NEY technical bulletin

MAPLEWOOD AVENUE, BLOOMFIELD, CONNECTICUT

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TYPE 1420 TURRET SLIP RING — TYPE 1356 BRUSH PERFORMANCE AT 1200 RPM

(NEYORO® G RINGS — PALINEY® 7 BRUSHES)

This bulletin presents the results of tests made to determine the performance of Ney Type 1420 slip ring assemblies operated at 1200 rpm. Of particular interest in this series of tests were the amount of material wear and electrical noise that occurred. Several other performance characteristics are presented to assist the designer in proper application of this assembly and similar units utilizing the same noble alloy materials.

BACKGROUND

Wear and electrical performance data previously reported [1] for metal to metal sliding contact systems at low energy levels has been principally based on tests run at 200 rpm or less. Intuitively we should suspect that such data would not apply to operation at substantially higher rpm. Also, the rapid accumulation of the distance of travel at high rpm increases the importance of the ring and brush material wear rates.

A general description of the slip ring assembly and its mating brush member, pictured in Fig. 1, will serve to point out their salient features:

Slip Ring Assembly Type 1420 — the turret assembly has six Neyoro® G alloy rings; each ring has a #30 AWG insulated lead wire attached. These Neyoro G ring members have a material thickness of 0.003 inch (0.076 mm) and are formed to an outside diameter of 0.312 inch (7.92 mm). Molded plastic of the assembly (including the mounting flange) is glass filled polycarbonate rated as self-extinguishing from a fire safety aspect.

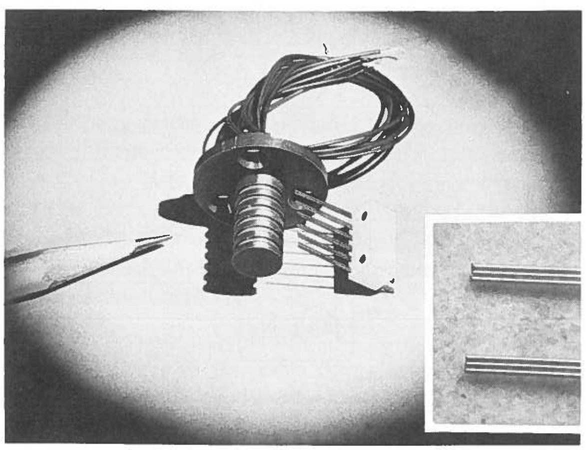

Fig. 1. Type 1420 slip ring assembly and mating brush, Type 1356. Insert at higher magnification shows groups of three strands of brush wire that contact each ring.

Brush Assembly Type 1356 — each brush (wiper) is 0.007 inch (0.178 mm) diameter Paliney® 7 alloy. Three wires in electrical parallel make contact with each slip ring, i.e., each of its six stations contains three strands of the alloy wire, as shown in Fig. 1. Molded plastic is self-extinguishing glass filled phenylene oxide based resin.

Electrical Noise — since electrical noise is the result of a changing resistance value through a ring-brush pair as rotation occurs, it has the usual origins. Such things as the change in number, size and location of a-spots (small areas where intimate contact occurs), the presence of thick films, and spurious motion such as stick-slip or contact bounce will produce electrical noise. In addition, the bulk resistance of the ring has an effect [2].

Wear — some comments are necessary about wear testing in general. Wear is not a very consistent phenomena and wide variations are the general rule, rather than the exception. The spread of test data reported here is not considered excessive.

The objective in regard to wiper wear in tests of this sort is to determine (K_w) a wear constant for use in the generally accepted wear formula $V = K_wFS$ where (V) is the volume of wiper wear for a given contact force (F) and a given distance of sliding (S).

[1]. Pitney, K. E., *Ney Contact Manual*, The J. M. Ney Co., 1973, p. 27.

[2]. Ibid. p. 126.

In regard to ring wear, it would appear that a constant K_r that could be used in the formula A_r/ring revolution $= K_rF$ would be more useful, where A_r is the cross sectional area of the ring wear and F is the contact force. K_r can then be used to calculate depths of wear in rings of somewhat differing diameters. Also, when the ring diameter is large in comparison to the wiper diameter it is easier to visualize that the wear of the ring depends on the *number* of times the ring passes under the wiper.

TEST PROCEDURE

Wiper brush assemblies were cleaned in the following manner prior to installation in test fixtures such as pictured in Fig. 2:

1. Spray clean with trichloroethylene and air dry.
2. Ultrasonic clean for five minutes in 1:64 solution of "Micro" cleaning agent in demineralized water. ("Micro" is manufactured by International Products Corp., Trenton, NJ.)
3. Spray rinse with demineralized water.
4. Spray rinse with Freon® TF and air dry.

