Wayne Koska
**TS-SSC 91-117**
6/12/91

# Disposition of Magnet DSA325

Magnet DSA325 has developed a resitive short between turns 19 and 18 approximately 3.75"±2" toward the return end from tap 19D on the lower coil (coil # 1M-50-116)[1]. This puts the short in the end can region. This was the first 50 mm magnet on which an aluminum end can was installed and three attempts were required before the can was positioned satisfactorily. The first two attempts were aborted when the can was not fully installed even at 8500-9000 pump psi on the installation fixture. Removal of the end can after these two attempts probably put considerable stress on the end of the magnet. The can was finally installed properly after 5 of 10 mils of extra kapton insulation was removed. (This extra insulation had originally been put in place to increase the prestress within the end can.) The inner surface of the can had also been polished between the first and second installation attempt[2]. It is possible that the damage which resulted in the short occurred during this process, however it did not appear in the resistance measurements made on 4-17-91 after the successful end can installation (see chart 1). The first indication of the short appeared during harmonics measurements on 4-18-91. Resistance measurements made on 4-22-91 show a 2 mΩ difference between the upper and lower coils (see chart 2). Inductance measurements also indicated a short existed.

| Coil(s) | DSA325 Inductance at 100 Hz |
|---|---|
| Total | 4.890 |
| Upper | 2.451 |
| Lower | 2.438 |
| Upper Inner | 0.897 |
| Lower Inner | 0.887 |
| Upper Outer | 1.552 |
| Lower Outer | 1.551 |

A set of voltage tap resistance measurements was made to determine the position of the short (See TS-SSC 91-084). The end can was then removed for use on DSA324. Resistance measurments made shortly after this on 4-26-91 indicated that the short no

Distribution: S. Delchamps, S. Gourlay, M. Lamm, J. Strait, M. Wake longer existed. The magnet was completely disassembled at this point and the resistance of the lower coils between taps 19D and 18B was compared to the resistance between taps 18D and 17B. These resistances were approximately equal. If the short still existed these resistances should not have been the same. We attempted to re-establish the short by putting the coil into the sizing fixture so that we could stress it and reproduce the conditions under which the short had appeared. The estimated position of the short put it very near the end of the straight section of the coil with the possibility that it was actually in the curved section of the end of the coil. For this reason the coil was installed in the sizing fixture using 6 inch metal bars to increase the length over which the coil could be pressed and to stress it as close to the end as possible. The coil was pressed at 8000 pump psi (7400 psi on the coil) for 2 hours with no indication of the short recurring. The coil was then "rung" at 500 V and 1KV to try to induce the short with no effect. Finally the coil was again placed into the sizing fixture and pressurized to 8000 pump psi and rung in 500 volt steps to 2 KV with no indication of the short (see figure 1). Since we have been unable to reproduce the short we conclude that it was probably in the end of the coil in a position where the coil cannot be easily stressed without reassembling the magnet and reinstalling the end clamp. We do not feel that it is worth the effort at this time to do this. We will not use this coil in a magnet.

1) W. Koska, TS-SSC 91-084, 5/30/91
2) Details of the end can installation were obtained from S. Delchamps.

## SSC 50MM COIL DC ELECTRICAL (SUMMARY) RESISTANCE

| MEAUREMENTS ARE TAKEN USING A VALHALLA 4300B | TRAVELER | INSPECTION | VOLTAGE TAP | COLLARING | COLLARING | KEYING | END CLAMP | END CLAMP |
|---|---|---|---|---|---|---|---|---|
|  | FUNCTION | FREE COIL POST CURE INSPECTION | PRE-ASSY CHECK | PRE-COLLARED ASSY | POST COLLARED INSPECTION | KEYING PRESS OPERATION | RETURN END INSTALLATION | LEAD END INSTALLATION |
|  | STEP # |  |  |  |  |  |  |  |
| **SERIAL NUMBER** | **COIL POSITION** | DC R = mΩ | DC R = mΩ | DC R = mΩ | DC R = mΩ | DC R = mΩ | DC R = mΩ | DC R = mΩ |
| 1M-50-220 | UPPER OUTER | 177.0 | 176.9 | 177.1 | 177.7 | 176.9 | 174.0 |  |
| 1M-50-117 | UPPER INNER | 104.5 | 104.7 | 104.6 | 105.0 | 104.3 | 102.8 |  |
| 1M-50-116 | LOWER INNER | 104.5 | 104.3 | 104.2 | 104.8 | 104.0 | 102.5 |  |
| 1M-50-219 | LOWER OUTER | 176.9 | 176.9 | 177.4 | 177.5 | 176.5 | 174.0 |  |
|  | UPPER HALF | ▨ | ▨ | 281.8 | 282.6 | 281.1 | 276.7 |  |
|  | LOWER HALF | ▨ | ▨ | 281.8 | 282.1 | 280.5 | 276.6 |  |
|  | TOTAL | ▨ | ▨ | 563.5 | 564.7 | 561.6 | 553.2 |  |
| TEMPERATURE "F" |  | 72° | 74° | 73° | 73° | 75° | 74° |  |
| HUMIDITY % |  | 82 | 80 | 62 | 60 | 73 | 67 |  |
| TECHNICIAN(S) |  | D.M.&K.C. | D.M.&K.C | P.S.&D.M. | P.S.&D.M. | [illegible] D.M | D.M.&K.C. |  |
| DATE |  | 3/27/91 | 3/27/91 | 4/1/91 | 4/3/91 | 4.2.91 | 4-17-91 |  |

