EA02-025

FORD 10/27/03

APPENDIX N

BOOK 24 OF 61

PART 3 OF 5

Brake Pressure Switch Questions

Competitive Vehicles

- **How is switch packaged?**
- **Is it always Powered (HOT_ALL_TIME) ?**
- **Are the contacts opened when pressure applied?**
- **What is fuse limit?**
- **What is being switched?**
- **Is it a redundant switch?**

Stewart Salter by 2/16/1999

What are descriptions from AWS and CQIS?
Joe Nemo/ Bill Abramczyk by 2/16/1999

Are the switch materials compatible with brake fluid?
Greg Stevens by 2/16/1999

Are the switch materials compatible with brake fluid in an electric field?
Greg Stevens by 2/16/1999

Are the switch materials compatible with brake fluid and contaminants?
Greg Stevens by 2/16/1999

Are the switch materials compatible with contaminated brake fluid in an electric field? Greg Stevens by 2/16/1999

What are we seeing in returned Speed control modules (FRACAS)?
Fred Kohl/ Dan Budzynski by 2/12/1999

What does TI DFEMA say about this failure mode?
Rob Sharpe by 2/10/1999

What are TI in-process test failures?
Rob Sharpe by 2/10/1999

What does Speed control FMEA say about Brake Switch ?
Fred Kohl by 2/9/1999

Brake Pressure Switch Questions

The Brake Pressure Switch (Deactivation Switch) coupled with the Stop Lamp switch are categorizes as "Automatic Deactivation". The FMEA lists Automatic Deactivation" as current design control for 66 different potential cause/ mechanical failures.

Brake Pressure Switch (Deactivator Switch) is one of the most important safety features.

When was non-Pressure actuated switched introduced?			
	Steve Reimers	**by**	**2/9/1999**
Is the Circuit drive hi-side or low-side?	**Fred Kohl**	**by**	**2/8/1999**
Circuit is low side driven.			
Results of Central Lab analysis	**Steve LaRouch**	**by**	**2/12/1999**
Analysis of harness pig-tails	**Joe Kafati**	**by**	**2/16/1999**
If a switch is contaminated can it start the event?			
	Fred Porter	**by**	**2/16/1999**
Flash points for all materials?	**Greg Stevens**	**by**	**2/16/1999**
What heat is conducted internally?		**By**	
Don't understand this questions!!!!!!!!!!!!!!			
Provide color photos of Econoline?	**Rob Sharpe**	**by**	**2/8/1999**
What is the difference in the base materials that look different?			
	Rob Sharpe	**by**	**2/16/1999**
TI analysis results of the Memphis parts (crease marks in diaphragm, etc) ?			
	Rob Sharpe	**by**	**2/9/1999**
What are the material call-outs for 1992 and 1993?			
	Rob Sharpe	**by**	**2/9/1999**
Results of testing with corrosion simulation?	**Fred Porter**	**by**	**2/16/1999**

Brake Pressure Switch Questions

What does it take to start an event? **Fred Porter** **by** **2/16/1999**

How does speed control use this switch? **Fred Kohl** **by** **2/11/1999**

1. *Brake Pressure Switch provides electrical power to the speed control servo clutch circuit The clutch circuit needs to be energized for the servo motor to pull the cable.*

2. *Switch provides a redundant method of sensing brake application independent of the primary system deactivation mode; this is a SDS (SC-0005) requirement.*
   - *Signal from the stop lamp switch is primary deactivation mode for brake application.*
   - *Under "hard" braking condition; Brake Pressure Switch provides redundant brake signal to the speed control logic (similar to stop lamp switch signal) and disconnects power to the clutch circuit; causing the speed control servo pulley to immediately return to the idle position. Note: Under normal braking conditions, only the stop lamp switch signal cancels speed control operation.*

Do all Ford applications use switch between fuse and load? **YES**
Fred Kohl **by** **complete**

Do all Ford applications have switch connected to HOT-ALL-TIMES?
Joe Kafati **by** **2/16/1999**

Why is this switch connected to HOT-ALL-TIMES?
Fred Kohl **by** **Complete**

Because the SDS requires it to be connected to the same fuse as the stop lamp.

What is SDS requirement number? **Fred Kohl** **by** **2/16/1999**

SDS (SC-0068) states: The stop lamp switch and redundant deactivator switch must be on the same fused circuit.

Can the switch act as a fuse? **Team** **by** **complete**

No.

Brake Pressure Switch Questions

Could a fuse (e.g. 2 amp) be added in series between the stop lamp fuse and the brake pressure switch? Failure parameters would have to be known.

Is it feasible to disconnect the switch as immediate containment?

Yes. The customer will not have use of the speed control.

Is it acceptable to Jumper out the switch as immediate containment?

Fred Kohl by 2/16/1999

NO... Would eliminate an important safety feature of the speed control system. The Brake Pressure Switch provides the redundant method for sensing brake application independent of the primary system deactivation mode. This is an SDS (SC-0005) requirement.

Elimination of this feature requires the concurrence of the OGC.

Other recommendations for immediate containment?

All by on-going

Add fuse between the stop lamp fuse and the brake pressure switch?

Can Brake Pressure Switch function be removed from power feed circuit and placed in ground return circuit? Fred Kohl by tbd

1. *Would require redesign of the speed control electronics.*
2. *Additional isolated ground circuit is required.*
3. *From FMEA position switching the ground circuit is not as good as switching the B+ feed.*
    - *With a ground return circuit; short to ground (fault) it would override the deactivation switch.*
    - *With the current power feed circuit; short to ground make the speed control system inoperative. A short to power is required to override the deactivation switch; much lower potential to occur.*

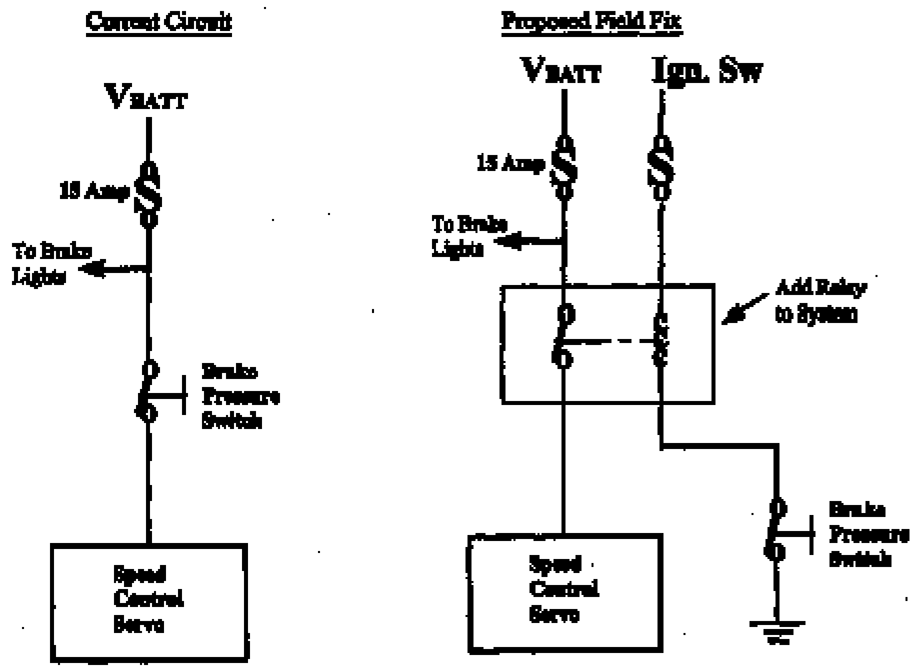
SPEED CONTROL BRAKE PRESSURE DEACTIVATION SWITCH

Below is a proposed wiring / circuit change for the Speed Control Deactivation Switch.

This would be a field fix for 1992 & 1993 Town Cars. The change is proposed to prevent deact switch failures. There is a potential this action could be for additional model years and vehicles lines that use brake pressure deact switches.

Note: brake pedal mounted switches are not affected.

Please review and let me know if you have any issues. Note the Speed Control System functions do not change.



Please send comments to Fred Kohl (FKOHL).
Note: Scott Simpson asked that all Application / Design / Software Engineers review this proposed change.

POWER ANALYSIS of 82 OHM in CLUTCH FLYBACK CIRCUIT (R44)

Transient voltage and peak power in single 82 ohm resistor in clutch flyback circuit.

$j := 1..9$ R_{w_j} := MidwinterWindingResistance $R_{ext} := 82$

I_{pk_j} := Envelope_of_Max_Current over worst case test voltage $L_{clutch} := 0.078$

$P_{pk}(j) := (I_{pk_j})^2 \cdot R_{ext}$

$R_{tot}(j) := R_{w_j} + R_{ext}$

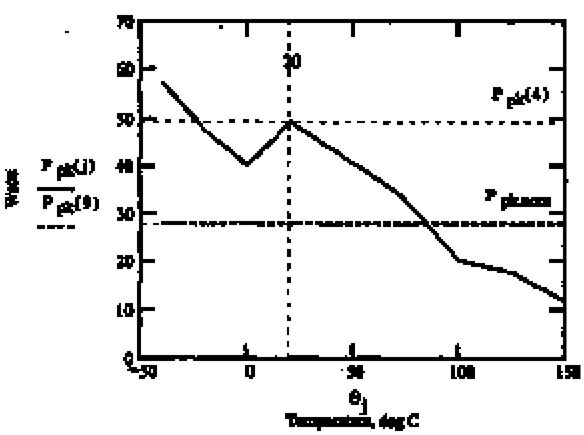
j	θ_j :=	R_{w_j} :=	Vdc_{in_j} :=	I_{pk_j} :=
1	-40	17.5	16	0.839
2	-20	19.4	16	0.763
3	0	21.2	16	0.7[illegible]
4	20	23	19	0.779
5	70	27.6	19	0.653
6	100	30.5	16	0.499
7	125	32.6	16	0.466
8	150	34.8	14	0.3[illegible]
9	20	23.9	14	0.586

Total Peak Power, watts $P_{pk}(j)$	Peak Resistor Power, watts $P_{pk}(j)$	θ_j
57.721522	57.721522	-40
47.737158	47.737158	-20
40.7[illegible]	40.7[illegible]	0
49.779432	49.779432	20
34.9[illegible]	34.9[illegible]	70
20.41[illegible]	20.41[illegible]	100
17.80[illegible]	17.80[illegible]	125
11.8[illegible]	11.8[illegible]	150
28.138472	28.138472	20

$I_{pk.nom} := \frac{14}{23.9}$ $P_{pk.nom} := (I_{pk.nom})^2 \cdot R_{ext}$ $T_{clutch.nom} := \frac{L_{clutch}}{23.9 + R_{ext}} \cdot 1000$

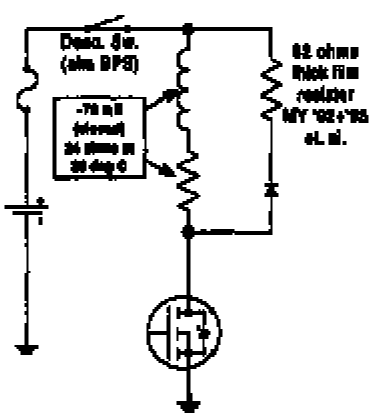
$I_{pk.nom} = 0.585774$ $P_{pk.nom} = 28.136782$ $T_{clutch.nom} = 0.736544$

$j := 1..8$



<--19 Vdc in @ 20 deg C (min limit clutch resistance)

<--14 Vdc in @ 20 deg C (nominal clutch resistance)



Original: CL_82R44.mcd dated 8/19/98 (2:06:42 pm (modified CL_81R44.mcd 082098?)
Schematic added 10/09/97

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RECTANGULAR FLAT CHIP RESISTOR POWER DISSIPATION *(generic)*

$\theta := 40, 41 .. 175$

$Pd_{2512}(\theta) := if[\theta < 70, 1000, 1000 - 0.0125 \cdot 1000 \cdot (\theta - 70)]$

$Pd_{2010}(\theta) := if[\theta < 70, 500, 500 - 0.0125 \cdot 500 \cdot (\theta - 70)]$

$Pd_{1210}(\theta) := if[\theta < 70, 250, 250 - 0.00952 \cdot 250 \cdot (\theta - 70)]$

$Pd_{1206}(\theta) := if[\theta < 70, 125, 125 - 0.00952 \cdot 125 \cdot (\theta - 70)]$

$Pd_{0805}(\theta) := if[\theta < 70, 100, 100 - 0.00952 \cdot 100 \cdot (\theta - 70)]$

$Pd_{0603}(\theta) := if[\theta < 70, 63, 63 - 0.0125 \cdot 63 \cdot (\theta - 70)]$

$Pd_{0402}(\theta) := if[\theta < 70, 63, 63 - 0.01818 \cdot 63 \cdot (\theta - 70)]$

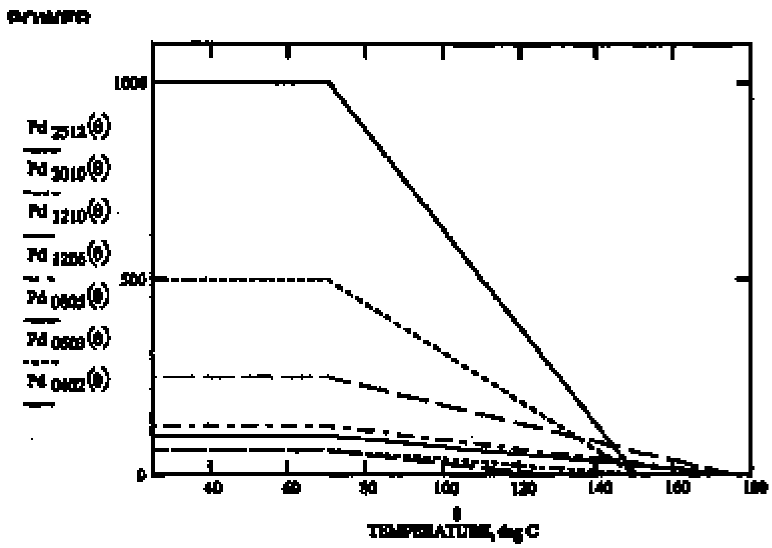

Figure 1.a:

Power derating curves for rectangular flat chip resistors.

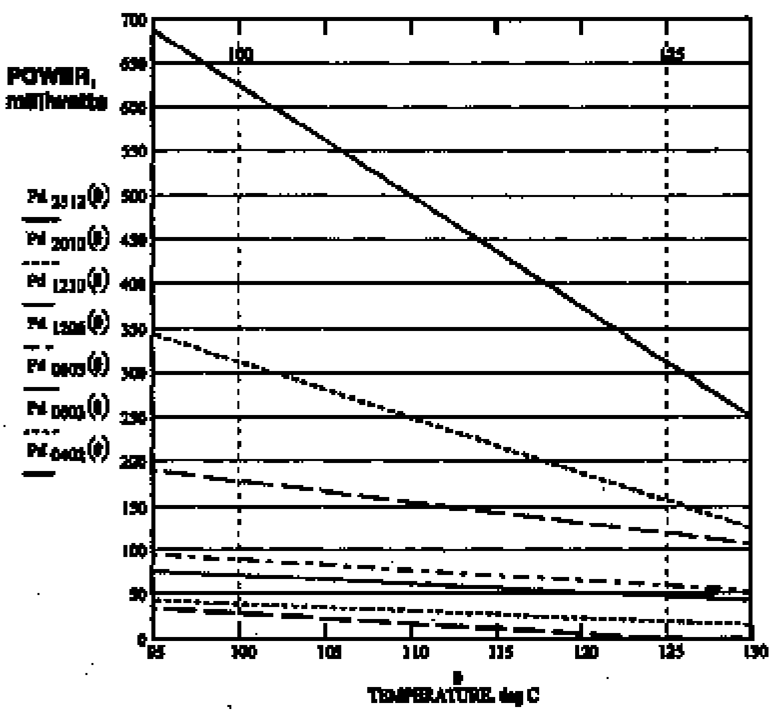

Figure 1.b:

Power derating curves for rectangular flat chip resistors at elevated temperatures.

$k := 1 .. 7$

$sz_k :=$ **Power Capability, mw @125 C**

sz_k	Power Capability, mw @125 C
2512	$Pd_{2512}(125) = 312.5$
2010	$Pd_{2010}(125) = 156.25$
1210	$Pd_{1210}(125) = 119.1$
1206	$Pd_{1206}(125) = 59.53$
0805	$Pd_{0805}(125) = 47.64$
0603	$Pd_{0603}(125) = 19.6875$
0402	$Pd_{0402}(125) = 6.3 \cdot 10^{-3}$

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PULSE LIMIT POWER (SINGLE PULSE) for RECTANGULAR FLAT CHIP RESISTORS *(generic)*

$x := 0.02, 0.04 .. \sqrt{1100}$

$t_p(x) := x^2$

$m_k := \frac{\ln(Y10_k) - \ln(Y0.04_k)}{\ln(10) - \ln(0.04)}$

k	$Size_k$:=	$Y0.04_k$:=	$Y10_k$:=	m_k	$Y0.04_k \cdot (25)^{m_k}$
1	2512	150	30	-0.29149	[illegible]
2	2010	75	20	-0.24171	34.897064
3	1210	40	12.5	-0.21095	20.309457
4	1206	22	8	-0.1[illegible]71	15.190091
5	0805	10.5	4.4	-0.15753	[illegible]
6	0603	6	2.5	-0.13[illegible]	3.847604
7	0402	3	1.6	-0.11396	2.079345

$$\ln(P_d) = \frac{\ln(Y10_k) - \ln(Y0.04_k)}{\ln(10) - \ln(0.04)} \cdot (\ln(t_p(x)) - \ln(0.04)) + \ln(Y0.04_k) = m_k \cdot (\ln(t_p(x)) - \ln(0.04)) + \ln(Y0.04_k)$$

$$\ln(P_d) = m_k \cdot (\ln(t_p(x)) - \ln(0.04)) + \ln(Y0.04_k) = \ln\left[\left(\frac{t_p(x)}{0.04}\right)^{m_k}\right] + \ln(Y0.04_k) = \ln\left[\left[Y0.04_k \cdot \left(\frac{t_p(x)}{0.04}\right)\right]^{m_k}\right]$$

$P_d = Y0.04_k \cdot (25 \cdot t_p(x))^{m_k}$

$P_1(k,x) := if\left[t_p(x) \le 0.04, Y0.04_k, \left[Y0.04_k \cdot (25)^{m_k}\right] \cdot t_p(x)^{m_k}\right]$

$P_o(k,x) := if\left(t_p(x) < 1050, P_1(k,x), 10^{-10}\right)$

Figure 2. SINGLE PULSE PEAK POWER, watts vs. PULSE DURATION, ms

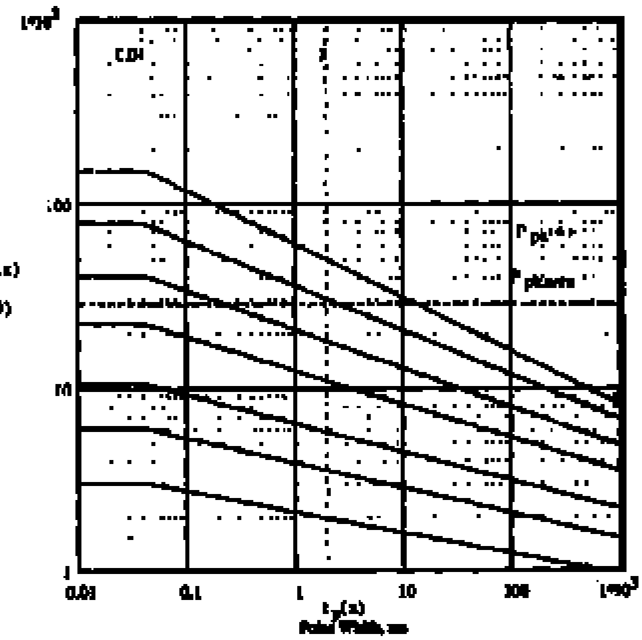
PEAK POWER, watts

at 40 µs

$Size_k$	k	$Y0.04_k$
2512	1	150
2010	2	75
1210	3	40
1206	4	22
805	5	10.5
603	6	6
402	7	3

$P_o(k,x)$

$P_{pk}(9)$



PULSE POWER RESISTOR CAPABILITY, watts at 1 and 2 ms

$Size_k$	$P_o(k,\sqrt{1})$	$P_o(k,\sqrt{2})$
2512	58.7	47.05
2010	34.9	28.31
1210	20.9	17.55
1206	12.9	10.74
805	4.32	3.87
603	3.85	3.5
402	2.58	1.92

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POWER ANALYSIS of 82 OHM in CLUTCH FLYBACK CIRCUIT (R44)

IDEALIZED TRANSIENT CURRENT PULSE IN SINGLE 82Ω resistor CLUTCH FLYBACK CIRCUIT:

$L_{clutch} = 0.078$ $R_{ext} = 82$ *ohms @ room temp.*

$\tau_{clutch}(j) := \frac{L_{clutch}}{R_{tot}(j)} \cdot 1000$ $i_g(j,t) := i_{pk_j} \cdot \exp\left(\frac{-t}{\tau_{clutch}(j)}\right)$

$v_g(j,t) := i_g(j,t) \cdot R_{ext}$ *Plotting limits:* $i(j,t) := if(t<3.5, i_g(j,t), 5000)$

$i_{nom}(t) := if(t<3.5, i_{nom.g}(t), 5000)$ $v(j,t) := if(t<3.5, v_g(j,t), 5000)$

j	$R_{tot}(j)$
1	98.5
2	101.4
3	103.3
4	105
5	109.6
6	112.5
7	114.6
8	116.6

$t := -0.2, -0.15 .. 6$

$\tau_{clutch.nom} := \frac{L_{clutch}}{23.9 + R_{ext}} \cdot 1000$

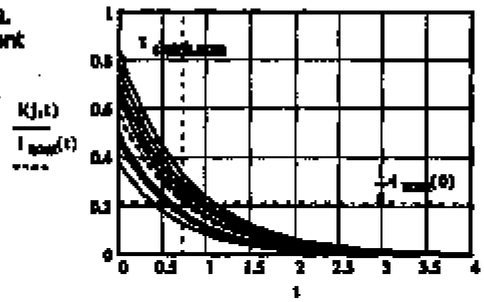
ohms @ various temps.

$\tau_{clutch.nom} = 0.734344$

$i_{nom.g}(t) := \frac{14}{23.9} \cdot \exp\left(\frac{-t}{\tau_{clutch.nom}}\right)$

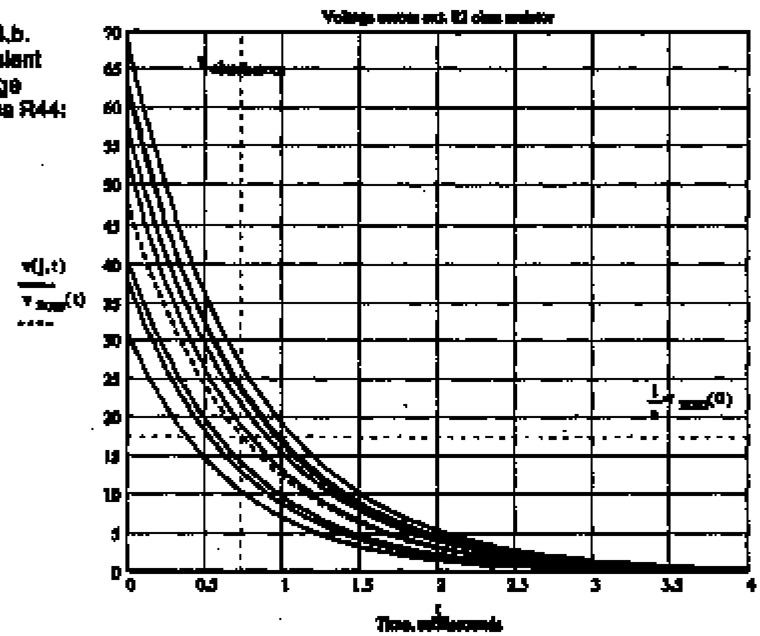
$v_{nom}(t) := if(t<3.5, R_{ext} \cdot i_{nom.g}(t), 5000)$

Fig. 3.a. Transient clutch current



j	Vdc_{inj}	θ_j	R_{cj}	$i_g(j,0)$	$v(j,0)$
1	16	-40	17.5	0.839	68.798
2	16	-20	19.4	0.763	62.566
3	16	0	21.3	0.701	57.482
4	16	20	23	0.776	63.632
5	16	70	27.6	0.653	53.546
6	16	100	30.5	0.499	40.918
7	16	125	32.6	0.466	38.212
8	14	150	34.5	0.381	31.245

Fig. 3.b. Transient voltage across R44:



Shown for worst case coil resistance and test voltage:

j	TEMP: θ_j	PEAK VOLTAGE $v(j,0)$	Vdc_{inj}
1	-40	68.798	16
2	-20	62.566	16
3	0	57.482	16
4	20	63.632	16
5	70	53.546	16
6	100	40.918	16
7	125	38.212	16
8	150	31.245	14

Nominal Peak Voltage:

$v_{nom}(0) = 48.033475$ volts

$\tau_{clutch.nom} = 0.734344$ millisec.

$\tau_{clutch}(4) = 0.742857$ millisec.

$P_{pk.g}(j,t) := v(j,t)^2 \cdot R_{ext}$

$P_{pk}(j,t) := if(t<3.5, P_{pk.g}(j,t), 50000)$

$P = R_{ext}\left[\frac{14}{23.9} \cdot \exp\left[\frac{-t}{78} \cdot (23.9 + R_{ext})\right]\right]^2$

$\frac{P}{R_{ext} \cdot \left(\frac{14}{23.9}\right)^2} = \exp\left[\frac{-t}{78} \cdot (23.9 + R_{ext})\right]^2 = \frac{1}{e}$

$P_{pk.nom.g}(t) := \frac{v_{nom}(t)^2}{R_{ext}}$ $P_{pk.nom}(t) := if(t<3.5, P_{pk.nom.g}(t), 50000)$

$\exp\left[\frac{-t}{78} \cdot (23.9 + R_{ext})\right]^2 = \frac{1}{e}$ whose solution for t_x is

$$\begin{bmatrix} \frac{.5000}{(306430 + 0.0128205 \cdot R_{ext})} \\ \frac{.5000}{(306430 + 0.0128205 \cdot R_{ext})} - 3.1415926535897932385 \cdot \frac{i}{(306418 + 0.0128205 \cdot R_{ext})} \end{bmatrix}$$

and the real part of the solution for the time constant of the power transient is

$\tau_p := \frac{.5000}{306418 + 0.0128205 \cdot R_{ext}}$ $\tau_p = 0.366372$ $R_{ext} = 82$

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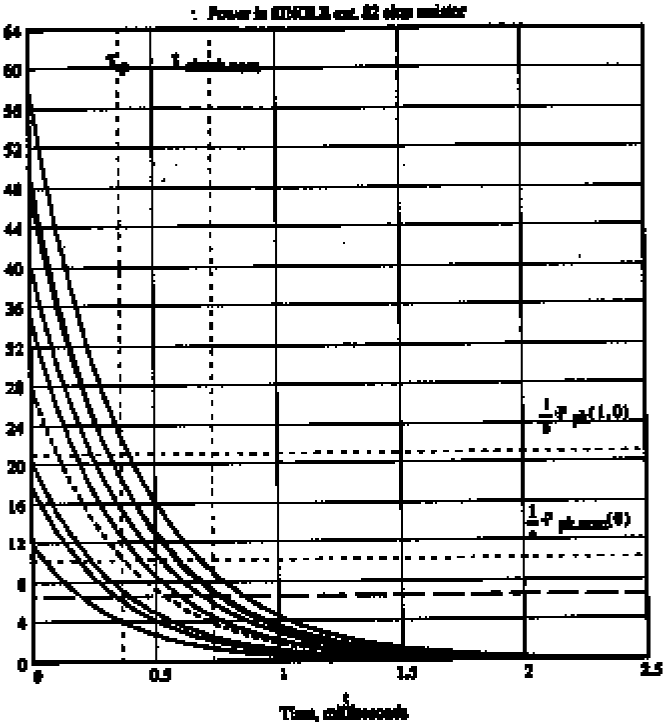
IDEALIZED TRANSIENT **POWER** PULSE IN **SINGLE** 82 OHM RESISTOR IN CLUTCH FLYBACK CIRCUIT:

Fig. 4.a. Transient power in R44:



$\tau_p = 0.348272$

Shown for worst case coil resistance and test voltage:

j	Vdc $_{in_j}$	TEMP: Θ_j	TOTAL PEAK VOLTS v(j,0)	TOTAL PEAK WATTS $P_{pk}(j,0)$
1	16	-40	68.798	57.722
2	16	-20	62.566	47.738
3	16	0	57.482	40.393
4	15	20	53.627	40.370
5	15	70	51.346	34.966
6	15	100	40.918	20.418
7	14	125	38.312	17.807
8	14	150	31.362	11.903

Totals in resistor:

$P_{pk}(1,0) = 57.721322$
worst Case 16 Vdc @: -40 deg C

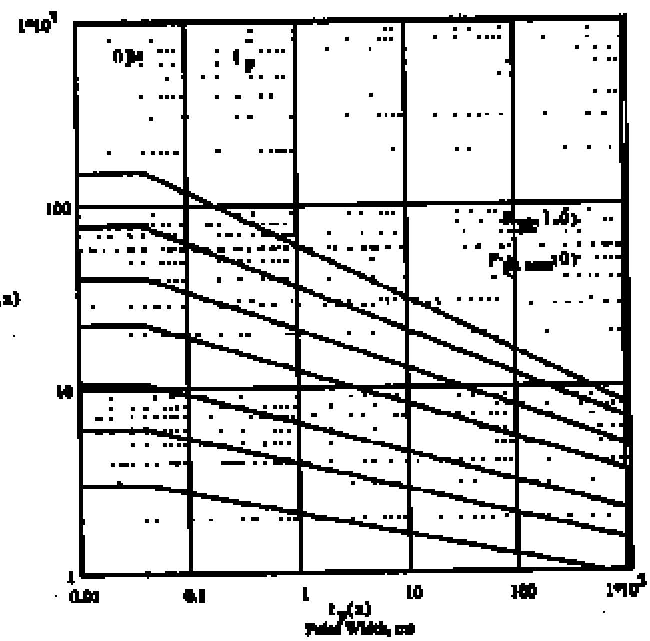
$P_{pk.nom}(0) = 26.136762$
@ Vdc.in = 14 volts

Figure 5: SINGLE PULSE PEAK POWER, watts vs. PULSE DURATION, ms

PEAK POWER, watts

at 40 µs

$Size_k$	$Y_{0.04_k}$
2512	150
2010	75
1210	46
1206	21
805	10.5
603	6
402	3



SINGLE 82Ω resistor

Peak power at time zero & worst case clutch resistance:

$P_{pk}(1,0) = 57.721322$

Peak power at time zero & nominal clutch resistance:

$P_{pk.nom}(0) = 26.136762$

PULSE POWER RESISTOR CAPABILITY, watts

at τ_p

$Size_k$	$P_o(k, \sqrt{\tau_p})$
2512	78.54
2010	44.43
1210	21.80
1206	14.63
805	7.4
603	4.42
402	2.33

$P_{pk.p}(j,x) := if(t_p(x) < 1000, P_{pk}(j,0), 10^{-10})$ ***Scale for plotting, only***