Ring assemblies were installed in a test fixture, brushes were set to the desired contact force and while rotating at 1200 rpm each was rinsed with several drops of Freon TF.

The ring-brush members of each assembly were connected in series as shown in Fig. 3; thus the noise reported is (unless otherwise specified) the total of all six ring-brush interfaces in series. Some positions were run without applied voltage except during noise measurement and some had 11.0 volts applied continuously. A Hewlett Packard 400E a-c millivoltmeter was used for noise measurements, which were taken several times per day for the first week of test and at least once per day afterward.

Tests were conducted in ordinary laboratory atmosphere and were dispersed over summer and winter indoor conditions in order to include a wide range of humidity in the event that this would influence lubricity, wear rates or electrical noise. Average relative humidity ranged from 30% in winter to 60% in summer laboratory conditions. Minimum values of 16% and maximums of 77% were observed. Other conditions of the test were:

Contact force — 1.7 or 2.2 grams per brush strand, as indicated.

Brush cantilever length — 0.3 inch (7.6 mm) from point of contact to plastic brush body.

Direction of rotation — unidirectional; counterclockwise with brushes to the right and top of rings.

Test duration — wear and noise results are based on specimens run for times ranging from 630 to 1110 hours (1000 hours is equivalent to 72 million revolutions).

Number of assemblies tested — 24 ring-brush pairs distributed among six tests.

Wear was determined by measuring the depth of ring and brush wear with optical comparator methods at magnifications up to 200X from which the wear scar volumes or areas were computed.

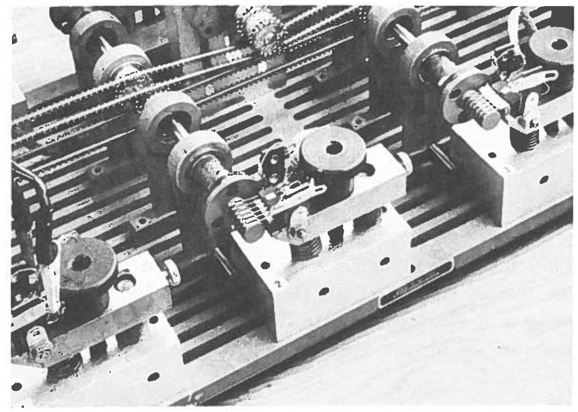

Fig. 2. Partial view of one of the test fixtures used for evaluating wear and electrical noise at 1200 rpm.

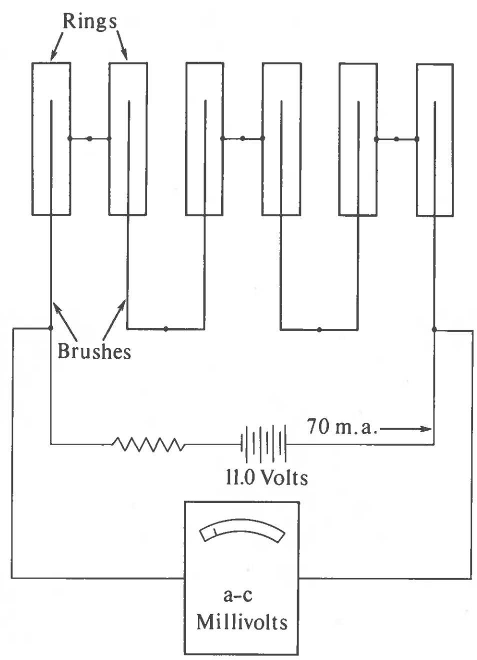

Fig. 3. Schematic of noise test circuitry.

Noise readings and wear rates were subjected to statistical analysis for determination of averages and σ (standard deviation) from

$$\sigma = \sqrt{\frac{\Sigma(x - \bar{x})^2}{N - 1}}$$

where x indicates value of an individual data point, $\bar{x}$ = average and N = number of data points in the set.

NOISE CHARACTERISTICS

The effect of the bulk resistance of the individual rings can be seen from Fig. 6, which pictures the signal across only one ring. When the lead wire attached to the ring is directly under the brush, ring resistance (and the voltage drop across it) is at a minimum, whereas when rotation is 180° away, the effective resistance is at its maximum. As a result, a sinusoidal pattern exists at the frequency of rotation and spurious sliding noise is superimposed on this signal. Observations show that this effective resistance is approximately 0.01 ohms for Type 1420 rings.