SSC 50MM "R1" CHART

Chart 1

AFTER R.E. CAN INSTALLATION preparing for [illegible]

# VOLTAGE TAP RESISTANCE READINGS

[redacted]

77.6°F
60% Humidity

(✓) INNER UPPER: 1M-50-117 (✓) LOWER INNER 1M-50-116

( ) OUTER UPPER ____________ ( ) OUTER LOWER ____________

| | | | |
|---|---|---|---|
| 19B TO 19A | .36 mΩ | 19B TO 19A | .35 mΩ |
| 19B TO 19C | 2.25 mΩ | 19B TO 19C | 2.25 mΩ |
| 19B TO 19D | 2.77 mΩ | 19B TO 19D | 2.69 mΩ |
| 19B TO 18B | 4.70 mΩ | 19B TO 18B | 3.74 mΩ |
| 19B TO 18A | 5.24 mΩ | 19B TO 18A | 4.04 mΩ |
| 19B TO 18C | 7.18 mΩ | 19B TO 18C | 5.14 mΩ |
| 19B TO 18D | 7.65 mΩ | 19B TO 18D | 5.49 mΩ |
| 19B TO 17B | 9.66 mΩ | 19B TO 17B | 7.47 mΩ |
| 19B TO 17A | 10.13 mΩ | 19B TO 17A | 7.95 mΩ |
| 19B TO 17C | 12.16 mΩ | 19B TO 17C | 9.98 mΩ |
| 19B TO 17D | 12.54 mΩ | 19B TO 17D | 10.37 mΩ |
| 19B TO16B | 14.62 mΩ | 19B TO16B | 12.44 mΩ |
| 19B TO 16A | 15.04 mΩ | 19B TO 16A | 12.87 mΩ |
| 19B TO 16C | 17.15 mΩ | 19B TO 16C | 14.95 mΩ |
| 19B TO 16D | 17.50 mΩ | 19B TO 16D | 0 mΩ |
| 19B TO 15B | 19.66 mΩ | 19B TO 15B | 17.49 mΩ |
| 19B TO 15A | 20.07 mΩ | 19B TO 15A | 17.90 mΩ |
| 19B TO 15C | 22.08 mΩ | 19B TO 15C | 19.93 mΩ |
| 19B TO 15D | 22.69 mΩ | 19B TO 15D | 20.53 mΩ |
| 19B TO 14B | 24.62 mΩ | 19B TO 14B | 22.45 mΩ |
| 19B TO 14A | 25.26 mΩ | 19B TO 14A | 23.08 mΩ |
| 19B TO 14C | 27.18 mΩ | 19B TO 14C | 25.03 mΩ |
| 19B TO 14D | 27.75 mΩ | 19B TO 14D | 25.58 mΩ |
| 19B TO 13B | 29.75 mΩ | 19B TO 13B | 27.59 mΩ |
| 19B TO 13A | 30.32 mΩ | 19B TO 13A | 28.17 mΩ |
| 19B TO 0A | 102.4 mΩ | 19B TO 0A | 100.5 mΩ |
| 19B TO 20A | .29 mΩ | 19B TO 20A | .29 mΩ |
| OUTER COIL | mΩ | OUTER COIL | mΩ |
| 19B TO 21A | mΩ | 19B TO 21A | mΩ |
| 19B TO 22A | mΩ | 19B TO 22A | mΩ |

0.52
1.93
0.54
1.94
0.47 0.43
2.01
0.47

0.44
1.05
0.3
1.1
0.35 9,63
1.98
0.48

Comments:

ELROW
Technician(s)

