Fermilab

DC MAGNETIC FIELD MEASUREMENT ON MAIN ACCELERATOR EXTRACTION MAGNETS

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Dec. 18, 1974

Magnet measurements on C-type and H-type main accelerator extraction magnets were requested up to 400 GeV level by the Accelerator Section. Stipulated with this request was that a 0.5% accuracy be maintained in the data. The following pages contain the results of the data of 0.2% accuracy taken in July, 1974.

Setup

The extraction magnets were aligned vertically, radially, and leveled. The C-type was aligned using the top edge of the 0.125 inch surfaces. This magnet has a 50 mil bow toward the manifold and the level along the magnet lengtn is very irregular. The H-type's 0.500 inch x 45 degree taper was used for its alignment. The H-type magnet has minimal sag and bow, vertically and radially.

The magnets were powered by a Transrex 500-5 power supply. The supply was run in a short term dc mode while data points were being measured. The current from this supply was measured with an external current shunt.

The $\int Bdl$ measurement was performed on magnets using a 4 mil tungsten wire separated by precision glass spacers of .500 inch (±.0001 inch). The stretched wire probe holders were placed 2 to

3 feet beyond the ends of the magnet to clear the fringe field. The holders were radially and vertically aligned to .005 inch of the center of gap. The output of the search coil was fed into an integrator and its output was read by a DVM.

The C-type $\int Bdl$ was measured at 0.0 inch and ±0.350 inch. The H-type magnet was measured at x = 0.0 inch position only. The corresponding central field values were measured with a Hall probe gaussmeter.

Fringing Field

Fringe field measurements were done with a Hall probe and a F.W.Bell 811AR gaussmeter. The C magnet was measured for fringe field at x = ±.350 inch and 0.0 inch. The H magnet was measured at x = 0.0 inch only. The fringe field was measured from 6 inches inside the magnet to 12 inches outside.

The fringing field of one end of the C-type magnet is effectively longer by 0.758 inch than the core length at 1000 and 1300A. The corresponding value for the H-type magnet is 0.412 inch.

Magnet Parameters

Magnet	C-type	H-type
Physical length	125-7/8 in.	126.0 in.
Gap	0.650 in.	0.625 in.
Turns	8	12
Resistance to core	300 k	∞
L_S at 1 kHz	0.532 mH	1.92 mH
Q at 1 kHz	2.20	3.23
dc Resistance	31.5 mΩ	14.5 mΩ
For 500 GeV	10 kG	15.6 kG

Equipment Used

Doubler measuring stands	
Glass spacers	0.500 in.±.0001
1 turn tungsten wire	.004 in.
Area probe	.504 in. wide
Resistance of probe	85. Ω
Integrator #	4
RC (integrator)	10.085 msec
DVM Dana 5333 (Hall probe readout)	NAL#5882
Hall Probe STL8-0404	Serial #82711
Cable	" #82712
Meter 811AR	NAL#10864
Shunt	50 mV/kA
DVM Dana 5333 (Shunt readout)	NAL#5801

Excitation Curves of C-Type Magnet

I Amp	∫Bdl (x = 0.0) kGm	B(x = 0.0) kG
0		6.6 g
200	3.935	1.216 kG
400	7.889	2.427
600	11.834	3.642
800	15.763	4.841
1000	19.686	6.051
1200	23.573	7.240
1300	25.491	7.829
1400	27.341	8.396

Difference in Field Shape

I	x = +.350 in.	0.0 in.	x = -3.50 in.
200	0.0%	0.0%	.301%
400	.160%		.190%
600	.067%		.206%
800	.215%		.160%
1000	.236%		.172%
1200	.281%		.154%
1300	.318%		.263%
1400	.410%	0.0%	.063%

$$\% \text{ diff.} = \frac{\int Bdl \ (x = \pm .350 \text{ in.}) - \int Bdl \ (x = 0.0 \text{ in.})}{\int Bdl \ x = 0.0 \text{ in.}}$$

Excitation Curve of H-Type Magnet

I Amp	∫Bdl kGm	B kG
0	-	
200	6.090	1.895
400	1.2297	3.760
600	1.8457	5.675
800	2.4661	7.570
1000	3.0837	9.460
1200	3.6954	11.310
1300	4.2749	12.240
1400	3.9926	13.070

