Fermilab

TM-1376
6023.000

B. VS. H CURVES FOR E706 MAGNET YOKE OF RUSSIAN STEEL

W. Baker, R. P. Smith, O. Mikhailov, A. Ito,
E. Black and W. Yang

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We have measured B vs H curves from four samples of Russian steel for E706 magnet yoke. The samples were machined into a toroidal shape of about 2" OD, 1.75" ID and 1/2" height. There are three ranges of measurements for each sample as shown below:

Sample	Range of Measurement with Bmax = 20kg		
	0 to 65 Oersteds,	0 to 180 Oersteds,	0 to 585 Oersteds
List I, Steel 08	Yes	Yes	Yes
List II, Steel 08	Yes	Yes	Yes
5257-00-00-05-01	Yes	Yes	Yes
5257-00-00-05-05	Yes	Yes	Yes

The results reduced to 8x11 size are shown in Figures 1 to 12. Copies of the full size originals can be obtained from W. Yang.

For the List I, Steel 08, we listed the B & H parameters for programmers who run Linda, Trim, or Poisson. See Table I. The values in the tables are the averge B values of the hysteresis loop.

Finally for comparison: (1) we plotted the results from List I, Steel 08 on a USS Steel 1010 graph, (2) we plotted the List I. Steel 08 vs the measured values of 1008 Steel from TM 1197, as shown in Figure 14.

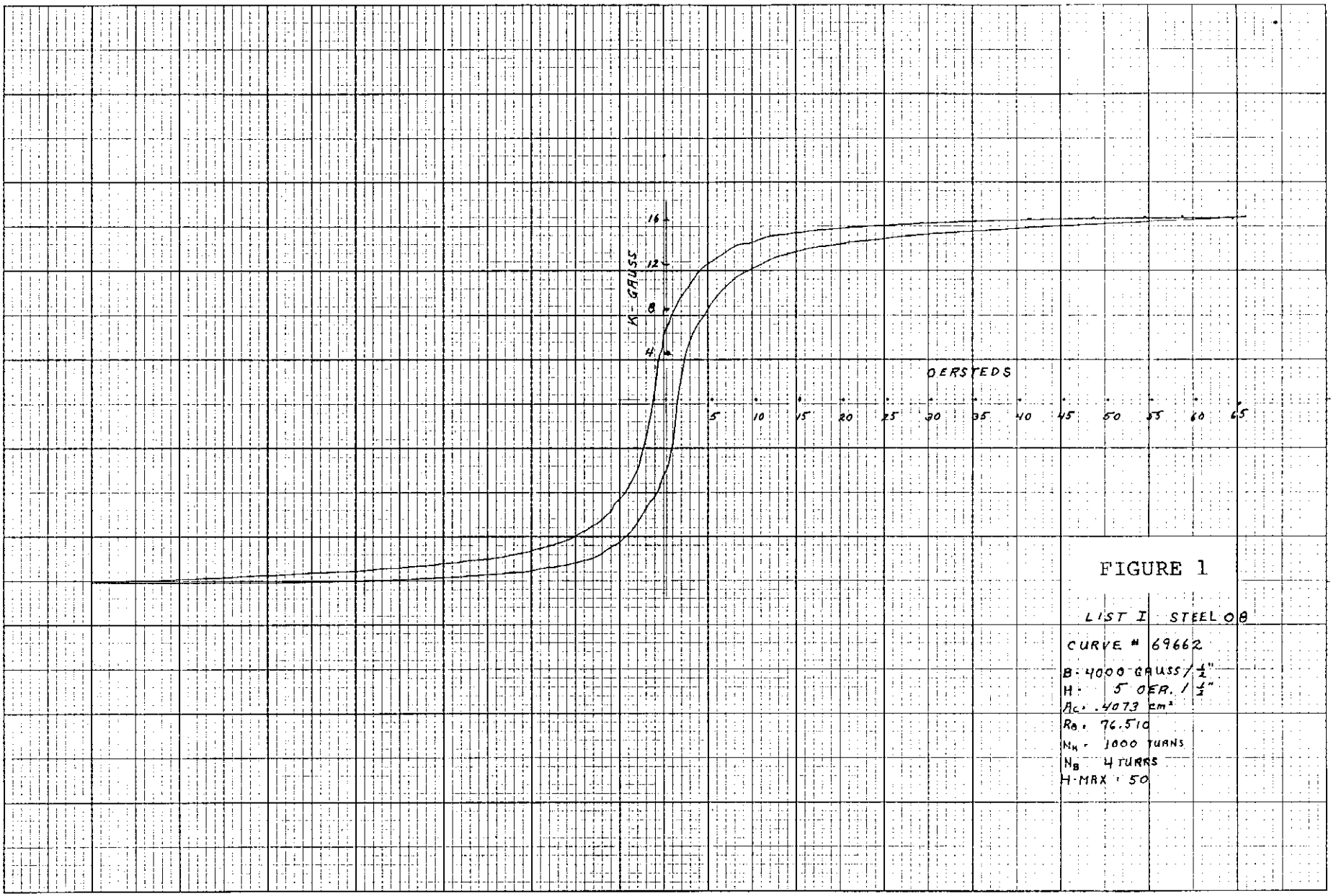
The samples were measured by Arnold Engineering, Marengo, IL, with accuracy of $\pm$ 3%.

Table 1

List I, Steel 08

1/8/86

B (Kg)	H(Oersted)	$B^2(\times 10^8)$	$H\ (\frac{\text{Amp-Turn}}{\text{meter}}, \times 10^2)$	$\gamma = \frac{1}{\mu} = \frac{H}{B}\ (\times 10^{-4})$
0	0	0	-	-
1.0	0	.01	-	-
1.5	-	.02	-	-
2	.2	.04	.16	1.00
3	.4	.09	.32	1.33
4	.9	.16	.72	2.25
5	1.2	.25	.95	2.40
6	1.5	.36	1.19	2.50
7	2.0	.49	1.59	2.86
8	2.5	.64	1.99	3.13
9	3.5	.81	2.79	3.89
10	4.5	1.00	3.58	4.50
11	5.5	1.21	4.38	5.00
12	7.5	1.44	5.97	6.25
13	9.9	1.69	7.88	7.62
14	14.5	1.96	11.54	10.36
15	24.5	2.25	19.50	16.33
16	47.5	2.56	37.80	29.69
17	81	2.89	64.46	47.65
18	167	3.24	132.90	92.78
19	264	3.61	210.10	138.95


K-GAUSS
16
12
8
4
OERSTEDS
5
10
15
20
25
30
35
40
45
50
55
60
65
FIGURE 1
LIST I STEEL OB
CURVE # 69662
B: 4000 GAUSS/½"
H: 5 OER./½"
Ac: .4073 cm²
Ro: 76.510
NH: 1000 TURNS
NB 4 TURNS
H-MAX: 50