4.22.91
Date

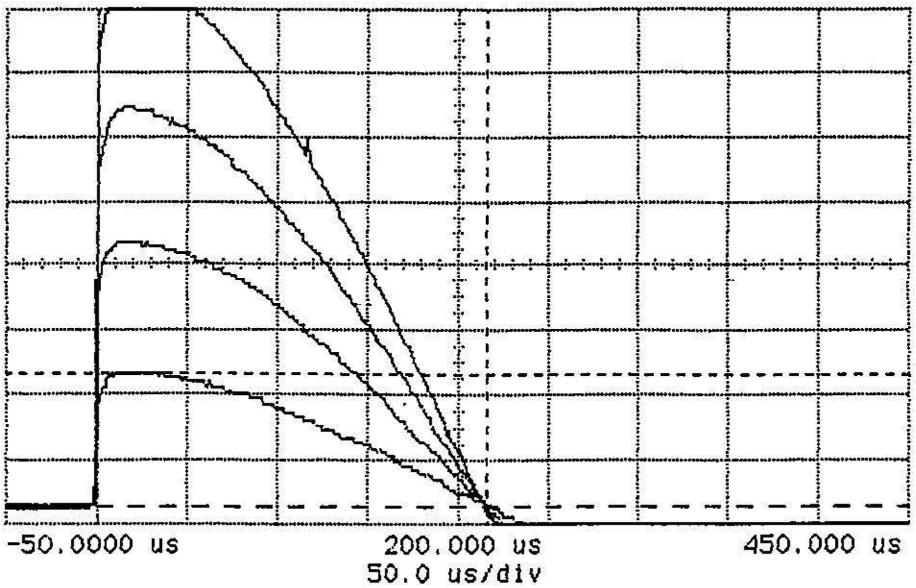
Leadman

Date

5-28-91

WHILE SQUEEZING, WITH SIZING FIXTURE

```
hp  stopped
```



```
1     250    V/div
offset: 875.0  V
  1000  :  1    dc
m1    250    V/div

m2    250    V/div

m3    250    V/div

m4    250    V/div
```

```
Vmarker2( 1 )   453.125 V    stop marker:   216.000us
Vmarker1( 1 )  -62.5000 V   start marker:   0.00000 s
 delta V( 1 )   515.625 V        delta t:   216.000us     1   ⌐ 125.0  V
                               1/delta t:   4.62963kHz
```

Figure 1

5-28-91

| | $R_{VAL}$ | $R_s$ | L | Q | |
|---|---|---|---|---|---|
| 0 psi | 106.84 mΩ | 0.113 Ω | 0.310 | 2.1 | 120 Hz |
| | | 0.202 Ω | 0.298 | 9.7 | 1000 Hz |
| 8000 psi | 106.92 mΩ | 0.115 Ω | 0.312 | 2.1 | 120 Hz |
| | | 0.208 Ω | 0.298 | 9.2 | 1000 Hz |
| | Δ 0.08 mΩ | Δ 0.006 Ω | | | |

---

| | $R_{19D-18B}$ | $R_{18D-17B}$ |
|---|---|---|
| 0 psi | | |
| 8000 psi | | |

Procedure for investigation of lower inner coil of
Which has a short (when end con is in place) ≈ 3.75" from Tap 19D (Toward return end) between Turns 19 + 18.
Prior to ringing, compare resistance of sections 19D-18B and 18D-17B. If They differ by more Than 0.5 mΩ, STOP!

Page 1 of 3

BEFORE RINGING

| $I_v$ | $R_{19D-18B}$ | $R_{18D-17B}$ |
|---|---|---|
| 0.1 A | 2.04 mΩ | 2.13 mΩ |

## Impulse Test of Coil #

Date:__________

1) Implement all high voltage safety procedures
2) Measure the coil inductance, resistance and Q.

BEFORE RINGING

| | | Ls | Rs | Q | Rvalhalla |
|---|---|---|---|---|---|
| Total Coil | 120K | 0.282 mH | 0.105 | 2.0 | 106.47 mΩ |
| | 1K | 0.280 mH | 0.135 | 14.7 | |

Predict Coil Resonant Frequency $\left(\frac{1}{2\pi\sqrt{L_sC}}\right)$ 1227.9

4) Connect the leads of the "ringer" to the main power leads of the magnet. Adjust scope vertical sensitivity to 50 V/Div.
5) Charge the ringer to 100 V

f = 1185
Δ43 Hz

Measured Voltage 100 Power Supply Setting__________

6) Discharge the ringer and store result. **Does measured frequency match predicted frequency ±25 Hz?** If normal, proceed with test.
7) Repeat step 6 with ringer charged to 0.5 kV, 1 kV, ~~1.5~~ kV and ~~2 kV~~. Adjust scope vertical sensitivity to ~~500~~ 250 V/Div. Check that zero-crossing points of last waveform match previous waveform zero-crossing points. If not contact Wayne Koska.

| Desired Voltage | Measured Voltage | Power Supply Setting. |
|---|---|---|
| 0.5 kV | 500 | 570 |
| 1.0 kV | 1000 | 1180 |
| ~~1.5 kV~~ | | |
| ~~2.0 kV~~ | | |

8) Print out results with the ~~4~~ 2 traces overlayed. The zero-crossing points of waveforms should coincide.

AFTER RINGING BEFORE SQUEEZING

| | | |
|---|---|---|
| $I_{VAL}$ | $R_{19D-18B}$ | $R_{18D-17B}$ |
| 0.1A | 2.04 mΩ | 2.13 mΩ |

## Impulse Test of Collared Coil #

Use Steel blocks To cover ≈ 6" of coil

If the previous test showed no indication of a short, place the tap B-D side of the coil into the sizing fixture as close to the return end as possible. Insulate the fixture from the coil with 5 mil thick kapton sheets, and attach a good earth ground to the fixture. Energize the sizing fixture to 8000 pump psi and repeat the ringing tests.

9) Measure the coil inductance, resistance and Q.

| | $L_S$ | $R_S$ | Q | $R_{valhalla}$ |
|---|---|---|---|---|
| Total Coil 120Hz | 0.279 | 0.105 | 2.0 | 106.53 mΩ |
| 1K | 0.280 | 0.135Ω | 150 | |
| Predict Coil Resonant Frequency | | | $\left(\frac{1}{2\pi\sqrt{L_s C}}\right)$ | ______ |

Make sure that $L_S$ matches the $L_S$ measured in step 2. If not, contact Wayne Koska.

