1/MDF Adapter
PMMA - .750" x
.625" Dia

Adiprene

SE-1 Lock Nut

SE-1
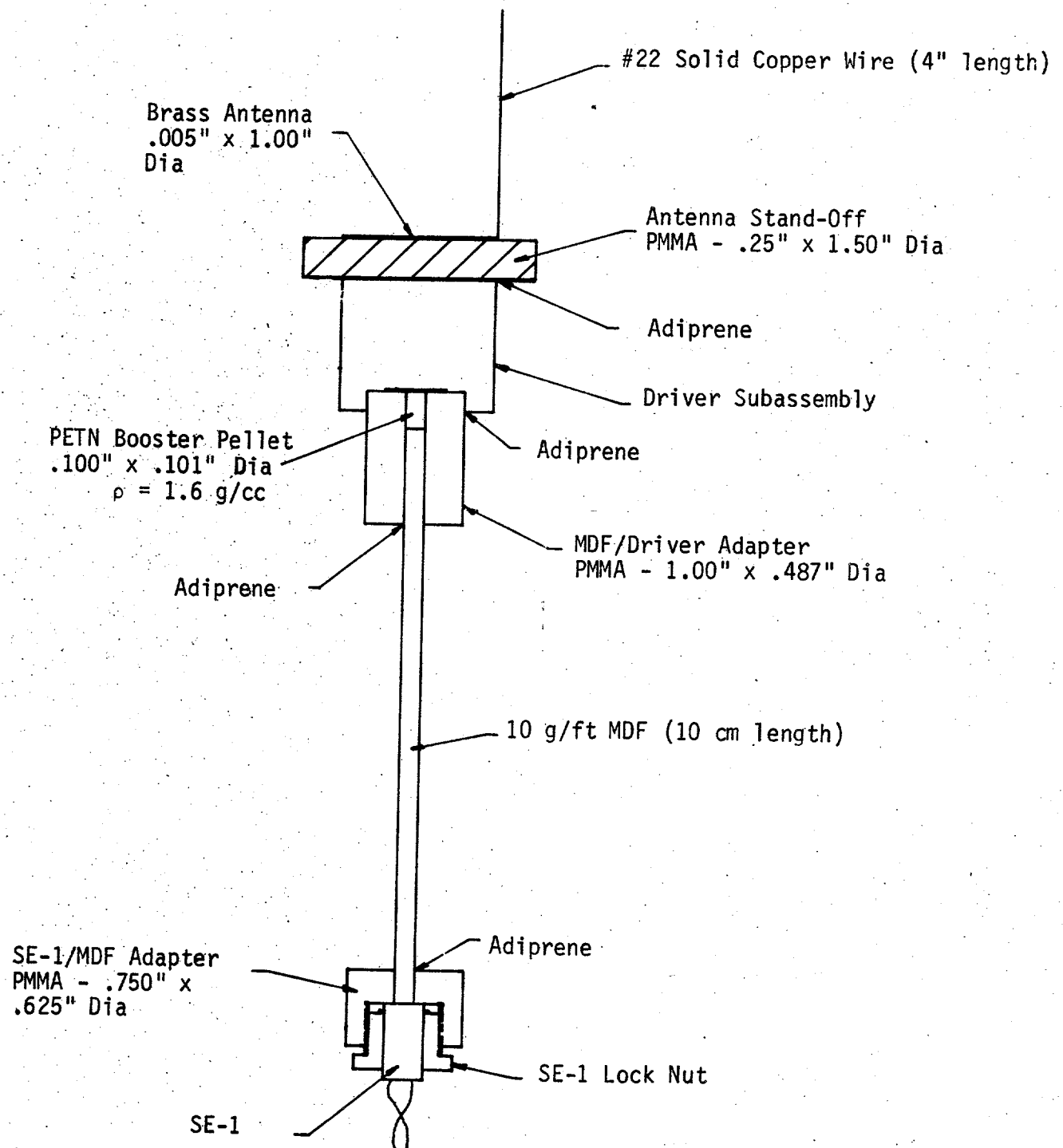
Fig. 2. Test Fire Assembly

S-3
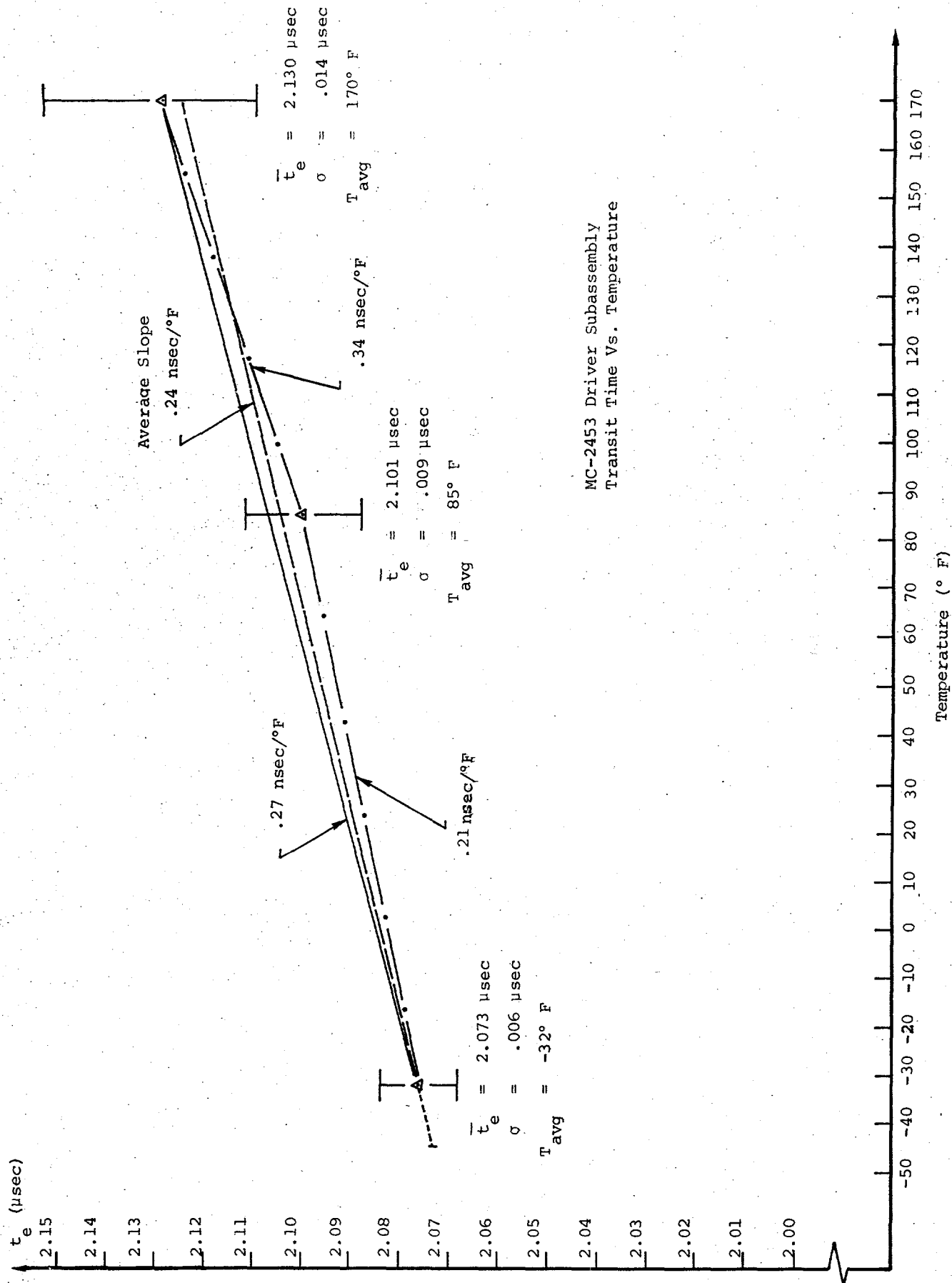
MC-2453 Driver Subassembly
Transit Time Vs. Temperature

Fig. 3

S-4

Aluminized Mylar

PETN MDF

Plexiglas

PETN Pellet

Ionization Switch
(Input)