Fringing Field of C-Type Magnet

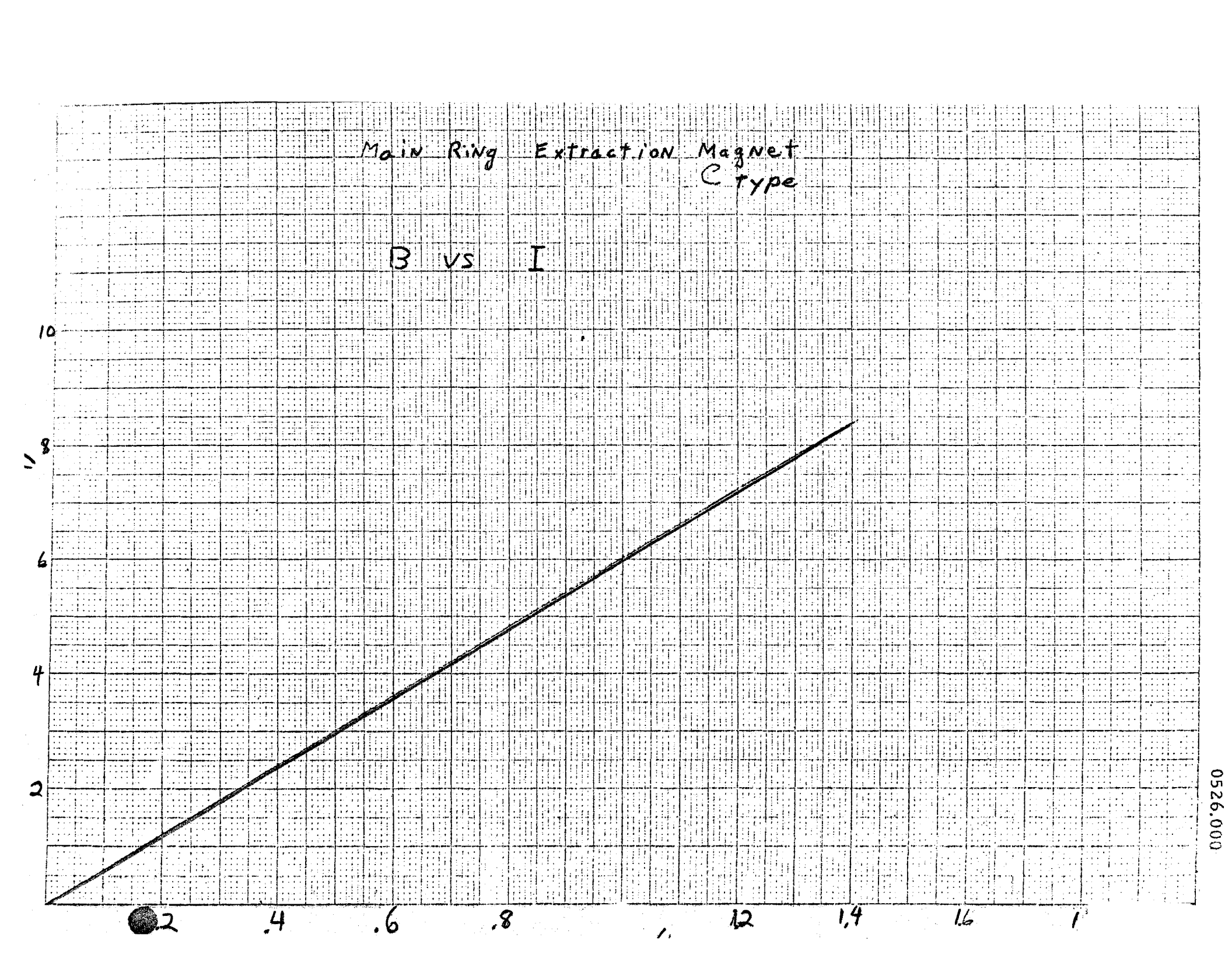
At x = 0.0 in.

