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## Recent Work

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Bevatron D.C. Model Magnet Tests

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UNIVERSITY OF CALIFORNIA RADIATION LABORATORY

BEVATRON  
D. C. MODEL MAGNET TESTS

April - September 1948

by

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- III. QUANTITIES USED TO COMPARE MODELS
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- V. RESULTS

## I. INTRODUCTION

This report is a summary of the results that were obtained from D. C. model magnet tests of the bevatron. These tests were made from April through September 1948. The main purpose of this work was to determine the magnet design that would meet the general specifications laid down by the initial calculations for the machine.

Four general types of measurements were made:

(1) Magnetization - the flux density at the gap center compared to the ampere turns applied to the magnet,

(2) Return path flux - the flux density at various positions in the iron return path compared to the number of ampere turns applied to the magnet,

(3) Uniformity - the variation of the flux density with position in the magnet gap,

(4) Coil flux linkage - the total flux linkages of the exciting coil compared to the number of ampere turns applied to the magnet.

The data for each model have been arranged in this general order.

While these tests were in progress it was decided to build the machine in two stages. The magnet for the initial stage would have a large aperture which would allow larger vertical and horizontal oscillations of the ions, and larger tolerances for the R. F. tracking system. This larger aperture design also would give smaller losses from gas scattering.

It has been assumed that the larger aperture design must be capable of being converted, by rewinding the existing coils and by adding poles to the existing steel yoke, to a magnet which will meet the specifications outlined in Section II of this report.

D. C. model magnets were used for these initial tests because they can be fabricated more cheaply and quickly than A. C. models. Also at the time these tests were made, D. C. magnetic measurements could be made with greater speed than the A. C. measurements.

Models DC6A.3 and DC6.6 were chosen as the large aperture (4' high by 14' wide) and the small aperture (1' high by 4' wide) design as a result of these tests. It was decided at this point that further tests should be made dynamically on A. C. models. The results of these A. C. tests will be covered in another report.

The results of the magnetic measurements on the quarter scale operating model which is now being constructed will be given in another report.

## II. GENERAL SPECIFICATIONS

The following are the general specifications for the bevatron magnet:

- A. The maximum stored energy of the magnet is not to exceed eighty megajoules.
- B. The rise time to peak current should not exceed 2 seconds with 100,000 KVA. (A shorter time is preferred.)
- C. The total weight of steel is not to exceed 10,000 tons.
- D. The peak ampere turns is not to exceed 735,000 ampere turns.
- E. The peak magnetic field at the center of the gap is to be at least 16 kilogauss.
- F. The value of  $n$  is dependent on theoretical factors. This value was first taken as 0.75 and later changed to 0.73.
- G. The radial width of the usable magnetic field at the injection field is not to be less than 48 inches. At the maximum magnetic field the useful radial width is not to be less than 18 inches.
- H. The inside dimensions of the vacuum chamber are to be at least 12 inches in height and 48 inches in radial width.

### III. QUANTITIES USED TO COMPARE MODELS

Models were made to scale in linear dimensions and coil placement. The results were computed for the full scale magnet from all quantities which were measured on model magnets. These results were compared directly with the full scale specifications.

A. The weight of the full scale magnet steel was computed from the weight of the model magnet steel scaled up.

$$T_{FS} = T_M (360^\circ/\theta) (S)^3$$

where

$T_{FS}$  is the weight of the full scale magnet steel

$T_M$  is the weight of model steel computed from model dimensions

$\theta$  is the "angular length" of the model in degrees

$S$  is the scaling factor.

B. The gap height scales directly as the scaling factor,  $S$ .

C. The radial pole width scales directly as the scaling factor,  $S$ .

D. The flux density in the model and the full scale magnet are equal.

E. The number of ampere turns on the full scale magnet is computed from the model magnet.

$$(NI)_{FS} = (NI)_M(S)$$

where

$(NI)_{FS}$  is the number of ampere turns on the full scale magnet

$(NI)_M$  is the number of ampere turns on the model magnet.

F. The average volts per coil turn is computed from the total coil loop flux linkage measurements on the model magnet.

$$\phi_M = (\phi_t)_M / N_M$$

where

$\phi_M$  is the average flux in maxwells linking a coil turn on the model magnet

$(\phi_t)_M$  is the total measured flux linkage on the model magnet in maxwell turns

$N_M$  is the number of turns in the coils of the model

$$\phi_{FS} = \phi_M (S)^2 (360^\circ/\theta)$$

where

$\phi_{FS}$  is the average flux in maxwells linking a coil turn on the full scale magnet

$\theta$  is the angle in degrees over which the flux linkage measurement was made

$$(V/N)_{FS} = \frac{\phi_{FS}}{t} (10^{-8})$$

where

$(V/N)_{FS}$  is the volts per turn on the exciting coils on the full scale magnet

$t$  is the rise time in seconds.

G. The peak KVA is computed in the following manner:

$$KVA = (V/N)_{FS} (NI)_{FS} \times 10^{-3}$$

H. The useful gap width, the radial distance from  $n = 1.0$  to  $n = 0.5$ , was determined from the radial uniformity curves. The value,  $n$ , is computed from the change in magnetic field in relation to the change in radius.

$$H = H_0 (r_0/r)^n$$

$$n \ln. r_0/r = \ln. H/H_0$$

$$-n/r = (1/H) (dH/dr)$$

$$n = -(r/H) (dH/dr)$$

where

$H$  is the magnetic field at a point

$H_0$  is the magnetic field at gap center

$r_0$  is the radius at gap center

$r$  is the radius where field is  $H$



I. The efficiency of the magnet is computed from the ratio of the mmf that appears across the center of the air gap to the total mmf produced by the current in the exciting coils.

$$(NI)_g = 2.02 (H)_g (L)_g$$

where

$(NI)_g$  is the number of ampere turns across the air gap

$(H)_g$  is the magnetic field in gauss at the center of the air gap

$(L)_g$  is the length of the air gap in inches

then

$$\% \text{ Efficiency} = \frac{(NI)_g}{NI} \cdot 100$$

where

$NI$  is the number of ampere turns of the exciting coils.

J. The stored energy of the full scale magnet is calculated from the total coil loop flux linkage measurements.

$$W_M = 10^{-8} \int_0^I I (d\phi_t)_M$$

where

$W_M$  is the stored energy on the model magnet in joules

$I$  is the current in amperes

$(\phi_t)_M$  is the total flux linkages in maxwell turns

$$W_{FS} = W_M (360^\circ/\theta) (S)^3$$

where

$W_{FS}$  is the stored energy of the full scale magnet

$\theta$  is the angle of the model magnet through which the flux was measured

K. Average coil leakage coefficient is calculated from the total coil loop flux linkage measurements and the magnetization measurements.

$$L = \phi_t / NHA$$

where

$L$  is the average coil leakage coefficient at a given current

$\phi_t$  is the total flux linkages in maxwell turns

N is the number of turns on the exciting coils

H is the flux density at the gap center

A is the pole area calculated from the minimum specified useful width at the injection field.

NOTE: It has been assumed for the calculation of these quantities that the flux density at the gap center is constant inside the magnet quadrant, but that it falls to zero immediately outside the end of the quadrant.

#### IV. TYPES OF MEASUREMENTS MADE ON DIRECT CURRENT MODEL MAGNETS

A. The flux density in the gap center was measured at various currents with a General Electric fluxmeter (Cat. No. 32C247G6) and a calibrated search coil. The search coils were approximately one centimeter high and 1 centimeter in diameter. They were wound with a large number of turns of small wire (A. W. G. #46) which gave them an effective area of approximately  $1500 \text{ turns cm}^2$ . Two procedures were used to make these measurements:

1. The search coil was held stationary while the exciting current was turned on and off. (The residual field must be added to these measurements.)
2. The exciting current was held constant while the search coil was flipped through  $180^\circ$ .

B. Flux in various positions in the magnetic path was measured at various exciting currents. A loop of wire was placed around the magnet part in which the flux was to be measured. This loop was connected to a fluxmeter. The observations were made when the exciting current was turned on and off.

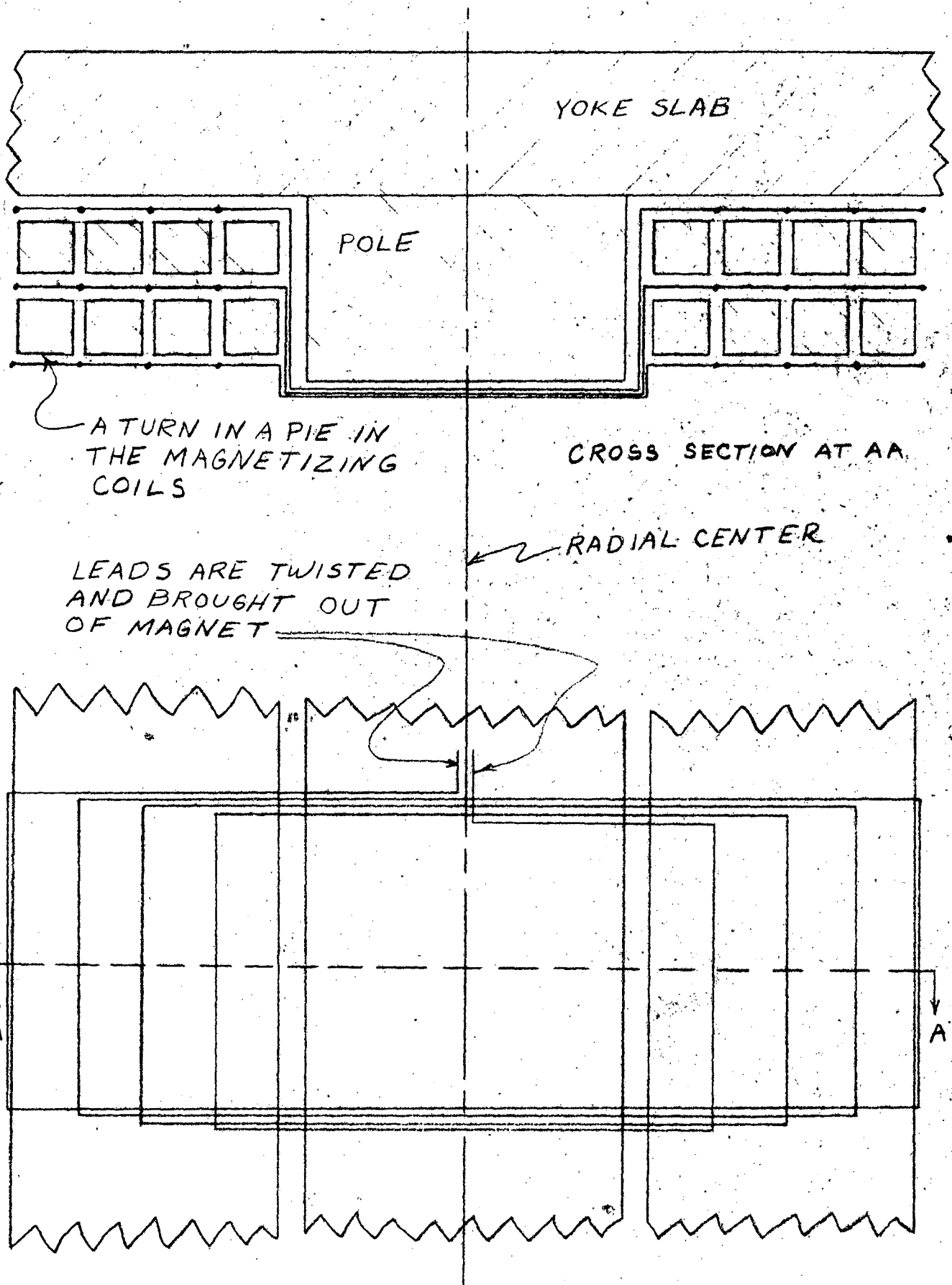
C. Coil flux linkages were measured by placing wire loops across the magnet pole end between the coil pies in such a manner that each exciting coil turn corresponded to a coil flux loop. (See sketch on following page.) The exciting current was turned on and off and deflections were observed on a fluxmeter.

D. Uniformity measurements (variations in flux density) at constant current were made within the model magnet gap along a radius and along an arc. A roving search coil, a stationary bucking coil, and a flux meter were used for these measurements. Differences in the magnetic field at a constant exciting current were measured by moving the search coil from point to point and observing the deflections on the fluxmeter.

E. Residual field measurements were made on the model magnets by flipping a search coil through  $180^\circ$  and observing deflections on a flux meter.

F. Stray field (flux density outside the magnet gap) was measured by the same procedure described in "D" of this section.

SCHEMATIC DRAWING OF LOOPS USED TO MEASURE  
COIL FLUX LINKAGES ON BEVATRON MODEL MAGNETS





Loops used to measure coil flux linkages on bevatron model magnets

BEVA 1/4 240

## V. RESULTS

### A. Table I

### B. Models

Two types of DC model magnets were designed and tested concurrently to predict magnet performance on the full scale bevatron. One type had the exciting coils across the air gap (referred to as Type A), and the other type had the exciting coils above and below the air gap (referred to as Type B). Type B was designed with "wings" to increase the useful gap width at the injection field. These "wings" will saturate at the higher fields and give a smaller useful gap width, hence, a greater magnet efficiency.

BEVATRON MODEL MAGNET TESTS (PAGE 1)

Model	Iron (Tons) Full Scale	Gap (Inches) Full Scale	Pole Width Inches Full Scale	Field (Gauss) Center of Gap	Amp Turns $\times 10^3$ Full Scale	Peak KVA Full Scale (1 Sec. Rise)	Useful Gap Width (Inches) $m=1/2$ to $m=1$	Ave. Coil Leakage Coeff.	Volts Per Coil Turn	Efficiency %	Energy Megajoules Full Scale
DC1	9600	14	48 (+ wings) ( 72 )	16000 245	9.0	236,000	5 46	1.40	261	50	67.9
DC3	7950	14	54	16000 230	5.0	127,000	22 26	1.35	253	91	63.2
DC3A	8650	26	108	8600	5.0	126,000	~73 ~73	1.26	251	91	~63.2
DC4	9800	14	48 (+ wings) (66 )	16000 379	7.0	206,000	18 ~40	1.58	293	65	80.3
DC4B	9800	14	48 (+ wings) (66 ) BENT	16000 208	7.1		20 ~ .52			64	
DC4C	9800	14	66	16000	8.0	256,000		1.76	320	56	~96.5
DC5A	8900	26	108	8000 197	4.4	100,000	94 95	1.20	226	94	62.2
DC5	8050	14	54	14100 205	4.3	107,000	44 44	1.40	250	94	
Ideal		14	48	16000	4.52	84,500	48	1.00	187	100	42.3
		26	96	8000	4.20	78,500	96	1.00	187	100	39.3
		54	168	4000	4.36	71,100	168	1.00	163	100	35.5
DC6A	8700	54	179.25	5000	6.63	147,700		1.18	223	82.5	67.0
DC6	9930	14	48 (+ wings) (66 )	16000	7.27	217,800		1.61	299	62.2	81.3
DC6I	9930	14	48(+ WINGS 66)	16000	7.09	204,800		1.55	289	63.9	79.2
DC6A.1	8700	54	179.25	5300	7.06	157,000	135	1.12	222	82.9	69.1



APRIL 26, 1949

EWC

171-8

## BEVATRON MODEL MAGNET TESTS (PAGE 2)

MODEL	IRON (TONS) (F.S.)	GAP (INCHES) (F.S.)	POLE WIDTH (INCHES) (F.S.)	FIELD (GAUSS) GAP CENTER	AMPERE TURNS $\times 10^5$ (F.S.)	PEAK KVA (1 SECOND RISE) (F.S.)	USEFUL GAP WIDTH (INCHES) $m=0.5$ TO $m=1$	AVE. COIL LEAKAGE COEFF.	VOLTS PER COIL TURN	EFF. (IN %)	ENERGY (MEGA JOULES) (F.S.)
DC6A	8700	54	179.25	5000	6.63	147,700		1.18	223	82.5	67.0
DC6	19,930	14	48 + WINGS 66	16000	7.27	217,800		1.61	299	62.2	81.3
DC6.1	19,930	14	48 + WINGS 66	16000	7.09	209,800		1.55	289	63.9	79.2
DC6A.1	8700	54	179.25	5300	7.06	157,000	135	1.12	222	82.9	69.1
DC6A.2	8790	54	179.25	5300	7.21		135			80.7	
DC6.2	10,190	14	48 + WINGS 66	16000	6.65					68.0	
DC6.3	10,450	14	48 + WINGS 66	16000	6.47					69.7	
DC6.4	10,090	14	48 + WINGS 66	16000	6.81					66.4	
DC6.5	10,020	14	48 + WINGS 66	16000	6.85	188,000		1.47	275	66.0	73.0
DC6.6	10,180	14	48 + WINGS 66	16000	6.56					69.0	
DC6.7	10,340	14	48 + WINGS 66	16000	6.45					70.2	
DC6.8	10,440	14	48 + WINGS 66	16000	6.49					69.9	
DC6.9	10,280	14	48 + WINGS 66	16000	6.58					68.9	
DC6A.3	8950	54	179.25	5350 5300	7.06 6.96	158,000	141	1.12	224	82.7 83.0	69.7
DC6A.4	8950	54	179.25	5300	6.72					86.1	
DC6A.5	8950	54	179.25	5300	6.61					87.5	
DC6A.6	8950	54	179.25	5300	6.68					86.5	

1 Model Magnet DCI Index

a. Discussion

b. Sketch

c. Photographs

BEVA 15

BEVA 13

d. Graphs

L-DCI-1 (cor) Efficiency and leakage coefficients

H-DCI-1 Flux density around the magnetic path

U-DCI-1 Radial uniformity

U-DCI-1a Radial uniformity - Expanded

F-DCI-1 (cor) Coil flux linkage

F-DCI-1a (cor) Total coil flux linkage

E-DCI-1 (cor) Stored energy

S-DCI-1 Stray field

## 1 Model Magnet DC1

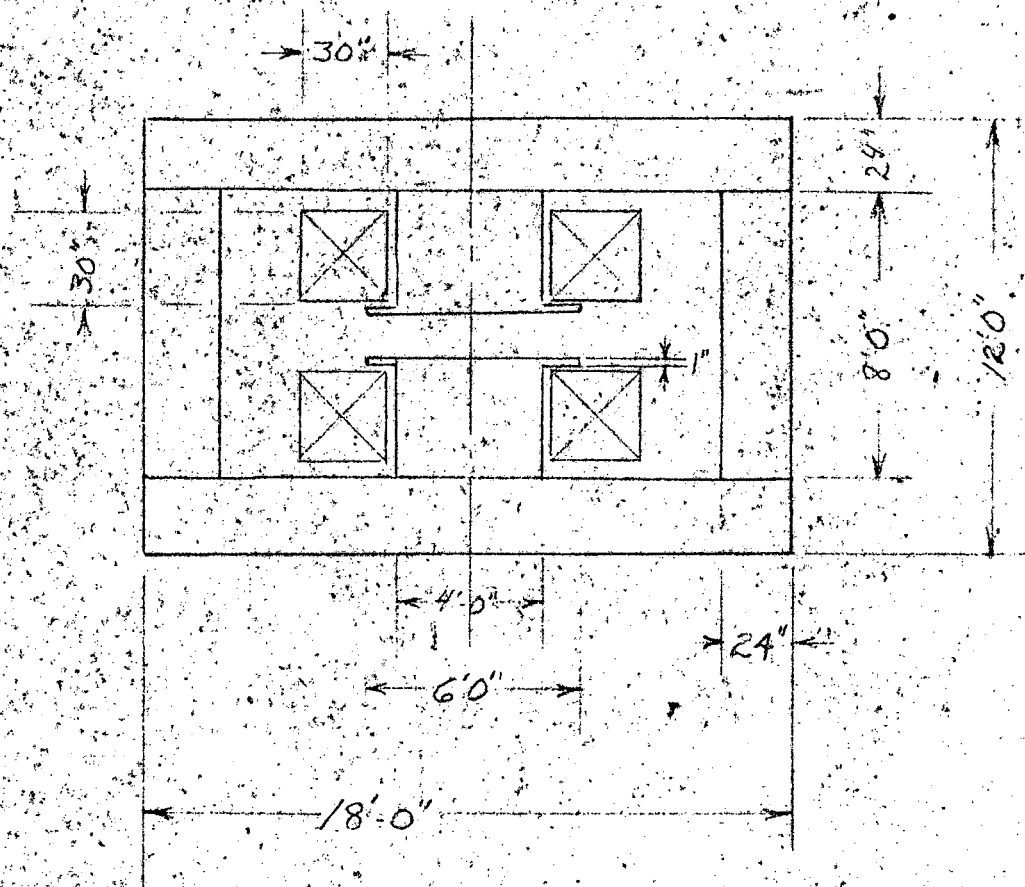
### a. Discussion

Bevatron model magnet DC1 was the first attempt to make a DC model (type B) to predict performance of the magnet for a full scale bevatron.

This magnet failed to meet some of the general specifications. (See Section II and Table I) The ampere turns required were  $9.0 \times 10^5$  instead of the <sup>specified</sup>  $7.35 \times 10^5$ . The peak KVA required was  $236 \times 10^3$  for a rise time of one second. The specified  $100 \times 10^3$  KVA is for a rise time of not greater than 2.0 seconds. The useful gap was 5 inches when the magnetic field strength was 16 kilogauss at the gap center instead of the specified 18 inches.

The efficiency of this magnet was only 50 percent. The flux loop measurements showed that a portion of the iron in the magnetic path reached saturation when the field in the gap was approximately 15,000 gauss. It was decided that drastic design changes should be made. These changes will be shown in the following model. (See model DC4)

# BEVATRON MODEL MAGNET DC I



GAP 14"

RADIUS 30'

$n = 0.75$

MODEL COILS: 6 COILS 25 TURNS EACH = 150 TURNS

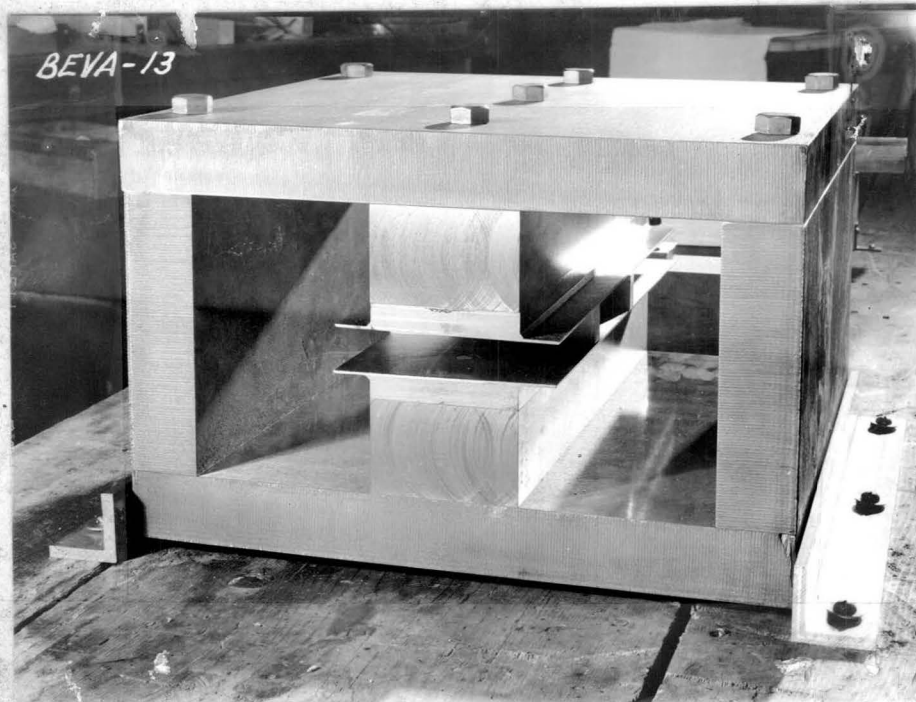
DIMENSIONS ARE FULL SCALE

MODEL IS  $\frac{1}{16}$  SCALE

ASSEMBLY DWG. 3L 1062



BEVA 15



BEVA 13

Bevatron Model Magnet DC1

REVATRON MODEL MAGNET DEF  
EFFICIENCY AND LEAKAGE COEFFICIENTS

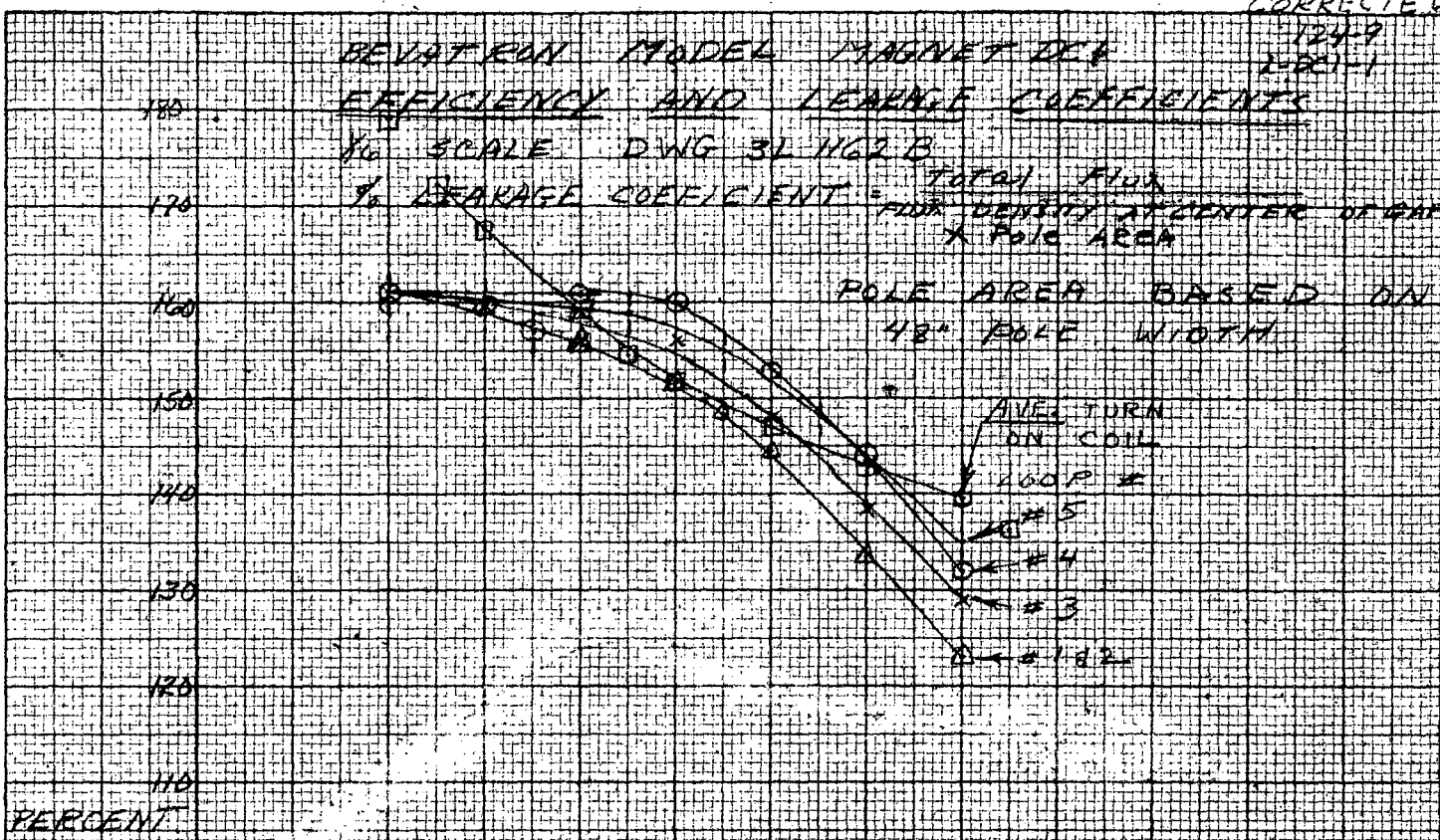
1/6 SCALE DWG 31162 B

$\% \text{ LEAKAGE COEFFICIENT} = \frac{\text{TOTAL FLUX}}{\text{FLUX DENSITY AT CENTER OF GAP} \times \text{POLE AREA}}$