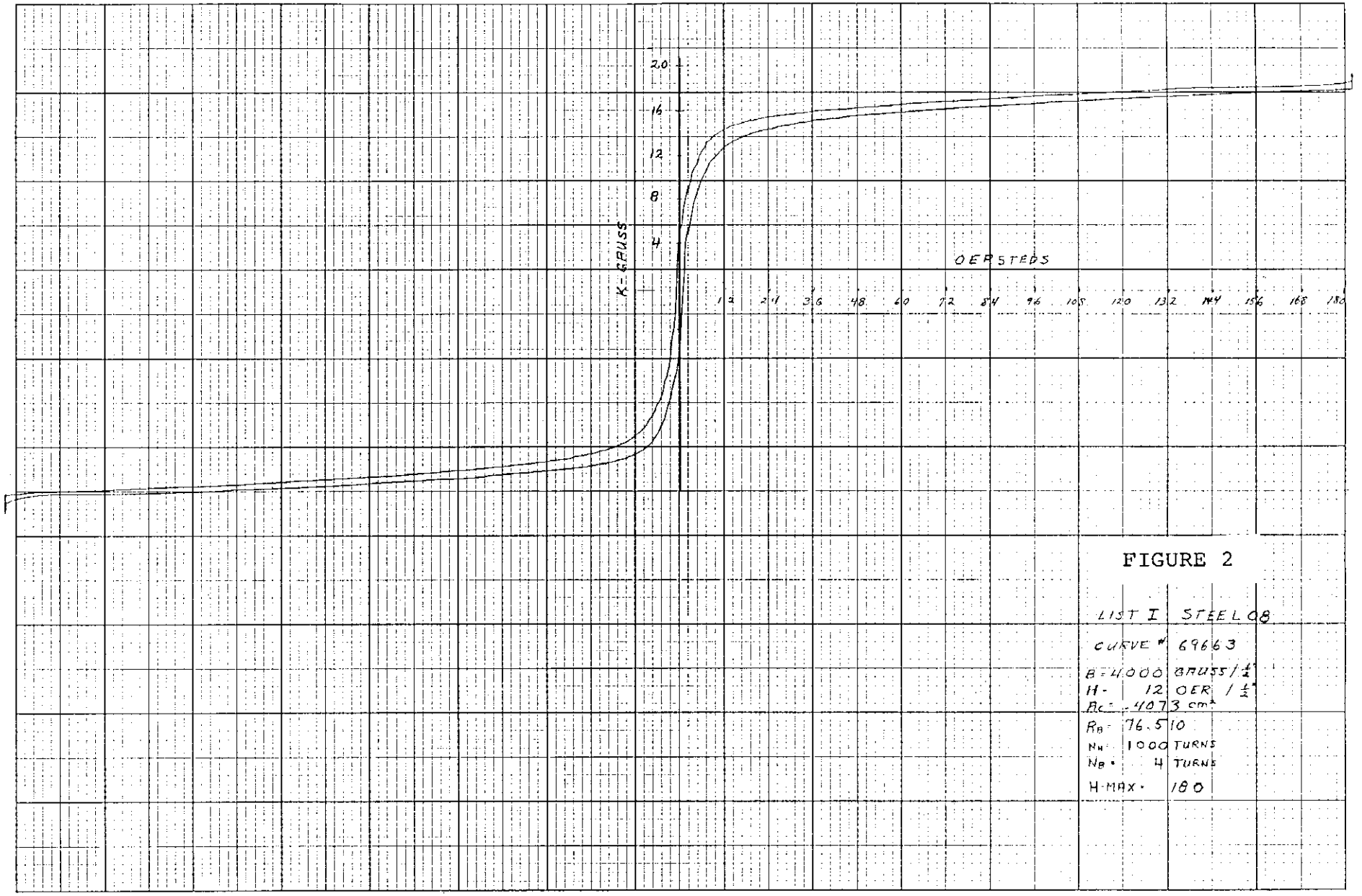

20
16
12
8
4
K-GAUSS
OERSTEDS
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
LIST I STEEL 08
CURVE # 69663
B = 4000 GAUSS / 1/2"
H - 12 OER / 1/2"
Ac = .4073 cm²
RB = 76.510
NH = 1000 TURNS
NB = 4 TURNS
H-MAX = 180

FIGURE 2

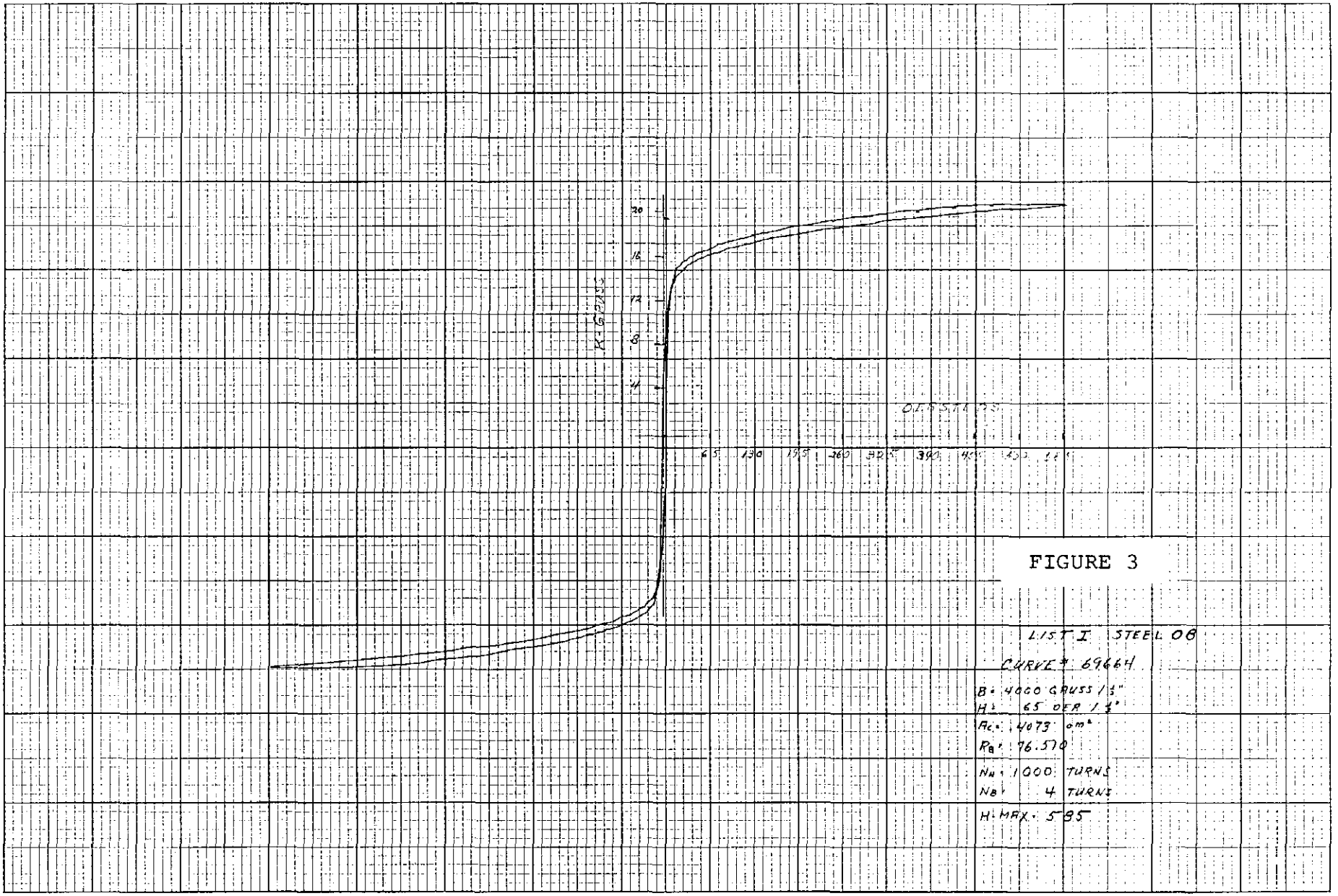

20
16
12
8
4
K-GAUSS
OERSTEDS
65
130
195
260
325
390
LIST I STEEL 08
CURVE # 69664
B = 4000 GAUSS 1½"
H = 65 OER 1½"
Ac = .4073 cm²
RB = 76.570
NH = 1000 TURNS
NB = 4 TURNS
H-MAX = 585