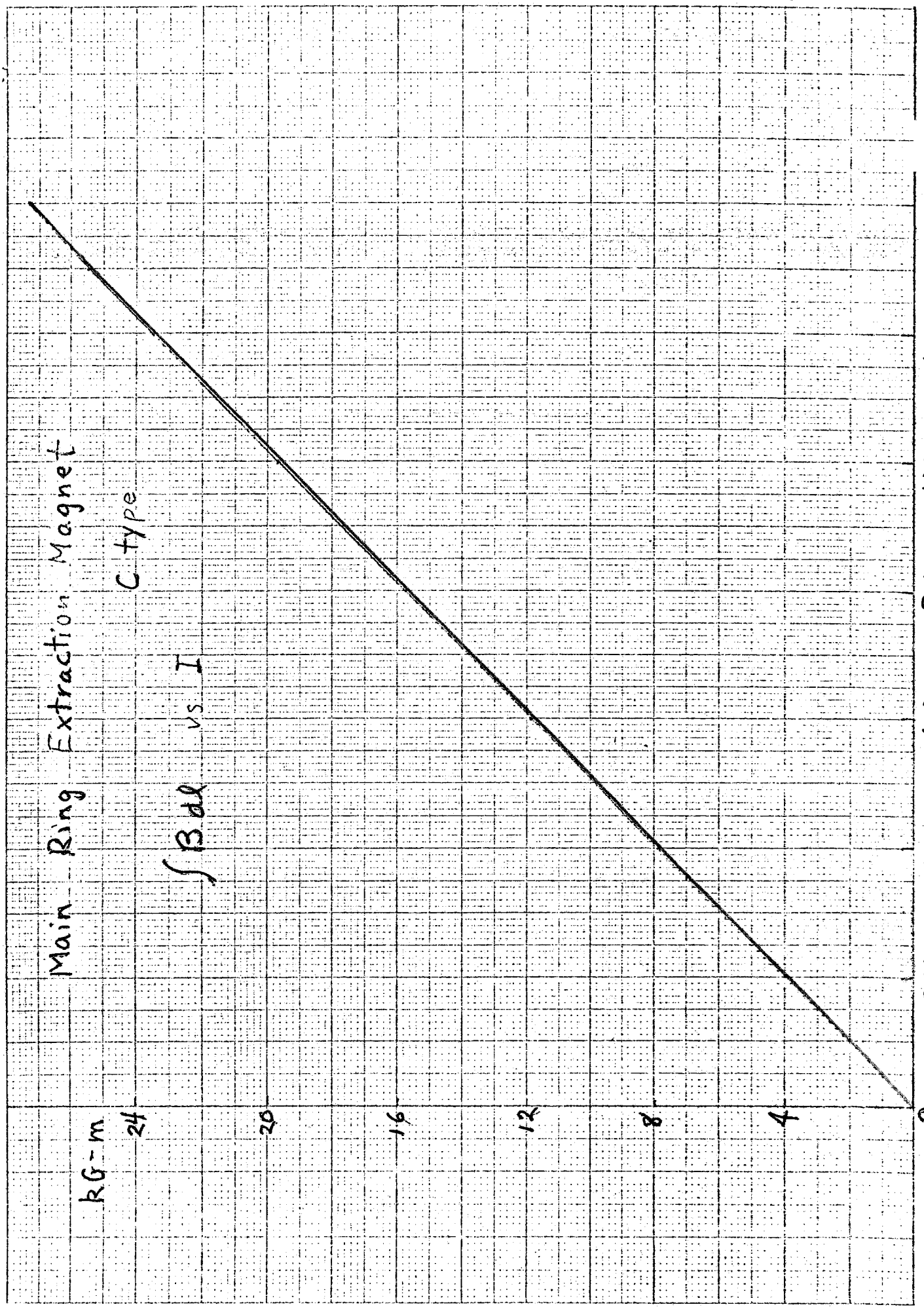
Position	I = 1000A	I = 1300A
+12.0 in.	6.051 kG	7.829
6.0	6.024	7.810
4.0	6.047	7.817
3.0	6.034	7.797
2.0	6.024	7.766
1.5	6.011	7.740
1.0	5.963	7.672
0.75	5.947	7.644
0.50	5.910	7.585
0.25	5.587	7.228
0.0	4.372	5.662
-0.25	2.985	3.851
-0.50	2.134	2.735
-0.75	1.708	2.247
-1.00	1.472	1.904
-1.5	1.279	1.653
-2.0	1.205	1.564
-3.0	0.290	0.370
-6.0	0.021	0.028
12.0	0.002	0.002