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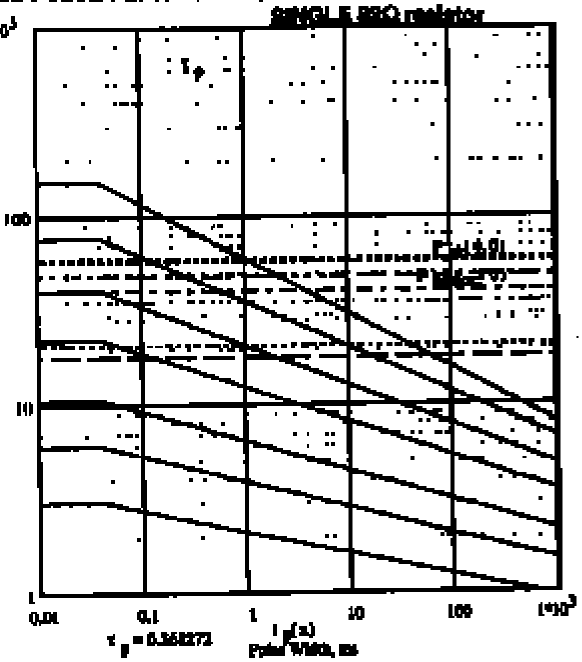
Figure 6.a: SINGLE PULSE PEAK POWER, watts vs. PULSE DURATION, ms

RESISTOR PEAK POWER CAPABILITY, watts

at 40 μs

$Size_k$	$Y_{0.04_k}$
2512	150
2010	76
1210	40
1206	22
805	10.5
603	6
402	3



$\tau_p = 0.368272$

j := 1 .. 9

WORST CASE OVER TEMP. & VOLTAGE:

TEMP & VOLT. TOTAL watts

θ_j	Vdc_{bj}	$P_{pk}(j,\theta)$
-40	16	57.728
-20	16	47.738
0	16	40.305
20	15	40.378
70	15	34.966
100	16	20.416
125	16	17.807
150	16	11.509
20	14	28.158

WORST CASE
<--16Vdc@-40C
__16Vdc@20C
<--14Vdc(nom)
__16Vdc@125C

$\tau_p = 0.368272$

$P_{pk}(4,0) = 40.378431$

$P_{pk,nom}(0) = 28.158762$

SINGLE 82Ω resistor
PULSE POWER RESISTOR CAPABILITY, watts
at $\tau_p = 0.368272$

$Size_k$	$P_d(k, t_p(\tau_p))$
2512	70.54
2010	44.43
1210	25.80
1206	14.65
805	7.4
603	4.43
402	2.33

k := 1 .. 4

$Size_k$	$Y_{0.04_k}$
2512	150
2010	76
1210	40
1206	22

$Pd_{2512}(\theta,x) := \mathrm{if}\left[\theta<70, P_j(1,x), P_j(1,x)-0.0125 \cdot P_j(1,x)\cdot(\theta-70)\right]$

$Pd_{2010}(\theta,x) := \mathrm{if}\left[\theta<70, P_j(2,x), P_j(2,x)-0.0125 \cdot P_j(2,x)\cdot(\theta-70)\right]$

$Pd_{1210}(\theta,x) := \mathrm{if}\left[\theta<70, P_j(3,x), P_j(3,x)-0.00952 \cdot P_j(3,x)\cdot(\theta-70)\right]$

$Pd_{1206}(\theta,x) := \mathrm{if}\left[\theta<70, P_j(4,x), P_j(4,x)-0.00952 \cdot P_j(4,x)\cdot(\theta-70)\right]$

$P_j(k, 0.04)$
150
76
40
22

$Pd_{2512}(125, 0.04) = 46.875$

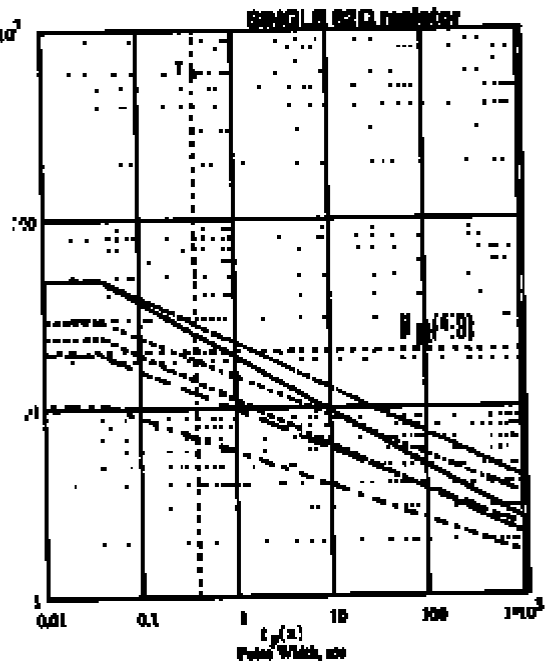
$Pd_{2010}(125, 0.04) = 23.75$

$Pd_{1210}(125, 0.04) = 19.056$

$Pd_{1206}(125, 0.04) = 10.4806$

Figure 6.b. SINGLE PULSE PEAK POWER, watts (derated to 125 C) vs. PULSE DURATION, ms

RESISTOR PEAK POWER CAPABILITY, (derated to 125 C) watts



WORST CASE OVER TEMP. & VOLTAGE:

TEMP & VOLT. TOTAL watts

j	θ_j	Vdc_{bj}	$P_{pk}(j,\theta)$
1	-40	16	57.728
2	-20	16	47.738
3	0	16	40.305
4	20	15	40.378
5	70	15	34.966
6	100	16	20.416
7	125	[illegible]	17.807
8	150	14	11.509
9	20	14	28.158

Nominal-->

SINGLE 82Ω resistor

$Size_k$
2512
2010
1210
1206

PULSE POWER RESISTOR CAPABILITY, watts
at $\tau_p = 0.368272$

Inter Office Mail Envelope

[redacted]

3713 5913

Texas Instruments Incorporated
8-D Problem Resolution Report # PS/CAR/93-3 CLOSED 12/1/93

Original Report: July 29, 1993

Update Report: October 18, 1993
Ford Part Number: F3TA-9F924-AA/BA/CA
Part Description: Speed Control Deactivation Switch

(STEP 1) PRODUCT TEAM

Manufacturing Engineering: Matt Sellers
Quality Assurance Engineering: Jim Watt
Product Marketing: Charlie Douglas
Design Engineering: Aziz Rahman (Champion)

(STEP 2) PROBLEM DESCRIPTION

Ford Light Truck Division Brake Engineering reported a noticeable increase in warranty returns, related to inoperative speed control systems for 1993 Econoline models during 4QTR'92 and 1QTR'93 time frame. Detailed breakdown of warranty data showed that a number of these claims were reported to be pressure switch related. Attachment "A" shows R/1000 data as collated from Ford warranty data. Texas Instruments and Ford started on 7/22/93 to call dealerships from the Master Claim list contacting over 150 dealerships. As of 10/18/93, (14) switches have been received, analyzed, and characterized.

The following table details the field data on these switches:

VID	Vehicle type	Switch date code
A84642	'93 Econoline	2316 (November '92)
A35294	'93 Econoline	2294
A40855	'93 Econoline	3078
A70383	'93 Econoline	2345
A61611	'93 Econoline	2345
A34137	'93 Econoline	2243
A32248	'93 Econoline	2286
A47374	'93 Econoline	2307
A50451	'93 Econoline	2316
A49359	'93 Econoline	2338
A57954	'93 Econoline	2345
A92609	'93 Econoline	3037
B15536	'93 Econoline	3078
A40855	'93 Econoline	3175

(13) switches were confirmed to be inoperative switches due to liquid ingress resulting in severe corrosion. Switch with date code 2307 was operating normally.

3713 5814

(STEP 3) INTERIM CONTAINMENT ACTION

We have completed the following actions in assessing the integrity of our current product:

1. Verified environmental seal integrity and proper function.

2. Verified switch connector base dimensions that could affect the mating connector sealing ability to be within specification.

Based upon Texas Instruments' verification of the critical connector base dimensions, the functionality of the environmental seal, and observation of fluid ingress into the switch cavity through the terminal blades, an analysis/investigation of the mating connector sealing system is warranted.

3. Texas Instruments, in cooperation with Ford Light Truck Engineering, conducted a water ingress test with various component combinations of the mating connector, to determine relative susceptibility of each combination. The following combinations were tested:

Current Light Truck	Light Truck Before 11/92	Current Pass Car
Black UTA shell	Black EPC shell	Black UTA shell
Gray Grommet	Gray Grommet	Gray Grommet
Red Silicon Seal	Red Sponge Seal	Red Sponge Seal

The matrix of components tested and the test sequence is outlined in attached charts. Preliminary data analysis did not show significant differences amongst various matrix elements. It has been concluded that the switches need extended exposure under shower to initiate water ingress. In addition to the above combination of components, 50% of the switches were tested with a "rocked" connector.

The shower test was halted on 10/6/93, when non-normal insulation resistance readings were observed on rocked switches. Upon removal of the connectors, water ingress was observed on all switches with rocked connectors. There was no ingress on correctly latched switches. The attached Table 1 summarizes the matrix of parts and visual observations. The ingress in vertical switches was of a magnitude higher than in horizontal switches. Photographs of the switches were sent to Ford Light Truck Engineering for review. The switches were calibrated for functionality. The attached Table 2 confirms the effect of ingress as seen in the reduction of insulation resistance and intermittent operation of the switches. The switches were then disassembled for internal inspection. It was observed that the ingress had proceeded through the connector cavity into the contact zone. Photographs are attached.

The ingress activity on the rocked switches was similar to that observed on parts returned from the field, albeit of a lesser magnitude. It is believed that, given sufficient time (to allow current to pass though the contacts), the ingress on the rocked switches would exhibit exactly the same failure as that observed on the warranty parts.

(STEP 4) ROOT CAUSE

The switches analyzed were inoperative since there was no electrical continuity between the terminals. Attachment 'B' shows the fishbone diagram for a stuck open switch. The lack of continuity was due to presence of large amounts of corrosion products inside the switch cavity and, in some cases, failure of contact elements due to corrosion. The large quantity of corrosion products is due to fluid that entered the switch cavity. Because of the severe amount of corrosion observed, it is believed that the corrosion is accelerated by the potential difference between the grounded body of the switch and current carrying members.

Thorough visual observation concluded the fluid entry to be through the mating connector end of the switch as evidenced by brass corrosion products along the terminal blades in the connector cavity (see attached photographs). Two of the switches exhibited blue/green corrosion by-products covering more than one half of the connector cavity. The others showed similar corrosion products but in lesser amounts. None of the switches showed any evidence of fluid ingress by the environmental seal.

The snap acting disc in all the returned switches was functioning normally.

The following observations were made by Texas Instruments on '93 Econoline and F-Series Trucks at a local Ford dealership:

1. Econoline: The wire leads coming out of the switch were routed below and touching the rear A/C line. This will create a propensity for water/condensation traveling along the line to flow along the wire leads to the grommet.

2. F-Series: The observed vehicles had a Red Sponge seal inside the mating connector, as opposed to the expected Red Silicone seal.

Additional observations regarding face seal variations:

1. The target zone for pressure switch sealing surface is smaller on the sponge seal, than the silicone seal. The smaller target zone, may lead to a sub-optimal sealing condition under worst case dimensional stack-up.

2. It has been seen that during the mating connector assembly process, there is an opportunity for the silicone seal to be rolled over. This can happen during insertion of the plastic terminal separator. The insertion is done after the silicone seal is placed in the plastic shell. A rolled over silicone seal would not provide protection against water ingress.

3. The silicone seal, by design, has a lower percent compression than the sponge seal. The design limits for the silicone seal are 10 - 15%, whereas the limits for the sponge seal are 38 - 50%. The reduction in percent compression was intended to maintain similar loading forces. It has been observed that there is a tendency for the mating connector to 'rock' in the latched position. The rocking tendency would lead to a higher percent change in the level of compression of the silicone seal than on the sponge seal.

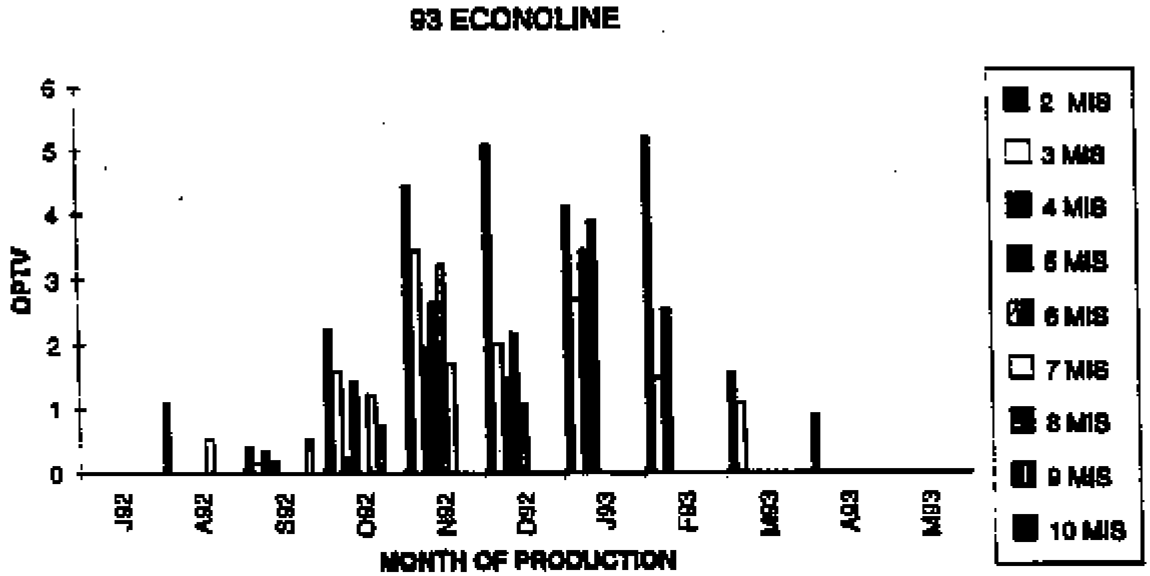
The shower test detailed above, leads to the conclusion that a 'rocked' connector was the most probable root cause of the observed problem. The impact of the problem is magnified in the Econoline platform due to the mounting location and vertical mounting position, both of which are unfavorable from a ingress point of view.

(STEP 5) PERMANENT CORRECTIVE ACTION

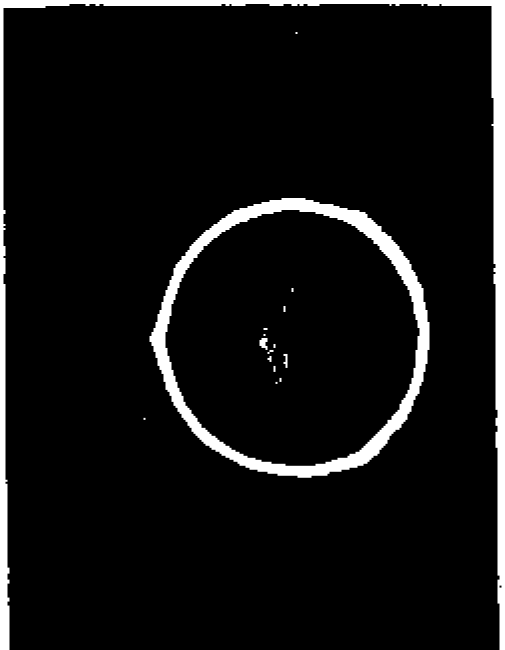
No corrective action is required from Texas Instruments at this point.

(STEP 6) VERIFY CORRECTIVE ACTION

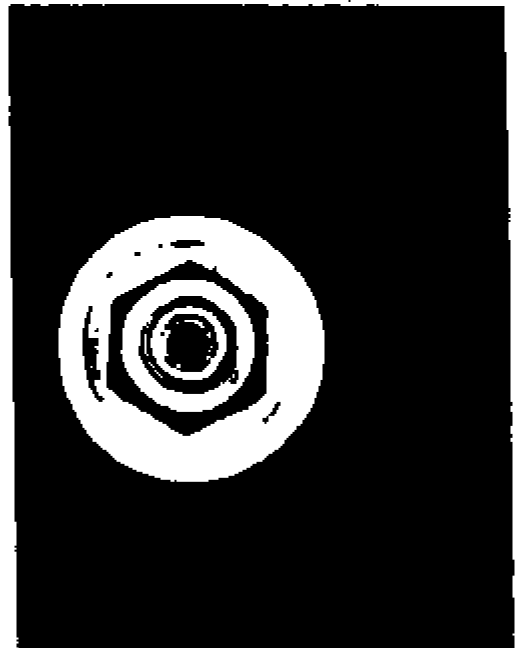
(STEP 7) PREVENT RECURRENCE



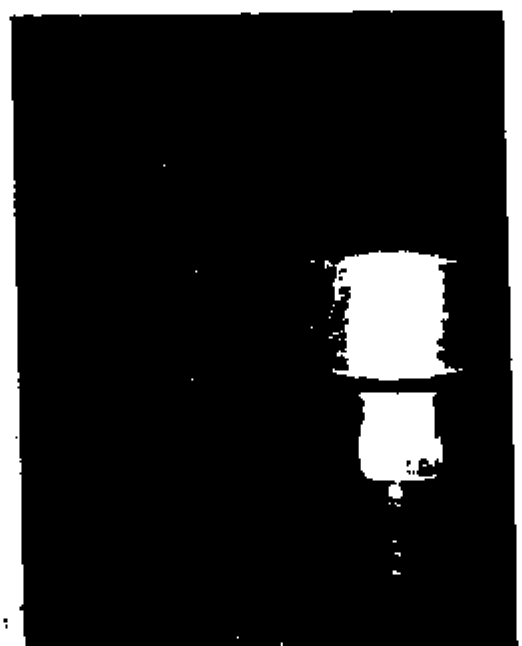
FROM FORD WARRANTY DATA OF 17AUG93



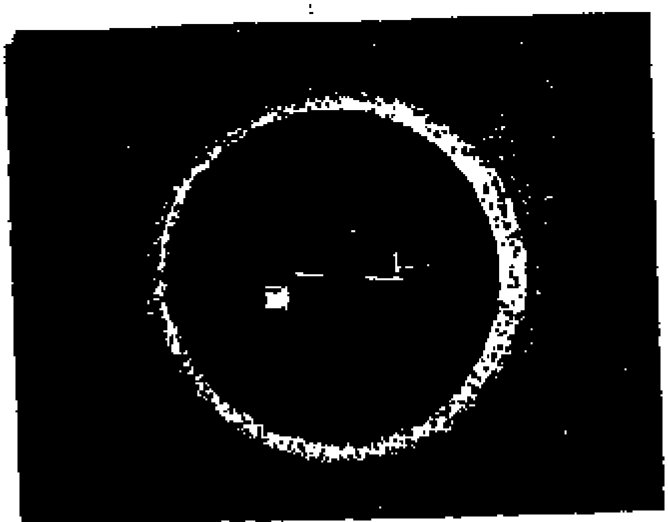
A40855 DC3078A



A40855 DC3078A



A40855 DC3078A

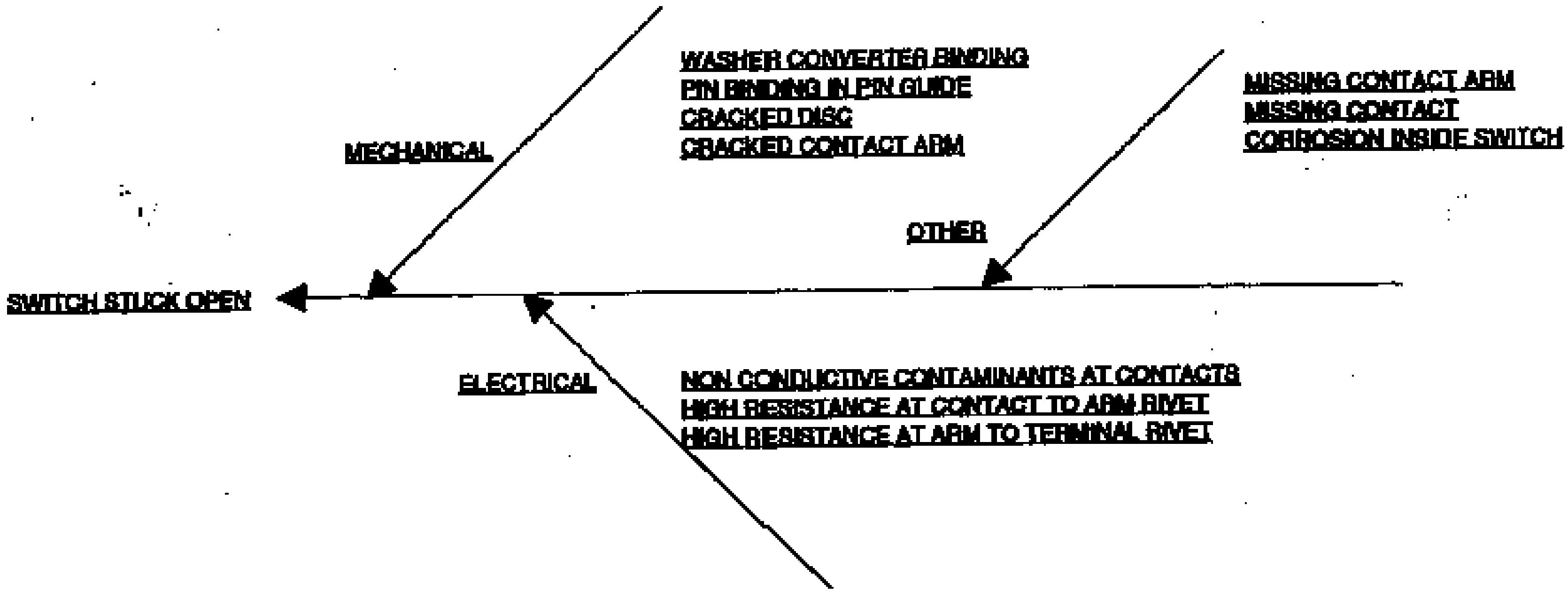


A35294

A35294

A35294

ATTAC. .NT "B"



3713 5821

connector system matrix 8/17/93

for shower test

	a	b	c	d	e	f
shell	uta	uta	uta	uta	epc	epc
grommet	gray	gray	gray	gray	gray	gray
face seal	sponge	sponge	silicone	silicone	sponge	sponge
wire leads	slack	tension	slack	tension	slack	tension
orientation	horizontal	horizontal	vertical	vertical	vertical	vertical
comment	pass-car/bronco	pass-car/ bronco	econoline	econoline	econoline	econoline
# of switches	2	2	2	2	2	2

77PBL3-3 SHOV. TEST- RAW DATA 8/23/93

SW. #	ACT	REL	PRE-TEST MV DR.	C-RES	I-RES	MV DR.	30 MIN C-RES	I-RES	MV DR.	60 MIN C-RES	I-RES	MV DR.	120 MIN C-RES	I-RES	MV DR.	420 MIN C-RES	I-RES
A1	253	183	4.4	0.1	NA	29.6	0.1	NA	52.8	0.1	NA	41.9	0.1	NA	37.7	0.1	NA
A2	253	180	4	0.1	NA	31.4	0.1	NA	54.7	0.1	NA	43.8	0.1	NA	38.6	0.1	NA
B1	235	179	4.6	0.1	NA	29.5	0.1	NA	52.6	0.1	NA	41.7	0.1	NA	37.4	0.1	NA
B2	263	187	4.3	0.1	NA	25.3	0.1	NA	46.7	0.1	NA	37.7	0.1	NA	39.9	0.1	NA
C1	228	175	4	0.1	NA	32.4	0.1	NA	13.6	0.1	NA	44.7	0.1	NA	38.9	0.1	NA
C2	261	187	4.3	0.1	NA	18.1	0.1	NA	39.1	0.1	NA	24.9	0.1	NA	22.7	0.1	NA
D1	248	177	4	0.1	NA	30.1	0.1	NA	53.7	0.1	NA	42.7	0.1	NA	40.2	0.1	NA
D2	258	193	4.2	0.1	NA	25.4	0.1	NA	41.6	0.1	NA	37.6	0.1	NA	41.1	0.1	NA
E1	242	191	4.4	0.1	NA	33.6	0.1	NA	57.3	0.1	NA	46	0.1	NA	41.6	0.1	NA
E2	255	193	4.3	0.1	NA	29.1	0.1	NA	52.9	0.1	NA	38.8	0.1	NA	39.6	0.1	NA
F1	249	184	4.1	0.1	NA	36.2	0.1	NA	58.3	0.1	NA	48.5	0.1	NA	42.8	0.1	NA
F2	237	182	6.6	0.1	NA	31.1	0.1	NA	56.5	0.1	NA	43.9	0.1	NA	38.7	0.1	NA

NA = GREATER THAN 20 MEGAOHMS

3713 5823

Table 1

F3TA-9F924-CA SPEED CONTROL DE-ACTIVATION SWITCH							10/6/93					
T.I. P/N	77PSL3-3											
UPDATE OF RESULTS FROM SHOWER TEST												
HOURS OF EXPOSURE TO DATE:		324										
	a		b		c		d		e		f	
shell	uta		uta		uta		uta		spc		spc	
grommet	gray		gray		gray		gray		gray		gray	
face seal	sponge		sponge		silicone		silicone		sponge		sponge	
wire leads	tension		slack		tension		slack		tension		slack	
orientation	horizontal		horizontal		vertical		vertical		vertical		vertical	
comment	pass-car/bronco		pass-car/ bronco		econoline		econoline		econoline		econoline	
latching	a1	a2	b1	b2	c1	c2	d1	d2	e1	e2	f1	f2
	latched	rocked	latched	rocked	latched	rocked	latched	rocked	latched	rocked	latched	rocked
results	o.k	ingress (minor	o.k	ingress (minor	o.k	ingress (major	o.k	ingress (major	o.k	ingress (major	o.k	ingress (major)

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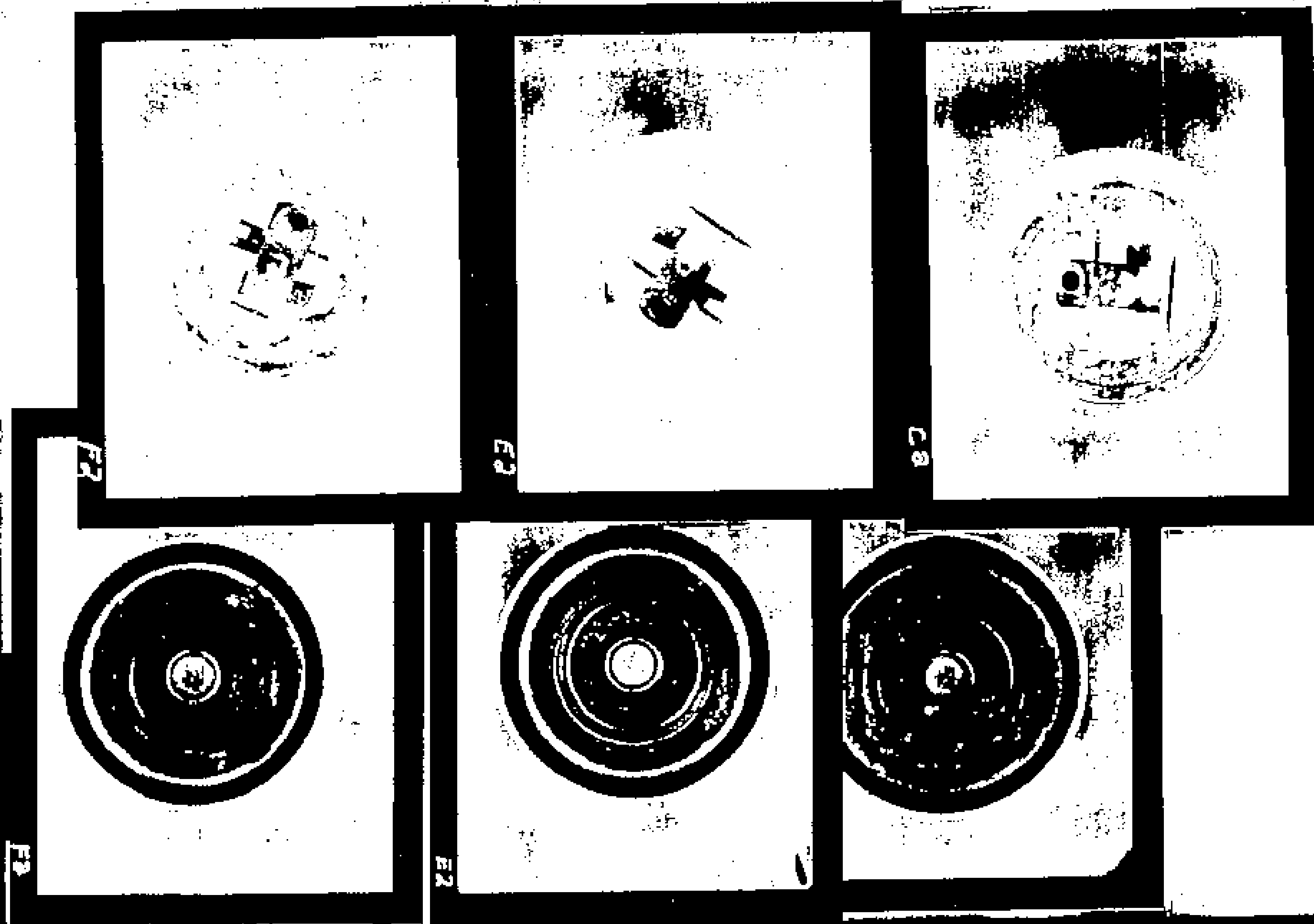
Table 2.

FSTA-9F924-CA	SPEED CONTROL DE-ACTIVATION SWITCH					10/18/93	
T.I. P/N	77PSL3-8						
RESULTS FROM SHOWER TEST							
HOURS OF EXPOSURE TO DATE:				324			
SWITCH #	ACT	REL	mv DROP	TERM TO TERM @ 300 PSI	TERM TO CASE 500 VDC MEGGER	CONNECTOR STATUS	INGRESS
A1	260	182	4	> 20 MEGAOHM	64 GIGA-OHM	LATCHED	NONE
A2	242	178	4	"	100 GIGA-OHM	ROCKED	MINOR
B1	239	172	4.2	"	68 GIGA-OHM	LATCHED	NONE
B2	268	165	4.2	"	60 GIGA-OHM	ROCKED	MINOR
C1	239	174	4	"	120 GIGA-OHM	LATCHED	NONE
C2	****	[illegible]	6.8	22.3 KILO-OHM	3 MEGA-OHM	ROCKED	MAJOR
D1	248	179	4.3	> 20 MEGA-OHM	130 GIGA-OHM	LATCHED	NONE
D2	265	166	4.1	26.4 KILO-OHM	27 MEGA-OHM	ROCKED	MAJOR
E1	257	192	4.1	> 20 MEGA-OHM	110 GIGA-OHM	LATCHED	NONE
E2	260	190	4.2	"	22 MEGA-OHM	ROCKED	MAJOR
F1	253	182	4	"	107 GIGA-OHM	LATCHED	NONE
F2	****	[illegible]	4	31.9 MEGA-OHM	1 MEGA-OHM	ROCKED	MAJOR
	****	= INTERMITTENT ACTUATION					

3713 5925



3719 5926

Drawing review-only - not vehicle level analysis

connector wedge
E3EB-14A468-DA

green = extreme gray end
pink = front harness end
green = wire to connector system
pink = wire to connector not acceptable?

