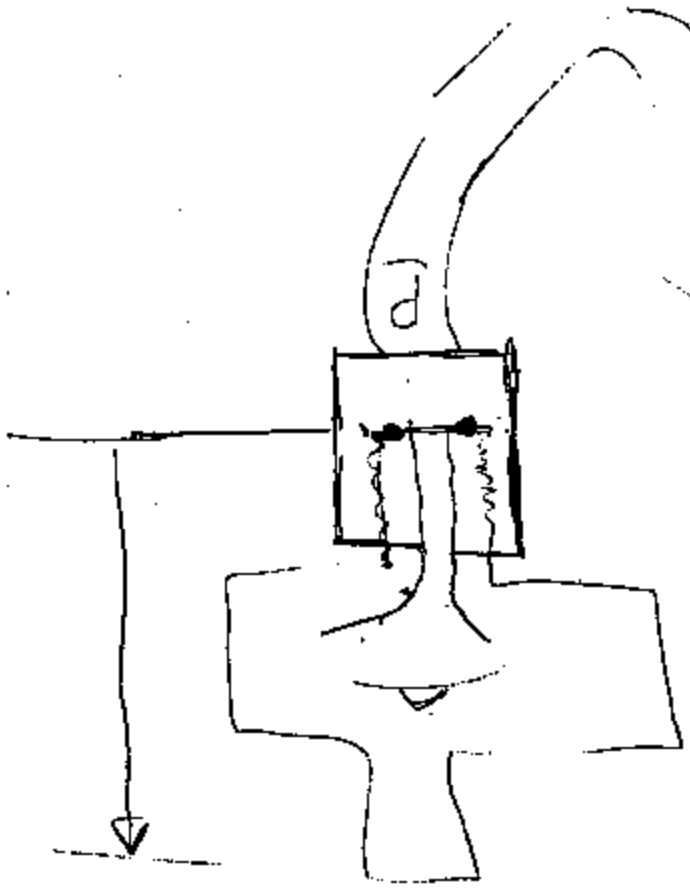
EA02-025

FORD 10/27/03

APPENDIX N

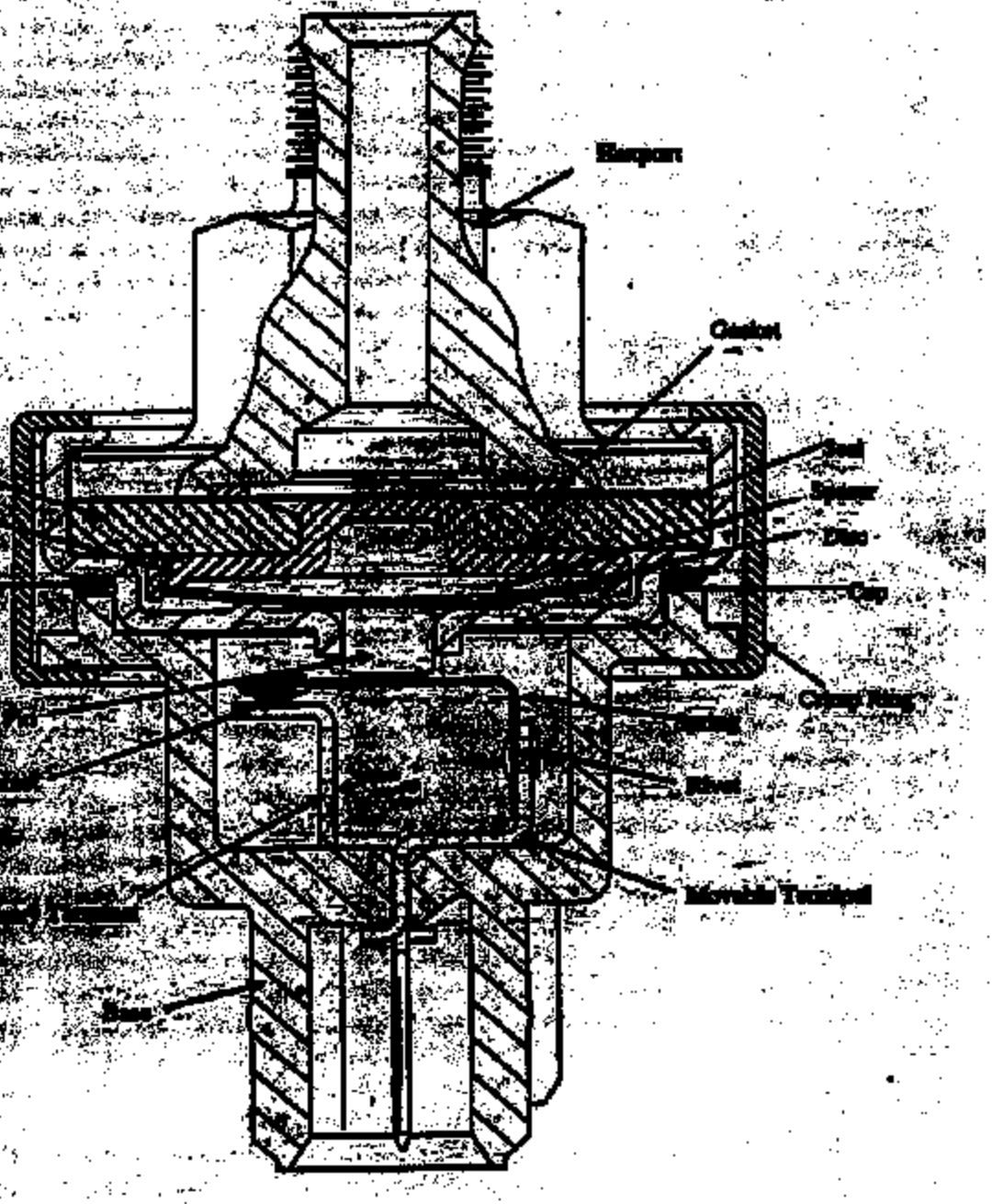
BOOK 31 OF 61

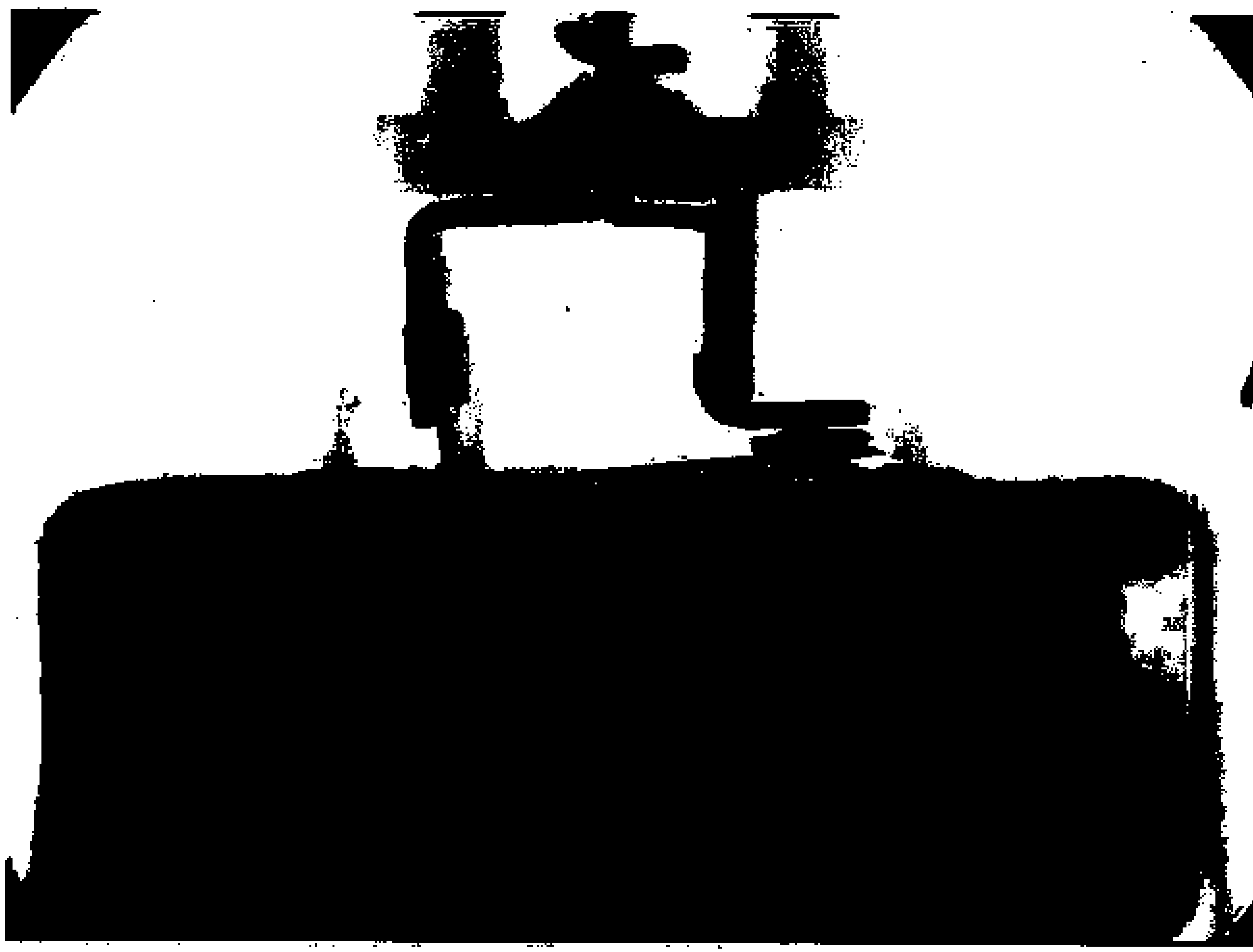
PART 2 OF 4



ATTACHMENT 5

Hydraulic Pressure Switch Cross Section





AB

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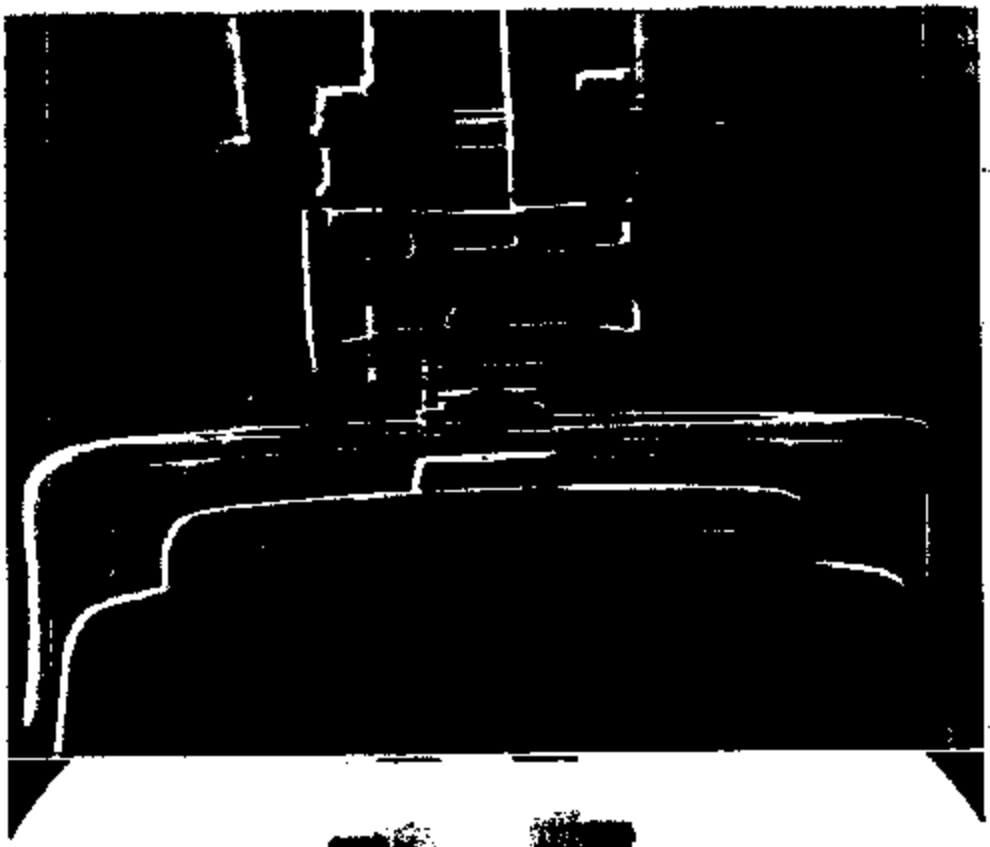
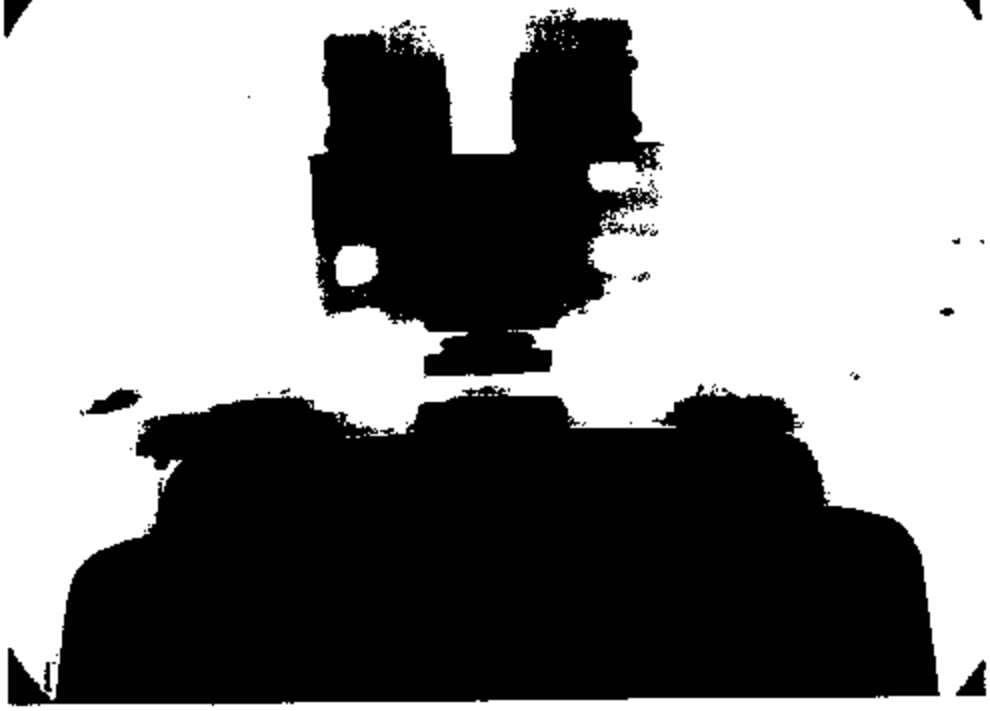




AB

3713 9621

11/1/99 | 10:00 AM

Steve R. -

2000 All Done Now ck resistance

Meas. Term to Term > .5 Ω
2 Term's to Hex < 100 K Ω

2000

10K pts total

1500 binned
200 Rejected
(1300) in Excel

1000/wk 4000 current

(1) Log Ro# & (2) Build ~~date~~ (3) R# (4) X (5) Yo / ZIP

sep. ~~#~~ 4 digit Prefix
6-7 dig. + Base
~~[illegible]~~ 2 dig. + suffix (13 dig.)

(5) Resis. between term
(6) Resis. Hex to Stu
(7) Resis. Mou. to Hex
(8) Signs of Heat Damage [illegible]

Easy way to see RO & Date [illegible]

3713 9622

- Part Seperated from Tag — just RO #.)
- Parts Binded in same bag.

Can't be matched

Warranty Center

▷ Chris Wash — Warranty Return Center
(313) 594-8281 Part Bldg park back door

▷ Harry DeSimone

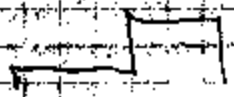
(313) 248-2044

FEDS1
RIC Code

15090 Commerce Dr. N
Dearborn, MI 48120

200 Tags a Day

Pts. Coming In



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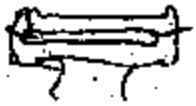
Notes 10/27/99

Central Lab

- Post Welds CL.
- Sleeve R. "
- Sim L. CL.
- ?

- Cracks in Stationary Terminal



▷ Microfocal X Ray
Fractional Focal System

Images Quickly — 2 views
• 2-3 days 432
$2500 for 3 full days

▷ No Real time (MQS) Inspection
- 150 KV
- Gama Radiograph sevicat. inches
Ron Scott

Large Films Here

160 KV 50 microns

Tube to Image Distance

Tube to Subject

Small Films

320 KV Focal Spot 3.5 mm

10 ma.

