Laboratori Nazionali di Frascati

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N. B. Smith: MAGNETIC FIELD MEASUREMENTS ON A. d. A.

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Introduction

A cross-section for the A.d.A. pole-pieces has been calculated and an experimental length constructed. The results of magnetic field measurements on this are tabulated.

Pole-Pieces

The pole-pieces were constructed to duplicate the calculated cross-section except that tips of 4 mm height were used unitially so that they could be reduced and their effect studied. As there is no alternating field they are not laminated. Width between tips is 70 mm and the gap at center 50 mm. The angle of the pole faces was derived from

$$N \frac{R.\triangle B}{B.\triangle R} \text{ for an N of } 0.6.$$

These experimental pole-pieces are 100 mm long and their separation is maintained by brass end plates. Fig. 1 shows the original contour and Fig. 2 the final, as determined by bench measurements.

It will be seen that the final tips are actually 1.33 instead of the intended 1.2. It is not known at what point in the machining this error was introduced.

Instrumentation

A 10 cm section of the 'Bob' magnet pole-pieces was removed and the experimental section inserted.

The I.N.F.N. Model M 02/41-44 Fluxmeter was used with an external voltmeter and, for the final measurements, and external Power Supply as some random variations were traced to the vibrator power supply.

A co-ordinator was rebuilt to give more accurate tracking and a coil of smaller cross-section was constructed. The support for this coil was later modified to allow 180° rotation. The fluxmeter input attenuator was wired to give inputs of x 1 and x 0.002.

The magnet was supplied from a 4V battery with current ranging from 250 to 300 amps.

Estimated errors

Coil Position: Initial setting ± 0.5 mm. Tracking error negligible. (Note: the center of the coil was set to the inside edge of the front tip and this position assigned 5 cm on an arbitrary scale).

Coil Movement (ΔR): Checked with a clock guage at 5.55 mm. Estimated error in operation 0.02 mm (0.35%).

Fluxmeter: With an external Power Supply and after a warm-up period of 30 minutes readings were repeated within 0.25%. This is practically the limit of readability of the meter. The same sensitivity was used throughout and the same range of the indicating meter. (Initial total field tests were made by switching the magnet on and off and the use of a rotating coil necessitated selecting a higher meter range. A 5% discrepancy in these results, with the switched readings high, was totally accounted for by a range error in the meter. A General Radio divider was added to the input to allow continued use of the original range). The input attenuator was checked in a bridge circuit with a General Radio potentiometer to an accuracy of 0.1%.

A suspected error in the Fluxmeter has recently been shown to exist by taking repeated readings (with the same reversing coil) of the field of a permanent magnet. The field was the same as that measured during the previous experiments so that test conditions were the same. Readings were obtained within ± 0.1% for the first two hours, after which a shift of 6% occurred over a period of 40 minutes. Following this, readings became erratic although continuing approximately at the new level for 2 $\frac{1}{2}$ hours. This shift is presumed to be outside the feedback circuit but has not yet been definitely located. Any measurements which contained this step were rejected from that point onwards.

The accumulative effect of the above errors should allow an overall accuracy of 1% but 2% is probably a more realistic figure.

Results

Fig. 3 shows copies of results for ΔB and N with different tip heights.

N is not flat in the central section but a small sbpe remains as this will be flattened, or reversed, at higher magnetic fields when the tips saturate.

Fig. 4 shows the total field together with the final curves for ΔB and N on a larger scale. It will be seen that N has a slightly lower value than in the previous curves. This alteration occurred after B and ΔB were re-measured with the stabilized Fluxmeter.

All curves are plotted directly in volts, normalized to a standard magnet current (286 amps) and corrected for input attenuation, if any.

Data

Fluxmeter Sensitivity: 5,000 Maxwell/Volt.

Input Attenuator: x 0.00205 and x 1
(Gen.Rad. divider at 0.006 also used).

Coil Dimensions: See Fig. 5

Further Work

A simulated straight section is being constructed. This will be joined to the present pole-pieces and field behaviour studied in this area.

Further measurements with higher magnetic fields are planned if it is possible to supply the magnet.