FIGURE 3

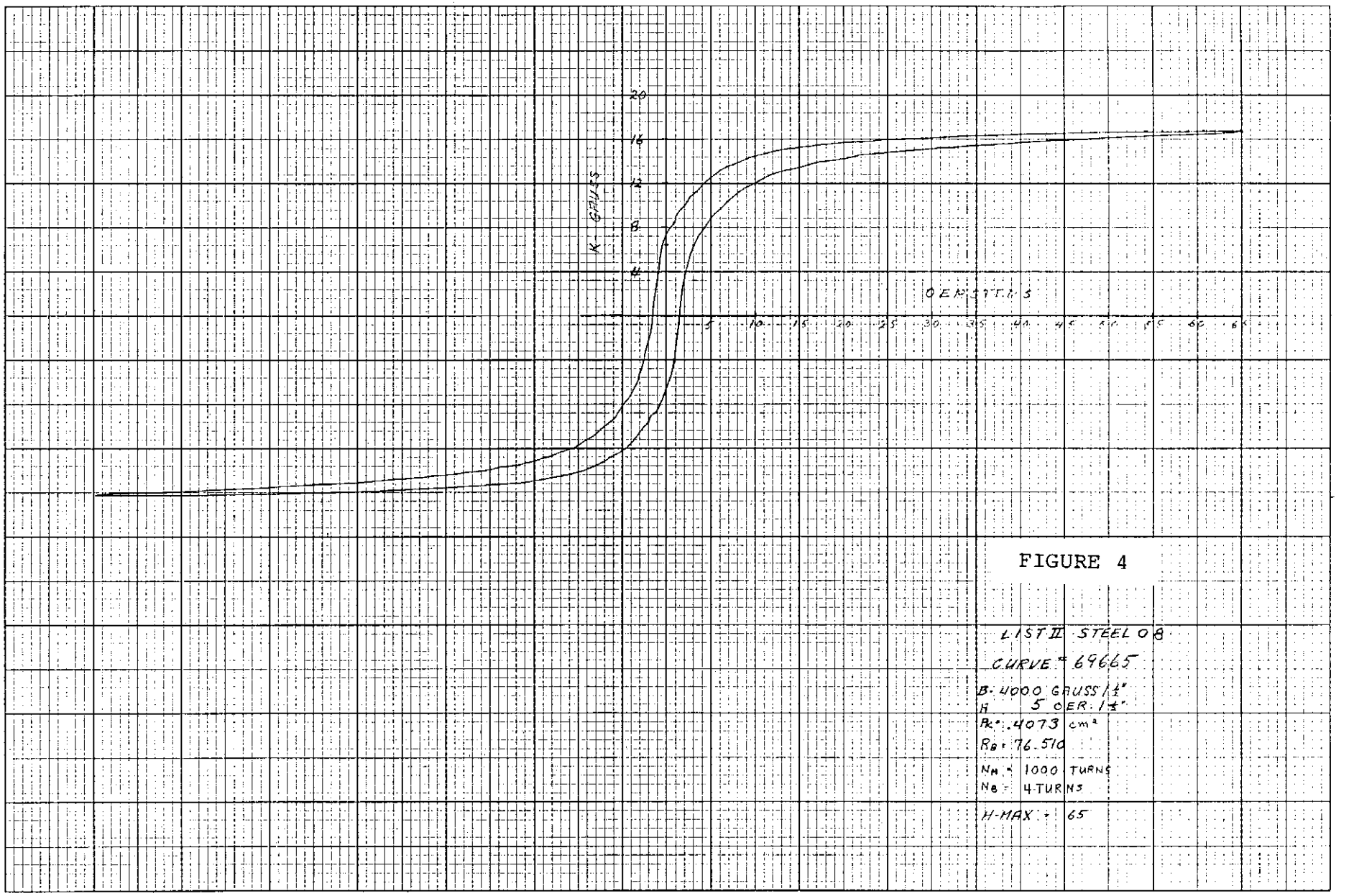

K GAUSS
20
16
12
8
4
OERSTEDS
5
10
15
20
25
30
35
40
45
50
55
60
65
LIST II STEEL 08
CURVE # 69665
B- 4000 GAUSS 1½"
H 5 OER. 1½"
Pc = .4073 cm²
RB = 76.510
NH = 1000 TURNS
NB = 4 TURNS
H-MAX = 65

FIGURE 4

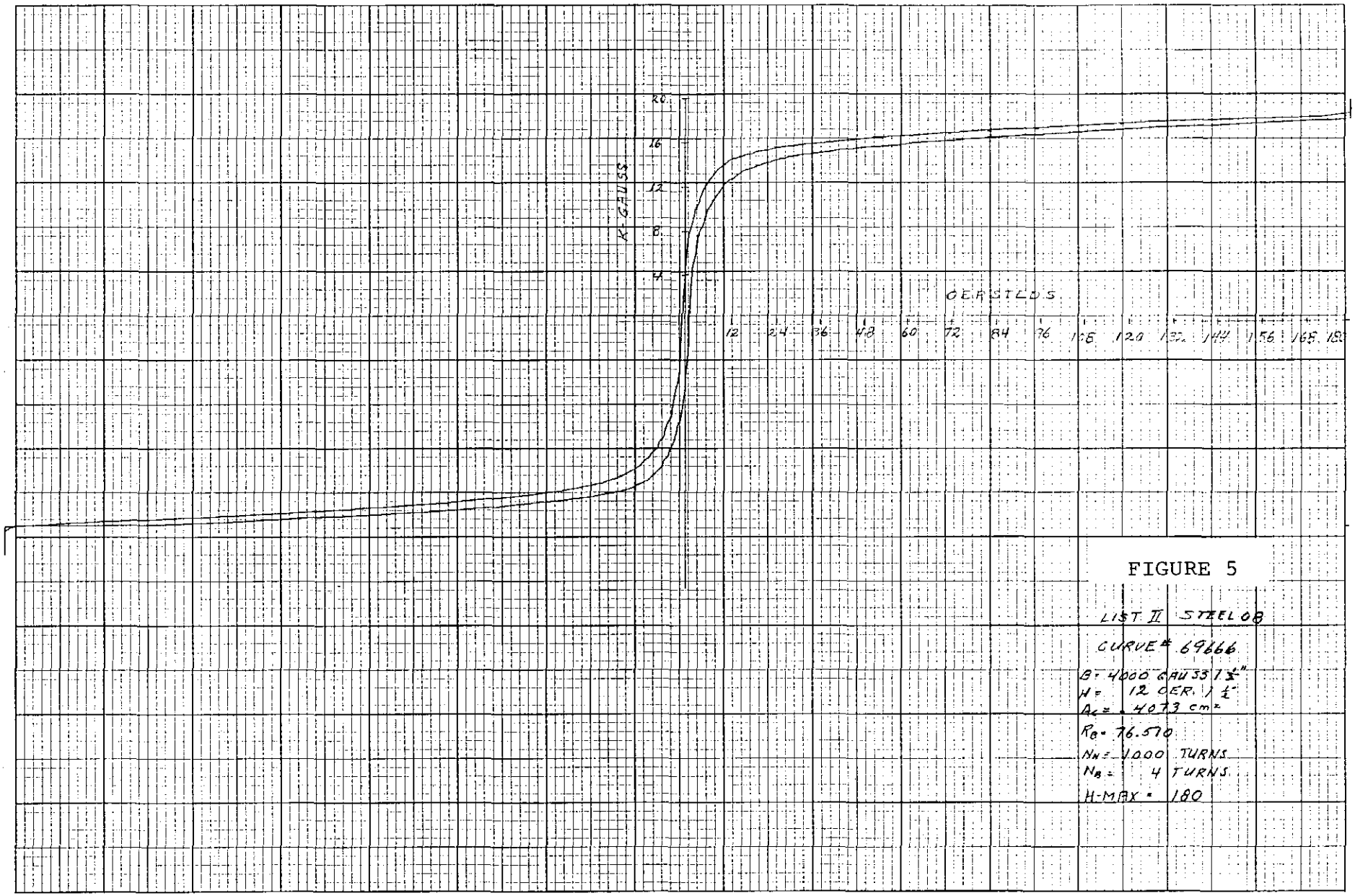

K-GAUSS
20
16
12
8
4
OERSTEDS
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
LIST II STEEL 08
CURVE # 69666
B = 4000 GAUSS 1 1/2"
H = 12 OER. 1 1/2"
Ac = .4073 cm²
RB = 76.570
NH = 1000 TURNS
NB = 4 TURNS
H-MAX = 180