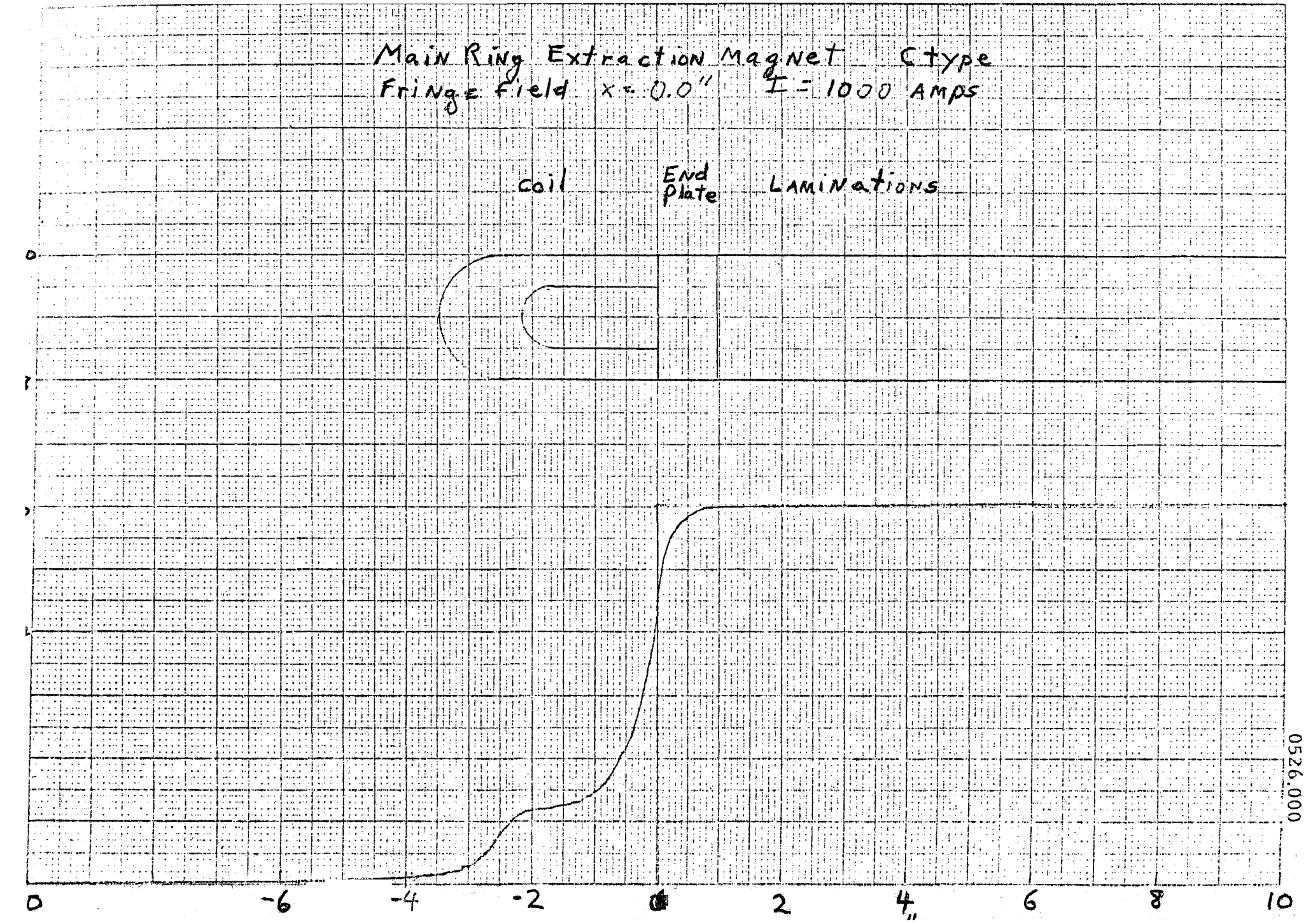
Fringing Field of H-Type Magnet

At x = 0.0 in.

Position	I = 1000A	I = 1300A
+6.0 in.	9.472 kG	12.25 kG
4.0	9.365	12.11
3.0	9.229	11.93
2.0	9.121	11.77
1.5	9.040	11.63
1.0	8.883	11.41
0.5	8.809	11.29
0.0	6.337	8.035
-0.5	2.899	3.705
-1.0	1.831	2.357
-2.0	1.163	1.509
-3.0	0.343	0.438
-4.0	0.064	0.082
-6.0	0.030	0.040
-8.0	0.011	0.014
-10.0	0.005	0.006
-12.0	0.003	0.004


Main Ring Extraction Magnet
C type
B vs I
10
8
6
4
2
.2
.4
.6
.8
1.2
1.4
1.6
1
0526.000


Main Ring Extraction Magnet
C type
$\int B\,dl$ vs I
RG-m
24
20
16
12
8
4
0
200
400
600
800
1,000
1200
1400
Amp