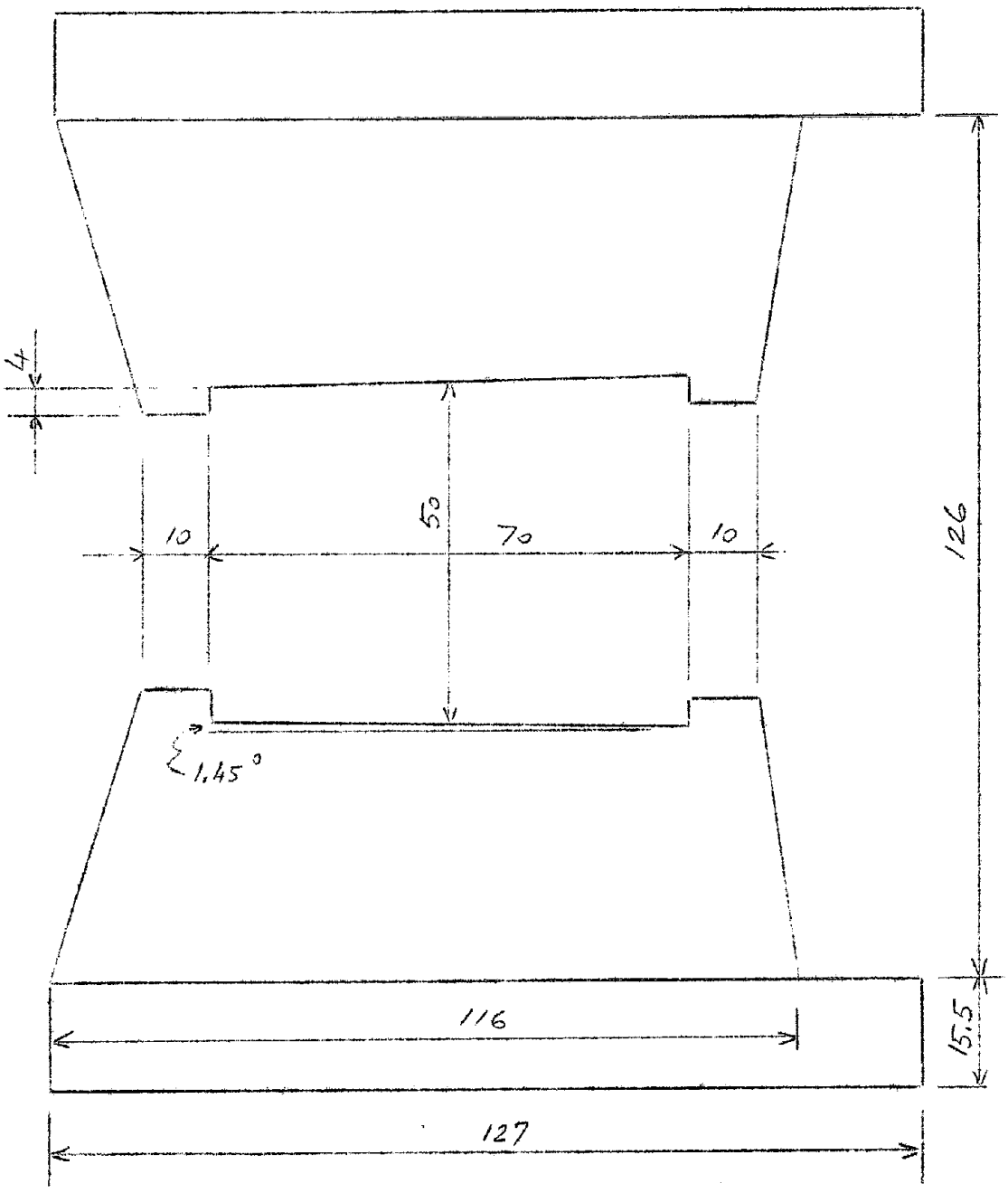


FIG. 1

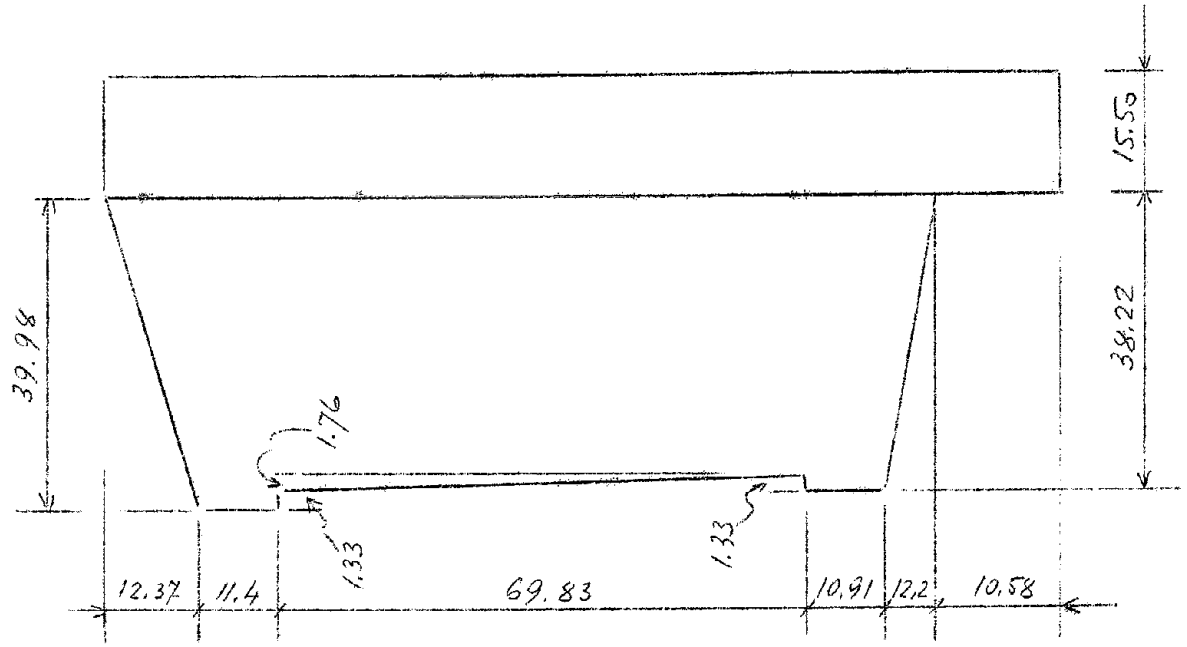