FIGURE 5

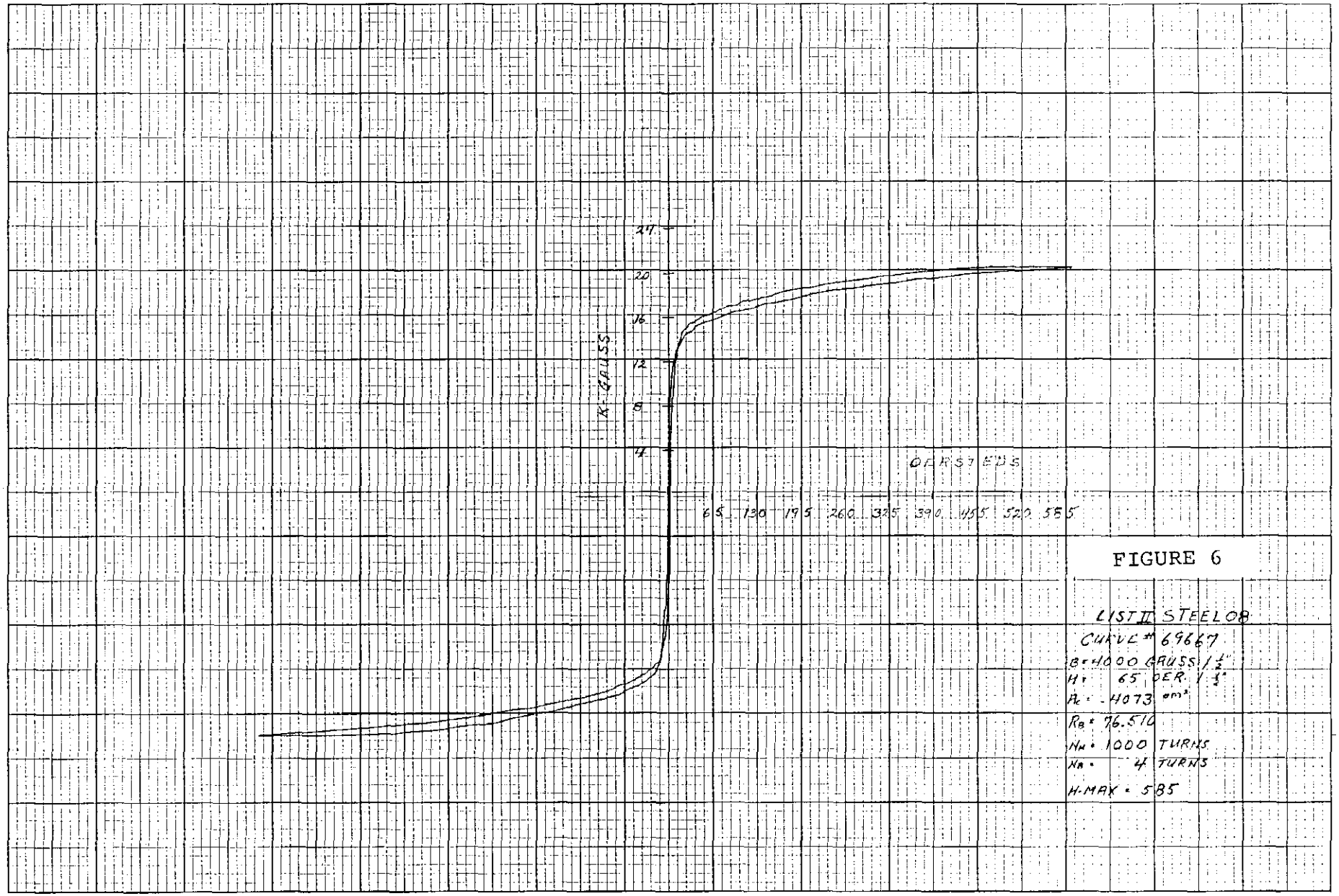

K-GAUSS
24
20
16
12
8
4
OERSTEDS
65 130 195 260 325 390 455 520 585
LIST II STEEL 08
CURVE # 69667
B = 4000 GAUSS / 1/2"
H = 65 OER. / 1/2"
Ac = .4073 cm²
RB = 76.510
NH = 1000 TURNS
NB = 4 TURNS
H-MAX = 585