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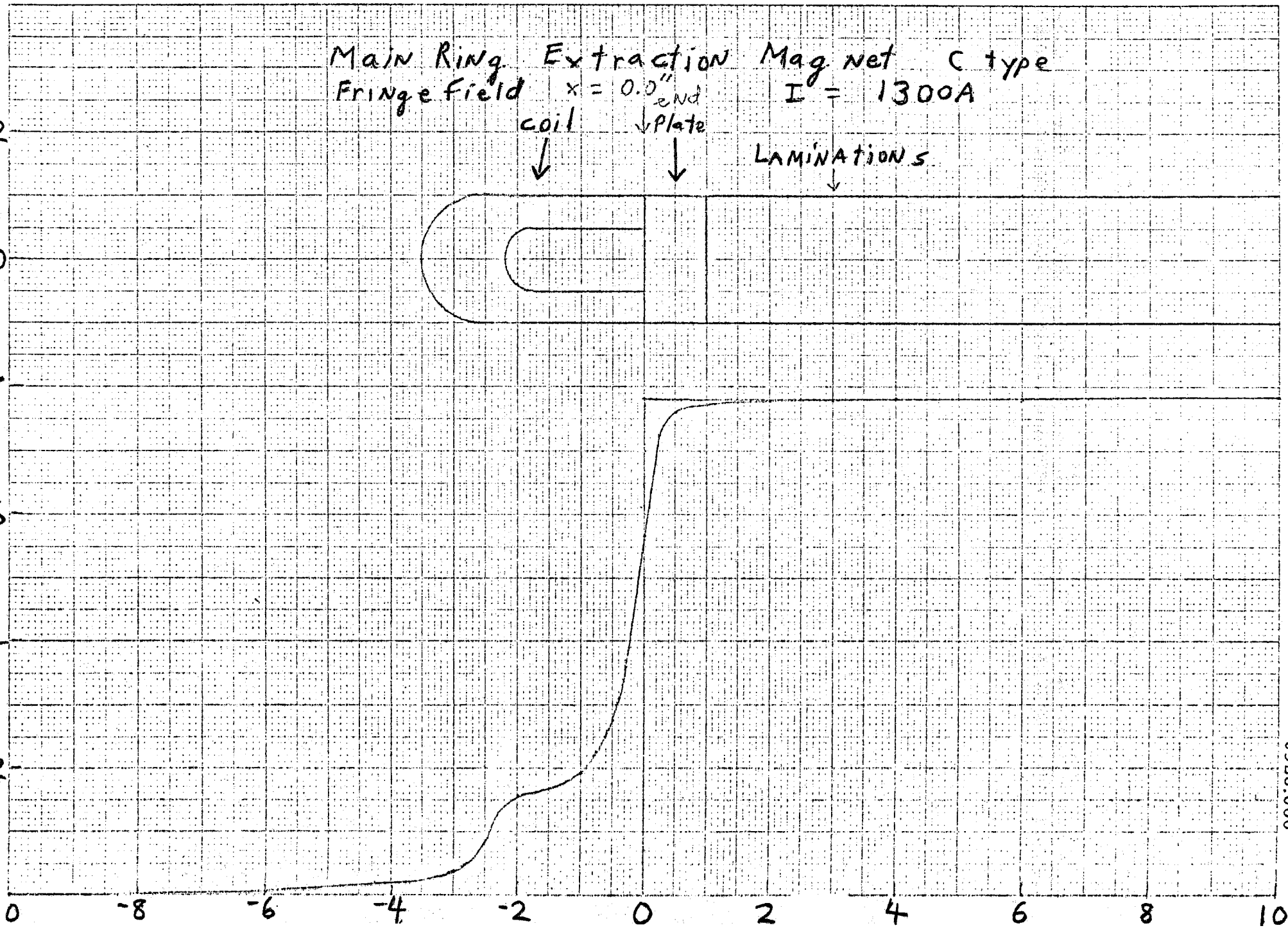