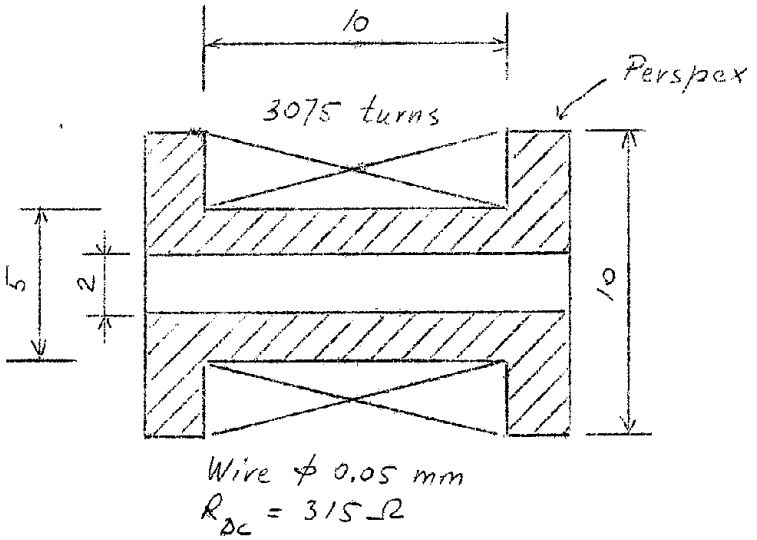


FIG. 2



FLUXMETER
COIL
(Section)