	92	93	94	95	96	97	98	99
BRONCO	F3TB-12A581-AC E9EB-14A464-AA 18Ga. AZ	F4TB-12A581-AN F4ZB-14A464-MA 18Ga., AZ SHORTING BAR	F5TB-12A581-AZ F4ZB-14A464-MA SHORTING BAR	F6TB-12A581-AJ F4ZB-14A464-MA 18Ga., AZ	F7TB-12A581-BJ F4ZB-14A464-MA 18Ga., AZ			
CAPRI								
CROWN VICTORIA/ GRAND MARQUIS	F3AB-14401-AS F2AB-14A464-ADA 16, AE	F4AB-14401-AE F2AB-14A464-ADA 16, AE	F5AB-14401-AZ F5VB-14A464-AA 18, AZ	F6AB-14401-AL F6VB-14A464-AA 18, AZ	F7AB-14401-AL F6VB-14A464-AA 18, AZ	F8OB-14A464-AA 18Ga., AZ	XW3T-14401- F8OB-14A464-AA 18Ga., AZ	
ECONOLINE	F3UB-12A581-CB E9EB-14A464-AA SHORTING BAR	F4UB-12A581-GZ F4ZB-14A464-MA 18Ga., AZ SHORTING BAR	F5UB-12A581-BZ F4ZB-14A464-MA 18Ga., AZ SHORTING BAR	F6UB-12A581-CZ F4ZB-14A464-MA 18Ga., AZ SHORTING BAR	F7UB-12A581-LY F4ZB-14A464-MA [illegible] SHORTING BAR			
EXPEDITION							XL14-12A581-AT F4ZB-14A464-MA 16Ga., AZ	

brake pedal location

3713 5927

Date Printed: 4/7/99

EXPLORER

92	93	94	95	96	97	98	99
		F57B-12A581-EZ	F87B-12A581-EV	F77B-12A581-AAB	F87B-12A581-	XL24-14398-AB	
		[illegible]	F57B-14A464-[illegible]	F57B-14A464-[illegible]	F57B-14A464-[illegible]	[illegible]	
		20Ga.; AZ	[illegible]Ga.; AZ	[illegible]Ga.; AZ	[illegible]Ga.; AZ	[illegible]Ga.; AZ	

F-SERIES

92	93	94	95	96	97	98	99
			F65B-12A581-KC	F75B-12A581-AV	F85B-12A581-AK	XL34-12A581-AR	
			F4ZB-14A464-MA	F4ZB-14A464-MA	F4ZB-14A464-MA	F4ZB-14A464-MA	
			[illegible]	[illegible]Ga.; AZ	[illegible]Ga.; AZ	[illegible]Ga.; AZ	

FALCON

92	93	94	95	96	97	98	99

MARK VIII

92	93	94	95	96	97	98	99
F3LB-14290-CX	F4LB-14290-AH	F5LB-14290-BK	F6LB-14290-	F7LB-14290-AR	F8LB-14290-AE		
F2AB-14A464-ADA	F2AB-14A464-ADA	[illegible]	[illegible]	F4ZB-14A464-MA	F4ZB-14A464-MA		
[illegible]	[illegible]	[illegible]Ga.; AZ	[illegible]Ga.; AZ	[illegible]	[illegible]Ga.; AZ		

NAVIGATOR

92	93	94	95	96	97	98	99
						XL74-12A581-AS	
						F4ZB-14A464-MA	
						[illegible]	

3713 6928

RANGER

XL54-14290-CA

92	93	94	95	96	97	98	99
						[redacted]	
						[redacted]	

TAURUS

92	93	94	95	96	97	98	99
F3DB-12A581-CK	F4DB-12A581-CM	F5DB-12A581-ED				XF1T-12B837	
E9EB-14A464-AA	E9EB-14A464-AA	F4ZB-14A464-MA				F4ZB-14A464-MA	
[redacted]	18GA., AZ	[redacted]				[redacted]	

WINDSTAR

92	93	94	95	96	97	98	99
[redacted]		F58B-14290-AZ	F58B-14290-FZ	F78B-14290-PY	F88B-14290-FG	XF2T-14290-KH	
		[redacted]	[redacted]	[redacted] A	[redacted]	F4ZB-14A464-MA	
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

TOWN CAR

12A581

92	93	94	95	96	97	98	99
F2AB-14A464-ADA	F2AB-14A464-ADA	F2AB-14A464-ADA	~~F5VB-14A464-AA~~ F2AB-14A464-ADA	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	18Ga., AZ	[redacted]	[redacted]		

?

AB	ESB-M1L85-B
AZ	ESB-M1L123-A

Date Printed: 4/7/99

3713 8929

9F924 Hydraulic Applications

Vehicle	MY	Part Number	Pressure Engage	Pressure Release	Color	Key	Port	Threads		Material	Location	Orientation	Component
Bronco	94	F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide			
Capri	94	94JA 9F924 AB	90-180	20	Grey	pos 1	o-ring	3/8-24M	Quiet		322	180, 0	Prop Valve
Club Wagon		F6LC 9F924 AA	200-300	40	Black	pos 1	J512	3/8-24M	Snap				
Club Wagon		F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide	321	0, 0	Master Cylinder
Crown Victoria	92, 93	F2VC 9F924 AB	90-180	20	Brown	pos 2	J512	3/8-24M	Snap	Celanex 4300	311	45, 0	Prop Valve
Crown Victoria	95?	F2AC 9F924 AA	90-200	20	Natural	pos 2	J512	3/8-24M	Quiet		311	45, 0	Prop Valve
Econoline	92, 93								Snap		211	0, 0	Brake Line
Econoline	94	F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide	321	0, 0	Master Cylinder
Econoline		F6LC 9F924 AA	200-300	40	Black	pos 1	J512	3/8-24M	Snap				
Expedition		F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide			
Explorer	95, 96, 97	F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide	321	0, 0	Master Cylinder
F-Series	94, 97	F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide	321	0, 0	Master Cylinder
Falcon		94DA 9F924 AA	90-180	20	Natural	pos 2	o-ring	M10x1.0M	Quiet				
Grand Marquis	92, 93	F2VC 9F924 AB	90-180	20	Brown	pos 2	J512	3/8-24M	Snap	Celanex 4300	311	45, 0	Prop Valve
Grand Marquis	95?	F2AC 9F924 AA	90-200	20	Natural	pos 2	J512	3/8-24M	Quiet		311	45, 0	Prop Valve
Mark VIII	93, 94	F2VC 9F924 AB	90-180	20	Brown	pos 2	J512	3/8-24M	Snap	Celanex 4300	311	100, 0	Prop Valve
Mark VIII	95, 96	F2AC 9F924 AA	90-200	20	Natural	pos 2	J512	3/8-24M	Quiet		113	180, 0	Prop Valve
Navigator		F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide			
Ranger	95, 96, 97	F3TA 9F924 CA	200-300	40	Red	pos 1	J512	3/8-24M	Snap	Polyphenylene Oxide	321	0, 0	Master Cylinder
SHO Taurus		F3DC 9F924 AA	90-180	20	Natural	pos 2	Snubber	3/8-24M	Quiet				
Town Car	92, 93	F2VC 9F924 AB	90-180	20	Brown	pos 2	J512	3/8-24M	Snap	Celanex 4300	311	45, 0	Prop Valve
Town Car	95?	F2AC 9F924 AA	90-200	20	Natural	pos 2	J512	3/8-24M	Quiet		311	45, 0	Prop Valve
Winstar		F58A 9F924 AA	90-180	20	Grey	pos 1	J512	3/8-24M	Quiet				

8713 5690

Thin WaLL

Standard Wall

Conn. Key #[illegible]

F57B-14A464-ALA (FIG. 1)	E9EB-14A464-AA (FIG. 1)	F2AB-14A464-ADA (FIG. 2)	F3LB-14A464-UA (FIG. 1)	F42B-14A464-MA (FIG. 1)	F5VB-14A464-AA (FIG. 2)				
REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	ITEM	PART NO.	NAME	COL
●	●		●	●		1	109-008-8P-1	SLEEVE-WIRING CONNECTOR-MALE	BLA
		●			●	6	109-008-8P-2	SLEEVE-WIRING CONNECTOR-MALE	GRA
	●	●		●		2	E087-001-8P-1	GASKET-WIRING CONNECTOR	RED
[illegible]			[illegible]		[illegible]	5	F3797	GASKET-WIRING CONN. (SILICONE)	RED
●				●	●	4	F4B3-14603-AA	GROMMET-WIRING CONNECTOR (TV)	BLU
	●	●	●			3	E459-14603-AA	GROMMET-WIRING CONNECTOR	GRA

Thin Wall

[illegible]

D C B A

3713 5931

REV	LET.	REVISIONS	CK	CAL NO.
		RELEASED F5VB-14A464-AA COMPLETE NB00-I-10112645-654		
	A1	ADDED F4ZB-14A464-HA WAS SHOWN ON C SIZE E9EB-14A464-AA (920321)		
	A2	ADDED F3LB-14A464-UA WAS SHOWN ON C SIZE DATED 911106		
	A3	ADDED F2AB-14A464-ADA WAS SHOWN ON C SIZE DATED 910115		
	A4	ADDED E9EB-14A464-AA WAS SHOWN ON C SIZE DATED 920321		
[illegible]		NB00-E-10091775-210 RD		
2[illegible]		RELEASED F57B-14A464-ALA COMPLETE NB00-I-10220008-160		[illegible]

3713 5932

	Vehicle	MY	Part Number	Pre[illegible] Engage[illegible]
e	Bronco	94	F3TA 9F924 CA	200-300
f	Capri	94	94JA 9F924 AB	90-160
g	Club Wagon		F6LC 9F924 AA	200-300
e	Club Wagon		F3TA 9F924 CA	200-300
→ a	Crown Victoria	92, 93	F2VC 9F924 AB	90-160
b	Crown Victoria	95?	F2AC 9F924 AA	90-200
	Econoline	92, 93		-
e	Econoline	94	F3TA 9F924 CA	200-300
g	Econoline		F6LC 9F924 AA	200-300
e	Expedition		F3TA 9F924 CA	200-300
e	Explorer	95, 96, 97	F3TA 9F924 CA	200-300
e	F-Series	94, 97	F3TA 9F924 CA	200-300
h	Falcon		94DA 9F924 AA	90-160
→ a	Grand Marquis	92, 93	F2VC 9F924 AB	90-160
b	Grand Marquis	95?	F2AC 9F924 AA	90-200
→ a	Mark VIII	93, 94	F2VC 9F924 AB	90-160
b	Mark VIII	95, 96	F2AC 9F924 AA	90-200
e	Navigator		F3TA 9F924 CA	200-300
e	Ranger	95, 96, 97	F3TA 9F924 CA	200-300
c	SHO Taurus		F3DC 9F924 AA	90-160
→ a	Town Car	92, 93	F2VC 9F924 AB	90-160
b	Town Car	95?	F2AC 9F924 AA	90-200
d	Windstar		F58A 9F924 AA	90-160

Service Part Number for ALL

Service Numbers

a) F2VY - 9F924 - A
b) F2AZ - - A
c) F3DZ - - A
d) F58Z - A
e) F3TZ 9F924 B
f) [illegible] found
g) F6LZ 9F924 AA
h) [illegible]

Originator: Fred Porter
File: USAGE.xls Vehicles

[illegible]

3713 5933

Scale Definition

Switch Base Material
- 4 Celanex 4300 - UL rating HB
- 3 Noryl GTX 830 - UL rating HB
- 2 Celanex 3316 - UL rating V0
- 1 Zytel - UL rating V0

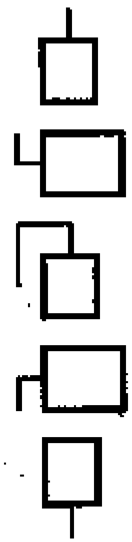
Switch vehicle location - splash zone
- 8 Wheel well
- 7 Underbody - spray line
- 6 Underbody - out of spray line
- 5 Engine compartment - low
- 4 Engine compartment - middle
- 3 Wheel well - behind splash guard
- 2 Engine compartment - high
- 1 Passenger compartment

Switch orientation - from vertical
- 4 0° to 90°
- 2 90° to 135°
- 1 135° to 180°

Proximity to combustible material
- 2 0" - 9"
- 1 > 9"

Wire routing - drip loop

5
4
3
2
1



Connector Face Seal
- 9 Foam
- 3 Silicone

Wire to Connector Grommet Seal
- 9 Incompatible
- 1 Compatible

3713 5934

Speed Control De-Activation Switch Concern
Info. By Vehicle Build Year

[redacted]

[redacted]					Recommendation		[redacted]										Recommendation		[redacted]										Recommendation
4	6	9	1	2			0	3		1	2	1	5	9	1	2			2	7		4	5	4	5	9	9	2	
4	5	9	1	2			2	15		4	5	4	5	9	1	2			0	4		4	5	4	5	3	1	2	
4	5	9		2			1	34		3	2	4	3	9	1	2			2	15		3				9	1		
				1			1	47		3	2	1	3			2			2	48		3							
[redacted]							[redacted]															3							
[redacted]							[redacted]															3	2	1	3	3	1	2	
[redacted]							[redacted]												[redacted]										
										3												3							
		9	1							4				9	1								2	1	1	3	1		
[redacted]							[redacted]												[redacted]										
		9	1											9	9								2	1	1	9	1	2	
[redacted]							[redacted]																2	1	1			2	

Speed Control De-Activation Switch Concern
Info. By Vehicle Build Year

[redacted]

Vehicle	[redacted]										Recommendation
Town Car	1	5		4	5	4	5	3	1	2	
CV/GM	1	12		4	5	4	5	3	1	2	
Econoline	0	0		3				9	1		
F-Series	0	0		3				9	1		
Ranger				3							
Explorer				3	2	1	3	3	1	2	
Capri											
Club Wagon											
Expedition	[redacted]										
Bronco				3							
Falcon											
Mark VIII					2	1	1	3	1		
Navigator	[redacted]										
SHO Taurus					2	1	1			2	
Windstar					2	1	1			2	

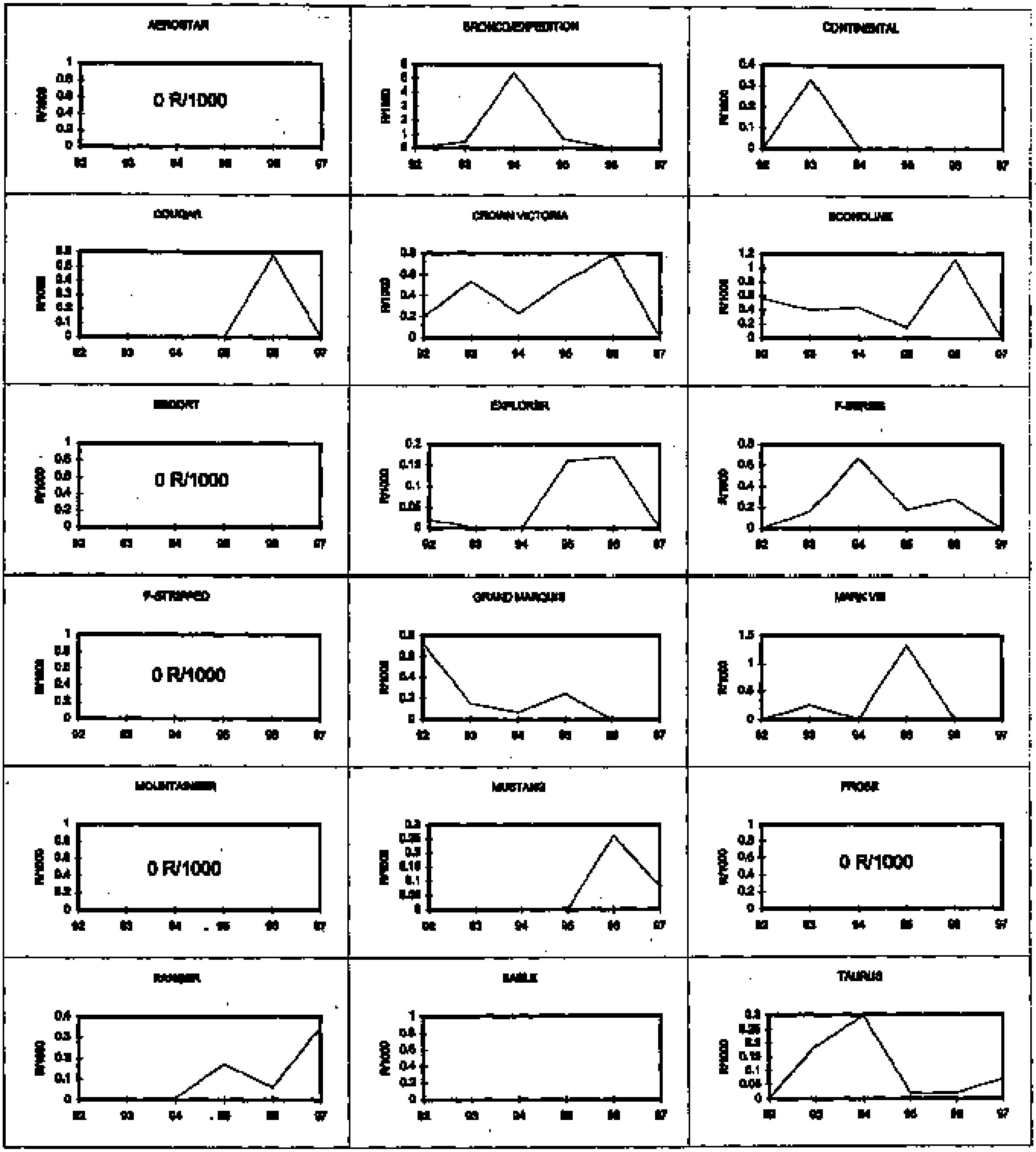
Vehicle	[redacted]										Recommendation
Town Car	0	1		4	5	4	5	3	1	2	
CV/GM	1	7		4	5	4	5	3	1	2	
Econoline	0	0		3	2	1	1	9	1	2	
F-Series	0	0		3	2	4	3	9	1	2	
Ranger				3	2	4	3			2	
Explorer				3							
Capri											
Club Wagon											
Expedition	[redacted]										
Bronco				3	2	4	3			2	
Falcon											
Mark VIII											
Navigator	[redacted]										
SHO Taurus	[redacted]										
Windstar					2	1	1			2	

Vehicle	[redacted]										Recommendation
Town Car	different switch - moved inside vehicle										
CV/GM	different switch - moved inside vehicle										
Econoline				3							
F-Series				3				9	1		
Ranger				3							
Explorer				3	2	4	3	3	1	2	
Capri	[redacted]										
Club Wagon											
Expedition											
Bronco	[redacted]										
Falcon											
Mark VIII								9	1		
Navigator				3	2	4	3			2	
SHO Taurus	[redacted]										
Windstar					2	1	1			2	

Vehicle	[redacted]										Recommendation
Town Car	different switch - moved inside vehicle										
CV/GM	different switch - moved inside vehicle										
Econoline				3	2	1	1				
F-Series				3				9	1	2	
Ranger				3	2	4	3	3	1	2	
Explorer				3	2	4	3	3	1	2	
Capri	[redacted]										
Club Wagon											
Expedition				3	2	1	1	9	1	2	
Bronco	[redacted]										
Falcon											
Mark VIII	[redacted]										
Navigator				3							
SHO Taurus	[redacted]										
Windstar					2	1	1			2	

3713 5936

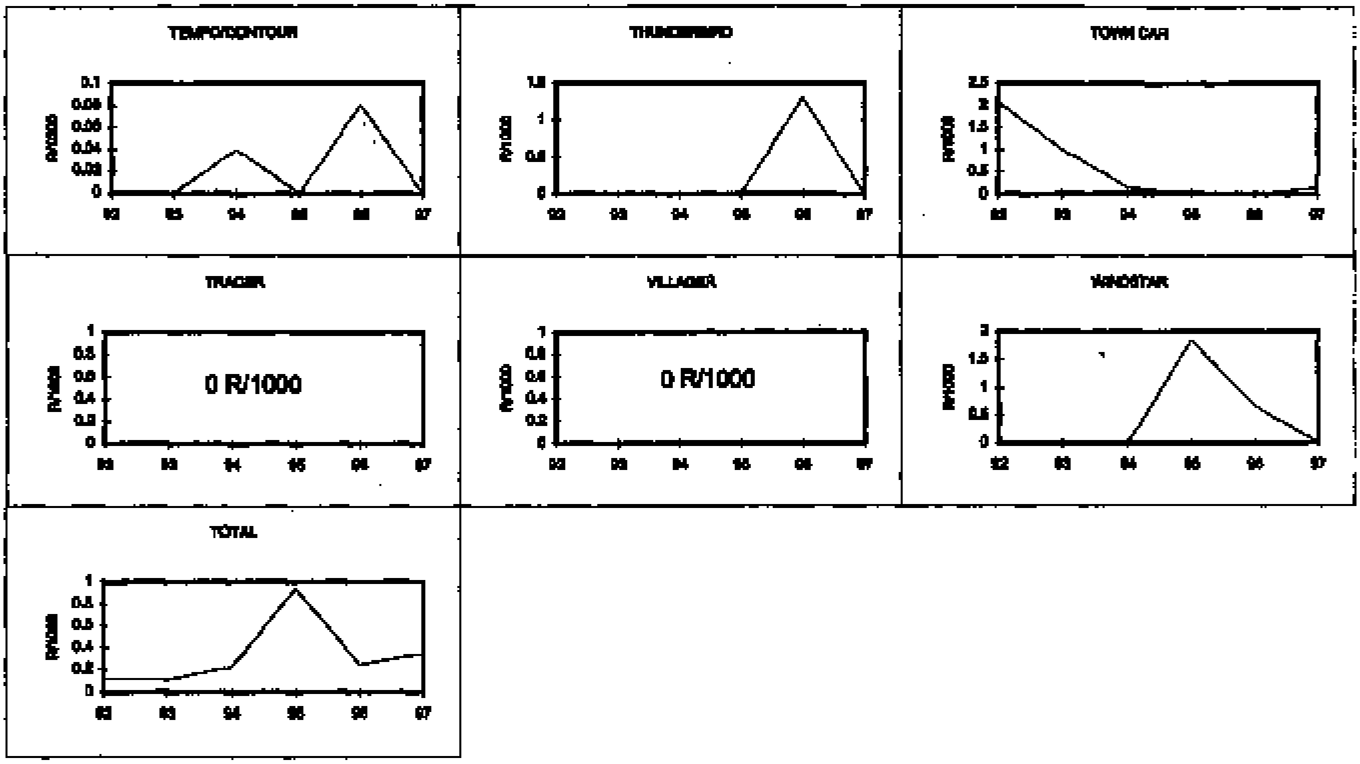
1992-1997 Extended Service Plan Warranty - R/1000
Part #9F924 - Switch Speed Control



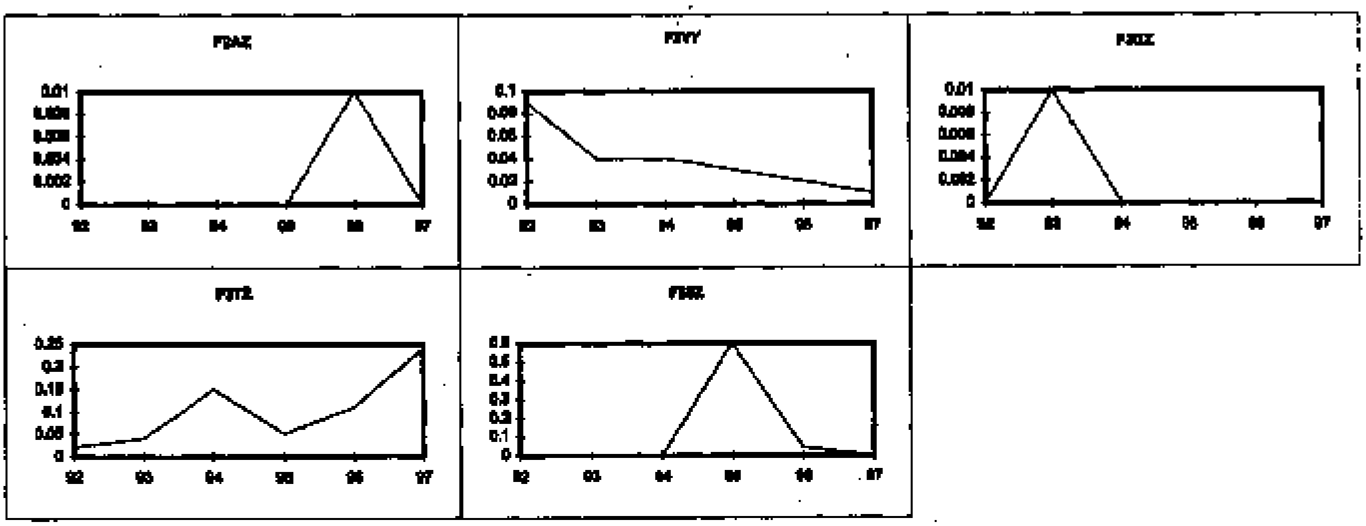
February 1999 AWS c/o
Sabine Peters, speters1
ESP9F924NEW.xls[Charts]

Date Created: 03/29/1999
Date Revised: 04/06/1999
Date Printed: 04/06/1999

1992-1997 Extended Service Plan Warranty - R/1000
Part #9F924 - Switch Speed Control



Breakdown by Part Prefix

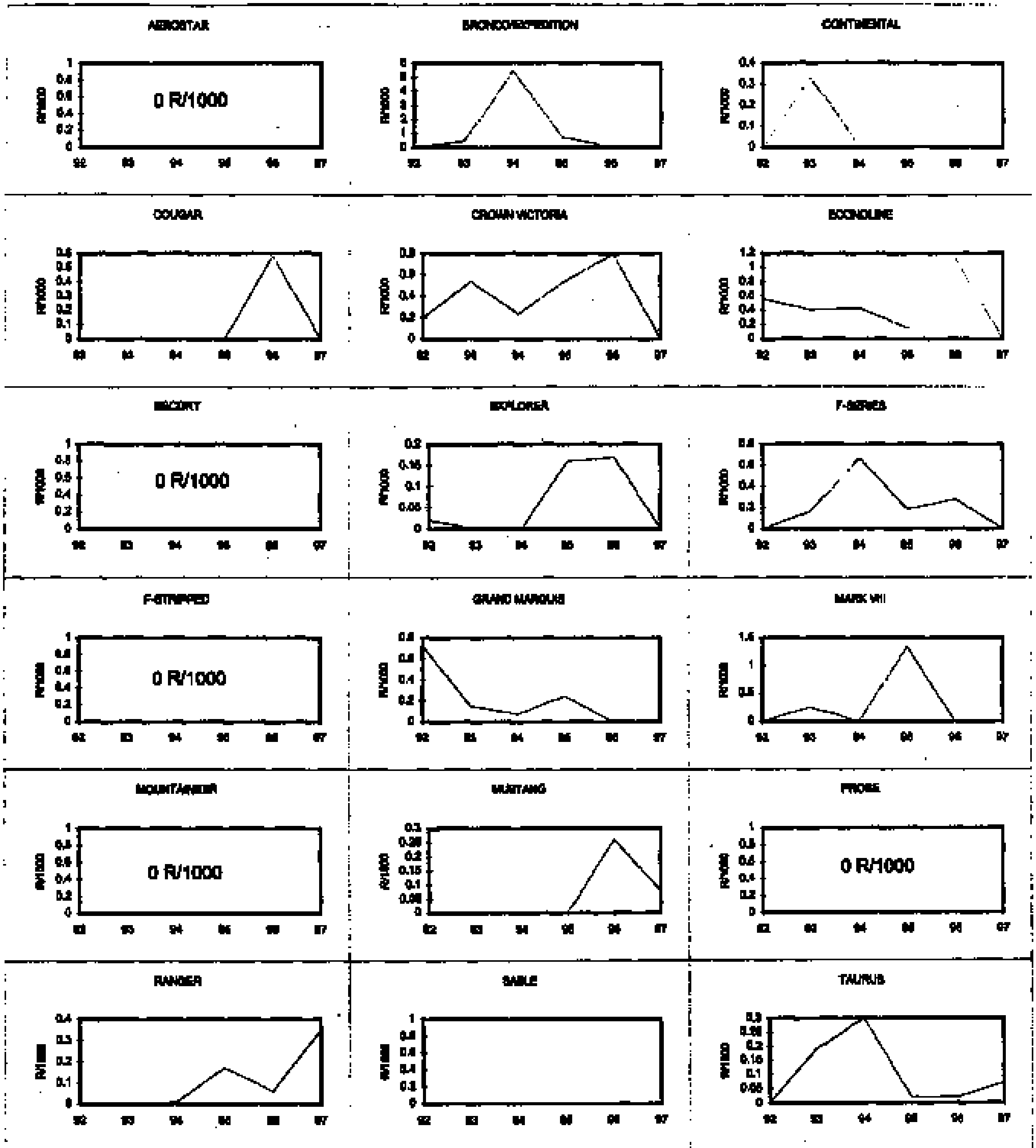


February 1999 AWS c/o
Sabina Peters, speters1
ESP9F924NEW.xls[Charts]

Date Created: 03/26/1999
Date Revised: 04/06/1999
Date Printed: 04/06/1999

3713 5938

1992-1997 Extended Service Plan Warranty - R/1000
Part #9F924 - Switch Speed Control

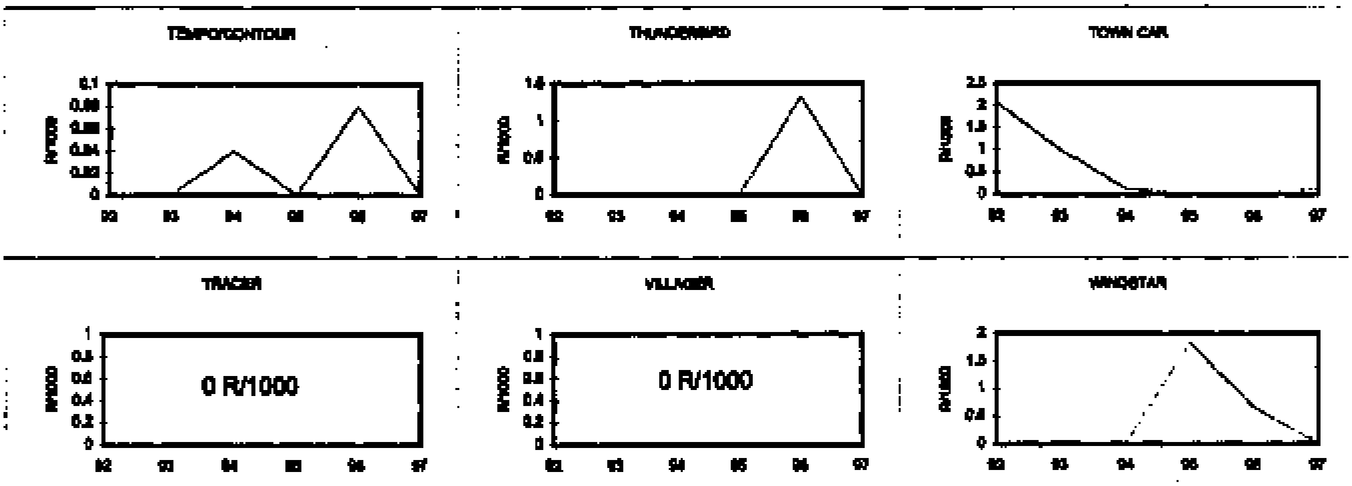


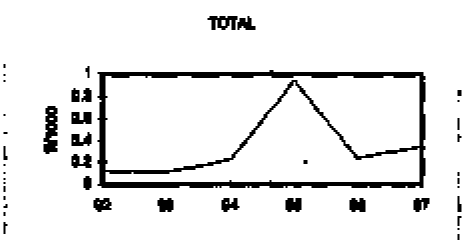
February 1999 AWS c/o
Sabina Peters, speters1
ESP9F924NEW.xls(Charts)

Date Created: 03/26/1999
Date Revised: 03/31/1999
Date Printed: 03/31/1999

3713 5939

1992-1997 Extended Service Plan Warranty - R/1000
Part #9F924 - Switch Speed Control





Data issues:

1) not factored by speed control take rate (vehicle line to vehicle line comparison not valid)

2) Sample size issue?