10) Connect the leads of the "ringer" to the main power leads of the magnet. Adjust scope vertical sensitivity to 50 V/Div.

11) Charge the ringer to 100 V

Measured Voltage __________ Power Supply Setting __________

12) Discharge the ringer and store result. **Does measured frequency match the frequency found in step 6, ±1 Hz?** If normal, proceed with test.

13) Repeat step 12 with ringer charged to 0.5 kV 1 kV, 1.5 kV and 2 kV. Adjust scope vertical sensitivity to 500 V/Div. Check that zero-crossing points of last waveform match previous waveform zero-crossing points. If not contact Wayne Koska.

| Desired Voltage | Measured Voltage | Power Supply Setting. |
|---|---|---|
| 0.5 kV | 500 | 570 |
| 1.0 kV | 1000 | 1180 |
| 1.5 kV | 1500 | 1670 |
| 2.0 kV | 2000 | |

AFTER RINGING, SQUEEZING, BEFORE RINGING WHILE SQUEEZING

| $I_{VAL}$ | $R_{190-18B}$ | $R_{180-17B}$ |
|---|---|---|
| 0.1 A | 2.15 | 2.10 |

## Impulse Test of Collared Coil #

If the previous test showed no indication of a short, place the tap B-D side of the coil into the sizing fixture as close to the return end as possible. Insulate the fixture from the coil with 5 mil thick kapton sheets, and attach a good earth ground to the fixture. Energize the sizing fixture to 8000 pump psi and repeat the ringing tests.

9) Measure the coil inductance, resistance and Q.

| | | $L_S$ | $R_S$ | Q | $R_{valhalla}$ |
|---|---|---|---|---|---|
| 8000 pump psi | Total Coil 120Hz | 0.309 | 0.112 | 2.1 | 106.87 |
| | 1k | 0.296 | 0.198 | 10,2 10 9 | 106.83 |
| 0 psi | | 0.297 | 0.193 | | |
| | Predict Coil Resonant Frequency | | | $\left(\frac{1}{2\pi\sqrt{L_s C}}\right)$ | ______ |

Make sure that $L_s$ matches the $L_s$ measured in step 2. If not, contact Wayne Koska.

10) Connect the leads of the "ringer" to the main power leads of the magnet. Adjust scope vertical sensitivity to 50 V/Div.

11) Charge the ringer to 100 V

Measured Voltage __________ Power Supply Setting __________

12) Discharge the ringer and store result. **Does measured frequency match the frequency found in step 6, ±1 Hz?** If normal, proceed with test.

13) Repeat step 12 with ringer charged to 0.5 kV 1 kV, 1.5 kV and 2 kV. Adjust scope vertical sensitivity to 500 V/Div. Check that zero-crossing points of last waveform match previous waveform zero-crossing points. If not contact Wayne Koska.

| Desired Voltage | Measured Voltage | Power Supply Setting. |
|---|---|---|
| 0.5 kV | __________ | __________ |
| 1.0 kV | __________ | __________ |
| 1.5 kV | __________ | __________ |
| 2.0 kV | __________ | __________ |

## Impulse Test of Collared Coil #

14) Print out results with the 4 traces overlayed. The zero-crossing points of waveforms should coincide.

15) Turn off ringer and disconnect.

Signed: ______________

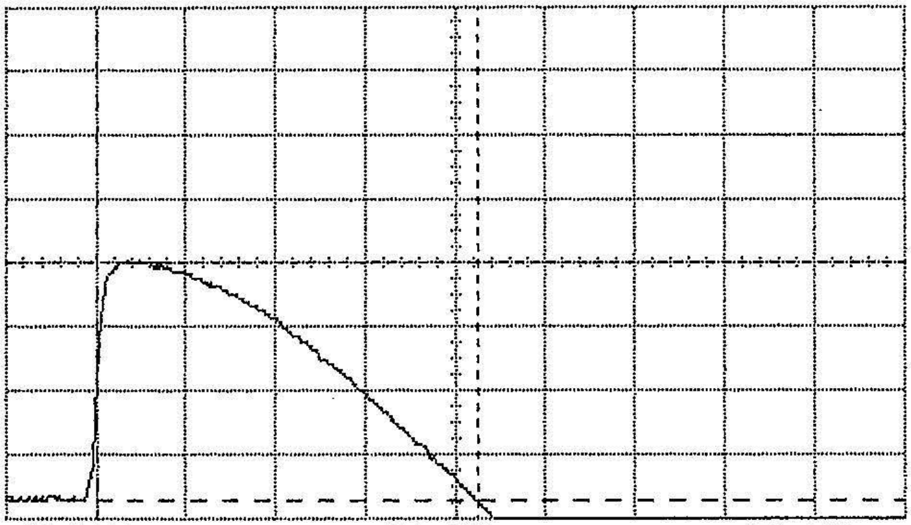
Date: ______________

5/23/91

100V

BEFORE SQUEEZING, NO SIZING FIXTURE

hp stopped



```
Vmarker2(m3)   -46.8750 V     stop marker:   212.000us
Vmarker1(m3)   -421.875 V    start marker:   0.00000 s
 delta V(m3)    375.000 V         delta t:   212.000us     1  ⌐ 25.00  V
                                1/delta t:   4.71698kHz
```