POLE AREA BASED ON  
48" POLE WIDTH

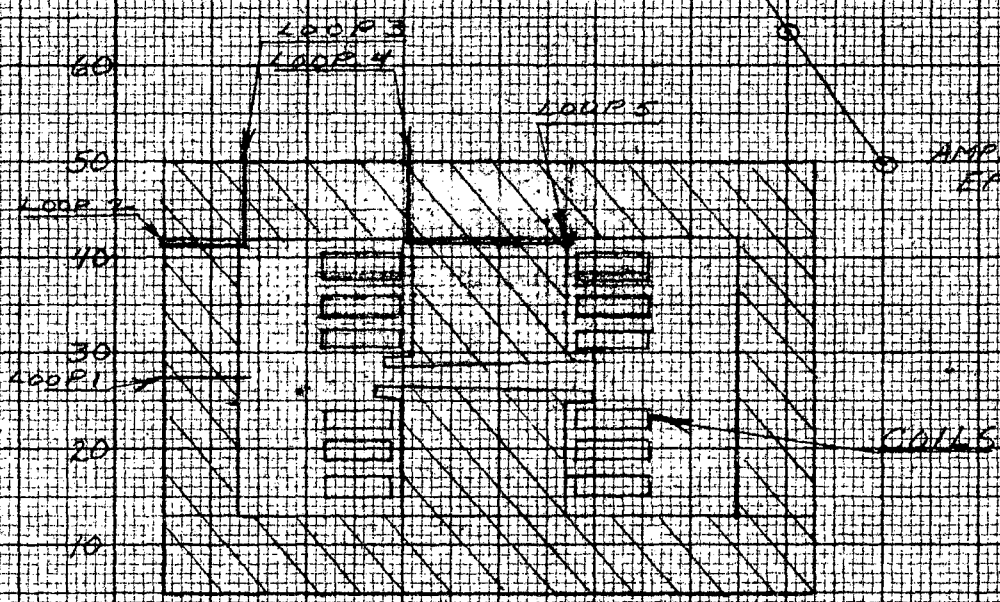
AVERAGE TURN  
ON COIL

- LOOP #
- #5
- #4
- #3
- #1 & 2



$\% \text{ EFFICIENCY} = \frac{2.02 \times \text{FLUX DENSITY AT CENTER OF GAP (INCHES)}}{\text{TOTAL AMPERE TURNS}}$

CROSS-SECTION OF MAGNET



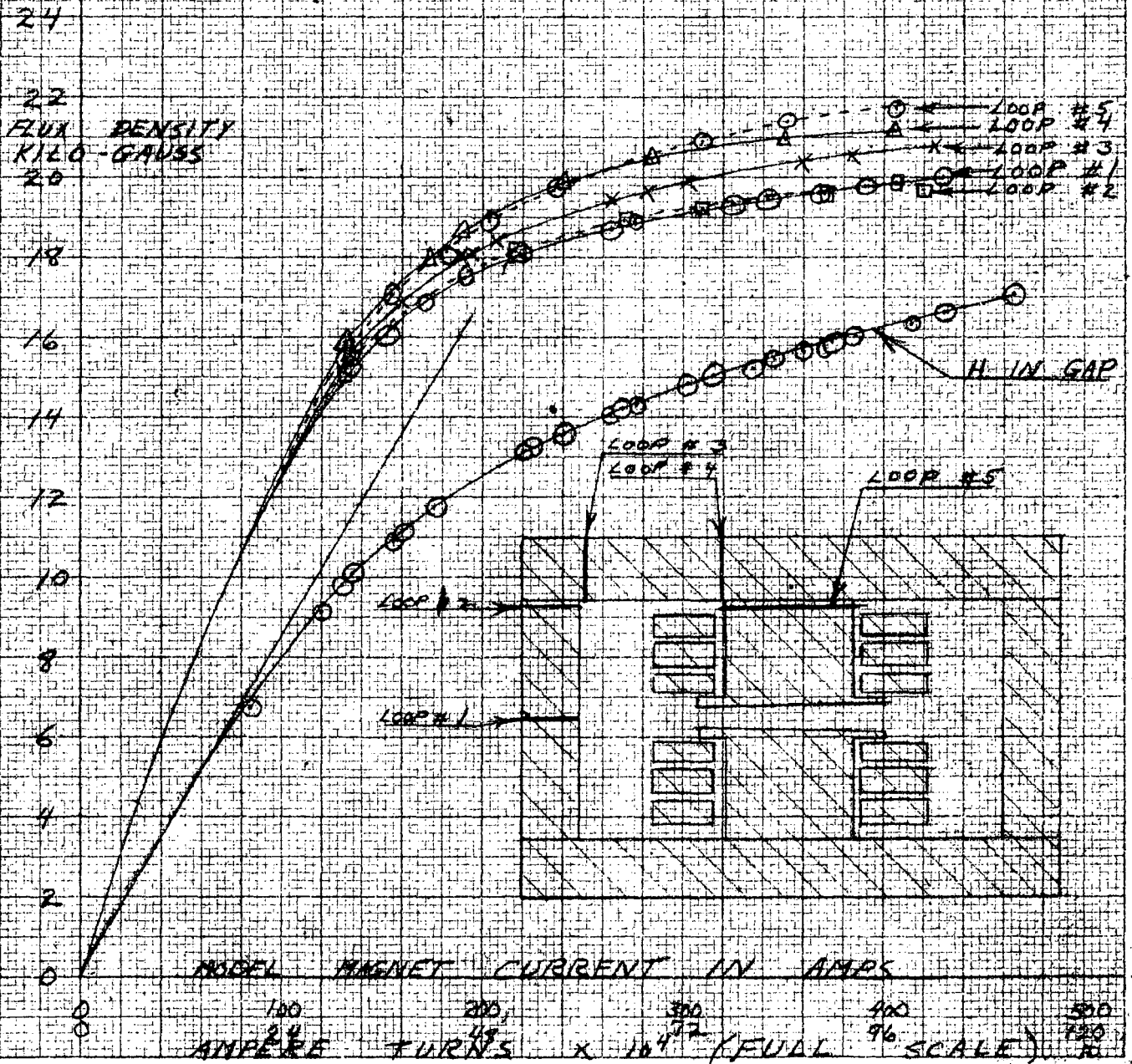
AMPERE TURN  
EFFICIENCY

COILS

MAGNETIC FIELD AT CENTER OF GAP - KILOGAUSS

124-9  
H-DCI-1

FLUX DENSITY AROUND MAGNETIC PATH  
 MARCH 9, 1948 BEVATRON MODEL MAGNET DCI  
 1/16 SCALE DWG # 3L1062  
 GAP 141 AT CENTER (FULL SCALE)  
 POLE TIP DWG # 3L1003  
 150 TURNS TOTAL ON COILS (MODEL)

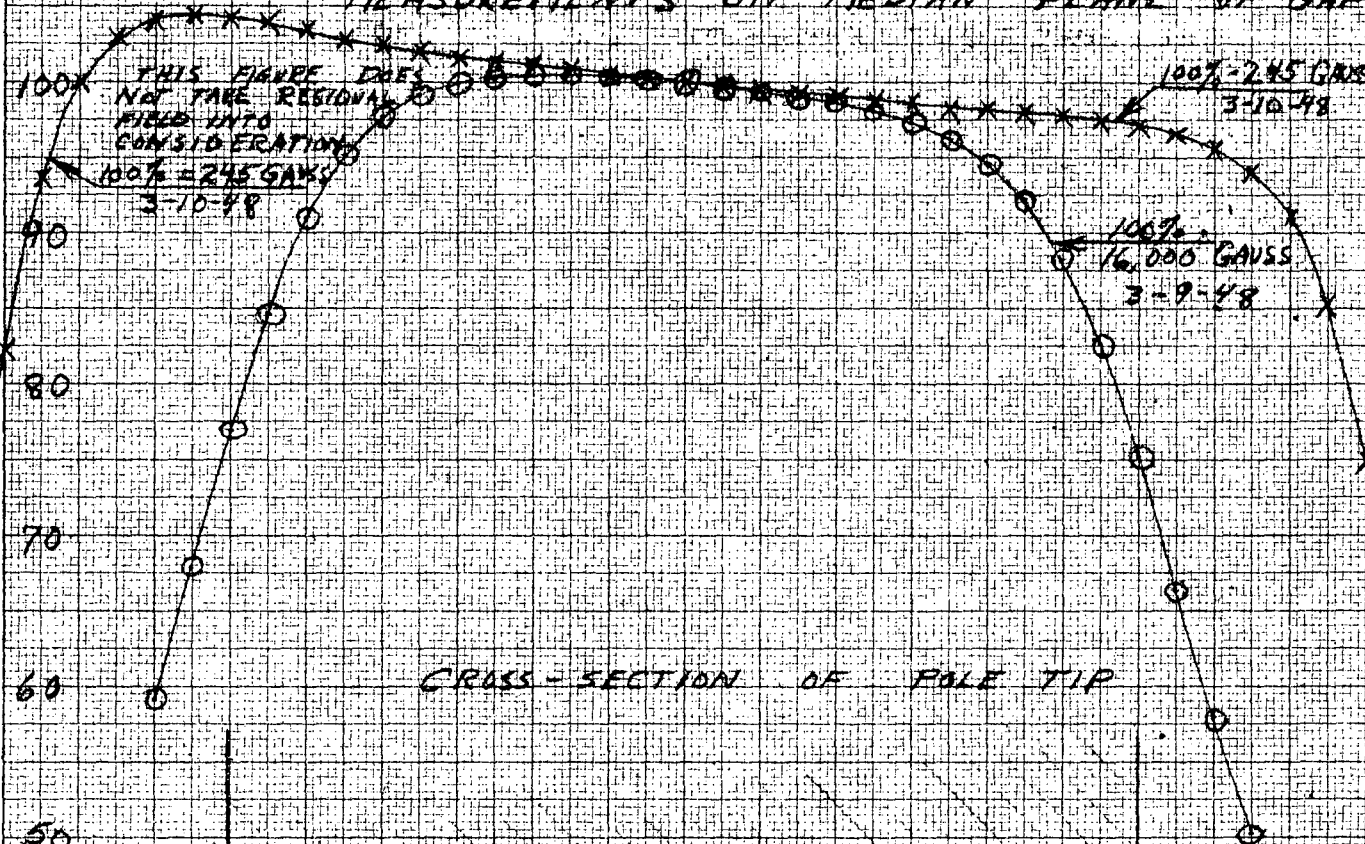


KEUFFEL & ESSER CO. N.Y. NO. 350-11  
 By  $\frac{1}{16}$  in the 1/16 in. 3/16 in. second d.  
 Engineering 1/16 in.

UNIFORMITY - RADIAL  
 BEVATION MODEL MAGNET DC-1  
 1/16 SCALE DWG # 3L1062A  
 POLE TIP DWG # 3L1003  
 GAP 1/4" AT CENTER (FULL SCALE)  
 MEASUREMENTS ON MEDIAN PLANE OF GAP

124-9  
 0001-1

110



CROSS-SECTION OF POLE TIP

PERCENT MAGNETIC FIELD

GAP TAPER 0.0179" / INCH

1/4" GAP

50' RADIUS

50  
40  
30  
20  
10

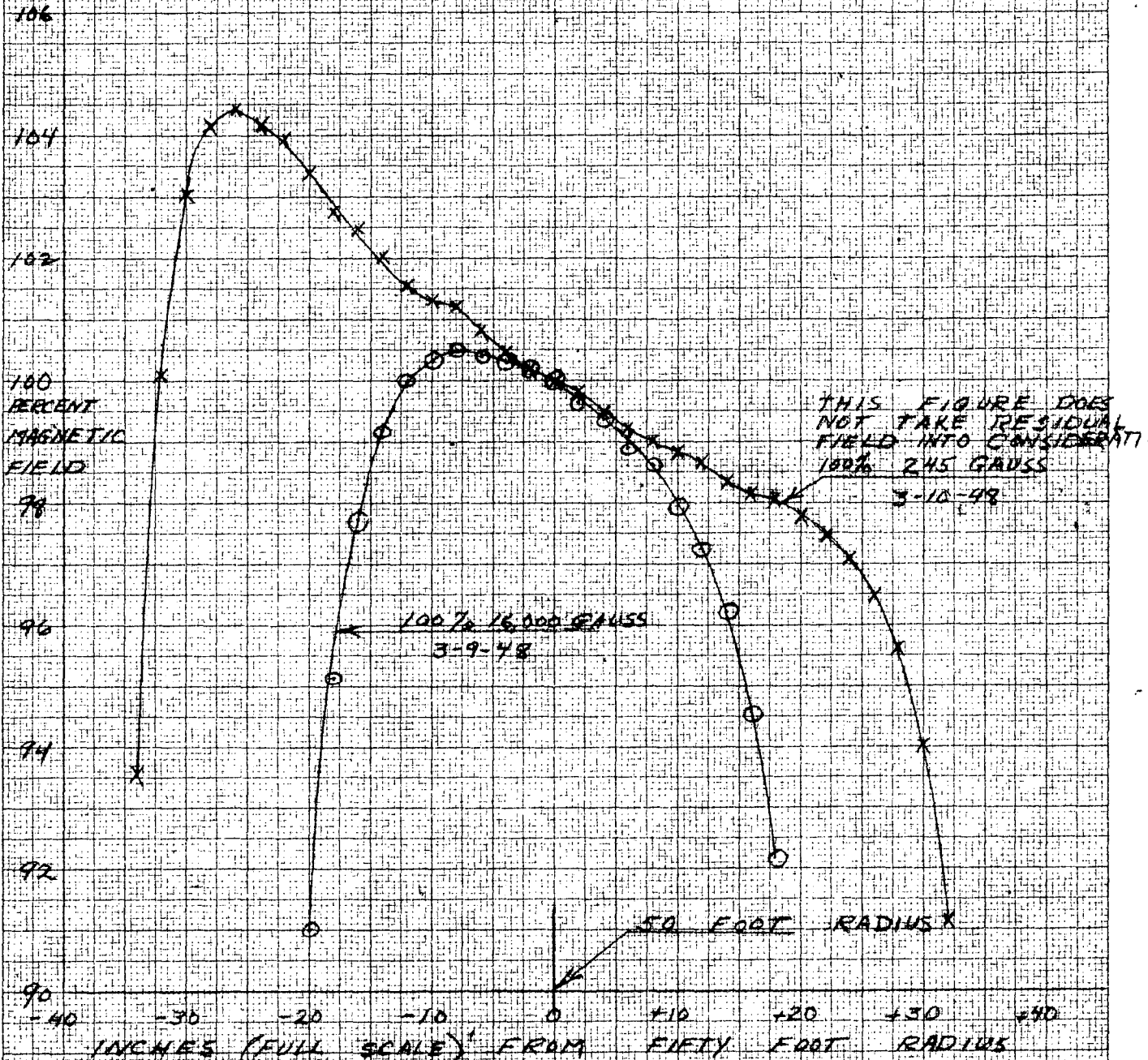
36 32 28 24 20 16 12 8 4 0 4 8 12 16 20 24 28 32 36  
 INCHES (FULL SCALE) FROM FIFTY FOOT RADIUS

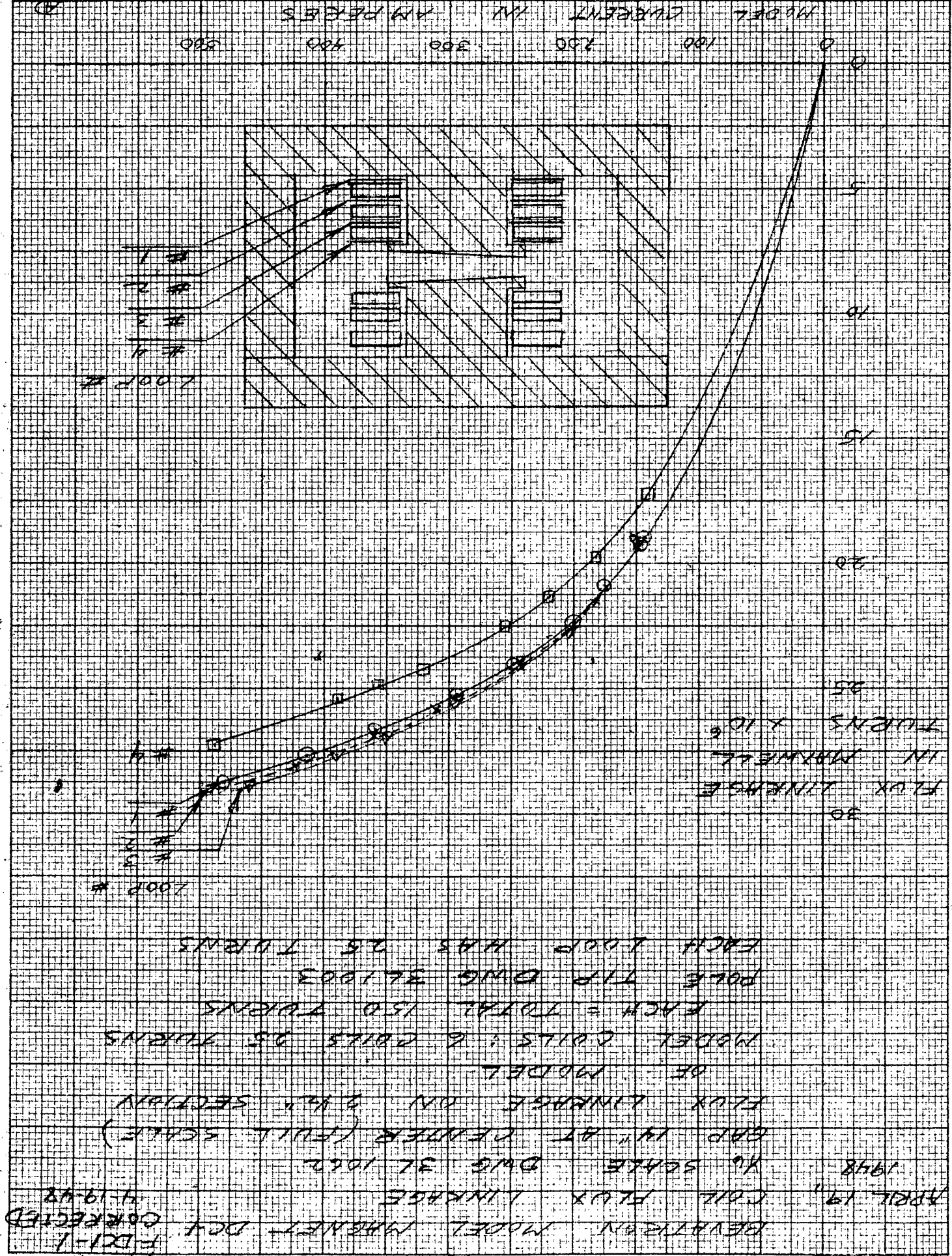
KEUFFEL & ESSER CO., N. Y. NO. 250-14  
 Millimeters. Built in U.S.A.

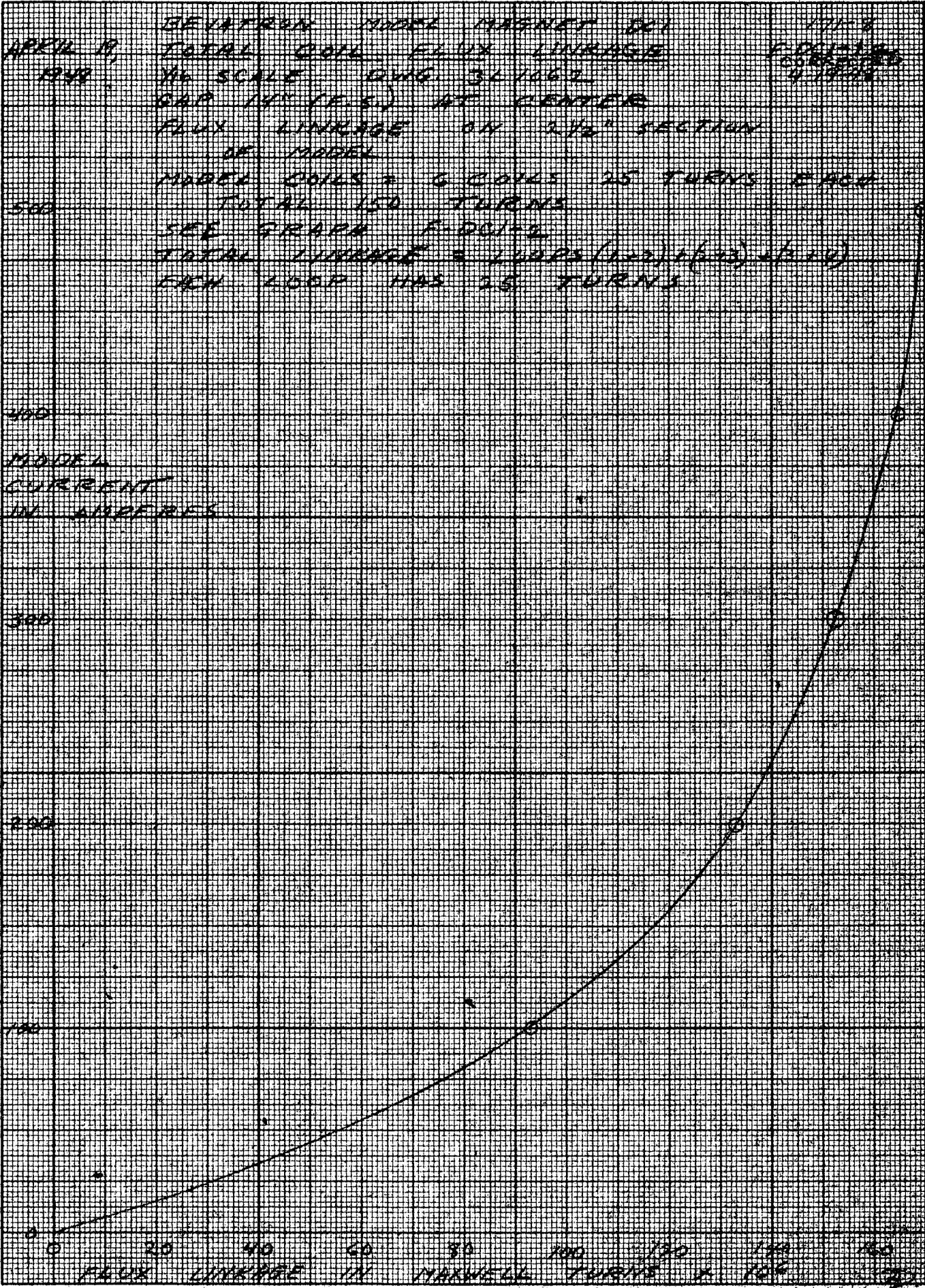


RADIAL UNIFORMITY  
 BEVATRON MODEL MAGNET DC-1  
 1/16" SCALE DWG # 341082A  
 SEE GRAPH U-DC1-1

134-9  
 U-DC1-1a







EUGENE DIETZGEN CO.  
 PRINTED IN U.S.A.

NO. 340 - M DIETZGEN GRAPH PAPER  
 MILLIMETER

STORED ENERGY

124-9  
E-DCI-1

MARCH 3, 1948

Corrected  
9-29-48

BEVETRON MODEL MAGNET DCI

1/16" SCALE DWG # 3L1062A

STORED ENERGY CALCULATED FROM TOTAL  
COIL FLUX LINKAGE SEE GRAPH # F-DCI-1a

$$\text{ENERGY (JOULES)} = 10^{-8} \int I d\Phi$$

WHERE I IS IN AMPS AND  $\Phi$  IS IN MAXWELLS

DATA FOR 2 1/2" SECTION OF MODEL  
POLE TIP DWG # 3L1003

240  
220  
200  
180  
160  
140  
120  
100  
80  
60  
40  
20  
0

STORED  
ENERGY  
IN JOULES

0 2 4 6 8 10 12 14 16 18 20 22 24

MAGNETIC FIELD AT CENTER OF GAP - KILO GAUSS

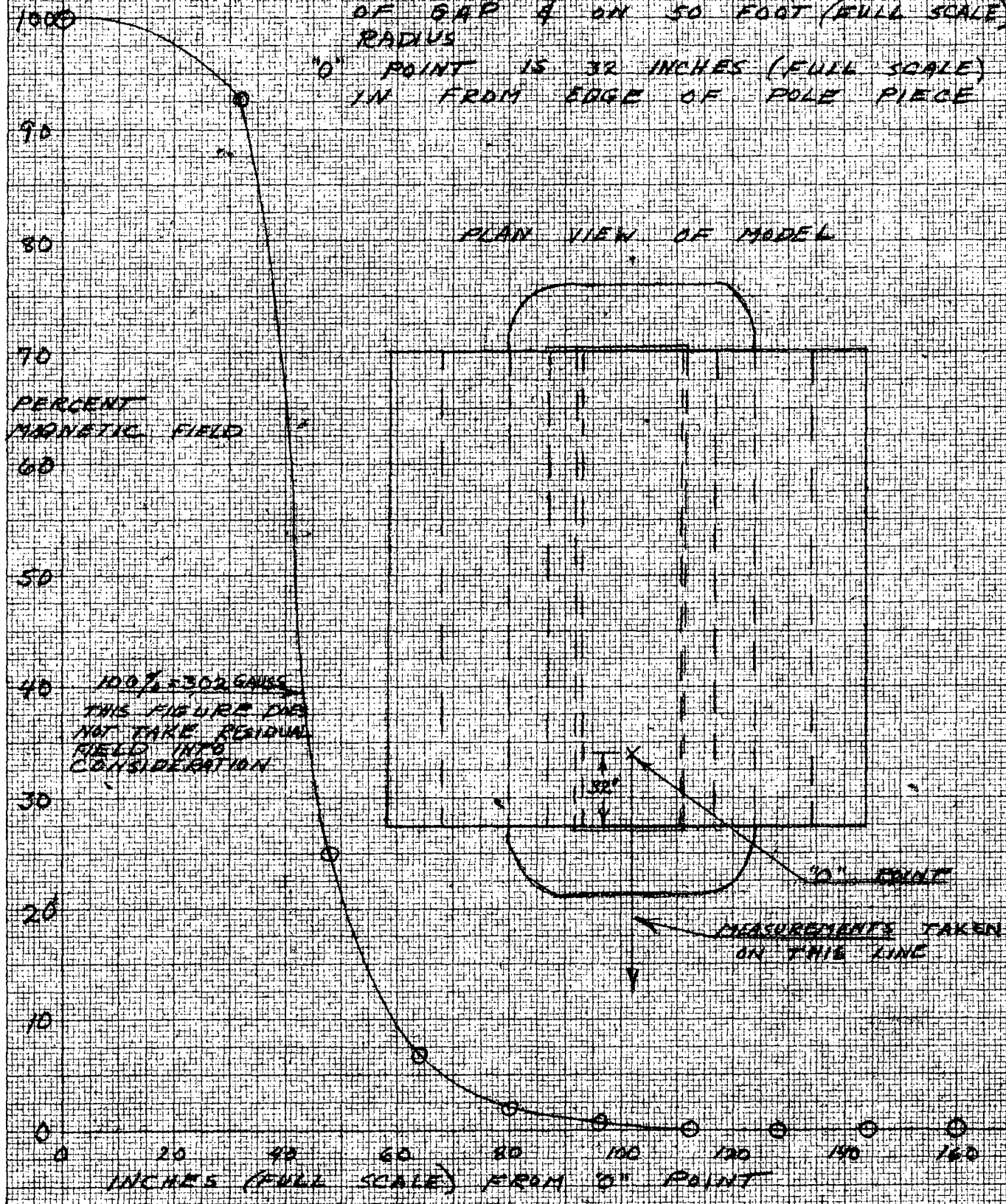
KEUFFEL & ESSER CO., N. Y. NO. 35B-11C  
10 X 10 to the 1/2 inch, 5th lines accented  
Engraving 7 X 10 in.  
MADE IN U.S.A.

ENC

124-9  
S-DC1-1

MARCH 17, 1949

STRAY FIELD  
BEVATRON MODEL MAGNET DC1  
1/4 SCALE DWG # 3L 1062A  
MEASUREMENTS ON MEDIAN PLANE  
OF GAP & ON 50 FOOT (FULL SCALE)  
RADIUS  
"O" POINT IS 32 INCHES (FULL SCALE)  
IN FROM EDGE OF POLE PIECE



DODSON

KEUFFEL & ESSER CO., N. Y. NO. 389-14  
Millimeters, 1/16th lines Dobby.  
MADE IN U. S. A.