1st Half (no name) (5 min)

Hamamatsu X Ray Tube

130 KV current 300 μA
100 μA

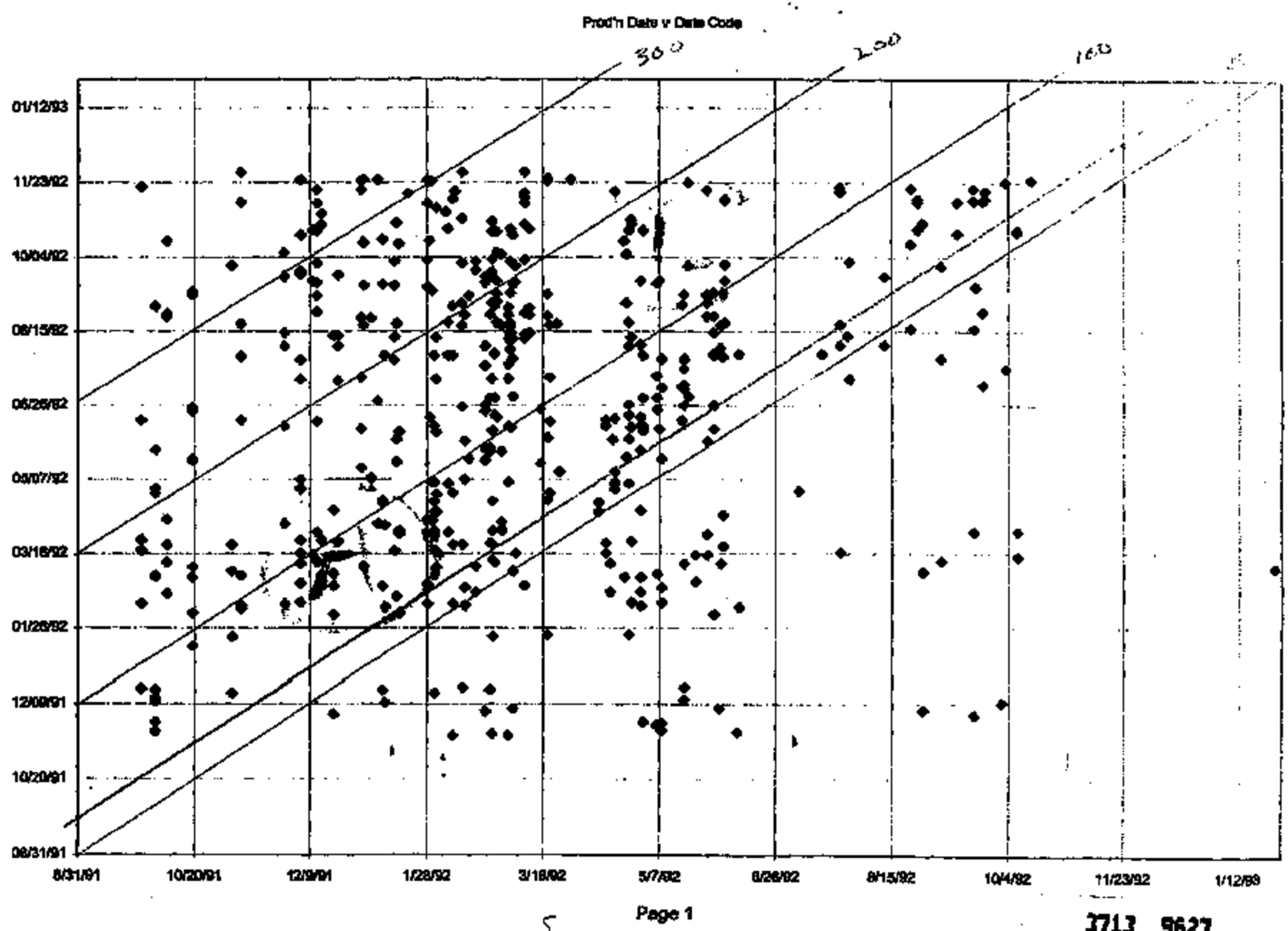
Focal 10 μ

2nd Half

Same

Another 160 KV micro focus

3713 9626


Prod'n Date v Date Code
300
200
160
01/12/93
11/23/92
10/04/92
08/15/92
06/26/92
05/07/92
03/18/92
01/28/92
12/09/91
10/20/91
08/31/91
8/31/91
10/20/91
12/9/91
1/28/92
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6/26/92
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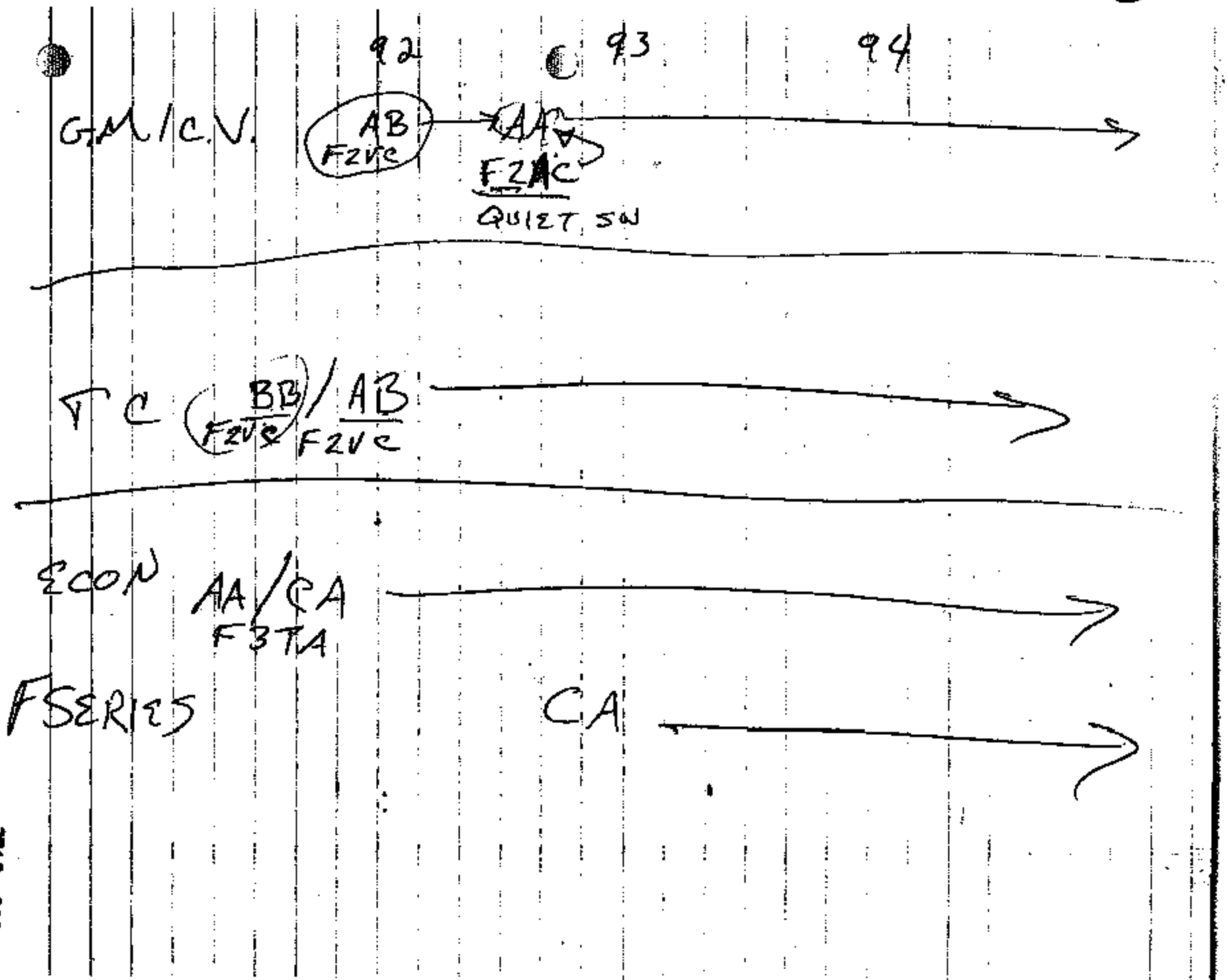
10/4/92
11/23/92
1/12/93

3713 9627


92
93
94
GM/C.V.
AB
F2VC
AA
F2AC
QUIET SW
TC
BB/AB
F2VC F2VC
ECON
AA/CA
F3TA
FSERIES
CA

Engineering Specification

PART NAME: SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

PART NUMBER: ▽ ES-F2VC-9F924-AA

LIT																			
PR																			
LIT																			
PR																			

DATE	LIT	PR	REVISIONS	DR	CK
			ADDED DATA TO COMPLETE		
			SPEC. & RETYPED		
9/11/80			NCCR E10079779C02		[illegible]

REFERENCE

PREPARED/APPROVED BY: R.J. Peo-10 9c07.10

CHECKED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR: [illegible signature]

DESIGN ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL: [illegible signature]

PURCHASING

SUPPLIER QUALITY ASSISTANCE: [illegible signature]

ELECTRONICS DIVISION: [illegible signature]

▽ CONTROL ITEM — THE ▽ SYMBOL ALSO IDENTIFIES PRODUCT ENGINEERING DESIGNATED CRITICAL CHARACTERISTICS. THESE, AND ADDITIONAL CRITICAL CHARACTERISTICS IDENTIFIED BY PROCESS REVIEWS, MUST APPEAR ON THE Q-101 CONTROL PLAN(S) WHICH REQUIRE PRODUCT ENGINEERING APPROVAL.

FRAME 1 OF 16 | REV | ▽ ES-F2VC-9F924-AA

PD 3947-a1 (Previous editions may NOT be used)

3713 9649

SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

I. General

This specification covers the test requirements for the speed control deactivate switch -9F924- used in the electronic speed control system. Design changes on the switch assembly or its components shall not be made without compliance to Section V of this specification and written approval from the releasing Production Engineering Office.

This engineering specification is a supplement to the released drawing on the above part, and all requirements herein must be met in addition to all other requirements of the part drawing. Minimum measures necessary for demonstrating compliance to these requirements are given in each section.

The engineering tests, sample sizes, and test frequencies contained within this engineering specification reflect the minimum requirements established to provide a regular evaluation of conformance to design intent. The engineering test program is intended as a supplement to normal material inspections, dimensional checking and in-process controls, and should in no way adversely influence other inspection operations.

QI suppliers may implement different test sample sizes and frequencies providing these changes have been included in an alternate Control Plan approved by the design responsible Product Engineering Office and concurred in by SQA.

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

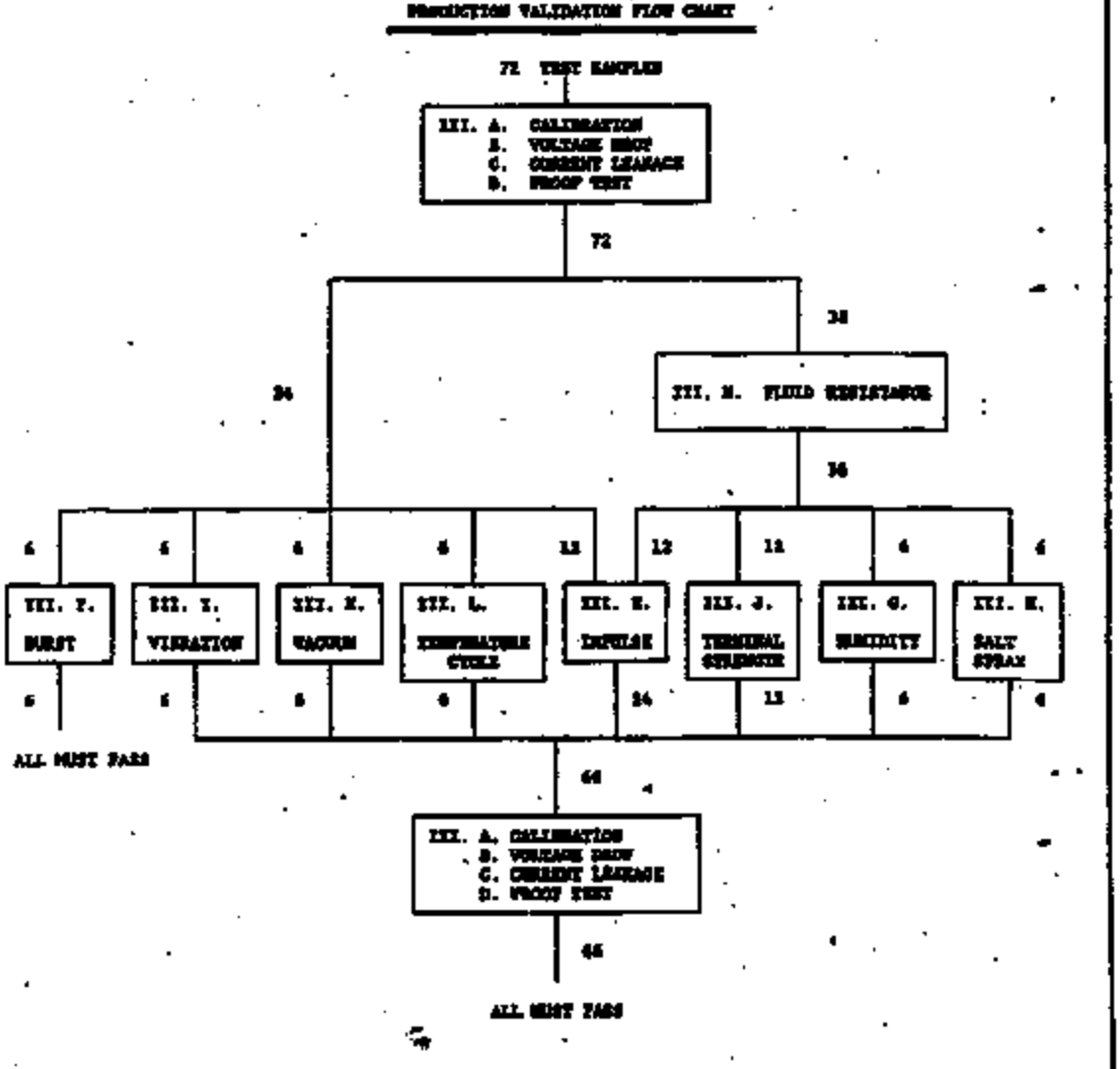
- Production Validation (PV) Tests must be completed satisfactorily with parts from production tooling (and processes where possible) before ISIR approval and authorization for shipment of production parts can be effected. Parts must be revalidated completely, or per Section V whenever any change is made which could possibly affect part function or performance.

- In-Process Test Phase 1 (IP-1) - IP-1 tests are used to demonstrate process capability and must be completed using initial production parts from production tooling and processes prior to first production shipment approval. IP-1 tests are to continue in effect until process capability is demonstrated.

- In-Process Tests Phase 2 (IP-2) - IP-2 test program may be implemented only after process capability has been established. Tests must be completed with production parts on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as much as possible. In the event that any of the requirements in these tests is not met, the reaction plan specified in Ford Q101 Sect. 3.5, "Engineering Specification (ES) Test Performance Requirements" shall be invoked.

SECTION III. TABLE OF TESTS

		Production Validation		In-Process IP-1		In-Process IP-2	
Item	Test Name Functional Tests	Minimum Sample Size	Statistical Test Acceptance Criteria	Minimum Sample Size	Statistical Test Acceptance Criteria	Minimum Sample Size	Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
M	Fluid Resistance	36	P90-.94	36/12Mo	P90-.94	36/12Mo.	P90-.94
	Durability Tests						
III.							
E	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
G	Humidity	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
H	Salt Spray	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72



FRAME 4 OF 18	REVISED		[illegible] NUMBER

MAC 7000 PD 3947-a2 (Previous editions may NOT be used)

III. TEST PROCEDURES AND REQUIREMENTS

▽ A. Calibration

1. Test Requirements

a. Switch calibration is to be checked at room temperature (16°C-35°C) using ambient air or equivalent.

b. Calibration settings shall be specified on the part drawing with the settings checked after 2 or more pressure cycles with ambient air, or equivalent. Pressure cycle range is to be determined by the manufacturer to insure switch calibration stability. The cut-in and differential set points are to be measured while conducting 750 ± 50 milliamperes while 13.0 ± 1.0 volts D.C. is applied. The cut-in point is to be checked with increasing pressure.

c. The cut-out point is to be checked with decreasing pressure, and the differential set point is to be calculated using the cut-in pressure minus the cut-out pressure.

2. Acceptance Requirements

a. Nonconformance is defined as any switch point which falls outside the tolerance band specified on the part drawing.

B. Voltage Drop

1. Test Requirements

a. Voltage drop is to be measured after 2 or more cycles with ambient air or equivalent from 0 to 10,000 ± 172 KPa (1450 ± 25 PSI) while conducting 750 ± 50 milliamps and 13.0 ± 1.0 volts D.C. is applied to the switch. Under these conditions with the switch closed the voltage drop is to be measured. Millivolt connection interface at terminals to be less than 10 millivolts.

2. Acceptance Requirements

a. Nonconformance is defined as a voltage drop in excess of 200 millivolts.

II. TEST PROCEDURES AND REQUIREMENTS (cont'd)

C. Current Leakage

1. Test Requirements

a. Current leakage is to be checked with 500 volts, 60 Hz alternating current.

b. Current leakage is to be checked:

(1) Between the switch leads with the contacts open.
(2) Between the lead and the switch housing with contacts closed.
(3) Between either lead and switch housing with the contacts open.

2. Acceptance Requirements

a. Nonconformance is defined as any leakage current in excess of one hundred (100) microampere.

D. Proof Test

1. Test Requirements

a. Subject sample switches to Section A to establish their initial switching pressures.

b. Proof test is to be conducted using brake fluid or equivalent as the pressure medium. Test pressure shall be as specified on the part drawing. Test pressure shall be isolated from pressure source and held for not less than 30 seconds.

c. Recheck the switches to Section A.

2. Acceptance Requirements

a. No evidence of fluid leakage, seepage, or drop in test pressure greater than 430 KPa.(62 PSI) is permitted.

b. A change in cut-in and out-out pressures greater than ± 5% from the initial value is not permitted.

c. The test samples must be destroyed after testing.

II. TEST PROCEDURES AND REQUIREMENTS (cont'd)

Impulse

1. Test Requirements

a. Test the switch for a total of 500,000 cycles. Cycle pressure between (low) 0-276 KPa (0-40 psi) and (high) 10,000 ± 345 KPa (1450 ± 50 psi).

1) 0 - 475,00 cycles: 13 ± 1 volts, trace current to monitor function.

2) 475,001 - 500,000 cycles: 13 ± 1 volts D.C., 750 ± 50 ma., per figure 4.

b. Brake fluid temperature to be 135 ± 14°C and ambient temperature to be 107°C min.

c. Cycle rate is to be 110-130 cycles per minute.

d. Switch must open and close each cycle.

2. Acceptance Requirements

a. After impulse test check to sections A, B, C, & D using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, & D.

c. Samples used for this test must be destroyed after all testing is completed.

F. Burst

1. Test Requirement

a. Burst strength is to be checked using brake fluid or equivalent as the pressure medium.

b. Pressurize the switch to 48.3 MPa (7000 PSI) minimum and hold for 30 seconds minimum.

2. Acceptance Requirements

a. Nonconformance is defined as any evidence of fluid leakage or seepage from the switch or threads. Samples used for this test must be destroyed after testing is completed.

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III. TEST PROCEDURES AND REQUIREMENTS (Cont'd)

G. Humidity

1. Test Requirements

a. Mount the switch in the test port in a humidity chamber. Currently released mating electrical connector must be installed before start of test.

b. Subject the switch to ten (10) continuous humidity cycles as follows:

(1) Raise temperature to 65 +10/-2 °C over 2.5 hours; at 90-98% relative humidity.