FIG. 5

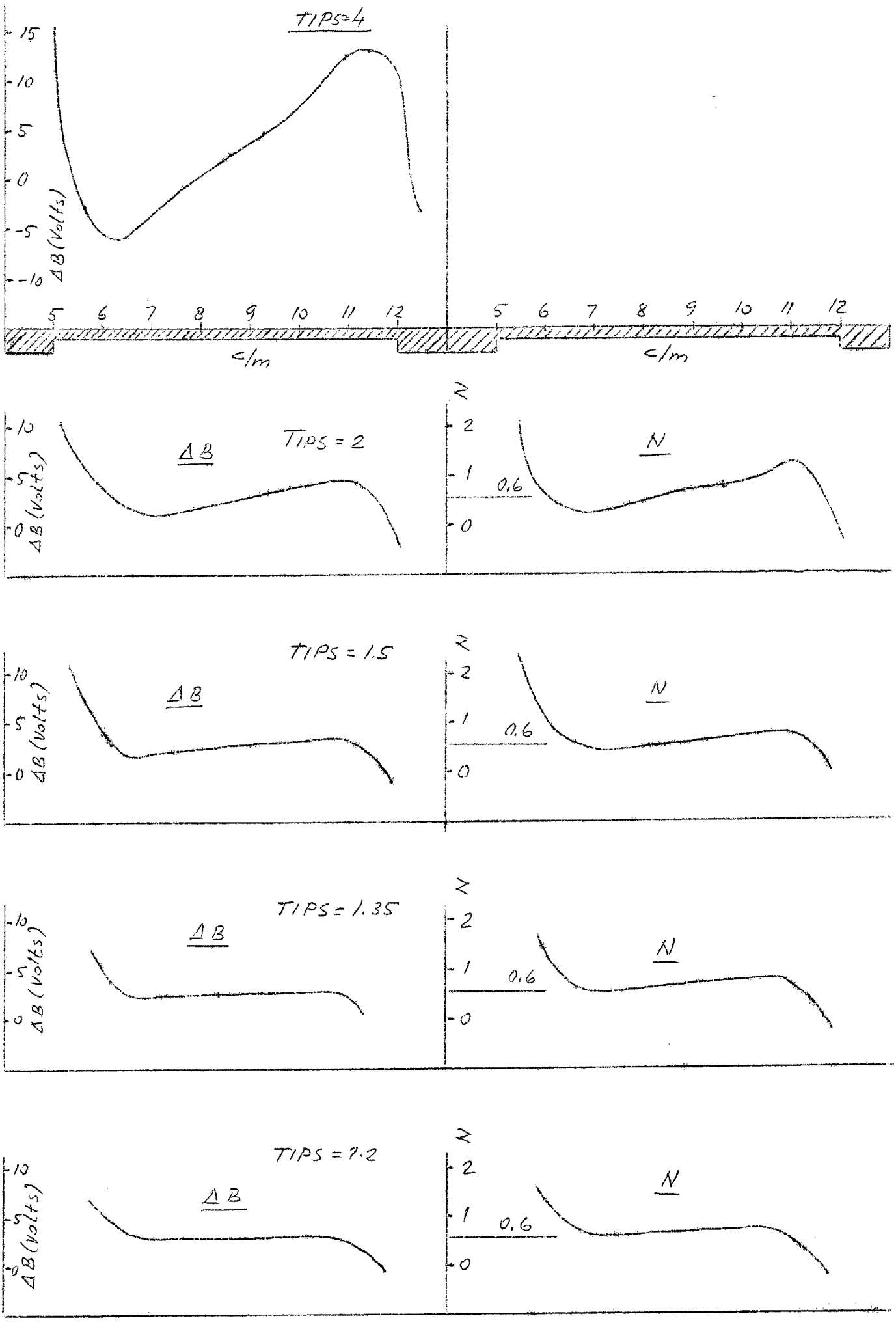

TIPS=4
15
10
5
0
-5
-10
ΔB (Volts)
5 6 7 8 9 10 11 12
c/m
5 6 7 8 9 10 11 12
c/m
10
5
0
ΔB (Volts)
ΔB
TIPS = 2
N
2
1
0.6
0
TIPS = 1.5
TIPS = 1.35
TIPS = 1.2