2 Model Magnet DC4 Index

- a. Discussion
- b. Sketch
- c. Photographs

BEVA 17

- d. Graphs

L-DC4-1	Efficiency and leakage coefficients
H-DC4-1	Flux density around the magnetic path
H-DC4-2	H in the gap center
U-DC4-1	Radial uniformity
U-DC4-1a	Radial uniformity - Expanded
F-DC4-1	Coil flux linkage
F-DC4-1a	Total coil flux linkage
F-DC4-2	Coil flux linkage (Low field)
F-DC4-2a	Total coil flux linkage - low field
E-DC4-1	Stored energy

## 2 Model Magnet DC4

### a. Discussion

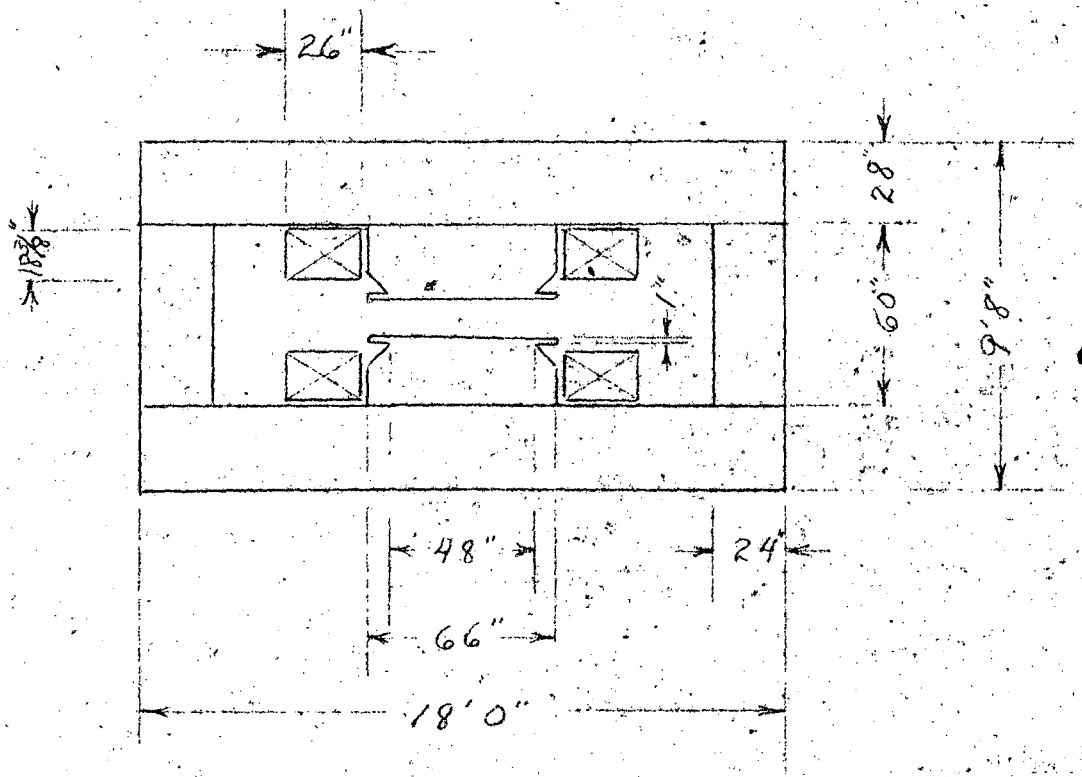
Bevatron model magnet DC4 was designed to correct faults observed in the tests made on model DC1. The thickness of the yoke slabs was increased. The distance between the yoke slabs was decreased. The height of the poles and the total radial width of the poles were decreased. Notches were cut in the pole pieces to form "wings", but the same radial width at the base of the pole was retained. The cross-sectional area of the exciting coils was decreased.

Model DC4 failed to meet some of the general specifications. (See Section II and Table I.) The peak KVA required was  $206 \times 10^3$  for a rise time of one second. The specified  $100 \times 10^3$  KVA is for a rise time of not greater than 2.0 seconds. The radial width of the usable field at injection field was 40 inches instead of the specified 48 inches.

A comparison of magnet performance on DC4 and DC1 shows some improvements. The number of ampere turns required was decreased from  $9.0 \times 10^5$  to  $7.0 \times 10^5$ . The peak KVA required was decreased from  $236 \times 10^3$  to  $206 \times 10^3$  for a rise time of one second. The useful gap width at 16 kilogauss field was increased from 5 inches to 18 inches. The efficiency of the magnet was increased from 50 percent to 65 percent.

It was decided to change the profile of the pole pieces to increase the useful width of the magnetic field at the injection field. (See DC4B and DC4C.)

# BEVATRON MODEL MAGNET DC 4



GAP 14"

RADIUS 50'

$n = 0.75$

MODEL COILS: 4 COILS 23 TURNS EACH = 92 TURNS

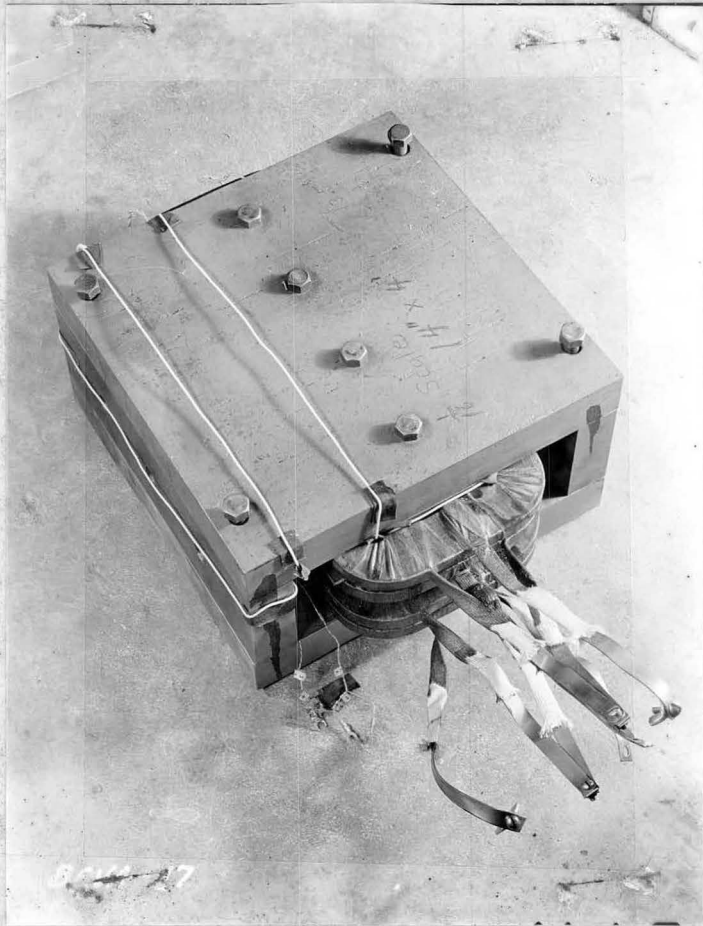
DIMENSIONS ARE FULL SCALE

MODEL IS  $1/16$  SCALE

ASSEMBLY DWG. 341292

POLE TIP DWG. 341262-1

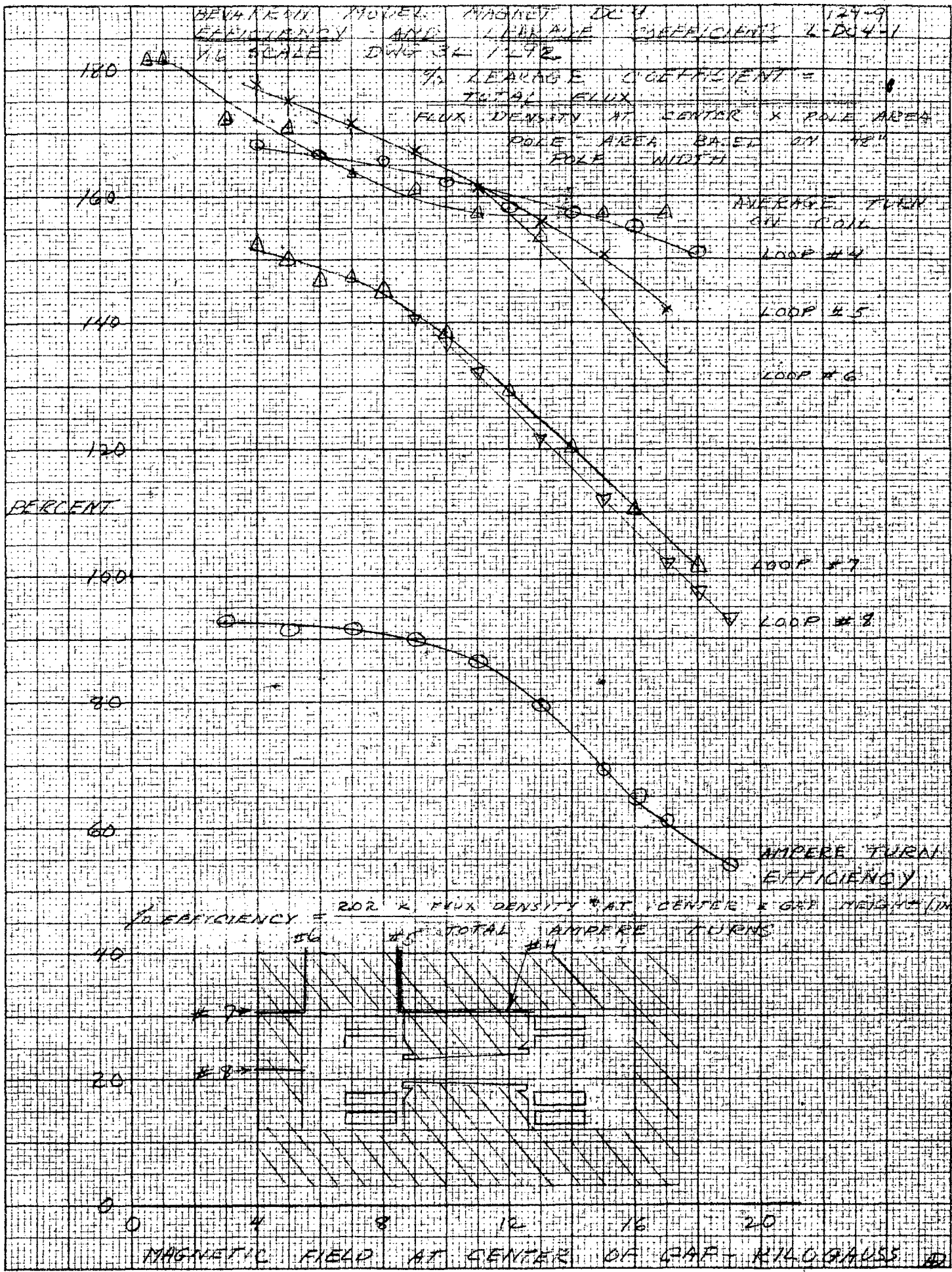




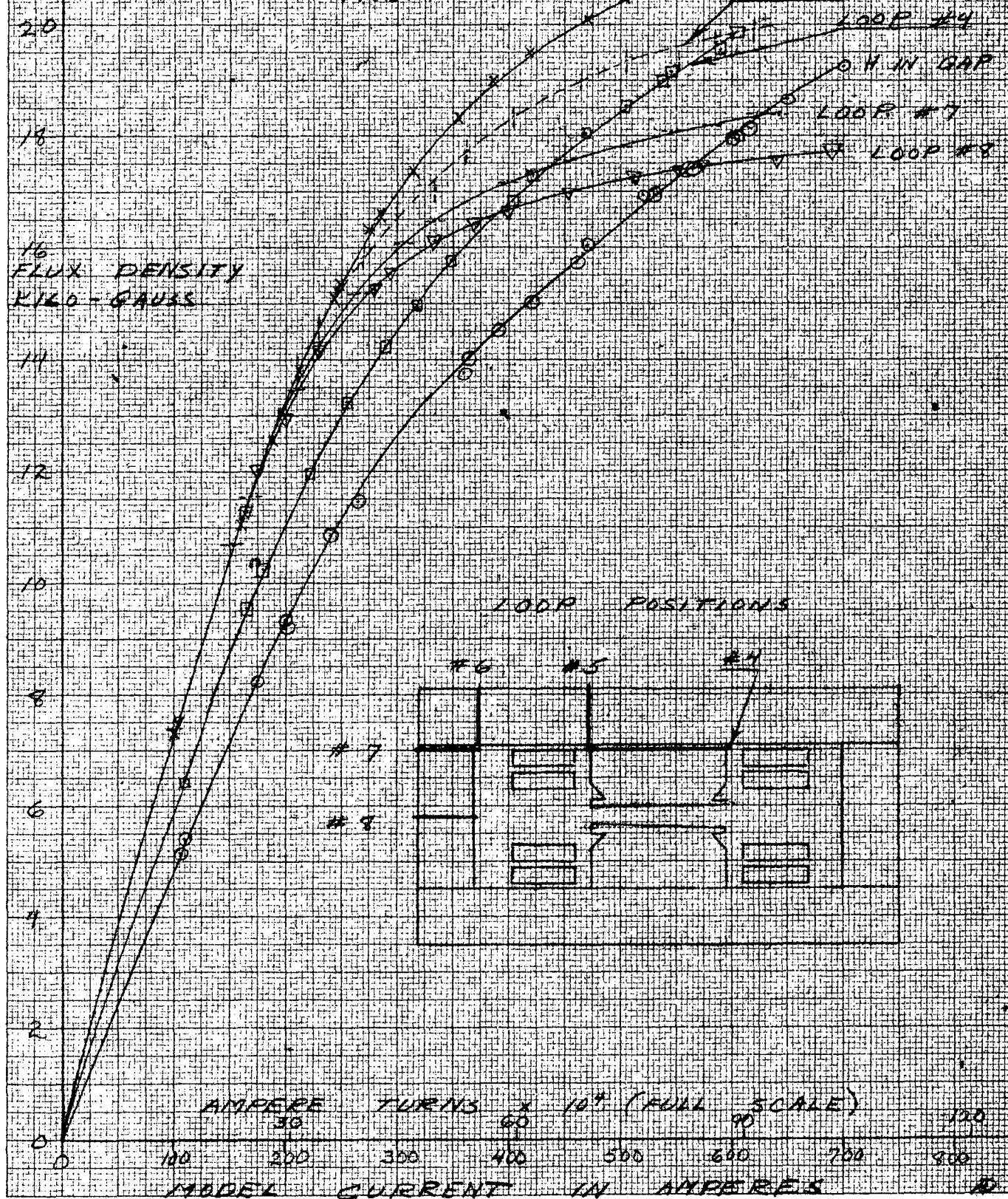
BEVA 17

Bevatron model magnet DC4

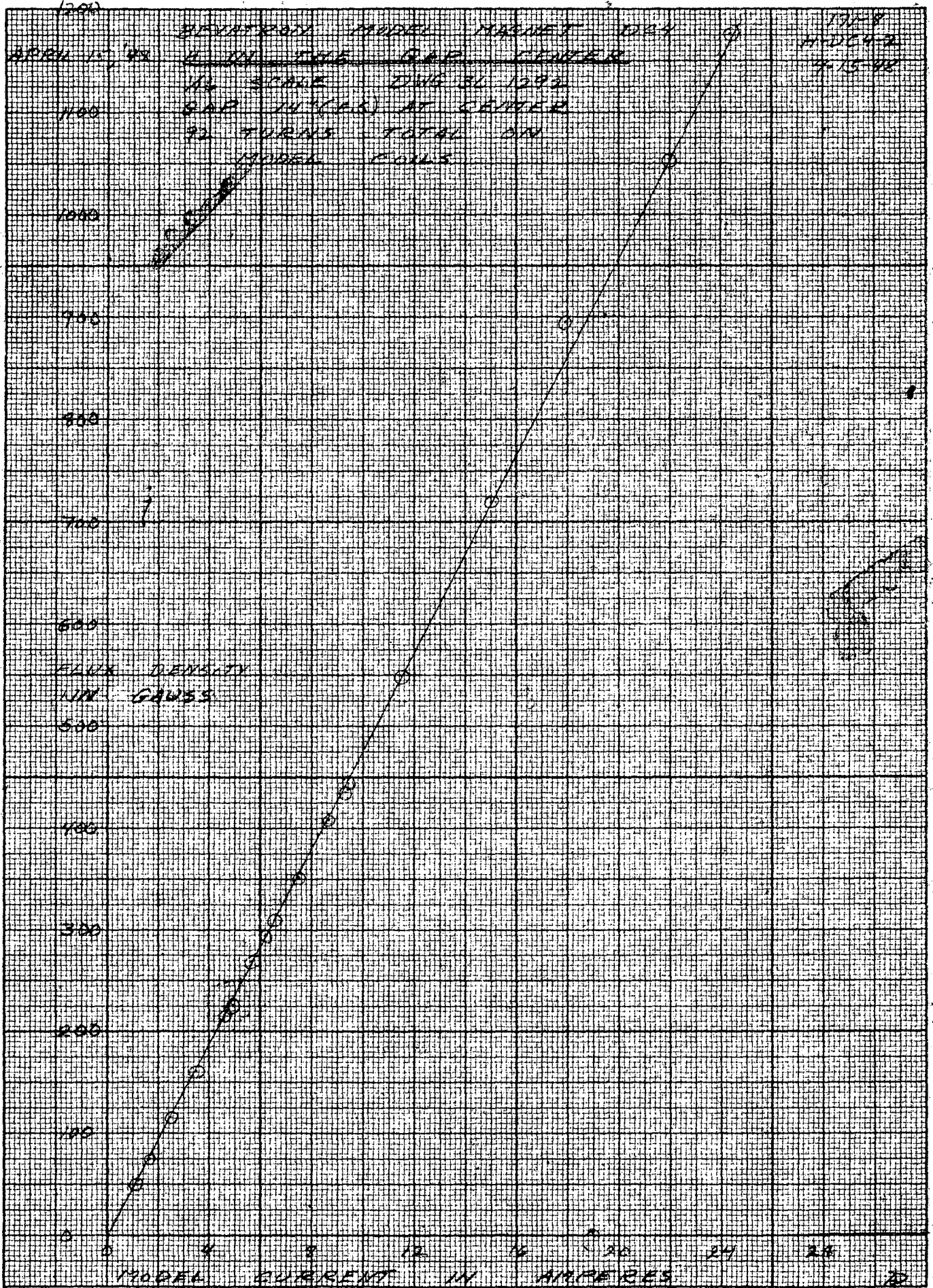
KEUFFEL & ESSER CO., N. Y. NO. 89-150  
 10 X 18 to the 1/2 Inch, 300 lines acented.  
 MADE IN U. S. A.



DEVIATION MODEL MAGNET DC 1 124-9  
 FLUX DENSITY AROUND MAGNETIC M-DC 4-1  
 APRIL 1, '48 PATH " 4-1-48  
 1/16 SCALE DWA 34 1292A  
 GAP 14" AT CENTER (FULL SCALE)  
 90 TURNS TOTAL ON MODEL COILS

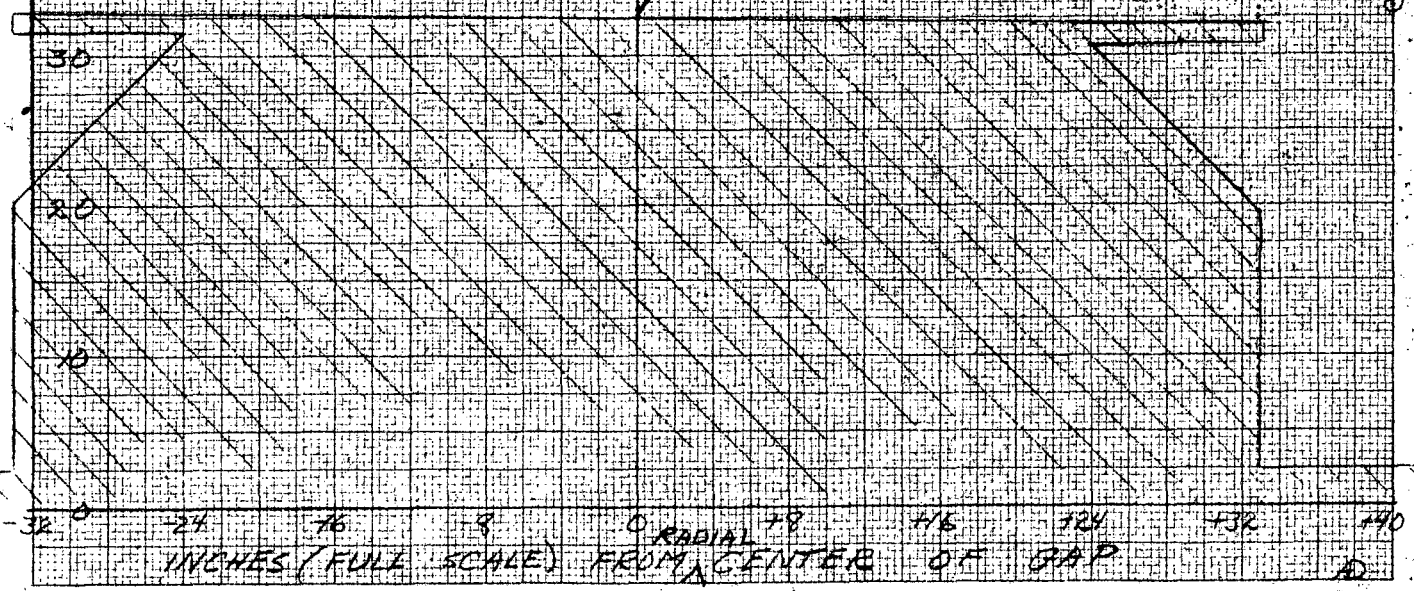
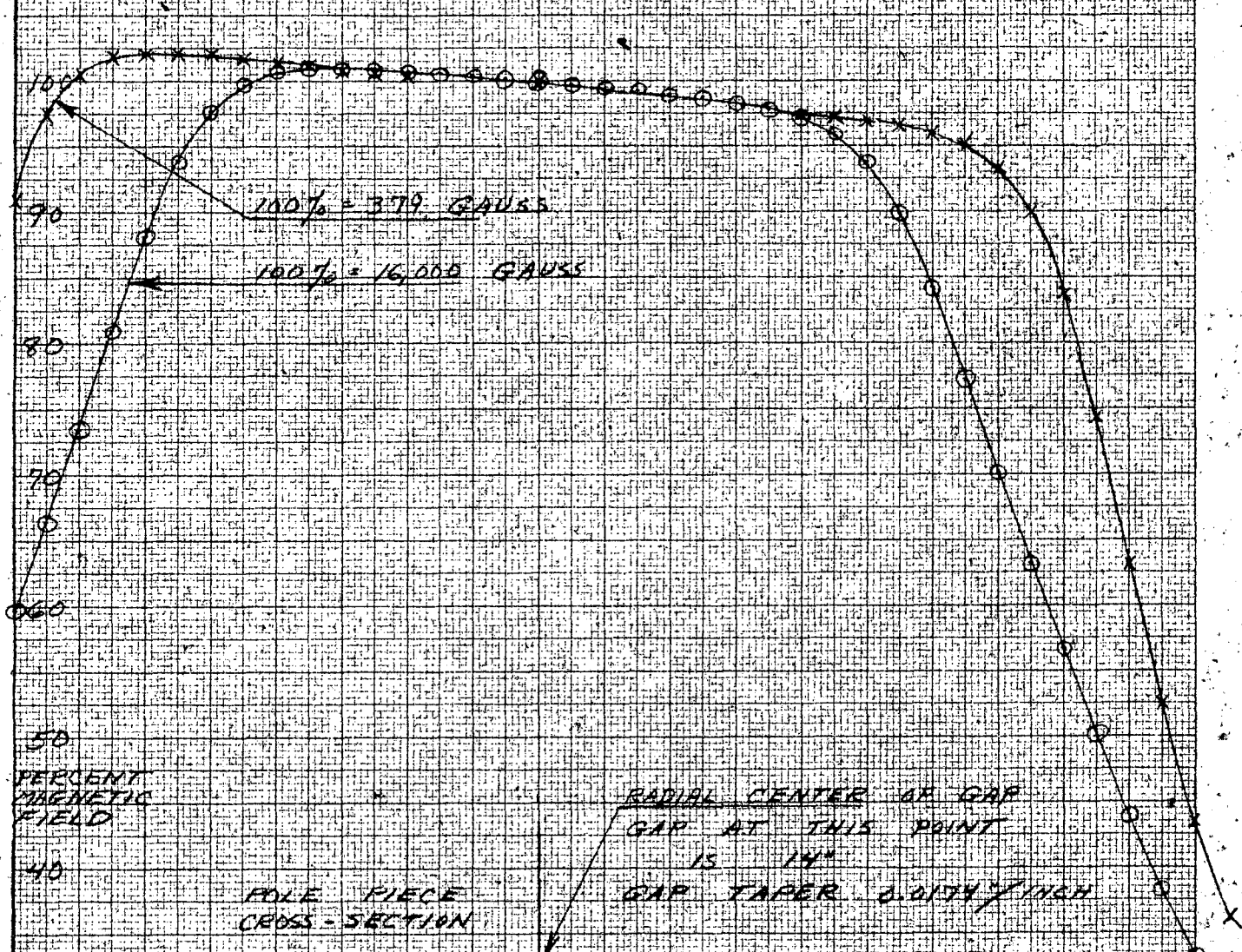


KRUFFEL & ESSER CO., N. Y. NO. 369-14  
 Millimeters, 10th lines heavy.  
 MADE IN U.S.A.



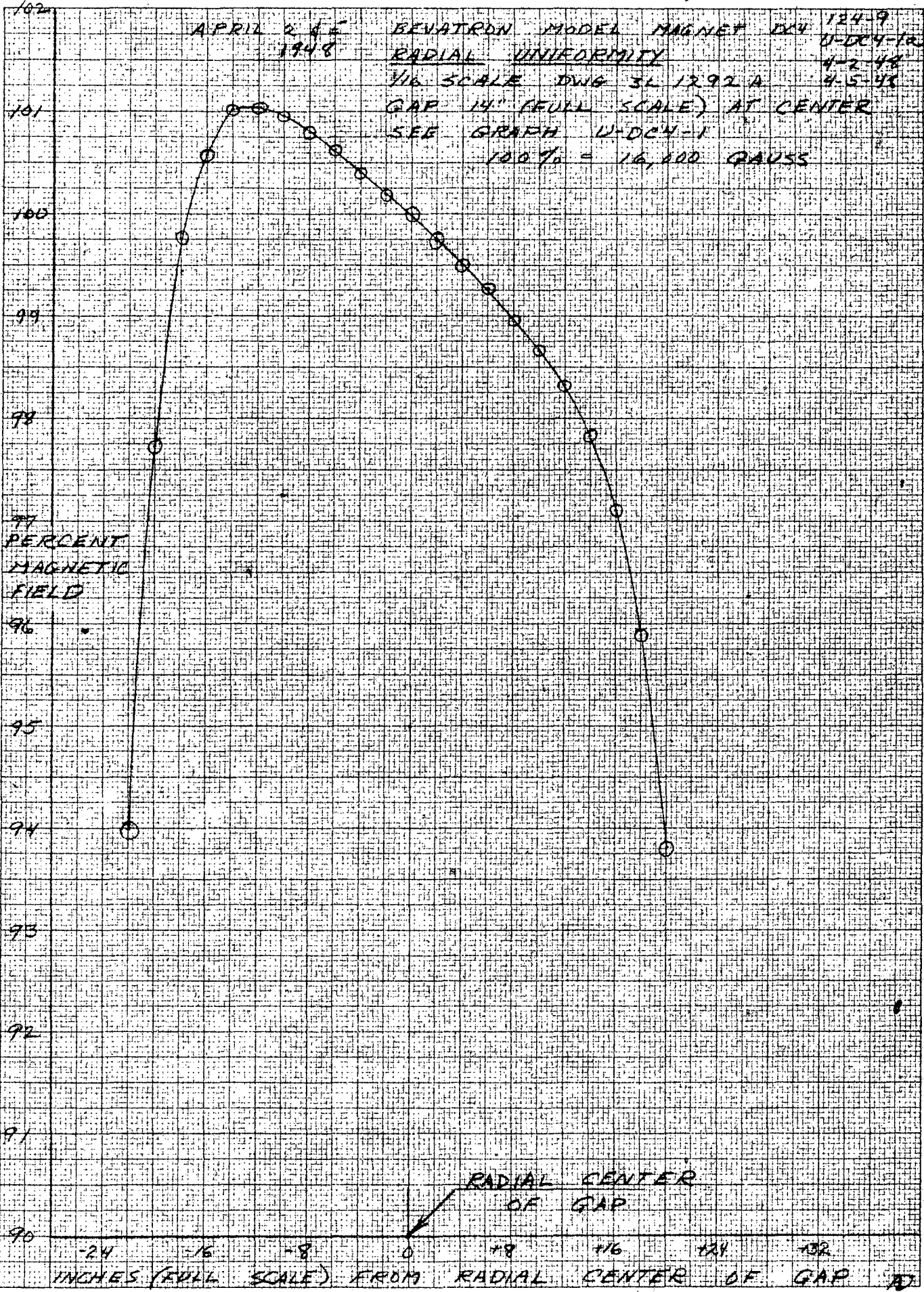
BEYHIEON MODEL MAGNET DC9  
 APRIL 24 1948 RADIAL UNIFORMITY  
 1/16 SCALE DWG 3L 1292 A  
 GAP 14" AT CENTER (FULL SCALE)  
 MEASUREMENTS ON MEDIAN PLANE OF GAP

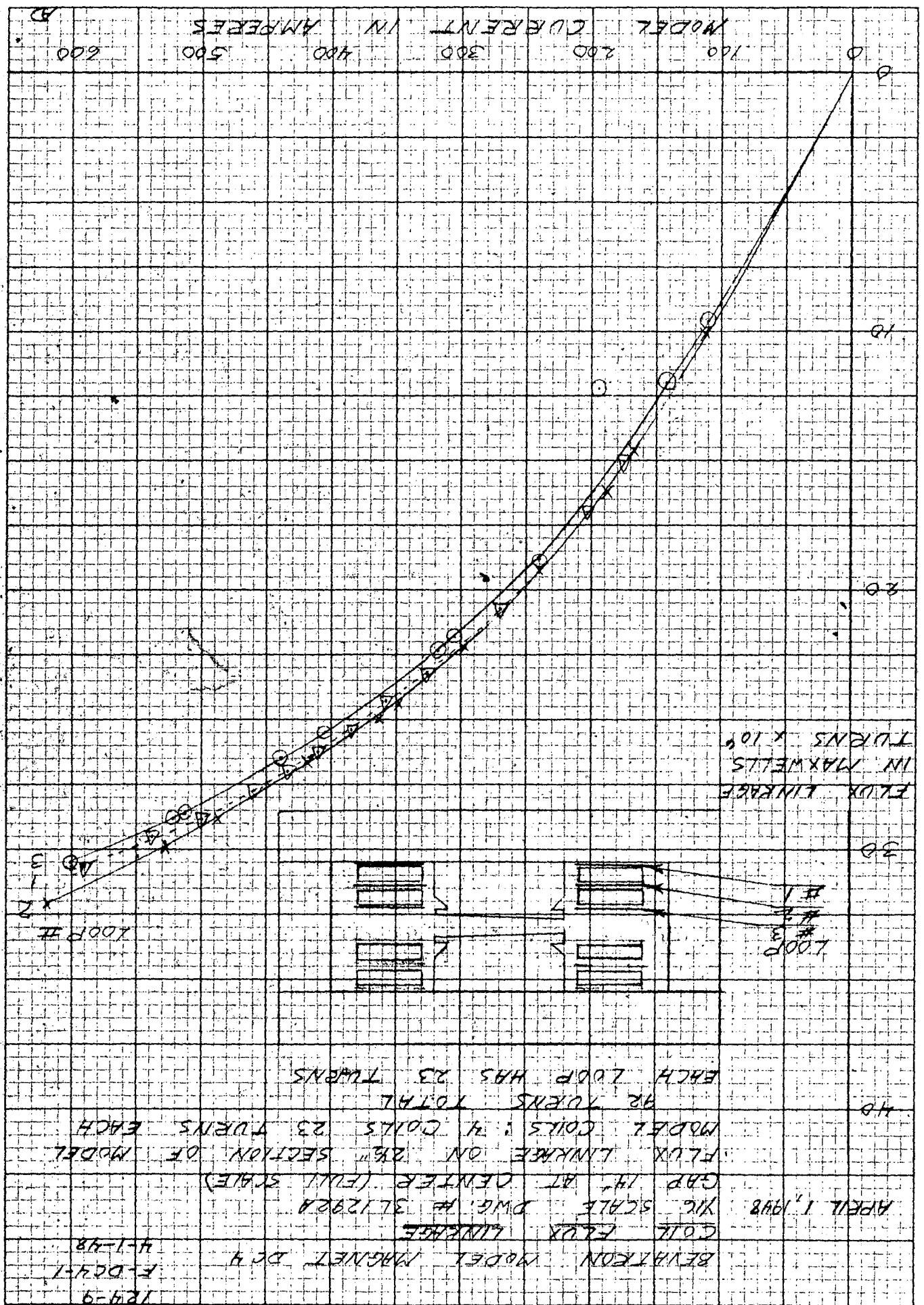
12419  
 U-DCW-1  
 4-2-48  
 4-5-48



KEUFFEL & ESSER CO. N. Y. NO. 368-14  
 Millimeters, Inch, Jipon heavy.  
 MADE IN U. S. A.