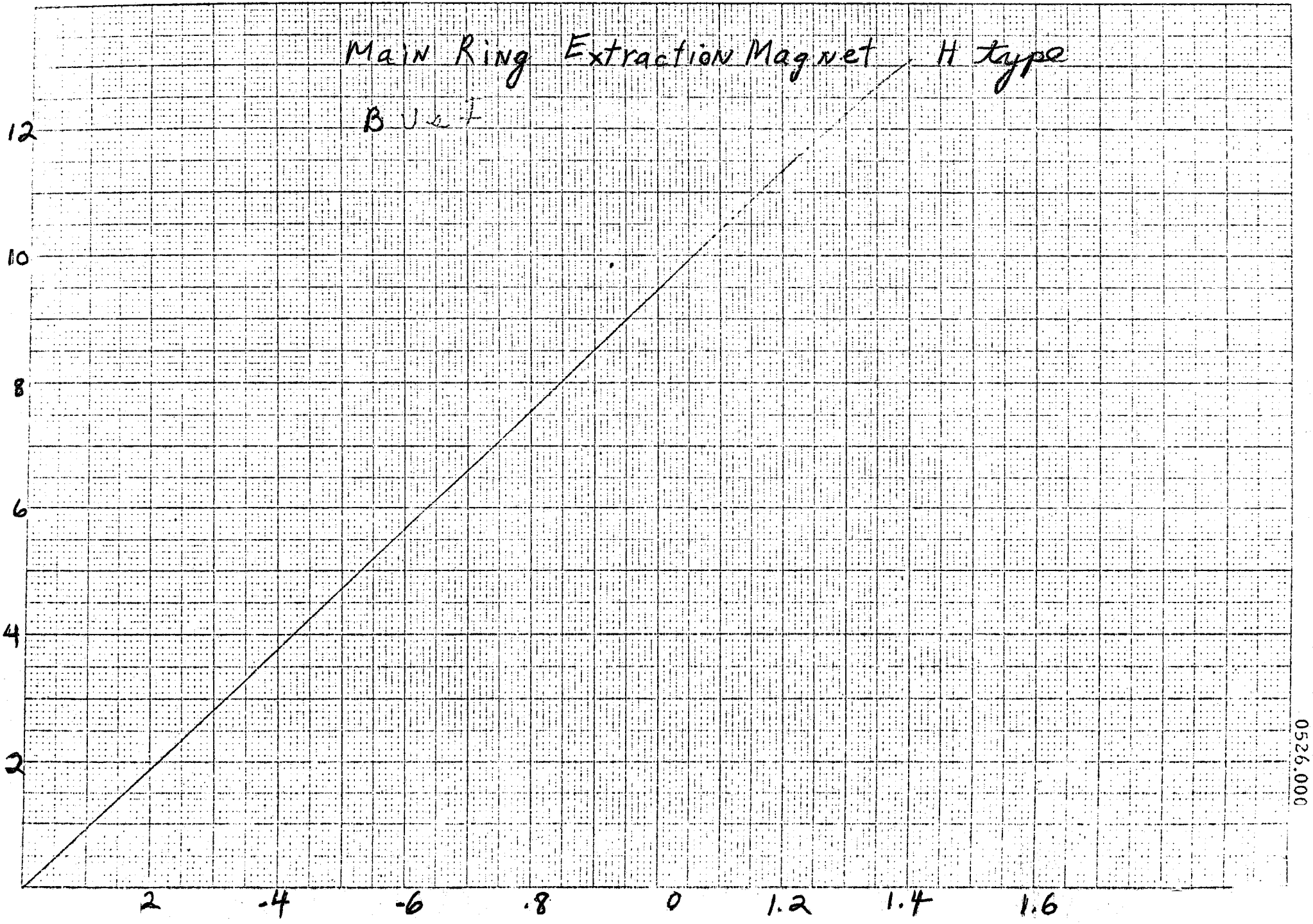
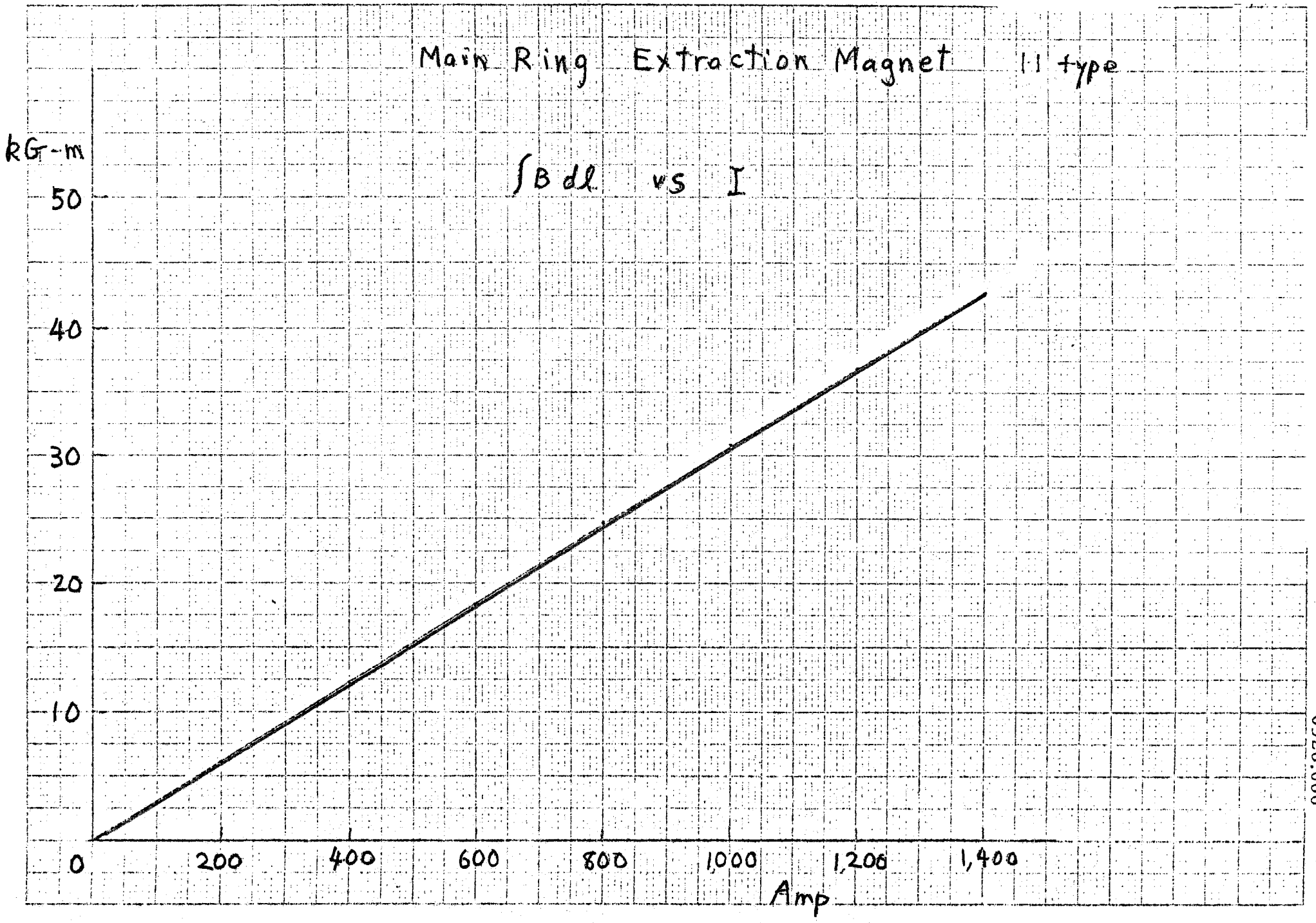