FIG. 3

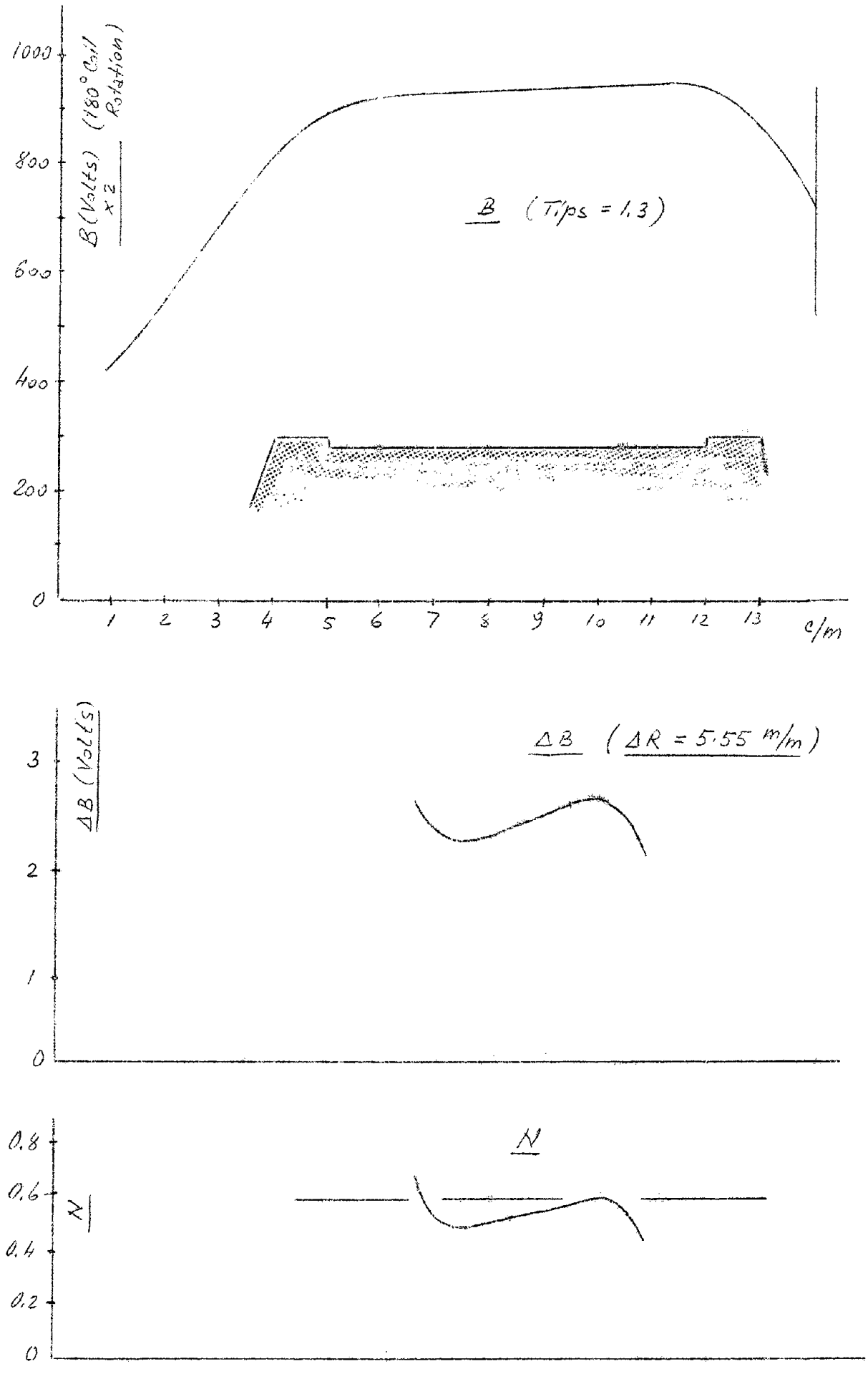

B (Volts) x 2 (180° Coil Rotation)
1000
800
600
400
200
0
B (Tips = 1.3)
1 2 3 4 5 6 7 8 9 10 11 12 13
c/m
ΔB (Volts)
3
2
1
0
ΔB (ΔR = 5.55 m/m)
N
0.8
0.6
0.4
0.2
0

FIG. 4