FIGURE 6

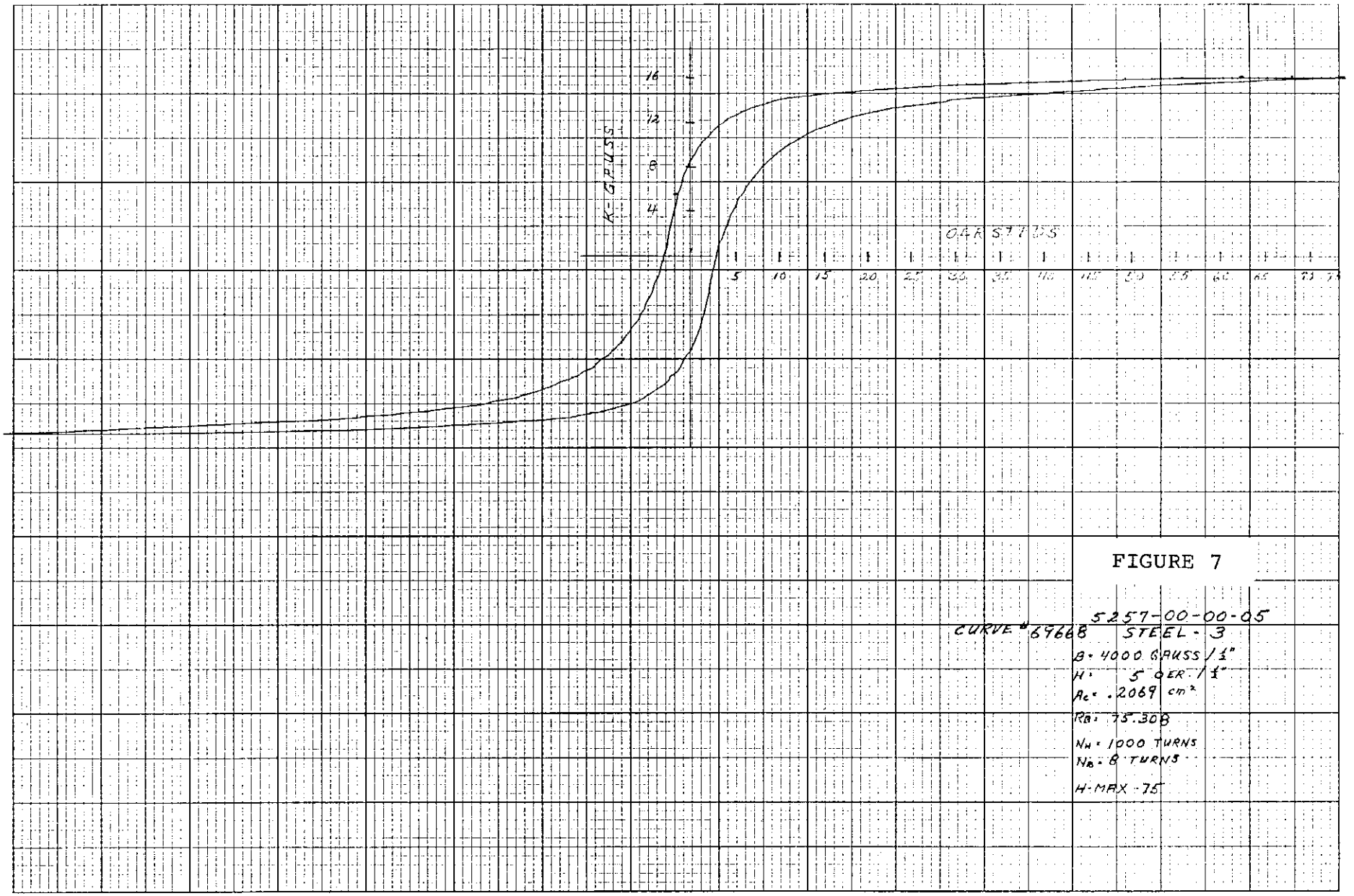


FIGURE 7

5257-00-00-05

CURVE # 67668 STEEL - 3

B = 4000 GAUSS / 1"

H = 5 OER. / 1"

A_c = .2069 cm^2

R_B = 75.308

N_H = 1000 TURNS

N_B = 8 TURNS

H-MAX = 75

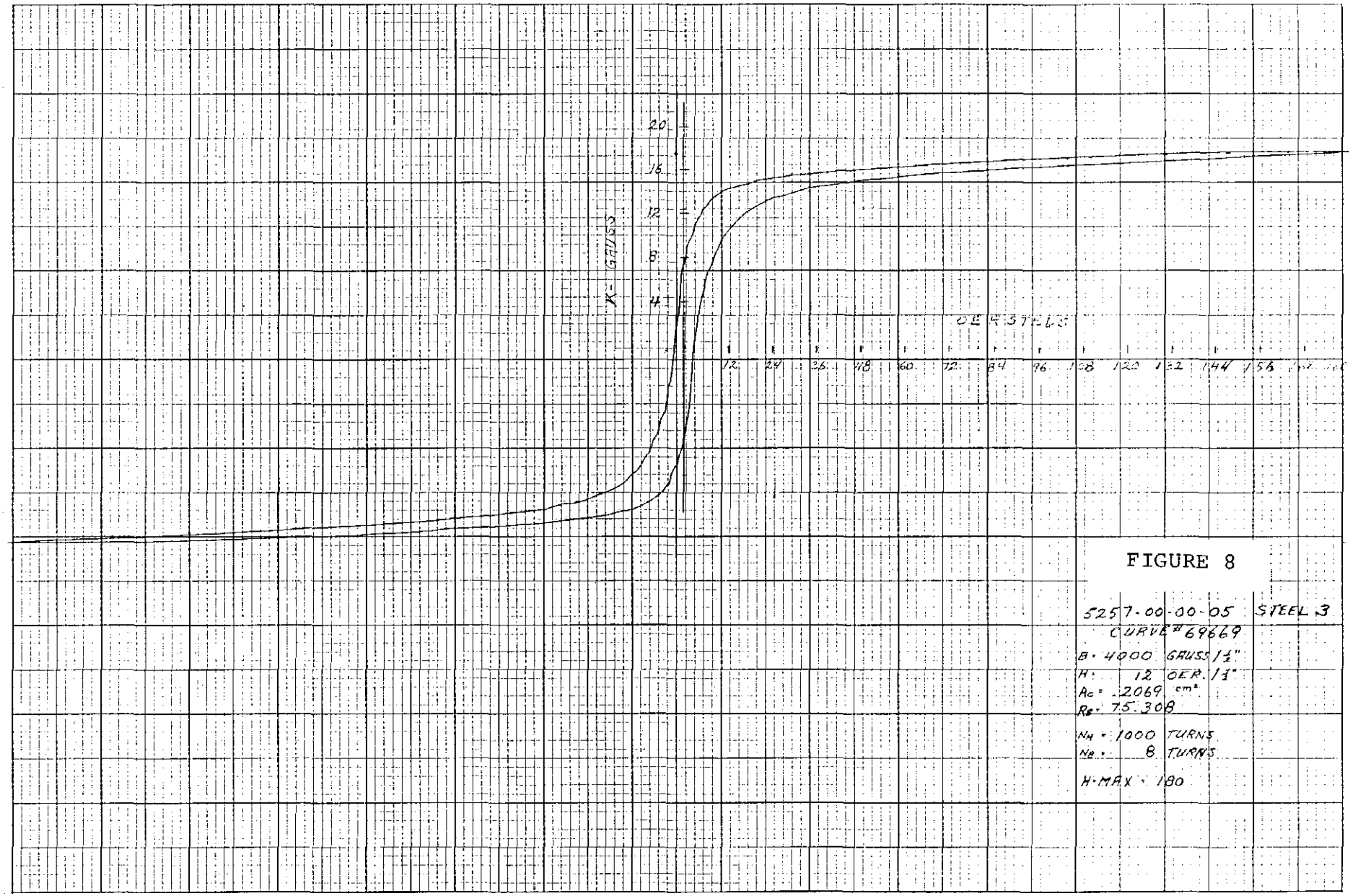

20
16
12
8
4
K- GAUSS
OERSTEDS
12
24
36
48
60
72
84
96
108
120
132
144
156
5257-00-00-05 STEEL 3
CURVE #69669
B = 4000 GAUSS 1½"
H = 12 OER. 1½"
Ac = .2069 cm²
Rg = 75.308
NH = 1000 TURNS
NB = 8 TURNS
H-MAX = 180