Ice Cube Chart Projections for Part 9F924 - Switch Speed Control
(Bumper-To-Bumper Projections - CPU)

Source	MY	[illegible]	RANK	[illegible]	[illegible]	AEROSTAR 4X2	AEROSTAR 4X4	CONTINENTAL	COUGAR	CONTOUR	CROWN VICTORIA	ECONOLINE	ESCORT	EXPEDITION 4X2	EXPEDITION 4X4	EXPLORER 4X2	EXPLORER 4X4	F-SER. 4X2 [illegible]	F-SER. 4X4 [illegible]	F-SERIES 4X2	F-SERIES 4X4	F-SERIES STRIPPED	GRAND MARQUIS	MARK VIII	MOUNTAINEER 4X2	MOUNTAINEER 4X4	MUSTANG	MYSTIQUE	NAVIGATOR 4X2	NAVIGATOR 4X4	RANGER 4X2	RANGER 4X4	SABLE	TAURUS	THUNDERBIRD	TOWN CAR	TRACER	VILLAGER	WINDSTAR
IceCubePrj	1996	Oct-96	103		0.10			-		1.34	-	-	-	-	-	-	-			-	0.01		-	-	-	-	0.05	-	-	-	-	-	-	0.01		-	-	-	0.04
IceCubePrj	1997	Oct-96	171		[illegible]	-	-	0.15	0.16	0.03	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	0.25	-			-	-	0.05	0.03	0.00	0.16	-	-	-
IceCubePrj	[illegible]	no data																																					
IceCubePrj	[illegible]	no data																																					
IceCubePrj	1994	n/a																																					

94 – 96 < 0.01

'94 1st year of data

3713 5941

CPD-EESE, Quality Systems
[illegible] Peters, speters1
[CECUB~1.XLS]Sheet1

Date Created: 03/29/1999
Date Revised: 03/29/1999
Date Printed: 03/29/1999

1992/3 Towncar Underhood Fire NHSTA Inquiry — Draft 2/10/99

Background

- On 11/24/98 NHTSA submitted inquiry PE98-055 alleging 21 reports of underhood fires in 1992/3 Towncars
- On 1/11/99 NHTSA submitted a supplemental inquiry requesting information on all Ford vehicles using
  - F2VC-9F924 brake pressure switches
  - 12A581 wire harness assemblies with a PIA relay center
  - EDIS 8 modules

- Present searches have identified the following:
  - 149 underhood fires or overheating events on 1992 and 1993 Towncars
  - 36 with engine off/vehicle parked, 9 with engine on, and 104 unidentified
  - 5 appear to be related to the brake pressure switch
  - 17 appear to be related to other components

Status

- ASO is collecting requested data to respond to NHTSA
- Task force established to investigate brake pressure switch… meeting weekly
- EESE person identified to lead the engineering investigation

Next Steps

- Identify potential affected vehicles/trends
  - identify Crown Victoria/Grand Marquis vehicles incidents since similar electrical configuration and vehicle package
  - identify potential trends by comparing incidents to vehicle options

- Identify potential root cause(s)
  - establish links to CAC/OGC/FCSD/NHTSA to quickly identify incidents and establish team to quickly investigate
  - perform tasks on brake pressure switch task force work plan
  - investigate other components as appropriate

- Identify potential interim containment actions for vehicles in the field

Vehicle/Customer Information/Incident Info

Model Year: Make: VIN#: Mileage (at inspection):

Inspection Date/Location: Vehicle Owner:

Incident date: Approximate mileage at incident:

Inspector Name:

Requested Info

Area of fire origination (engine compartment quadrant, component, etc)

Identify if any underhood relays show evidence of internal overheat

Identify if any fuses or fuse links were blown or show evidence of other damage

Determine if the correct fuse for the stop lamp switch in the fuse box

Identify is there was any damage to wiring in the area where the fire was started (ie chafing, miss ing insulation)

Assess whether the air suspension pump shows evidence of internal overheating

Identify if there were any aftermarket modifications to the vehicle? (specifically car alarm, trailer tow, or remote start)

If possible, identify if the vehicle was involved in a natural disaster/accident that required significant vehicle clean up? If so where was cleanup performed?

If possible, identify vehicle repair history

Any other info that may be pertinent to the incident…

Parts that we would like from vehicle if possible to acquire

Brake pressure switch (preferably with wire pigtail/connector attached and still attached to prop valve)

Sample of brake fluid at prop valve (in sealed glass container)

Relay pack located on LH fender apron (with as much wiring as possible)

EDIS 8 module located on LH fender

Speed control module located on LH fender

Air suspension compressor located under air filter

Air suspension relay

Photograph of door jam VIN sticker

Other suspect parts

rev 2.0 — 3/19/99

Vehicle/Customer Information

Model Year: Make: VIN#: Mileage:

Build Date: Present Vehicle Location: Who owns vehicle now:

Customer Name: Phone: Is it ok for engineering to contact customer:

Incident Info/Vehicle History

Where did fire originate? (engine compartment quadrant, suspect location, or suspect component(s))

What was the vehicle circumstances when the fire was noticed? Was the vehicle running, parked, engine on/off… if off, how long?

Did customer notice anything unusual prior to fire? (specifically… difficulty getting the vehicle out of park, speed control not working, brake warning lamp illuminated, stop lamp inoperative)

Do any underhood relays show evidence of overheat?

Were the underhood fuse links blown?

Were there any fuses that were blown or show evidence of other damage?

Is the correct fuse for the stop lamp switch in the fuse box?

Was there any damage to any wiring in the area where the fire was suspected to start?

Does the air suspension pump show evidence of overheating?

Was there any aftermarket modifications to the vehicle? (specifically car alarm, trailer tow, or remote start)

Was the vehicle involved in a natural disaster/accident that required significant vehicle clean up? If so where was cleanup performed?

What was vehicle repair history?

Parts that we would like from vehicle if possible to acquire

Brake pressure switch (preferably with wire pigtail/connector attached and still attached to prop valve)

Sample of brake fluid at prop valve (in sealed glass container)

Relay pack located on LH fender apron (with as much wiring as possible)

EDIS 8 module located on LH fender

Speed control module located on LH fender

Air suspension compressor located under air filter

Air suspension relay

Other suspect parts

Which vehicles to look at

Any new incident of 1992-1995 Towncar, Crown Victoria, or Grand Marquis alleged to have an underhood fire

Specific prior incidents... vins forwarded in a separate file

1992-95 Town Car/Crown Vic/Grand Marquis/ Under Hood Fire Questionnaire

We are contacting you, because you reported smoke or fire in your vehicle. Ford is investigating your report and would like to ask you some questions about it. We hope everyone was ok...

Vehicle/Customer Information

ModelYear:______Make:____________VIN#:______________________________

Present Vehicle Location: ______________________Who owns vehicle now: ____________

Customer Name:______________________________Phone:______________

Is it ok for engineering to contact customer:______

Was the vehicle involved in a natural disaster/accident that required significant vehicle clean up? __________

If so, where was cleanup performed? ______________________________

What is the general repair history of the vehicle? ______________________________

____

Was it equipped with any aftermarket components? (specifically car alarm, trailer tow, or remote start ________

Insurance Agency Info. (If appropriate):

Agency Name: ______________________Agency phone number:______________

Claim number:____

Contact :______________________________Phone number:______________

Incident Info

Date of fire: ______________Mileage ________Was the vehicle repaired?______________

If repaired, when and where?______________________________________

Any idea where the fire started? (engine compartment quadrant... front, back, left, right) ____________

Was the vehicle parked or running?________ If parked, where?(garage, carport, parking lot) __________

Was the engine ON or OFF? ____________If OFF, how long was it parked before fire?______________

Did customer notice anything unusual prior to fire? ______________________________

Was there any difficulty getting the vehicle out of park:_____ Was speed control not working:__________

Was the brake warning lamp illuminated:______________Were the brake lights inoperative:__________

Any other info that you think may be useful to our investigation?______________________________

BRAKE PRESSURE SWITCH

(CRUISE CONTROL)

Central Laboratory
15000 Century Drive
Dearborn, MI 48120-1267
FAX (313) 322-1614

RECORD COPY
SCHEDULE NO. 7-4-2
RETAIN UNTIL 2002

Report 9804106

April 22, 1999

To: G. Stevens (313) 32-38686 (313) 39-0724 FAX

From: S. LaRouche (313) 84-54876

Subject: Speed Control Cut-off Switch
Part Number: F2VY-9F924-A
Specification: See Appendix A
Supplier: Texas Instruments

Received: One burned speed control cut-off switch and attached connector were received on December 17, 1998. The switch was identified as Reddick (Memphis).

Object: Determine cause of burned switch and connector.

Conclusion: The switch cavity of the base exhibits the most severe heat damage, which suggests that the fire may have originated in that location.

Although several conditions were discovered in the switch cavity which could contribute to the switch fire, it could not be determined if any of these conditions were the actual cause:

The deposits on the face of the cup contain elements (copper and zinc) from the brass contacts. This indicates transfer of the contact material to the cup, possibly as a result of an electrical cell being set up between the contacts which are electrically hot (+) and the cup which is grounded (-). The face of the cup and switch cavity contain a glycol based material (probably brake fluid) which could have acted with other materials (possibly water or an oxalate) as an electrolyte. If a cell occurred, it would have been a current path between the electrically hot contacts and ground.

The stationary contact is corroded and exhibits dezincification. Dezincification in brass is usually caused by exposure to water. The contact also exhibits cracks which are intergranular and appear to have been caused by stress corrosion cracking. Stress corrosion cracking in copper alloys is usually caused by exposure to ammonia, ammonia compounds, or amines. Portions of the contact have been reduced in cross sectional area by as much as 50 as a result of corrosion. All of these conditions could have increased the resistance of the contact.

The movable contact appears to have been melted back into the bulkhead between the switch and wire cavities of the switch base, most likely due to arcing. The surfaces of the melted area are clean which suggests that this damage may have occurred in the later stages of the fire.

The Kapton seals (diaphragms) exhibit cracks, possible mechanical damage, and embrittlement associated with the cracks. The cause of the cracks could not be determined. The cracks appear to have formed a leak path for the brake fluid to enter the switch cavity.

Data and Analysis:

Visual Examination

For reference, the components and internal construction of a typical switch are shown in Appendix I.

The base and connector of the submitted assembly have a burned and melted appearance. The base separated from the pressure side of the assembly approximately flush with the crimp ring. This left the face of the cup exposed. The face of the cup is partially covered with a greenish deposit and what appears to be some type of liquid. Small samples of the deposit and liquid were removed from locations A and B shown in Figure 1 for subsequent analyses.

The switch cavity contains the stationary contact which has a corroded appearance. The movable contact and its base are missing. The ceramic transfer pin is also missing. The cavity appears to be the most severely burned portion of the base. The plastic appears to have been charred away in this area, with only fibrous filler material remaining. This suggests that the fire may have started in this area. The connector appears to have been bonded to the switch base by heat from the fire. The exterior of the connector is covered with a white deposit.

The switch was examined with a fluoroscope (see Fluoroscopic Examination) and then sent to Texas Instruments (switch supplier, Attelboro, MA) for disassembly and examination (witnessed by N. LaPointe). The disassembled components were photographed by N. Lapointe (Figures 2 through 14). After disassembly and examination by Texas Instruments, the switch components were returned to Central Laboratory.

The Kapton seals are discolored and appear to have been cracked. These were sent to the Polymers section of Central Laboratory for further examination (see Examination of Kapton Seals section of this report).

The interior of the cup, the washer, converter, disc, and spacer are covered with a liquid and black residues (Figures 13 and 14). These were sent to the Organic Section of Central Laboratory for sampling and analysis.

The connector and switch base had been separated during examination by Texas Instruments. After the parts were returned from Texas Instruments, the connector was examined at Central Laboratory in the presence of UTA (connector supplier). The gray seal where the wires enter the connector appears intact (Figure 15). The cavity below the seal contains white deposits similar in appearance to those noted on the exterior (Figure 16). The sealing surface of the red seal is no longer intact and appears to have been partially melted by heat from the fire (Figure 17). Part of the melted seal material appears to have been transferred to the switch base (Figure 18). The insulation was carefully removed from the wires. The wires exhibit some tarnish and greenish discoloration (Figure 19). After this examination was completed, the contact bases and terminals were removed from the switch base.

The stationary contact exhibits cracks in the corners of the window below the contact pad and bridge (Figure 20). One corner away from the pad exhibits what appears to be localized arc damage. Approximately 50% of the bridge cross section has been lost by what appears to be corrosion. Cracks are also present in the base of the contact where it is bent and crimped to the bulkhead in the switch base. The terminal is covered with a black deposit.

The movable contact appears to have been melted back into the bulkhead of the switch base. The contact appears to have been melted into a large globule which has a clean and shiny appearance (Figure 20). The clean surfaces suggest that this damage is fresh and may have occurred in the later stages of the fire. The terminal is covered with olive green deposits.

Fluoroscopic Examination

Fluoroscopic examination revealed the presence of cracks in the stationary contact (Figures 21 and 22). It also shows loss of material in the bridge (Figure 21). The movable contact is missing. The base and terminal of the movable contact terminate in a large globule in the bulkhead of the switch base (Figure 23). The switch base and pressure side of the switch assembly were placed together to show the approximate relative position between the stationary contact and cup (Figures 23 through 26). Close ups of the pressure side of the switch assembly show the washer, converter, and disc in position inside the cup (Figures 27 and 28.

Examination of Kapton Seals
(Reflected Light Microscopy and Scanning Electron Microscopy (SEM))

The switch contains three Kapton seals which were splayed at ~45° angle to one another. Each seal has a laminated construction of Kapton between Teflon films. All three Kapton seals exhibit radial and circumferential cracks in the area that conformed over the converter and depression in the washer (Figure 29). The direction of the cracks and appearance of the damage suggest that they were caused by buckling or pinching of the Kapton. The cracking and damage appears to have initiated along the side of the seal which was against the washer. The Teflon appears to have been torn in the crack areas. The cracked areas of the Kapton material have been darkened and embrittled by some unknown mechanism (Figure 29). The cracks in the Kapton occurred in a brittle mode (Figures 30 and 31) and appear to have provided a leak path for brake fluid to enter the switch cavity.

Surface Analysis
(Scanning Electron Microscopy (SEM) and Energy dispersive X-ray Spectroscopy (EDS))

The surfaces and cracks of the stationary contact were examined with the SEM. Most of the surfaces of the contact exhibit damage suggesting corrosive attack (Figure 32). One corner of the contact bridge, away from the contact pad, exhibits what appears to be localized arc damage (Figure 33). The crack surfaces exhibit intergranular features (Figures 34 and 35), indicating stress corrosion cracking. EDS was performed to identify elements present in the following materials:

Oxide material on side of stationary contact.
Greenish deposit removed from face of cup.
Fibrous material on cup.
Material scraped from new switch base.
Material scraped from burned switch base.
White deposits removed from wire cavity in connector.
Material scraped from pad of stationary contact.
Material on crack surface.
Green material on terminal of stationary contact.
Black material on terminal from movable contact.

Spectra from these analyses are shown in Figures 36 through 47.

The spectrum from the material on the side of the stationary contact exhibits elements from the base metal (brass) as well as a trace amount of sulfur. This suggests that the material on the surface of the stationary contact is most likely an oxide of the base metal with possibly a sulfur compound.

Surface Analysis - continued

The spectrum from the greenish deposit on the cup exhibits mostly copper and zinc with trace amounts of sulfur, potassium, silicon, chromium, and iron. The presence of copper and zinc indicates that the deposit is primarily an oxide of the brass contact material which has transferred to the cup. The presence of sulfur suggests that some of the material may be a sulfate. The chromium and iron are most likely from the cup. The deposit also contains fibers which have spectra similar to those in the switch housing.

Spectra from the switch bases are similar. Aluminum, silicon, and calcium are most likely from the fillers (fibers, etc.) used in the housing material.

Spectra from the white deposit exhibit elements which would be found in dry chemical fire extinguishers, i.e., high phosphorus content material with plates of Si, Al, F - rich material (Muscovite).

The spectrum from the material on the pad of the stationary contact exhibits elements from the base metal (brass) as well as sulfur and traces of potassium and silicon. This suggests that the material on the surface of the pad is most likely an oxide and a sulfur compound of the base metal.

The spectrum from the black deposit on the movable contact terminal exhibits elements from the brass base material and the tin coating with sulfur. The deposit appears to be an oxide and sulfur compound of the terminal materials.

The spectrum from the green deposit on the stationary contact terminal exhibits elements from the base metal as well as sulfur, silicon, potassium, calcium, and aluminum. The deposit is most likely a sulfur compound of the terminal material with possible oxide. The silicon, calcium, potassium, and aluminum could be present from the fillers in the switch base or from a dry chemical fire extinguisher.

Molecular Characterization
(FTIR, Qualitative, Microscopic)

Deposit on Face of Cup

Arrow B in Figure 2 points to area where analysis was performed). Spectra of the fluid noted on the metallic surface [chloroform micro casts - several areas] are characteristic of a glycol ether [spectrally similar to Dow HD 50-4 brake fluid] with evidence of an ester and metal soap.

Spectra of the new, brown base are characteristic of a polyester on the base of terephthalic acid.

Spectra of the burned base are similar to the new base and are characteristic of a polyester on the base of terephthalic acid.

Molecular Characterization :
(FTIR, Qualitative, Conventional and Microscopic)

Hexport Deposit

Spectra as received are characteristic of a glycol based material [probably brake fluid] and a metal salt [probably an oxalate].

Spectra of the methanol solubles are characteristic of a glycol based material [probably brake fluid] and ester.

Spectra of the insolubles are characteristic of essentially a metal salt [possibly an oxalate].

Converter Deposit

Spectra as received are characteristic of a glycol based material [probably brake fluid] and a metal salt [probably an oxalate].

Spectra of the methanol solubles are characteristic of a glycol based material [probably brake fluid, ester, and other material.

Spectra of the insolubles are characteristic of essentially a metal salt [probably an oxalate].

Spacer Deposit

Spectra of the deposit [as received] are characteristic of a metal salt [probably an oxalate] and a glycol based material [probably brake fluid].

Washer Deposit

Spectra of the deposit [as received] are characteristic of a glycol based material [probably brake fluid] and a metal salt [possibly an oxalate].

Diaphragm #2 Internal Fluid/Deposit

Spectra as removed are characteristic of a glycol based material [probably brake fluid] and a metal salt [possibly an oxalate].

Water Content, % by weight[1] ~10
(ASTM D 1744)

Metallographic Analysis
(ASTM E 3)

The corroded bridge area of the stationary contact was mounted and polished for metallographic examination. The corroded area exhibits dezincification, suggesting exposure to moisture (Figures 48 and 49).

[1] Accuracy of this result is unknown based on the small sample size and possible interference caused between compounds present in the deposit and the titrant.

Concur: P. Klaas, Supervisor
Metallurgy Section

By: Steven LaRouche (SLAROUCH)

Enclosures: Appendix I
Figures 1 through 49

SL/sl

3713 5954

Appendix I

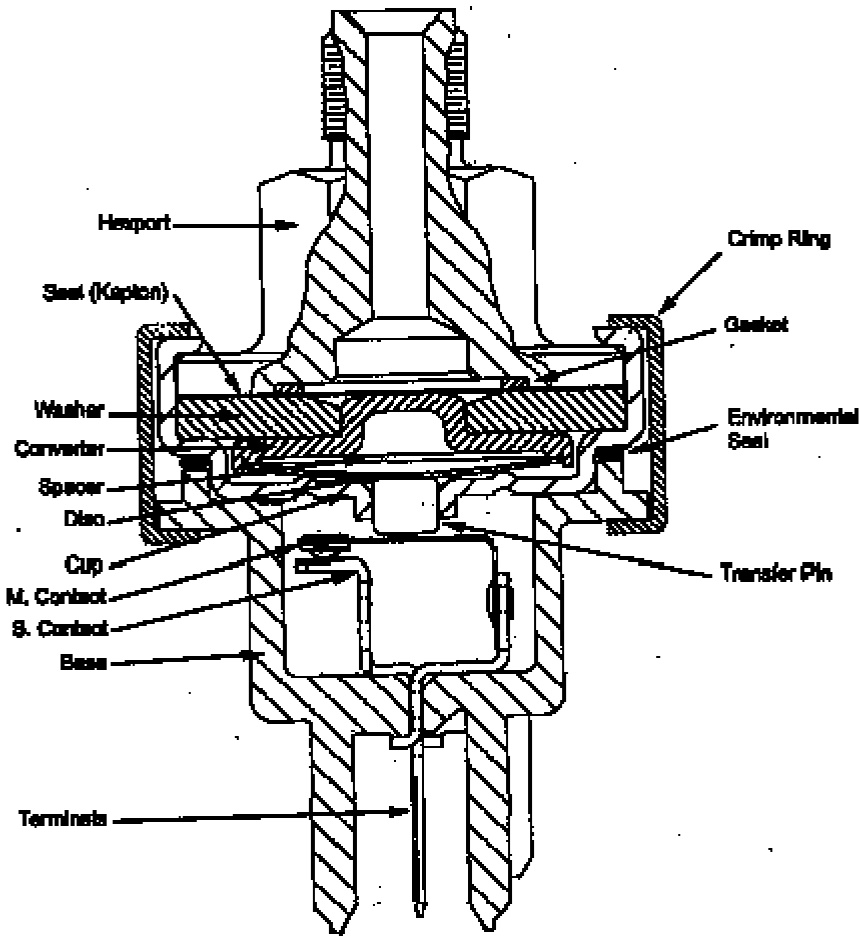
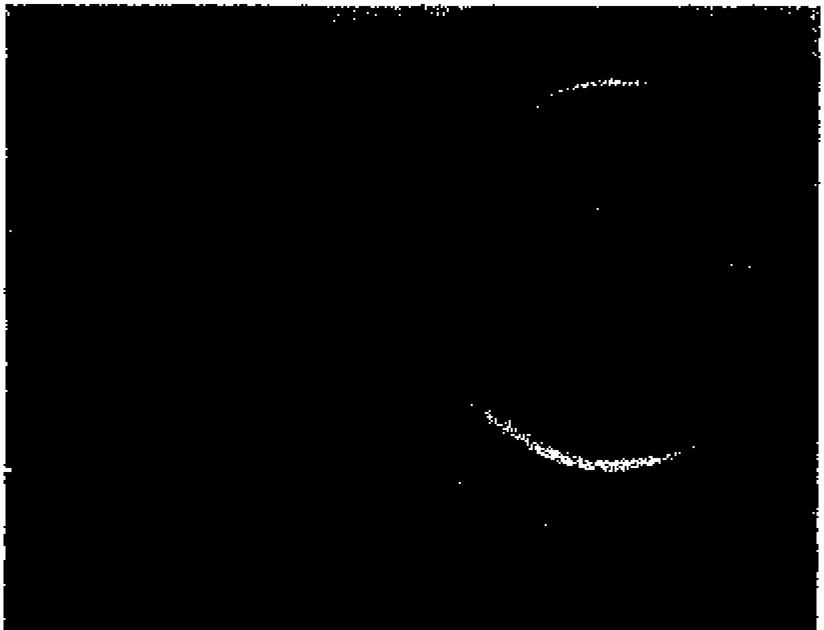


Diagram showing components of switch.



~1.7X

Figure 1: Photograph showing as-received switch and locations where samples were removed from cup face.

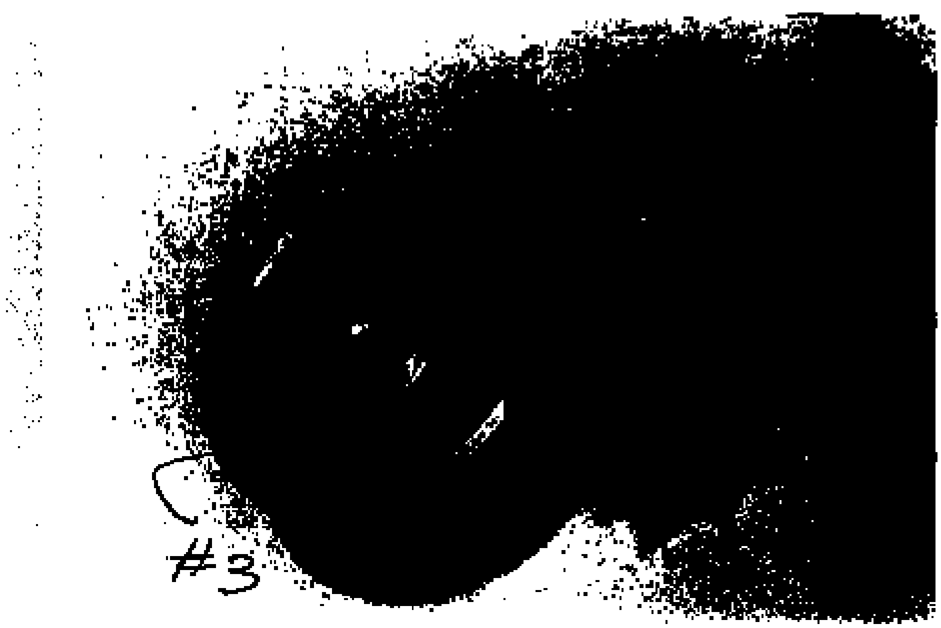
~1.4X

Figure 2: Photograph showing cup, Kapton seals, and hexport after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.

~2X

Figure 3: Photograph showing hexport after disassembly at Texas Instruments (N. LaPointe).



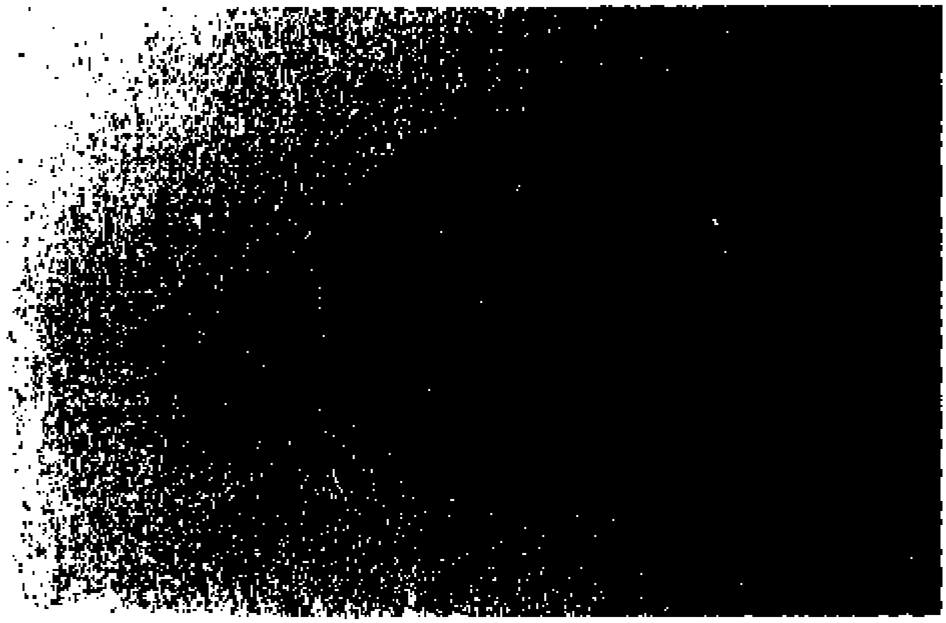
~1.9X

Figure 4: Photograph showing Kapton seals after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.

~3.5X

Figure 5: Photograph showing gasket after disassembly at Texas Instruments (N. LaPointe).



~3.5X

Figure 6: Photograph showing gasket (opposite side of that shown in Figure 5) after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.

~3.4X

Figure 7: Photograph showing Kapton seal #1 (closest to hexport) after disassembly at Texas Instruments (N. LaPointe).

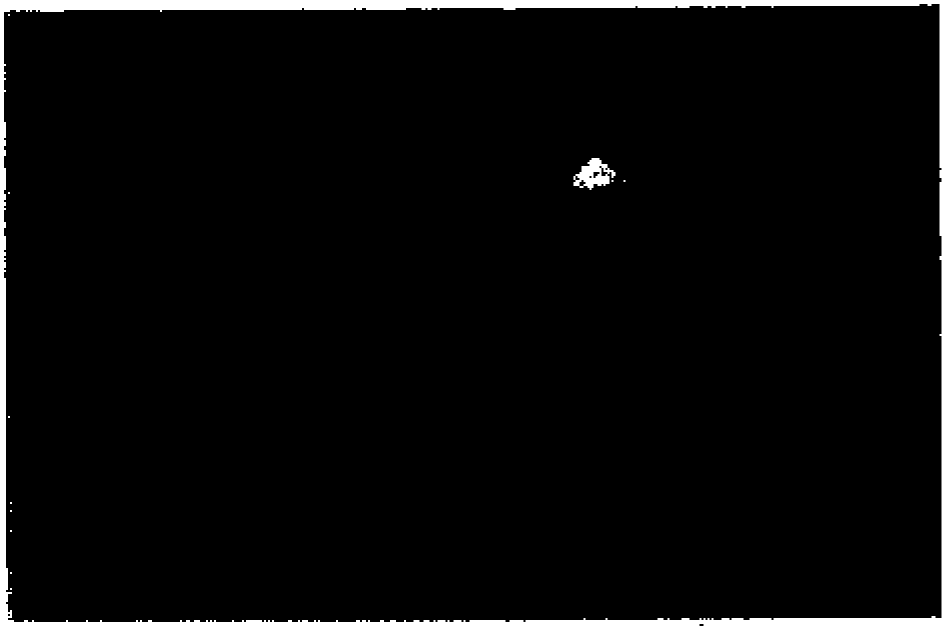
~3.4X

Figure 8: Photograph showing Kapton seal #1 (opposite side of that shown in Figure 7) after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.

~3.4X

Figure 9: Photograph showing Kapton seal #2 after disassembly at Texas Instruments (N. LaPointe).



~3.4X

Figure 10: Photograph showing Kapton seal #2 (opposite side of that shown in Figure 9) after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.

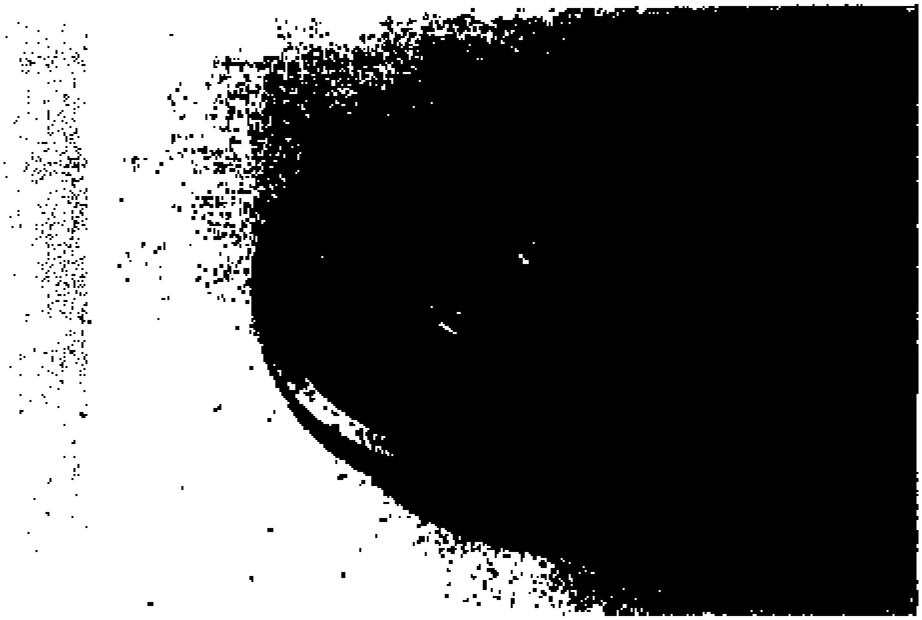
~3.4X

Figure 11: Photograph showing Kapton seal #3 (closest to washer) after disassembly at Texas Instruments (N. LaPointe).