MCUFFEL & ESSER CO., N. Y. NO. 360-14  
Millimeters, (with large brass)  
MADE IN U.S.A.





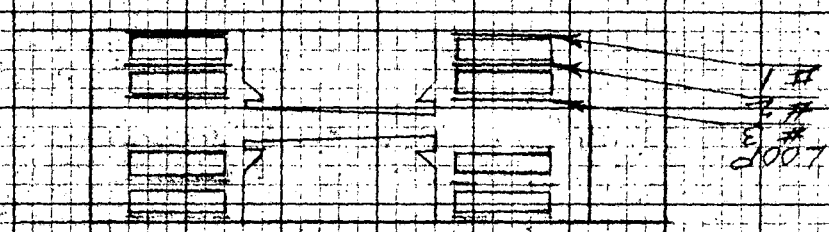
124-9  
 F-DC-1  
 4-1-48

BEVATRON MODEL MAGNET DC  
 COIL FLUX LINKAGE

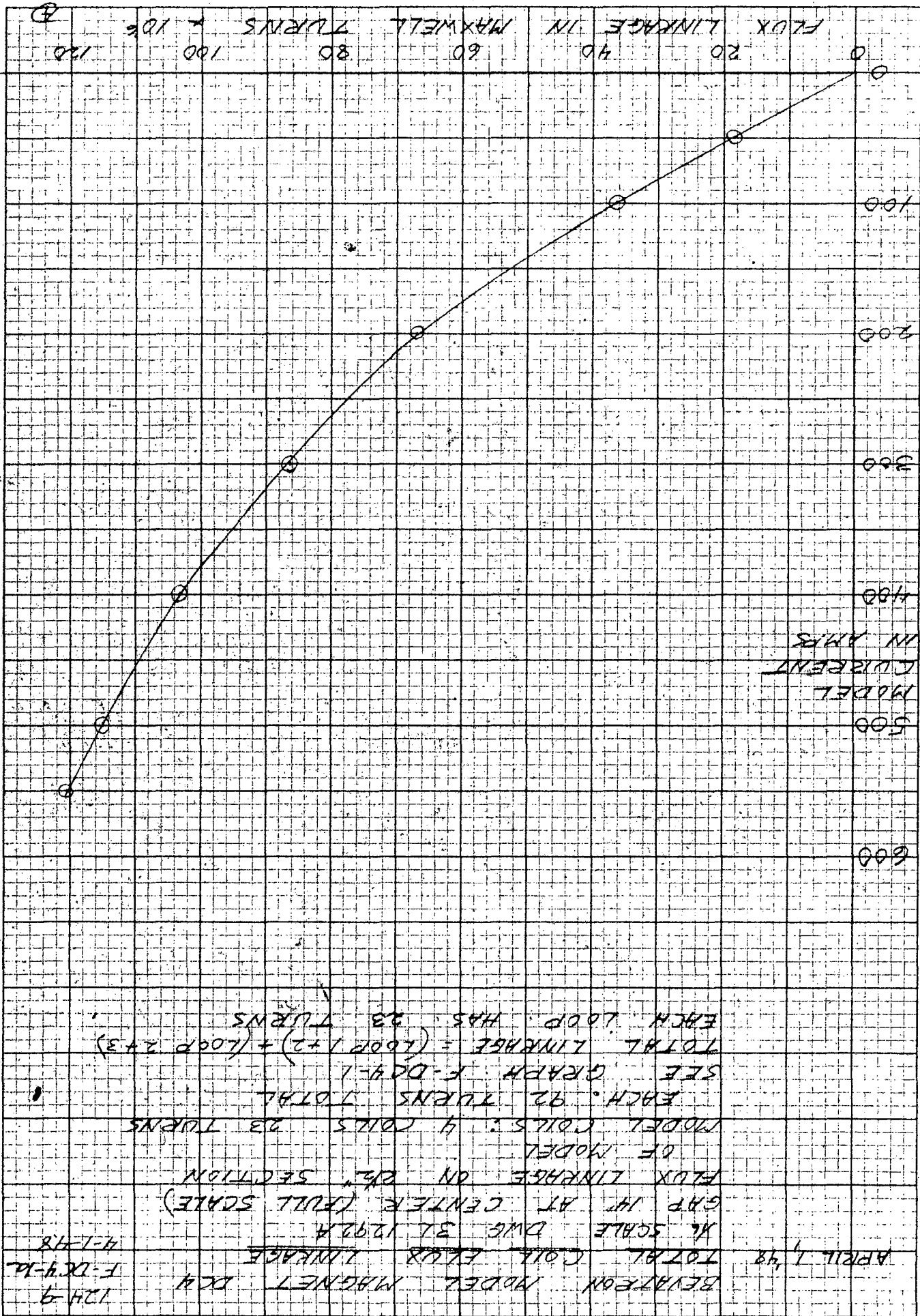
APRIL 1, 1948

Y/C SCALE DWG. # 31292A  
 GAP 1/4" AT CENTER (FULL SCALE)

FLUX LINKAGE ON 2 1/2" SECTION OF MODEL  
 MODEL COILS: 4 COILS 23 TURNS EACH  
 92 TURNS TOTAL  
 EACH LOOP HAS 23 TURNS



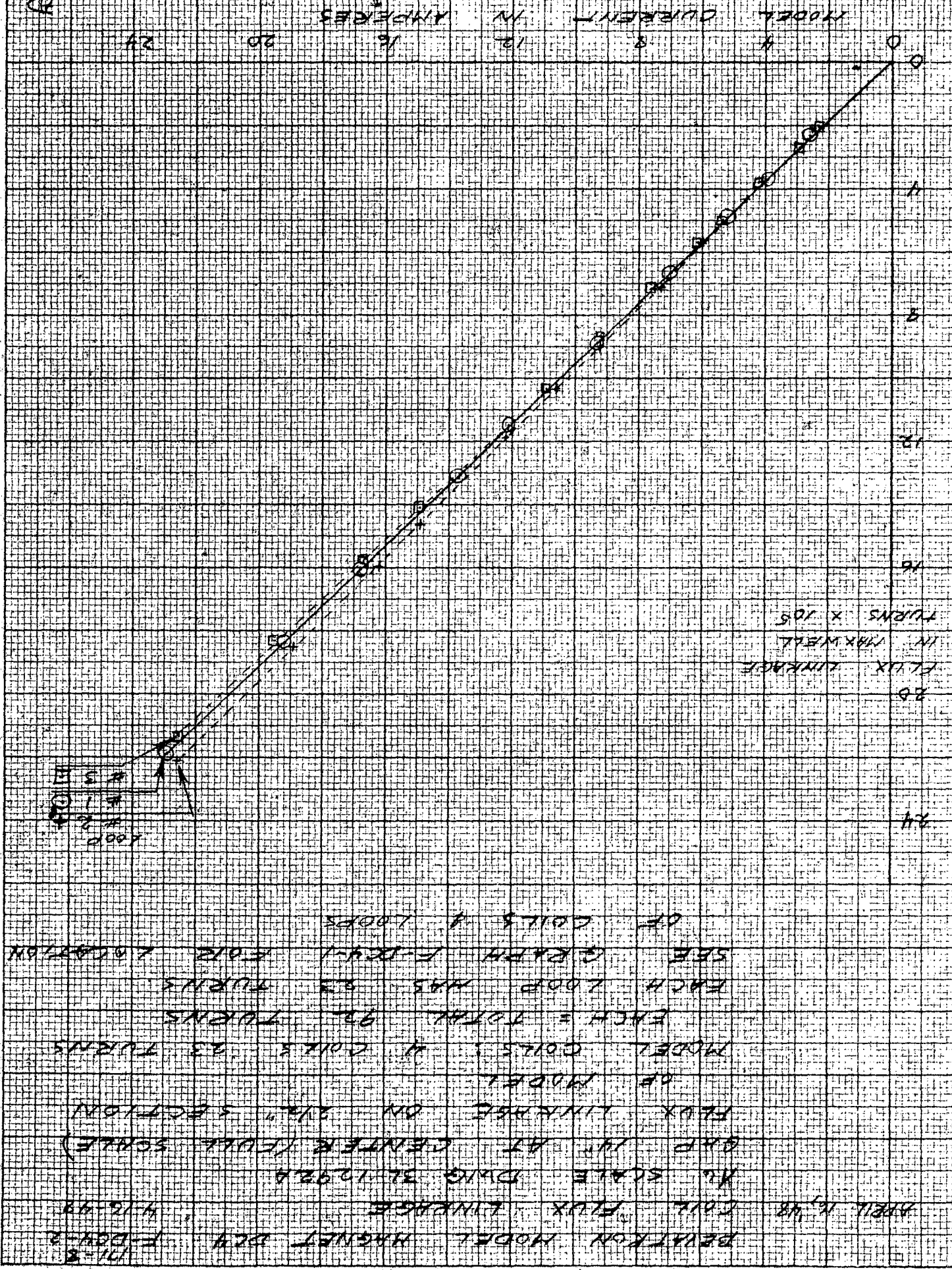
LOOP #1  
 #2  
 #3  
 #4



BEATEON MODEL MAGNET DC4  
 APRIL 1, 1948  
 TOTAL COIL FLUX LINKAGE  
 124-9  
 F-124-14  
 4-1-48

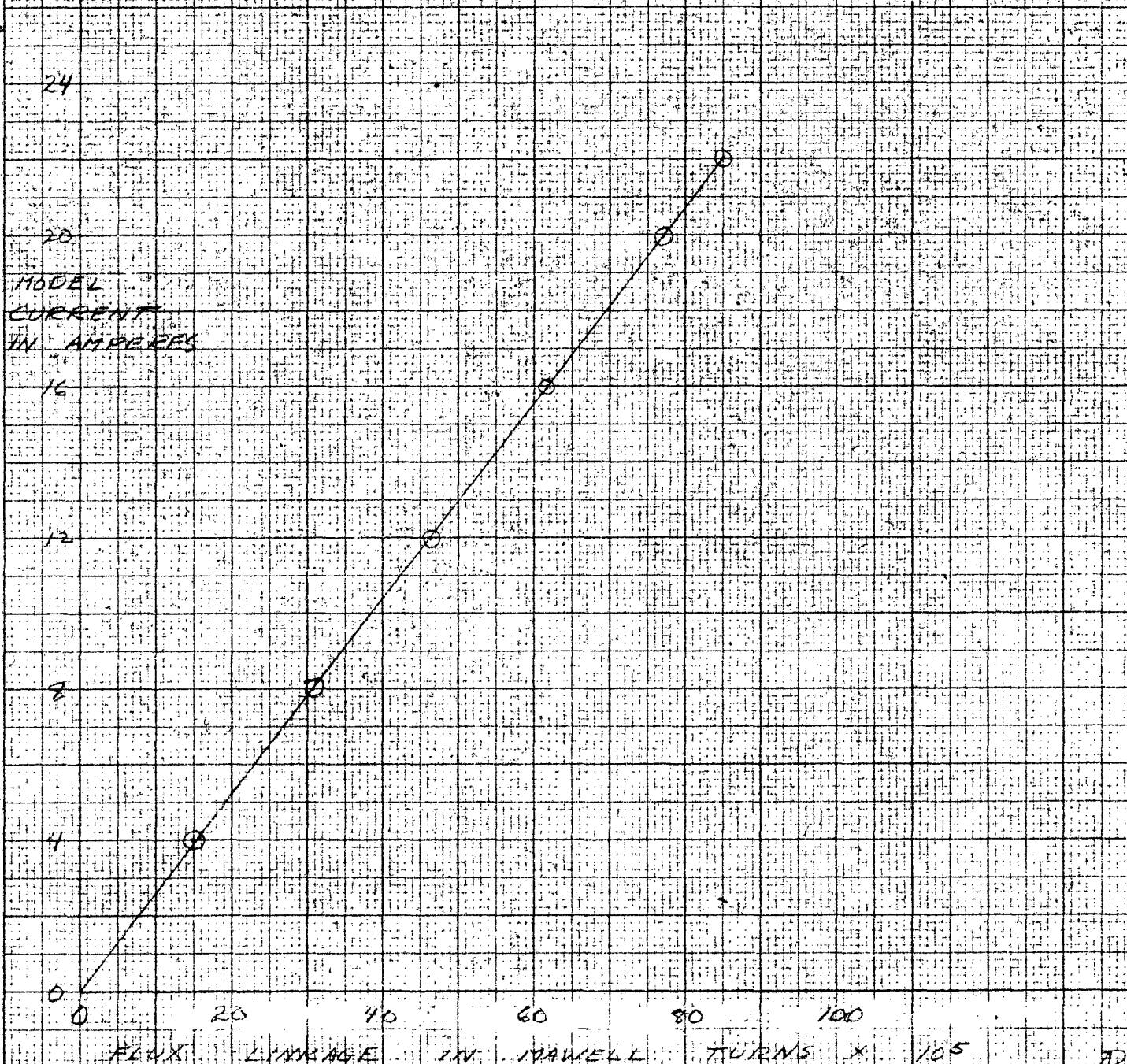
GAFF IN AT CENTER (FULL SCALE)  
 FLUX LINKAGE ON CH. SECTION  
 OF MODEL  
 MODEL COILS: 4 COILS 23 TURNS  
 EACH. 92 TURNS TOTAL  
 SEE GRAPH F-D4-1  
 TOTAL LINKAGE = (LOOP 1+2) + (LOOP 2+3)  
 EACH LOOP HAS 23 TURNS





BEATSON MODEL MAGNET BEY F-204-2  
 475-48  
 COIL FLUX LINKAGE  
 NO. SCALE DIVID 321092.8  
 G.P. IN AT CENTER (FOOT SCALE)  
 FLUX LINKAGE ON 1/2" SECTION  
 OF MODEL  
 MODEL COILS: 4 COILS 23 TURNS  
 EACH TOTAL 92 TURNS  
 EACH LOOP HAS 23 TURNS  
 SEE GRAPH BELOW FOR LOCATION  
 OF COILS & LOOPS

BEVATRON MODEL MAGNET D-4  
 APRIL 16, '48 TOTAL COIL FLUX LINKAGE F-DC4-2a  
 1/6 SCALE DWR 31 1292A 4-16-48  
 GAP 1/4" AT CENTER (FULL SCALE)  
 FLUX LINKAGE IN 2 1/2" SECTION  
 OF MODEL  
 MODEL COILS 4 COILS 23 TURNS  
 EACH = TOTAL 92 TURNS  
 EACH LOOP HAS 23 TURNS  
 SEE GRAPH F-DC4-2  
 TOTAL LINKAGE = LOOP (4+2) + (2+3)



KEUFFEL & ESSER CO., N. Y. NO. 880-120  
 10 X 10 in. the 1/4 inch. 50% lines reserved  
 MADE IN U.S.A.

240

BEVATRON MODEL MAGNET DC4 124-9  
STORED ENERGY E-DC4-1

APRIL 1, 1948 1/16 SCALE DWB SL 1292A 4-1-48

200

STORED ENERGY CALCULATED  
FROM TOTAL COIL FLUX LINKAGE  
SEE GRAPH E-DC4-10

ENERGY (Joules) =  $10^{-8} I^2 \lambda$   
WHERE I IS IN AMPERES &  $\lambda$  IS  
IN MAXWELL TURNS  
DATA IS FOR 2 1/4" SECTION ON  
MODEL

150

100

160  
MODEL  
STORED  
ENERGY  
170  
IN JOULES

120

100

80

60

40

20

0

MAGNETIC FIELD AT CENTER OF GAP - KILOGAUSS

0 2 4 6 8 10 12 14 16

AD

KEUFFEL & ESSER CO., N. Y. NO. 369-14  
Millimeter, Inch, Drive Runny.  
MADE IN U.S.A.

### 3 Model Magnet DC4B Index

a. Discussion

b. Sketch

c. Graphs

H-DC4B-1	H in gap center
U-DC4B-1	Radial uniformity
U-DC4B-1a	Radial uniformity - Expanded

### 3 Model DC4B

#### a. Discussion

Bevatron model magnet DC4B was designed to try to increase the useful radial width of the magnetic field at the injection field by changing the profile of the pole pieces of model DC4. The outer 3" on each "wing" of the pole was bent slightly toward the gap center. This was the only change from model DC4. Although this change did not give the proper shaped magnetic field it was concluded from these measurements that the useful gap width at the injection field could be increased to approximately 50 inches by making small changes in the shape of the wings. The pole pieces were not further modified to obtain the desired field at this time. Otherwise, the performance of model DC4B was similar to that of DC4 on the basis of the measurements which were made.

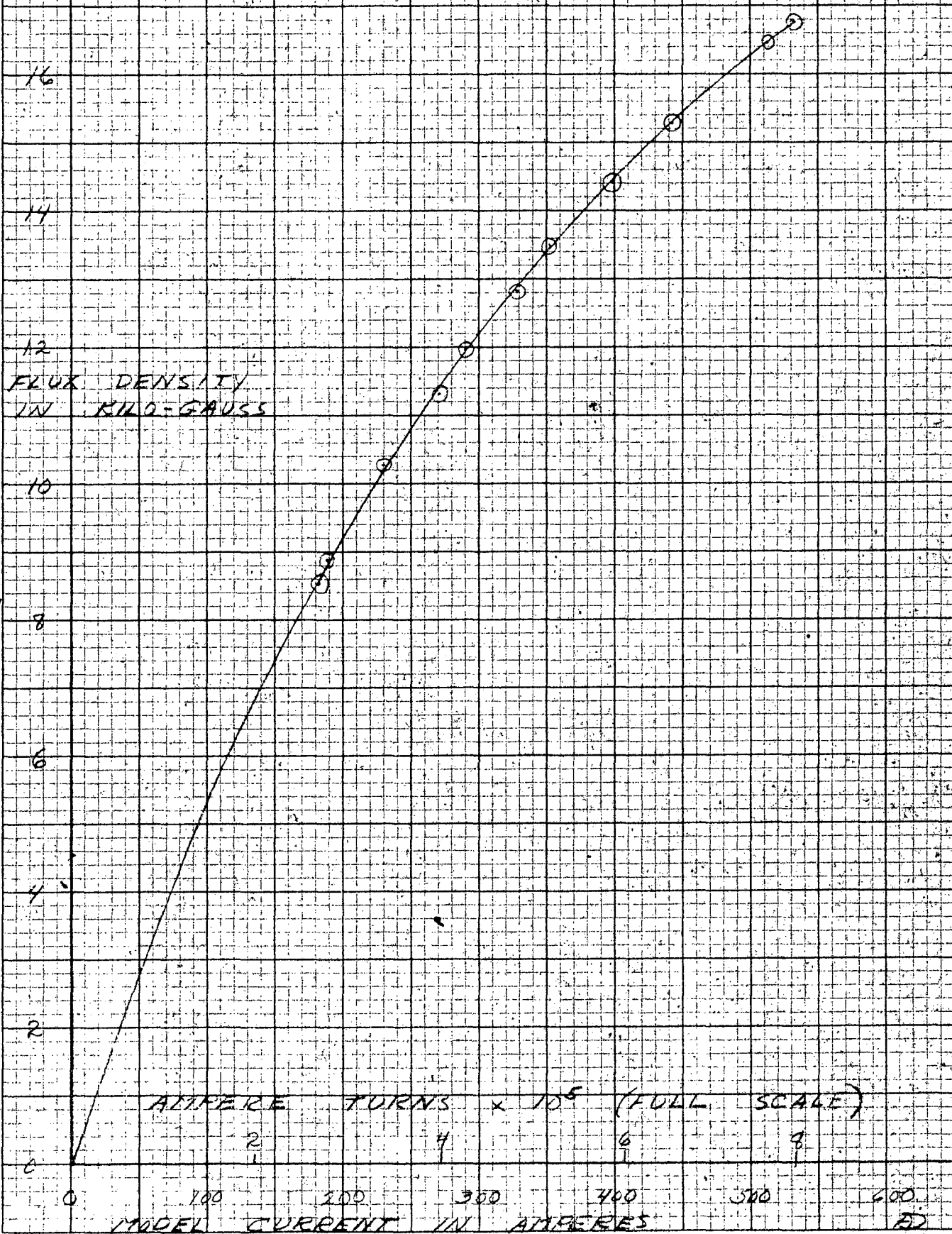
BEVATRON MODEL MAGNET DC 4 B



GAP 0.038"  
 RADIUS 50"  
 $\mu = 0.75$   
 MODEL COILS 4 COILS 23 TURNS EACH = 92 TURNS  
 DIMENSIONS ARE FULL SCALE  
 MODEL 15 1/16 SCALE  
 ASSEMBLY DWG # 31 1292  
 POLE TIP DWG 31 1262-2

H IN GAP CENTER

APR. 23, 1948 BEYATRON MODEL MAGNET 171-8  
 DC 4B - 1/16 SCALE DWG. 34 1292 N. DC 4B-1  
 GAP 19" (F.S.) AT CENTER 4-23-48  
 92 TURNS TOTAL IN MODEL COILS



KEUFFEL & ESSER CO., N. Y. NO. 389-6  
 5 x 5 to the 1/2 inch.  
 MADE IN U.S.A.

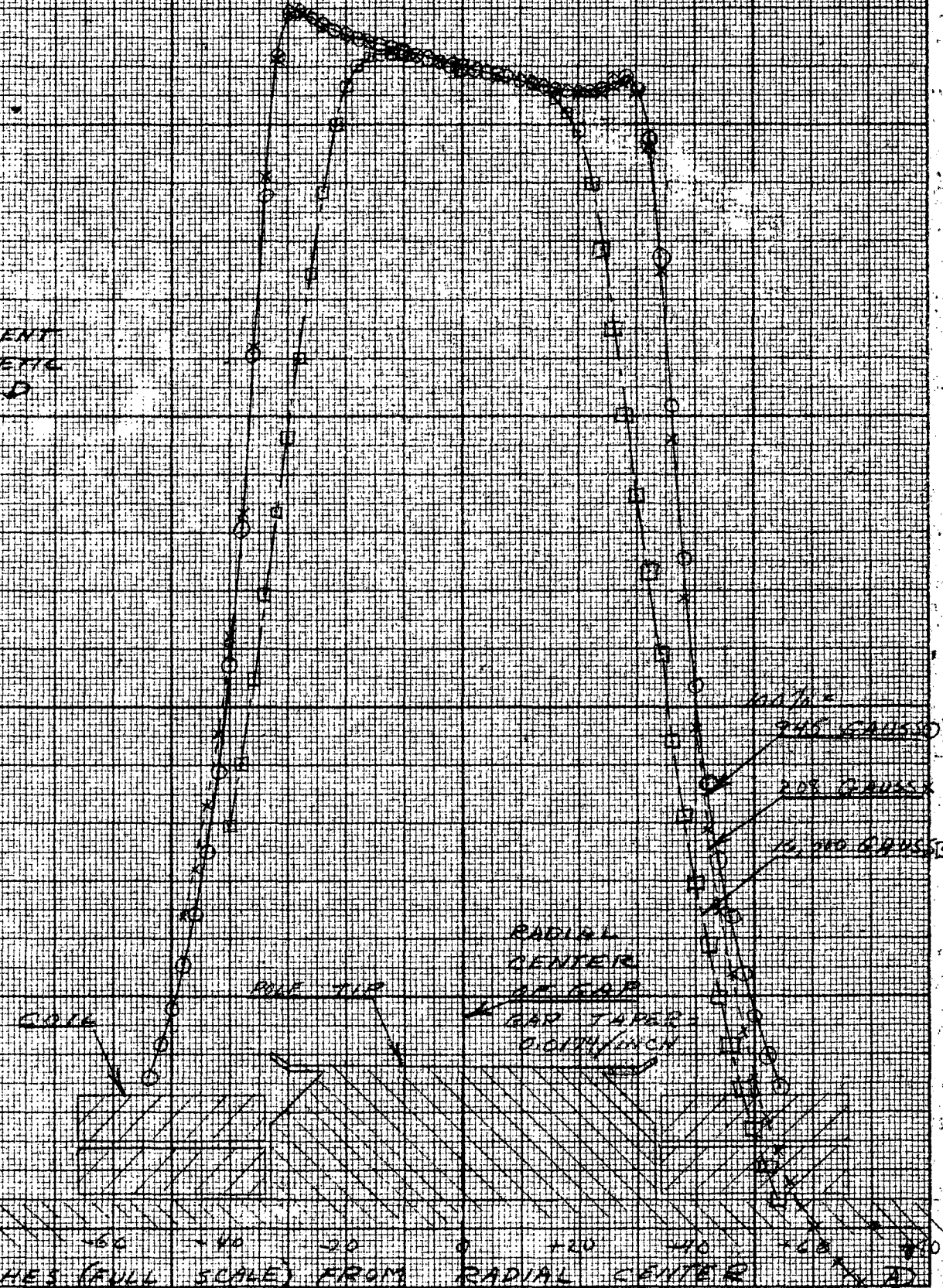
171-8

BEVATRON MODEL MAGNET CORE  
 RADIAL UNIFORMITY  
 70 SCALE DATE 31 1958  
 GAP IN AT CENTER (FULL SCALE)  
 MEASUREMENTS IN MEDIUM PLANE OF GAP

100  
 90  
 80  
 70  
 60  
 50  
 40  
 30  
 20  
 10  
 0

PERCENT  
 MAGNETIC  
 FIELD

0 -60 -40 -20 0 20 40 60 80  
 INCHES (FULL SCALE) FROM RADIAL CENTER



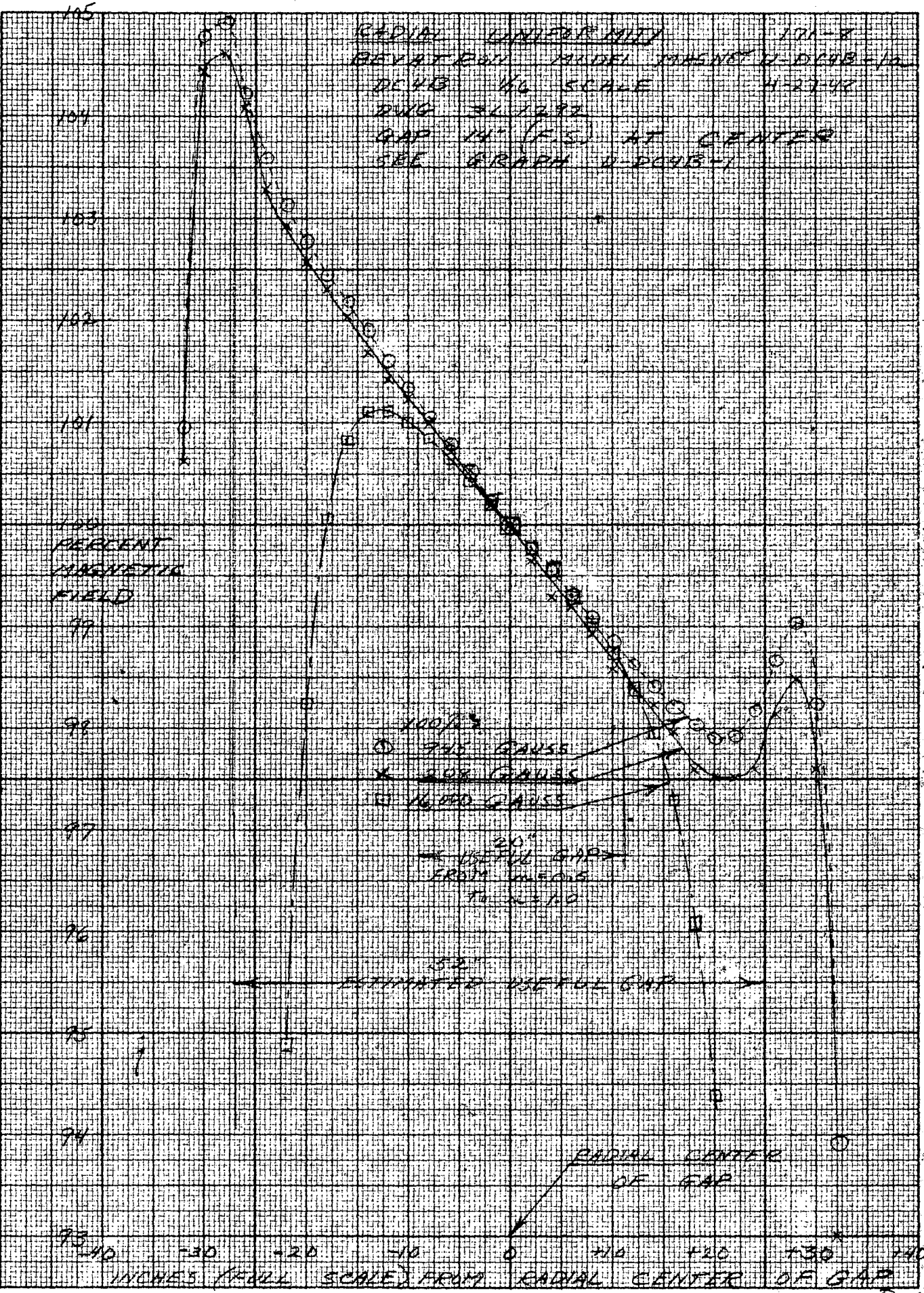
EUGENE DIETZGEN CO.  
 PRINTED IN U.S.A.