$f_{meas}$ = 1179

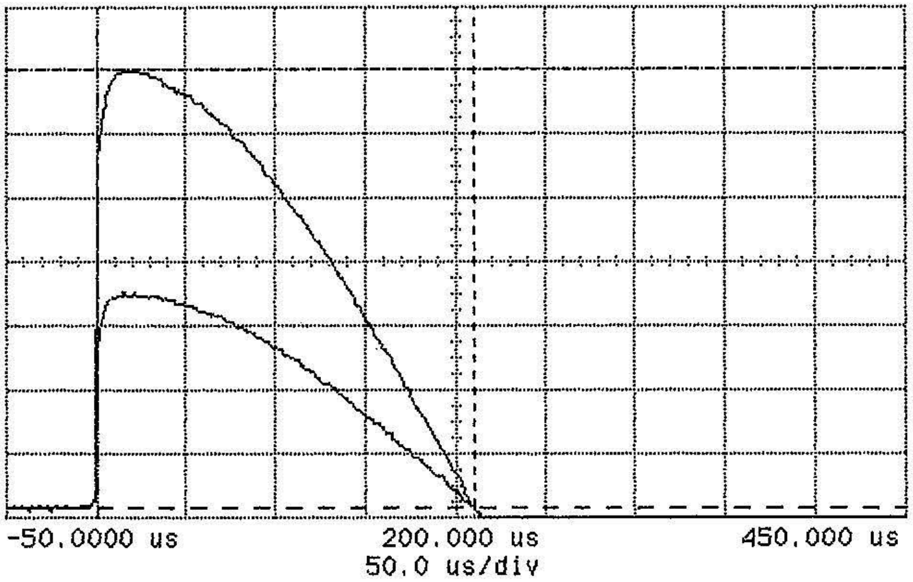
$f_{predict}$ = 1228    Δ49 Hz

500 V 5/23/91

1000V

BEFORE SQUEEZING, NO SIZING FIXTURE

```
hp  awaiting trigger
```



```
1     150    V/div
offset: 525.0  V
  1000  : 1    dc
m1    150    V/div
```

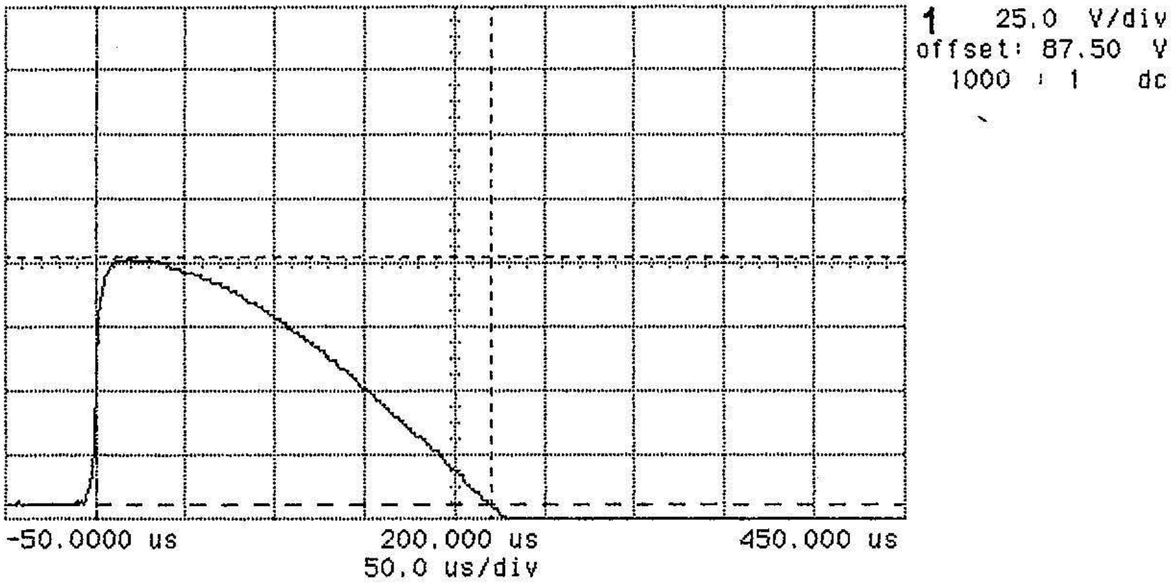
```
Vmarker2(m1)    975.000 V      stop marker:   210.000us
Vmarker1(m3)   -434.375 V     start marker:   0.00000 s
  delta V(m3)   1.40938kV          delta t:   210.000us      1   ⌐  100.0  V
                                 1/delta t:   4.76190kHz
```