(2) Hold 3 hours at 65 +10/-2 °C at 90-98% relative humidity.

(3) Lower temperature to 25 +10/-2 °C over 2.5 hours; at 80-98% relative humidity.

2. Acceptance Requirements

a. Within 15 minutes after completion of the tenth humidity cycle check the switch to sections A, B, C, D, using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D.

H. Salt Spray

1. Test Requirements

a. Mount the switch in the test port in a salt spray chamber. The currently released mating electrical connector and wiring must be installed prior to start of test.

b. Expose the switch assembly to 72 hours of salt spray per ASTM B-117.

2. Acceptance Requirements

a. After exposure, check the switch to sections A, B, C, D, using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

9656 1741

II. TEST PROCEDURES AND REQUIREMENTS (cont'd)

I. Vibration

1. Test Requirements

a. Mount the switch in the test port and attach the currently released mating electrical connector before start of test.

b. Switches are to be vibrated in all 3 planes with electrical continuity being monitored during the entire test. See Figure 1 for switch orientation in the 3 planes. Vibration tests are to be conducted at room temperature using brake fluid, ambient air, or equivalent as the pressure medium.

c. Internal pressure shall be maintained at 0 KPa G, when the switch is in the closed position and 1.1 times max actuation pressure shown on print when the switch is in the open position.

d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

e. Vibrate the switch in alternate one-hour periods in the open and closed positions for a total of 8 hours in each plane. (Total test time is 24 hours).

2. Acceptance Requirements

a. After the entire vibration sequence check the switches to sections A, B, C, or D using the procedure established in each section.

b. Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

II. TEST PROCEDURES AND REQUIREMENTS (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

(1) Apply a 89 ± 9 N axial force to each terminal.

(2) With a pendulum apply a 45 ± 5 N impact force to the switch housing at the connector and, perpendicular to the centerline axis of the switch. See Figure 2 for force application point and direction.

2. Acceptance Requirements

a. Check the switch to sections A, B, C, and D using the procedures established in each section.

b. Nonconformance is defined as any terminal or housing fracture, or any switch not meeting the criteria in sections A, B, C, or D.

K. Vacuum

1. Test Requirements

a. Mount the switch in the test port. Vacuum tests are to be conducted at room temperature using ambient air as the pressure medium.

b. Subject the switch to 5 cycles of vacuum from atmospheric pressure (760 mm Hg) to an absolute pressure of 3-6 mm Hg. Maintain the vacuum for a minimum of 60 seconds.

2. Acceptance Requirements

a. Check the switch to sections A, B, C, and D using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, and D.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

L. Temperature Cycle

1. Test Requirements

a. Mount switches in test ports; test to be run using currently released brake fluid.

b. Repeat the following procedure 25 times.

(1) Lower the switch and fluid temperature to at least -40°C.

(2) Cycle the switches ten times at 10 seconds/cycles. One cycle consists of a pressure variation from 0 - 276 KPa.G (0-40 psi) to 10,000 ± 345 KPa.G (1450 ± 50 PSI). Note: Switch must open and close each cycle.

(3) Raise switch and fluid temperature to 38°C minimum.

(4) Repeat Step 2.

c. At completion of Step b, check switches per sections A, B, C, and D.

2. Acceptance Requirements

a. Nonconformance is defined as any evidence of switch fluid leakage, seepage, or not meeting the criteria of sections A, B, C, and D.

M. Fluid Resistance

1. Test Requirements

a. Mount the switch in the test port and orient as installed in the vehicle.

b. Install the currently released mating electrical connector (with wire leads) to the switch.

c. Sequentially, immerse the switch into each of the specified fluids, at a temperature of 23 ± 2 °C, for 5 ± 1 second. Remove the switch and drain and store the switch for the specified time at room temperature, prior to immersing into the next fluid.

TEST PROCEDURES AND REQUIREMENTS (cont'd)

Fluid	Drain Time	Storage Time
Reference Fuel C ASTM D471	60 ± 5 min.	none
10W40 Engine Oil	24 ± 1 hour	14 days
Ethylene Glycol/ Water 50/50 by Volume	24 ± 1 hour	24 ± 1 hour
Brake Fluid DOT 3	24 ± 1 hour	48 ± 1 hour
Automatic Transmission/ Power Steering Fluid (same) ESP-M2C138-CJ	24 ± 1 hour	14 days
Isopropyl Alcohol/ Water 50/50 by Volume	24 ± 1 hour	none
Reference Fuel C, ASTM D471 with Methyl Alcohol 85/15 by Volume	24 ± 1 hour	none

d. Per the Flow Chart, subject the prescribed number of immersed switches to the post immersion tests specified below:

III. E. Impulse
III. G. Humidity
III. H. Salt Spray
III. J. Terminal Strength

Acceptance Requirements

a. Switches must fully meet the requirements of the specified post immersion test.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

V. STATISTICAL ANALYSIS METHODS

A. For PV, IP-1 and IP-2 tests, all samples tested must pass. Having all the required sample size pass will provide data to support the conclusion that the switch has a minimum reliability R, at a given confidence of C. The notation Pc-R is interpreted as minimum reliability equal to R, at a confidence C; thus P90-.80 means a minimum reliability of 80% at 90% confidence.

B. All samples must pass is the statistical test acceptance criteria stated for tests with 100% frequency; or samples from lots, which could have a variable size.

V. REVALIDATION REQUIREMENTS

A. No change in design, material, process or component supplier shall be made without prior approval from the releasing Product Engineering Office. As part of approving a change, the releasing Product Engineering Office will establish the portion of the Product Validation tests required to be run to revalidate the switch. The following table is to be used as a guide in determining the type of tests required for revalidation requirements.

RUNNING CHANGE REVALIDATION

Component	Process or Material Change or New Supplier
1. Terminals, Contacts, or Connector	III, B, C, E, G, H, I, J, L, M.
2. Case or Housing	All Tests
3. Disc or Diaphragm	III, A, D, E, F, I, K, L.
4. Fitting or Fluid Connection	III, D, E, F, H, I, M.

B. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

A lot is defined as no more than eight (8) hours of production up to 4,000 pieces. If shifts extend beyond eight (8) hours, or more than 4,000 pieces are produced in a shift, the product must be separated into at least two lots.

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VII. RECORD RETENTION

A. Recording and record retention shall conform with Ford Q-101.

B. Production Validation test results and analysis are to be forwarded to the releasing Product Engineering Office before approval for shipment of production parts can be granted.

C. In-Process test results shall be available at the supplier's manufacturing facility for the releasing Product Engineering Office and Ford SQA or its representatives to review on request.

VIII. INSTRUCTIONS AND NOTES

All switches are to be identified with the Ford part number, supplier identification, and a date code indicating final assembly.

All test equipment and test procedures for testing to this specification must be approved by the releasing Product Engineering Office and no change in equipment or procedure may be made without their written concurrence.

Test port configuration is shown in Figure 3.

O-rings, if used in the design, shall be free from cuts, nicks, abrasions or any other damage which would result in a fluid leak.

All switches must have a shipping cap installed over the port threads to prevent contamination. All shipping caps must be approved by the releasing Product Engineering Office prior to production incorporation.

All switches that do not pass the calibration test are to either be readjusted and rechecked, or scrapped. (Salvage of component parts permitted with 100% reinspection).

If product nonconformance occurs for test Sections III. B, C, D, E, F, and J, production shall be stopped and the problems corrected. All production lots shall be sorted 100% prior to shipment. Suspected nonconformance of any shipped parts shall be reported immediately to the releasing Product Engineering Office.

If nonconformance of the statistical acceptance criteria occurs for test Sections III. G, H, I, K, L and M, a cause to recall the subject weeks production and to stop production may result.

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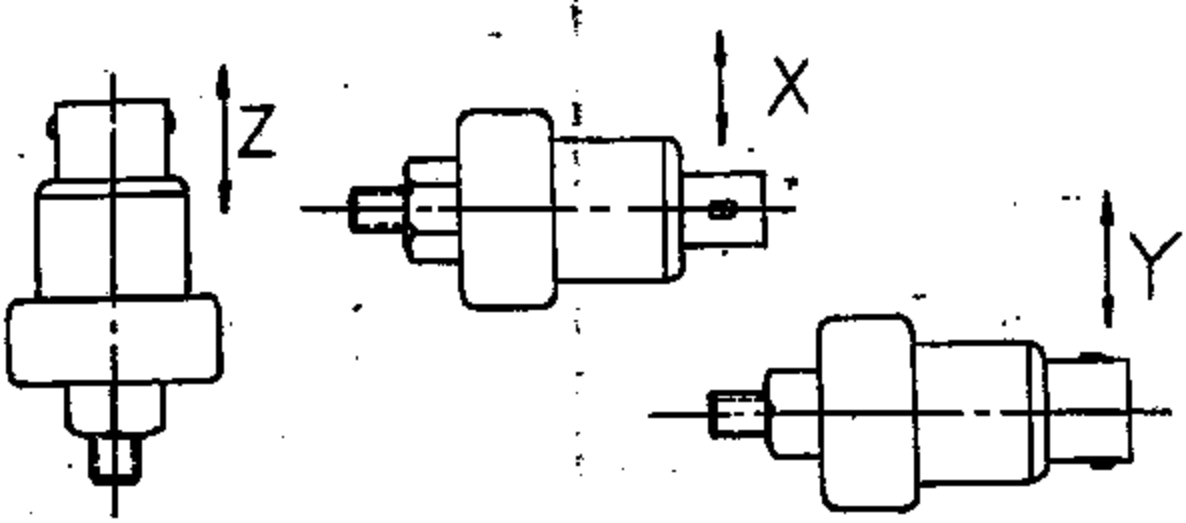
IX. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1990 Edition

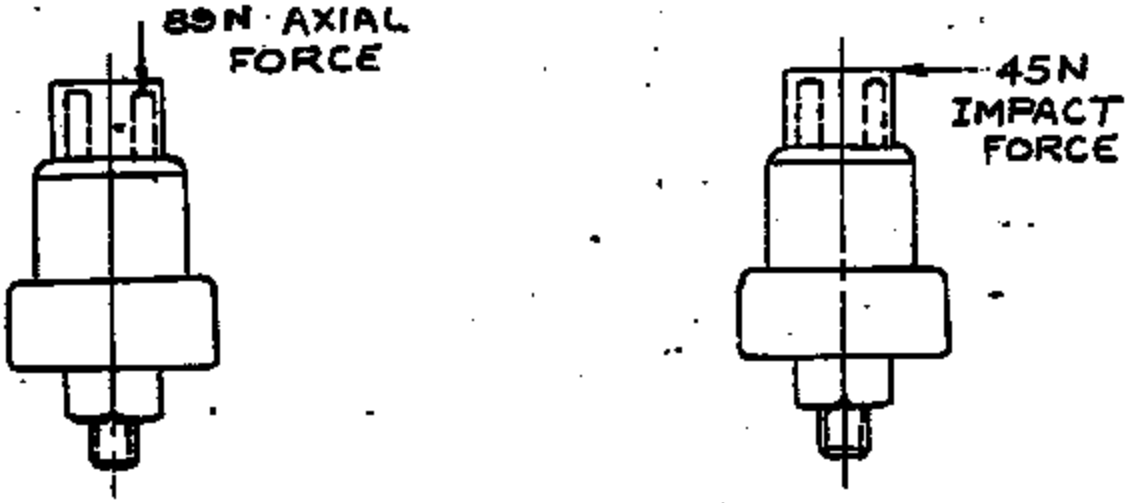
ES-F0EB-14A464-AA, Specification - SLV Assy - Wire Connector

ES-F2VF-9C735-AA, Specification - Servo Assembly Speed Control



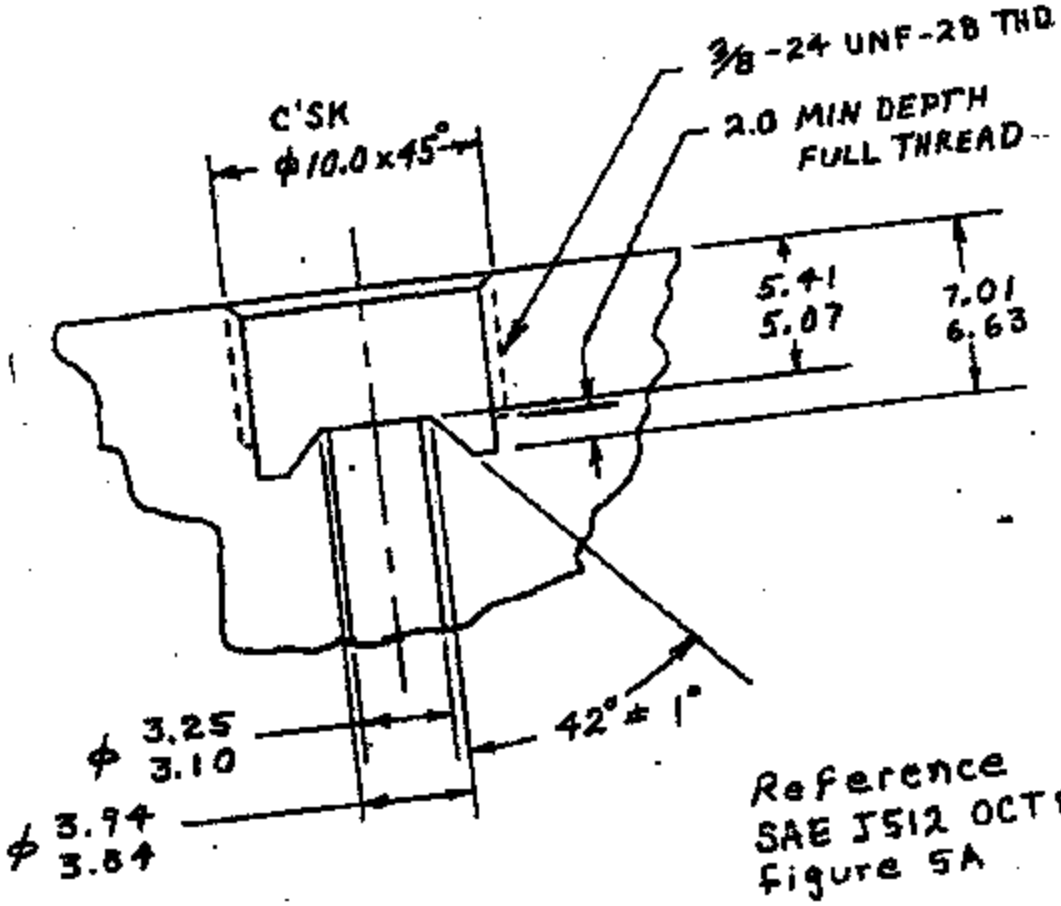
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



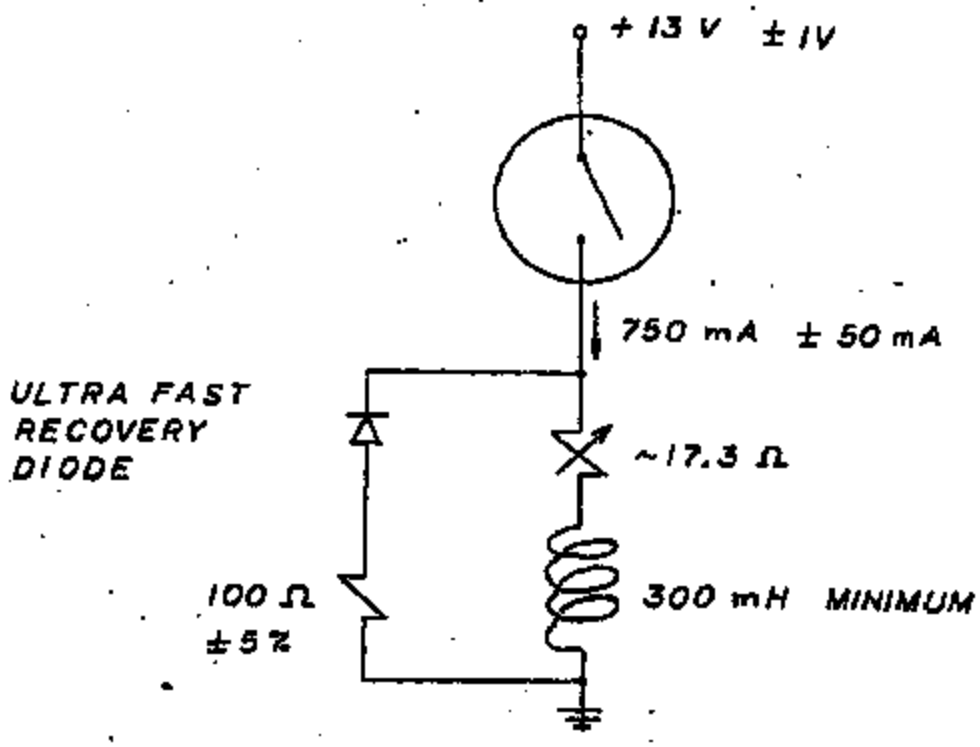
TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.



TEST FIXTURE PORT CONFIGURATION

FIGURE 3



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

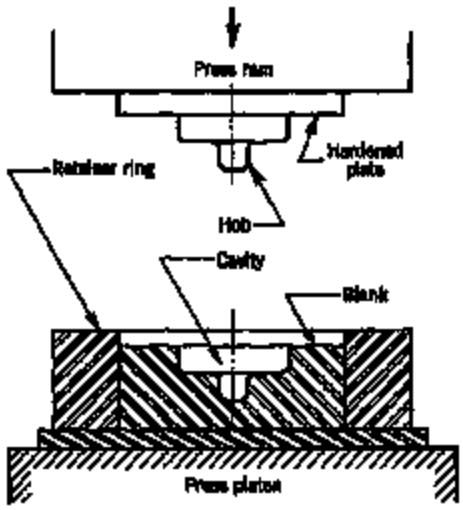


Figure 13.16 Die hob producing a mold cavity by pressing into soft steel.

sary hardness and strength to withstand the tremendous pressures involved. Pressing the hob into the blank requires much care, and frequently several alternate pressings and annealings are necessary before the job is complete. During the hobbing operation the flow of metal in the blank is restrained from any appreciable lateral movement by a heavy retainer ring placed around it. The actual pressing is done in hydraulic presses having capacities ranging from 250 to 8000 tons (2 to 70 MN).