~3.4X

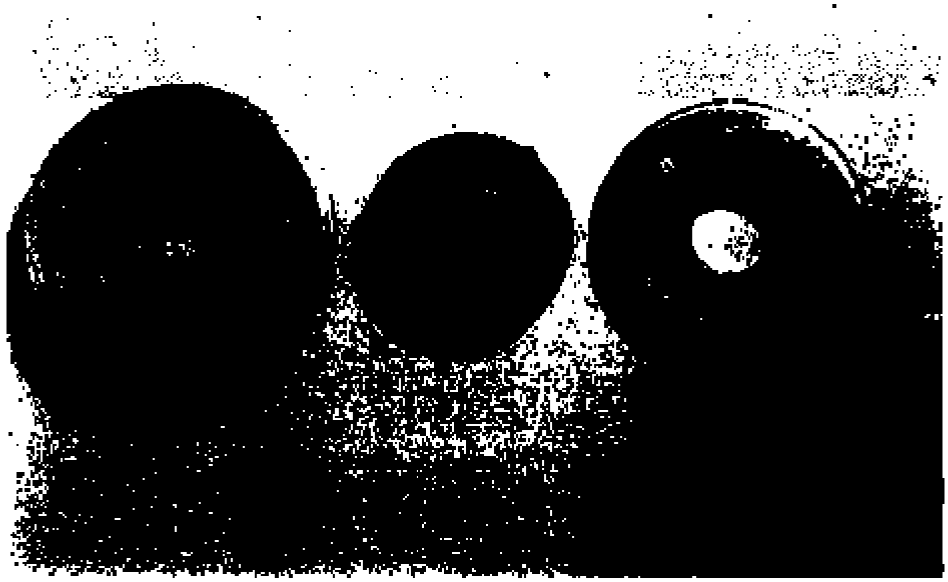
Figure 12: Photograph showing Kapton seal #3 (opposite side of that shown in Figure 11) after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.



~1.9X

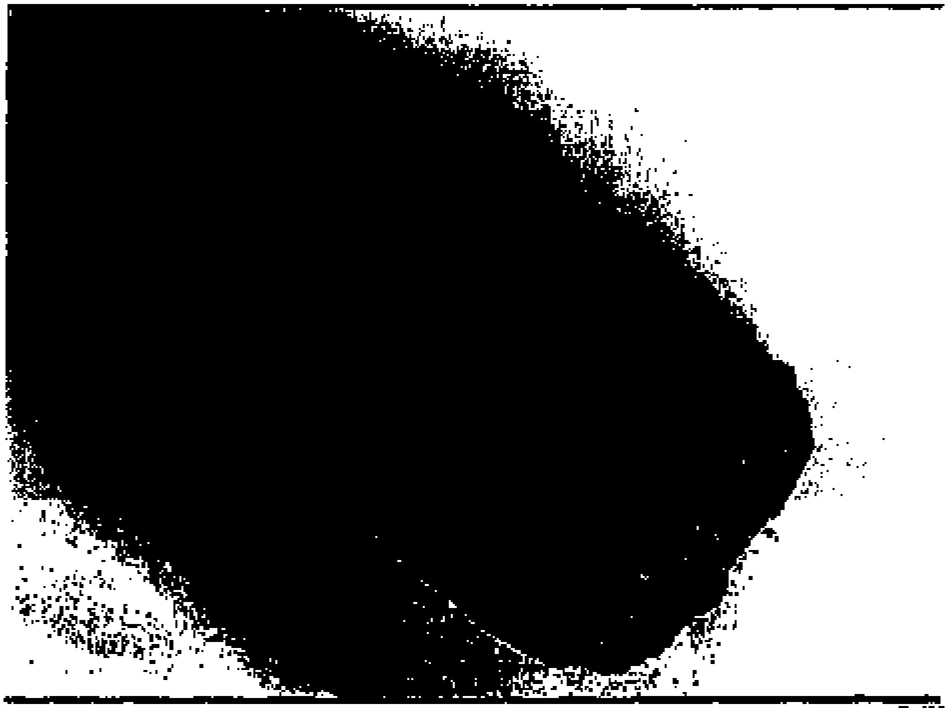
Figure 13: Photograph showing face of washer after disassembly at Texas Instruments (N. LaPointe).



~1.4X

Figure 14: Photograph showing internal surfaces of cup, converter/disc, and washer after disassembly at Texas Instruments (N. LaPointe).

Note: Nominal magnifications given for photomicrographs.



~5.4X

Figure 15: Image showing grey seal.

~5.9X

Figure 16: Image showing white deposit in cavity below grey seal.

Note: Nominal magnifications given for photomicrographs.


~4.6X

Figure 17: Image showing condition of red seal.

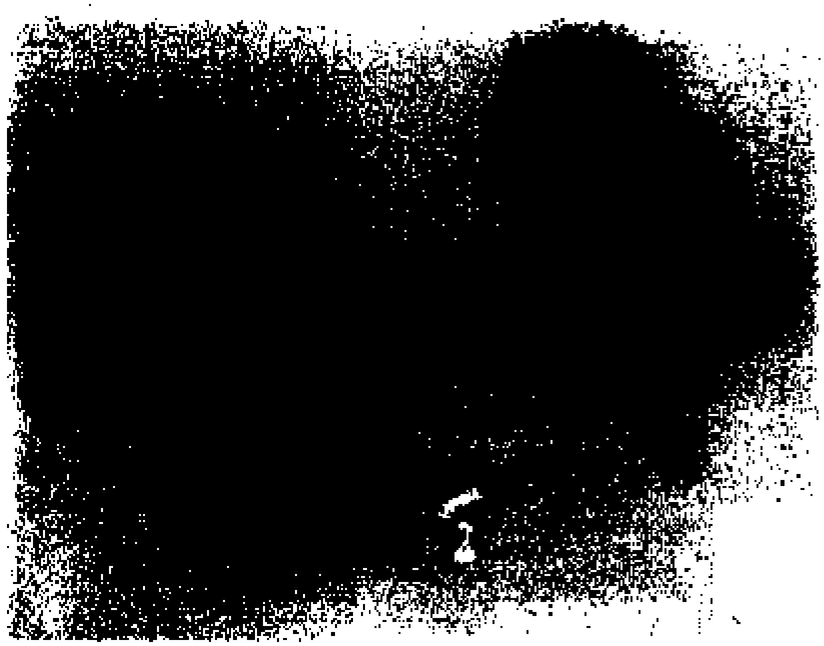

~6.3X

Figure 18: Image showing transfer of red seal material to switch base.

Note: Nominal magnifications given for photomicrographs.

~6.9X

Figure 19: Image showing tarnished condition of wires below insulation.



~3.7X

Figure 20: Photograph showing contacts, bases, and terminals after removal from switch base.

Note: Nominal magnifications given for photomicrographs.

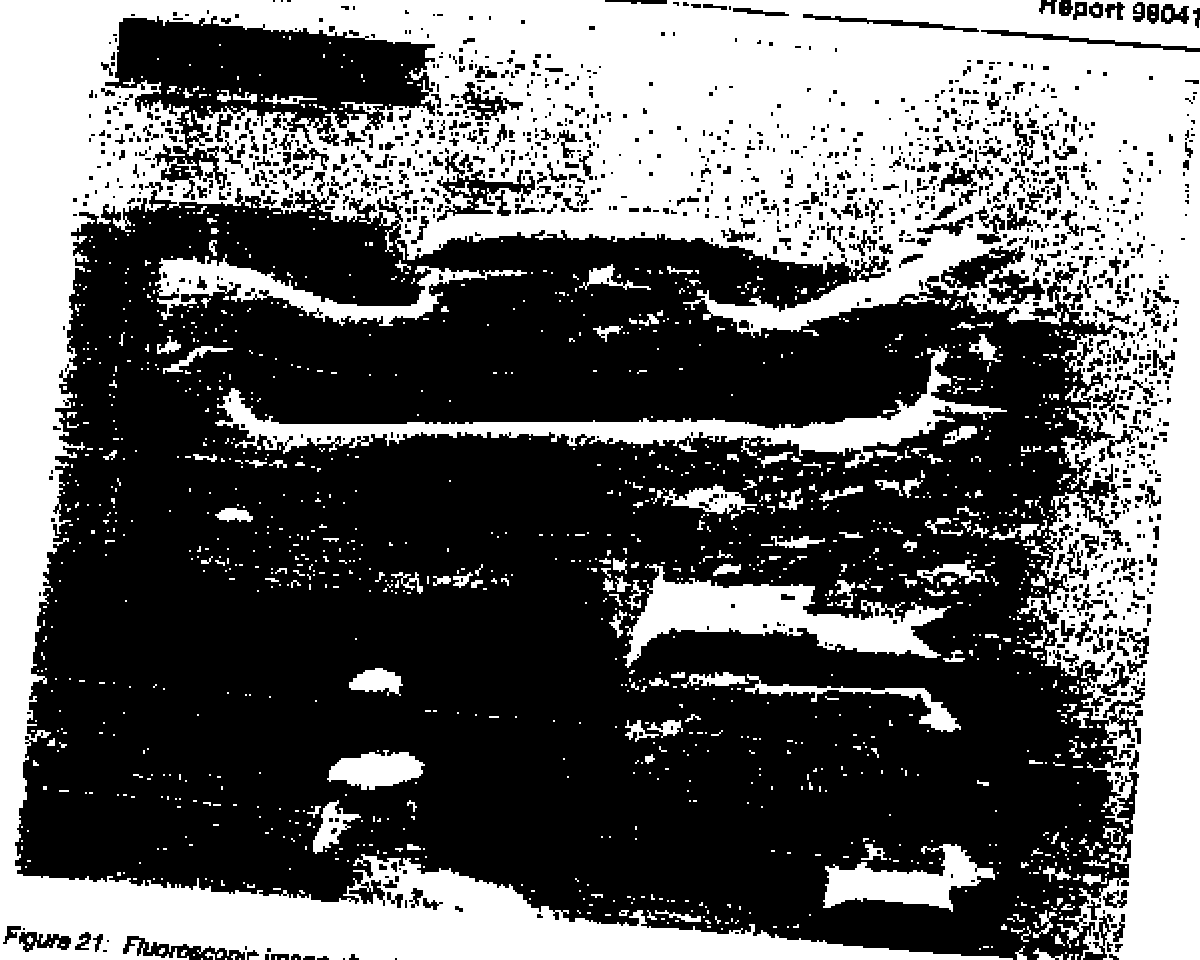


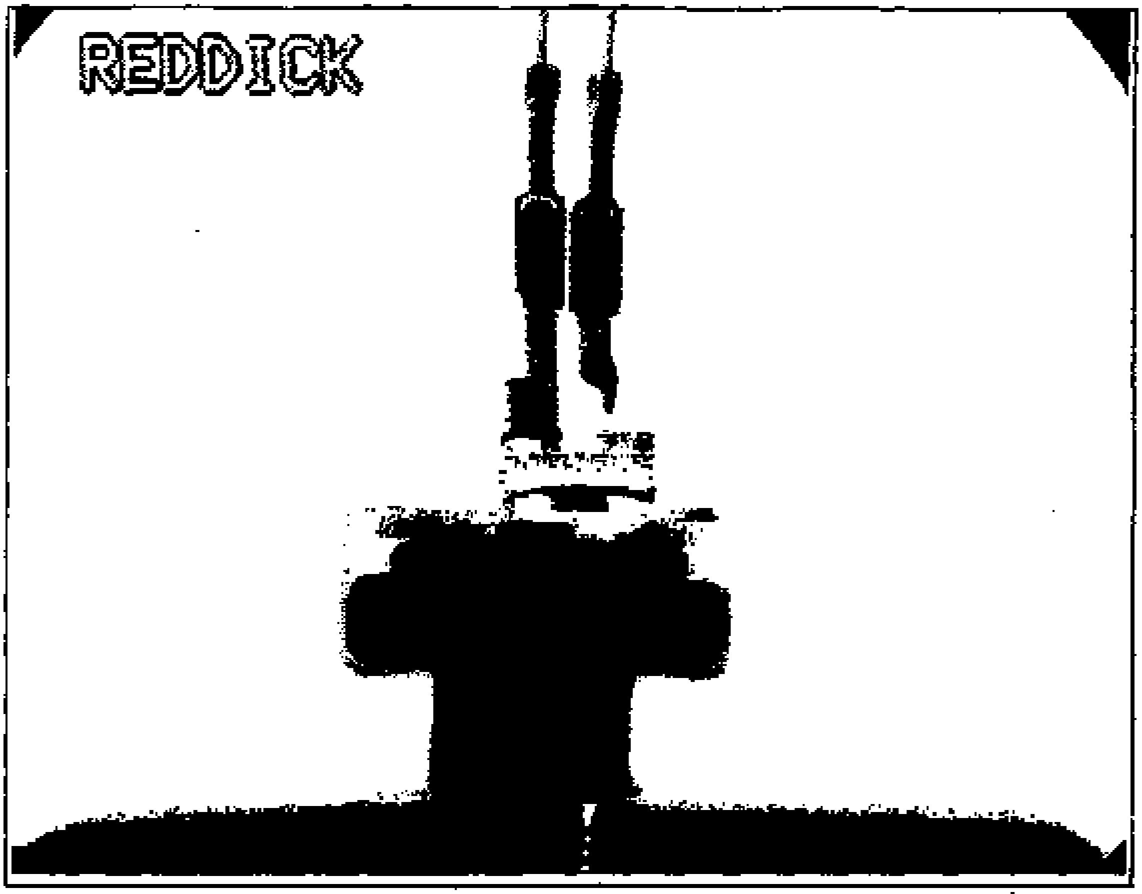
Figure 21: Fluoroscopic image showing cracks and loss of material in stationary contact. ~8.8X

Note: Nominal magnifications given for photomicrographs.

~4.9X

Figure 22: Fluoroscopic image showing cracks and loss of material in stationary contact.

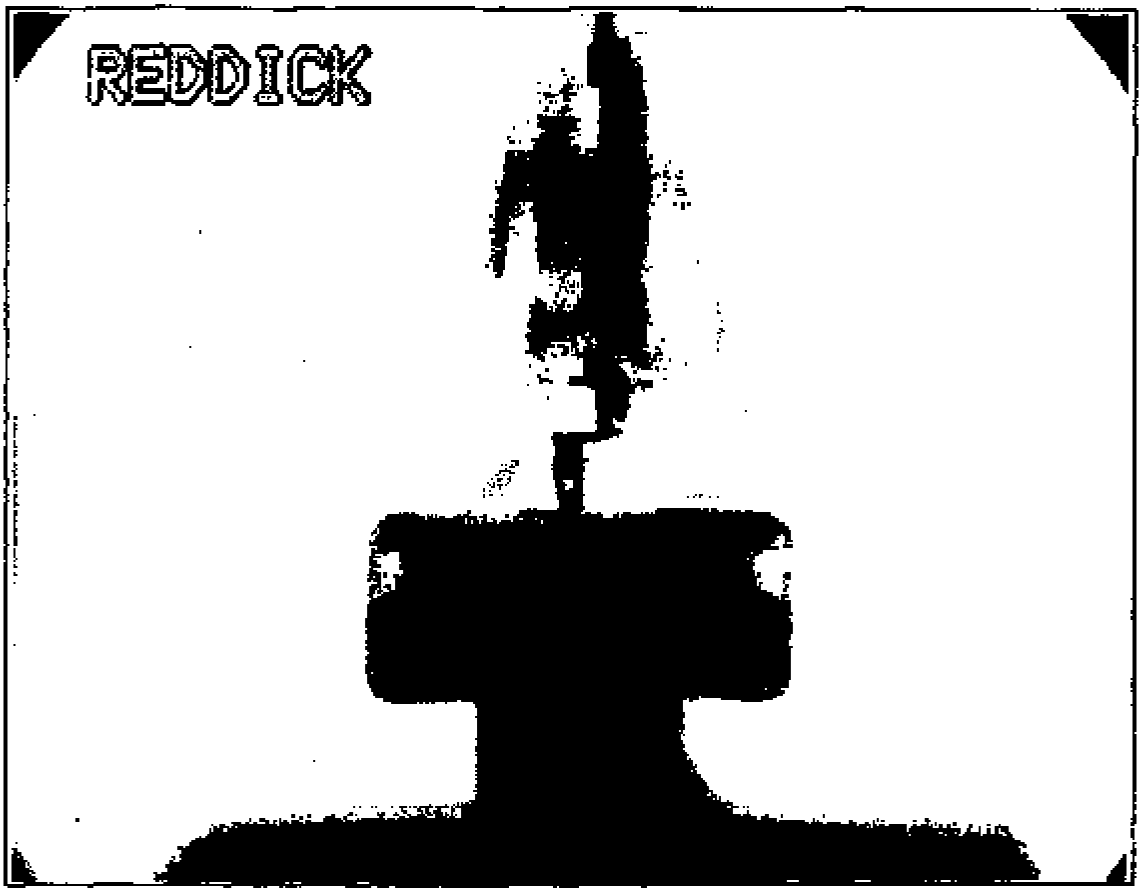
Note: Nominal magnifications given for photomicrographs.



~1.8X

Figure 23: Fluoroscopic image showing switch base and pressure side of switch placed together. Note base of movable contact terminating in large globule.

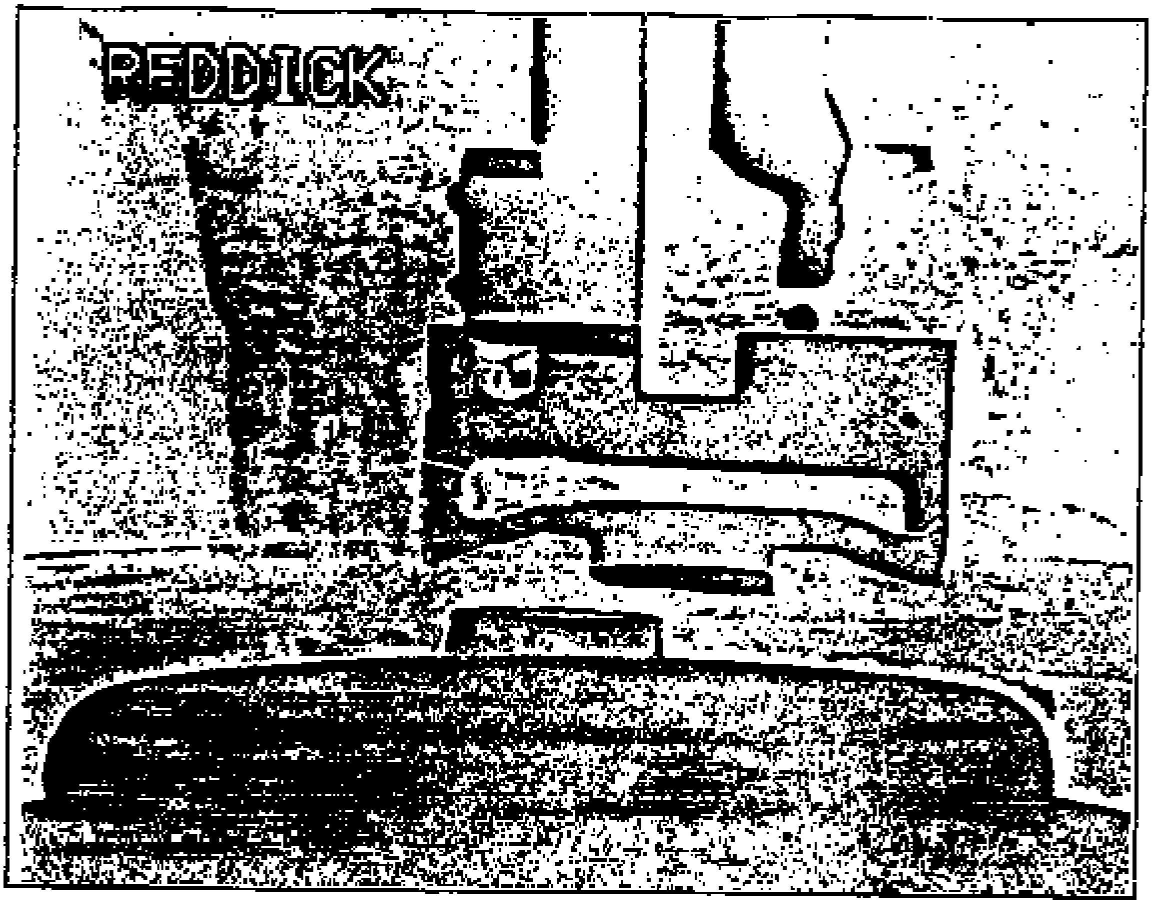
Note: Nominal magnifications given for photomicrographs.



~1.9X

Figure 24: Fluoroscopic image showing switch base and pressure side of switch placed together.

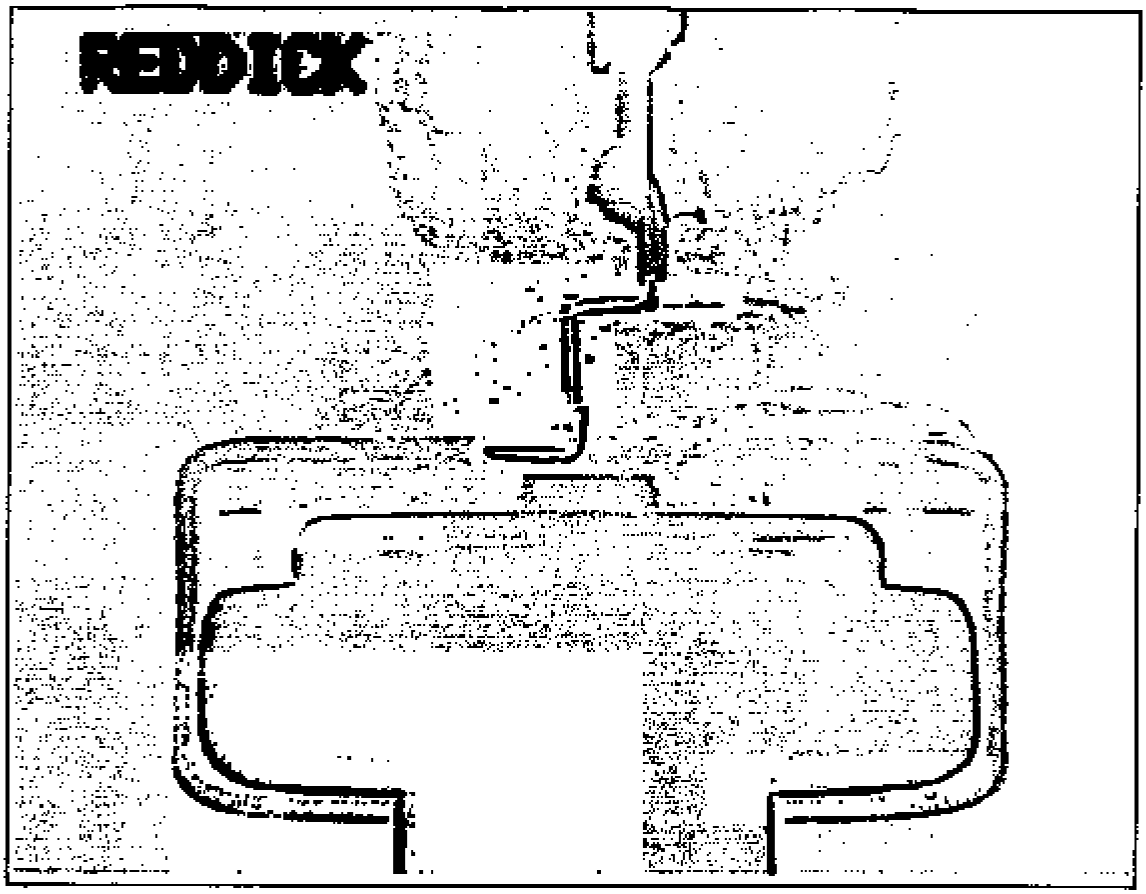
Note: Nominal magnifications given for photomicrographs.



~5.2X

Figure 25: Fluoroscopic image showing switch base and pressure side of switch placed together.

Note: Nominal magnifications given for photomicrographs.



~3.7X

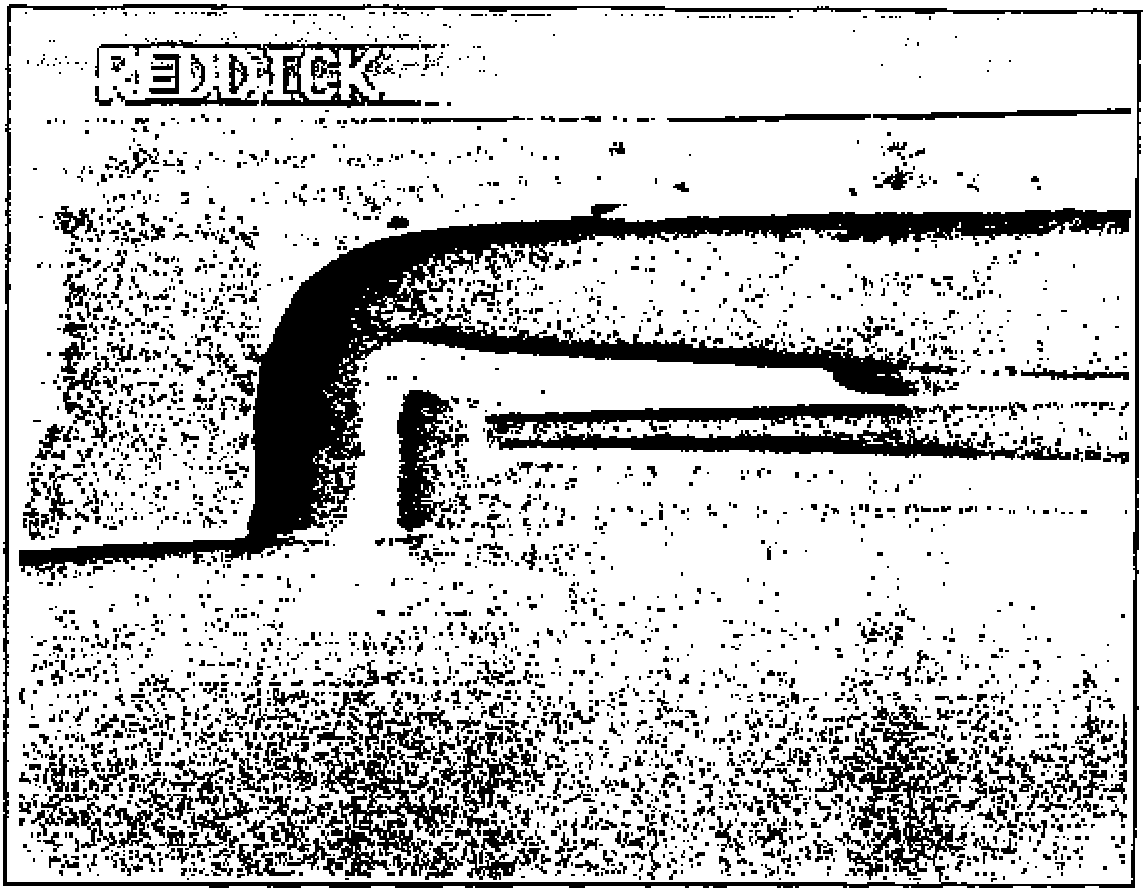
Figure 26: Fluoroscopic image showing switch base and pressure side of switch placed together.

Note: Nominal magnifications given for photomicrographs.

~5.9X

Figure 27: Fluoroscopic image of washer, converter, and disc in place.

Note: Nominal magnifications given for photomicrographs.



~19X

Figure 28: Fluoroscopic image showing converter and disc in place.

Note: Nominal magnifications given for photomicrographs.

Figure 29: Image showing typical damage to Kapton seals. Kapton Strip (Teflon Layers Removed) Closest to Washer with Concave Side Down

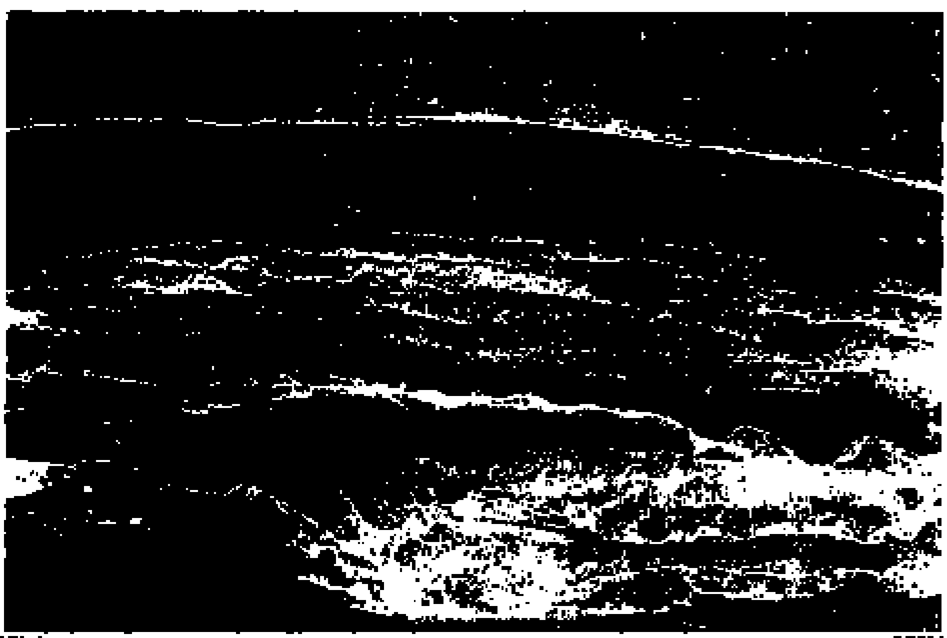


Figure 30: SEM photomicrograph showing brittle crack in Kapton seal. Crack appears to have propagated away from the washer. The direction of propagation is perpendicular to the plane of the page

Note: Nominal magnifications given for photomicrographs.

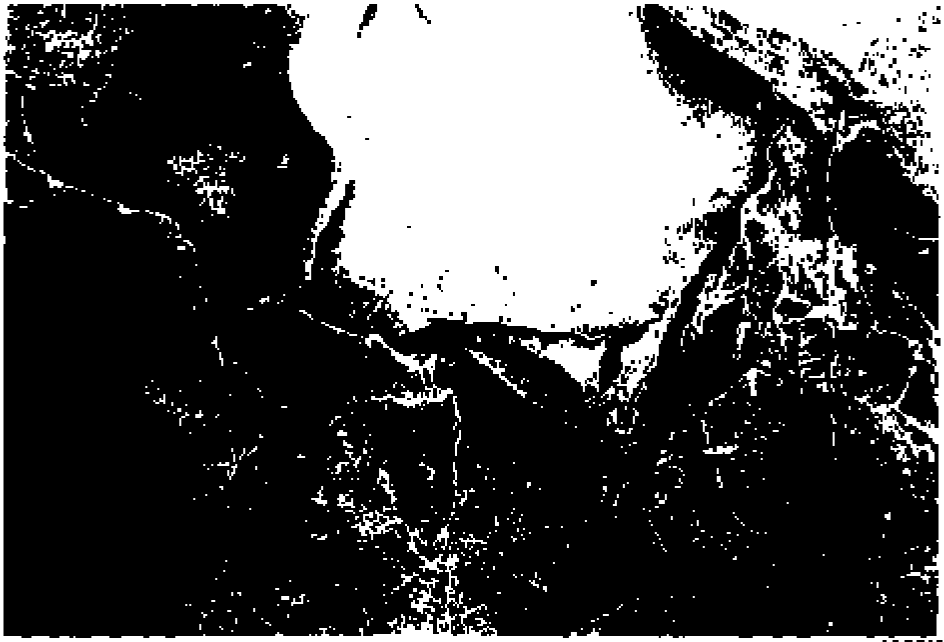
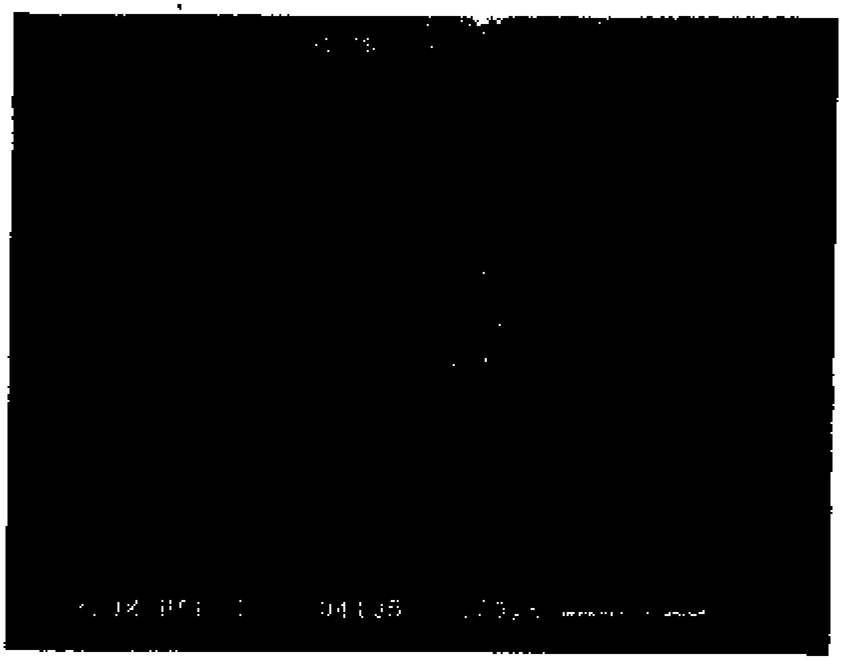


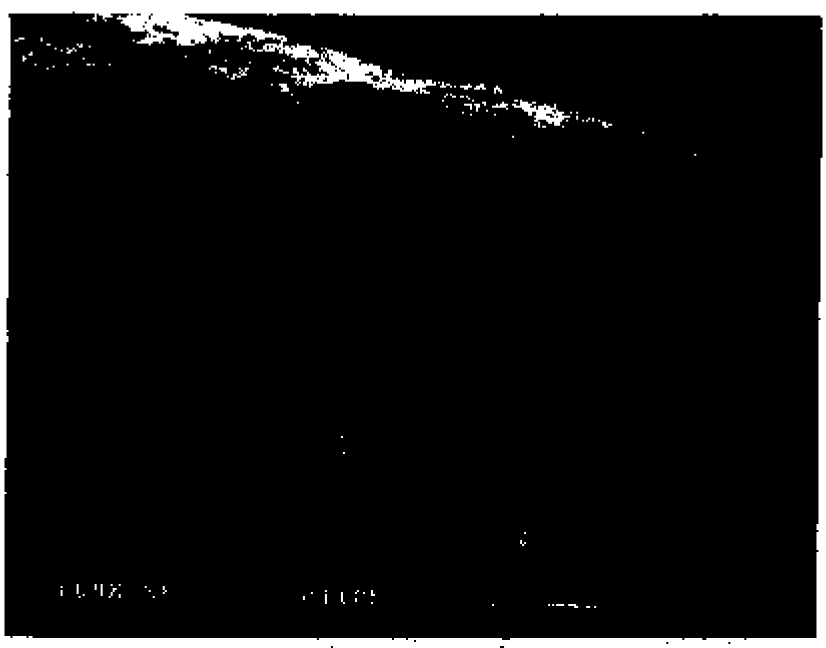
Figure 31: SEM photomicrograph showing brittle crack in Kapton seal. Direction of propagation is perpendicular to plane of page.