NO. 340 - M DIETZGEN GRAPH PAPER  
 MILLIMETER



EUGENE DIETZGEN CO.  
PRINTED IN U. S. A.

NO. 340 - M DIETZGEN GRAPH PAPER  
MILLIMETER



#### 4 Model Magnet DC4C Index

a. Discussion

b. Sketch

c. Graphs

L-DC4C-1	Efficiency and leakage coefficients
H-DC4C-1	Flux density around the magnetic path
U-DC4C-1	Radial uniformity
U-DC4C-1a	Radial uniformity - Expanded
F-DC4C-1	Coil flux linkage
F-DC4C-1a	Total coil flux linkage
E-DC4C-1	Stored energy

#### 4 Model Magnet DC4C

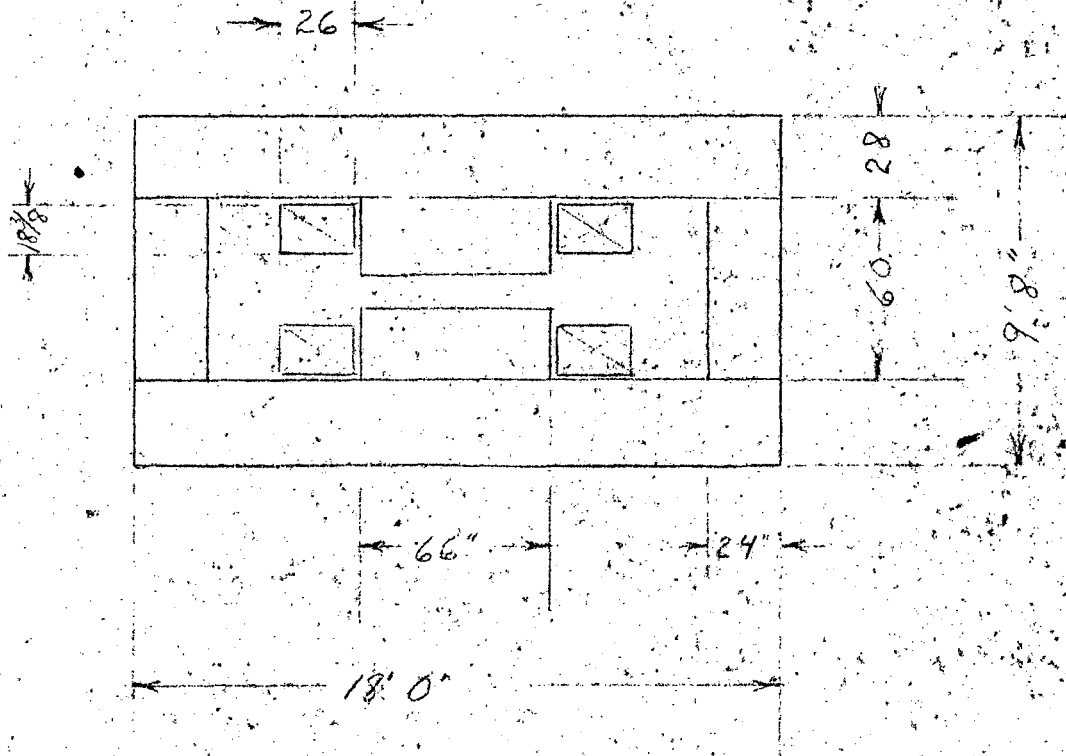
##### a. Discussion

Bevatron model magnet DC4C was designed to observe the difference in magnet performance caused by a solid pole piece. The pole pieces were designed with straight sides, without notches or "wings". This was the only change from model DC4.

Model Magnet DC4C failed to meet some of the general specifications. (See Section II and Table I.) The number of ampere turns required was  $8.0 \times 10^5$  instead of  $7.35 \times 10^5$  as specified. The peak KVA required was  $256 \times 10^3$  for a rise time of one second. The specified  $100 \times 10^3$  KVA is for a rise time of not greater than 2.0 seconds. The maximum stored energy was 97 megajoules instead of 80 megajoules as specified.

A comparison of magnet performance on DC4 and DC4C shows some differences. The number of ampere turns required was increased from  $7 \times 10^5$  to  $8 \times 10^5$ . The peak KVA required was increased from  $206 \times 10^3$  to  $256 \times 10^3$  KVA for a rise time of one second. The useful radial width of the magnetic field at the injection field was increased from 40 inches to 46 inches. The efficiency of the magnet decreased from 65% to 56percent. The maximum stored energy increased from 80 megajoules to 97 megajoules. It was concluded from the preceding comparison of models DC4 and DC4B that the "winged" poles are more efficient for this type magnet. The next type B model was DC6.

# BEVATRON MODEL MAGNET DC 4C



GAP 14"

RADIUS 50'

$n = 0.75$

MODEL COILS : 4 COILS 23 TURNS EACH = 92 TURNS

DIMENSIONS ARE FULL SCALE

MODEL IS 1/16 SCALE

ASSEMBLY DWG. 3L 1292

POLE TIP DWG. 3L 1392

May 5, 1949

Hewlett-Packard Model Magnet DC 4G  
Efficiency and Leakage Coefficients

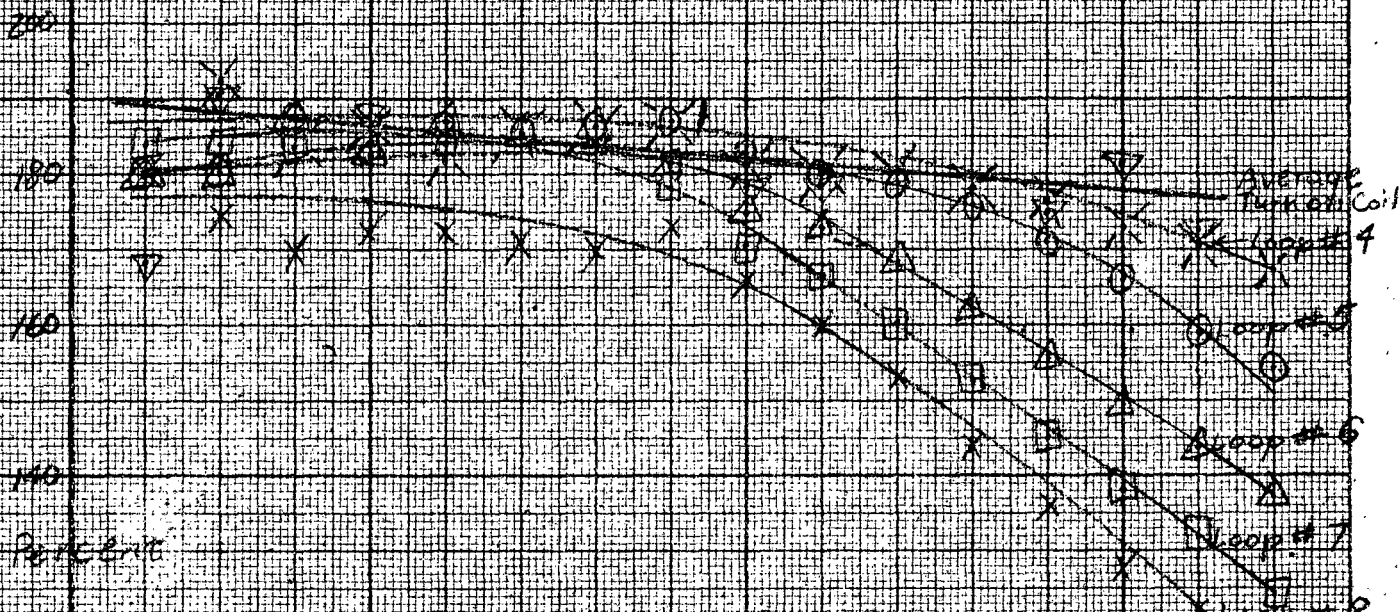
1/16 Scale DWG 311392 (pole tip)

% Leakage Coefficient =

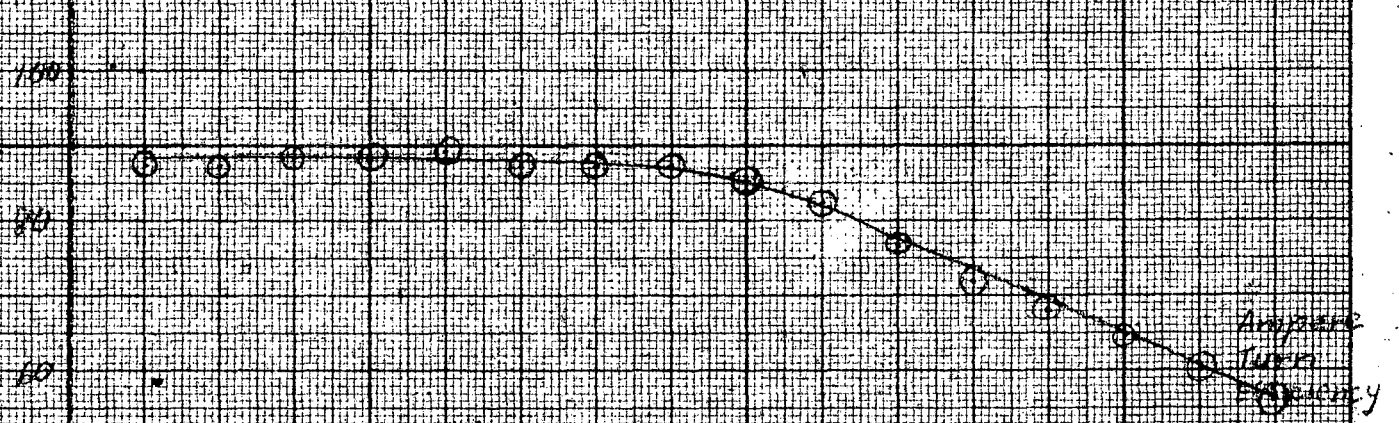
Total Flux

Flux Density at Center of Pole Area  
Pole Area Based on 48" Width

171-8  
1-D5AC  
5-5-48



% Efficiency =  $2.02 \times \text{Flux Density at Center} \times \text{Gap Height (inches)}$   
Total Ampere Turns



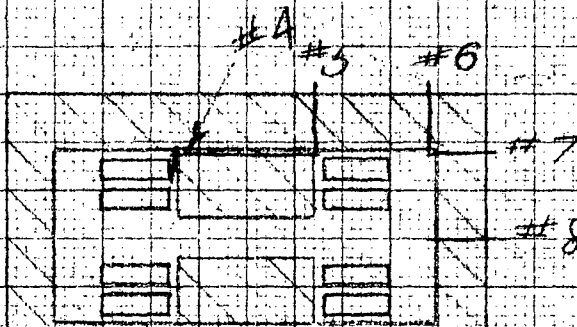
Magnetic Field at Center of Gap - Kilo Gauss

EMUC

EUGENE DIETZGEN CO.  
PRINTED IN U.S.A.

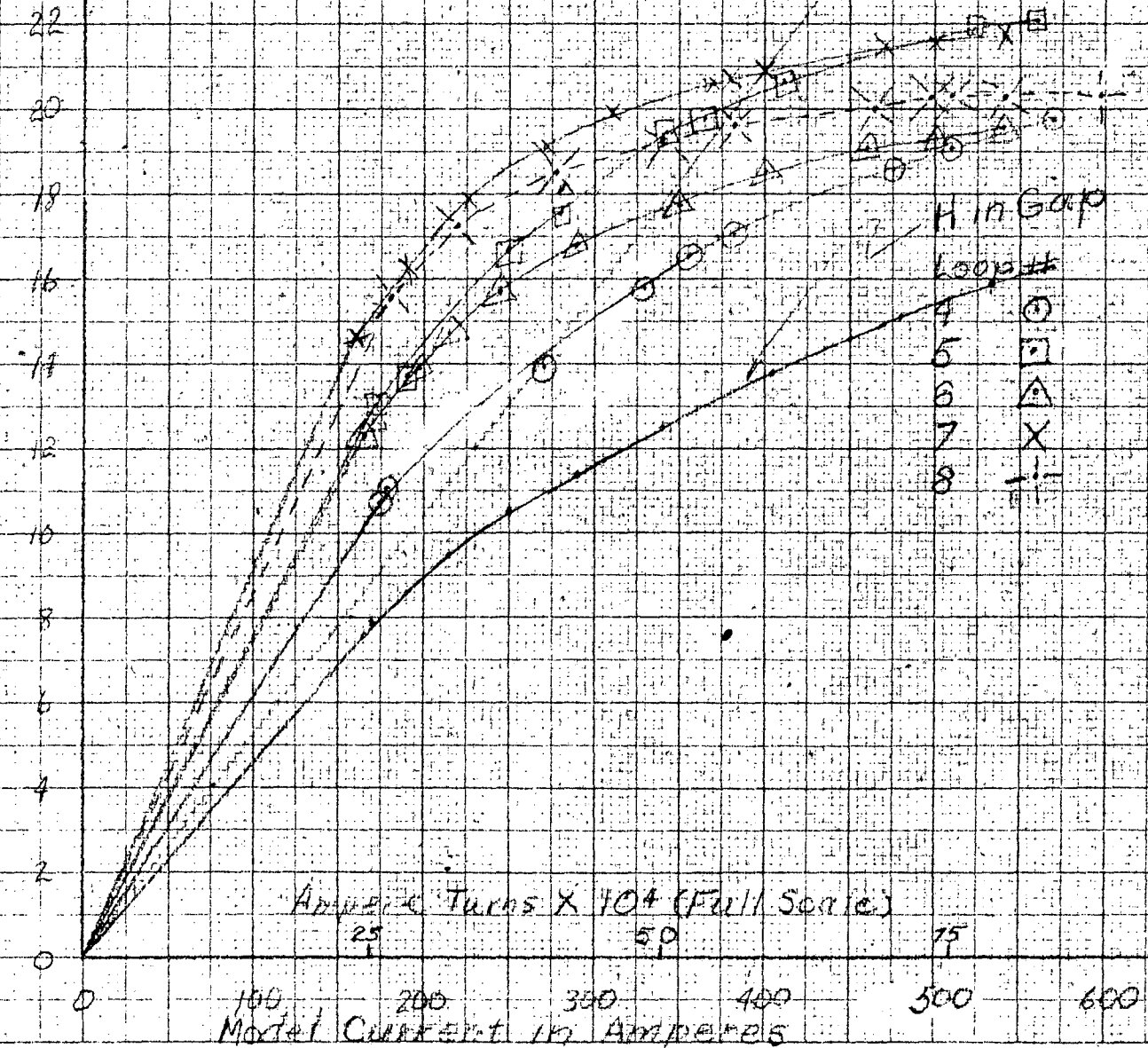
NO. 340 - M - DIETZGEN GRAPH PAPER  
MILLIMETER

April 29, 1948 *Bevatron Model Magnet DC4C* #171-8  
 Flux Density Around Magnetic Path H-DC4C-1  
 1/16 Scale DWG 3L1392 (Pole Tip) 4-29-48  
 Gap 14" (Full Scale) at Center  
 92 Turns Total on Model Coils



Flux Density

in Kilo-Gauss



May 6, 1942

Bevatron Model Magnet DCAC

Radial Uniformity

1/16 Scale DWG 31 1392 (Pole Tip)

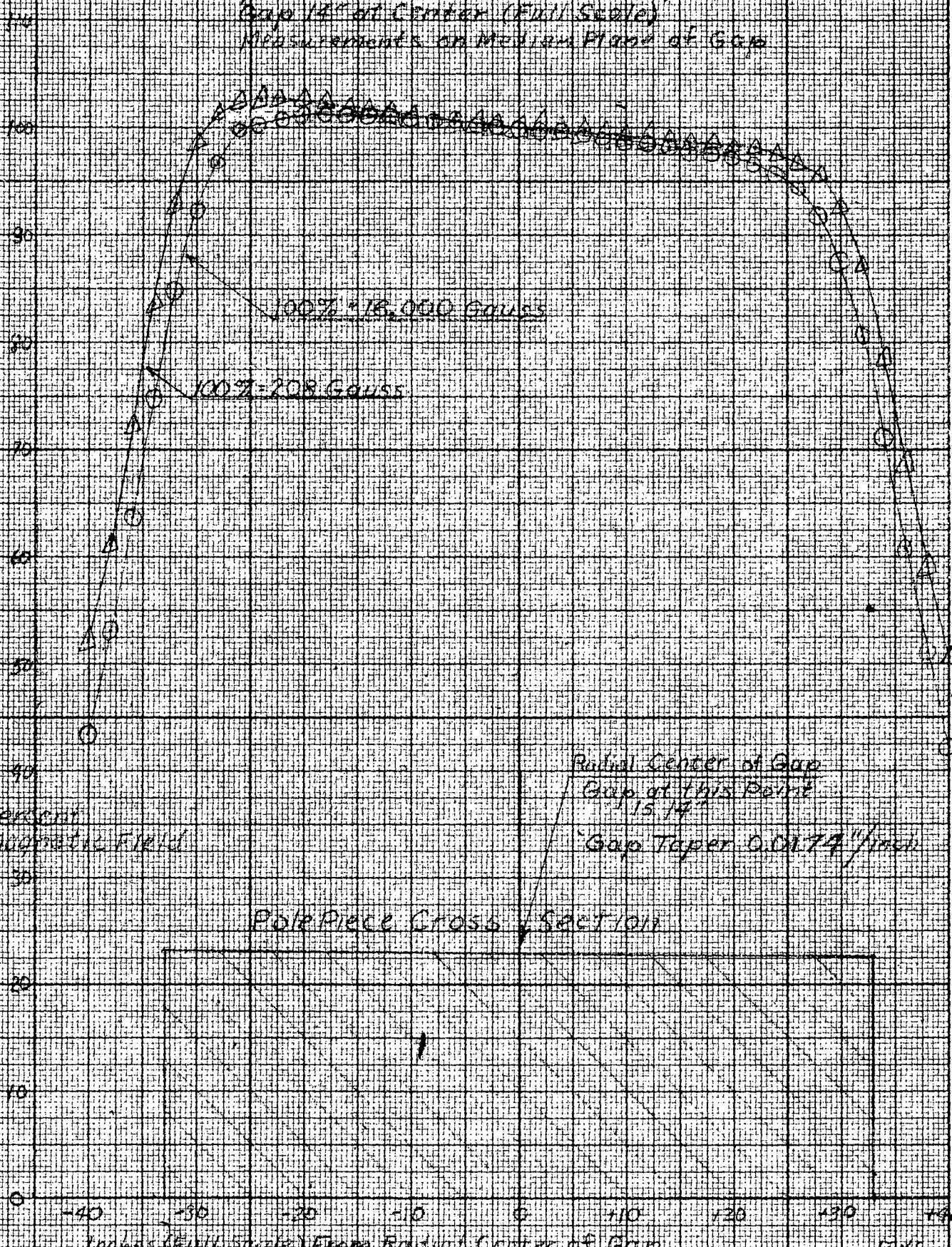
Gap 14" at Center (Full Scale)

Measurements on Median Plane of Gap

171-8

U-DCAC

5-8-42



EUGENE DIETZGEN CO.  
ANN ARBOR, MICH.

NO. 340 - M. DIETZGEN GRAPH PAPER  
MILLIMETER

May 11, 1948

Deviation Magnet Magnet DC 4C

171-E

Radial Uniformity

U-DC4C-1

1/16 Scale DING 3/1592 (Pole Tip)

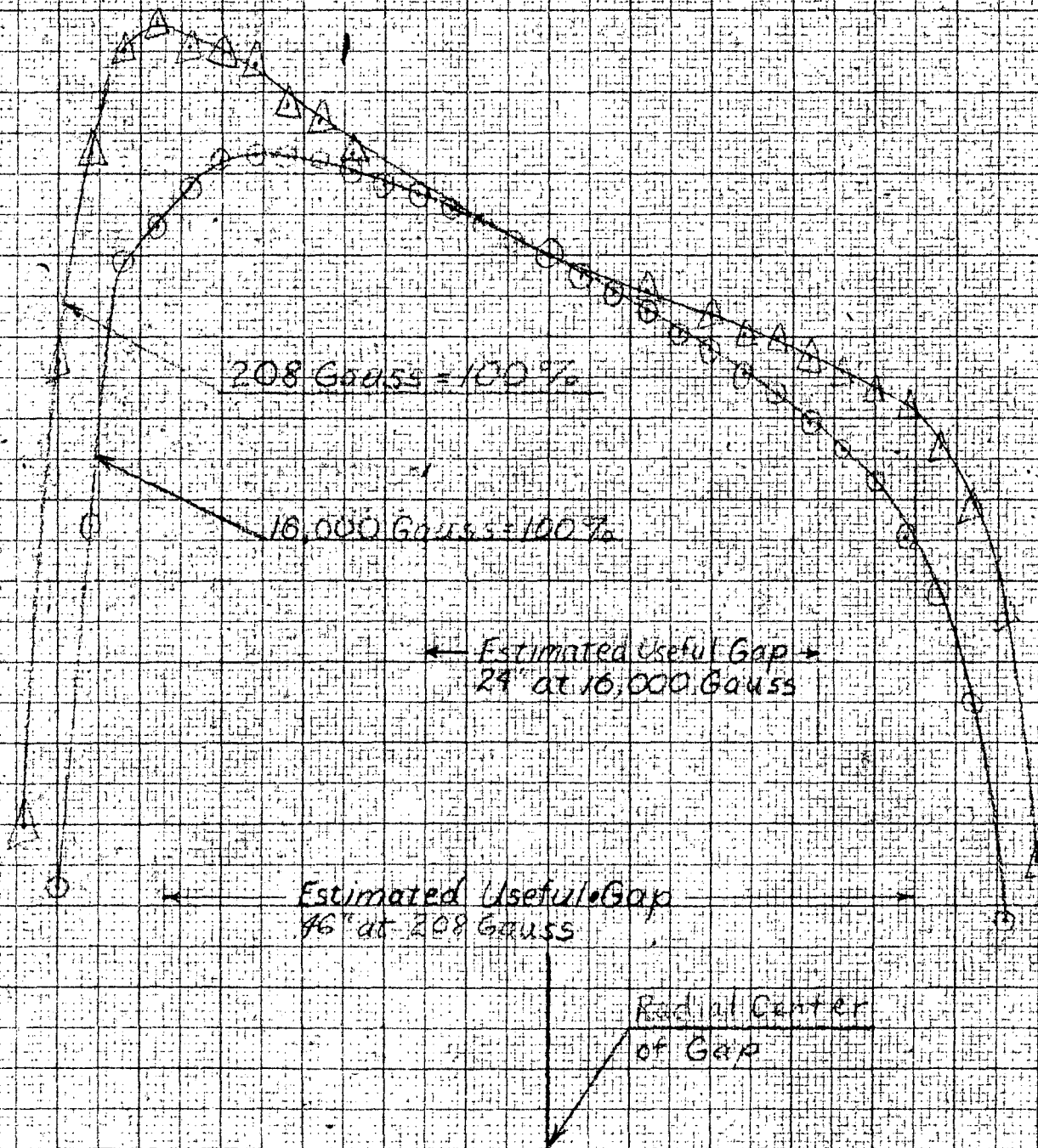
5-11-48

Gap 17" (Full Scale) at Center

See Graph U-DC4C-1

PERCENT  
MAGNETIC  
FIELD

103  
102  
101  
100  
99  
98  
97  
96  
95  
94  
93  
92  
91



208 Gauss = 100%

16,000 Gauss = 100%

← Estimated Useful Gap →  
24" at 16,000 Gauss

← Estimated Useful Gap →  
46" at 208 Gauss

Radial Center  
of Gap

-30 -25 -20 -15 -10 -5 0 15 20 25 30  
INCHES Full Scale From Radial Center of Gap ETC

KRUEGER & ESSER CO. N. Y. NO. 389-110  
10 X 10 to the 4/10 inch, 5th lines acented  
Engraving 7 X 10 in.  
MADE IN U.S.A.