The advantage of hobbing is that multiple, identical cavities can be produced economically. The surfaces of the cavities have a highly polished finish, and no machine work is necessary other than to remove surplus metal from the top and sides of the blank. This process is used in producing molds for the plastic and die-casting industries.

Coining and Embossing

The operation of *coining*, shown in Figure 13.17, is performed in dies which confine the metal and restrict its flow in a lateral direction. Shallow configurations on the surfaces of flat objects, such as coins, are produced in this manner. Because special-type presses developing high pressures are required in this operation, its use is limited to fairly soft alloys.

Embossing is more of a drawing or stretching operation and does not require the high pressures necessary for coining. The punch is usually relieved so that it touches only the part of the blank that is being em-

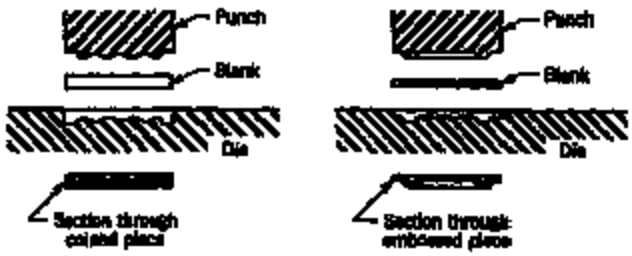
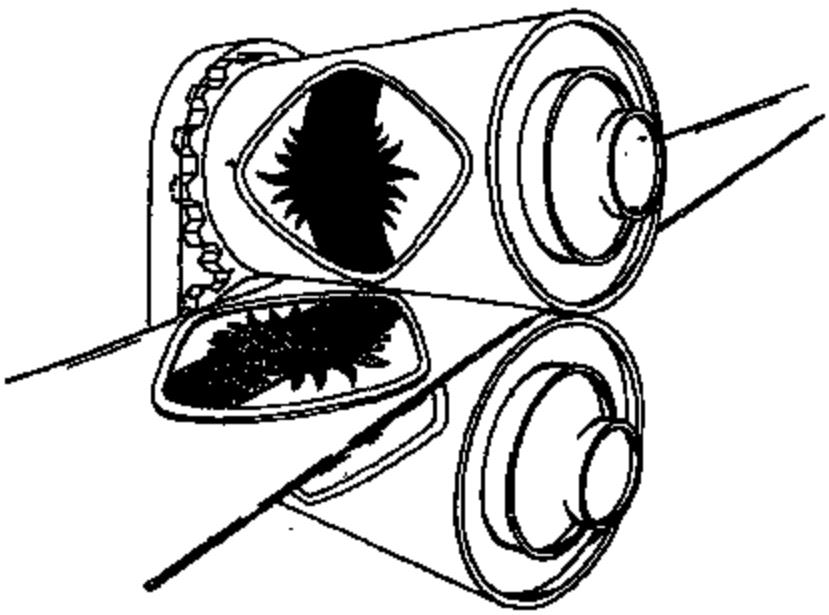


Figure 13.17 Illustrating the difference between coining and embossing.

bossed. The major use for embossing is in making nameplates, medallions, identification tags, and aesthetic designs on thin sheet metal or foil. The embossed design is raised from the parent metal. The mating die, Figure 13.17, conforms to the same configuration as the punch so that there is very little metal squeezing in the operation and practically no change in the thickness of the metal. Debossing refers to the case in which the design is pressed into the parent metal and is used where a raised pattern would cause difficulty. Rotary embossing, using cylindrically shaped dies, is extensively used on thin sheet metal and foils. The metal is fed through the rolls as shown in Figure 13.18.

Figure 13.18 Rotary embossing.



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Review of Crimp Marks 12/15/92

1335	12/1/91	
1338	- 2	
1331	- 2	
2032	2/1/92	
2031	3	0071453817
2029	2	007 120 7545
2029	2-3	0071247026
2036	3	0070809793
2036	2	007 027 7916
2122	- 5/1/92	
2119	8	006 963 7210
2119	8	007113 8055
2119	8	0070750725
2126	5	0071849397
2127	8	0071611873
2126	8	007 146 1942
2119	7	007 113 8055
2214	8/1/92	
2224	7	0069543732
2209	7	0070388015
2209	8	0071604108
2205	8	0071051661
2235	8	0069327415
2238	8	007166 7428

3713 9669

Review of Chimp Marks 12/15/99

1993	None to review			
1994				
4054	4	006962 2917	<Large Lettering>	AA
4144	34	007118 8125	"	AB
4154	3	007060 3030	"	AA
5278	2	0070609743	"	AA
1995				
1996				
6095	8	006938 6444	"	AA
6300	7	007067 7645	"	AB
6131	7	007068 3189	"	AB
1997				
817	8	007124 9515	"	AB
		(All Same)		
1998 8280	8	007066 7366	"	AB

2068 - 2071 Container

2069 -	2	007 078 345 7	AB
2069 -	3	0071080302	AB

2105 to 2106 Container

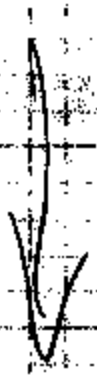
2104	2	0070558590	AB
2104	2	0070694179	AB

2107 to 2113 Container

2108	2	007 125 0724	AA
2112	3	0070839517	AA
2113	3	0071092729	AA

2112	3	0070839517	AA
2113	8	007 109 3883	AA

Picture



2117 - 2120 Container

2119 - 8 - 0070750725 AA
2120 - 8 - 006940 3715 AA
2119 - 8 - 006 963 7210 AA
2120 - 8 - 0071303819 AA

2128 - 2130 Container
2128 - 8 - 0070863477 AB
2128 - 7 - 0070139003 AB
2128 - 8 - 0069327348 AB
2128 - 8 - 007 132 4112 AB

2135 - 2137 Container
2137 - 7 - 007 033 5588 AA
2137 - 8 - 0071287875 AA
2137 - 8 - 0071288951 AA
2136 - 8 - 007 081 5519 AA

2149 - 2155 Container
2150 - 7 - 007 115 4747 AA
2153 - 8 - 0070855626 AA
2150 - 8 - 007 085 0781 AA
2154 - 8 - 007 [illegible] AA

2198 - 2211. Container

2209 - 8 - 0071850624 AA

2209 - 7 - 0071396342 AA

2205 - 7 - 0070775203 AA

2205 - 7 - 0072436563 AA

2240-2253 Container

2248 - 7 - 0072033 8358 AA

2240 - 8 - 0071470980 AA

2248 - 8 - 0070663762 AA

2240 - 8 - 0070141411 AA

2261 - 2267 Container

2262 - 7 - 0069320998 AA

2262 - 8 - 0071547691 AA

2266 - 8 - 0071504333 AB

2262 - 6 - 0071123349 AA ("Rushed")

2275 - 2281 Container

2281 - 8 - 0071139424 AB

2278 - 8 - 0071696899 AB

2278 - 8 - 0071200824 AB

2281 - 8 - 0070910807 AB

2281 - 8 - 0071930039 AB

3713 9673

2282 - 2309 Container

2287 - 7 - 007063761 AB

2287 - 7 - 007181 3214 AB

2338 - 2366 Container

2352 - 8 - 007142 6395 AB

Robert Panek

From: Reimers, Steve (S.J.) [sreimers@ford.com]
Sent: Tuesday, December 14, 1999 12:01 PM
To: Robert Panek (E-mail)
Subject: Pre-Crimp Inspection

Rob,

I would like Exponent to do a non-destructive examination of the pre-crimp
witness marks on one Brake Pressure switch
from each of the following dates (as close as possible):
12/1/91 – 1355
2/1/92 - 2052
5/1/92 – 2122
8/1/92 - 2214
1993
1994
1995
1996
1997
1998.

As you may recall when we were disassembling parts we noticed a difference
in the pre-crimp witness marks.
We would like to find out when these marks appear or disappear.
The pre-crimp marks are visible from the hexport and just inside the aluminum cup edge.
thanks,

Steve Reimers
V&T EE&E Chassis E/E Systems
313 39 03286, fax 313 39 04145

BROWN McCARROLL & OAKS HARTLINE, L.L.P.

111 Congress Avenue, Suite 1400
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(512) 479-1101 - Facsimile

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Houston, Texas 77019-2100
(713) 526-3110
(713) 615-6185 - Facsimile

220 Energy Centre
1127 Judson Road
Longview, Texas 75606-3909
(903) 236-9000
(903) 236-8787 - Facsimile

500 Crescent Court
Suite 1400
Dallas, Texas 75201-6920
(214) 999-6100
(214) 999-6170 - Facsimile

July 14, 2000 (512) 479-9761

FAX COVER SHEET

TO:	NAME:	Doug Lampe
	COMPANY:	FORD MOTOR COMPANY
	PHONE:	(313) 594-4111
	FAX NO.:	(313) 845-3686
TO:	NAME:	Robert Panek
	COMPANY:	Exponent - Failure Analysis
	PHONE:	(248) 324-8100
	FAX NO.:	(248) 324-9199
TO:	NAME:	Fred Porter
	COMPANY:	FORD MOTOR COMPANY
	PHONE:	(313) 845-3722
	FAX NO.:	(313) 390-4145
FROM:	NAME:	Jeffrey C. Manske
	USER ID:	6587
	TOTAL NO. OF PAGES:	3
	CLIENT/MATTER NO:	13486.94658

Completed By:_____ Date:_____ Time:_____

3713 9676

Brown McCarroll & Oaks Hartline, L.L.P.

ATTORNEYS AT LAW

111 Congress Avenue, Suite 1400, Austin, TX 78701-4043
Phone 512-472-5456 • Fax 512-479-1101

July 14, 2000

Writer's Direct Number:
(512) 479-9761

VIA FACSIMILE

Mr. Johnny W. Carter
Susman, Godfrey, L.L.P.
1000 Louisiana, Suite 5100
Houston, TX 77002

Re: Cause No. 35650-S; [redacted] *vs. Ford Motor Company, et al.*; In the329th Judicial District Court of Wharton County, Texas

Dear Johnny:

This letter is to confirm Texas Instrument's inspection of field returned brake pressure switch components on Monday, July 17, and Tuesday, July 18, 2000, beginning at 9:00 a.m. and concluding at 5:00 p.m. each day. The inspection will take place at the following facility:

Exponent
39100 Country Club Drive
Farmington, MI 48331

For your convenience, I am enclosing written directions from Detroit Metro Airport to Exponent in an attachment to this correspondence.

Ford has informed me that arrangements are being made to have a microscope available. Additionally, I have also been informed that the documents you have requested in earlier correspondence, as well as the computer disc previously discussed, will all be available to you at the inspection.

Upon arriving at Exponent, please ask for Mr. Robert Panek.

If you have any questions regarding the above or the enclosed, please do not hesitate to contact me. I look forward to seeing you on Monday.

Until our next communication, I remain

Very truly yours,

Jeffrey C. Manske

JCM:rhd
Enclosure
ADS:HN92RL1
13481.94001

3713 9677

Exponent
Failure Analysis Associates

Exponent
149 Commonwealth Dr.
Menlo Park, CA 94025

telephone 650-326-9400
facsimile 650-326-9072
www.exponent.com

FAX COVER SHEET

To:	**Sarah A. McLaren, Esquire**	**248-258-0421**
	Name	Fax
	Feeney, Kellett, Wiener & Bush	**10-27-00**
	Company	Date
From:	**Bruce Ketcham**	**248-324-9118**
	Name	Telephone
	Managing Engineer	**248-324-9199**
	Title	Fax
	Draft Supplemental Protocol & Data Form	
	Subject	
	3	**bketcham@exponent.com**
	Total pages including this page.	E-mail

If you do not receive all of the pages indicated, please call _____ at ( ) _____ as soon as possible.

PLEASE NOTE: *The information contained in this facsimile transmission is intended to be sent only to the stated recipient of the transmission. If the reader of this message is not the intended recipient's agent, you are hereby notified that any dissemination, distribution or copying of the information contained in this facsimile transmission is prohibited. You are further asked to notify us of the error as soon as possible at the telephone number shown above and to return the facsimile documents to us immediately by mail at the address shown above. Thank you.*

SPECIAL INSTRUCTIONS:

Sarah:

As discussed.

Bruce

Exponent

DRAFT

October 27, 2000

Brake Pressure Switch Disassembly Protocol – Supplement

For each previously disassembled brake switch:

1. Remove the three plastic bags containing the three kapton diaphragms from the plastic bag that contains the disassembled switch components. Remove each bag and open the petri dish that contains the kapton diaphragm. Remove the kapton layer from the petri dish. Use a micrometer[1] to measure the thickness of the kapton diaphragm at the three unmarked diaphragm corners. Record the measured thickness and the measurement location relative to the marked corner with the mark facing outward and positioned at 12 o'clock. Return each kapton diaphragm to its respective petri dish, recover the dish and place in its plastic bag and return to the plastic bag for the respective switch.

[1] Mitutoyo 0-1" Micrometer, No 293-765-10, Serial Number 2392940, Calibration date 07/28/2000.

Exponent
Date of Inspection: _____ DRAFT Inspected by: _____

Data Form for Examination and Disassembly of Brake Switch - Supplement

Long Tag Number: _____

Measurement Position	Measurement (in)
3:00 o'clock	_____
6:00 o'clock	_____
9:00 o'clock	_____

Attorneys At Law

Austin • Dallas • Houston • Longview • Round Rock • The Woodlands

FAX COVER SHEET

AUSTIN OFFICE
111 Congress Avenue
Suite 1400
(512) 479-9761 Austin, Texas 78701-4043 (512) 479-1101 (FAX)

TO:	Fred Porter	FROM:	Jeff Manske
Company:	Ford Motor Company	User ID:	8696
Phone No.:		Client/Matter No.:	13486.94858
FAX No.:	313/390-4146	Total Pages:	35

DATE: December 15, 1999 Confirmation Receipt Required X Yes ☐ No

MESSAGE: Please review the attached and contact me.

Completed By: _____ Date: _____ Time: _____

39100 Country Club 248 324 9112
Ft 48331

Rob Some margin notations are mine. BK

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-08-16

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION:
The Thermal Cycle test was successfully expedited in order to begin the important Impulse test as soon as possible. Half of the Impulse test is run on virgin devices, and the other half is to be run on parts which have completed the Fluid Resistance test. We are now running the virgin Pass Car and Light Truck parts simultaneously. A significant problem is occurring on the PC devices. We have had three failures to date (325K of 500K) due to fluid leakage. Autopsy of two (thus far) shows fatigued Kapton; no real evidence of foreign matter nor damage to the Kapton during assembly. Sam Hamol is providing valuable assistance in failure analysis. Note that we are running AMI-built PC and LT side-by-side, with no failures of the LT parts, which is directing F/A toward the cup. We are continuing to run the test for two reasons: one, to attempt to complete the LT parts successfully; and two, to continue to fail PC parts to provide additional F/A clues. Hypotheses include: increased copperse travel in the rebump design; extraordinarily tight sensor crimp as evidenced by the deformations where the Kapton layers overlap; very flat washers (unlike the norm, which is slightly cup-shape) which may also contribute to tight crimp. We are giving this matter top priority. At this point, it is safe to assume that the PC parts presently undergoing Fluid Resistance will also fail on Impulse. This means that after the problem is corrected, at the very least the Fluid Resistance test will need to be re-run, or at worst the entire validation will have to be re-run from scratch, which is about a nine-week process either way. We are now trying to determine how to best approach Ford with this news.

MECHANIZATION:
Mechanization has performed repeated measurements on the three AMI gage blocks and three switch assemblies, and Jeff has performed exactly the same measurements manually. The AMI calibrator (measure-only mode) and the check station produced commendable sigma's, although lack of agreement between the two requires more effort to understand. Jeff's measurements produced sigma's slightly worse than the automatic equipment. The good news is that it appears that a very good correlation exists between Jeff's manual measurements and the check station. We are planning a "pre-effectivity run" (a.k.a. "final debug run") of a few hundred switch assemblies, collecting all data on each piece and identifying each individually for later analysis. This will provide a statistically significant number of parts for check station vs. Jeff correlations, as well as allow Pareto analysis of problems which occur during the run.

Dave Padpoll has spent quite a bit of time working on the rivetor on the Eastern Automation equipment. At present, we've got a hybrid of Milford and Thompson rivetor parts, which seems to be running fairly well. However, for the long-term Mechanization is looking into elimination of the rivet. We are working with an ultrasonic welding firm, Stapla, who has provided very impressive samples. I am meeting with them today to provide actual springs and movable terminals, so we can do actual in-product performance and life tests.

Progress on the above items is presently impacted by lack of terminals. We have 27K movables and 45K stationaries from Bassler which were rejected for contamination. The sticky green substance has been identified as the environmentally-friendly cleaner/rustproofing product (Irmco 119) that Bassler uses to remove the EF stamping lube (Irmco 185).

1 919000 - New Number
- OXYLIC ACID? CONTENT — NOT LIKELY per TI-003500

IRMCO MSDS MATL SAFETY DATA SHEETS

CSL ISR

3713 9602

Apparently he is not drying and/or removing this product correctly. Rick B. has determined that a phosphoric-acid tumbling product he uses regularly in-house will remove the green stains. We are having him expedite this cleaning process so we may continue with riveter work and the pre-effectivity run.

MISCELLANEOUS:
We have finally received the correct mating-connector terminals and wedges from UTA. The confusion was caused in part because this is a brand-new design and is not properly documented yet; additionally the correct individual who has knowledge of this product was out sick..

The hexport samples in 10B21 material have arrived. One has been sent to TSL for analysis of hardness, in the same fashion as done previously for a 10L10 part. This will allow direct comparison, in order to determine if the 10B21 is actually significantly harder. These parts, without re-roll, gaged very well - however, they were not plated in a 5K batch size, and they were packed individually for shipment. The hardness results, along with the quote, will help determine whether we will proceed with a full plating lot (5K).

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-08-23

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION:
Light Truck 77PS devices have successfully completed the first phase of Impulse testing, including 475K mechanical cycles and 25K powered cycles.