Note: Nominal magnifications given for photomicrographs.



200X

Figure 32: SEM photomicrograph showing apparent corrosion damage to surface of stationary contact.



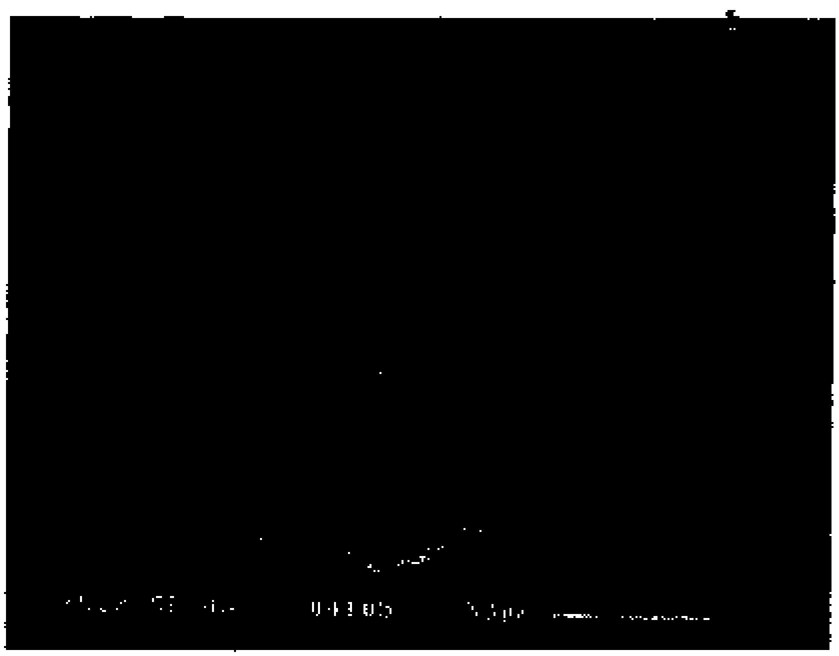
100X

Figure 33: SEM photomicrograph showing what appears to be localized arc damage to corner of stationary contact.

Note: Nominal magnifications given for photomicrographs.

75X

Figure 34: SEM photomicrograph showing intergranular crack in stationary contact.



750X

Figure 35: SEM photomicrograph showing intergranular crack in stationary contact.

Note: Nominal magnifications given for photomicrographs.

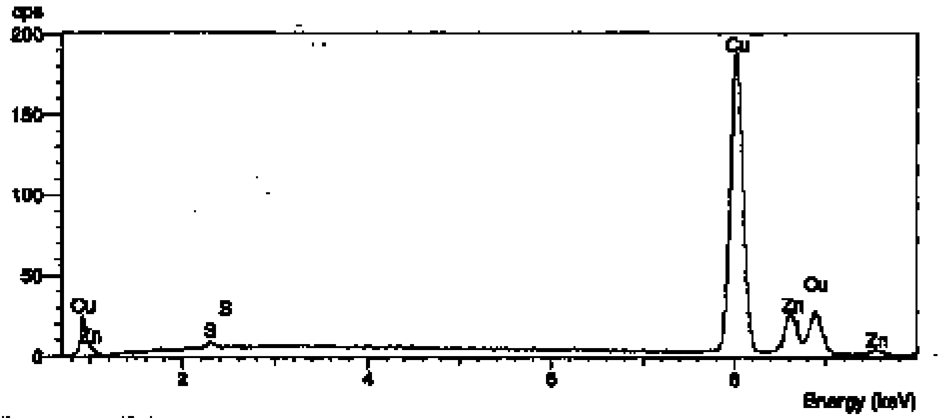


Figure 36: EDS X-ray spectrum of material scraped from the side of the stationary contact body.

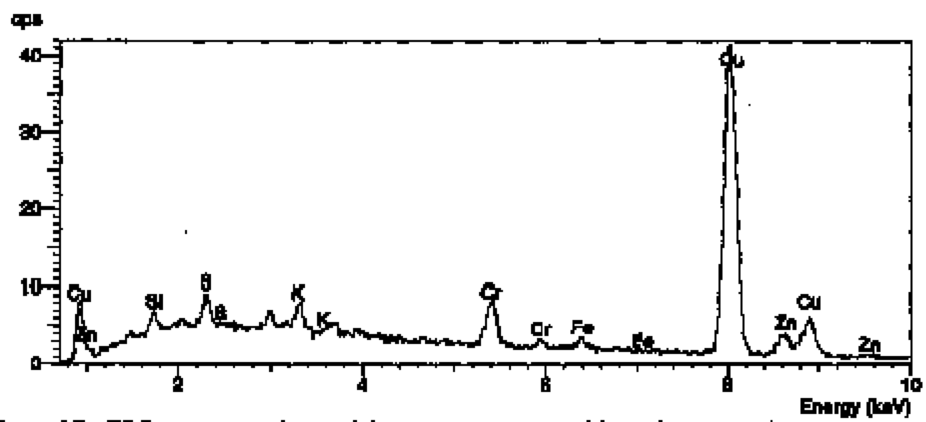


Figure 37: EDS spectrum of greenish compound scraped from the cup region.

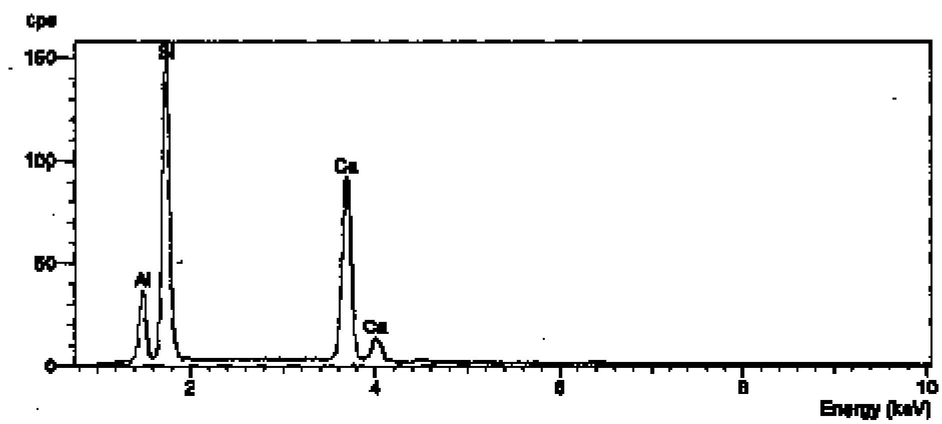


Figure 38: EDS X-ray spectrum of fibrous material scraped from the cup region.

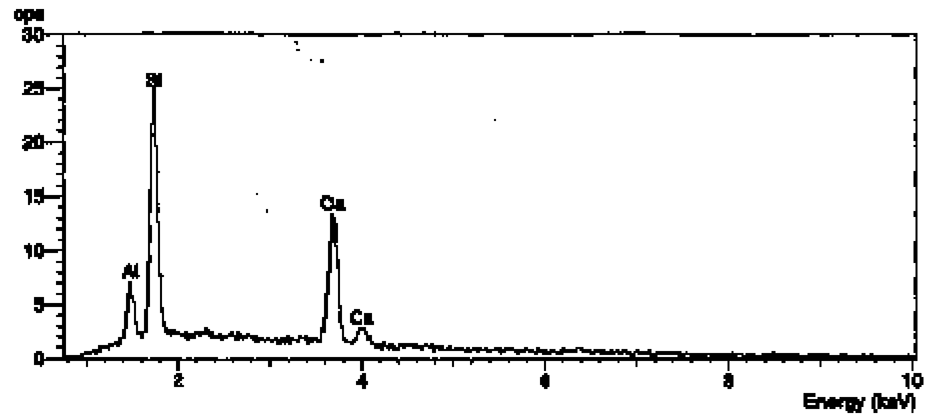


Figure 39: EDS X-ray spectrum of material shaved from a new base.

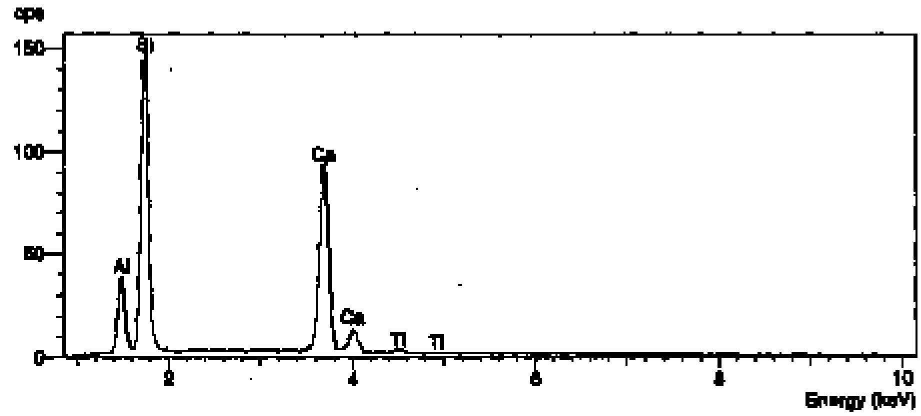


Figure 40: EDS X-ray spectrum of fibrous material scraped from the old base.

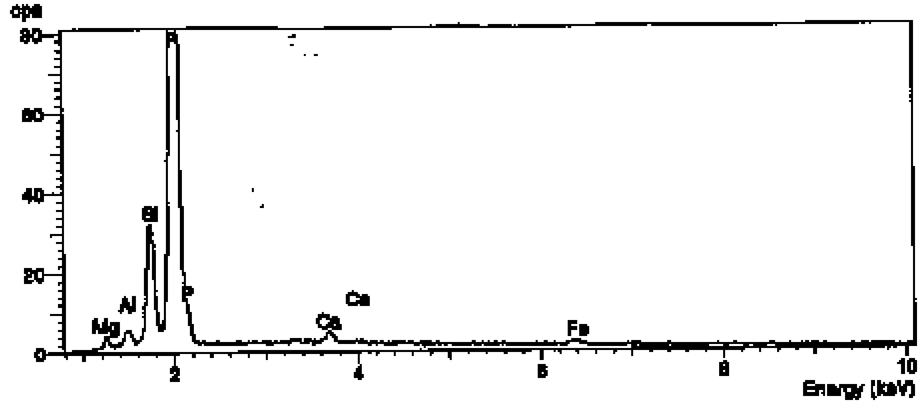


Figure 41: EDS X-ray spectrum of one of three samples of the white powder taken from the connector cavity below the wire seal.

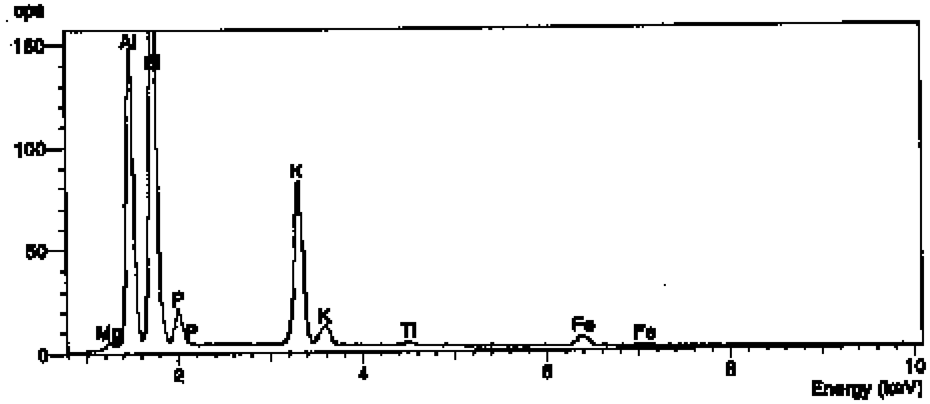


Figure 42: EDS X-ray spectrum of the second of three samples of the white powder.

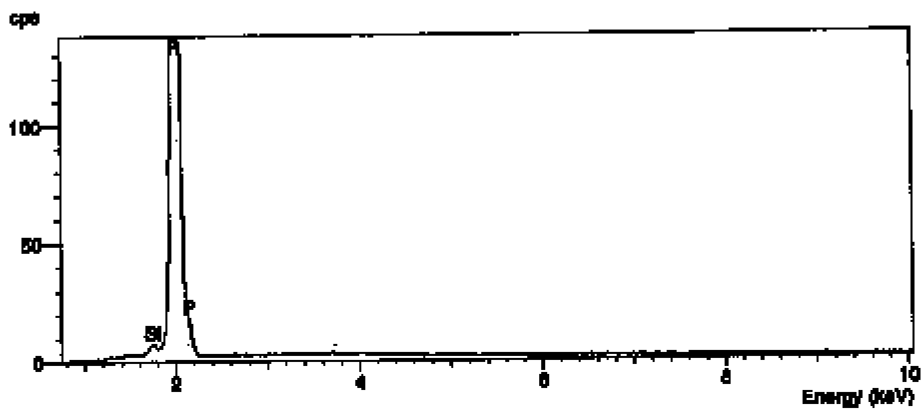


Figure 43: EDS X-ray spectrum of the third of three samples of the white powder.

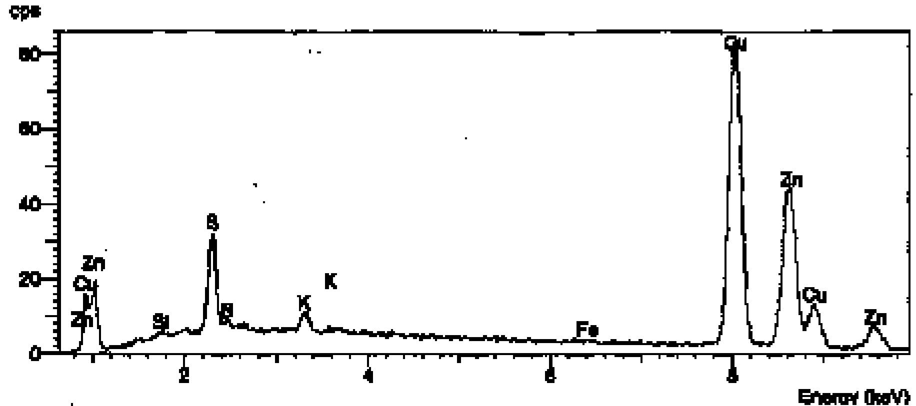


Figure 44: EDS X-ray spectrum material from pad of stationary contact.

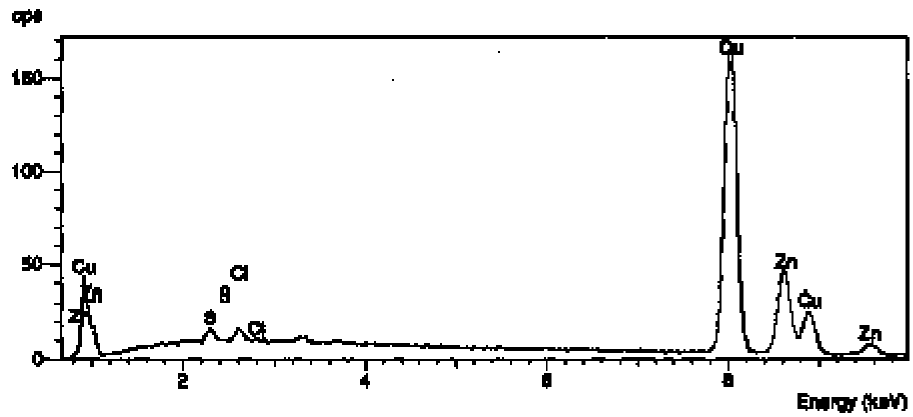


Figure 45: EDS X-ray spectrum of the crack surface.

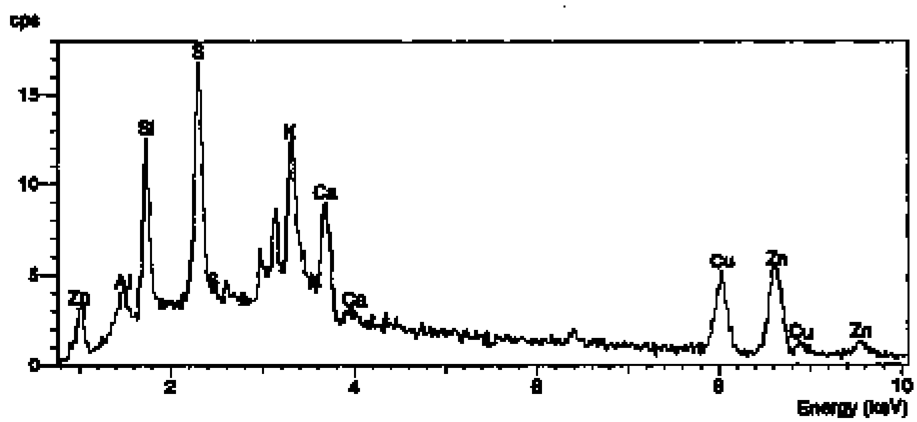


Figure 46: EDS X-ray spectrum of the green deposit from terminal of stationary contact.

Note: Nominal magnifications given for photomicrographs.

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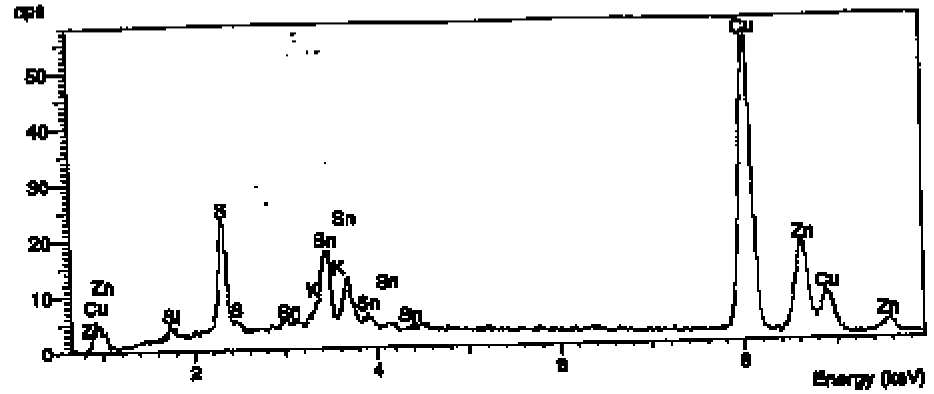
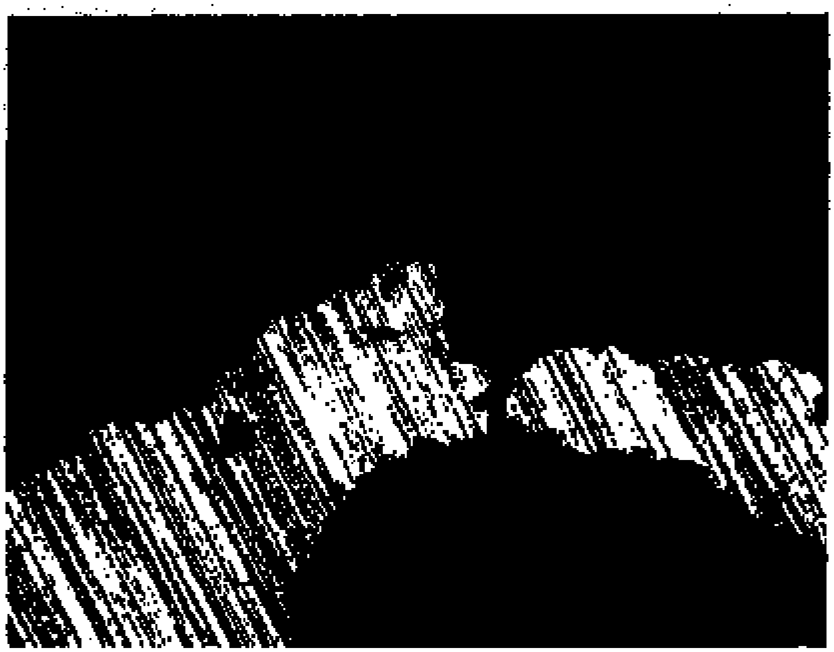


Figure 47: EDS X-ray spectrum of the black deposit from terminal of movable contact.

Note: Nominal magnifications given for photomicrographs.



As-polished 80X

Figure 48: Photomicrograph showing dezincification in stationary contact.

As-polished 500X

Figure 49: Photomicrograph showing dezincification in stationary contact.

Note: Nominal magnifications given for photomicrographs.

All shaded areas must be filled in to process your request

Administrative Use Only

Laboratory Number	Date
9804105	12-17-98

Request for Central Laboratory Service

15000 Century Dr., Dearborn MI 48120-1267 Phone [313] 32-21676 FAX [313] 32-21614

Your Name [Send report to]	Telephone	PROFS ID	FAX
G. STEVENS	36686	GSTEVEN1	36686
Secondary Contact	**Telephone**	**PROFS ID**	**FAX**
N. LAPOINTE	42686	NLAPOINT	

Send Report To / **Bill To**

Room No./Mail Drop/PO Box	Department/Activity	Building	Location Code	Dept. #	Work Task # [For 5100 Loc. Only]
MD 5006	MATERIALS AVT	Bldg 45	5100	T-113	X0604

Samples

Total # of Samples	Sample Handling	TOX/CAS#	Source	Supplier Code
1	X Return after test ___ Dispose after test ___ Dispose after 30 days			

Part/Material Name	Sample Identification [Continue below if needed]	Part Number [If any]	Material Specification [If any]	CPSC Code	Supplier
				--.---.--	TEXAS
SPEED CONTROL	BURNED	F2VY-9F924-A	NA	--.---.--	INSTRUMENTS
CUT-OFF SWITCH	CONNECTOR &			--.---.--	
	PRESSURE ACTUATOR			--.---.--	
	(REDDICK)			--.---.--	

Investigation

Nature of Investigation/Specific Tests Required [Check all that apply]

- ___ Production/Plant problem
- X Failure Analysis
- X Legal
- ___ Specification Compliance
- ___ Perform Tests as in Lab No.________
- ___ Photograph [Describe below]
- ___ Use Specification ________ as a guide
- ___ Other [Describe below]

Requester Info. Box [For requester use]: HIGH PRIORITY - POSSIBLE LEGAL

Stop testing upon failure? ___ No ___ Yes

Does this support CAE testing? ___ No ___ Yes (If "Yes", what is the expected outcome?)

Do you need to know your CL contact and timing? ___ Yes

Additional Sample Information/Testing Requirements

DETERMINE CAUSE OF BURNED CONNECTOR
- RADIOGRAPH
- PHOTOGRAPH
- PRESSURE TEST DIAPHRAGM

EVALUATE / UNDERSTAND CIRCUITRY OF NEW SWITCHES

ATTN: S. LAROCHE

NOTE: ALL COMMUNICATIONS / REPORT, ETC. TO BE DUAL (I.E. NLAPOINT &

Report

Date you would like report 1-19-99

Date you must have report 1-14-99

Format (Check all that apply)
- X FAX preliminary results
- ___ FAX typed report
- ___ FAX hand written
- ___ Mail hand written
- ___ Mail typed report
- ___ Electronically transfer report
- ___ Phone preliminary results

For information about services or assistance in completing this form please refer to the Central Laboratory WEB page. [www.gtn.ford.com/central/home.htm]
Laboratory number and date cannot be assigned without receipt of samples.
Samples will be disposed of after 30 days unless otherwise indicated above.

CL-Form #CLF07_01

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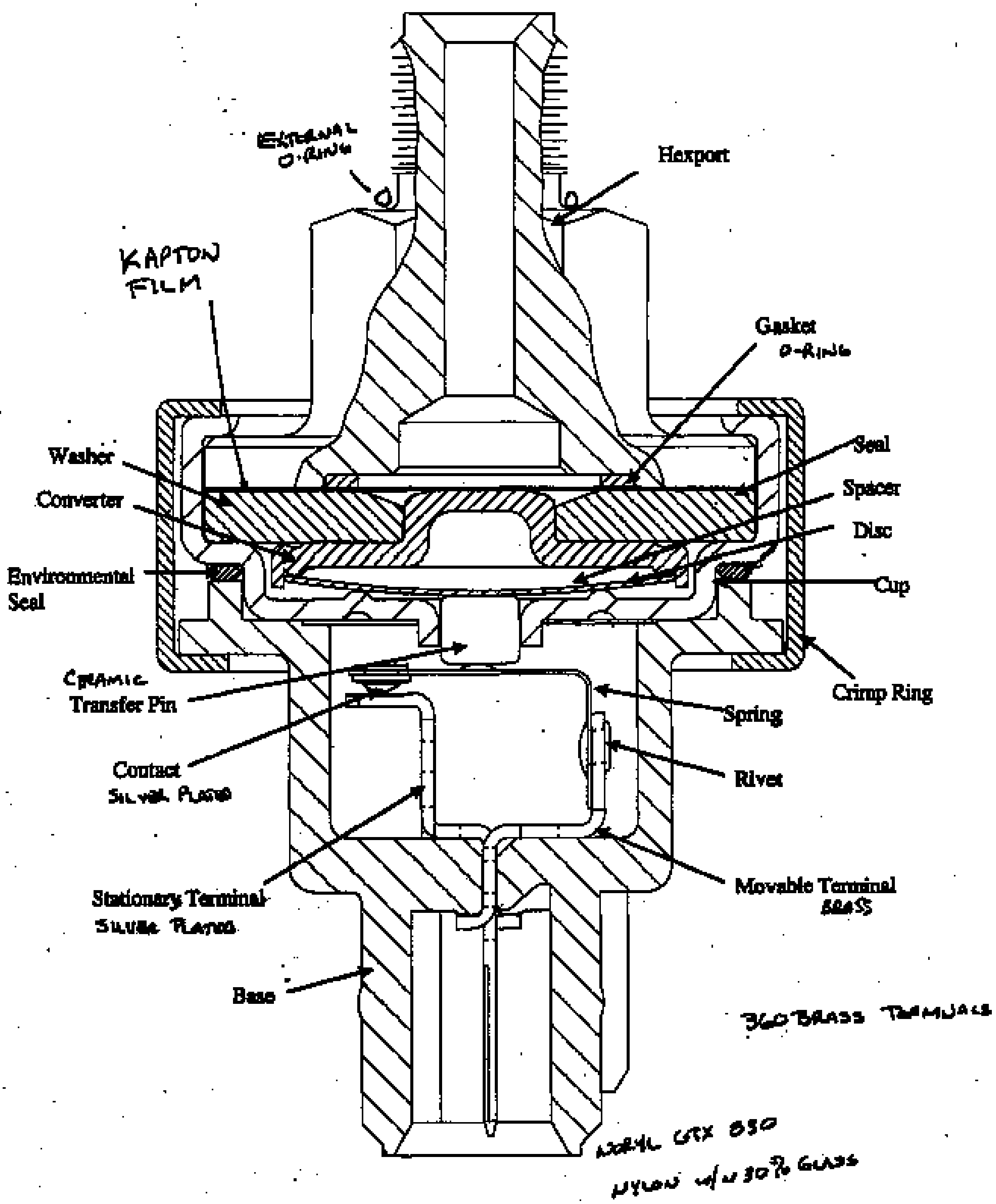
Hydraulic Pressure Switch Cross Section



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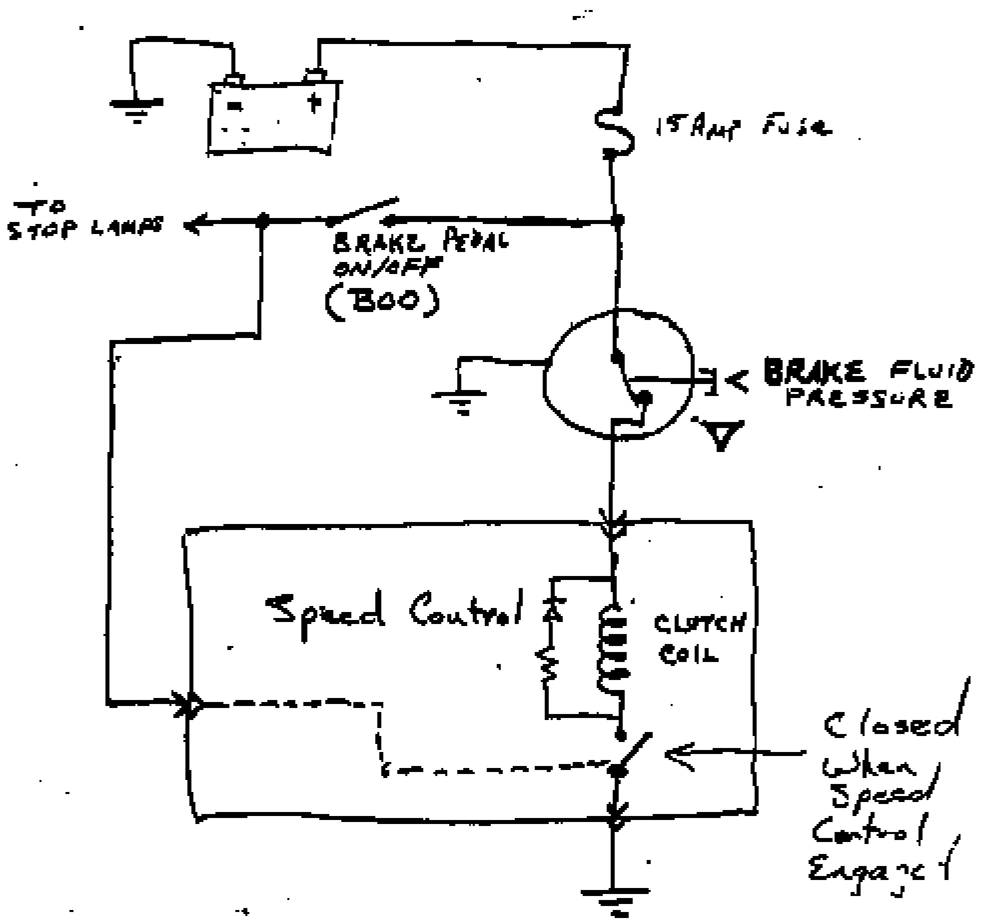
Brake Pressure Switch Function-

