Turn to Turn Short in DSA321

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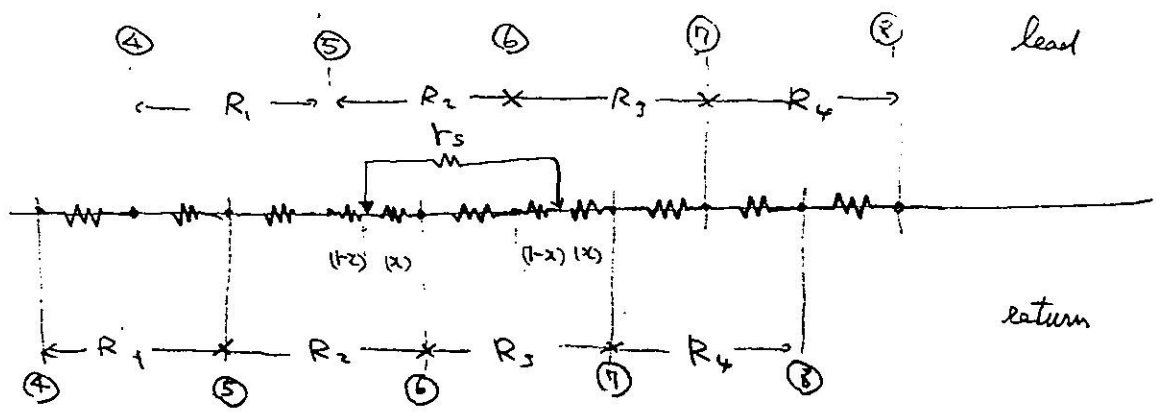
The resistance measurement of the coils gave a change of ~3Ω in the lower outer coil as follows.

Coil		Before Collaring	After Collaring
U0	1M50-206	174.6Ω	174.2Ω
D0	1M50-205	175.0Ω	170.3Ω
UI	IM50-105	104.2Ω	103.9Ω
DI	IM50-106	104.2Ω	103.9Ω

Using potential needle, the resistance of each turn was measured. Turns 13 and 14 had a lower resistance compared with other turns.

Turns from the Top Angle	Lead End	Return End
4-5	6.40Ω	-
5-6	4.77Ω	6.41Ω
6-7	3.50Ω	2.44Ω
7-8	6.69Ω	5.86Ω
8-9	6.50Ω	6.48Ω

Electrical circuit of these points are represented in the following scheme.



The position of the shorted point with shorting resistance R_S can be found by this measurement. The averaged resistance per turn $\overline{R}$ in the shorted area should be

$$\overline{R} = \frac{R_1 + R_4}{2}$$

if there were no shorts. Because of the shorts, the effective resistance of the shorted turn, R_e, is

$$R_e = R_2 + R_3 - \overline{R}$$

because this area should contain a resistance of one normal turn.

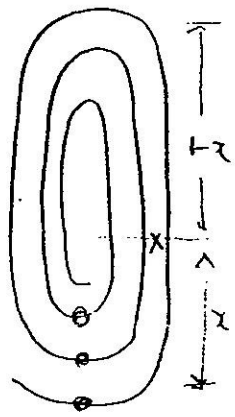
Therefore the short resistance R is given by

$$R_s = \frac{1}{\frac{1}{R_e} - \frac{1}{\overline{R}}}$$

The values of this short are

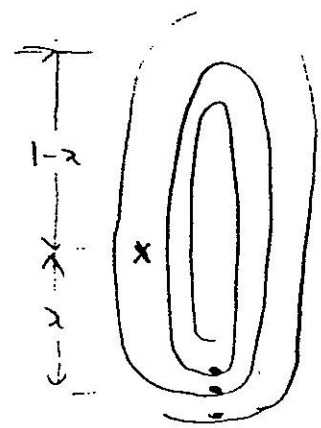
	$\overline{R}$	R_e	R_s
Lead End Measurement	6.44Ω	1.83Ω	2.556Ω
Return End Measurement	6.445Ω	1.855Ω	2.605Ω

Suppose the position of shore is at the x from one end and (1-x) from the other end, where $0 \le x \le 1$. The x is found in each of the following cases:



(A) $R_2 < R_3$

$$x = \frac{R_1 - R_3 - R_3 + R_4}{R_1 - R_2 - R_3 + R_4}$$



(B) $R_2 > R_3$

$$x = \frac{R_1 - R_2 - R_2 + R_4}{R_1 - R_2 - R_3 + R_4}$$

If we use the measured value the value for x is 0.258 for the return end measurement and 0.734 for the lead end measurement. Both measurements are pretty much consistent. Since the length of the coil is 54.4", the shorted point should be 13" from the center in the return end lead side of turn 14 and turn 13.

The magnet was uncollared and the eyeball inspection found an abnormal sticking out of a strand at the exact position we expected. After confirming the change of the resistance using sizing fixture, the coil was cut at the point. What was found there was a broken strand bent in the opposite direction.

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