FIGURE 8

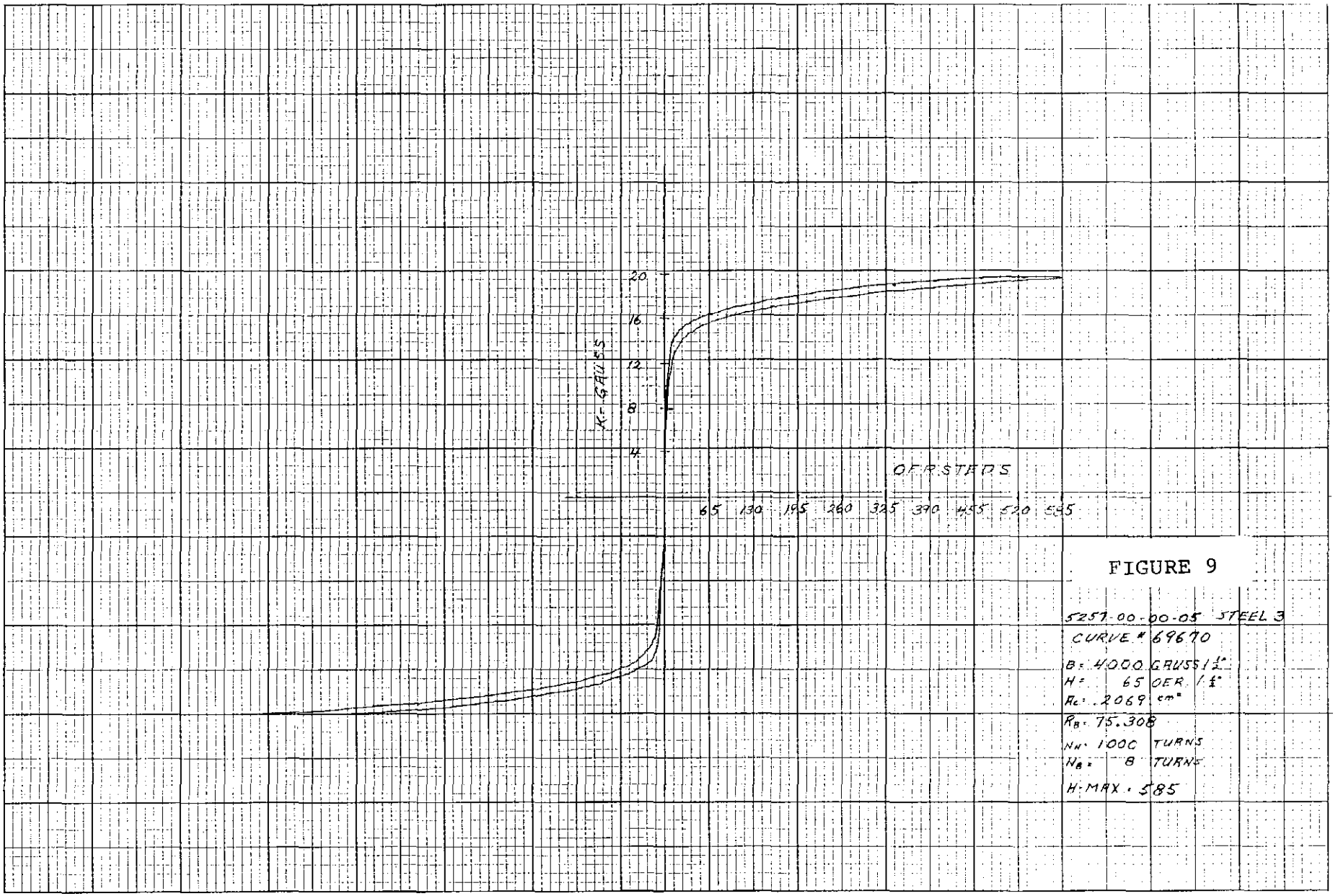

20
16
12
8
4
K-GAUSS
OERSTERS
65 130 195 260 325 390 455 520 585
5257-00-00-05 STEEL 3
CURVE # 69670
B = 4000 GAUSS 1/2"
H = 65 OER 1/2"
Ac = .2069 cm²
RB = 75.308
NH = 1000 TURNS
NB = 8 TURNS
H-MAX = 585

FIGURE 9

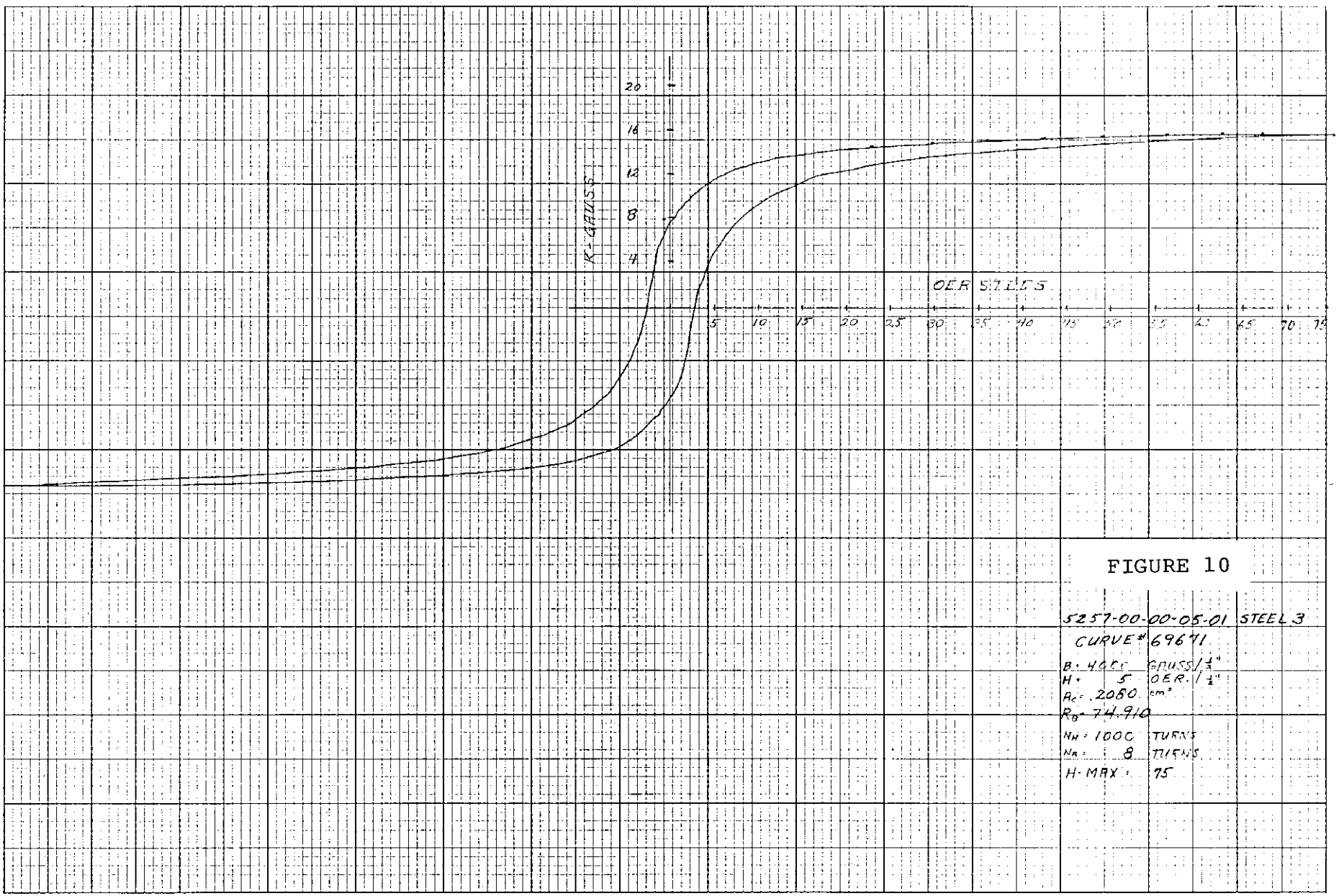

K-GAUSS
20
16
12
8
4
OER STEEL S
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
5257-00-00-05-01 STEEL 3
CURVE # 69671
B: 4000 GAUSS/1/2"
H: 5 OER./1/2"
Ac: .2080 cm²
Rb: 74.910
NH: 1000 TURNS
NB: 8 TURNS
H-MAX: 75