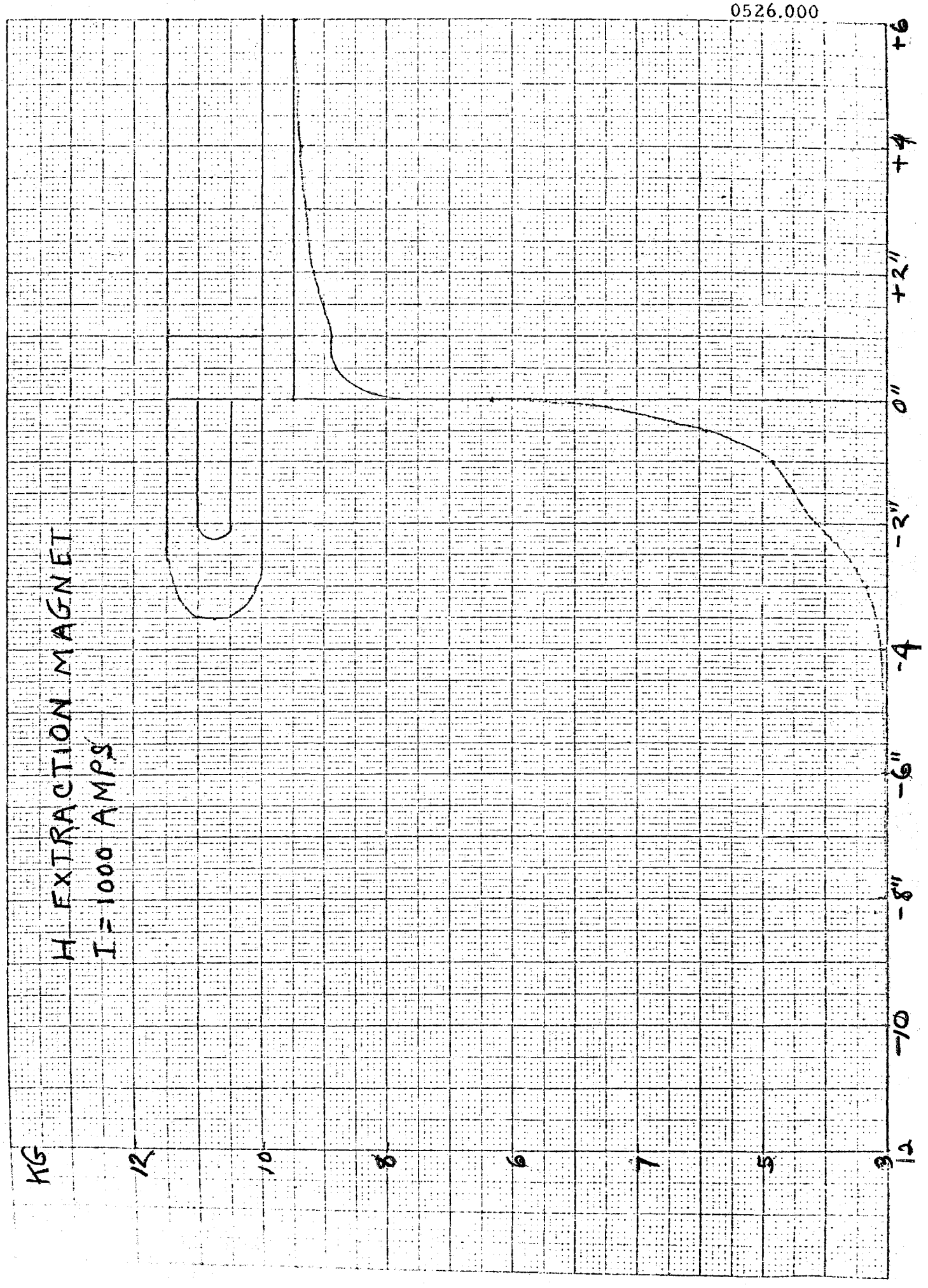
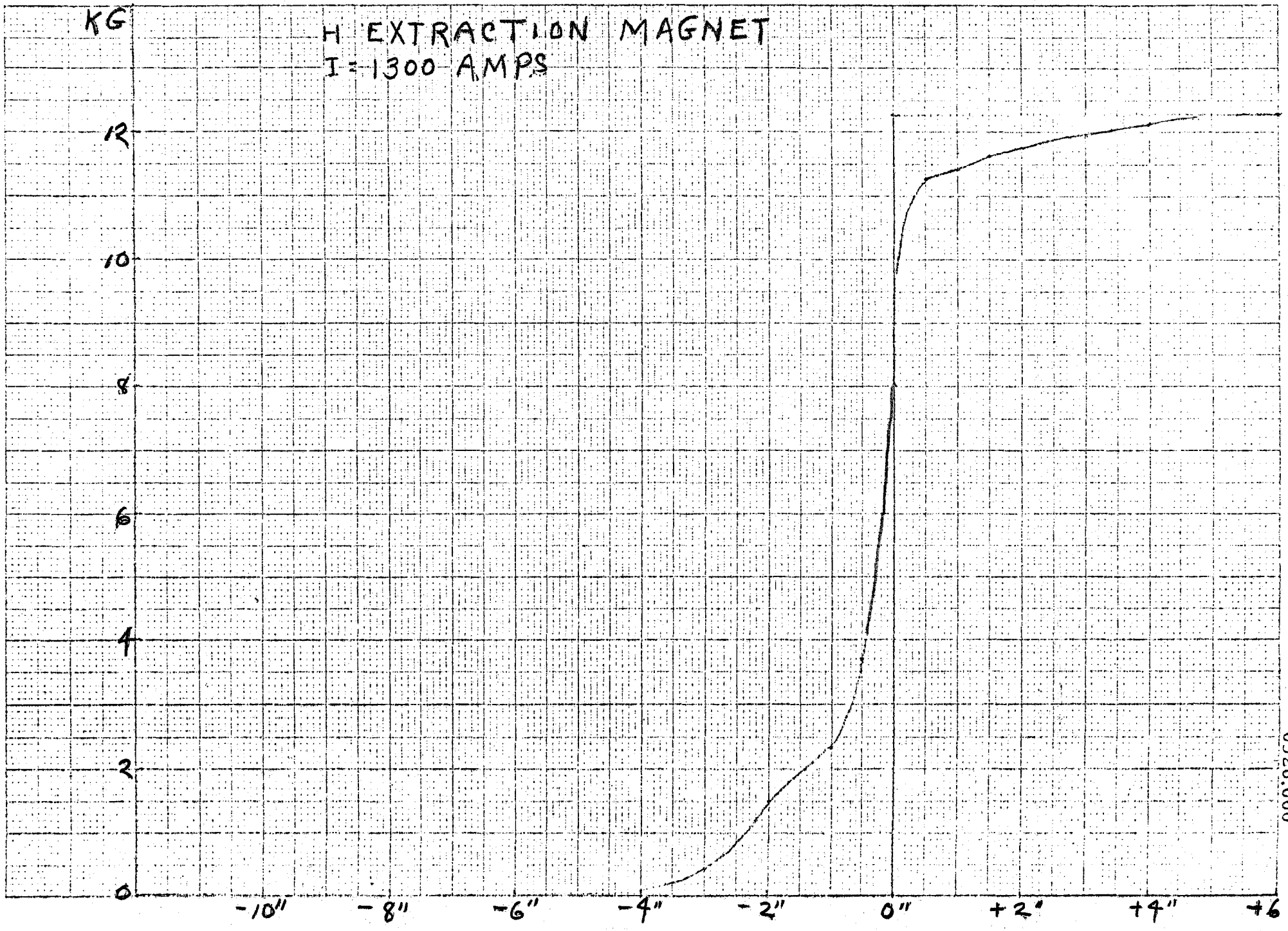