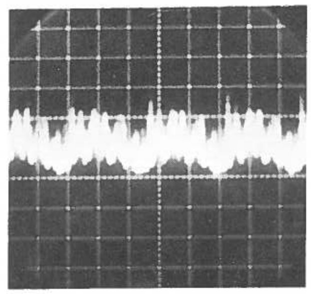

Fig. 6. Oscillograph of noise across single ring. See text re sinusoidal pattern. Tektronix 502A oscilloscope 1 mV/cm vertical sensitivity.

Influence of current and source voltage on noise was studied (a) by adjusting the d-c supply voltage for various current levels and (b) by adjusting the resistance in series with the rings, which was done at three source voltage levels. The results in Figs. 7 through 10 show that there is a distinct proportionality of noise and current as would be forecast by sliding contact theory. The tendency of the noise level vs current to have a lesser slope at current values generally below the 20 ma region is due to radio frequency interference, which was found to be at the .05 to .15 millivolt level at the test site. Noise vs current for source voltages between 1.5 and 11.0 are almost identical, which indicates that any minor films that may be present on the contact interfaces *do not* require substantial source voltage to electrically puncture them. Rather, the mechanical scrubbing action is adequate to insure surface cleanliness and good conduction.

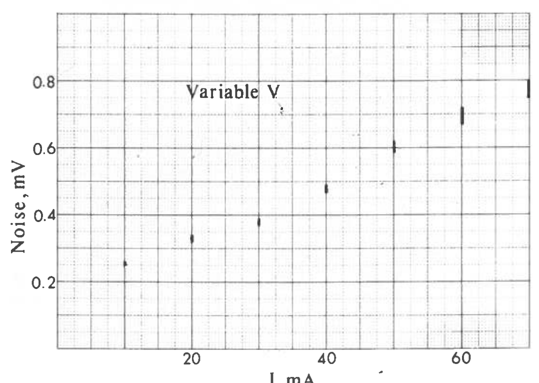

Fig. 7. Noise vs current where source voltage was varied. At 70 mA current, source voltage = 11.0 volts.

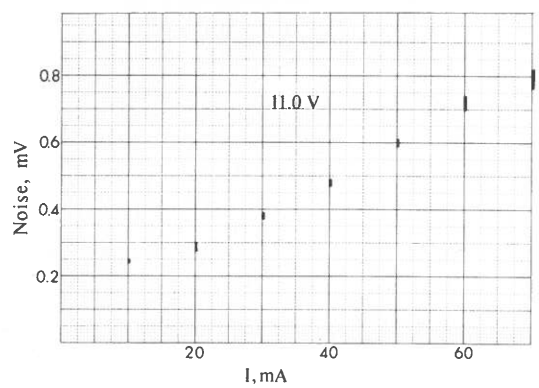

Fig. 8. Noise vs current at 11.0 V source voltage where series resistance was varied.

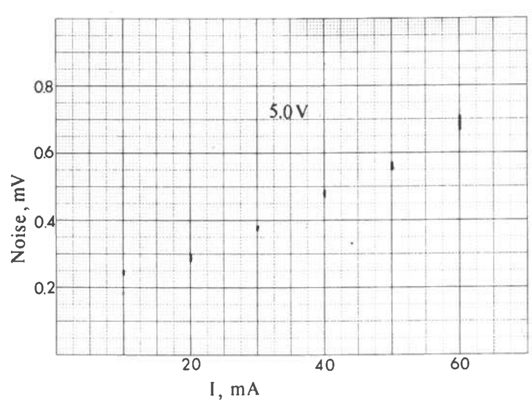

Fig. 9. Noise vs current at 5.0 V source voltage where series resistance was varied.

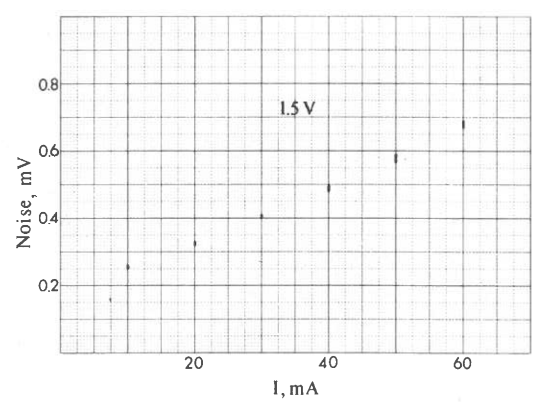

Fig. 10. Noise vs current at 1.5 V source voltage where series resistance was varied.