The AMI-built Pass Car devices on this same test were aborted at 389K cycles, with 8 of 12 failed due to ruptured Kapton. One hypothesis explored was that the Pass Car converters travel farther than the standard design (due to different disc support bump location in the cup) which results in additional strain on the Kapton. This was substantiated with converter force/deflection measurements done on Pete Sampson's equipment. We calculated that the standard design travels .017" at 1450 psi, while both the model shop and production rebump design travels .023". However, previous validation work on 57PS using the model shop rebump crimped on the hand-line did not show any Kapton problems. We are now running a matrix test, with two variables: rebump cup, model shop or production; and crimp technique, AMI or hand-line. The control lot, hand-line model shop rebumps, was taken from the original 57PS CCPS validation, and therefore should pass 500K as before. The test lot, AMI built production rebumps, is taken from the present 77PS validation lot and is expected to turn up failures beginning around 270K. The opposite diagonal of the matrix, AMI-built model shop rebumps and hand-line production rebumps, have never been run before and will help identify which test variable is the major contributor to failure. The plan is to run the test until sufficient failures have occured in all four lots. Weibull and autopsy will be used to analyze the failures. Due to the extreme priority given to this test, plans are being made to have the test monitored throughout the weekend. I will come in early Sat. AM and noon Sat. Jeff will come in Sunday AM, and I will come in again Sun. PM. When failures are found, they will be removed, the manifold plugged, and the test restarted. Weekend monitoring should allow completion of about 400K cycles by Monday morning, and should turn up significant failures of the test groups which may allow initial conclusions well before all devices ultimately fail.

As yet, we have not decided how to approach the customers with this issue. Kelsey-Hayes is somewhat aware that we are having a problem, because they have requested a quantity of 150 77PSL2-1's by 91-08-30 for DVP&R testing, we have been forced to inform them that these may be delayed. If we miss the given date, they will bring this issue to Ford. The plan is to develop a strategy on Monday once we have initial information from the failure test.

MECHANIZATION:
Eastern Automation spent two days here this week, working on the contact feed/transfer system. Apparently this design is very finicky, but does work okay when dialed in. The riveter has been acting up again; it seems that every time one problem is fixed another one occurs. This equipment is causing significant delays to the planned effectivity runs and the pre-effectivity run. The pre-effectivity run of about 250 pc. is very important from a design standpoint, since we plan to collect all calibration and check-station data for every single part, as well as every machine malfunction, and use this to Pareto-ize problems; establish check/cal/manual correlations, etc. It is unclear at this point when we will be able to perform the pre-effectivity run, although we are now several weeks late and the priority is very high.

HEXPORT:

We had a conference call this morning with Elco specifically relating to one of the points raised in Steve Fulton's letter, regarding thread condition and reroll. Steve points out that ANSI B1.1 allows a *plated* 2A thread additional allowance in pitch and major diameter, such that the no-go gage used is still 2A but the go gage is 3A. The difference here is an additional 1.1 mils on the high end. Also, SAE J512 specifically states that the additional allowance applies, and invokes ANSI B1.1. This fact should significantly help in our negotiations with the customers to approve this change. Also per ANSI, if this additional allowance is unacceptable for various reasons (lubricant or sealant clearance required in threads, or very high temperature service where expansion is an issue) then the thread designation on the print must include a "G", for example: 3/8-24-UNF-2AG. Of course, our print does not have the "G" which basically means we are at liberty to inspect per the relaxed ANSI spec. I checked 10 parts which were unacceptable on the 2A go gage, and found 8 of them to be okay on the 3A gage, the other two being marginal and requiring use of the 4.5 in-lb torque technique for arbitration. I believe that this additional tolerance, combined with one of the other ideas presented in Steve's letter (harder material and/or slightly reduced plating thickness) will be sufficient to eliminate the thread reroll and reduce thread rejections to near zero.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-08-29

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION:
The matrix test designed to help identify the cause of early Kapton failures in Pass Car devices is well underway. This includes production caps built on AMI and hand-line, and model shop rebumps built on AMI and hand-line. All AMI-built parts are dead, with production caps ranging from 307K to 504K, and model shop caps ranging from 541K to 861K. Half of each of the hand-line lots are also dead, with production caps beginning to fail at 830K and model-shop caps at 790K. The test is presently a few hour shy of one week in length, with about 1.1KK cycles to date made possible by significant efforts during and after regular work hours. These results are definitely pointing to the crimp method as the primary contributor to failure, with the cap style a secondary factor.

A second matrix has been placed on this test in parallel, although these are 790K behind the first matrix. This is testing the influence of pre-crimp, since the AMI uses pre-crimp and the hand-line does not. Devices with (control) and without pre-crimp were built on AMI, and a lot with pre-crimp was built on the hand-line. No failures yet.

AMI ⇒ Less pressure
Hand Line ⇒ higher peak pressure

Devices using pressure-sensitive paper between the Kapton and the washer were built both on the hand-line and the AMI, with and without pre-crimp. Definite differences are apparent between AMI and hand-line, but no difference attributable to pre-crimp. The AMI parts show generally less pressure applied, while the hand-line parts show higher peak pressures in the Kapton area and, significantly, evidence of washer/bexport touching which is absent on AMI. This is further supporting evidence that the hand-line crimp is deforming (elastically) the washer and/or bexport such that the effective Kapton clamp diameter is moved outward, allowing more effective Kapton area to react to the strain of converter motion. Planned cross-sections will help to justify this hypothesis.

MECHANIZATION:
We were able to complete our first pre-effectivity runs yesterday. Small lots were run to develop a correlation between the manual measurement and the check station, which proved to be quite good, with an offset of only about 0.6 mils. Next, a quantity of 57 devices were built, individually serialized, and manually measured for comparison with printed calibration and check station data. 42.1% were good based on manual measurements, and were called good by the machine. 21.8% were junk for various reasons such as mangled or missing components. 15.8% were good but called bad by the machine. Most of these fall outside the correct calibration window, yet manual and check station measurements found them to be good. Given the excellent correlation of the check station, I have proposed that the software be modified so that anything found good by the check station will be considered good. This will eliminate most of the rabbit "good parts called bad" and significantly increase yields. Another 15.8% of the parts were bad and were called bad. Most of the problems here are related to abnormal spring geometries which cause erratic correlation between the calibrator and check station, resulting in a part calibrated correctly but failing check. Finally, 3.5% of the parts were found to be bad, but called good by the machine. These are mechanical issues which can be corrected easily with addition of sensors, etc. It is very important that this be accomplished, given the severe consequences of a bad part which is allowed to be built into a finished device. Next, we plan to run the AMI's to build 150 customer samples urgently needed by Kelsey-Hayes. We are in a good position to accomplish this.

TI-003604

- results of HH testing?

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-09-06

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION:
Results of Kapton lifetesting to date are as follows. Given the Weibull beta's and theta's for each test lot, reliabilities have been calculated for 500K cycles.

Rel @ 500K	Configuration
99.85%	Prod. cup, Hand line crimp, with AMI precrimp
99.77	Prod. cup, AMI crimp (built 910828)
99.26	Prod. cup, Hand line crimp
97.63	Model shop cup, Hand line crimp (9010xx validation)
96.75	Prod. cup, AMI crimp without precrimp (910828)
94.81	Model shop cup, AMI crimp
14.69	Prod. cup, AMI crimp (built 9107xx for PC Val.)

Notably, the lot of standard PC production parts recently built on AMI as a control lot (#2 above) turned out to be very significantly different than the failed validation parts. The hand line crimp displays some slight advantage over the AMI crimp, and the presence of pre-crimp also displays an advantage.

We plan to get Light Truck parts, built in July along with the failed PC parts above, on test ASAP. The reason for this is because these parts are now also suspected to have reduced life. One of the LT parts which recently passed Impulse testing was found to be wet inside; it was very close to failure which would have stalled current LT validation progress. Understanding the characteristic life of these LT parts built in this timeframe may shift the focus away from the increased PC converter travel, and towards either component parts or a production problem which has since been corrected.

We are also testing new lots of PC parts which are designed to modify converter travel. One lot actually decreases travel by preloading the tube, hence shortening its throw. The other lot raises the converter relative to the washer, such that the total travel is the same, but is shifted up so at maximum travel the flexure of the Kapton is similar to a LT part. Yet another control lot is included with these parts.

It has been decided to go ahead and rebuild PC validation parts now, even though the cause of the early failures has not been identified and corrected yet. PC control lots built recently are displaying very good life. We plan to get these parts onto the cycler by the end of the day today, which will allow them to reach 500K roughly mid-day Tuesday if all goes well. During build of these sensors on AMI, we also ran a couple of parts with pressure-sensitive film. The pressure traces on these looked essentially identical to the ones that were taken during the previous AMI build (the one that produced excellent life). We hope that a similar crimp pressure will mean a similar life expectancy.

Another significant tool for solution of this problem is the cross-sections of the original failed parts and controls. However, we have not received the parts from TSL yet, and Paul Sherman has not returned my calls.

TI-003605

MECHANIZATION:
We have proposed that the control software on the switch AMI be changed such that the check station is the final arbitrator of a "good" part. This is because we have demonstrated excellent correlation between the check station and the real world. Presently, a part bad on either cal or check will be called bad, decreasing yields if cal is bad but check is good. Before Mech. will make this fundamental software change, they'd like to see effort placed on understanding the differences between the calibrator and the check station.

We have begun to experiment with the system of weights on the calibrator in order to try to close the gap in correlation between it and the check station. A quick-and-dirty experiment was conducted, using a limited selection of poorly-fitting weights. We did discover that additional weight over the transfer-pin area seems to close the correlation gap slightly. We also noted that the check station itself is running commendably well, with sigma's on repeated measurements of the same part running in the range of 0.06 - 0.14 mils. See MSG #182281 for a complete discussion.

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HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-09-27

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION, PASS CAR:
Test reports were finalized late last Friday, and fax'ed to Joe Schuck in preparation for a call first-thing Monday morning to Bruce Pease to solicit his support for a conditional ISR. Because he was about to leave on business for several days, he asked us to approach his supervisor, Bruce Masroff, with a concise explanation of the situation. Apparently Mr. Pease did not prepare Mr. Masroff, because the deviation from procedure, using hand-line built parts without Fluid Resistance testing to pass Impulse, has caused quite a commotion. Joe is very critical of our reluctance to approach Ford up-front when the problems began. At this point, SQA Mark Scholler has asked for Bruce P. to write an "alert" at which point Mark will enter a 90-day extension. We'd like to understand Ford's position relative to holding us to only 90 days, because this simply might not be enough time to get the Kapton rupture issue cleaned up to Ford's liking, which includes at least a re-run of Fluid Resistance and Impulse. A complete explanation of the Kapton issue has been forwarded to Joe, to arm him with more facts for use in dealing with Ford.

VALIDATION, LIGHT TRUCK:
A different set of problems to deal with as Light Truck. Here, salt-spray failures occurred which were attributed to the mating connector. Our validation was run with EPC connectors, which are an older design and not very robust. This has raised questions such as which connector LT actually plans to use, which we do not know. They may in fact choose (-or-have chosen) the UTAG connector, which we used successfully on Pass Car. We have tried to claim similarity in the ISR writeup, which at this point has not been well received. There has been talk of re-running the whole thing with UTAG connectors, which is ridiculous.

KAPTON LIFE:
Cycling of the various test lots continues. At this point, we have, generally, 4 or more failures of 6 in each lot, enabling decent Weibulls to be calculated. For the modified-converter-travel lots, we have learned that there is no difference between the control lot, the lot with .006" reduced washers to raise the converter bump, and the lot with .005" stepped washer to pre-deflect the disc and limit travel. All three have Beta's between 4.4 and 5.1, and Theta's between 1073 and 1145. Note that these AMI-built parts actually performed atypically well in terms of characteristic life (Theta), although Beta's are typical. For the lot with the stepped hotpoint to move the Kapton clamp diameter outward, we found the test lot significantly worse than the control lot. The Beta & Theta for the control lot was 4.0 & 711, versus 2.8 & 573 for the test lot. Maybe we actually need to bring the clamp diameter inward, as Stan Hoenol has suggested. We're also analyzing the hand-line built Pass Car validation parts, and have found a Beta of 7.2 and Theta of 1080, very typical numbers for hand-line product (compares with 6.0 and 1133 previously).

Presently, we have on test the AMI-built validation attempt which was run in Stan's cycler at reduced pressure (different parts from same lot), and two lots of parts being run to support production. These two lots are part of a 1500-pc Pass Car lot accidentally built on the AMI, and we are now cycling them to determine if they are, by chance, actually good. We have six straight off the AMI, and another 6 which were crimped on AMI then crimped again on the hand-line, which may expose a potential salvage technique.

HIGHLIGHTS

Stephen B. Offiler

Week Ending 91-09-20

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION:

Rough drafts of both the Pass Car and Light Truck ISR reports are complete; final reports are being slightly delayed by the Humidity test. This should have completed yesterday (Thurs.), however, the chamber in ETL was hit by an electrical disturbance during a thunderstorm Tuesday night and shut down. We had completed three full cycles at this point, so another seven were required after re-start. This will complete this afternoon at 4:30pm. Jeff has been scheduled to work until 6:30 tonight to finish final characterization on these devices so the reports can be finalized.

Unfortunately, problems occured in both the Car and Truck devices during the testing; the ES states "all devices must pass." Car is worse, due to the significant difficulties encountered with Kapton life, and the reaction plan which finally led to running 24 manual-built devices on an emergency test without any initial characterizations and without subjecting -12 to Field Resistance. It is likely that Pass Car will grant conditional approval at best, or no approval at all, until we straighten out the Kapton problems and re-run the test "by the book". Problems encountered with Truck are much less severe, and hopefully will not prevent approval. The difficulty we had was salt spray failures, where 4 of 6 devices filled with salt solution which caused extremely high current leakage. However, careful scrutiny of these devices showed the leak path was via the mating connector, and we have blamed the design of this connecter in the writeup.

We plan to fax the final versions of the reports to Joe Schuck so he may prepare for telecon's with Bruce Pease and John Pelkey on Monday morning. The actual finished product will be bound in TI Test Report standard format for inclusion with the rest of the ISR package, and shipped early next week.

KAPTON LIFE:

Now that the CCPS cycler has been fixed up by completion of validation, we plan to continue with the various test-lots for Kapton failures. Testing includes devices with limited converter travel (via modified washers); devices with modified hexports to control Kapton clamping and move it outward; and devices with switches versus without switches, which the data strongly suggests as a variable.

SPRING AND STATIONARY TERMINAL BREAKAGE:

When Q.C. ran their QAS pilot test procedure on LT 77's off of the effectivity runs, spring breakage was noted on parts cycled at 640/min on the production cycler. This had never previously been an issue, although until this time all parts have typically been run only in the CCPS cycler at under 150/min. A comparison test was started, using parts picked at random from the effectivity runs, running on the production cycler and the CCPS cycler in parallel. This done, the production cycler turned up not only broken springs, but also broken stationary terminals. Parts on the CCPS cycler have not been completely analyzed, but we do not suspect any problems with these parts. We've cut windows in a couple of devices and took high-speed video of the spring action on both cyclers. This footage will be analyzed as soon as possible to attempt to determine the differences between the cyclers. As far as stationary

HIGHLIGHTS - 910920 - Page 2

terminal breakage, we've discovered that they were not cut off strip symmetrically on the AMI, and the calibrator was deforming them improperly. Both these issues are being addressed. A toolmaker is presently working to modify the spring bending station on the HA equipment to bring it closer to the spec, which should help minimize bending stresses and breakage.

SAMPLES:

We had an order for 12 parts for Ford Australia which was due to ship on 910917. However, correspondence via fax with the brake engineer, Brent Franks, made it clear that an M10 x 1.0 thread is required. Previous samples used M10 x 1.25, and we have no hexports with the correct thread. I sent a lengthy memo to Brent, copying TI Australia Field Sales and Engineering, explaining the confusion over the thread spec and the schedule slip it has caused. At this point, we need to have hexports made on CNC lathe in order to complete the order.

We have received an urgent request from Hilhe Industries / Pitts' head of purchasing for 300 Pass-Car 77's for their validation. They want these devices next Friday. We should be able to meet this need if we crimp sensors on the manual line and correct the problems with the springs and stationary terminals.

Mfg. Eng. has exposed a key piece of information in the crimp puzzle. Actual pressure-transducer measurements of the crimp cylinder pressures has shown that the AMI was running significandy lower in pressure on both stages of crimp. This data was collected before some maintenance (cleaning filters, etc) was done on AMI, so the plan is to repeat the measurements to obtain the present status. Furthermore, a test is planned by Mfg. Eng. with our support where devices will be built with pressures on AMI at lower values, and at values matching the hand-line. Controls will be built on the hand-line as well. These will be cycled to failure in our cycler for direct comparison with all previous data, as soon as manifold positions begin to open up early next week. We also plan to build a couple from each lot with Fuji pressure-sensitive film.

MECHANIZATION:
Mfg. Eng. and Mechanization have spent significant efforts to correct the problems noted with the EA and the AMI. This includes the spring-bending tool, which was leaving score marks, bending to an insufficient angle, and the bottom die was found to be chipped. On AMI, the cutoff stations for both terminals have been upgraded to ensure that asymmetric cutoff cannot occur, which combined with a new, lower calibrator target should help avoid broken stationary terminals. We plan to begin testing with devices calibrated .005 lower and using the corresponding pin (.146 -.005 = .141).

The Final Asm Machine and the pressure tester have been moved from B20 to B12, and are presently being set-up and connected to utilities. The Base Asm Machine and the EA machine are in the process of being moved. It will be several days before we can even power-up the machines, at which point several more days will be needed to get them back to their status before the move.

SAMPLES:
The schedule for the 300-pc lot of 77PS's requested by Plus for ISR work has been successfully moved forward by Marketing, pending the correction to the base mold, which also co-incides with the completion of the machine move. They are expecting parts around 911007.