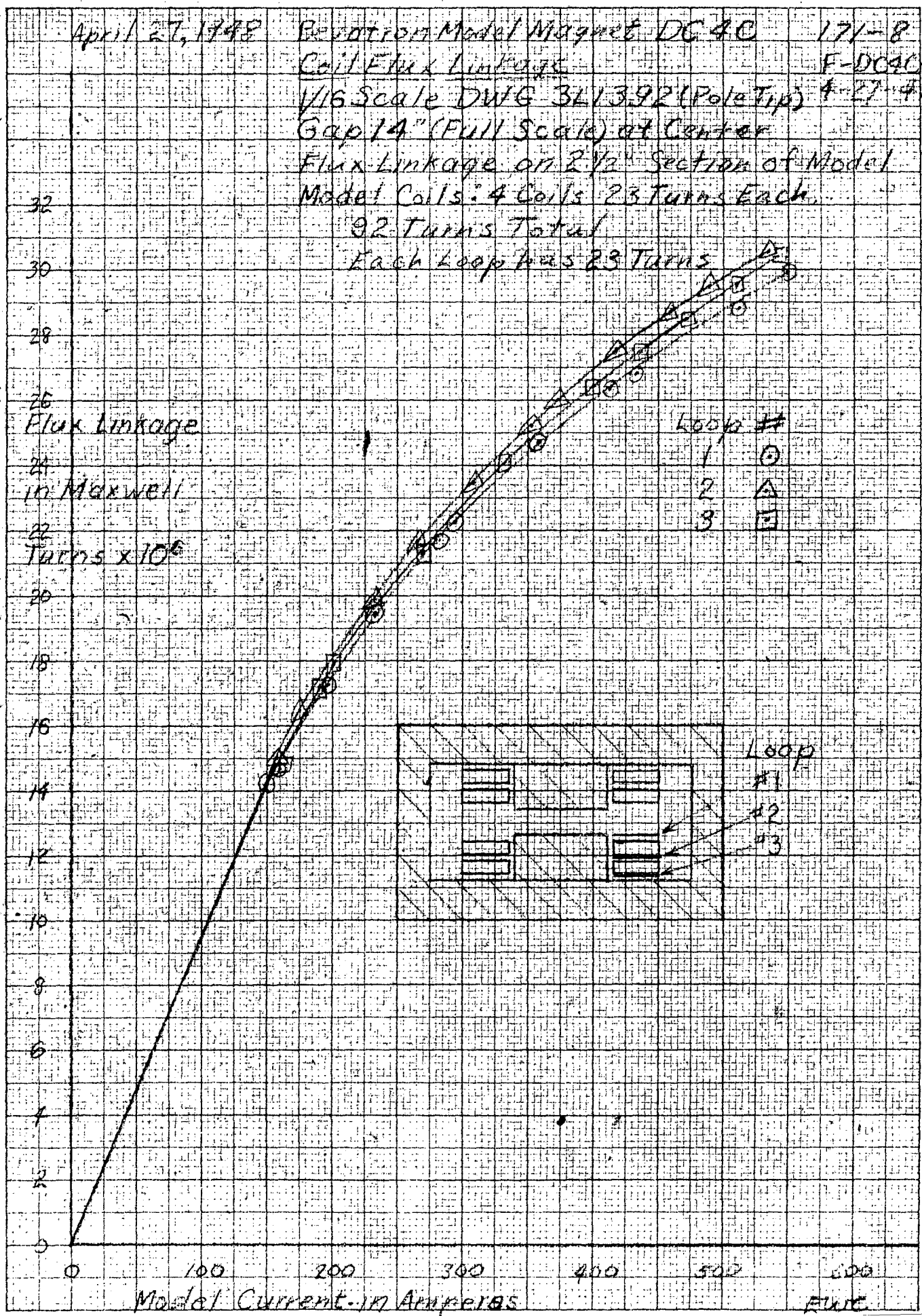
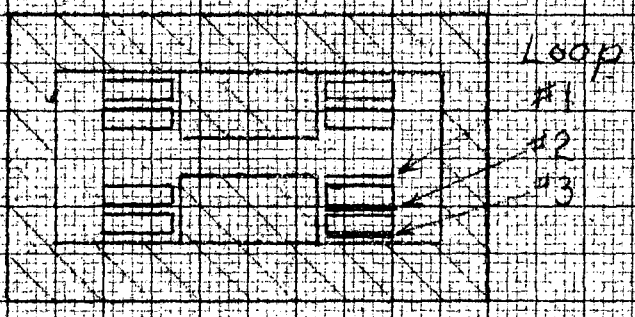
April 27, 1948

Rotation Model Magnet DC 40 171-8  
 Coil Flux Linkage F-DC40-1  
 1/16 Scale DWG 3L1392 (Pole Tip) 4-27-48  
 Gap 14" (Full Scale) at Center  
 Flux Linkage on 2 1/2" Section of Model  
 Model Coils: 4 Coils 23 Turns Each  
 92 Turns Total  
 Each Loop Has 23 Turns

32  
30  
28  
26  
24  
22  
20  
18  
16  
14  
12  
10  
8  
6  
4  
2  
0

Flux Linkage  
in Maxwell  
Turns x 10<sup>6</sup>

Loop #  
1 O  
2 Δ  
3 E



Model Current - in Amperes

FLUX

May 4, 1948

Bevatron Model Magnet DC4C

171-8

Total Coil Flux Linkage

F-DC4C-1a

1/16 Scale DWG 3L1392 (Pole Tip)

5-4-48

Gap 14" (Full Scale) at Center

Flux Linkage on 2 1/2" Section of Model

Model Coils - 4 Coils 23 Turns Each

92 Turns Total

See Graph F-DC4C-1

Total Linkage = Loops (1+2) + (2+3)

Each Loop Has 23 Turns

600  
Model  
Current  
in Amps  
500

400

300

200

100

0

0

20

40

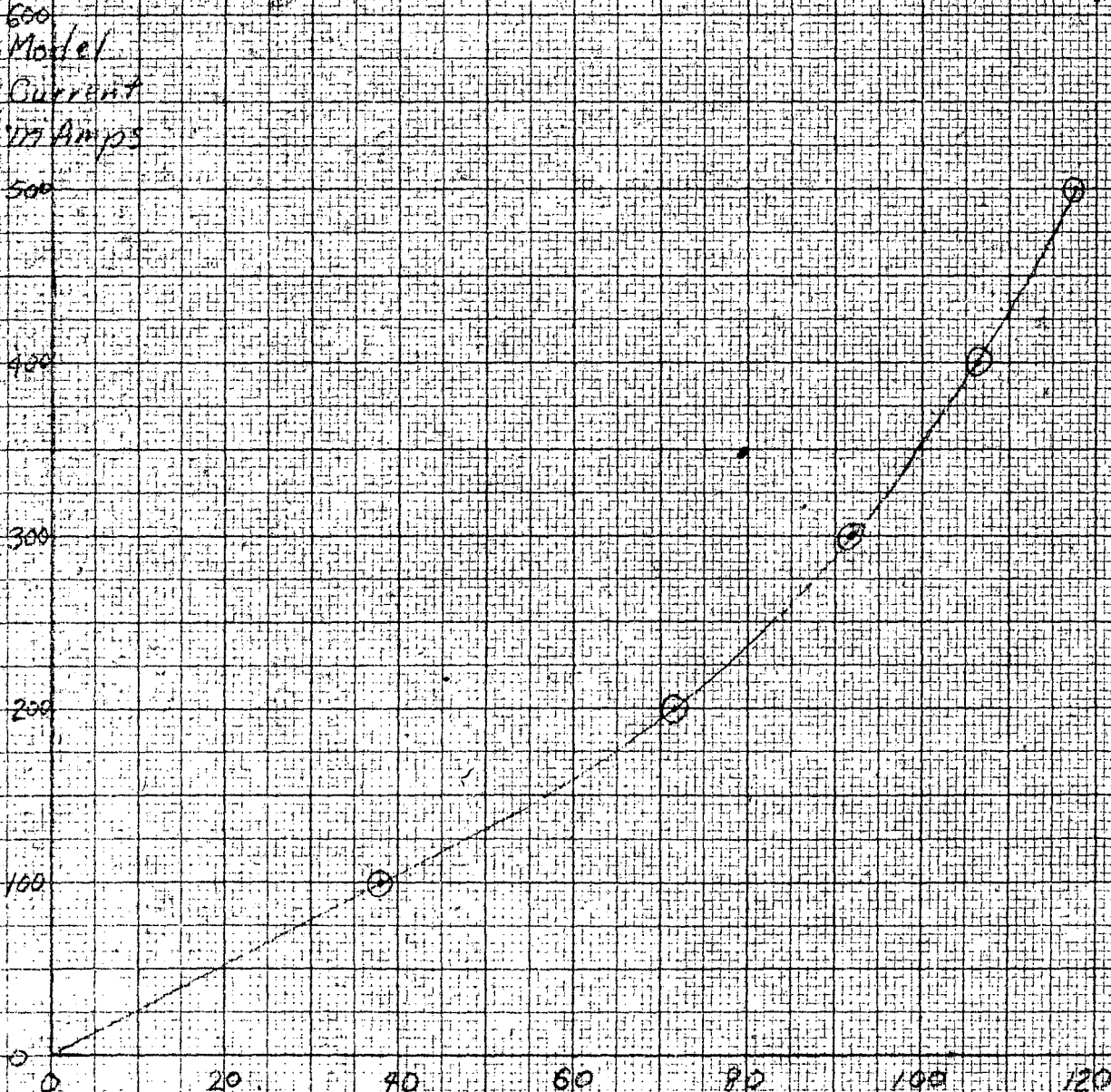
60

80

100

120

Flux Linkage in Maxwell Turns  $\times 10^6$



May 16, 1948

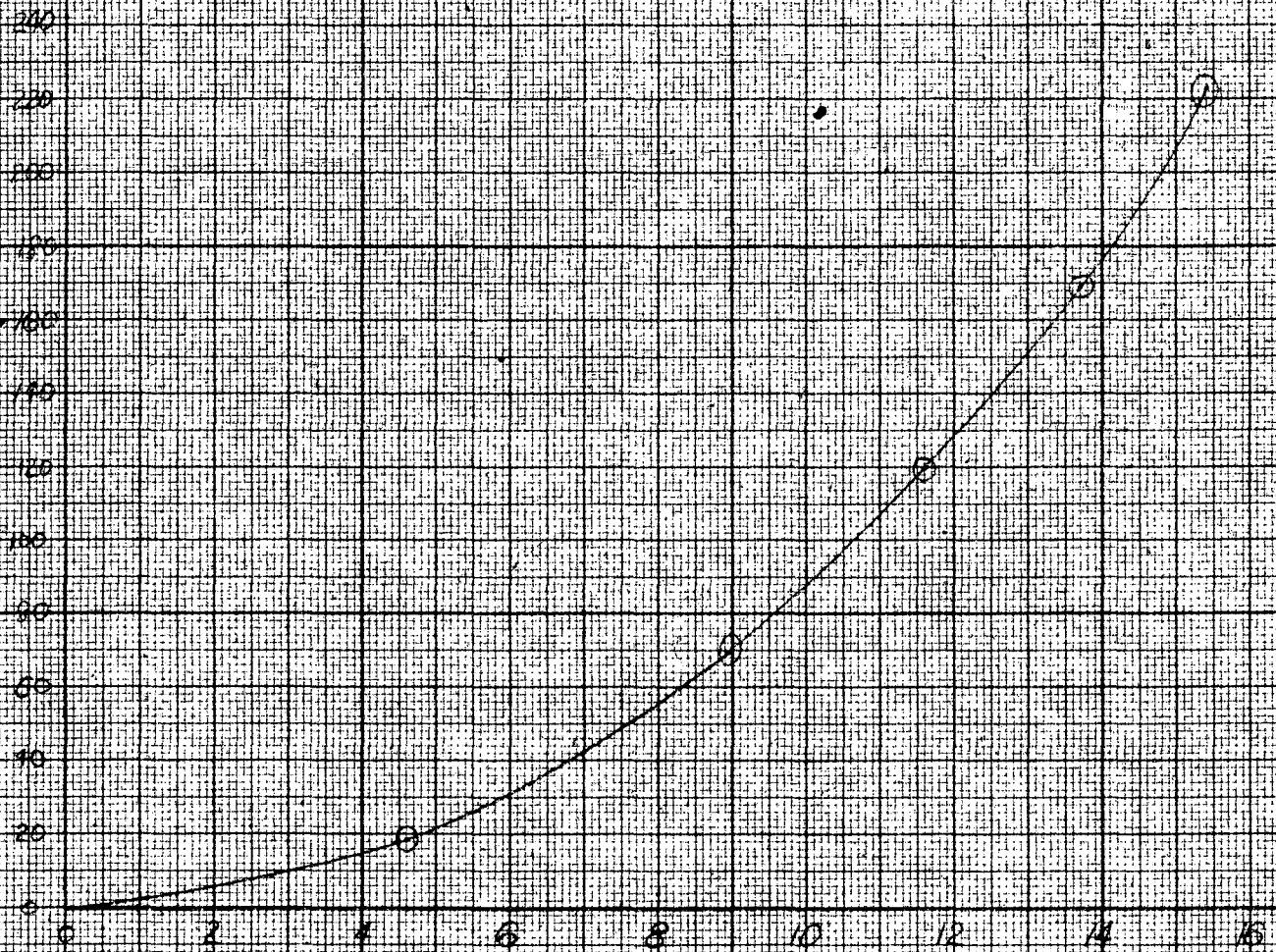
Bevatron Model Magnet DC40  
1/16 Scale DWG 311392 (Pole Tip)  
Stored Energy Calculated From  
Total Coil Max Linkage

171-2  
E-DC40-1  
5-11-48

Energy (Joules) =  $10^{-21} I^2 N^2$   
where I is in amperes  
N is in Max. coil Turns

Data is for 3/4" Section of Model

Model  
Stored Energy  
in Joules



Magnetic Field at Center of Gap - Pole Cores

ENC

5 Model Magnet DC3 Index

a. Discussion

b. Sketch

c. Photographs

BEVA 16

d. Graphs

L-DC3-1	Efficiency and leakage coefficients
H-DC3-1	Flux density around the magnetic path
U-DC3-1	Radial uniformity (26")
U-DC3-1a	Radial uniformity (26") - Expanded
U-DC3-2	Radial uniformity (62")
F-DC3-1	Coil flux linkage
F-DC3-1a	Total coil flux linkage
E-DC3-1	Stored energy

## 5 Model Magnet DC3

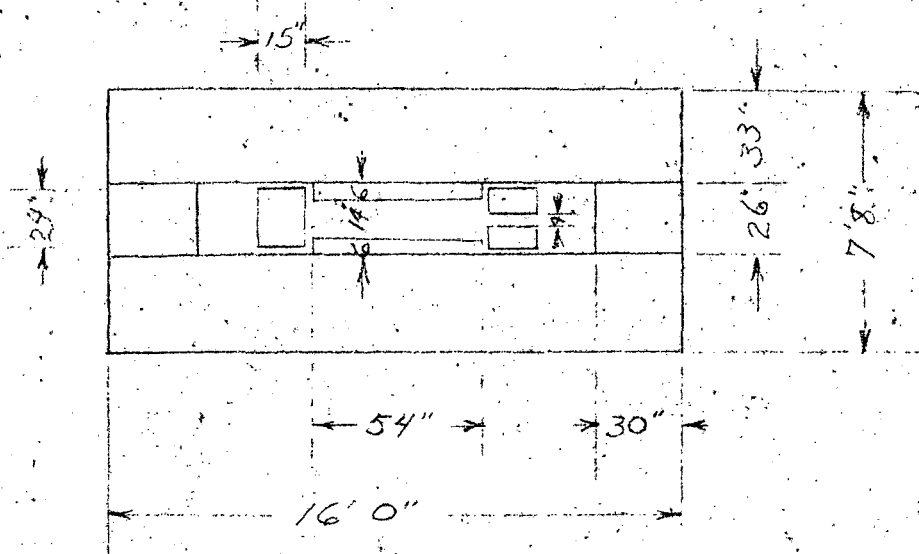
### a. Discussion

Bevatron model magnet DC3 was the first attempt to design a DC model magnet of type A to predict performance of the magnet for a full-scale bevatron.

This model met the general specifications except that the useful width of the magnetic field at the injection field was 26 inches instead of the specified 48 inches.

A decision was made at this time to design a model magnet with a larger aperture, 2 feet by 8 feet, as an initial stage in the development of the bevatron. This magnet was to be designed so that it could be converted to the 1' x 4' aperture at a later time. Changes were made to adapt model DC3 for the larger aperture. (See model DC3A.)

# BEVATRON MODEL MAGNET DC3



GAP 14"

RADIUS 50'

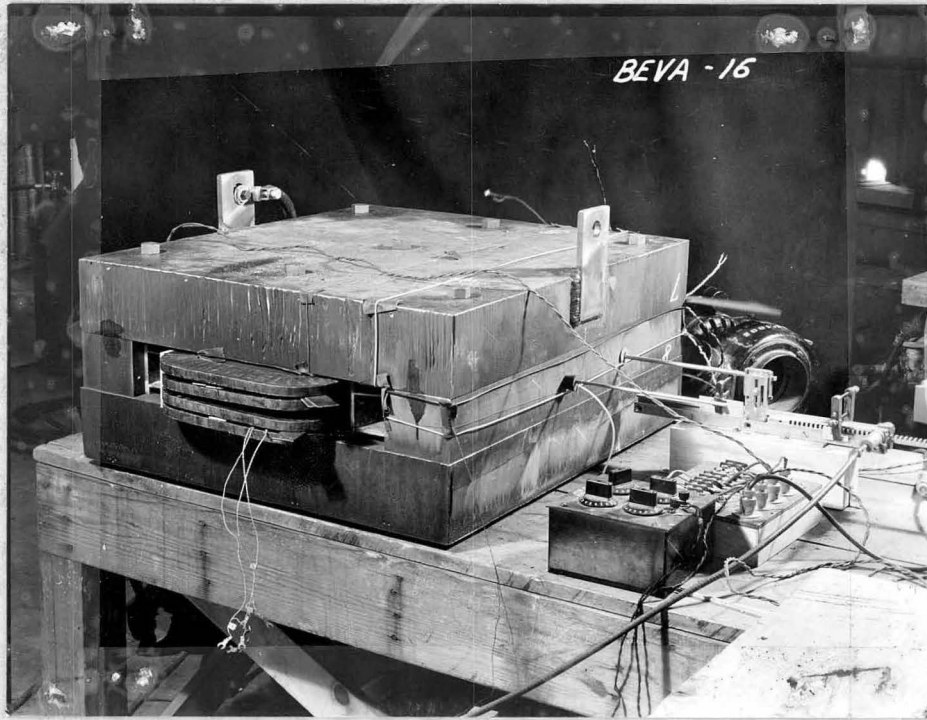
$\mu = 0.75$

MODEL COILS : 4 COILS 27 TURNS EACH = 108 TURNS

DIMENSIONS ARE FULL SCALE

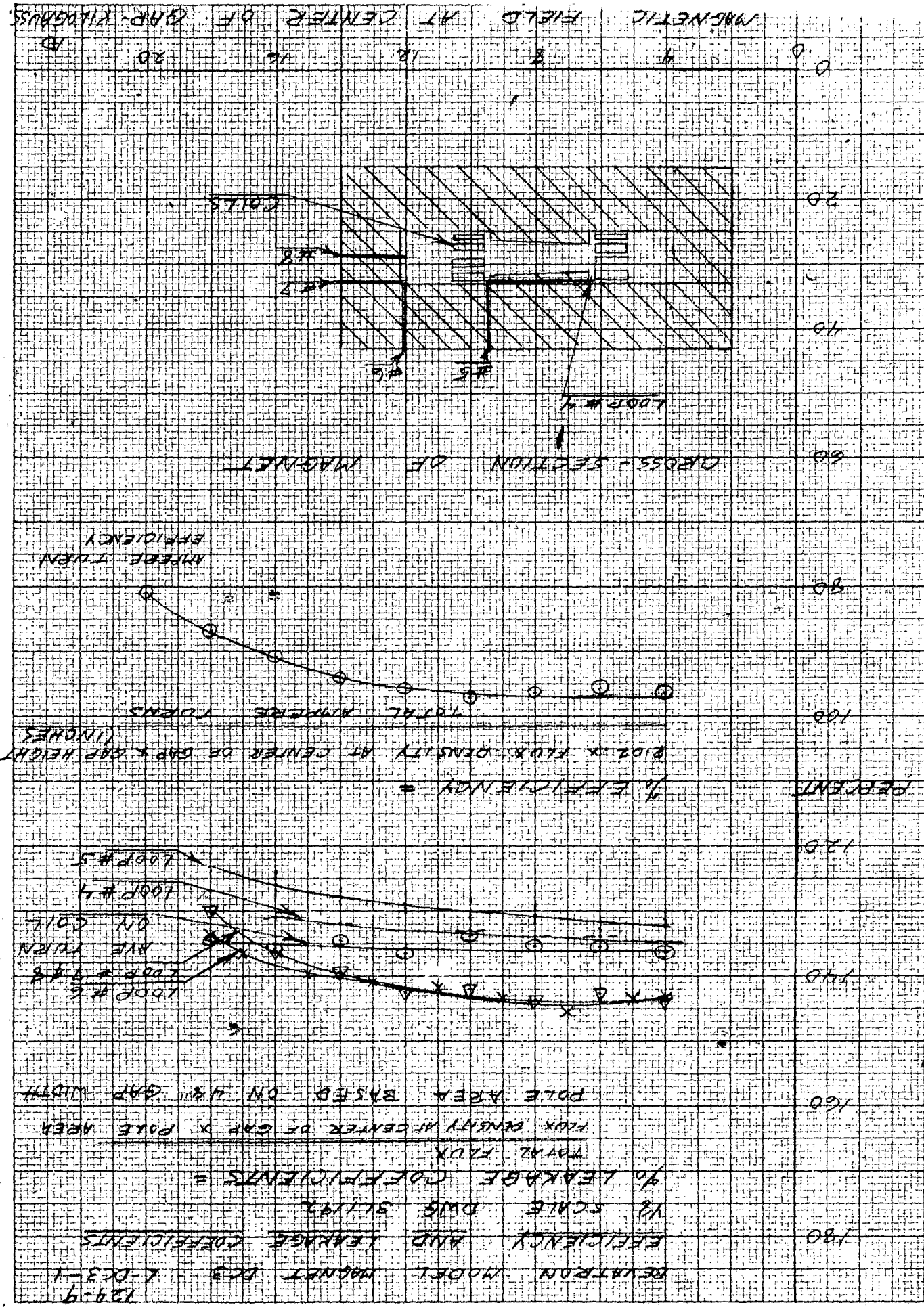
MODEL IS 1/8" SCALE

ASSEMBLY DWG. 34 1192



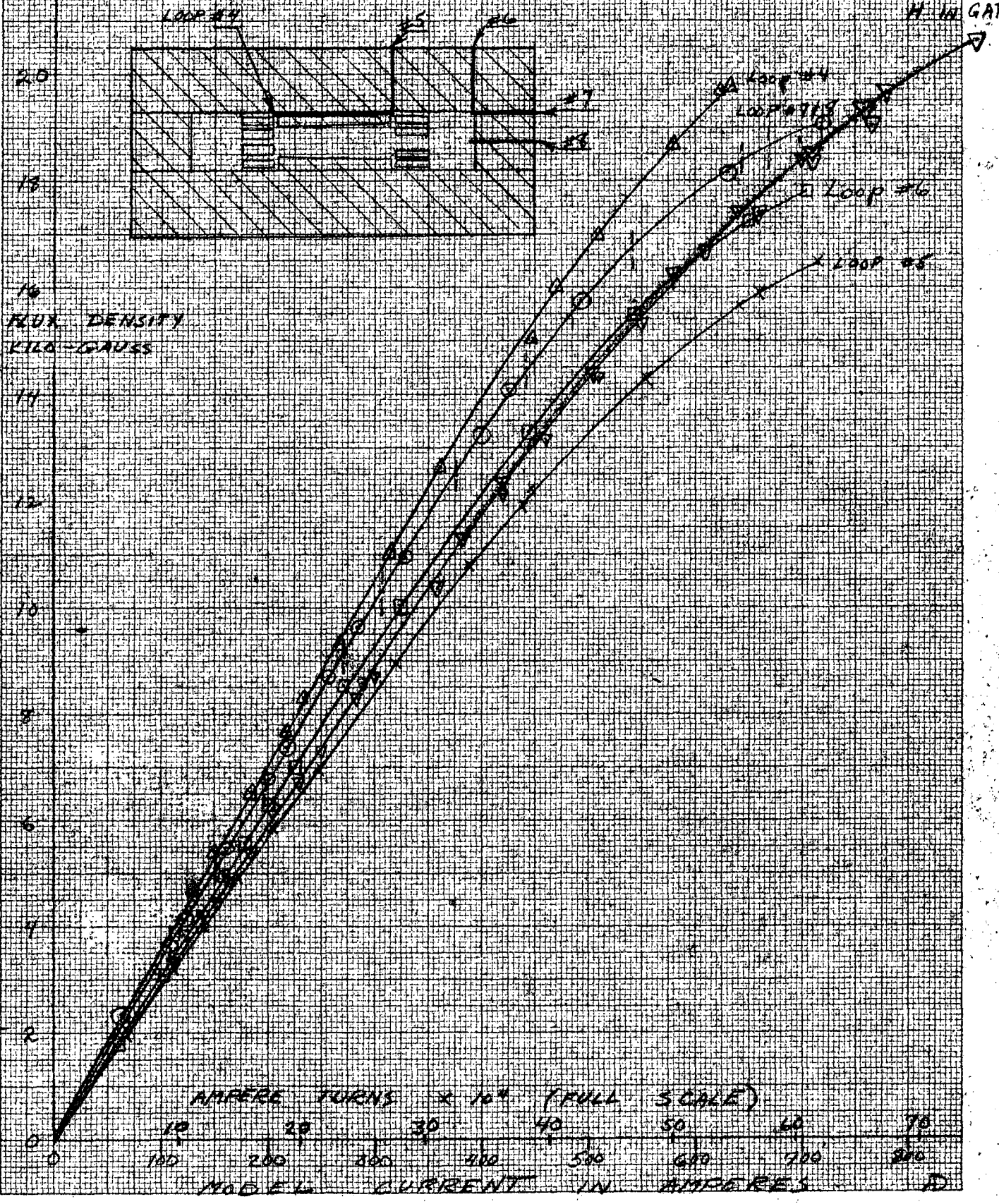
BEVA 16

Bevatron Model Magnet DC3



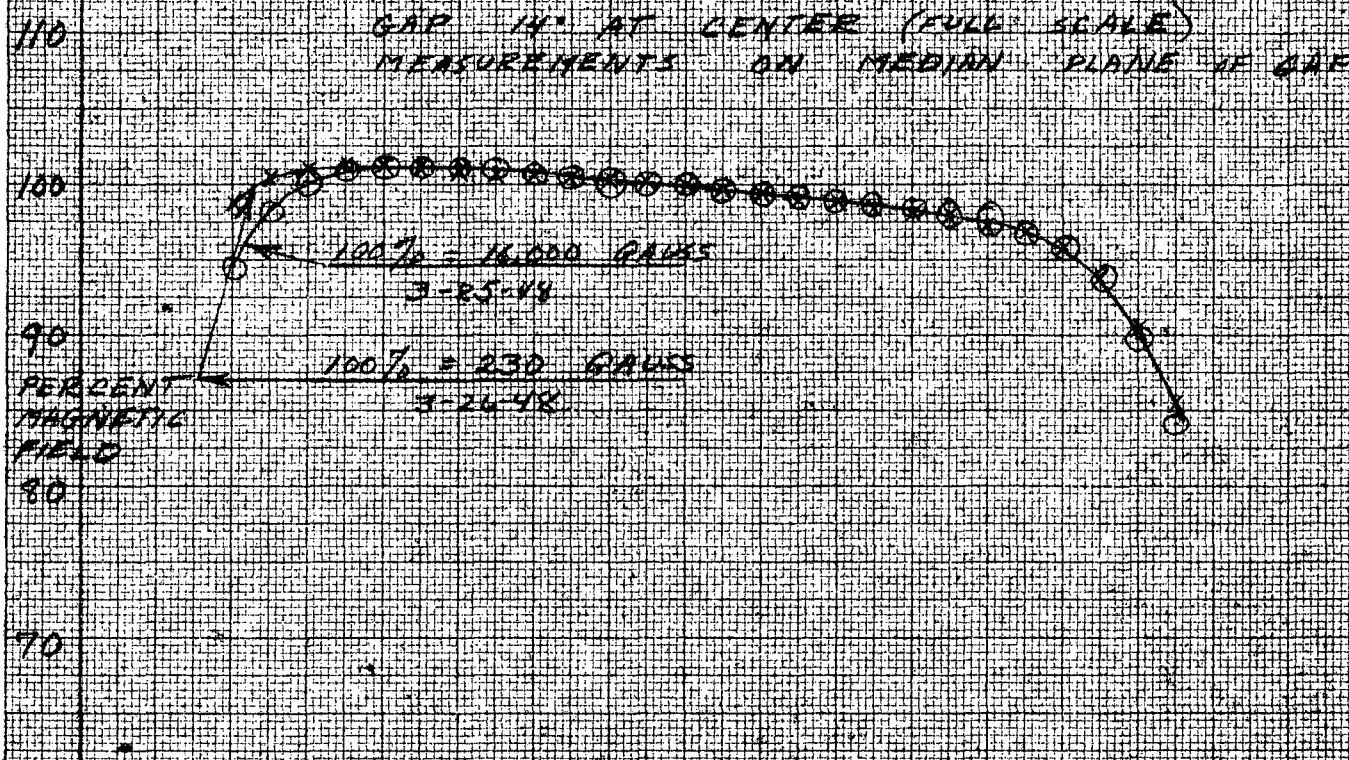


BEVATRON MODEL MAGNET DO 3 H-203-1  
 MARCH 28 1954 FLUX DENSITY AROUND MAGNETIC PATH  
 1/4 SCALE DWG # 3L1192  
 GAP 1/4" AT CENTER (FULL SCALE)  
 100 TURNS TOTAL ON MODEL COILS

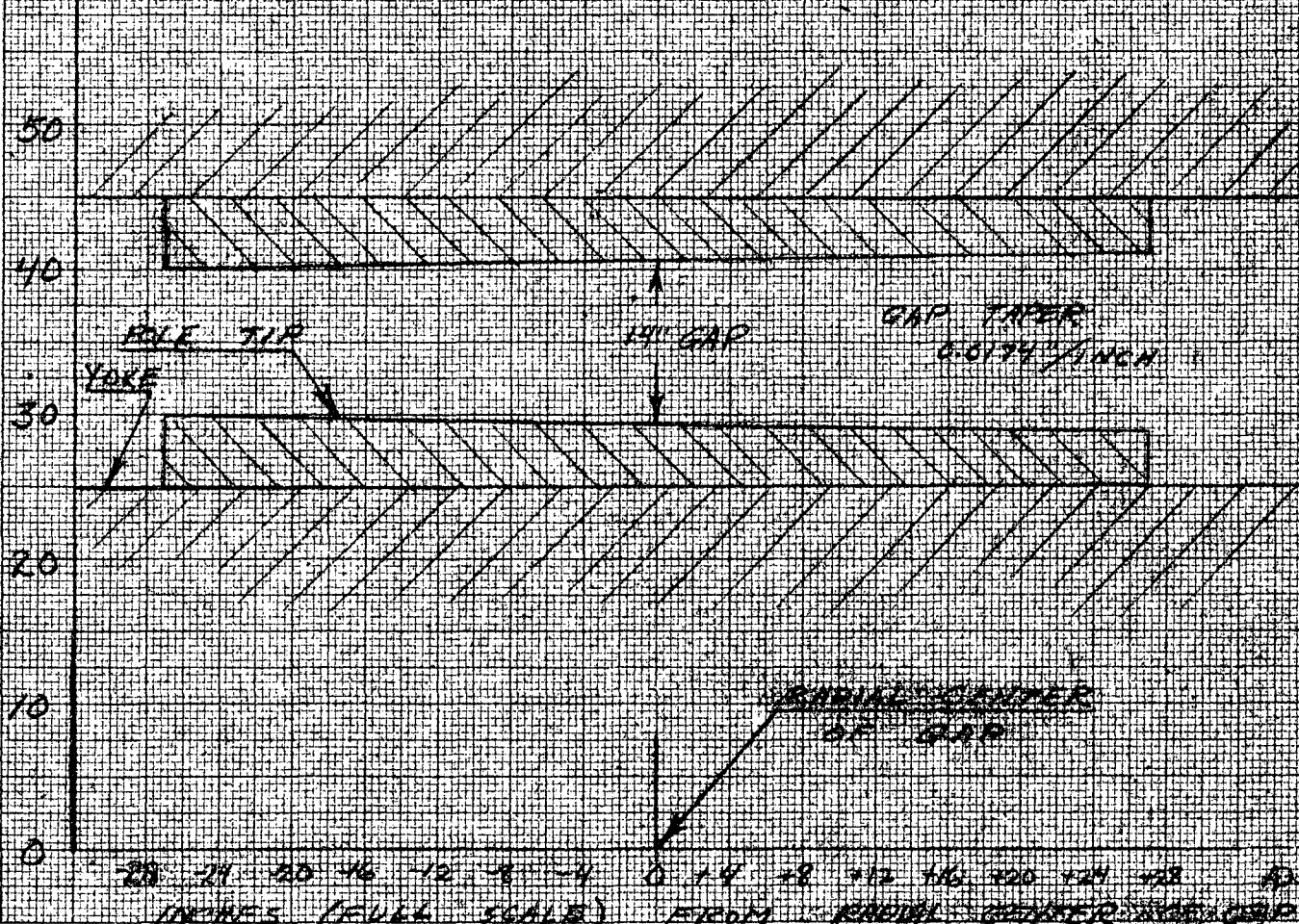


KEUFFEL & ESSER CO., N. Y. NO. 388716  
 MILWAUKEE, 400 State Street  
 MADE IN U.S.A.