$f_{meas}$ = 1190

fpredict 1228

100 V BEFORE SQUEEZING 5/28/91
BUT: SIZING FIXTURE IN PLACE

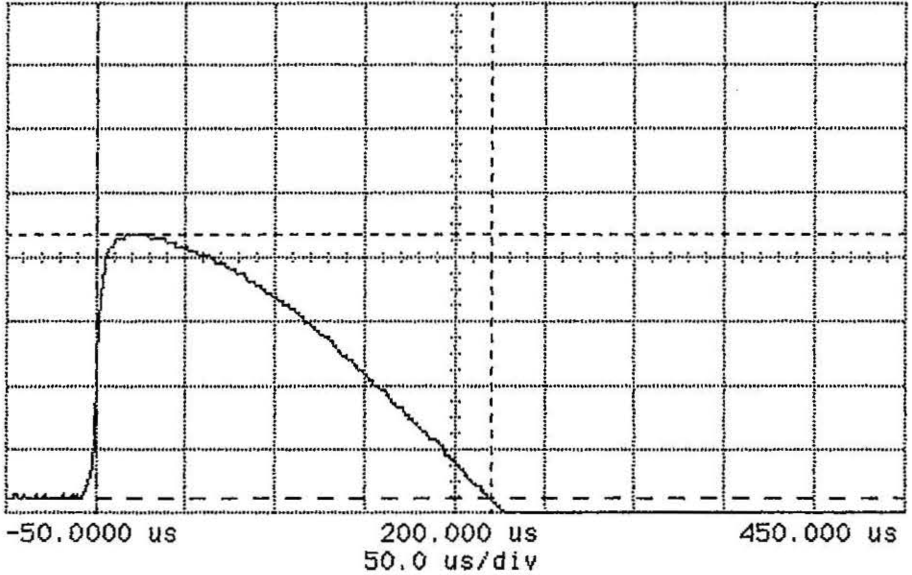
hp stopped



```
Vmarker2( 1 )   89.8440 V      stop marker:   220.000us
Vmarker1( 1 )  -7.03100 V     start marker:   0.00000 s
 delta V( 1 )   96.8750 V          delta t:   220.000us
                                 1/delta t:   4.54545kHz      1  ⨍ 25.00  V
```

I THINK THIS FREQ
COULD BE INCREASED ~ 2 "TICKS"
TO 4.62963 kHz!

hp stopped 100 V While squeezing 5/28/91.
WITH SIZING FIXTURE

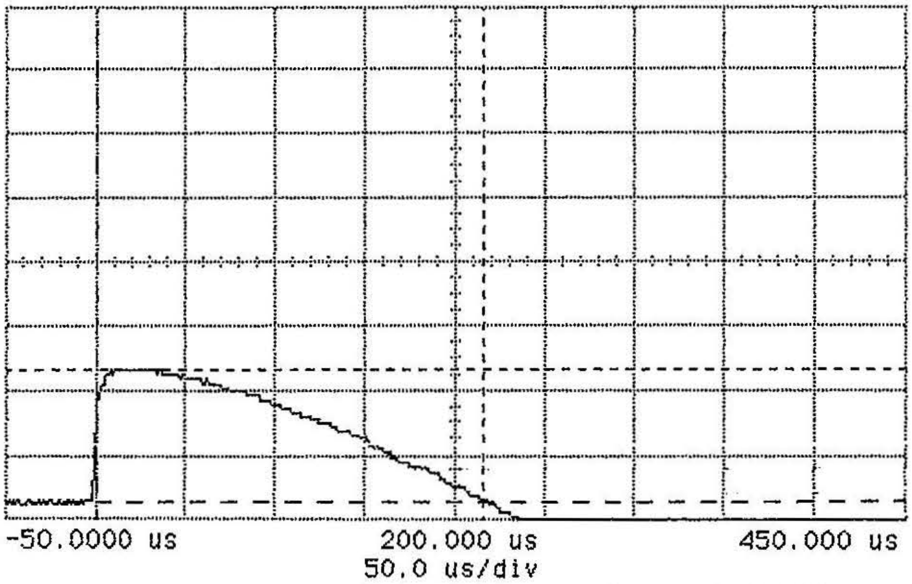


```
1    25.0  V/div
offset: 87.50  V
  1000  : 1    dc
```

```
Vmarker2( 1 )    96.0940 V     stop marker:   220.000us
Vmarker1( 1 )   -7.03100 V    start marker:   0.00000 s
 delta V( 1 )    103.125 V         delta t:   220.000us
                                 1/delta t:   4.54545kHz      1   ⨍ 25.00  V
```