Stainless Steel 303

Extex

Copper Ribbon

Saran Wrap Washer

Tetryl

Printed Circuit
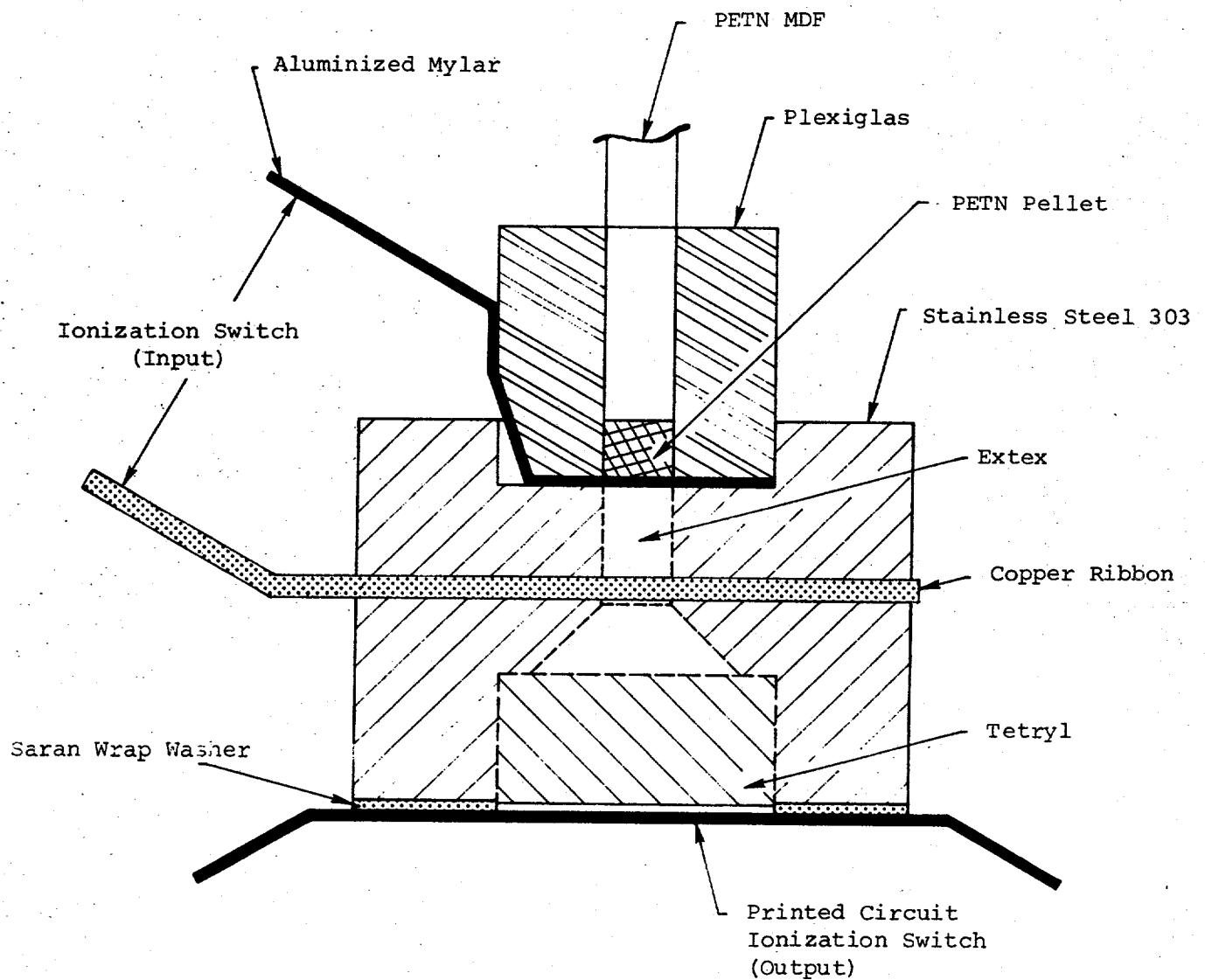Ionization Switch
(Output)

Fig. 4

shot was lost due to a failure of the output switch. Furthermore, inspection of the data would suggest that the transit time of Unit MBZ 23 is questionable. "Student's t" statistics yielded an average transit time of 2.10 μsec with a standard deviation of 0.022 μsec when the questionable time is included. The exclusion of that time yields an average of 2.09 μsec with a standard deviation of 0.005 μsec. These times compare with the average transit time of 2.10 μsec with a standard deviation of 0.009 μsec obtained at ambient temperature by the detonation electric effect.

CONCLUSIONS

The test fire data of the MC-2453 driver subassembly indicates that the transit time of this unit increases at a rate of +0.21 nsec/F between the temperatures of - 32 F and +85 F. This rate increases to a value of +0.34 nsec/F between +85 F and +170 F. The average rate of increased transit time is +0.24 nsec/F between temperature extremes. Further observation of the data also indicates an increased spread in transit time with an increase in temperature. Transit times obtained from the +0.24 nsec/F line (Fig. 3) are: 2.12 μsec at +165 F, 2.10 μsec at 85 F, and 2.07 μsec at -45 F (an extrapolation of the slope). At ambient temperatures, transit times obtained by incorporating ionization switches with MC-2453 driver subassemblies agree favorably with transit times obtained with the detonation electric effect under similar conditions. This comparison allows the use of the detonation electric effect as a method of determining the function time of the MC-2453 driver subassembly.

Table I. Transit Time as Obtained From the Detonation
Electric Effect Versus Temperature

Cold

Unit No.	Transit Time (μsec)	Temperature (F)
MBZ 1006	2.07	-22
MBZ 1022	2.08	-32
MBZ 1042	2.07	-47
MBZ 1045	2.08	-27
MBZ 1015	2.08	-32

$$\bar{t}_e = 2.076 \text{ μsec}$$

$$\sigma = 0.006 \text{ μsec}$$

$$T_{avg} = -32 \text{ F}$$

Ambient

Unit No.	Transit Time (µsec)	Temperature (F)
MBZ 1061	2.11	85
MBZ 1060	2.10	83
MBZ 1044	2.11	86
MBZ 1021	2.09	84

$$\overline{t}_e = 2.101 \ \mu sec$$

$$\sigma = 0.009 \ \mu sec$$

$$T_{avg} = 85 \ F$$

Hot

Unit No.	Transit Time (µsec)	Temperature (F)
MBZ 1024	2.13	174
MBZ 1047	2.15	172
MBZ 1018	2.11	167
MBZ 1023	2.13	170
MBZ 1040	2.13	168

$$\overline{t}_e = 2.130 \ \mu sec$$

$$\sigma = 0.014 \ \mu sec$$

$$T_{avg} = 170 \ F$$

Table II. Transit Time at Ambient Temperature as Obtained From Ionization Switches

Unit No.	Transit Time (µsec)
MBZ 29	No Record
MBZ 23	2.14
MBZ 24	2.08
MBZ 25	2.08
MBZ 26	2.09
MBZ 29	2.09