DEVIATION MODEL MAGNET DC'S 1024-9  
 RADIAL UNIFORMITY U-DC3-1  
 1/8" SCALE DWG. # 311192  
 GAP 14" AT CENTER (FULL SCALE)  
 MEASUREMENTS ON MEDIUM PLANE OF GAP



CROSS-SECTION SHOWING GAP

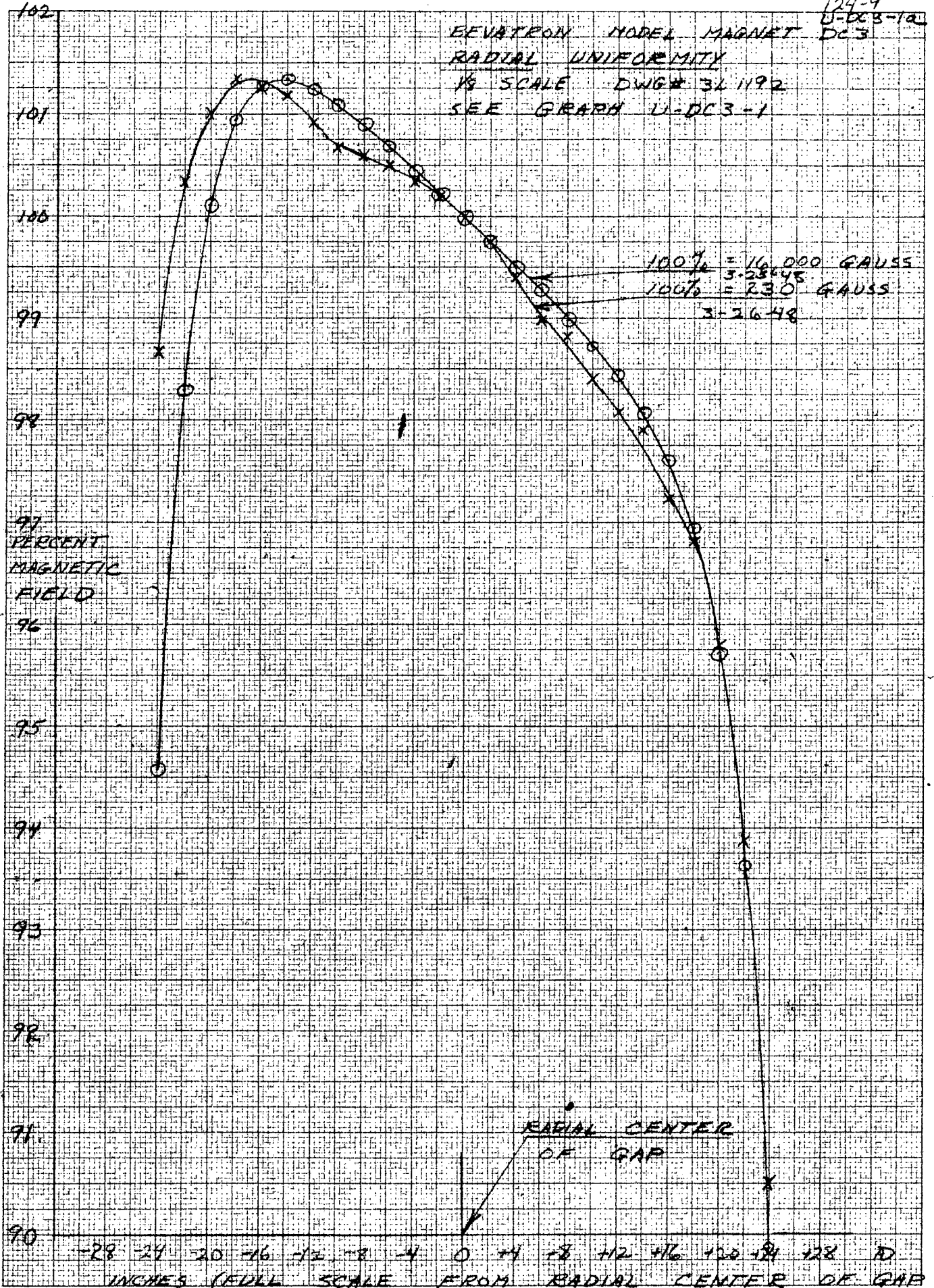


KEUFFEL & ESSER CO. N. Y. NO. 369-14  
 Millimeter, 10th. Fine Series.  
 MADE IN U.S.A.

A

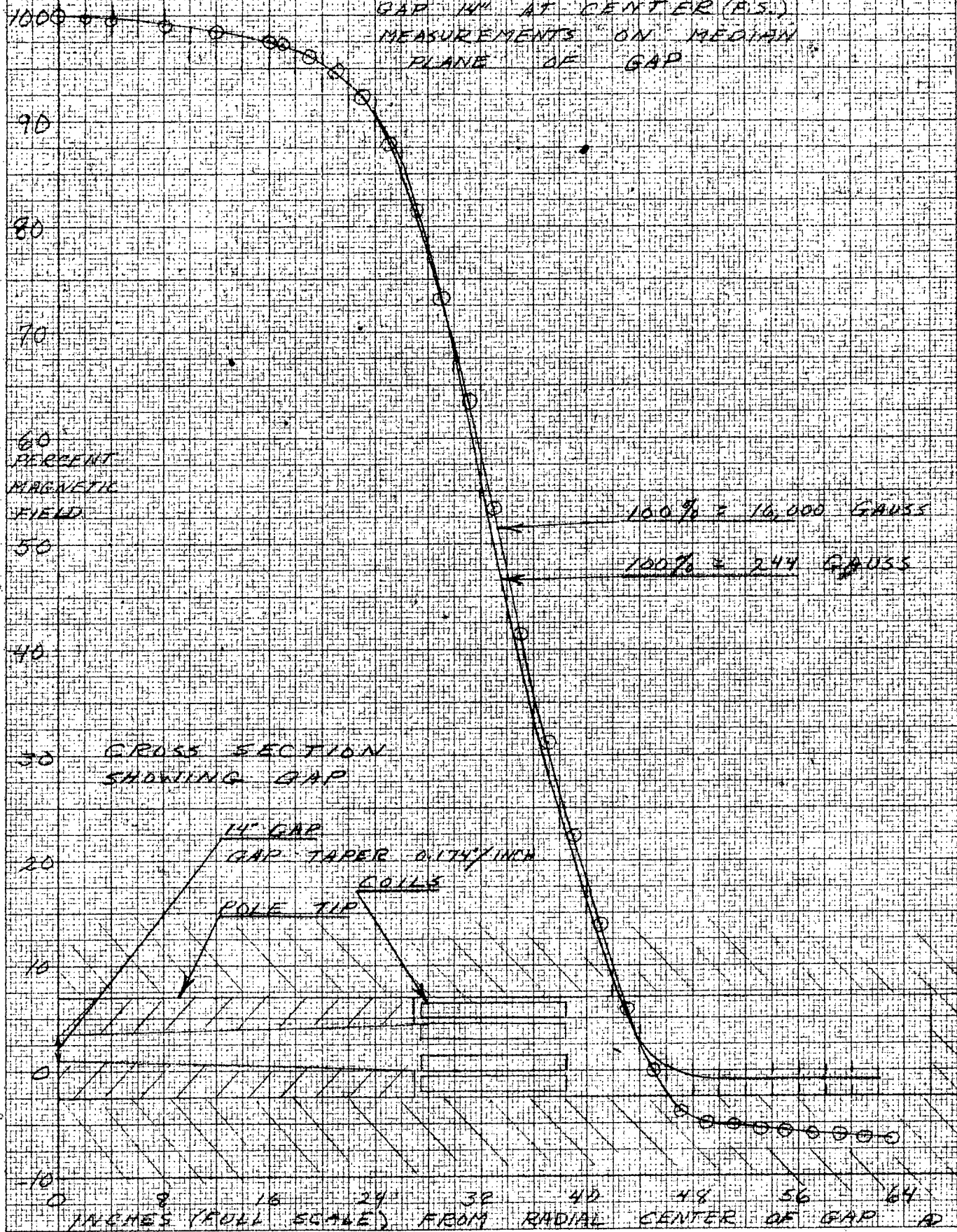
124-9  
U-DC3-10  
DC3

EVATRON MODEL MAGNET  
RADIAL UNIFORMITY  
1/8" SCALE DWG# 3L1192  
SEE GRAPH U-DC3-1



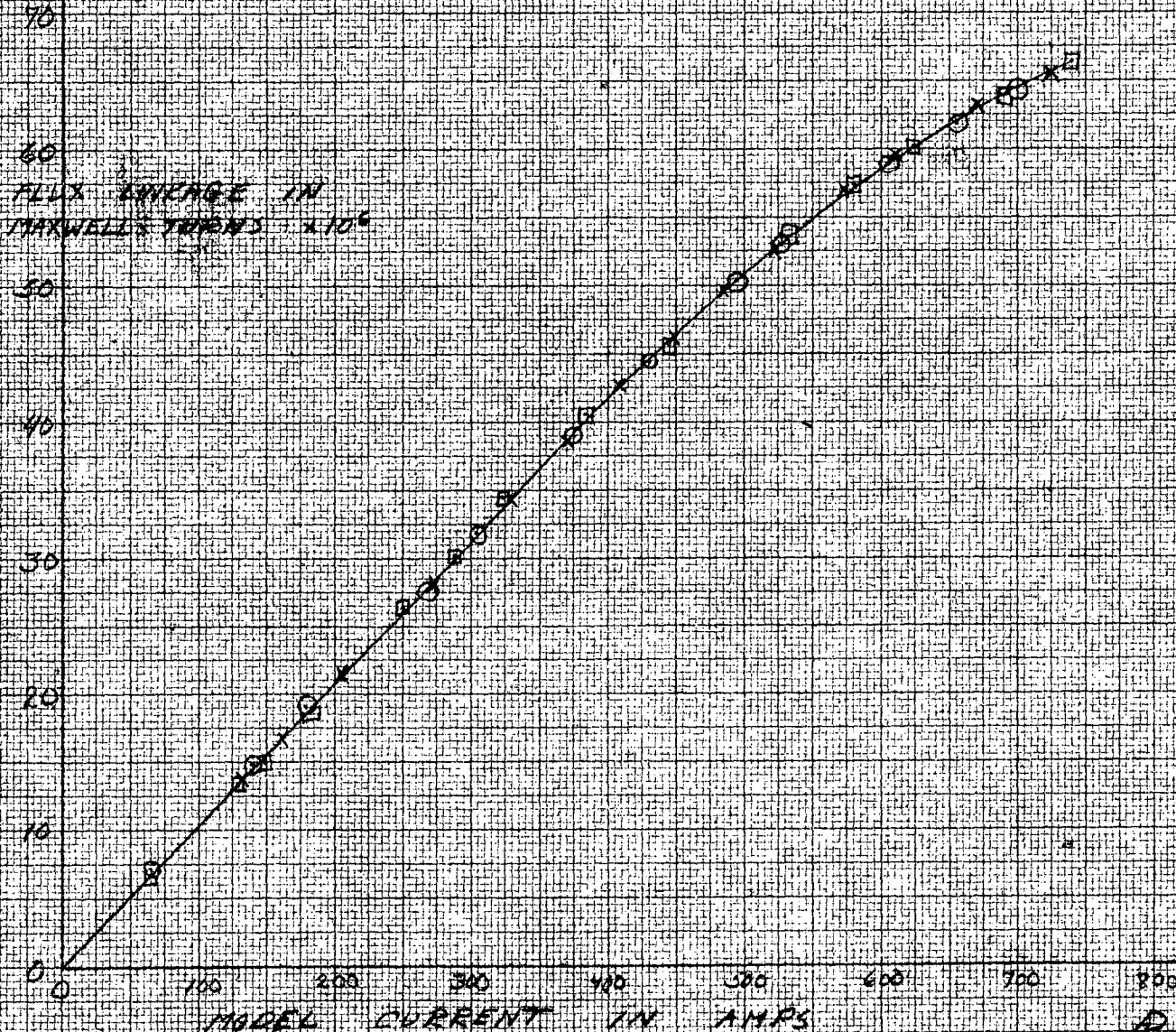
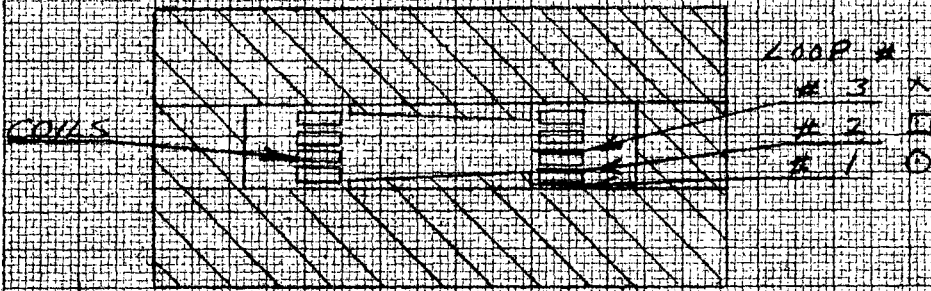
KEUFFEL & ESSER CO., N. Y. NO. 369-14  
Millimeter, both lines heavy.  
MADE IN U. S. A.

123- BEVETRON MODEL MAGNET 124-9  
 MARCH 30, 1948 RADIAL UNIFORMITY U-003-2  
 1/8" SCALE DRAWN 3/11/48 3-30-48  
 GAP 1/4" AT CENTER (P.S.)  
 MEASUREMENTS ON MEDIUM  
 PLANE OF GAP



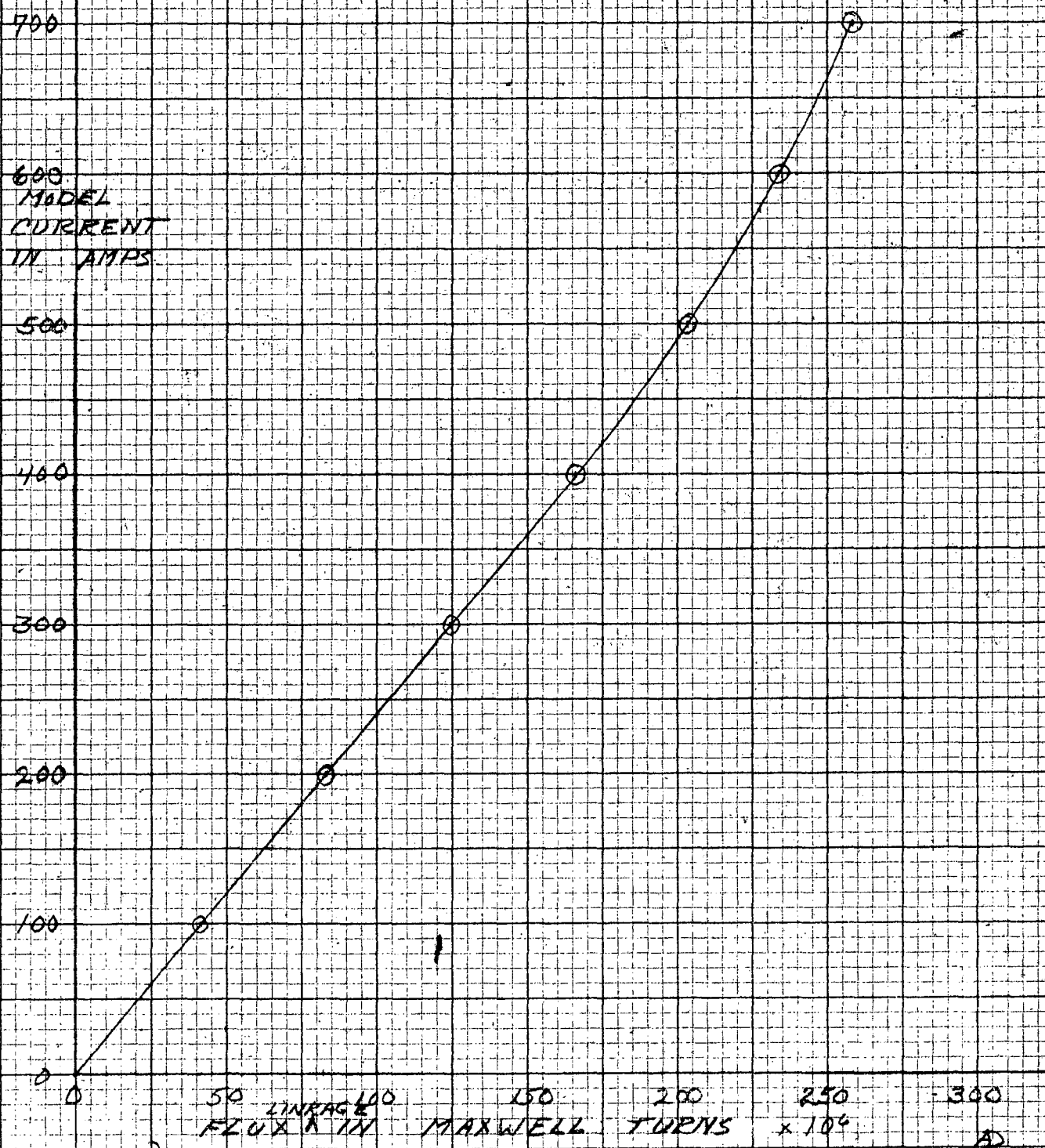
KEUFFEL & ESSER CO., N. Y. NO. 558-14  
 Millimeter, 10th Street, New York,  
 MADE IN U. S. A.

COIL FLUX LINKAGE 124-9  
 MARCH 23, '48 BEWATRON MODEL MAGNET DC3 F-DC3-1  
 1/4 SCALE DWG # 31 1197  
 GAP 1/4" AT CENTER (FULL SCALE)  
 FLUX LINKAGE ON 1/4" SECTION ON MODEL  
 MODEL COILS 4 COILS 27 TURNS EACH  
 108 TURNS TOTAL  
 EACH LOOP HAS 27 TURNS

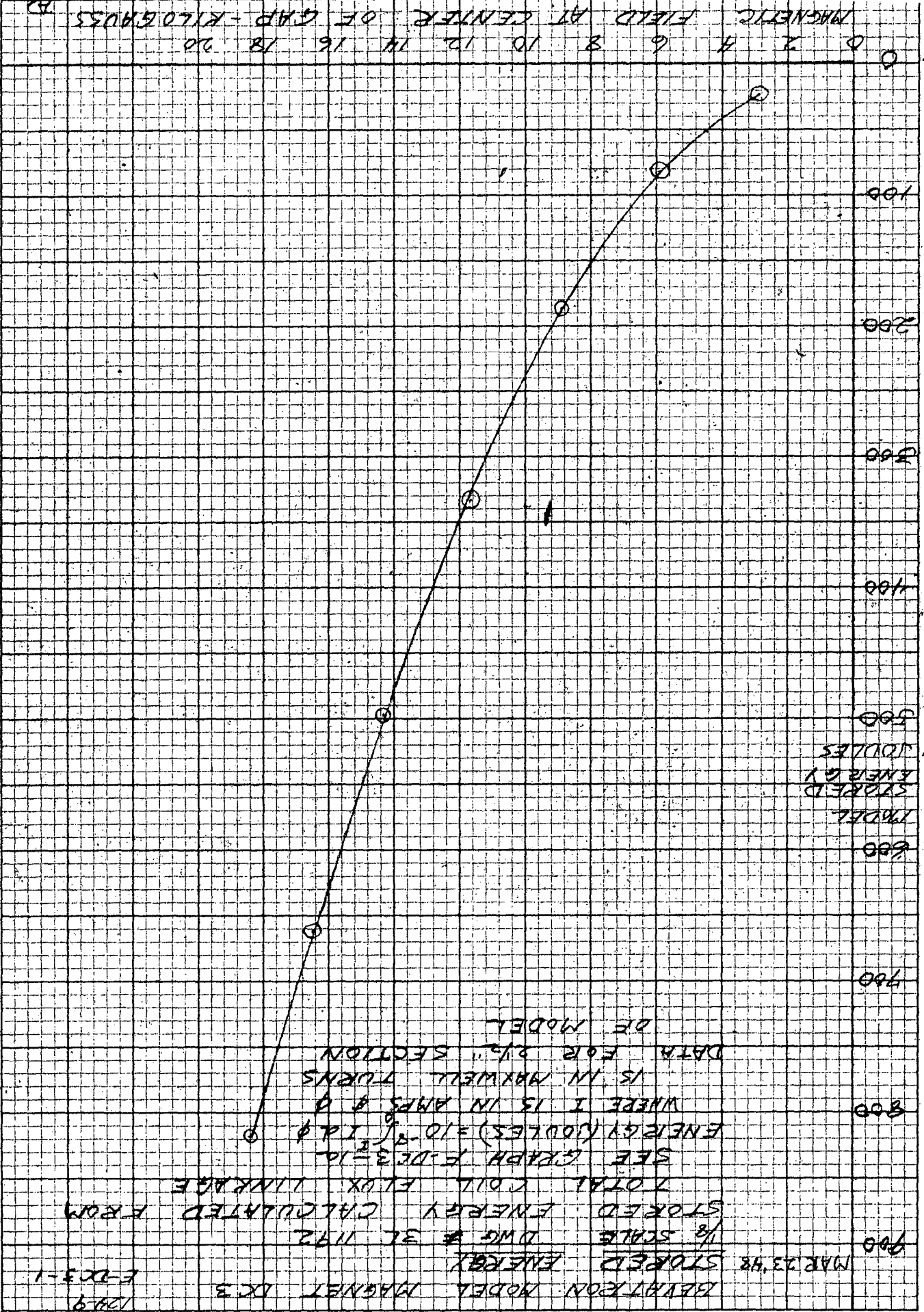


BEVATRON MODEL MAGNET DL3 124-9  
 TOTAL COIL FLUX LINKAGE F-DC3-12

MARCH 23, '48 1/8 SCALE DWG # 3L 1192  
 GAP 14" AT CENTER (FULL SCALE)  
 FLUX LINKAGE ON 2 1/2" SECTION  
 OF MODEL  
 MODEL COILS: 4 COILS 27 TURNS EACH  
 108 TURNS TOTAL  
 SEE GRAPH # F-DC3-1  
 TOTAL LINKAGE = (LOOP 1+2) + (LOOP 2+3)  
 EACH LOOP HAS 27 TURNS



KEUFFEL & ESSER CO., N. Y. NO. 359-6  
 1/2" x 5 to the 1/2" inch.  
 MADE IN U. S. A.



BEHAVIOR MODEL MAGNET DC3  
 MAR 23 '48 STORED ENERGY  
 1/8 SCALE DWG # 31 1172  
 STORED ENERGY CALCULATED FROM  
 TOTAL COIL EXC LINKAGE  
 SEE GRAPH P.D.C. 3-10  
 ENERGY (Joules) =  $10^{-4} I^2 L \phi$   
 WHERE I IS IN AMPS &  $\phi$   
 IS IN MAXWELL TURNS  
 DATA FOR 2 1/2" SECTION  
 OF MODEL

1249  
 EDC3-1

6 Model Magnet DC3A Index

e. Discussion

b. Sketch

c. Photographs

BEVA 18

d. Graphs

L-DC3A-1	Efficiency and leakage coefficients
H-DC3A-1	Flux density around the magnetic path
U-DC3A-1	Radial uniformity
F-DC3A-1	Coil flux linkage
F-DC3A-1a	Total coil flux linkage
E-DC3A-1	Stored energy



## 6 Model Magnet DC3A

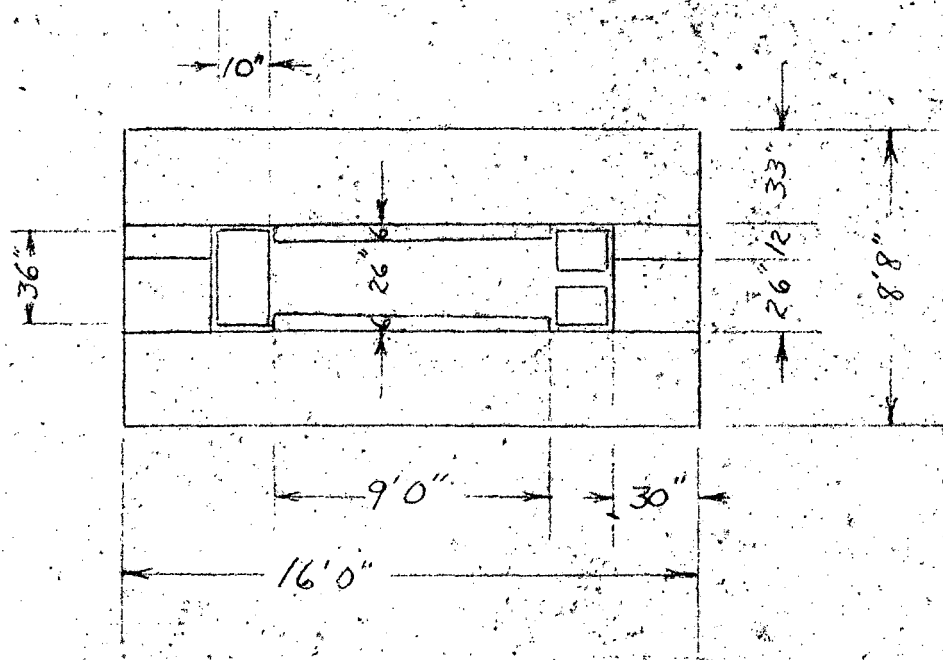
### a. Discussion

Bevatron model magnet DC3A was a larger gap design of model DC3. The general specifications (see Section II) for the smaller aperture (1' x 4') apply to this larger aperture (2' x 8') except for the maximum flux density at the gap center and the width of the useful magnetic field. It was decided to accept whatever was available for the maximum flux density and useful gap width when the other specifications were met, with the additional provision that when this model is converted to give the 1' x 4' aperture, all of the original specifications must be met.

The following design changes were made in model DC3 to give this model DC3A. The pole pieces were increased in radial width from 54 inches to 108 inches. The gap was increased from 14 inches to 26 inches. Extensions were added to the legs to increase the distance between the yoke slabs. The cross-sectional area of the exciting coils was increased. An error in the design resulted in an  $n$  of 0.40 instead of 0.75 as specified.