For the Ford Australia samples, I have updated the metric hexport dwg EX3423-61 to include the correct thread, M10 x 1.0 - 6g. I have also reviewed the ISO toleranciag technique and calculated the correct pre-plate major and pitch diameters for the thread, which have been placed on the print. The specified 6H (internal) and 6g (external) thread tolerances correspond with our 2B and 2A respectively; while the metric standard actually provides about 13% more tolerance. The EX has been forwarded to Mike McHugh for creation on the CNC lathe.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-10-04

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

INITIAL SAMPLE REPORT (ISR):
Conditional approval has been granted at Pass Car; Bruce Pease has written a 90-day "alert" which means we must complete full ISR in this timeframe. Basically this means correction of the problems which led to early Kapton failures, and a re-run of some (or all) of the ES tests. If the correction is simple and straightforward, then it is likely we'll only need to submit Fluid Resistance and Impulse; whereas if significant process or design changes are made, we'll need to do the whole thing. Timing, of course, is absolutely critical, since our 90-day period (911002 thru 911231) is effectively shortened because it encompasses both holidays. Bruce has asked for a detailed action plan ASAP, which is in the works. Before submittal to Bruce we will review this plan formally with Design, Mfg. Eng., Mfg., Quality, and Mkt. The rough outline shows that regardless of which tests we run, we must have the final parts built on Wed. 911030, three and a half weeks from today.

The Design FMEA was completed on a very high priority basis last weekend for review with Mark Scholler (SQA) during Dave's trip last Tuesday 911001. Apparently our DFMEA technique/approach on this program (and others) is not pure Design; we seem to have a tendency to mix too much process in with it. Mark is being very helpful on this. We need to revamp the DFMEA and resubmit. Weekly FMEA meetings will recommence.

We are now expediting arrival of new, blue-colored environmental seals for Pass Car to replace the current ones, which have only a hard-to-find stripe mark for differentiation. We plan to file an SREA for these, and if all goes well, we'll build the above revalidation parts with these.

KAPTON LIFE:
Diaphragm lifetesting of various experimental lots was suspended last Sat. 910928 due to hydraulic pump failure. The pump was removed from the cycler and hand-carried to an authorized service center in Warwick, RI. Repair was turned around in two days, and we are in the process of re-installing it in the cycler. Excellent job by Jeff D., Natalia in Purchasing, and Tri-Power Sales & Service. Since a failure of this nature can set critical testing back by a week minimum, we have decided it is wise to purchase a spare Enerpak unit which will be available for any of the cyclers (not just CCPS) in the event of failure.

We plan to run an experiment to test the hypothesis that air pressure in the AMI crimp heads was insufficient during the original (failed) validation build. We've taken a sample of pre-crimp-only devices directly off the AMI during a production run. The pressures will be turned down to the lower level discovered recently to crimp one test lot; they will be turned up to match the hand-line to crimp the other lot. These will be cycled to failure and analyzed with Weibull techniques for comparison with other test-lots.

HEXPORT:
Thread rejections continue to waste everyone's time. Most are written in-process, and end up being a gaging-technique issue rather than a true rejection. We are attempting to streamline the process by instituting a reaction plan whenever a potential rejection is discovered. Use of the 4.5 in-lb gage torque is the arbitrator if rejected on the GO gage.

TI-009612

We are creating an evaluation plan for the 10B21 hexport samples. These have the potential to solve the thread problem because the thread is significantly harder (per actual DPH measurements) than current 10L10, hence damage during plating should theoretically be lessened. We will look at undergoing tests of strength (burst, stripping torque) and environmental resistance. We'll need to approach Ford with an SREA if all evaluations are positive. Also, we are expecting soon the full-plating-lot of reduced zinc parts (.00015 vs current .0003 min) which have olive-drab chromate to help regain some lost corrosion resistance. These spend significantly less time in the plating bath, and hence they theoretically are damaged less.

At some point, it is conceivable that we'll combine all of our thread efforts to produce a higher quality part. This includes the above 10B21 harder material, with thinner plating and olive-drab chromate, using the ANSI B1.1 gaging technique which allows 3A GO / 2A NOGO on plated parts.

SAMPLES:
Due to the move of the Mechanization equipment, we are presently unable to produce any parts. Efforts have been prioritized by Mfg. Eng. to correct issues with the Eastern Automation movable terminal equipment, then get the base asm. machine up, then last-but-not-least the final asm. This is likely to take about another week, including interim evaluations of the EA progress, cycled on the severe production cycler. This will put us behind schedule in shipping the 300-pc run for Pitts.

I've discovered that the paperwork for the Ford Australia metric hexport samples was lost somewhere between the Model Shop and the CNC Lathe in Bld. 20. We are still a couple of weeks from shipping these samples.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-10-11

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

INITIAL SAMPLE REPORT (ISR):
We have completed the detailed action plan for correction of outstanding ISR issues, and sent it via MSG (#165560) to Joe Schuck for relay to Bruce Pease. We have good confidence that the Kapton life can be improved via minor process upgrades/controls, since over the course of Kapton life testing we have seen numerous "control" lots which have demonstrated excellent life. The challenge remains to isolate the cause and eliminate/control it, and progress is being made.

KAPTON DIAPHRAGM LIFE:
Crimp pressures (i.e. the air pressure in each of the two crimp stages) remain the suspected primary cause of poor Kapton life. We are running a test of six lots of devices, built on AMI with known, consistent components, and crimped over a range of pressures from about 45/40 to 70/60. These will be cycled to failure beginning today and analyzed with Weibull techniques for comparison with previous test lots. This test should identify the correct crimp pressures to use.

We are also investigating secondary influences, specifically the washer. Of all internal components directly or indirectly affecting the Kapton, the washer is the only one which is built on several different tools and is therefore known to have the potential for geometric differences. Furthermore, we have learned from production operators that significant shifts in device characteristics can be obtained by changing washer lots. They sometimes use this fact to help control piloting. Parts hand-built by Jeff typically have no control over washer lot, so we plan to go back through our past experimental lots to check washers. Pending results of this investigation, we'll likely produce another set of test lots, varying only washer lot, with the inclusion of a Ni-plated lot. These will be crimped at a pressure which produces poor life, in the interest of obtaining comparative results more quickly.

Given our experiences with cycler failures during the course of this investigation, we are looking into spare parts to allow rapid repair in the future. Jeff has discovered that the Enerpak hydraulic pump unit is around $2300, and the Moog servovalve is around $2500. The alternative to purchase of spare parts is to comprehend potential downtime delays. Failure of either causes a minimum delay of 4-5 days, potentially longer.

CUSTOMER ISSUES:
Tim Andresen (Pass Car Brake Eng.) has requested a couple of silent 77's. We happen to have a couple of spare switches of this configuration already built. These will be shipped N/C to Joe for hand delivery to Tim.

We had a brief meeting with Dave Polrier of GM Powertrain Eng. They were here on APT business, but during the course of the meeting Dave learned of our switch capabilities and realized he had a potential application. Cadillac (Northstar) is working on an engine torque management safety system (an offshoot of traction control) which will reduce engine power if sensors determine the driver is on the brake and gas simultaneously. They are unsure as to the pressure range, but Dave's gut feel is that a typical brake-control-deactivate level is appropriate. During the informal 77PS line tour, he was particularly impressed by our base calibration technique requiring only one pin length.

HIGHLIGHTS

STEPHEN A. OFFILER
W/E 91-10-25

KAPTON DIAPHRAGM LIFE:

As Jeff D. reported last week, the results of the crimp pressure showed absolutely no influence on diaphragm life. We are now in the middle of the master test, using O-ring Ni plate, O-ring Sn plate, and O-ring Zn plate. The O-ring Zn seems worse than the other two, which are about equal, preliminarily. Failures in the bellow hits ... began around 800K, so the washer is merely a secondary variable.

Based on Carl Sanford's inputs, we tried lubricating gaskets (using silicone DOT-5 brake fluid) to see if this would have any effect on the "teardrop" shape observed in the Kapton surface when the bellows is cut off a crimped device. Dry and lubed parts were crimped on H-L and Amis. Teardrops were observed in most devices; on dry Amis part and on lubed H-L part had no teardrop. Since essentially no difference was observed in any of the tests, we have no confidence that the teardrop phenomenon has any influence on Kapton life. We plan to go back to previous failed devices and cut off bellows to see if any further clues can be obtained using this analysis techniques.

We have elevated the priority on the HL vs Amis die revamp so we can get test parts cycling over the weekend. Jeff, Dave, Matt, and I will work together to get these test-slots built today. A full matrix will be built: Amis tools on both crimpers, plus HL tools on both crimpers. Jeff is hand-selecting parts, using O-ring Zn washers. We'll need to bring Jeff in a couple times over the weekend to keep the test running.

SAMPLES:

I think we're finally straight on the Ford Australia samples, after a flurry of correspondence between Charlie and John Butler @ TI Australia. We'll ship 12 TPS's of mating connectors and MIDNID kits for US$25 each. Mike McHugh reports that bellows will be machined Oct 29. Plating should be complete by Nov 2, allowing build & ship Nov 4 if all goes well.

TI-003615

Jeffrey DiDomenico
Weekly Highlights for Steve Offiler
10/18/91

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

KAPTON DIAPHRAGM LIFE:
Impulse of test lots crimped at different pressures is nearly complete. Weibull analysis of the data has revealed a general downward trend in reliability at 500K as crimp pressure is increased, however, we have not seen the drastic differences or trend we expected.

Crimp Pressures	Beta	Theta	Reliability at 500K
45/40	1.6	677	76%
50/44	3.4	672	81%
55/48	3.9	669	73%
60/50	2.8	764	74%
65/55	4.9	632	73%
70/60	3.6	643	67%

A new matrix of test lots are scheduled to go on impulse by the end of today. This matrix will target differences in washer as a cause of diaphragm failure. The matrix will include 0-cut washers (control lot) which have more of a chamfer on the inner edge than a radius, 2-cut washers which have the best radius we have seen, and the old-style nickel plated washers which are more slippery. A fourth group will be added to the matrix early next week which will be crimped on the AMI with the tools from the hand-line crimper substituted.

CUSTOMER ISSUES/SAMPLES:
It is still unclear which thread is required to fulfill the 12-piece sample order for Ford of Australia. Charlie Douglas hopes to have confirmation one way or the other by Monday. If the M10 x 1.25 thread is correct, we can ship samples next week. However, if the M10 x 1.0 is required, we will not be ready to ship until early November due to back log in the CNC lathe department and the necessity of plating.

CRUISE CONTROL AUTOMATION EQUIPMENT:
Manufacturing engineering and mechanization continue to iron out problems with the switch assembly AMI (6N7AM) and the Easten Automation machine. Production has an order of 3,570 parts to be shipped on Monday which has put this debug on emergency status. 100% of Dave Peripoli's time will be dedicated to this effort until resolved. This accounts for the delay in the above test lot being delayed until next week.

TI-003616

HIGHLIGHTS

Steel Office
W/E 91-11-91

DIAPHRAGM LIFE:

Results of washer test (using 0 wt Zn plate; 2 wt Zn plate; and 0 wt Ni plate) all crimped on Amsi @ "normal" position:

	LOT	β	θ	
a)	0 wt Ni	2.4	1630	(first fail @ 603K)
d)	2 wt Zn	2.4	1472	(first fail @ 607K)
c)	0 wt Zn	3.3	560	(first fail @ 418K)

Mixed failure modes were apparent from the Weibull graphs;... the first failures seemed to be on a different curve than the latter ones. The above β and θ therefore actually represent averages of the mixed modes combined.

Results of crimp tool swap:

	LOT	β	θ	
a)	Hand tie tools on Amsi	10.4	709	cut open
d)	Hand tie tools on HL	5.3	670	
c)	Amsi tools on Amsi	6.6	668	
b)	Amsi tools on HL	7.9	540	

Contrary to washer test, mixed modes did not appear to be a factor. It seems that the hand tie tools produce a higher θ, while the Amsi produces a higher β. All above used 0 wt washers tested. as results of washer test. However, cut C of washer test should be identical to cut c of crimp tool swap.

Based on a combination of the above, it would appear that hand-tie tools on the Amsi dies with 2-wt washers will produce our best shot at good devices. Of course, we still have no concrete idea why.

Jeff DiDomenico has developed a very good hypothesis which explains leadtop formation. He suggests that the washer & support loading is quite possibly asymmetric, leading to greater clamp in some areas and less in others. These areas clamped less would allow the Kapton to pull out, producing the "print" of the leadtop. We're experimenting with this hypothesis using stepped relief in the support combined w/ full round Kapton.

TI-003617

Using the relatively new technique of cutting away the heatsink to observe the top Kapton layer while the device is still fully crimped, we have opened up the worst and best devices from the three wafer lots. This was done to attempt to understand the apparent differences in failure mode. Evidence of bonding shape was fairly subtle, but nonetheless the three low-life parts had a fairly narrow area of perforation, apparently at the peak of the bonding (but this is questionable, since the bonding could be a result of the perforation rather than the cause.) In contrast, the high-life parts showed the top layer to be folding uniformly all the way around.

It is unfortunate that we are at our drop-dead point to build ISIR parts, because all indications seem to be pointing to the bonding as the fundamental problem, and we are only just beginning to understand the cause and remedy to this phenomenon. With Joe Schwalb's departure, it might be wise for Marketing to place a call to Bruce Rose to update him on our status and request an extension to our 90-day deadline.

TI-003618

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-11-08

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

PASS-CAR REVALIDATION:
Two lots of parts were constructed to undergo the combined Fluid Resistance and Impulse testing, which was compromised in the original validation attempt. One lot uses the desired production technique (AMI) whereas the other uses the technique we were forced into as a fallback during the original validation (57PS Hand Line). Based on results of failure testing over the last several weeks, the best-performing crimp dies and washers were used. Half of each lot was precharacterized and delivered to the Chem Lab on time to begin the Fluid Resistance test on schedule Tuesday. The other half, which undergo only Impulse, started cycling on Wednesday. These will complete their 475K mechanical cycles early Saturday, and Jeff will come in to set up and run the 25K powered cycles. Post-characterizations will be done early next week, then all parts will be run to failure in order for the sake of information. An interesting observation was made regarding act/rel pressures. Parts crimped on the hand-line were lower on average than the AMI parts, by about 3 psi on act and 11 psi on release. We plan to take a closer look at this phenomenon to see if it provides any clues to the diaphragm life issue.

KAPTON DIAPHRAGM LIFE:
We're continuing to work on the teardrop shape in the Kapton surface as a contributor to early life failures. We've seen the perforation in the diaphragm to generally coincide with the apex of the teardrop if present; if absent the diaphragm wear is well distributed around the perimeter. We're looking into the possible mechanisms that promote teardrop formation, including pre-crimp, gasket friction, and asymmetric clamping. We're also looking into whether teardrop formation is an issue with Light Truck parts.

CUSTOMER ISSUES, SAMPLES:
For the Ford of Australia samples, the M10 x 1.0 hexports were completed by an outside house, plated in B11, and have been built into devices. We planned to test these on the production tester, but apparently it would not seal properly. We're making an adapter so we can manually test these on our Life Test check station. They will ship today, on-time per the revised schedule. They were originally promised for 91-09-17 until confusion over thread spec's arose.

Charlie Douglas met with Bruce Pease earlier this week to discuss the Kapton life / revalidation issue. Charlie reports that the meeting went well, and Bruce is convinced we're making good progress on the solution to this problem. It looks like an extension to the 90-day alert is possible, if required. On another subject, Charlie hand-delivered the SREA for the change to blue-colored environmental seals for PC devices.

MECHANIZATION:
John Kourtesis and crew are presently working on eliminating the rivet from the Eastern Automation movable-terminal assembly machine. The two options being considered are ultrasonic welding and resistance welding. I'm working on a quick sketch of the terminal/spring redesign for presentation at a meeting John will hold early next week. Of course, this change will require revalidation. I propose that we use our P & DFMEA's to drive the justification for this change, possibly rethinking the PRN's associated with the rivet and riveting process relative to a welding process.

HIGHLIGHTS

Stephen B. Offiler

Week Ending 91-11-15

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

PASS-CAR REVALIDATION:

Twelve parts from each lot (AMI crimp and HL crimp) successfully passed the Impulse test. Twelve more of each will undergo this test when they complete the Fluid Resistance test in December. They have been characterized post-test, and are now running to failure for information. They are at 950K cycles with no significant number of failures to report yet. As previously reported, the pre-test characterization showed significant differences in release pressure between the two lots. This difference disappeared during cycling; it is possible that it is attributable to a Kapton-wearing phenomenon. We're looking into linking this with observed differences in the crimp techniques which are suspected to lead to diaphragm life problems. Also, Jeff has noticed crimp dimension differences between the two lots, even though the same crimp dies were used for both. We're looking into this with Mfg. Eng. help.

HEXPORT:

We have completed an initial evaluation of the mechanical strength of the 10B21 hexports. Two tests were used: burst, and torque-to-breakage. Results of both tests indicate that the 10B21 hexports have better strength. The average burst strength of 10B21 was 7983 psi versus 7650 psi for 10L10. The average torque of 10B21 was 51.8 ft-lb versus 41.3 for 10L10. Also, we previously cross-sectioned samples of each material and measured the hardness in the thread area. Results of 8 measurements at the crests of the threads show the 10B21 averaging 244 DPH (200 gram Diamond Pyramid Hardness), with the 10L10 averaging 194 DPH. If no cost differences exist (as Elco has led us to believe) then we should seriously consider a move to 10B21 material. Final decision on this is pending environmental analysis of the reduced plating thickness (to reduce thread damage in plating barrel) as well as final decision on the ANSI-specified gaging technique, using 2A LO and 3A GO gages. I'm confident that the combination of the above will finally eliminate the chronic thread problems we've been experiencing on this and all other Elco hexports.

SAMPLES / CUSTOMER ISSUES:

We've begun to receive sample request for silent devices from Ford for WIN88 (Truck style centered connector with Pass Car style pressure) and from Bendix for Truck. We're establishing new part numbers, envelope drawings, and parts lists for these products. Samples are due in early December, which doesn't seem to be a problem since we already have small quantities of silent discs. Base colors have not been firmly established, hence for samples we'll use standard black for truck and brown for car.

The Ford Australia samples with metric M10 x 1.0 o-ring hexports shipped last week. We received a fax from Brent Franks, the F of A engineer on this program, which indicates he's experiencing audible noise difficulties. I have responded to this, indicating that this is an established concern and we are working to minimize it. Brent also alluded to a possible change in pressure spec's, downward. I am trying to steer him away from this, since the Pass Car disc already has reduced throw (relative to Truck and other 57PS's) and making it silent will only worsen this; compounded with even lower pressure spec's may reduce throw to an unacceptable level.