500V while squeezing 5-28-91
WITH SIZING FIXTURE

```
hp stopped
```



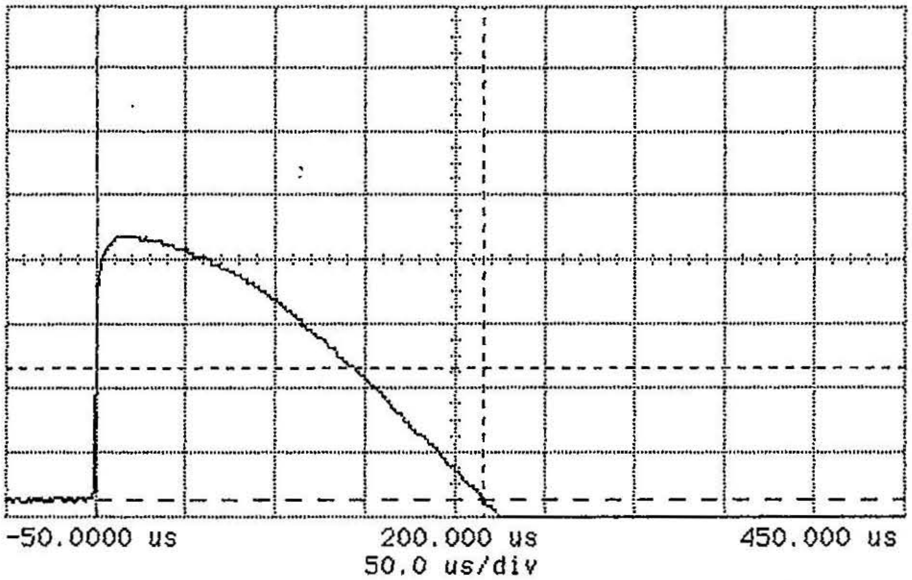
```
1   250   V/div
offset: 875.0  V
  1000  : 1    dc
m1   250   V/div
```

```
Vmarker2( 1 )   453.125 V     stop marker:   216.000us
Vmarker1( 1 )  -62.5000 V    start marker:   0.00000 s
 delta V( 1 )   515.625 V         delta t:   216.000us
                                1/delta t:   4.62963kHz      1  ↑  125.0  V
```

1000 V while squeezing
with sizing fixture

5-28-91

hp stopped



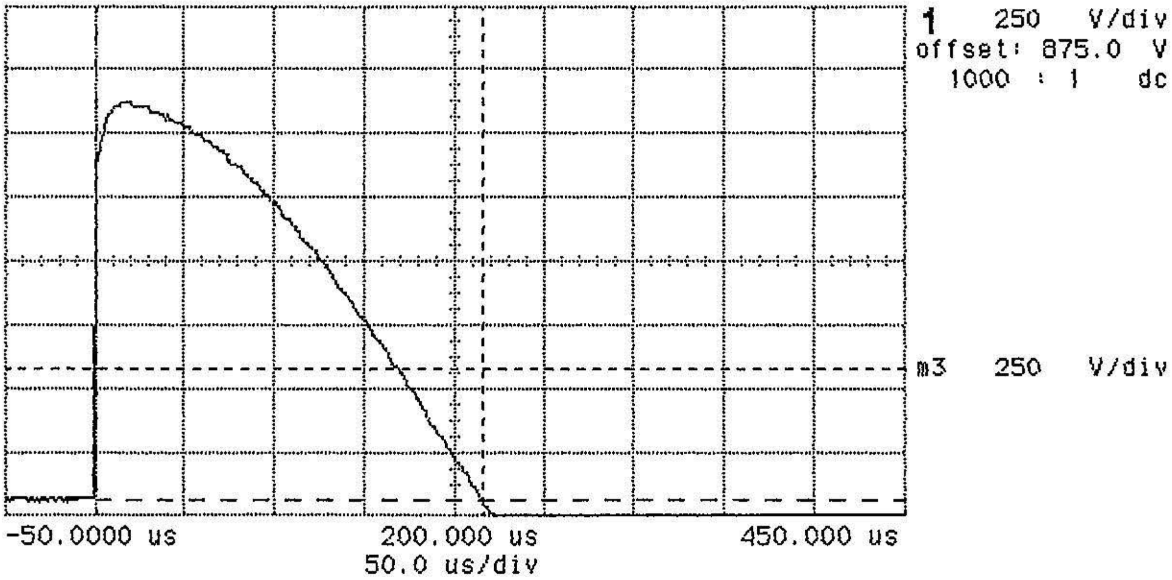
```
1        250    V/div
offset:  875.0  V
  1000  :  1    dc

m2       250    V/div
```

```
Vmarker2( 1 )   453.125 V     stop marker:   216.000us
Vmarker1( 1 )  -62.5000 V    start marker:   0.00000 s
 delta V( 1 )   515.625 V          delta t:   216.000us
                                 1/delta t:   4.62963kHz     1  ⨍  125.0  V
```

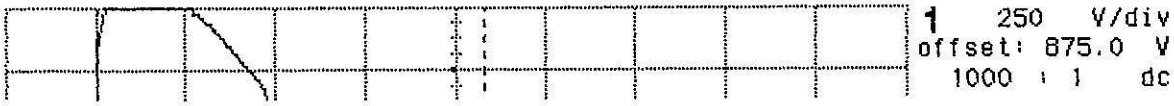
1500 V while squeezing with sizing fixture 5-28-91