- **Provide power to Speed Control Clutch circuit. Clutch engages servo-motor to pull throttle cable.**

- **Provide redundant sensing of brake application independent of the primary system deactivation mode by disconnecting power to clutch circuit causing servo-motor to release throttle cable.**
    - **Under Hard Braking only**
    - **Stop lamp signal is primary (normal braking)**



Brake Pressure Switch
F2VC-9F924-AB
Material List for MY 92/93

[illegible]	[illegible]	[illegible]
Gasket	Elastomer Ethylene Propylene	JBL Compound # E-7104-70
Diaphragm	Kapton, Polyimide	Dupont 500 FN131L, 3 Diaphragms per switch
Base	PBT, Plastic	Grade Celanex 4300
Crimp Ring	Aluminum	Grade # 5052
Spacer	Kapton, Polyimide	Dupont #200H,Friction Reducer on Disc
Rivet	Brass	CDA 260
Transfer Pin	Ceramic	Steatite , L-3 Grade
Environmental Seal	Silicone	JBL Compound # S7510
Converter	Cold Rolled Steel	Grade # 1008
Washer	Cold Rolled Steel, Zinc Plated	Grade # 1050
Cup	Cold Rolled Steel	Grade 1010
Spring Arm	Beryllium Copper	Grade # C17200
Movable Contact	Silver Plated Copper	Oxygen Free Cu, Fine Silver
Stationary Terminal	Brass + Silver inlay	CDA 260
Movable Terminal	Brass	CDA 260
Disc	Stainless Steel	Grade 302
Hexport	Cold Rolled Steel, Zinc Plated	C10L10
Thread Cap	LDPE, Plastic	

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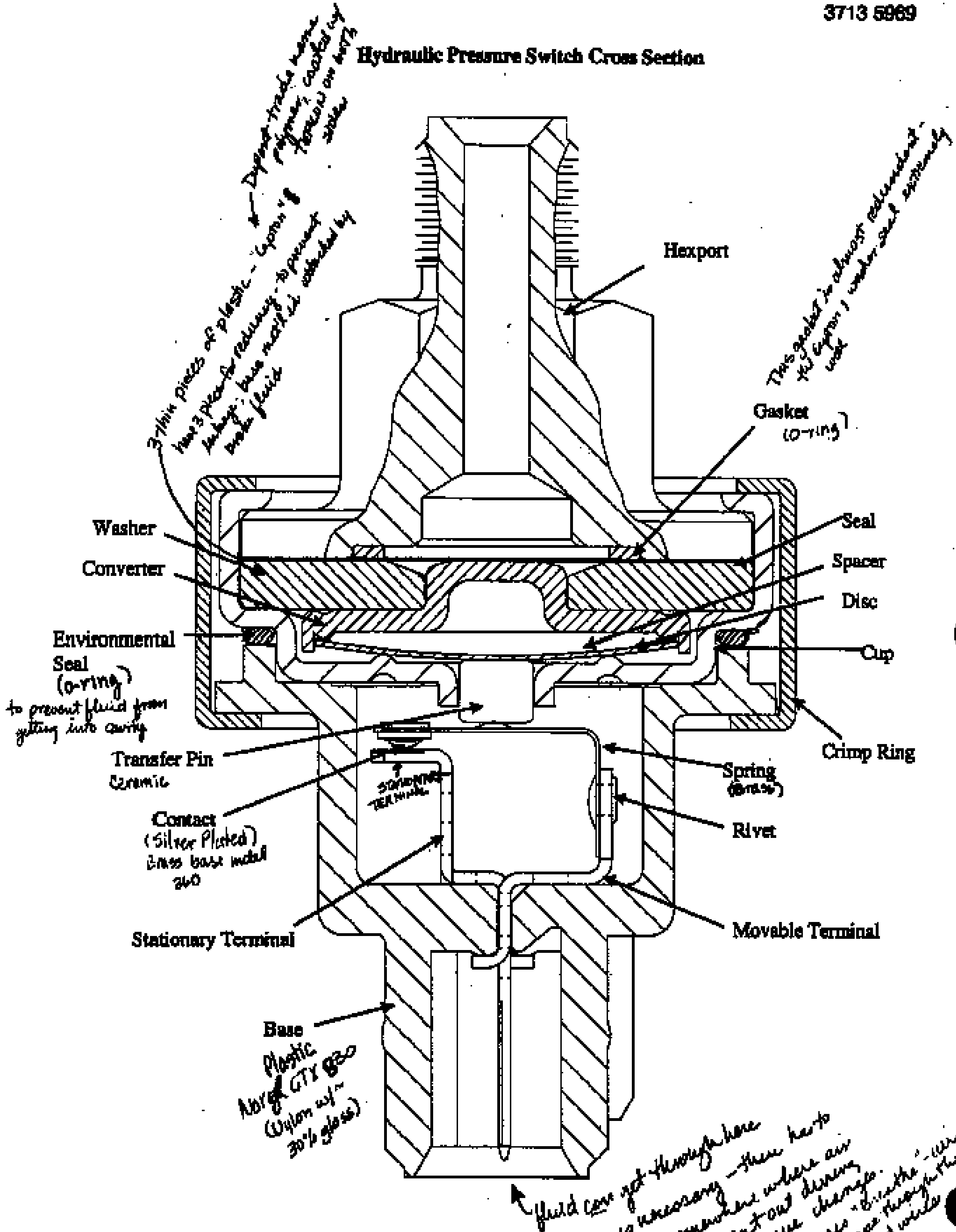
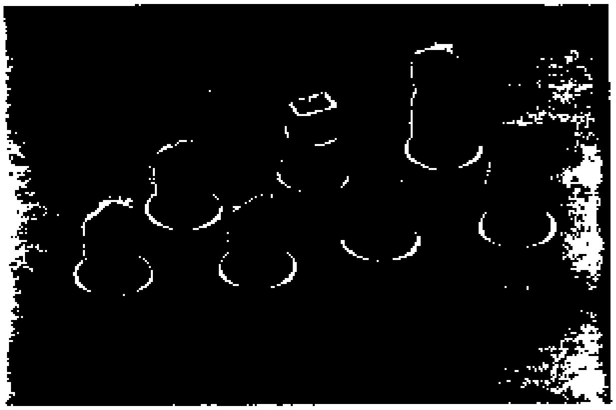
Hydraulic Pressure Switch Cross Section



Texas Instruments

Materials & Controls Group
Automotive Business Unit

Low Cost Automotive Hydraulic Line Mount Pressure Switches



TI's pressure switches provide low cost, on/off controls for many automotive systems. The snap action disc reacts to changing pressure by reversing its curvature and activating electrical switch contacts.

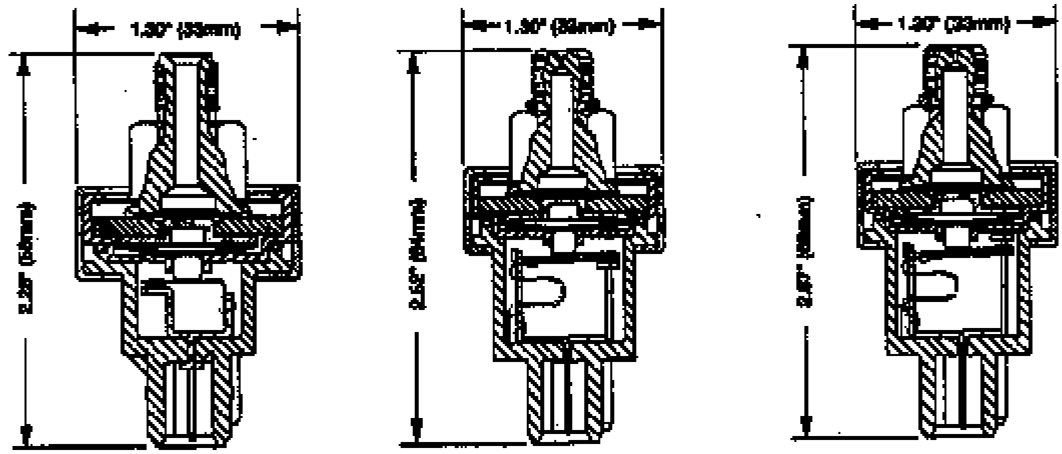
Key Features Include:

- Designed for underhood environment
- Low weight
- Custom packaging for specific application needs
- Automotive temperature range of -40 to 135°C
- Normally open and normally closed contact logic
- Industry proven since 1984

Typical Applications

- Power Steering Systems
- Cruise Control Systems
- Brake Systems
- Transmissions
- Suspension

Dimensions (typical examples, other styles available)



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Summary of Chemical Properties
3/2/99

The following pages were supplied by Dupont and show chemical and physical properties for Teflon and Kapton. In summary, water will degrade the mechanical properties of Kapton, but Teflon is unaffected by water. This is the reason why the Teflon-Kapton-Teflon system was selected for Texas Instruments switch diaphragm (3 mil thick Kapton layer coated with 1 mil Teflon on both sides). Page 1 (marked with "A") indicates that the Teflon is non-reactive with water. While page 2 shows Teflon has a relatively low vapor transmission rate (marked with "B"). Page 3 shows how the mechanical properties of Kapton degrade with water and temperature exposure (marked with "C").

End of document.

Chemical Properties

DuPont FEP fluorocarbon film is chemically inert and solvent resistant to virtually all chemicals except molten alkali metals, fluorine at elevated temperatures, and certain complex halogenated compounds such as chlorine trifluoride at elevated temperatures and pressures.

In circumstances where end-use temperatures are close to the upper service limit 205°C (400°F), 80% sodium hydroxide, metal hydrides, aluminum chloride, ammonia, and certain amines ($R\text{-}NH_2$) may attack the film in a manner similar to molten alkali metals. Special testing is required when such extreme reducing or oxidizing conditions are evident.

With these exceptions noted, DuPont FEP fluorocarbon films exhibit a very broad range of chemical and thermal serviceability.

Due to the many complex aspects of performance in severe environments, final selection should be based on functional evaluations or experience under actual end-use conditions.

The chemical substances listed in Table 6 are representative of those with which DuPont FEP film has been found to be nonreactive.

Table 6
Typical Chemicals with Which DuPont FEP Film is Nonreactive*

Abietic acid	Cyclohexanone	Hydrofluoric acid	Phthalic acid
Acetic acid	Dibutyl phthalate	Hydrogen peroxide	Pinene
Acetic anhydride	Dibutyl sebacate	Lead	Piperidene
Acetone	Diethyl carbonate	Magnesium chloride	Polyacrylic nitrile
Acetophenone	Diethyl ether	Mercury	Potassium acetate
Acrylic anhydride	Dimethyl formamide	Methyl ethyl ketone	Potassium hydroxide
Allyl acetate	Di-isobutyl adipate	Methacrylic acid	Potassium permanganate
Allyl methacrylate	Dimethylformamide	Methanol	Pyridine
Aluminum chloride	Dimethylhydrazine, unsymmetrical	Methyl methacrylate	Soap and detergents
Ammonia, liquid	Dioxane	Naphthalene	Sodium hydroxide
Ammonium chloride	Ethyl acetate	Naphthols	Sodium hypochlorite
Aniline	Ethyl alcohol	Nitric acid	Sodium peroxide
Benzonitrile	Ethyl ether	Nitrobenzene	Solvents, aliphatic and aromatic**
Benzoyl chloride	Ethyl hexoate	2-Nitro-butanol	Stannous chloride
Benzyl alcohol	Ethylene bromide	Nitromethane	Sulfur
Borax	Ethylene glycol	Nitrogen tetroxide	Sulfuric acid
Boric acid	Ferric chloride	2-Nitro-2-methyl propanol	Tetrabromoethane
Bromine	Ferric phosphate	n-Octadecyl alcohol	Tetrachlorethylene
n-Butyl amine	Fluoronaphthalene	Oils, animal and vegetable	Trichloracetic acid
Butyl acetate	Fluoronitrobenzene	Ozone	Trichlorethylene
Butyl methacrylate	Formaldehyde	Perchlorethylene	Tricresyl phosphate
Calcium chloride	Formic acid	Pentachlorobenzamide	Triethanolamine
Carbon disulfide	Furane	Perfluoroxylene	Vinyl methacrylate
Cetane	Gasoline	Phenol	Water
Chlorine	Hexachloroethane	Phosphoric acid	Xylene
Chloroform	Hexane	Phosphorus pentachloride	Zinc chloride
Chlorosulfonic acid	Hydrazine		
Chromic acid	Hydrochloric acid		
Cyclohexane			

*Based on experiments conducted up to the boiling points of the liquids listed. FEP resins have normal service temperatures up to 205°C (400°F). Absence of a specific chemical does not mean that it is reactive with FEP film.

**Some halogenated solvents may cause moderate swelling.

Page 1

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TEFLON FEP.

Physical Properties

Absorption

Almost all plastics absorb small quantities of certain materials with which they come in contact. Submicroscopic voids between polymer molecules provide space for the material absorbed without chemical reaction. This phenomenon is usually marked by a slight weight increase and sometimes by discoloration.

DuPont FEP fluorocarbon films have unusually low absorption compared with other thermoplastics. They absorb practically no common acids or bases at temperatures as high as 200°C (392°F) and exposures of up to one year. Even the absorption of solvents is extremely small. Weight increases are generally less than 1% when exposed at elevated temperatures for long periods. In general, aqueous solutions are absorbed very little by DuPont FEP film. *Moisture absorption is typically less than 0.01% at ambient temperature and pressure.*

Permeability

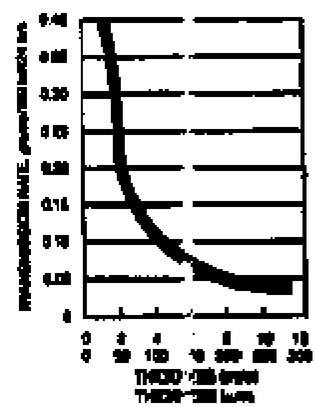
Many gases and vapors permeate FEP films at a much lower rate than for other thermoplastics (see Figure 13). In general, permeation increases with temperature, pressure, and surface contact area and decreases with increased film thickness. Table 6 lists rates at which various gases are transmitted through DuPont FEP fluorocarbon film, while Table 7 lists rates of vapor permeability for some representative substances. Note that the pressure for each material is its vapor pressure at the indicated temperature.

Table 6
Typical Gas Permeability Rates of DuPont FEP Fluorocarbon Film, 25 µm (1 mil) Thickness
(Test Method: ASTM D-1434 at 25°C (77°F))

Gas	Permeability Rate* cm³/(m²·24 h·atm)
Carbon Dioxide	25.9×10^3
Hydrogen	34.1×10^3
Nitrogen	5.0×10^3
Oxygen	11.6×10^3

*To convert to cm³/(100 in²·24 h·atm), multiply by 0.0645.

Figure 13. Water Vapor Transmission Rate of DuPont FEP Film at 40°C (104°F) by ASTM E-96 (Modified)



Notes: Values are averages only and not for specification purposes. To convert the permeation values for 100 in² to those for 1 m², multiply by 15.5.

Table 7
Typical Vapors Transmission Rates of DuPont FEP Fluorocarbon Film, 25 µm (1 mil) Thickness
(Test Method: Modified ASTM E-96)

Vapor	Temperature °C	Temperature °F	Vapor Transmission Rate SI Units g/(m²·d)	Vapor Transmission Rate English Units (g/100 in²·d)
Acetic Acid	35	95	6.3	0.41
Acetone	35	95	14.7	0.95
Benzene	35	95	9.9	0.64
Carbon Tetrachloride	35	95	4.8	0.31
Ethyl Acetate	35	95	11.7	0.76
Ethyl Alcohol	35	95	10.7	0.69
Freon® F-12	23	73	372.0	24.0
Hexane	35	95	8.7	0.56
Hydrochloric Acid	25	77	<0.2	<0.01
Nitric Acid (Red Fuming)	25	77	160.0	10.5
Sodium Hydroxide, 50%	25	77	<0.2	<0.01
Sulfuric Acid, 98%	25	77	2×10^{-3}	1×10^{-4}
Water	39.5	103	7.0	0.40

P. 2

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[illegible] ON KAPTON

[illegible]

Chemical		Time?	Temp.?	% Prop. Retained: Tensile?	Elong.?	Modulus?
[illegible]		1 YR.	RT.	87	77	100
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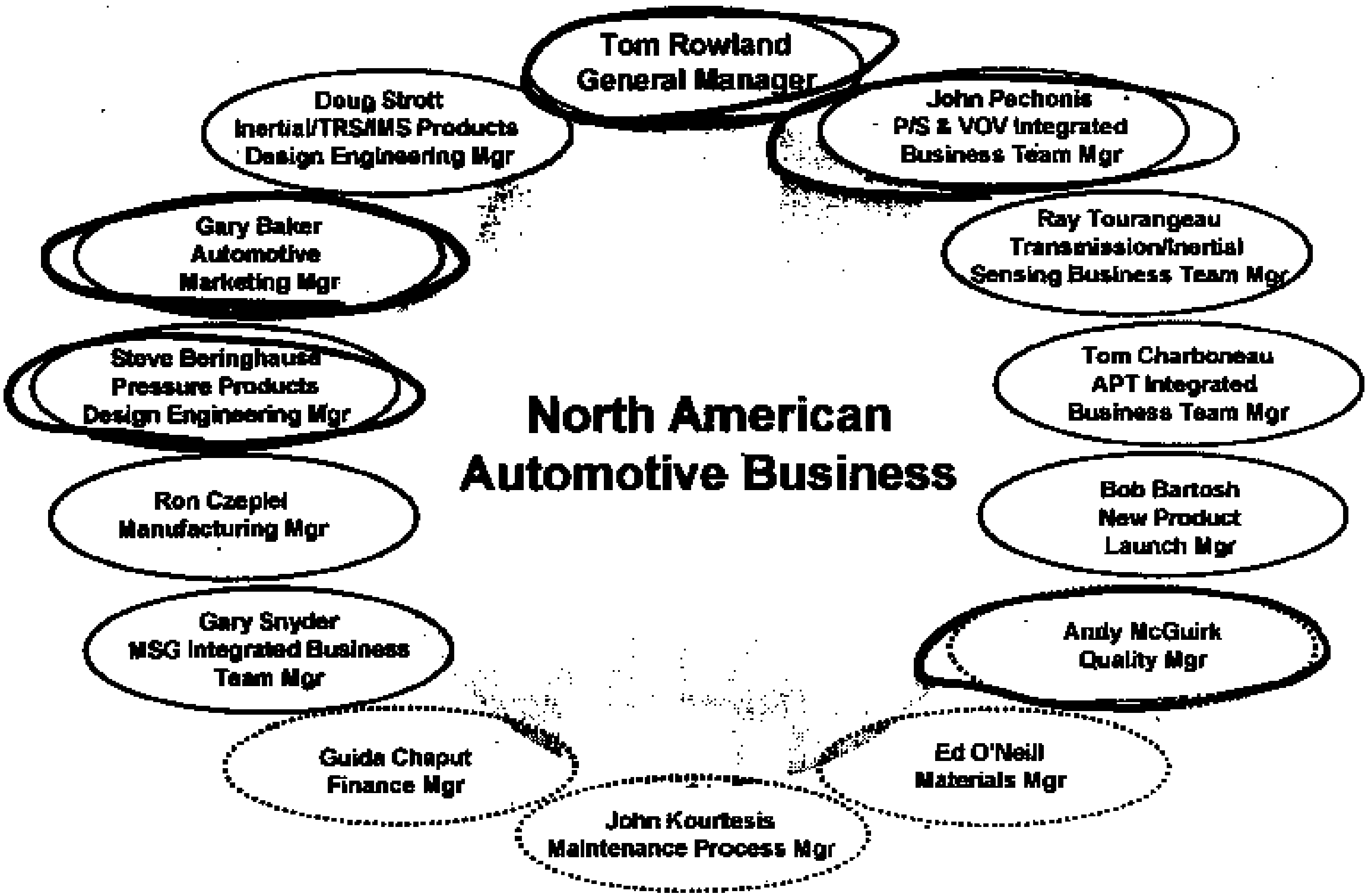
Page 3

TEXAS INSTRUMENTS

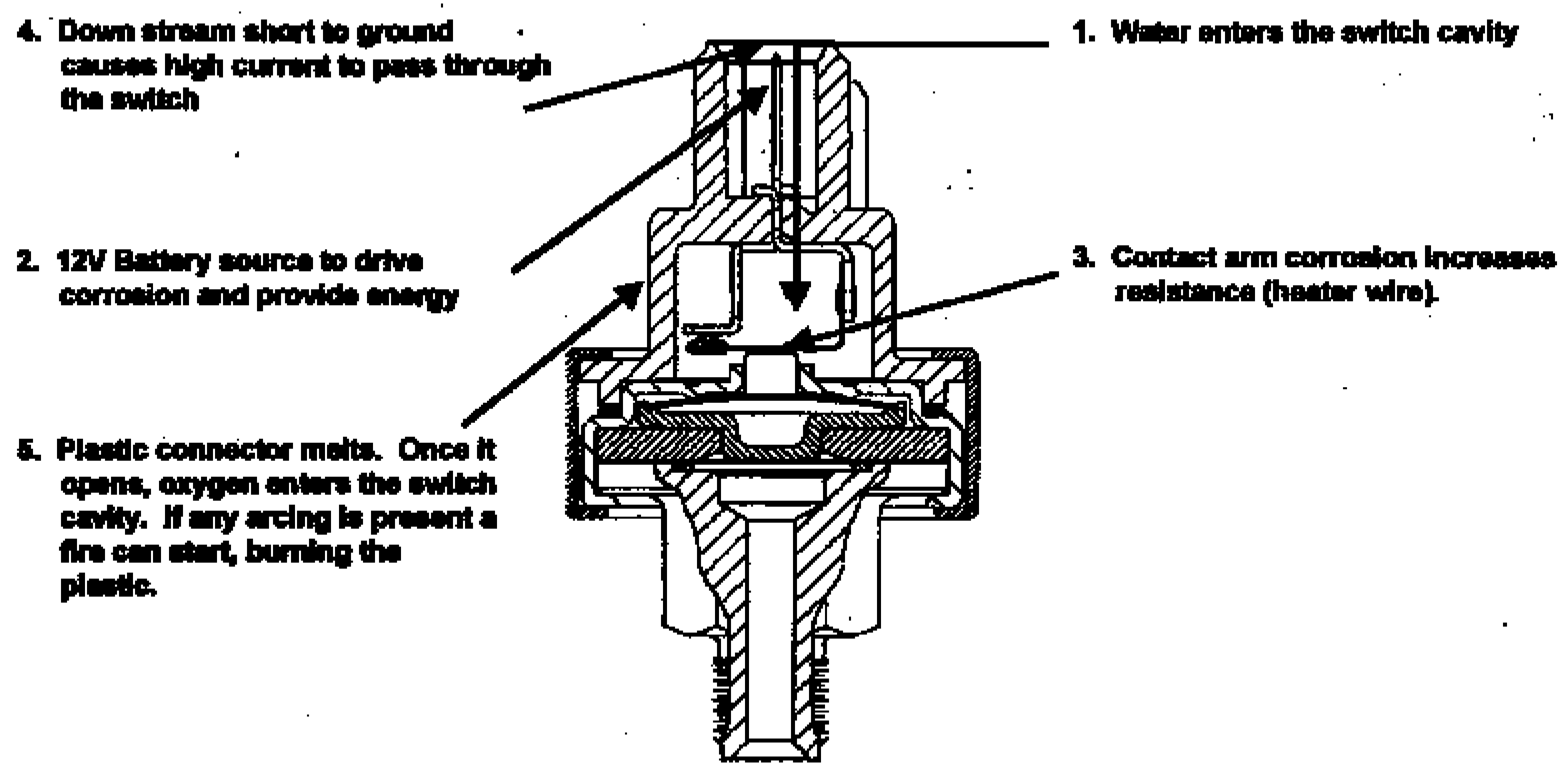
Materials & Controls



3713 5995

Texas Instruments

Brake Pressure Switch
Potential Thermal Event Theory - 2/24/99



TEXAS INSTRUMENTS

Brake Pressure Switch
Potential Factors - 3/3/99

1. Connector Seal

   a. Kapton Seal   improve durability

2. Power continuously available   filled with water (High Current) 2-5 amp typical operating ↓ DRYING OUT 600-800°F (thermocouple in connector)

3. Switch orientation   ↑ resistance goes up with corrosion

4. Current limit / fuse   1 amp vs 15 amp

5. Hexport isolation   to ground

   move switch—brake hose / prop valve

6. Higher temperature plastic

3719 S997

(AA1)

E45B-14603-AA

WIRING CONNECTOR GROMMET

Greg

9-27

⊕ DENOTES TOLERANCE ZONE FOR BASIC DIMENSIONS IN RELATION TO A FEATURE

[X.XX] DENOTES BASIC DIMENSIONS HAVING ZERO TOLERANCE DESCRIBING THE EXACT THEORETICAL LOCATION OF CONTOUR

(K) FLASH EXTENSION OF 0.25 THICK x 1.00 WIDE IS THE MAXIMUM PERMISSIBLE AND MUST NOT AFFECT FUNCTION OR FIT OF PART

PART MUST BE IDENTIFIED WITH MOLD LETTER AND CAVITY NUMBER ON ONE SIDE

ENGINEERING APPROVAL OF SAMPLES FROM EACH SUPPLIER IS REQUIRED PRIOR TO AUTHORIZATION OF PART PRODUCTION

PART MUST MATE WITH E45E-14489-A

FOR ADDITIONAL GENERAL NOTES SEE ES-D8AB-1293-A

(X2) (A) [redacted] SAME AS ESB-M2D280-A SILICONE ELASTOMER-INHERENTLY LUBRICATED.

EXCEPT
1 ORIGINAL PROPERTIES
HARDNES
TENSIL
TEAR
ULA
EL

(AB2)

Work Plan- Brake Pressure Switch

Root Cause Investigation-

Identify the combustibles?
AVT EESE Materials Engineering

Identify the contaminants in returned parts?
Central Lab analysis

Identify source of contaminants?
Central Lab analysis

Identify causes of brake fluid leakage?
Central Lab and Texas Instrument

Identify heat source(s) start event?
AVT EESE Chassis Electronics

Create Event in Lab
AVT EESE Chassis Electronics

Collect Field Samples
LVC - Safety

Root Cause Investigation Tasks

What are the combustibles?

AVT EESE Materials Engineering

Are the switch materials compatible with brake fluid?
by 2/18/99

Are the switch materials compatible with brake fluid in an electric field?
by 2/18/99

Are the switch materials compatible with brake fluid and contaminants?
by 2/18/99

Are the switch materials compatible with contaminated brake fluid in an electric field? by 2/18/99

Flash points for all materials? by *completed*

TI provided to Norm LaPointe

Get Dow assistance by 2/16/99

How can a fire start with the switch given the constraints:

Continuous Battery voltage applied between switch electrical components and the hydraulic connection, circuit fused at 15 amps, inductive load current of 0.5 amps switched when speed control is turned off, the switch cavity contains a black material containing at least copper, zinc, sulfur, and brake fluid (probably containing water), vehicle underhood temperatures.

By 2/22/99

What is the difference in the base materials that look different?
Texas Instruments by *complete*

Color of plastic base identifies calibration. Also, plastic material change from Cellanex 4300 to Noryl GTX430 in MY 1995 when P/N changed from F2VC to F2AC

What are the material call-outs for 1992 and 1993?

Texas Instruments by 2/15/99

Brake Pressure Switch
F2VC-9F924-AB
Material List for MY 92/93

Component Name	Material	Comment
Gasket	Elastomer Ethylene Propylene	JBL Compound # E-7104-70
Diaphragm	Kapton, Polyimide	Dupont 500 FN131L, 3 Diaphragms per switch
Base	PBT, Plastic	Grade Celanex 4300
Crimp Ring	Aluminum	Grade # 5052
Spacer	Kapton, Polyimide	Dupont #200H, Friction Reducer on Disc
Rivet	Brass	CDA 260
Transfer Pin	Ceramic	Steatite, L-3 Grade
Environmental Seal	Silicone	JBL Compound # S7519
Converter	Cold Rolled Steel	Grade # 1008
Washer	Cold Rolled Steel, Zinc Plated	Grade # 1050
Cup	Cold Rolled Steel	Grade 1010
Spring Arm	Beryllium Copper	Grade # C17200
Movable Contact	Silver Plated Copper	Oxygen Free Cu, Fine Silver
Stationary Terminal	Brass + Silver Inlay	CDA 260
Movable Terminal	Brass	CDA 260
Disc	Stainless Steel	Grade 302
Hexport	Cold Rolled Steel, Zinc Plated	C10L10
Thread Cap	LDPE, Plastic	

What are the contaminants in returned parts?

Central Lab analysis

Results of Memphis part analysis by 2/18/99

Results of testing with corrosion simulation?

AVT BESE Chassis Electronics by *complete*

Black corrosion recreated in lab on virgin parts. Given to Lab for analysis

TI analysis results of the Memphis parts (crease marks in diaphragm, etc) ?

Texas Instruments by *complete*

3713 6001

TI gave to Norm LaPointe on 2/10/99. Crease mark caused by degradation of Kapton. TI chemical analysis matches Ford analysis.

What is source of contaminants?

Central Lab analysis by 2/18/99

What causes brake fluid leakage? By 2/24/99

Central Lab and Texas Instrument

What does TI DFEMA say about this failure mode?

Texas Instruments by 2/16/99

TI identifies potential for leaks. Copy to Norm Lapointe.

What are TI in-process test failures?

Texas Instruments by *completed*

TI provided IP and Weibull test reports to Fred Porter and Norm Lapointe. First leaker observed at 994,000 cycles. Test suspended at 1.6 million cycles. Leaker was by Kapton diaphragm.

Provide TI end-of-life lab test parts to Norm Lapointe.

TI by 2/18/99

Does the event occur only on vehicles with ABS?

LVC-Safety by 2/18/99

Characterize the real vehicle brake pressure seen at the switch.

AVT Chassis Brakes by

Characterize the real vehicle brake pressure during ABS and TC events seen at the switch. AVT Chassis Brakes by

DOE work plan for TI activities.

TI by 2/16/99

Correlate Lab test cycle Kapton wear with field mileage Kapton wear.

TI and Central Lab by 2/29/99

What heat source(s) start event?

AVT EESE Chassis Electronics

Analysis of harness pig-tails

AVT EESE OPD by 2/18/99

Use thermocouple to record switch temperature during and after driving. AVT EESE OPD by 2/18/99

Recreate Event in Lab

AVT EESE Chassis Electronics

What does it take to start an event? by on-going

If a switch is contaminated can it start the event? by on-going

Switch with clean Brake fluid inside is being monitored for increase in leakage current.

If current is stopped does combustion stop?

Collect Field Samples

LVC - Safety

Collect Brake Pressure switches and speed control servos with harnesses attached. By 2/22/99

3713 8003

Miscellaneous

Can the switch act as a fuse?

Team by complete

No.

Could a fuse (e.g. 2 amp) be added in series between the stop lamp fuse and the brake pressure switch? Failure parameters would have to be known.

What are descriptions from AWS and CQIS?

LVC-Safety by 2/18/99

What are we seeing in returned Speed control modules (FRACAS)?

Visteon Speed Control by 2/17/99

Provide color photos of Econoline?