HIGHLIGHTS

Stephen B. Offiler

Week Ending 91-11-22

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

PASS-CAR REVALIDATION:

Eight of ten parts crimped on the hand line, cycling to failure for information, have died between 853K and 1336K. The remaining two have been removed from test for diaphragm analysis. In contrast, only one of the eight parts crimped on AMI (using HL crimp dies) has failed thus far, at 1361K cycles. Two of these have also been removed for analysis. The remaining five will continue to run to failure. This lot is of particular interest, because this is the first time since we began diaphragm life testing in August that the AMI has produced parts superior to the hand line.

DIAPHRAGM LIFE:

The planned analysis of the four long-life parts from the above validation consists of F/d characterization, to observe if differences in converter travel (pre-deflection caused by crimp differences?) account for the drastic life differences, plus opening for observation of diaphragm condition/teardrop. F/d curves have been obtained on virgin sensors from this test to explore the observed differences in release pressures between AMI crimp and HL crimp. It was learned that the effective area on actuation is comparable for all, whereas the effective area on release is much larger for the HL crimp parts, which accounts for their much lower release values. No good hypothesis has been generated to explain this large shift, however.

The model shop has built a set of test bexports which have a step to clamp the Kapton at the outer circumference. This was tried previously, however this time we're using three different step heights, and full-round Kapton. We're using this to explore teardrop formation/wetting, to understand whether the Kapton primarily stretches (deforms plastically) to wet, or whether it primarily pulls out from under the clamped area. We've opened two samples from each of the test lots for diaphragm observation. The control lot (square Kapton, no step) has one textbook teardrop, and one which is wetted ideally. The round Kapton test lots show generally poor wetting with no actual teardrop but some lobedness and upward bulging. The fact that we're observing poor wetting in the test lots seems to suggest that the square Kapton promotes some pulling out from the clamp area in order to wet, and the teardrops form if the Kapton pulls out asymmetrically. We are also characterizing samples from these lots, which should show the differences in wetting as smaller effective area hence higher actuation and release values relative to the control group. Finally, these parts will be cycled to failure.

Another extensive test of the theory of teardrop formation is getting underway now. We're marking all cups, so that orientation in the test during crimp can be controlled. Thus, if the flexing of the "C" frames of the crimp tools (radially outward) is a factor, there should be some correlation between teardrop and position. Some parts are being run with Fuji pressure-sensitive paper, while others are "normal" construction. We'll be performing extensive measurements of the crimp height/diameter of these parts (relative to position), as well as opening them for observation of teardrop. A few will be removed from the table before the air-blast station, to help determine if the teardrop forms before or during wetting.

MECHANIZATION/MANUFACTURING:
A problem with staking the stationary terminal on the base asm machine has been observed. Various efforts to correct this, including comparison with staking on the 57PS-style stakers, has led to the conclusion that a small amount of lubrication is required in order to fold the stake tab correctly. In fact, simply touching the stake tool with a finger has been shown to produce good stakes for several parts. A short-term lubrication procedure, swabbing the tool with Vanishing Oil, has been implemented. Longer term, Mechanization is working on staking tools with various surface treatments (chrome, nitriding) which do not require lubrication. It is generally assumed that the movable terminal does not exhibit this problem due to trace amounts of lubricant picked up from the exhaust of the air cylinders in the movable terminal assembly machine, and the 57PS does not exhibit this problem because all terminals are handled by operators during assembly.

A meeting was held with Stapla, a manufacturer of ultrasonic welding equipment, to explore the possibility of replacing the troublesome spring arm rivet with a weld. They showed extensive literature and examples of ultrasonic welds of copper to brass, as well as many other material combinations. They claim to have excellent acceptance with the US automotive companies and their electrical suppliers. Mechanization has contracted them to produce prototypes for us, which we will initially evaluate with various cycling and pull/peel tests.

HIGHLIGHTS

Stephen B. Offiler

Week Ending 91-11-27

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

DIAPHRAGM LIFE:

All of the Pass Car Revalidation parts have been cycled to failure. The AMI-crimped parts (hand-line crimp tools) exhibited by far the best diaphragm performance to date, with a Beta of 15.3 and a Theta of 1579; versus the hand-line crimped parts with 7.2 and 1207 respectively. We have held aside several sensors from each lot for analysis of this large difference, including virgins, 500K cycles, and long-life parts which hadn't failed at 1350K cycles.

We are now cycling the experimental lots with full-round Kapton, built with stepped hexports in order to concentrate the clamping force at the outer circumference. Control lots with round Kapton/no step, and normal square Kapton are also included. Initial characterization showed the full-round lots actuated and released at higher values than the square control lot, which was expected because the Kapton is not wetted very well hence a smaller effective area and larger pressures needed to develop equivalent disc force. A quick interim characterization of a few of the parts at 450K cycles shows that the pressures have dropped, again as expected, since cycling has completed the wetting. The only failures have been in the lots with the largest step (.007" nom.) and based on the very slow progression of the leakage I expect we'll find extruded gaskets, not diaphragm problems.

We have completed the build of all test parts for the analysis of the asymmetric-clamp study, to help determine if crimp tool "C" frame flexing contributes to teardrop formation. We're checking two parts from each nest with Fuji pressure-sensitive paper, to look for nest-to-nest variations, as well as analyzing crimp height and diameter and teardrop formation relative to the nest and the direction of the "C" frame flex. This test is delayed slightly by the fact that the decrimper is down for repairs, as well as lack of tech support while Jeff is attending Hydraulic Training.

57PS TO 77PS CONVERSION:

The initial phase of this testing program has gotten underway. 57PS sensors with the highest actuation and the widest release (L8-1) were chosen as representative of the largest pin travel and the highest snap energy. Sensors were pre-characterized and the pin window analyzed, then built onto 77PS switches using a pin length skewed long (towards creep-release) to obtain the largest spring deflections. Devices were given an initial characterization and returned to Mary to be cycled on production cycling equipment. They will be checked for continuity every 50K cycles, and failures will be opened for analysis as they occur. Weibull techniques will be employed as well after all have failed.

MISCELLANEOUS:

We have received word from Ford SQA Mark Scholler that the revamped partial DFMEA has been corrected consistent with Ford philosophy. We must now continue to revamp the rest of the document in the same fashion.

It has come to my attention that the on-line 57PS inspection equipment for current leakage has not been upgraded yet to comprehend the 77PS. They are therefore relying on us to supply lab equipment for this test, which is unacceptable for several reasons: equipment availability; setup time; and especially safety concerns, since our 500VAC sources are not protected and guarded appropriately for use by non-technically-astute production personnel.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-12-06

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

DIAPHRAGM LIFE:
The test of round diaphragms continues. Five of six controls (standard, square Kapton) have failed with a beta of 7.5 and theta of 1245, which is quite good. However, only two of the twenty test devices (round Kapton with various hexport steps) have failed, beginning at nearly 1700K. We are presently working on a new set of controls, which use square Kapton cut from the exact same material as the round parts. A "standard" control lot will again be included.

We have expanded the plans for the determination of the mechanism of teardrop formation. We are now looking at process and design contributors. Test lots are being built using all standard parts, as well as lots without gaskets, and lots with modified converters to produce a zero-height bump. These will be crimped to various stages of completion, including removal prior to air-blast, prior to final (stage II) crimp, and prior to stage I crimp. In order to examine the diaphragm in the pre-crimp condition (prior to stage I), we plan to have the model shop modify hexports to make them into 2-piece units which match a standard hexport when assembled but allow easy removal of the hex portion from the flange.

The test of possible asymmetry in the crimp procedure has been partially completed. We have observed no real correlation between the location of the seamdrop and the orientation of the device relative to the nest. Based on this, we've decided to abort the rest of this test in order to place emphasis on the above test of teardrop mechanism.

57 TO 77 CONVERSION:
To date, using 77 switches calibrated to .089" and 57PSL8-1 sensors, pinned high, we have had one spring break (in the expected location, at the top of the rivet head) at 900K cycles. The remaining 9 have passed 1250K cycles, and the test continues.

We are formulating a game plan to begin a detailed test, based on tentatively positive results from the above. This will include a study at tolerance extremes, using high- and low-calibrated switches, pinned at each extreme of the pin window. The test will use the actual sensor assembly in question rather than the worst-case as above. Cycling will be done on the CCPS cycler rather than the production equipment, at the ES specified temperatures and pressures.

Co-ordination with Marketing is planned, to ensure that our testing program is aimed at the high-volume 57PSL product(s), and to decide on the correct approach for customer approval and validation of the new product. At some point a decision will be reached on a TI part number designation for these; it is inappropriate to call them 57's, and it may be risky to call them 77's due to the price difference between these and cruise control 77's. It has been suggested to use the next available series number, probably 78PS.

DFMEA:
We plan to get work underway again on the Design FMEA. Given the number of parts and an estimate of the time required to complete each part, based on recent hexport work, it looks like the completion date will be mid-February if all goes well.

TI-003624

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-12-13

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

VALIDATION: The two lots of PC revalidation parts (AMI built and HL built) have completed the Fluid Resistance test, and are presently undergoing the Impulse test. This test will be completed by Tuesday morning, with final characterization to commence immediately, and final test report writeup to take place Wednesday in order to prepare the ISR package addendum by Friday. The plan is to report results from both lots, hopefully to gain approval from Ford for both processes.

DIAPHRAGM LIFE: The test of round diaphragms is nearing completion. Approx. nine survivors from the various test lots are presently at 2250K cycles, running in parallel with the above reval test. The control lot, with all standard components, is complete with Beta=5.3, Theta=1369, and Rel at 500K=99.52%. The lot with round Kapton and all other components standard has only 3 failures (beginning at 1933K) and no stat's calculated yet. The lot with round Kapton and .003" step in the hexport to control Kapton clamp has 5/6 dead, Beta=10.2, Theta=2090, and Rel at 500K=99.9999%. The other two experimental lots, with various size steps in the hexport, also do not have enough failures to allow stat's. These results certainly suggest that the round Kapton has much better life expectancy relative to square, but other significant problems exist, specifically device calibration drift and manufacturing concerns.

The test to determine the mechanism of teardrop formation is partially complete, and some initial conclusions can be made. Standard parts, parts without gaskets, and parts modified to produce zero-height converter buttons are being crimped to various stages of completion, in order to track the progress of teardrop formation. We've seen parts with the familiar teardrop after final crimp and air blast having a twin-apex teardrop (Mickey Mouse) pre-air blast, and a somewhat fuzzy suggestion of the Mickey shape pre-final crimp (post 45° crimp). The next significant milestone in this experiment is to check the condition of the diaphragm pre-45° crimp (post precrimp). The only way to do this is to use 2-piece hexports, which allow normal precrimp assembly action and also allow inspection of the diaphragm without needing to lathe-cut the hexport. The model shop is presently working on these. The parts without gaskets are also very interesting. Pre-air blast (post final crimp) there is significant excess material which has been moved radially inward; although there is no suggestion of a teardrop shape. At the previous process step, pre-final crimp (post 45° crimp) the same sort of condition is apparent, but less material has been moved inward at this point. The 2-piece hexports will be used to complete this sequence as well. At this point, we are definitely seeing a progressive action taking place, which is tending to move material radially inward as the crimps are made. Without gaskets, much more material seems to be allowed to move.

57 TO 77 CONVERSION: Using 77PS switches calibrated to .089" and 57PSL8-1 sensors pinned high, we have seen 7/10 devices fail on the production cycler due to fractured springs. All are breaking in the expected location, at the top of the rivet head where the spring is effectively constrained and the bending stresses are concentrated per cantilever beam theory. Weibull analysis shows Beta=2.1 and Theta=3230 with Rel @ 225K=99.63% and Rel @ 1000K=91.83%.

Charlie Douglas hand-carried 6 samples of the 57PSL2-2 conversion to Tom Strauss at Ford Power Steering. These were well-received. Charlie discussed revalidation requirements, and also found out that they're planning to switch to the more robust UTA mating connector.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 91-12-20

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

DIAPHRAGM LIFE:
All devices from the round Kapton test have finally failed (except one, expected to go any second now). Results are as follows:

Control lot, square Kapton	Beta=5.3	Theta=1369K Rel @ 500K=99.52%
All round Kapton lots	Beta=9.2	Theta=2350K Rel @ 500K=99.9999%

The only questionable aspect of the above test is that the round Kapton came from a different lot of material, possibly produced in a lab process, and therefore it possibly has greater mechanical properties which help account for the increased life. We plan a test using square versus round Kapton from the same material lot.

We plan to consolidate all recent knowledge gained from various design and process testing, and hold a meeting in early January.

VALIDATION:
The Pass Car revalidation has been completed successfully, and the addendum to the original test report has been written, bound in TI test report format, and delivered to QRA for submission to Ford. The 90-day clock expires on 91-12-31. We ran two test lots in parallel: crimped on Hand Line, and crimped on AMI using HL tools. All of these devices passed 500K cycles with flying colors. The writeup includes both test lots, such that we will be approved for both processes *using HL crimp dies*.

57 TO 77 CONVERSION:
The lifetest of 10 devices (L8-1 sensors, 77 switches) has been aborted at 6KK cycles, with 2 devices remaining. A rough draft development schedule has been assembled, which shows that we can begin shipping new devices as early as 03/92 *if* all goes well, and high priority is placed on completion of all internal and customer validation testing. This also assumes red-tape (customer envelope prints into Ford's system, TI parts lists, all ISR paperwork, etc. etc.) is handled efficiently.

DFMEA:
Work is progressing fairly smoothly. Since we recently began the serious attempt at completing this task, we've experienced only minor scheduling snags. Additional meetings have been scheduled in order to continue on a path to intercept mid-February completion. At this point, this effort is occupying significantly more than the 8-10 hours/week I previously estimated, and this is likely to continue.

HIGHLIGHTS

Stephen B. Offiler

Week Ending 92-01-10

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

57-to-77 CONVERSION: I have officially reserved the number 87PS (project #3472) for the new devices. For the sake of continuity and mfg simplicity, we plan to retain the same suffix, for example 57PSL11-2 becomes 87PSL11-2. It is important that we agree upon a strategy soon, since we are beginning to fall behind the aggressive schedule drafted in December and there remains some question whether we work exclusively on L2-2 or simultaneously work on all candidates, i.e. L2-2, L8-1, L11-2, and L11-3 as well as 57PS devices which need validation of Al crimp ring and line-move.

SILENT DEVICE FOR MY93 SHO TAURUS: We have received a M/C, with our silent 77PS switch installed, from Tim Andresen at Ford. They claim that the supposedly silent switch makes audible noise in the passenger compartment, and request an evaluation and test report. We plan to fixture the M/C on benchtop, confirm that the switch is the culprit, and next obtain an ABS Taurus to install this M/C and quantify the audible noise. Other experimentation, such as use of a snubber, can be executed at the same time.

— STD. SILENT SWITCH ; SUPERIOR SILENT; AVERAGE- N/A ?

DIAPHRAGM LIFE: We are presently running a test which is comparing square and round Kapton which is taken from the exact same material lot. This is because the exemplary life performance of the round Kapton witnessed previously was compared to production square Kapton from a different lot and different mfg. process. We've included a control group using standard production parts, and another test group using Ube polyimide material obtained from Gary Baker.

We have completed all testing designed to expose the formation process of the teardrop. Results will be presented and discussed at a meeting with Mfg. Eng. early next week.

DFMEA: Significant efforts are being expended in order to remain on track for completion in early February. While this is requiring more time commitment than originally planned, the team is very pleased thus far with the results. This should become a benchmark document for future DFMEA's.

TI-003627

HIGHLIGHTS

Stephen B. Offiler
Week Ending 92-01-17

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

87PS: Charlie Douglas has begun to hold startup meetings, and we are proceeding with required planning to co-ordinate internal design validation plus customer production validation of 87PSL2-2, L4-1, and L11-1. Also included are revalidation of 57PSF3-5, and 57PSF9-1 which are running in parallel with 87PS testing. Certain devices already have ISR dates promised to Ford (92-04-15), which will serve to direct priorities. We are working on several items to streamline this process, including approval from Ford to consolidate specifications.

Since a fairly large number of devices will ultimately need to undergo Impulse and Thermal Cycle (using similarity as much as possible for all other tests) we are beginning to plan for cycler capacity. Jeff has devised a scheme to set up the new cycler to run the complex TC test unattended. He will place an order for an Omega dual-setpoint temperature controller needed to accomplish this, as well as a spare brake-fluid-compatible hydraulic cylinder.

SILENT DEVICE FOR MY93 SHO TAURUS: Benchtop testing of the M/C with our silent 77 installed showed extremely little audible noise, requiring amplification to hear at all. This suggests that the noise problem is emanating from elsewhere in the system, but of course it could still be stimulated by our switch. Ford has requested we perform an evaluation and respond with a formal test report. This will require that we obtain an ABS-equipped vehicle in order to isolate the source of noise. Any ABS Taurus, or any Continental (ABS standard) will fit this Teves M/C. We prefer a Taurus if possible, since Ford reports the problem manifests itself here, but we are having significant trouble locating a rental ABS Taurus. We may have to try the Continental, which is based on the Taurus platform but probably includes more sound-deadening materials which will make the audible noise situation different.

DIAPHRAGM LIFE: The ongoing square vs. round Kapton test has begun to produce interesting results. (Recall that round Kapton from a previous test, from an 8.5 x 11 sample sheet, produced exemplary results.) This test compares round and square cut from the same sample sheet. The test also includes a Japanese polyimide film from Ube, square, and a control lot. As the test nears 1KK cycles, 3 of 6 Ube parts are dead beginning at 414K; 4 of 6 controls are dead beginning at 545K; and NO failures from either square or round lot from sample sheet material. It seems obvious that the sample material has much greater resistance to rupture, and it remains to be seen whether round vs. square makes a significant difference in these parts. Upon completion of this test, we should involve Dupont to explain the material differences (production vs. sample sheet) and possibly upgrade the production material.