RESULTS

Wiper wear and ring wear results are tabulated in Table I, along with the values of K_w and K_r. Analysis of the raw data showed that wear was not influenced by the presence of the 11.0 volt signal so the table combines

Table I. Wiper and Ring Wear

Test No.	Test Duration (Hours)	Wiper Force (Grams)	Wiper Wear Constant, K_w				Max. Wiper Wear Depth/1000 Hrs.		Ring Wear Constant, K_r				Max. Ring Wear Depth/1000 Hrs.	
			$10^{-17} \frac{in^3}{in\ g}$		$10^{-17} \frac{cm^3}{cm\ g}$				$10^{-15} \frac{in^2}{rev.\ g}$		$10^{-15} \frac{cm^2}{rev.\ g}$			
			Avg.	σ	Avg.	σ	Mils	mm	Avg.	σ	Avg.	σ	Mils	mm
1-10	1010	1.7	0.65	1.3	4.2	8.4	0.30	0.008	2.8	2.5	18.	16.	0.5	0.013
2-14	1110	1.7	0.16	0.4	1.0	2.5	0.17	0.004	0.4	0.9	2.8	5.7	0.3	0.008
3-21	1060	2.2	0.03	0.04	0.2	0.3	<0.1	<0.003	4.6	2.3	29.	15.	0.6	0.015
4-24*	630	2.2	1.93	3.4	12.5	22.0	0.5	0.013	4.8	3.3	31.	21.	0.7	0.018
5-25*	830	2.2	1.93	3.4	12.5	22.0	0.5	0.013	4.8	3.3	31.	21.	0.7	0.018
6-28	950	2.2	0.02	0.02	0.1	0.1	<0.1	<0.003	4.2	2.4	27.	16.	0.5	0.014
All Tests Combined			0.58	1.7	3.7	11.2	—	—	2.9	2.9	19.	19.	—	—

*Wear data for these tests were combined as each contained only two specimens and operating conditions were essentially the same.

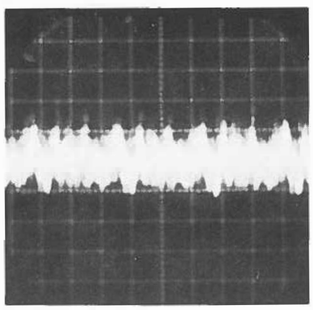

Fig. 4. Oscillograph of noise when meter reading was 0.7 mV. Tektronix 502A oscilloscope, 2 mV/cm vertical sensitivity.

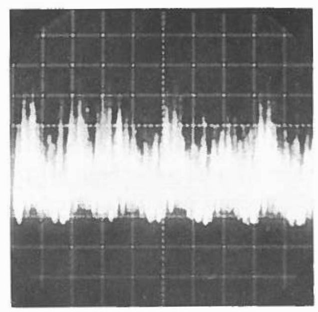

Fig. 5. Oscillograph of noise when meter reading was 1.3 mV. Tektronix 502A oscilloscope, 2 mV/cm vertical sensitivity.

results of those with and without the applied voltage. Humidity, over the wide range tested, does not have a discernible effect on the wear rate. The low magnitude of brush and ring wear in terms of depths of wear shows that only a fraction of the potential life of the assemblies has been accumulated within 1000 hours of operation.

Table II. Electrical Noise Results

Test Number	Test Duration (Hours)	Wiper Force (Grams)	Noise, mV	
			Average	Standard Deviation
1-21	1060	2.2	0.75	0.33
2-24	630	2.2	0.98	0.45
3-25	830	2.2	0.98	1.65
4-28	950	2.2	0.67	0.17
5-31	740	2.2	1.02	0.81
6-32	985	2.2	1.08	0.57

Noise measurement results of the many tests are shown in Table II. To show the relationship of noise as read on the a-c meter with what would be seen on an oscilloscope, Fig. 4 shows a typical oscillograph when the meter was reading 0.7 mv and Fig. 5 when a meter reading of 1.3 mv was observed. The comparisons illustrate that the meter readings are truly sensitive to changes in noise level.

Although the noise is at levels that are readily observed and measured, it is small in relation to the 11 volt signal applied. In regard to the low noise level, for comparison, a test was made using N eyoro 28A rings with both Paliney 7 and N eyoro G mating brushes. These combinations were selected because of their wide use in slip ring assemblies intended for very low noise level but at much lower rpm. When these material combinations were run at 1200 rpm, however, the noise levels were from 500 to 1000 times higher than the Neyoro G-Paliney 7 combination!

Citation:

"Type 1420 Turrent slip Ring - Type 1356 Brush Performance at 1200 RP M (Neyoro G Rings - Paliney 7 Brushes)." *Ney Technical Bulletin.* Bloomfield, Connecticut: J M Ney Company, 1973.