FIGURE 10

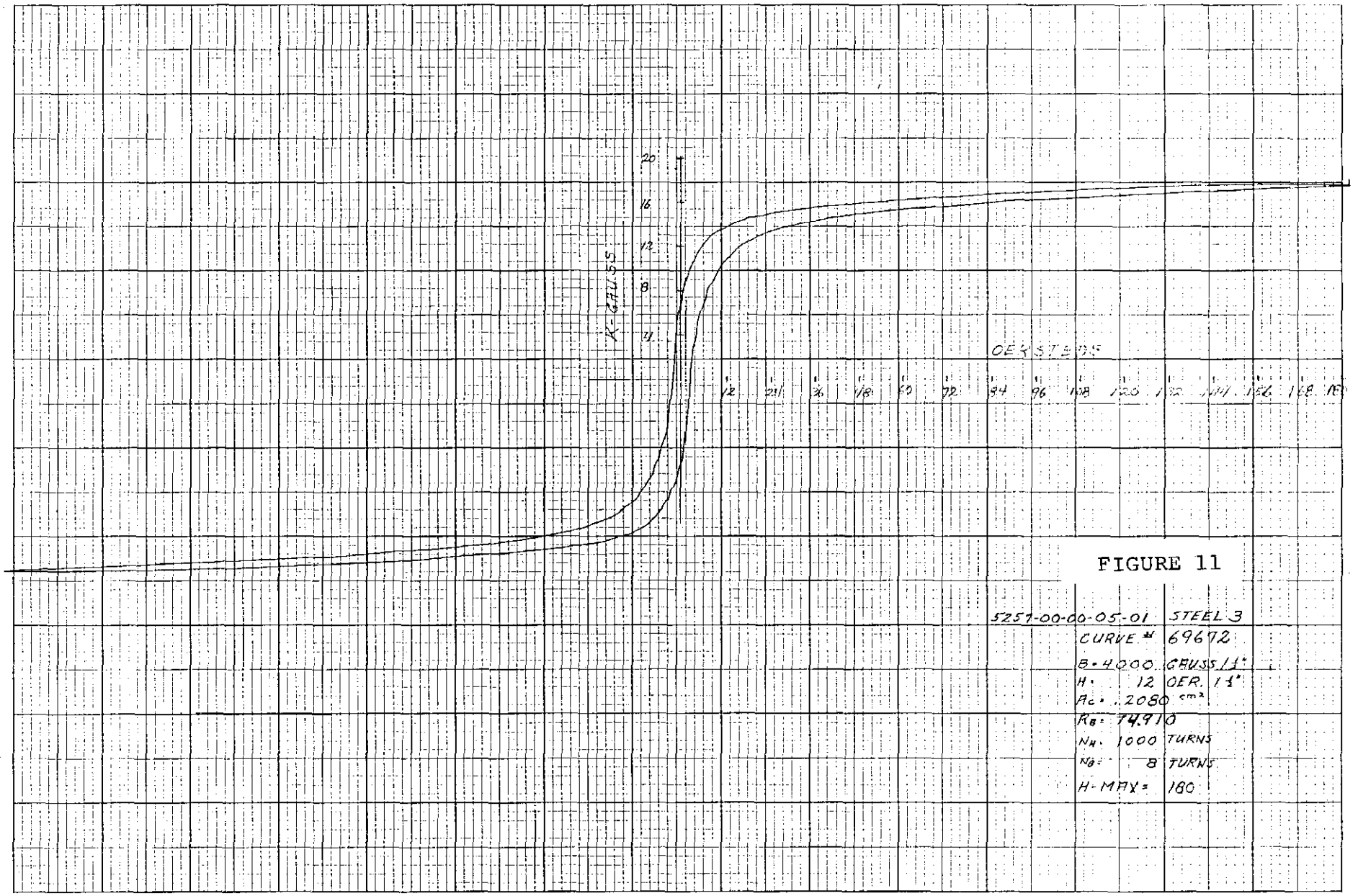

K-GAUSS
20
16
12
8
4
OERSTEDS
12
24
36
48
60
72
84
96
108
120
132
144
156
168
180
5257-00-00-05-01
STEEL 3
CURVE # 69672
B = 4000 GAUSS 1½"
H = 12 OER. 1½"
Ac = .2080 cm²
Rc = 74.910
NH = 1000 TURNS
NB = 8 TURNS
H-MAX = 180

FIGURE 11

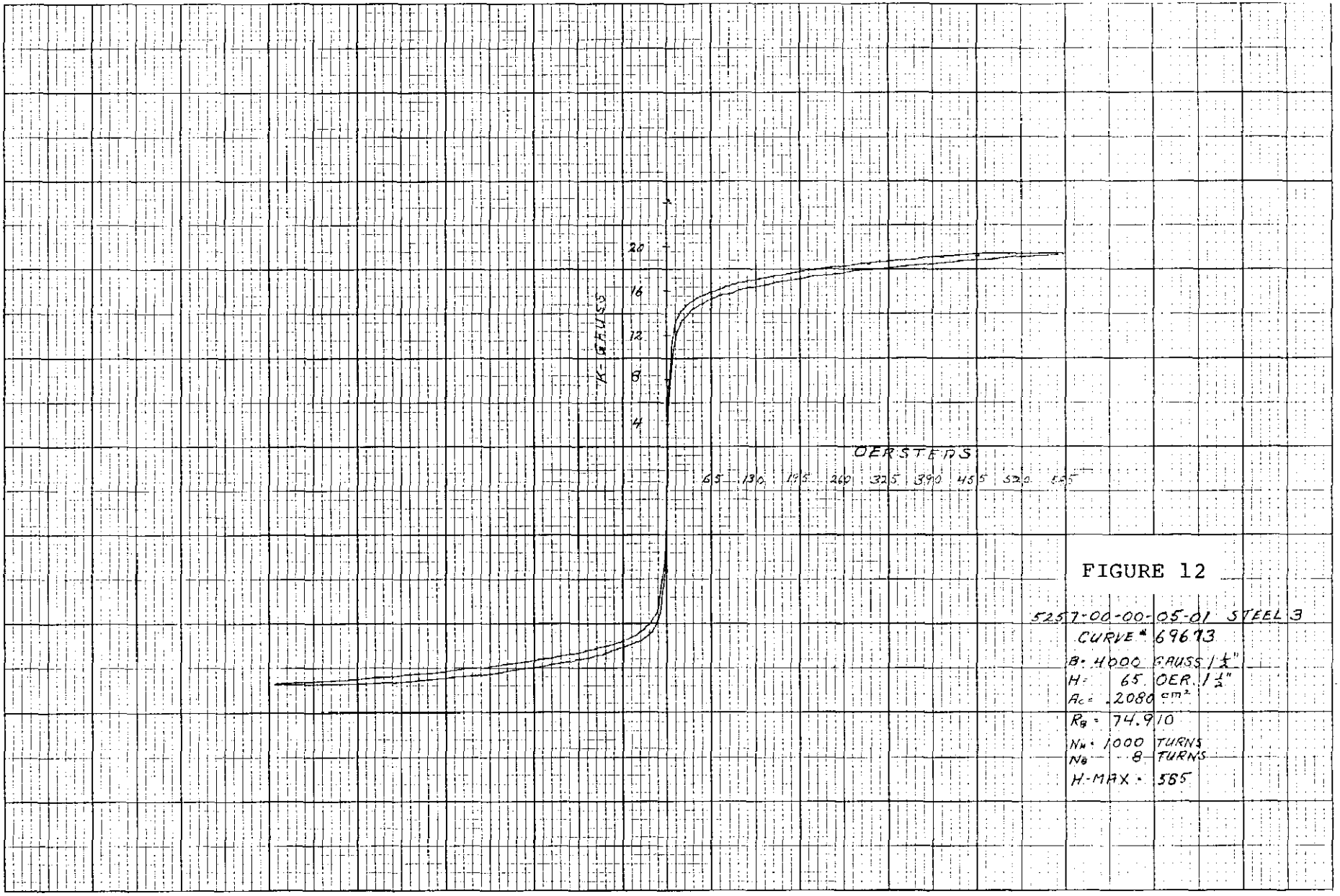
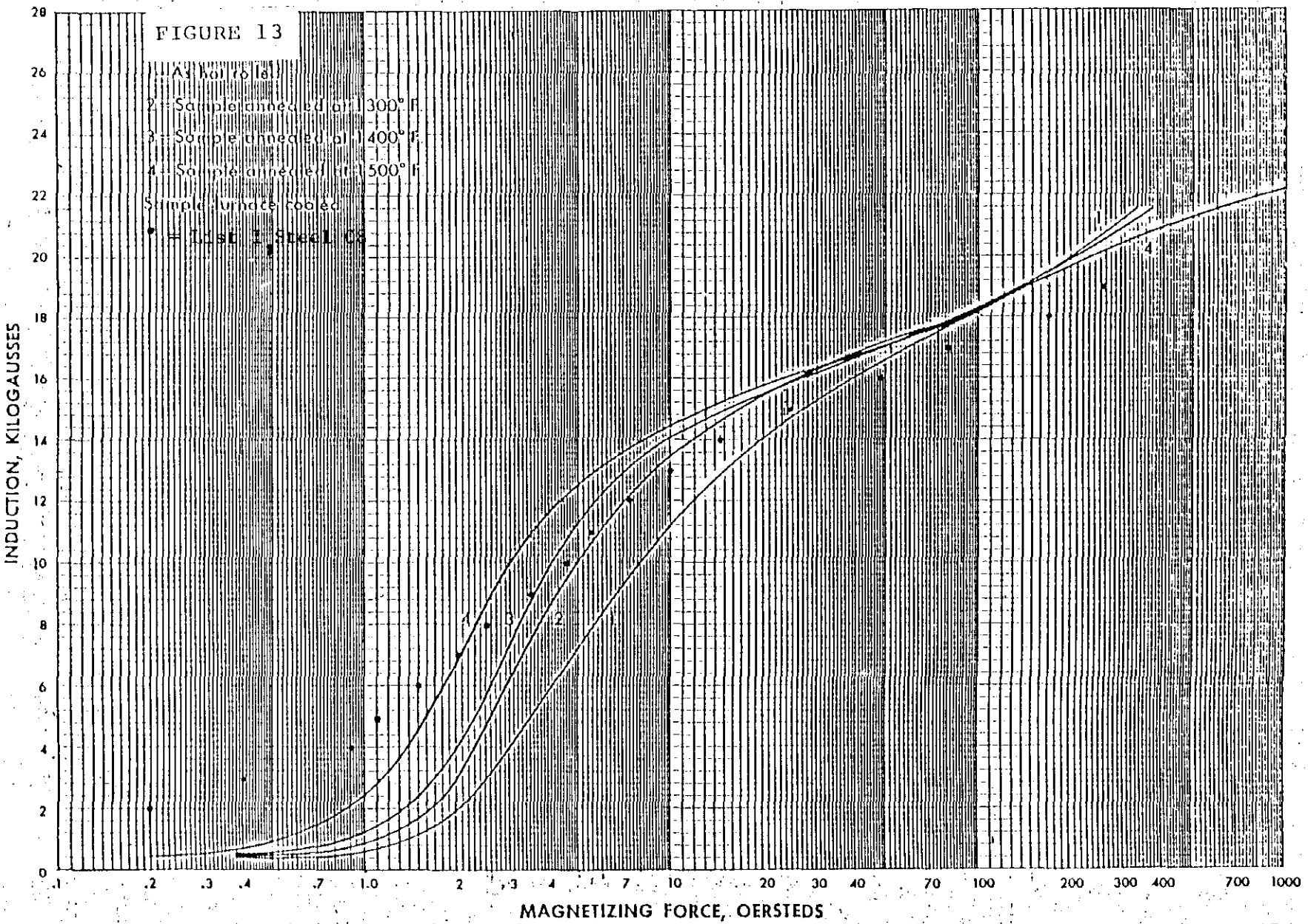