A synopsis of developments in diaphragm life testing was presented this week. As a result, several good ideas were generated. The general attitude is that a more robust design is required, which is not sensitive to production line variables such as crimp tool geometries, crimp forces, etc. We will proceed with testing and development work, including the following experimentation: reduce/limit Kapton clamping by machining a step on the outer portion of the hexport flange to provide metal-to-metal contact to washer and using a small-diameter round diaphragm; try full-round diaphragms with only 2 layers; try Kapton without Teflon; addition of a "bump" male feature on the hexport with corresponding female in the washer in order to stretch the Kapton during assembly; and use of pre-bent, concave hexports (salvage parts, for example) to see if this eliminates the tendency of the diaphragm to move radially inward which is thought to happen as the hexport and washer bend at crimp.

TOKICO: Info coming from Charlie in Dearborn via Dave indicates we've laid our hands on a Tokico M/C with Hy-Stat switch installed. Apparently the switch mounts at an angle in order to clear the reservoir. We plan to completely characterize the switch, take photos and X-rays, then cross-section it.

SNAP DISC, CREEP RELEASE SEE TAGE

209/144

TI-003628

3713 9769

HIGHLIGHTS

Stephen B. Offiler

Week Ending 92-01-24

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

87PS: Planning for the various validations and all attendant documentation continues. We are presently working with Tom Strauss (PC Steering) and John Kuippel (LT Steering) to consolidate the two separate ES's (E53C for most applications, and E57A for LT). We've been able to steer LT away from the temperature characterizations required during their Thermal Cycle test. The Impulse test, previously 225K to 1450 psi and 775K to 600 psi was tentatively changed to 250K at 1450 psi, but John dug up a hose assembly ES which calls out 400K to 1600 psi. Before we settle on anything, I've requested that John forward a copy of that spec. It is possible that other parameters (such as temperature) are also different. Regardless, any changes apply to Validation testing, not to In-Process testing which will remain the same.

CUSTOMER ISSUES: Marketing has come up with a plan to borrow a car from Tasca Lincoln-Mercury in order to install the Teves M/C and conduct experiments on switch noise. We will visit Tasca today to finalize details. I have roughed out a test plan which will be presented to Tasca management. We have five switches that we'd like to experiment with: 1) the low-differential "silent" switch removed with the M/C; 2) a snubber device with snap disc; 3) a snubber device with low-diff disc; 4) a device using a custom diaphragm composed of layers of Kapton and EPDM rubber; 5) the Hi-Stat switch. We hope to be able to determine where the noise is coming from, and under what conditions, so that we may recommend possible solutions to Ford.

We've learned that our delay in producing an envelope drawing for WIN88 has upset a certain individual on that program, who has now threatened to go ahead with Hi-Stat. In order to placate this individual, we will place high priority on producing this print, although his reaction is somewhat childish and underscores a seemingly fundamental problem with the TI/Ford working relationship.

DIAPHRAGM LIFE: The present test of round vs. square diaphragms is nearing completion. The round test parts are again showing the best life, with only 3 of 6 dead and no Weibull stat's calculated yet. The square test parts (same sample-sheet material as round) have 5 of 6 dead, with a rel. at 500K = 99.91%. The controls (production material) have all 6 dead, with rel. at 500K = 95.76%. Finally, the Japanese polyimide material shows the worst life with all 6 dead and a rel. at 500K = 83.29%.

We have an outline, but still need to finalize plans to continue with diaphragm life experiments as discussed at last week's meeting. This is complicated somewhat by the need for cycler resources to conduct the battery of validation tests for 57PS and 87PS.

PRODUCTION ISSUES: Mfg. Eng. is interested in redefining the 77PS switch calibration scheme, by running the calibrate/check station at a fixed value and selecting pins as appropriate for different sensor lots. A meeting will need to be organized in the near future to explore ramifications of this.

TI-003629

HIGHLIGHTS

Stephen B. Offiler
Week Ending 92-01-31

92-01-31

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

87PS: We've received information from John Kalppel (LT Steering) which shows the requirement for the hoses used in PS assemblies is 400K cycles at 150 C fluid / 135 C ambient to 1600 psi. John has asked us to increase our requirement (for Validation only) to this, with the exception that he hasn't asked for any change in our present test temperature, which is 135 C fluid / 107 C ambient. We are generally in agreement that we can meet the higher number of cycles and higher pressure without any problem, and furthermore it appears to be a large negotiation concession on our part. We now owe John a marked-up spec. for finalization, and concurrance with other PS engineers (Pass Car. Europe, etc.).

SHO TAURUS NOISE ISSUE: We have obtained a brand-new '92 Mercury Sable as a test vehicle from Tasca Lincoln-Mercury in Seekonk, MA. Their co-operation in this matter has been exemplary. The car is to be returned the morning of Feb. 6. We have installed the master cylinder that was sent to us by Tim Andresen, along with the prototype "silent" 77PS device which they found to make noise on a '93 SHO Taurus evaluation prototype. We have installed this M/C, and discovered a very minor noise in the system, and tactile feel in the pedal. With engine off or on, the noise is not as noticable as the sound made by the brake light switch. Subjectively, the noise/feel are generally not considered annoying in any way by several individuals who have experienced it. We have noted at least three points in the pedal travel which produce some noise and/or tactile-feel: the BLS, our switch, and the third is suspected to be the ABS pedal-travel sensor. The Ford memo from Tim Andresen which accompanied the M/C mass: "Based on the number of cars we have built with the switch, I don't think this is a 100% problem. However, some of the switches make significant noise which may be intermittent." This seems to suggest that the noise we are experiencing is not necessarily as acute as it might be under different conditions. We plan to continue evaluations, including: installation of a normal snap device for comparison sake; isolation of the "silent" switch with rubber hose; a custom device with rubber diaphragm; and we are considering the logistics required in order to use the prototype snubber devices we've prepared with silent and snap discs.

DIAPHRAGM LIFE: The most recent test of square vs. round Kapton has been completed. The round Kapton from the sample sheet fared best, with rel. at 500K = 99.71%; next is square Kapton from the same sample sheet at 99.53%; then production square Kapton at 93.76%; finally the Japanese polyimide at 83.29%. (all values at 50% confidence).

HIGHLIGHTS

Stephen B. Offiler
Week Ending 92-02-07

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

SWITCH NOISE ISSUE: We have completed testing on the borrowed '92 Sable w/ Teves ABS, and the car has been restored to original equipment condition and returned on schedule to Tasca Lincoln Mercury. We had the opportunity to explore a number of different switch configurations, including: discs at various differentials; snubbers vs. standard 1512 ports; remote mounting with rubber hose; and the HI-Stat device. We confirmed the noise issue reported by Ford, as well as a tactile feel, although the so-named "low-differential" (4 psi) device implicated by Ford was not considered significantly obtrusive. Subsequent testing showed absolutely no noise or feel using discs with "ultra-low differential" up to 2.6 psi, while a 3.6 psi device was marginal. It is generally felt that 3.0 psi max differential would be sufficient to completely eliminate this customer concern. We'll need to explore the disc-processing ramifications of such a spec. Experimentation conducted with snubber hexports showed 4.0 psi diff. was undetectable, while 5.6 psi was marginal, suggesting a spec of about 5.0 max. However, concerns with the snubber include the fact that snubber plus 1512 will be quite expensive, standard o-ring snubber may be sellable to Pass Car but won't help this issue when it arises at Light Truck, and finally air entrapment. We found no difference in noise and feel when the switches were remotely mounted with about 12" of 1/4" I.D. hydraulic hose. Finally, running the HI-Star switch for information showed that even with its snubber it has significant noise and feel, to a somewhat greater extent than our low-diff device and somewhat less than one of our production snap devices.

PRODUCTION ISSUES: Production Impulse testing turned up spring arms cracking at the bump. Analysis by Mfg. Eng. and Mech. showed that the bump was not being formed correctly, with a fairly sharp crease in one area where the bump comes out of the plane of the spring. This corresponded with the location of the crack. The tool was dimmended and it was learned that the die was formed asymetrically, causing this sharp crease. Since this feature has not been touched since day 1, there is some cause for concern that all product shipped has this potential to crack. However, the production cycler is known to be unrealistically severe. We have had no problems to date with any spring arms' fits in our cycler. We are presently running a sampling of recent production devices in our cycler to ensure that there truly isn't any cause for concern. The feature in the die which caused this condition was expertly re-worked by hand, and the bumps now look exemplary.

Process Control

CUSTOMER ISSUES: We were forced to rush to get a print out to WINSS, and as such did not have the opportunity to reduce the number of dimensions as we intend to do on all future envelope prints. This print was turned around by drafting in one day. Our "lateness" perceived by Ford is a black eye for TI, although the real reason the print was "late" is that we don't seem to have a good ability to anticipate the requirements of Ford's system, thus we're caught unprepared and forced to rush which causes negative feelings and greatly increases the chances for error.

TI-003691

HIGHLIGHTS

Stephen B. Offiler
Week Ending 92-02-14

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

SWITCH NOISE ISSUE: We've begun to work with the disc department to arrive upon a production-viable method to produce ultra-low-differential discs. We've returned the original Disc Dept. prototype lot of 1.3 psi diff. to Ted for further analysis, including Force-Deflection work. The goal is to develop a means of producing and checking these discs in production. Additionally, Ted has provided a bit of disturbing news: the disc used in the actual device which caused the customer noise complaint has a differential of 2.5 psi (all quoted measurements using Disc Dept equipment) while our experimentation showed a 3 psi device to be undetectable. Does this mean that diff. is not necessarily correlatable to sound ? *Mfg. Eng.* and *Mechanization* are becoming involved at this point. A meeting will be held next Monday to discuss how to pilot, build, and test a device which is silent.

HI-STAT DEVICE: We've completed a competitive evaluation of this device. This includes X-rays, characterizations, cycle testing to failure, and disassembly. We discovered quite a bit of drift in characterization, with initial readings of 289/144, 10K readings of 279/129, and 50K readings of 265/134. The mV drop looked okay. The device was a release-creep. The device developed a leak at about 100K cycles. Upon opening, we discovered the internal seal (composed of a round-section O-ring, colored purple) had extruded. Design features include an insert-molded base, with very beefy sections to support the crimp operation which must withstand the entire burst pressure. No transfer pin is used, rather the discs (2 stacked) act directly on the spring arm with a Kapton insulator. Overall the device appears very prototype in nature, with no plating of any kind on any steel internal components. Additionally, the device is quite poor in terms of Design For Assembly, with the diaphragm, the pressure/force converter pin, and the discs poorly located and easy to misplace.

DIAPHRAGM LIFE: We've received test parts from the model shop, and evaluations have begun. Configurations include:

- stepped hexports to accomodate small-diameter round diaphragms which are constrained primarily by the gasket rather than clamped between hex flange and washer
- hexports and washers with features to stretch the diaphragm during assembly
- two vs. three pieces of full-round Kapton to explore drift and life
- concave features cut into washer and hex flange to mimic the "bear" geometry which occurs during crimp

HEXPORT: As a result of the Elco meeting, we are planning to do a combined Impulse and Thermal Cycle test of the 10821 hexports in order to have this information available if the customers request it when we inform them of the material change. This is likely to be combined with the evaluation of the Staplo ultrasonic welded movable terminals, and one of the higher-pressure disc lots for 87PS conversion.

TI-003682

HIGHLIGHTS

Stephen B. Offiler
Week Ending 92-02-21

FORD MY'92 ELECTRONIC SPEED CONTROL, DEACTIVATE PS

57 AND 87 VALIDATIONS: The decision has been made to significantly elevate the priority on these programs. All six are planned to progress more or less in parallel, but rearrangements can and will be made in order to finish 57PSL11-3 and 57PSF3-3 to avoid jeopardizing the 920415 date promised to Ford. The internal motivation for completing the other four ASAP is to expedite the changeover of 57Lx-x business to 87Lx-x, which improves company profits. We are presently working on the detailed timing, and in parallel Jeff has begun to co-ordinate device builds and equipment requirements. Additional resources required will be determined by the timing charts. The elevated priority of these six programs tends to place everything else on the back burner.

SILENT DEVICE: Initial meetings have been held with Mechanization to begin to explore production techniques for piloting/pinning (calibration) silent devices. Pending test results on the first lots of silent ultra-low-differential discs from the disc dept., we'll begin looking at force- and pressure-deflection curves to determine characteristics that would be correlatable to pinning technique, such as inflection points in the hatchet curves and determination of slope changes that define these points, etc. etc. Additionally, we'll be doing more work with the numerical approach originally proposed, where the ratio's of device differential vs. act. sigma across a range of calibrator settings produce a local peak at the center of the pinning window. Mechanization has taken a first-pass look at an automatic machine to collect hatchet-curve data on sensors to find the center of the pin window. The cost is very roughly $88K.

DIAPHRAGM LIFE / MISC TESTING: Progress on the current lots of diaphragm-life experiments has been halted by the validations. Some progress has been made: we have discovered that features which stretch the Kapton during crimp leave asymmetric strain patterns in the diaphragm (not teardrops, but actually worse); the lots using small round diaphragms constrained by the gasket (rather than clamped by the hex flange/washer) look quite good, and we plan to eventually cycle a lot of these; and the two-vs-three full round Kaptons running to determine drift performance has produced a leaker in the two-pc lot.

Stan Hamel has provided a bagful of miscellaneous 52PS and 57PS devices built in 1986. We plan to choose a few 52's from the bag (built on AMI) and open them up to look for teardrops.

Devices using ultrasonic-welded movable terminal assemblies and 10B21 hexports have been built to undergo a hybrid Impulse and Thermal Cycle test. This is designed to provide data on the life of these components at temperature, pressure, and cycling extremes. The hybrid test was originally conceived to expedite individual Impulse and TC tests and distribute the temperature cycling throughout life cycling. ~~Hide-test-from-bold~~

While cycling production devices recently (looking for spring arm cracks at the bump) we had one PC device that went open-circuit at high temperature. It actually displayed continuity very briefly during release, which we attributed to bounce. The switching action seems to suggest the device was pinned very short. We opened the device, and discovered the base was calibrated to .092" (outside the .089" +/- .002 machine settings) and the T-pin was .142". Our calculations show this is at least .003" too short. We need to understand if thermal expansion is causing a pin-shift at high temp, and/or if temperature causes characteristic changes to the hatchet curve. This may lead to revised room-temp pinning to compensate, shooting for the high end of the window instead of the center.

Engineering Specification

PART NAME	PART NUMBER
[redacted]	[redacted]

LET																			
FR																			
LET																			
FR																			

DATE	LET	FR	REVISIONS	DR	CK
			ADDED DATA TO COMPLETE		
			SPEC. & RATIFIED		
96 11 30			NCOGN100793Y79002		

REFERENCE

PREPARED/APPROVED BY: D.J. Paolo 96 09 16

CHECKED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR

DESIGN ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL

SUPPLIER QUALITY ASSURANCE

ELECTRONICS DIVISION

▽ CONTROL ITEM — THE ▽ SYMBOL AND IDENTIFIES PRODUCT ENGINEERING DESIGNATED CRITICAL CHARACTERISTICS. THESE AND ADDITIONAL CRITICAL CHARACTERISTICS DESIRED BY PROCESS REVIEW, MUST APPEAR ON THE CONTROL PLAN WHICH REQUIRE PRODUCT ENGINEERING APPROVAL.

FRAME 1 OF 18 | REV | ▽ ES-F2TC-...

FORD PD 3947-a1

TI-003634

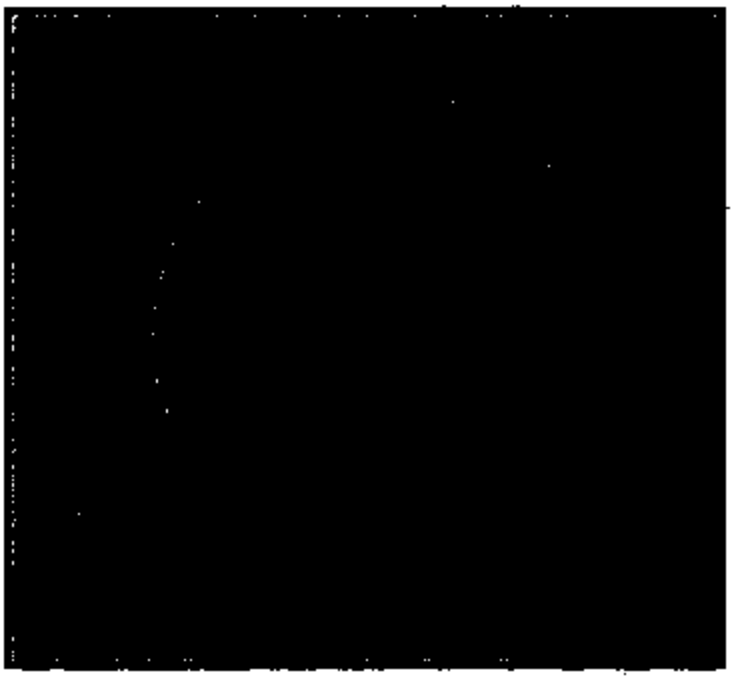
3713 9715

Sample #:_____

Layer Position: _____

Brake Fluid Side

Connector Side



Brake [illegible]cklist:

0003244

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F2VC9	Favc9	F2vc9	F2vc9	F2vc9	F2vc9	F2vc9	F2vc9	F2vc9	
924 AB	F924 AB	F924 AB	F924 AB	F924 AB	F924 AB	F924 AB	F924 AB	F924 AB	
9	13381	2008	2062	2052	2014	2074	2031	2029	
	92'TC	92'TC	92 CV	92 TC	92 TC	92 GM	92 TC	93 GM	
	107739	178245	107629	109341	103652	103217	105832	109138	
	58691-A	041910-B	181298-A	070138-C	058080-01	038727-A	057837-A	079951-01	
	[illegible]	Working on an New Not [illegible]	None	None	None	None	None	None	
	>	9:50	10:30	11:00	4:00	1:00	3:00	9:30	
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		Blue Seal [illegible]	Blue Seal [illegible]	Blue Seal [illegible] connector [illegible]	Blue Seal Crossing in [illegible]	Blue Seal Crossing in [illegible]	Blue Seal Small [illegible]	Blue Seal Very [illegible] Small connector	

Positions relative to start of thread @ 12:0 viewed from connector end.