hp stopped



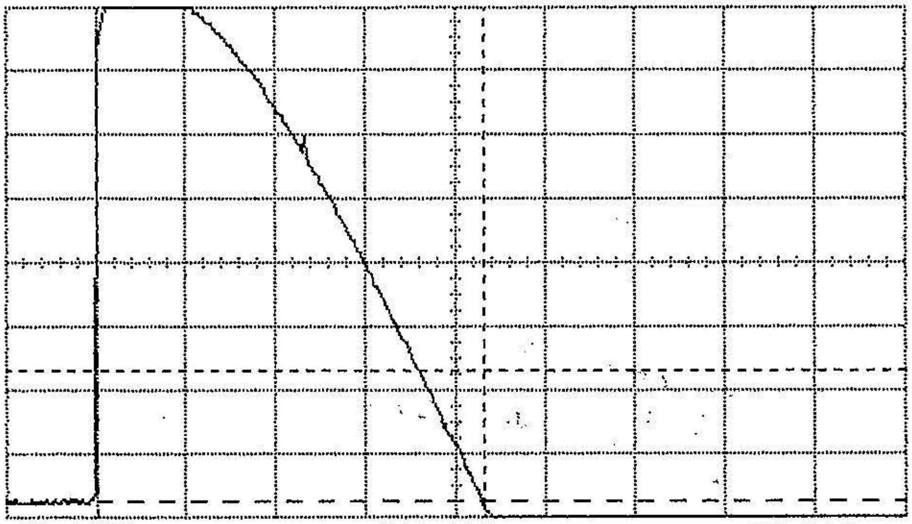
```
Vmarker2( 1 )   453.125 V     stop marker:  216.000us
Vmarker1( 1 )  -62.5000 V    start marker:  0.00000 s
 delta V( 1 )   515.625 V         delta t:  216.000us
                                1/delta t:  4.62963kHz      1  ⎍ 125.0 V
```

hp stopped



2000V while squeezing with sizing fixture 5-28-91

hp stopped



1 250 V/div
offset: 875.0 V
1000 : 1 dc

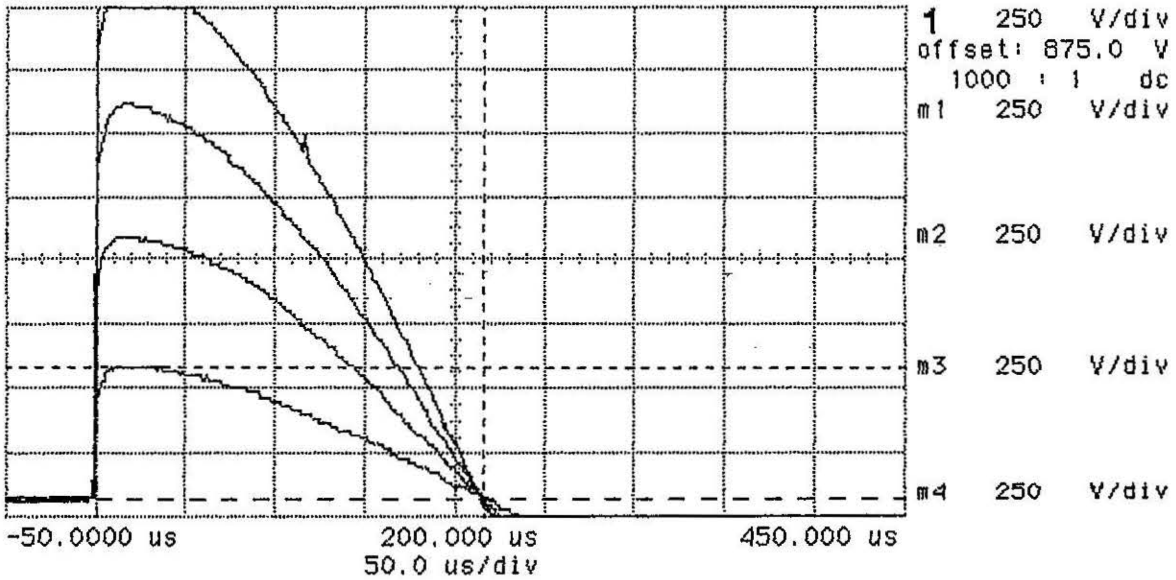
```
Vmarker2( 1 )    453.125 V      stop marker:   216.000us
Vmarker1( 1 )   -62.5000 V     start marker:   0.00000 s
 delta V( 1 )    515.625 V          delta t:   216.000us
                                  1/delta t:   4.62963kHz
```

1 ↑ 125.0 V

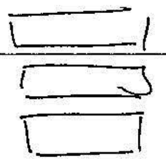
5-28-91

WHILE SQUEEZING, WITH SIZING FIXTURE

*hp* stopped



```
Vmarker2( 1 )    453.125 V     stop marker:   216.000us
Vmarker1( 1 )   -62.5000 V    start marker:   0.00000 s
 delta V( 1 )    515.625 V         delta t:   216.000us      1  ⨍ 125.0  V
                                 1/delta t:   4.62963kHz
```



3 x 5 ton

DSA325 r.e. clamp.

16-Apr – 1st installation of aluminum can.
(this was ~~ea~~ first can received; no surface finish.)

– 2 extra 5mil layers of kapton insulation

– @ 8520 pump psi, can was still not fully installed.

– removed aluminum can.

– can ~~was~~ showed no distortion from pre-installation shape.

– internal surface of can was hand-polished w/ alcohol + fine emory cloth.

17-Apr

– 2nd installation

– 2 extra 5 mil layers

– @ 8500, can was not fully installed

– went to 9000; still not fully installed

– removed

- 3rd installation
- 1 extra 5 mil layer of ~~inco~~ kapton
- 8750 psi required to fully install cam

| Φ | mils |
|---|---|
| 1 | 34 |
| 2 | 34 |
| 3 | 37 |
| 4 | 34 |