20
16
12
8
4
K-GAUSS
OERSTEDS
65
130
195
260
325
390
455
520
585
5257-00-00-05-01 STEEL 3
CURVE # 69673
B: 4000 GAUSS 1 1/2"
H: 65 OER. 1 1/2"
Ac = .2080 cm²
Rg = 74.910
Nw = 1000 TURNS
Nb = 8 TURNS
H-MAX = 585

FIGURE 12

USS HOT ROLLED LOW CARBON STEEL PLATES
C1010 — OVER .250 INCHES
DC MAGNETIZATION



Test Conditions: Lengthwise samples tested in Fahy Permeameter.

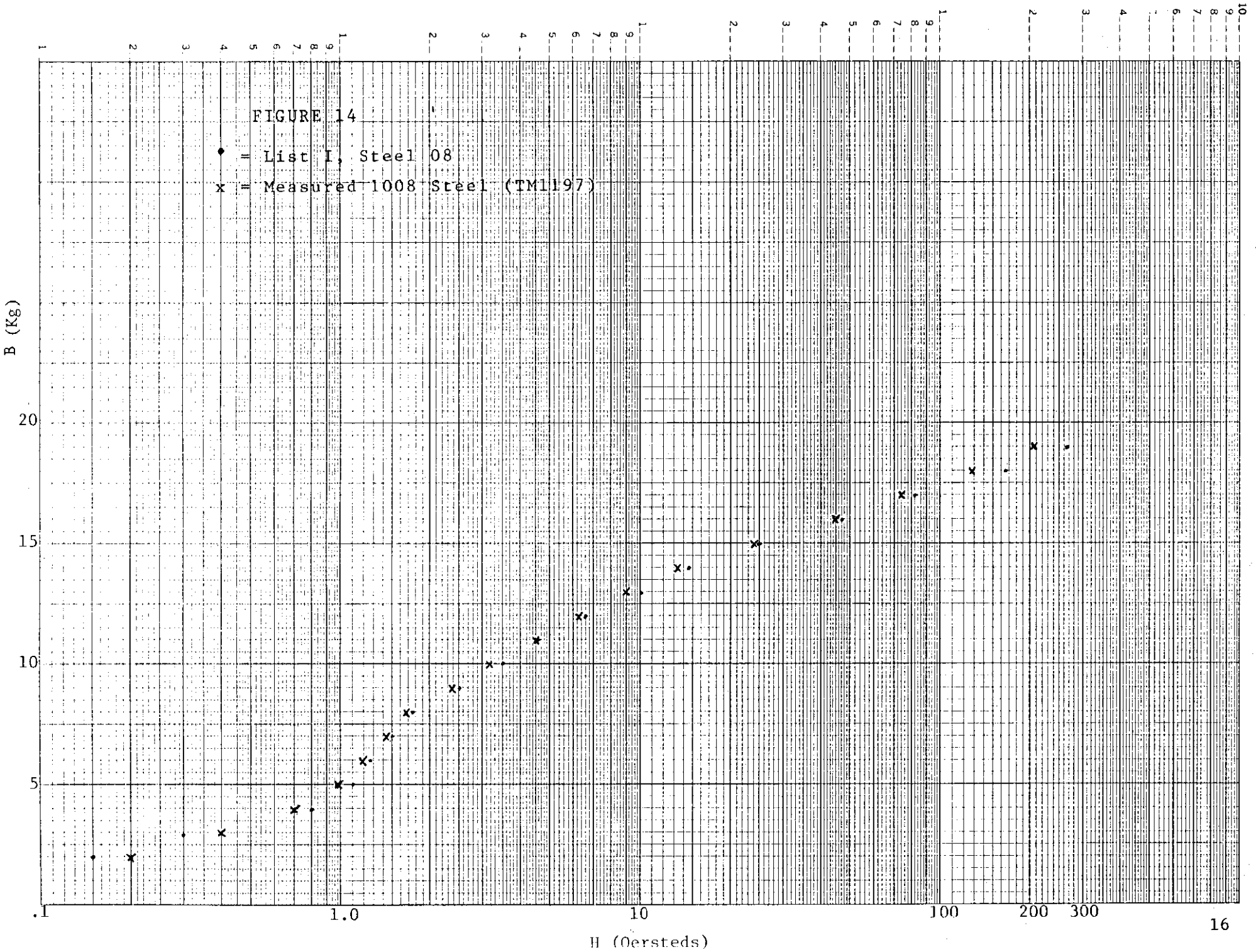


FIGURE 14
● = List I, Steel 08
x = Measured 1008 Steel (TM1197)
B (Kg)
20
15
10
5
.1
1.0
10
100
200
300
H (Oersteds)