Main Ring Extraction Mag net C type
Fringe field x = 0.0" end
I = 1300A
coil
Plate
Laminations
2
0
8
6
4
2
-10
-8
-6
-4
-2
0
2
4
6
8
10"
0526.000


Main Ring Extraction Magnet, H type
B vs I
12
10
8
6
4
2
2
-4
-6
.8
0
1.2
1.4
1.6




H EXTRACTION MAGNET
I = 1000 AMPS
KG
12
10
8
6
4
3
+6
+4
+2"
0"
-2"
-4
-6"
-8"
-10
12



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June 27, 1975

Professor John Poirier
University of Notre Dame
College of Science
Notre Dame, Indiana 46556

Subject: Correction of TM-568
Page 5

Dear Professor Poirier:

We thank you for your letter pointing out the errors on Page 5 of TM-568.

The $\int Bdl$ data from 400-1400 Amperes is off by a factor of ten. The 1300 Amp and 1400 Amp data are also interchanged.

We are sorry for any inconvenience we might have caused. Our Library will also be notified of these errors.

Listed below is the correct data.

Ampere I	$\int Bdl$ KGm	B KG
0	-	-
200	6.090	1.895
400	12.297	3.760
600	18.457	5.675
800	24.661	7.570
1000	30.837	9.460
1200	36.954	11.310
1300	39.929	12.240
1400	42.749	13.070

Very truly yours,

D. Krause

DK/en
cc: Fermilab Library