Texas Instruments by *complete*

There are no color photos.

3713 6004

Containment / Corrective Action Tasks

Competitive Vehicles

How is switch packaged?
Is it always Powered (HOT_ALL_TIME) ?
Are the contacts opened when pressure applied?
What is fuse limit?
What is being switched?
Is it a redundant switch?

AVT EESE Competitive Analysis **by** **2/24/99**

What does Speed control FMEA say about Brake Switch ?

Visteon Speed Control **by** *completed*

The Brake Pressure Switch (Deactivation Switch) coupled with the Stop Lamp switch are categorizes as "Automatic Deactivation". The FMEA lists Automatic Deactivation" as current design control for 66 different potential cause/ mechanical failures.

Brake Pressure Switch (Deactivator Switch) is one of the most important safety features.

When was non-Pressure actuated switched introduced?

AVT EESE Chassis Electronics **by** *completed*

95 Continental and T/Bird were first to use it.

Is the Circuit drive hi-side or low-side?

Visteon Speed Control **by** *completed*

Circuit is low side driven.

How does speed control use this switch?

Visteon Speed Control **by** *completed*

1. *Brake Pressure Switch provides electrical power to the speed control servo clutch circuit The clutch circuit needs to be energized for the servo motor to pull the cable.*

2. *Switch provides a redundant method of sensing brake application independent of the primary system deactivation mode; this is a SDS (SC-0005) requirement.*

- *Signal from the stop lamp switch is primary deactivation mode for brake application.*
- <u>*Under "hard" braking condition:*</u> *Brake Pressure Switch provides redundant brake signal to the speed control logic (similar to stop lamp switch signal) and disconnects power to the clutch circuit; causing the speed control servo pulley to immediately return to the idle position. Note: Under normal braking conditions, only the stop lamp switch signal cancels speed control operation.*

Do all Ford applications use switch between fuse and load?

Visteon Speed Control **by** *complete*

YES

Do all Ford applications have switch connected to HOT-ALL-TIMES?

AVT EESE OPD **by** **2/18/99**

Can Brake Pressure Switch function be removed from power feed circuit and placed in ground return circuit?

Visteon Speed Control **by** *completed*

1. *Would require redesign of the speed control electronics.*
2. *Additional isolated ground circuit is required.*
3. *From FMEA position switching the ground circuit is not as good as switching the B+ feed.*
    - *With a ground return circuit; short to ground (fault) it would override the deactivation switch.*
    - *With the current power feed circuit; short to ground make the speed control system inoperative. A short to power is required to override the deactivation switch; much lower potential to occur.*

Why is this switch connected to HOT-ALL-TIMES?

Visteon Speed Control **by** *completed*

Because the SDS requires it to be connected to the same fuse as the stop lamp.

What is SDS requirement number?

Visteon Speed Control **by** *completed*

SDS (SC-0068) states: The stop lamp switch and redundant deactivator switch must be on the same fused circuit.

Is it feasible to disconnect the switch as immediate containment?

Yes. The customer will not have use of the speed control.

Is it acceptable to Jumper out the switch as immediate containment?

Visteon Speed Control **by** *completed*

NO... Would eliminate an important safety feature of the speed control system. The Brake Pressure Switch provides the redundant method for sensing brake application independent of the primary system deactivation mode. This is an SDS (SC-0005) requirement.

Elimination of this feature requires the concurrence of the OGC.

Other recommendations for immediate containment?

All **by** **on-going**

Add fuse between the stop lamp fuse and the brake pressure switch?

Recommendations for increased Life of switch.

TI **by** **3/5/99**

TI suggested looking at an Automotive ceramic diaphragm pressure transducer (not a switch) that is used for ABS.

Brake Pressure Switch Test Log
Updated 2/16/99

Category	Test	Location	Test Parameters	Results Update
Lab Simulation	1	TI	Various Levels of Brake Fluid, Water, Detergent	100+ hours into test, max current 5mA
of Potential Ignition			14Vdc to one terminal, hexport grounded	No significant change with time
In Switch	2	TI	Various Levels of Brake Fluid, Water, Detergent	100+ hours into test
			1 Amp through switch terminals	No significant temperature rise with time
	3	AVT	Brake Fluid in Switch, 24 VDC to one terminal	> 200 hours into test, max current 7mA
			Hexport Grounded	No significant change with time
	4	AVT	Brake Fluid in Switch, 24 VDC to one terminal	16 hours into test max current 5mA
			Hexport Grounded, Ambient at 100 C	No significant temperature rise with time
	5	AVT	Brake Fluid in Switch, 16 Amps	Temperature rise of 20 C above room temp
			Through switch terminals	Delta T reached steady state at 20 C
	6	TI	Build heater element into Switch	Expected update 2/19
			Heat till failure	
Life Cycle Reliability	7	TI	0-1400 psig pressure pulses at 135C ambient	Parts at 600k cycles, no leaks.
of Pressure Switch			per ES	Will continue to failure
Diaphragm Wear	8	TI	0-1400 psig pressure pulses at 135C ambient	Parts withdrawn every 200k cycles, characterized for wear
Field vs Lab Correlation	9	Central Labs	Various Field returns, from dealer lots, junkyards	Parts in Central Labs, being processed
Design Of Experiments	10	TI	Various Levels of Brake Fluid, Water,	Test being structured. Expected Phase One to begin 2/19
Evaluating Factors			Under ES conditions, to failure	
Effecting Diaphragm Wear				
On-Vehicle Characterization	11	AVT	Monitor Pressure and Temperature	Logistics being worked out.
of Pressure & Temperature			at Switch Location for ABS and non-ABS	
Profile in Town Car			braking events.	

Brake Pressure Switch
Evaluation Plan for Field Returns

DATE CODE P/N

Sw #
Mileage
Date of update

Category	Step #	Action	Notes/Data	Comments
Field Info	1	Log Field Info into Switch Log.xls		
	2	Photograph Switch		
	3	Record any unusual external visual observations		See note below
	4	Check for Connector engagement		If not correct conduct X-Ray to determine fit-up between base lip and red seal
Switch & Connector [illegible]	5	Wire 1 to Wire 2 Resistance		
	6	Wire 1 to Hexport Resistance		
	7	Wire 2 to Hexport Resistance		
	8	Separate Harness from Switch		
Connector only	9	Verify Connector Seal		Visual check of Red Seal, Dirt lines, Indentation mark.. Indentation mark must be 360 degrees.
	10	Wire 1 to Wire 2 resistance		
	11	Current Leakage Wire 1 to Wire 2		
	12	Check for full engagement of connector		Visual check of dirt lines on mated switch base
	13	Check wire insulation		
	14	Check wire gray seals		
	15	Cut wire insulation to check for corrosion		Cut insulation longitudinally to check for wicking along wires. If signs of corrosion, identify color, save samples for chem I.d.
Switch only External Unpressurized	16	Assemble Switch to Calibration Stand		
	17	Terminal 1 to Terminal 2 Resistance		
	18	Terminal 1 to Hexport Resistance		
	19	Terminal 2 to Hexport resistance		
	20	Base to Hexport Resistance		
	21	Current Leakage Terminal 1 to Hexport		
	22	Current Leakage Terminal 2 to Hexport		

3713 6009

	23 Voltage drop at 750 mA	
Switch External Pressurized	24 Switch Opening Pressure	Do not perform on parts from underhood fires, as may disturb diaphragm/other condition
	25 Switch Closing Pressure	Do not perform on parts from underhood fires, as may disturb diaphragm/other condition
	26 Proof Test for Leakage	Do not perform on parts from underhood fires, as may disturb diaphragm/other condition
	27 Repeat Steps 17 through 23 at 180 psig	
Switch Internal	Refer to Protocol Established By Norm LaPointe & Steve LaRouche and Al Hopkins (TI) for the Memphis Part. Norm/Steve, please e-mail Aziz a copy of the protocol. Aziz will frame it in a flow chart format and insert here.	
Data Entry	Log All data from this sheet into Switch Log Aziz will revise Switch Log to include cells for this data. Photographs, Elemental maps etc must be retained and referenced by Switch #	

Log Updated 2/15/1999

Sw #	Sw Date Code	Vehicle	VIN	Event	Mileage	Leaker?	Kapton #1	Kapton #2	Kapton #3	Term-Hexpo Resistance	Present Location of Sw.	Present Status	Comments
Memphis		Town Car		Sw. Fire			Tear	Tear	Tear		Central Lab		
A		Town Car		Underhood Fire							Central Lab	Analysis in Progress	
B		Town Car		Underhood Fire							N/A	Sw. not available	
C		Town Car		Underhood Fire							Central Lab	Analysis in Progress	
D		Crown Vic Police Car		Cruise Inop			Tear?	Tear?	Tear?		Central Lab	Analysis in Progress	
E		Town Car		Reference							Central Lab	Analysis in Progress	
F		Town Car		Cruise Inop			Tear?	Tear?	Tear?		Central Lab	Analysis in Progress	
1	2006	Town Car	NX762858	Reference	79164						AVT		
3	3015	Town Car	PY724043	Reference	71337						AVT		
4	2048	Town Car	PY628170	Reference	89087						AVT		
5		Town Car		Reference	98349						Central Lab	Analysis in Progress	
6		Town Car		Reference	47325						Central Lab	Analysis in Progress	
7	2059	Town Car	NX728439	Reference	86922						AVT		
8	3025	Town Car	PX160223	Reference	65814						AVT		
9	2260	Town Car	PX837766	Reference	??						AVT		
10	2281	Town Car	PY659375	Reference	82224						AVT		
11	3028	Town Car	PY726066	Reference	91358						AVT		
From TX trip of 2/10 to 2/12													
1	2028	Town Car	PY638990	Reference							AVT		With Connector and servo
2	3053	Crown Vic Police Car	PX163920	Reference	199999						AVT		With Connector and servo
3	3295	Grand Marquis	RX641595	Reference	??						AVT		With Connector and servo
4	3025	Crown Vic	PX163312	Reference	40642						AVT		With Connector
5	2063	Town Car	PY610384	Reference	73115						AVT		With Connector
6	??	Town Car	NY724366	Underhood Fire	??						AVT		
7	3081	Town Car	PY750172	Reference	??						AVT		With Connector
8	2045	Town Car	NY733191	Underhood Fire	106610						AVT		With Servo, Prop Valve
9	3098	Town Car	PY758158	Reference	??						AVT		With Connector, Prop Valve, Servo
10	2272	Crown Vic	PX151140	Reference	72814						AVT		With Connector, Prop Valve, Servo
11	2115	Town Car	NY757408	Reference	??						AVT		With Connector
12	3085	Town Car	PY742858	Reference	??						AVT		With Connector
13	3089	Town Car	PY7433413	Reference	105048						AVT		With Connector and Servo

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			Memphis	A	B	C	D	E	F	1
			PY622977	PY686224	NY746119	NY703705	VX145373	NX758774	NY760065	NX752858
Field Info	1	Log Field Info into Switch Log.xls	C	C	C	C	C	C	C	C
		Condition	FIRE	FIRE	FIRE	FIRE	BF LEAK	NO FIRE/LEAK	BF LEAK	NO FIRE/LEAK
	2	Photograph Switch	C	C	C	C	C	C	C	NP
	3	Record any unusual external visual observations	C	C	C	C	C	C	C	C
	4	Check for Connector engagement	C	NA	NA	NA	NA	NA	NA	NA
		X-ray if applicable	C	NA	NA	NA	NA	NA	NA	NA
Switch + Connector Assembly	5	Wire 1(LB/WHT) to Wire 2(ORANGE) Resistance	NA	NA	NA	NA	NA	NA	NA	NA
	6	Wire 1(LB/WHT) to Hexport Resistance	NA	NA	NA	NA	NA	NA	NA	NA
	7	Wire 2(ORANGE) to Hexport Resistance	NA	NA	NA	NA	NA	NA	NA	NA
	8	Separate Harness from Switch	C	NA	NA	C	NA	NA	NA	NA
Connector Only	9	Verify Connector Seal	C	NA	NA	C	NA	NA	NA	NA
	10	Wire 1(LB/WHT) to Wire 2(ORANGE) resistance	NA	NA	NA	NA	NA	NA	NA	NA
	[redacted]									
	12	Check for full engagement of connector	NA	NA	NA	NA	NA	NA	NA	NA
	13	Check wire insulation	C	NA	NA	NA	NA	NA	NA	NA
	14	Check wire grey seals	C	NA	NA	NA	NA	NA	NA	NA
	15	Cut wire insulation to check for corrosion	C	NA	NA	NA	NA	NA	NA	NA
Switch External Unpressurized	16	Assemble Switch to Calibration Stand	NA	NA	NA	NA	NA	NA	NA	C
	17	Spring Terminal to Stationary Terminal Resistance	NA	NA	NA	NA	0.4	0.2	NP	0.3
	18	Spring Terminal to Hexport Resistance	NA	NA	NA	NA	4.8M	INF	2M	INF
	19	Stationary Terminal to Hexport resistance	NA	NA	NA	NA	NP	NP	NP	INF
	20	Base to Hexport Resistance	NA	NA	NA	NA	1.1	8.6M	NP	3.3M
	[redacted]									
Switch External Pressurized	24	Switch Opening Pressure	NA	NA	NA	NA	NA	NA	NA	122
	25	Switch Closing Pressure	NA	NA	NA	NA	NA	NA	NA	59
	26	Proof Test for Leakage	NA	NA	NA	NA	NA	NA	NA	NO LEAK
	27	Repeat Steps 17 through 20 at 1500 psig	NA	NA	NA	NA	NA	NA	NA	C
	[redacted]		NA	NA	NA	NA	NA	NA	NA	INF
			NA	NA	NA	NA	NA	NA	NA	INF
			NA	NA	NA	NA	NA	NA	NA	INF
			NA	NA	NA	NA	NA	NA	NA	INF
Switch	28	Remove aluminum crimp ring	C	C	NP	C	C	C	C	NP
	29	Examine revealed surfaces. Photograph	C	C	NP	C	C	C	C	NP
	30	Remove cap	C	C	NP	C	C	C	C	NP
	31	Examine revealed surfaces. Photograph	C	C	NP	C	C	C	C	NP
Techniques	31	SEM-EDX/FTIR (caps, contacts, terminals)	C	C	NP	C	C	C	C	NP
	32	SEM-EDX/FTIR cup, hexport, washer seals, etc.	C	C	C	C	C	C	C	NP
	33	Metallographic analysis of contacts.	C	NA	NP	C	C	C	C	NP
		Look for evidence of corrosion or arcing	C	NA	NP	C	C	C	C	NP

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			3	4	5	6	7	8	9	10
			PY724043	PY828170	PY632329	PY729611	NX729439	PX160223	PX637768	PY699375
Field Info	1	Log Field Info into Switch Log.xls	C	C	C	C	C	C	C	C
		Condition	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK
	2	Photograph Switch	NP	NP	NP	NP	NP	NP	NP	NP
	3	Record any unusual external visual observations	C	C	C	C	C	C	C	C
	4	Check for Connector engagement	NA	NA	NA	NA	NA	NA	NA	NA
		X-ray if appropriate	NA	NA	NA	NA	NA	NA	NA	NA
Switch + Connector Assembly	5	Wire 1(LG/W) to Wire 2(ORANGE) Resistance	NA	NA	NA	NA	NA	NA	NA	NA
	6	Wire 1(LG/W) to Hexport Resistance	NA	NA	NA	NA	NA	NA	NA	NA
	7	Wire 2(ORANGE) to Hexport Resistance	NA	NA	NA	NA	NA	NA	NA	NA
	8	Separate Harness from Switch	NA	NA	NA	NA	NA	NA	NA	NA
Connector Only	9	Verify Connector Seal	NA	NA	NA	NA	NA	NA	NA	NA
	10	Wire 1(LG/W) to Wire 2(ORANGE) resistance	NA	NA	NA	NA	NA	NA	NA	NA
	[redacted]									
	12	Check for full engagement of connector	NA	NA	NA	NA	NA	NA	NA	NA
	13	Check wire insulation	NA	NA	NA	NA	NA	NA	NA	NA
	14	Check wire grey seals	NA	NA	NA	NA	NA	NA	NA	NA
	15	Cut wire insulation to check for corrosion	NA	NA	NA	NA	NA	NA	NA	NA
Switch External Unpressurized	16	Assemble Switch to Calibration Stand	C	C	NA	NA	C	C	C	C
	17	Spring Terminal to Stationary Terminal Resistance	0.2	0.3	NA	NA	0.2	0.2	0.2	2.2
	18	Spring Terminal to Hexport Resistance	INF	INF	NA	NA	INF	INF	INF	INF
	19	Stationary Terminal to Hexport resistance	INF	INF	NA	NA	INF	INF	INF	INF
	20	Base to Hexport Resistance	11.4	1.6M	NA	NA	7.8M	16.5	7.5M	1.4M
	[redacted]									
Switch External Pressurized	24	Switch Opening Pressure	134	160	NA	NA	147	132	140	137
	25	Switch Closing Pressure	59	69	NA	NA	70	69	112	60
	26	Proof Test for Leakage	NO LEAK	NO LEAK	NA	NA	NO LEAK	NO LEAK	NO LEAK	NO LEAK
	27	Repeat Steps 17 through 20 at 160 psig	C	C	NA	NA	C	C	C	C
	[redacted]		INF	INF	NA	NA	INF	INF	INF	INF
			INF	INF	NA	NA	INF	INF	INF	INF
			INF	INF	NA	NA	INF	INF	INF	INF
			INF	INF	NA	NA	INF	INF	INF	INF
Switch	28	Remove aluminum crimp ring	NP	NP	C	C	NP	NP	NP	NP
	29	Examine revealed surfaces. Photograph	NP	NP	C	C	NP	NP	NP	NP
	30	Remove cup	NP	NP	C	C	NP	NP	NP	NP
	31	Examine revealed surfaces. Photograph	NP	NP	C	C	NP	NP	NP	NP
Techniques	31	SEM-EDX/FTIR base, contacts, terminals	NP	NP	NP	NP	NP	NP	NP	NP
	32	SEM-EDX/FTIR cup, kapton, washer seals, etc.	NP	NP	NP	NP	NP	NP	NP	NP
	33	Metallographic analysis of corrosion.	NP	NP	NP	NP	NP	NP	NP	NP
		Look for evidence of corrosion or arcing	NP	NP	NP	NP	NP	NP	NP	NP

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			11	12	13	14	15	16	17	18
			PY726066	PX865270	NY740206	PX823872	PY895374	BY838864	PY850225	PY888795
Field Info	1	Log Field Info into Switch Log.xls	O	C	C	C	C	C	C	C
		Condition	NO FIRE/LEAK	[redacted]						
	2	Photograph Switch	NP							
	3	Record any unusual external visual observations	C							
	4	Check for Connector engagement	NA							
		X-ray if appropriate	NA							
Switch + Connector Assembly	5	Wire 1(LB/P) to Wire 2(ORANGE) Resistance	NA							
	6	Wire 1(LB/P) to Hexport Resistance	NA							
	7	Wire 2(ORANGE) to Hexport Resistance	NA							
	8	Separate Harness from Switch	NA							
Connector Only	9	Verify Connector Seal	NA							
	10	Wire 1(LB/P) to Wire 2(ORANGE) resistance	NA							
	[redacted]									
	12	Check for full engagement of connector	NA							
	13	Check wire insulation	NA							
	14	Check wire poly seals	NA							
	15	Cut wire insulation to check for corrosion	NA							
Switch External Unpressurized	16	Assemble Switch to Calibration Stand	C							
	17	Spring Terminal to Stationary Terminal Resistance	0.2							
	18	Spring Terminal to Hexport Resistance	INF							
	19	Stationary Terminal to Hexport resistance	INF							
	20	Base to Hexport Resistance	INF							
	[redacted]									
Switch External Pressurized	24	Switch Opening Pressure	139							
	25	Switch Closing Pressure	71							
	26	Proof Test for Leakage	NO LEAK							
	27	Repeat Steps 17 through 20 at 180 psig	C							
	[redacted]		INF							
			INF							
			INF							
			INF							
Switch	28	Remove aluminum crimp ring	NP							
	29	Examine revealed surfaces. Photograph	NP							
	30	Remove cup	NP							
	31	Examine revealed surfaces. Photograph	NP							
Techniques	31	SEM-EDX /FTIR base, contacts, terminals	NP							
	32	SEM-EDX /FTIR cup, hexport, washer seals, etc.	NP							
	33	Metallographic analysis of contacts.	NP							
		Look for evidence of corrosion or arcing	NP							

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Section	No.	Step	19	20	21	22	23	1	2	3
			PY774256	PY754575	PX843515	??	PX629934	PY638990	PX163920	RX841595
Field Info	1	Log Field Info into Switch Log	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
		Condition	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK
	2	Photograph Switch	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	3	Record any unusual external visual observations	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	4	Check for Connector engagement	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
		X-ray if appropriate	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NA	C	NA
Switch + Connector Assembly	5	Wire 1(LG/W) to Wire 2(ORANGE) Resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.3	0.4	0.2
	6	Wire 1(LG/W) to Hexport Resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	7	Wire 2(ORANGE) to Hexport Resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	8	Separate Harness from Switch	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
Connector Only	9	Verify Connector Seal	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	10	Wire 1(LG/W) to Wire 2(ORANGE) resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	12	Check for full engagement of connector	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	13	Check wire insulation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	14	Check wire grey seals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	15	Cut wire insulation to check for corrosion	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	TBP	TBP	TBP
Switch External Unpressurized	16	Assemble Switch to Calibration Stand	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	17	Spring Terminal to Stationary Terminal Resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.3	0.1	0.2
	18	Spring Terminal to Hexport Resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	19	Stationary Terminal to Hexport resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	20	Base to Hexport Resistance	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5.5	INF	17.7K
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Switch External Pressurized	24	Switch Opening Pressure	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	158	127	126
	25	Switch Closing Pressure	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	66	92	64
	26	Proof Test for Leakage	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO LEAK	NO LEAK	NO LEAK
	27	Repeat Steps 17 through 20 at 100 psig	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	C	C	C
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	0.1	INF
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	INF	INF	INF
Switch	28	Remove aluminum crimp ring	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP
	29	Examine revealed surfaces. Photograph	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP
	30	Remove cup	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP
	31	Examine revealed contacts. Photograph	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP
Techniques	31	SEM/EDX/FTIR base, contacts, terminals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP
	32	SEM/EDX/FTIR cup, hexport, washer seals, etc.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP
	33	Metallographic analysis of contacts.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	NP	NP
		Look for evidence of corrosion or arcing	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NP	C	NP

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			4	5	6	7	8	9	10	11
			PX163512	PY610384	NY724366	PY750172	NY733191	PY758168	PX151140	NY757408
Field Info	1	Log Field Info into Switch Log-in	C	C	C	C	C	C	C	C
		Condition	NO FIRE/LEAK	NO FIRE/LEAK	FIRE	NO FIRE/LEAK	FIRE	NO FIRE/LEAK	NO FIRE/LEAK	NO FIRE/LEAK
	2	Photograph Switch	C	C	C	C	C	C	C	C
	3	Record any areas of external visual observations	D	C	C	C	C	C	C	C
	4	Check for Connector engagement	C	C	NA	C	NA	C	NA	C
		X-ray if appropriate	C	NA	NA	NA	NA	C	NA	NA
Switch + Connector Assembly	5	Wire 1(LG/RY) to Wire 2(ORANGE) Resistance	NP	0.2	NA	INF	NA	2	0.4	NP
	6	Wire 1(LG/RY) to Hexport Resistance	NP	INF	NA	INF	NA	6.0M	INF	NP
	7	Wire 2(ORANGE) to Hexport Resistance	NP	INF	NA	INF	NA	6.1M	INF	NP
	8	Separate Harness from Switch	C	C	NA	C	NA	C	C	C
Connector Only	9	Verify Connector Seal	C	C	NA	C	NA	C	C	C
	10	Wire 1(LG/RY) to Wire 2(ORANGE) resistance	NP		NA	INF	NA	INF	INF	NP
	[redacted]									
	12	Check for full engagement of connector	C	C	NA	C	NA	C	C	C
	13	Check wire insulation	C	C	NA	C	NA	C	C	C
	14	Check wire grey seals	C	C	NA	C	NA	C	C	C
	15	Cut wire insulation & check for corrosion	TBP	TBP	NA	TBP	NA	TBP	TBP	TBP
Switch External Unpressurized	16	Assemble Switch to Calibration Stand	C	C	NA	C	NA	C	C	C
	17	Spring Terminal to Stationary Terminal Resistance	0.1	0.2	NA	0.8	NA	1.5	0.4	0.1
	18	Spring Terminal to Hexport Resistance	INF	INF	NA	INF	NA	6.5M	INF	INF
	19	Stationary Terminal to Hexport resistance	INF	INF	NA	INF	NA	6.4M	INF	INF
	20	Base to Hexport Resistance	INF	190K	NA	463K	NA	0.4	6.8	INF
	[redacted]									
Switch External Pressurized	24	Switch Opening Pressure	133	151	NA	136	NA	164	138	135
	25	Switch Closing Pressure	63	62	NA	68	NA	60	109	74
	26	Proof Test for Leakage	NO LEAK	NO LEAK	NA	NO LEAK	NA	NO LEAK	NO LEAK	NO LEAK
	27	Repeat Steps 17 through 20 at 160 psig	C	C	NA	C	NA	C	C	C
	[redacted]		INF	INF	NA	INF	NA	0.1	INF	INF
			INF	INF	NA	INF	NA	~970K	INF	INF
			INF	INF	NA	INF	NA	~970K	INF	INF
			INF	INF	NA	INF	NA	INF	INF	INF
Switch	28	Remove aluminum crimp ring	NP	NP	NP	NP	NP	C	NP	NP
	29	Examine exposed surfaces. Photograph	NP	NP	NP	NP	NP	C	NP	NP
	30	Remove cup	NP	NP	NP	NP	NP	C	NP	NP
	31	Examine exposed surfaces. Photograph	NP	NP	NP	NP	NP	C	NP	NP
Techniques	31	SEM-EDX /FTIR kapton, contacts, terminals	NP	NP	NP	NP	NP	C	NP	NP
	32	SEM-EDX /FTIR cup, hexport, washer seals, etc.	NP	NP	NP	NP	NP	C	NP	NP
	33	Metallographic analysis of contents.	NP	NP	NP	NP	NP	NP	NP	NP
		Look for evidence of corrosion or arcing	NP	NP	NP	NP	NP	C	NP	NP

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			12	13	OASIS	OASIS	EAA	EAA	EAA	
			PY742858	PY7433413	NY734410	PY805828	PY614995	NY736847	NY706341	
Field Info	1	Log Field Info into Switch Log	C	C	C	C	C	C	C	
		Condition	NO FIRE/LEAK	NO FIRE/LEAK	BF LEAK	BF LEAK	FIRE	FIRE	FIRE	
	2	Photograph Switch	C	C	C	C	C	C	NA	
	3	Record any unused external (Ford) connections	C	C	C	C	C	C	NA	
	4	Check for Connector engagement	C	C	NA	NA	NA	NA	NA	
		X-ray it if appropriate	C	NA	NA	NA	NA	NA	NA	
Switch + Connector Assembly	5	Wire 1(LG/R) to Wire 2(ORANGE) Resistance	0.3	0.3	NA	NA	NA	NA	NA	
	6	Wire 1(LG/R) to Hexport Resistance	20.9M	INF	NA	NA	NA	NA	NA	
	7	Wire 2(ORANGE) to Hexport Resistance	21.5M	INF	NA	NA	NA	NA	NA	
	8	Separate Harness from Switch	C	C	NA	NA	NA	NA	NA	
Connector Only	9	Verify Connector Seal	C	C	NA	NA	NA	NA	NA	
	10	Wire 1(LG/R) to Wire 2(ORANGE) resistance	INF	INF	NA	NA	NA	NA	NA	
	[redacted]									
	12	Check for full engagement of connector	C	C	NA	NA	NA	NA	NA	
	13	Check wire insulation	C	C	NA	NA	NA	NA	NA	
	14	Check wire grey seals	C	C	NA	NA	NA	NA	NA	
	15	Cut wire insulation to check for corrosion	TBP	TBP	NA	NA	NA	NA	NA	
Switch External Unpressurized	16	Assemble Switch to Calibration Stand	C	C	C	C	NA	NA	NA	
	17	Spring Terminal to Stationary Terminal Resistance	0.2	0.2	>700K	>130K	NA	NA	NA	
	18	Spring Terminal to Hexport Resistance	24M	INF	>950K	>17K	NA	NA	NA	
	19	Stationary Terminal to Hexport resistance	39M	INF	>350K	>120K	NA	NA	NA	
	20	Base to Hexport Resistance	63.4K	7.5M	INF	INF	NA	NA	NA	
	[redacted]									
Switch External Pressurized	24	Switch Opening Pressure	148	160	182	NO SOUND	NA	NA	NA	
	25	Switch Closing Pressure	81	70	92	NO SOUND	NA	NA	NA	
	26	Prod Test for Leakage	NO LEAK	NO LEAK	NO LEAK	NO LEAK	NA	NA	NA	
	27	Repeat Steps 17 through 20 at 160 psig	C	C	C	C	NA	NA	NA	
	[redacted]		0.1	INF	>1.0M	170K	NA	NA	NA	
			INF	INF	>500K	>140K	NA	NA	NA	
			INF	INF	>400K	>15K	NA	NA	NA	
			INF	INF	INF	INF	NA	NA	NA	
Switch	28	Remove aluminum crimp ring	SCI LAB	NP	C	C	TBP	TBP	NA	
	29	Examine revealed surfaces. Photograph	SCI LAB	NP	C	C	TBP	TBP	NA	
	30	Remove cup	SCI LAB	NP	C	C	TBP	TBP	NA	
	31	Examine revealed surfaces. Photograph	SCI LAB	NP	C	C	TBP	TBP	NA	
Techniques	31	SEM-EDX / FTIR base, contacts, terminals	SCI LAB	NP	TBP	TBP	TBP	TBP	NA	
	32	SEM-EDX, FTIR cup, hexport, washer seals, etc.	SCI LAB	NP	TBP	TBP	TBP	TBP	NA	
	33	Metallographic analysis of contacts.	SCI LAB	NP	TBP	TBP	TBP	TBP	NA	
		Look for evidence of corrosion or arcing	SCI LAB	NP	TBP	TBP	TBP	TBP	NA	

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Field Info	1	Log Field info into Switch Log.xls								
	2	Photograph Switch								
	3	Record any unusual external visual observations								
	4	Check for Connector engagement								
		X-ray it if appropriate								
Switch + Connector Assembly	5	Wire 1(LB/W) to Wire 2(ORANGE) Resistance								
	6	Wire 1(LB/W) to Hexport Resistance								
	7	Wire 2(ORANGE) to Hexport Resistance								
	8	Separate Harness form Switch								
Connector Only	9	Study Connector Seal								
	10	Wire 1(LB/W) to Wire 2(ORANGE) resistance								
	[redacted]									
	12	Check and test for full engagement of connector								
	13	Check wire insulation								
	14	Check wire gray seals								
	15	Cut wire insulation to check for corrosion								
Switch External Unpressurized	16	Assemble Switch in Calibration Stand								
	17	Spring Terminal to Stationary Terminal Resistance								
	18	Spring Terminal to Hexport Resistance								
	19	Stationary Terminal to Hexport resistance								
	20	Base to Hexport Resistance								
	[redacted]									
Switch External Pressurized	24	Switch Opening Pressure								
	25	Switch Closing Pressure								
	26	Proof Test for Leakage								
	27	Repeat Steps 17 through 25 at [illegible] psig								
	[redacted]									
Switch	28	Remove aluminum crimp ring								
	29	Examine revealed surfaces. Photograph								
	30	Remove cap								
	31	Examine revealed surfaces. Photograph								
Techniques	31	SEM/EDX /FTIR base, contacts, terminals								
	32	SEM/EDX /FTIR cap, hexport, washer seals, etc.								
	33	Metallographic analysis of contacts.								
		Look for evidence of corrosion or arcing								