It was decided after testing this model to change the design to increase the useful gap width at the injection field. (See model DC5 and DC5A.)

# BEVATRON MODEL MAGNET DC 3A



GAP 26"

RADIUS 50'

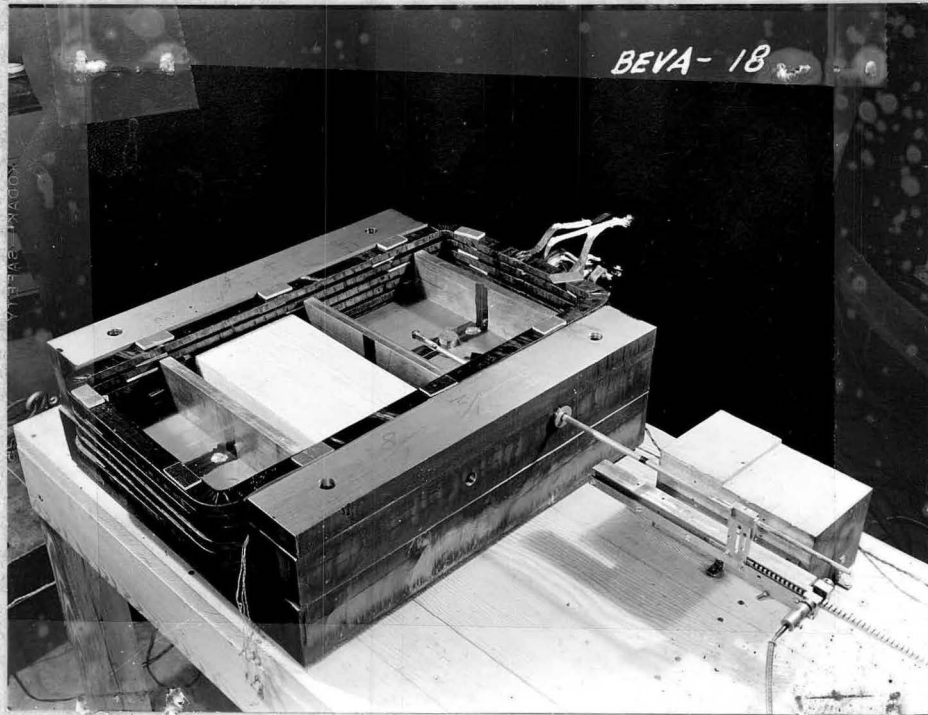
$n = 0.40$

MODEL COILS 6 COILS 17 TURNS EACH = 102 TURNS

DIMENSIONS ARE FULL SCALE

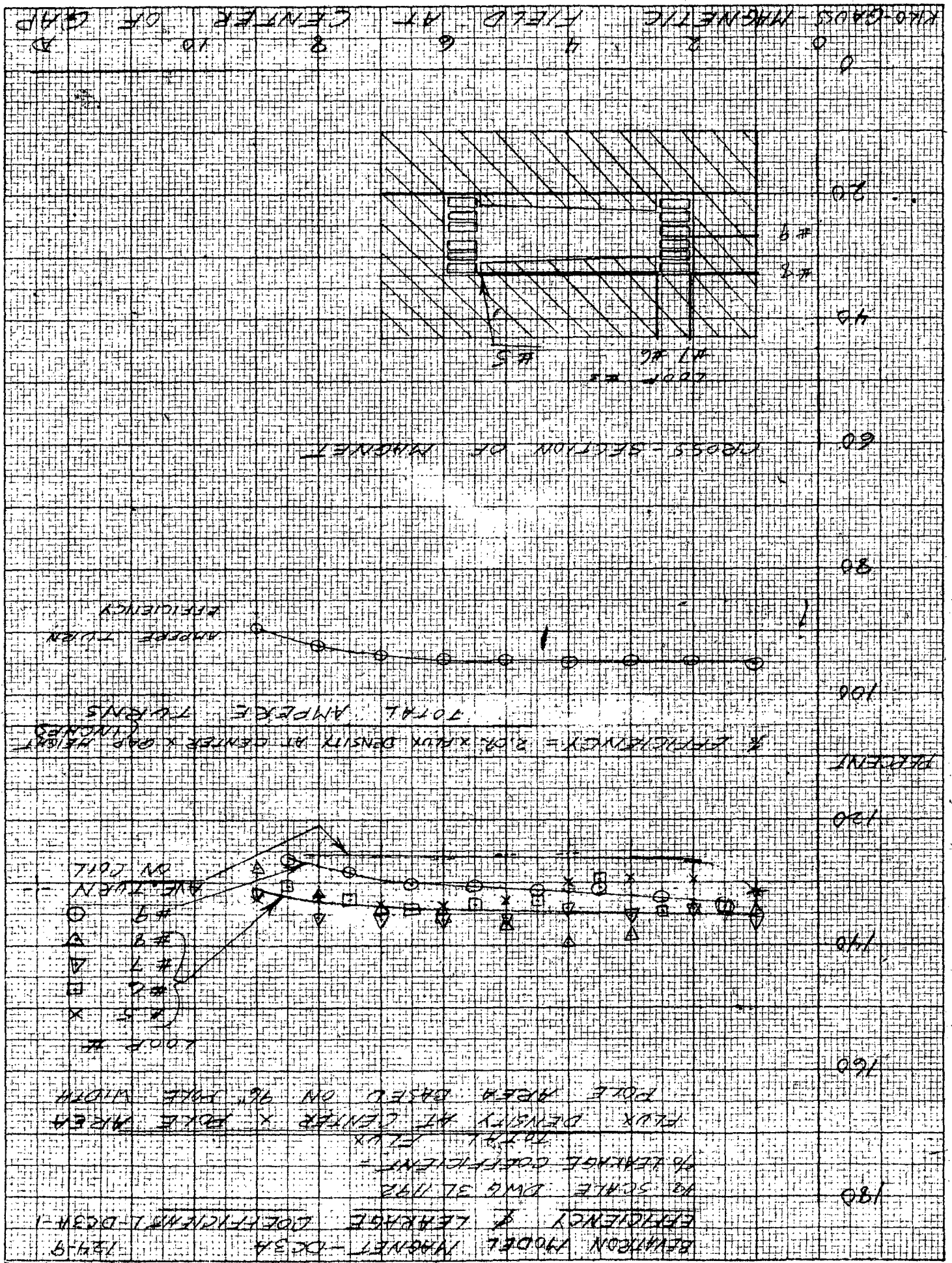
MODEL IS  $1/8$  SCALE

ASSEMBLY DWG. 3L 119R



BEVA 18

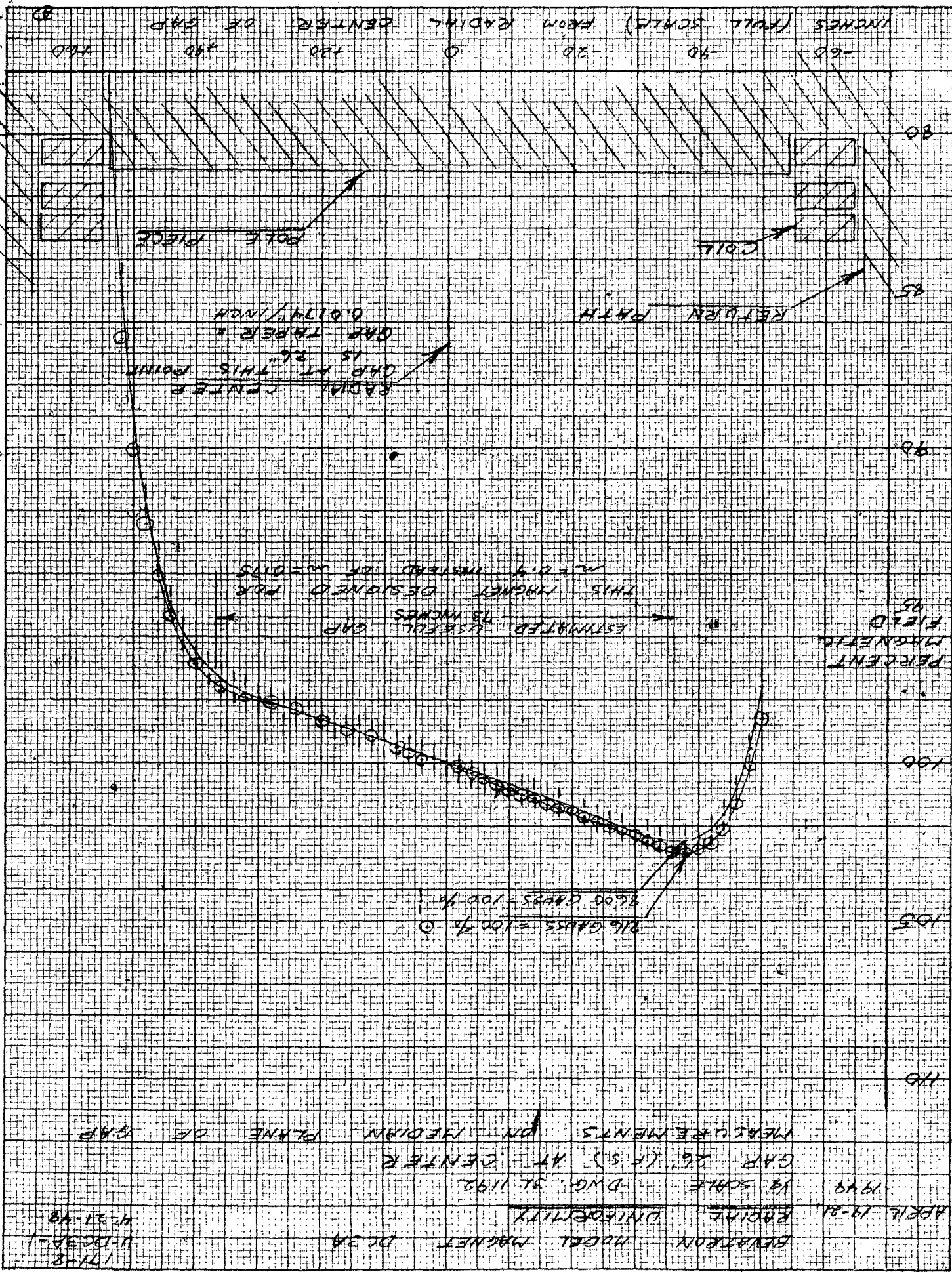
Bevatron Model Magnet DC3A







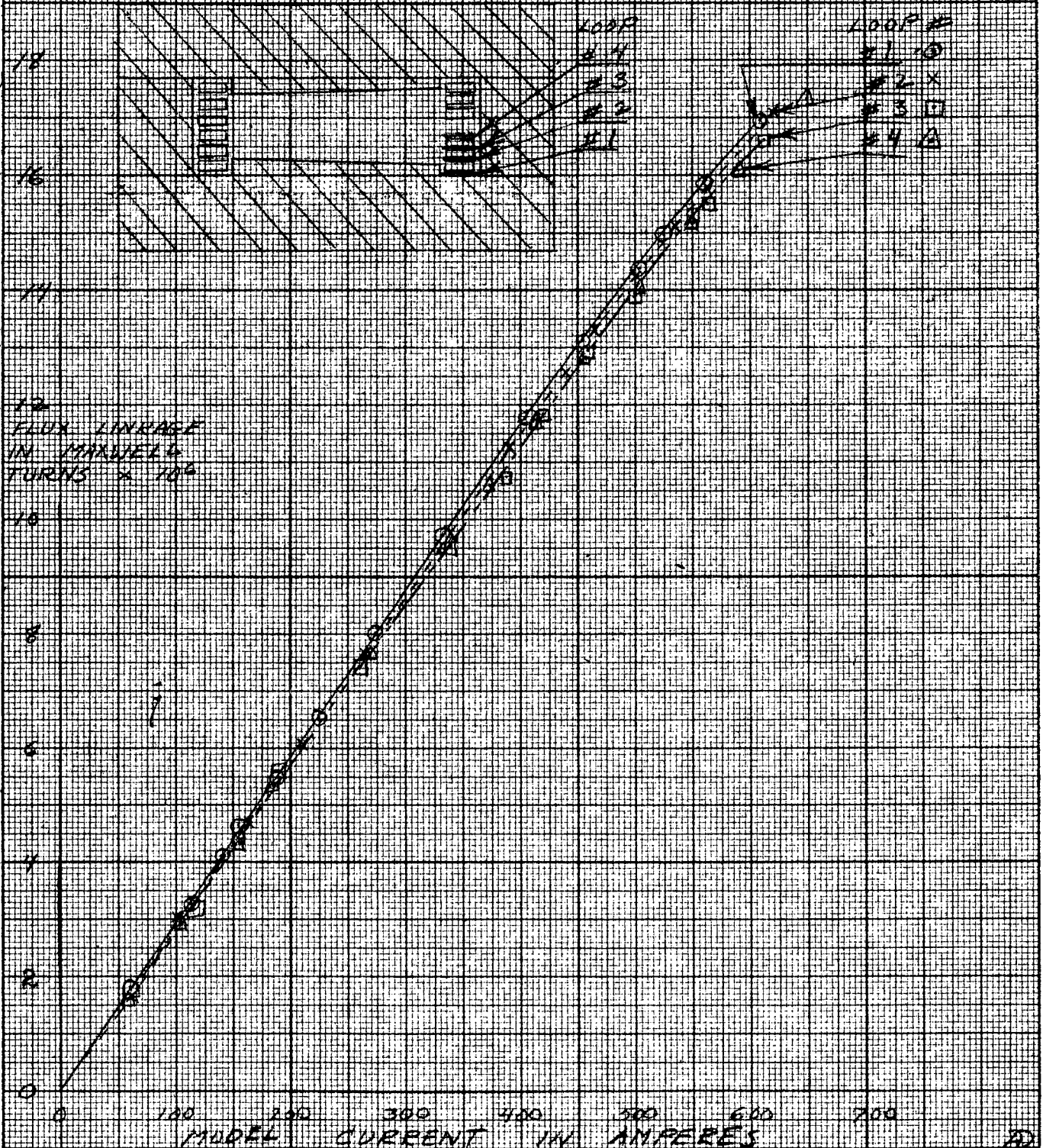
KUHPFEL & ESSLER CO., N. Y. NO. 889-130  
 10 X 10 to the 1/8 Inch. 5th. lines accounted.  
 MADE IN U. S. A.

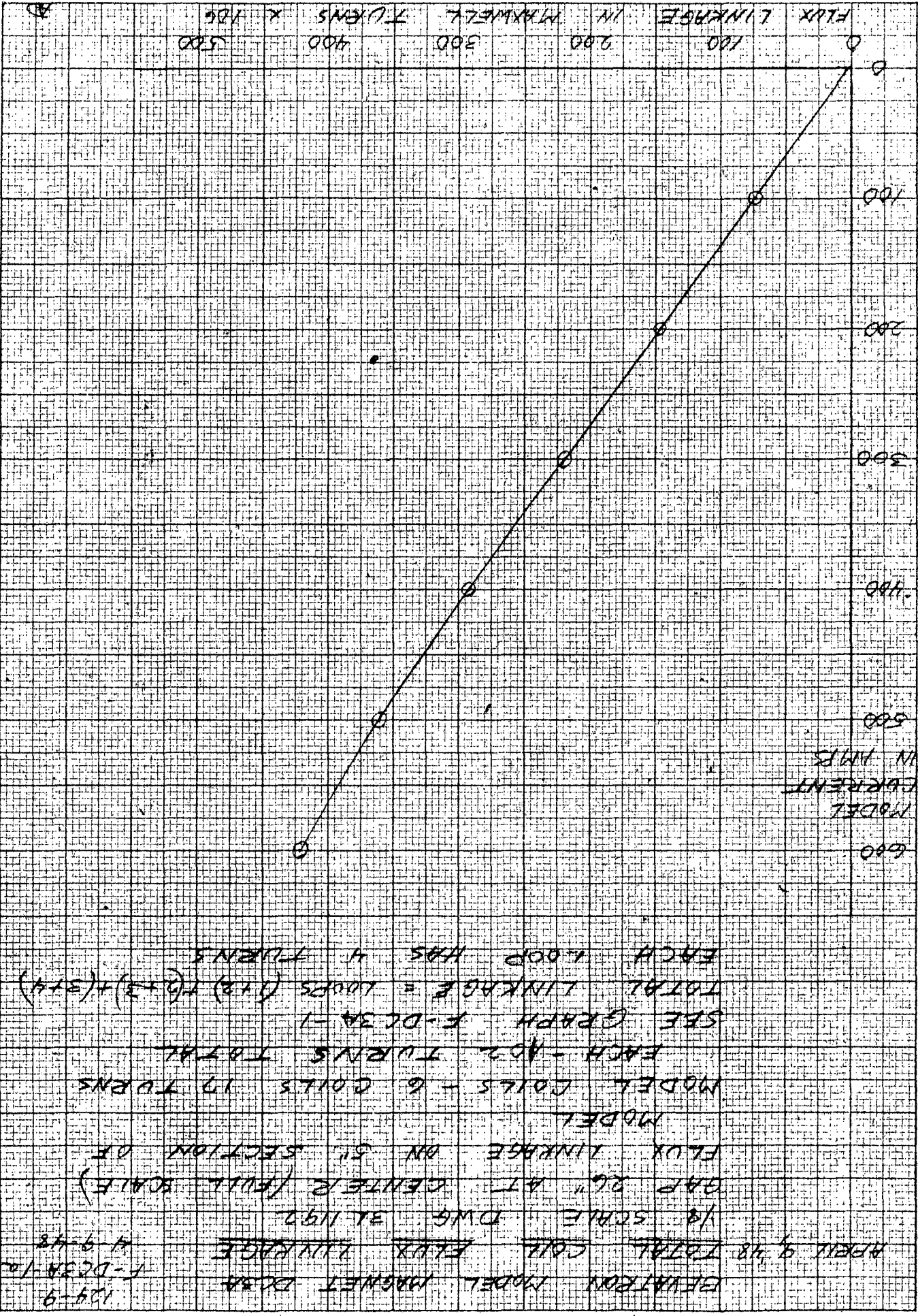


APRIL 9  
1946

BEVATRON MODEL MAGNET DC 3A  
COIL FLUX LINKAGE  
1/8 SCALE DWG 31192  
GAP 26" AT CENTER (FULL SCALE)  
FLUX LINKAGE ON 5" SECTION OF  
MODEL  
MODEL COILS: 6 COILS 17 TURNS EACH  
102 TURNS TOTAL  
EACH LOOP HAS 4 TURNS

124-9  
FLUX-1  
4-9-46



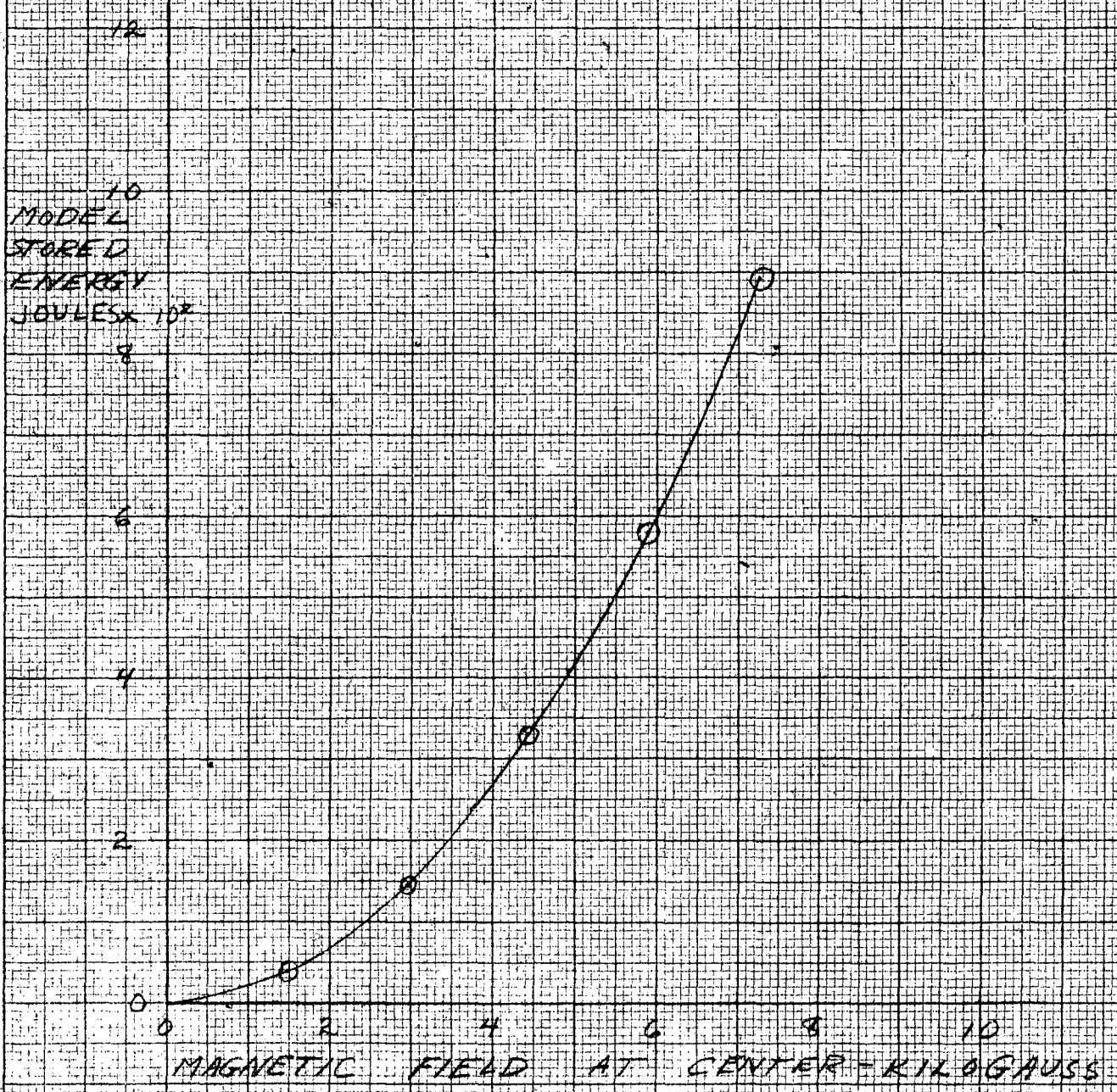


EXPLANATION MODEL MAGNET DESIGN  
 AREAS 9.48 TOTAL COIL FLUX LINKAGE  
 1/8 SCALE DWG. AT 1/92  
 GAP .06" AT CENTER (FULL SCALE)  
 FLUX LINKAGE ON 5" SECTION OF  
 MODEL  
 MODEL COILS - 6 COILS 19 TURNS  
 EACH - NO. 2 TURNS TOTAL  
 SEE GRAPH F-DC 3A-1  
 TOTAL LINKAGE = 100S (1+2) + (3+4) + (5+6)  
 EACH LOOP HAS 4 TURNS

104-9  
 F-DC 3A-1  
 4-9-48



BEVATRON MODEL MAGNET-DC3A 171-8  
 APRIL 9, 48 1/8 SCALE DWG 3L 1192 E-DC3A-1  
 5-10-48  
 STORED ENERGY CALCULATED FROM  
 TOTAL COIL FLUX LINKAGE H-DC3A-1a  
 $ENERGY(JOULES) = 10^{-9} I^2 \Phi$   
 WHERE I IS IN AMPERES &  
 $\Phi$  IS IN MAXWELL TURNS  
 DATA FOR 5" SECTION ON MODEL



KEUFEL & ESSER CO., N. Y., NO. 289-11G  
 10 X 10 to the 1/2 inch, 5th lines centered.  
 Engraving 7 X 10 in.  
 MADE IN U. S. A.

7 Model Magnet DC5 Index

a. Discussion

b. Sketch

c. Photographs

BEVA 23

d. Graphs

L-DC5-1

Efficiency and leakage coefficients

H-DC5-1

Flux density around the magnetic path

U-DC5-1

Radial uniformity

U-DC5-1a

Radial uniformity - Expanded

F-DC5-1

Coil flux linkage

F-DC5-1a

Total coil flux linkage

E-DC5-1

Stored energy

## 7 Model Magnet DC5

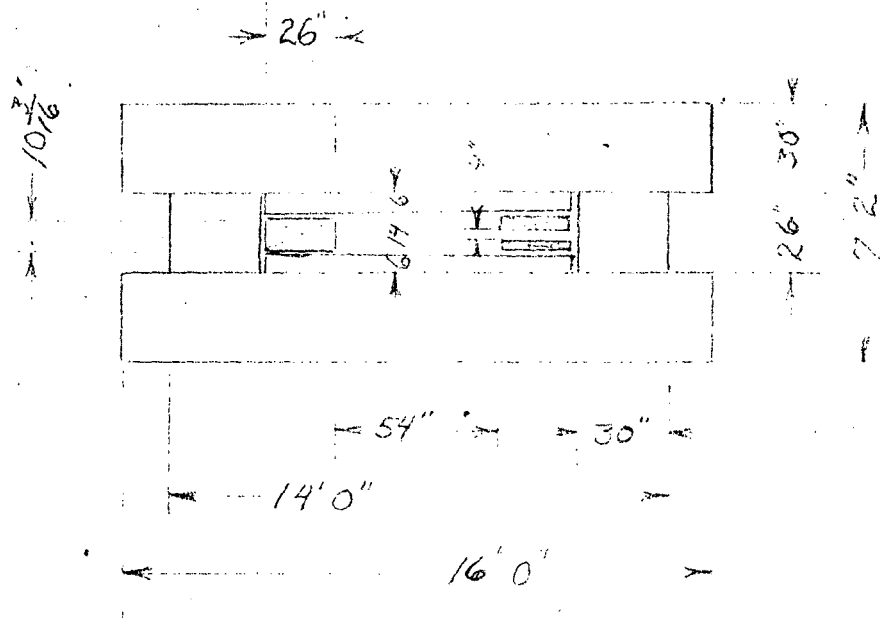
### a. Discussion

Bevatron model magnet DC5 was similar in design to model DC3. Changes were made in the exciting coils in an effort to increase the useful gap width. The distance between the leg slabs was decreased but the radial width of the yoke slabs and the thickness of the leg slabs were not decreased.

A comparison of magnet performance of model DC5 with the performance of model DC3 shows some changes. The peak KVA required was increased from  $127 \times 10^3$  to  $142 \times 10^3$  KVA for a rise time of one second. The useful radial gap width was increased at the injection field from 26 inches to 44 inches and at 16 kilogauss from 22 inches to 44 inches.

Model magnet DC5 was then modified for the larger aperture (2' x 8') model of DC5. (See DC5A)

# BEVATRON MODEL MAGNET DC 5



$\mu = 0.75$

GAP 14"

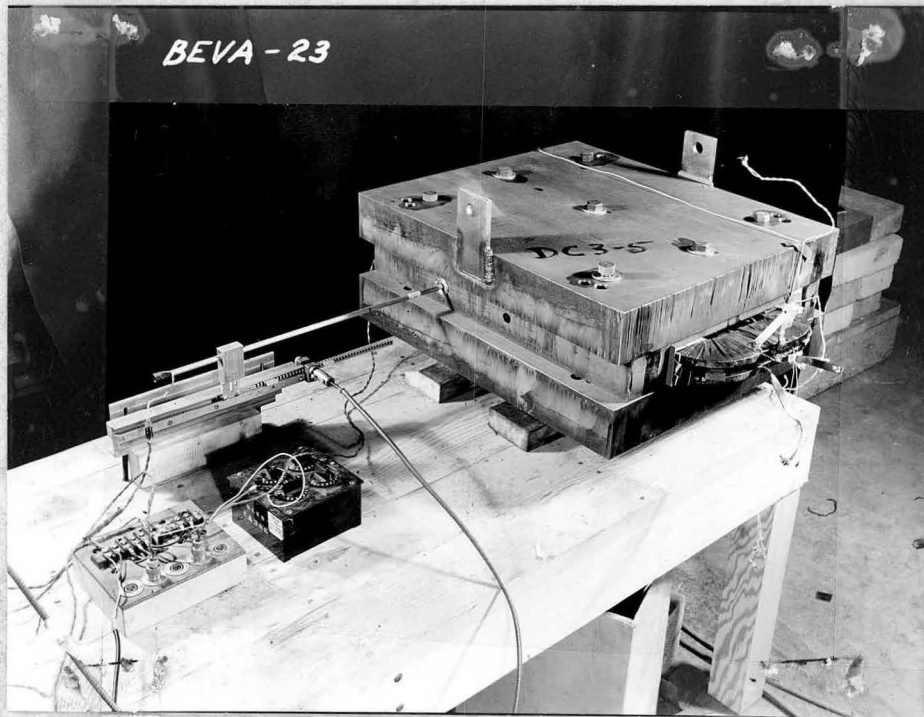
RADIUS 50'

MODEL COILS: 2 COILS 46 TURNS EACH = 92 TURNS

DIMENSIONS ARE FULL SCALE

MODEL IS 1/8 SCALE

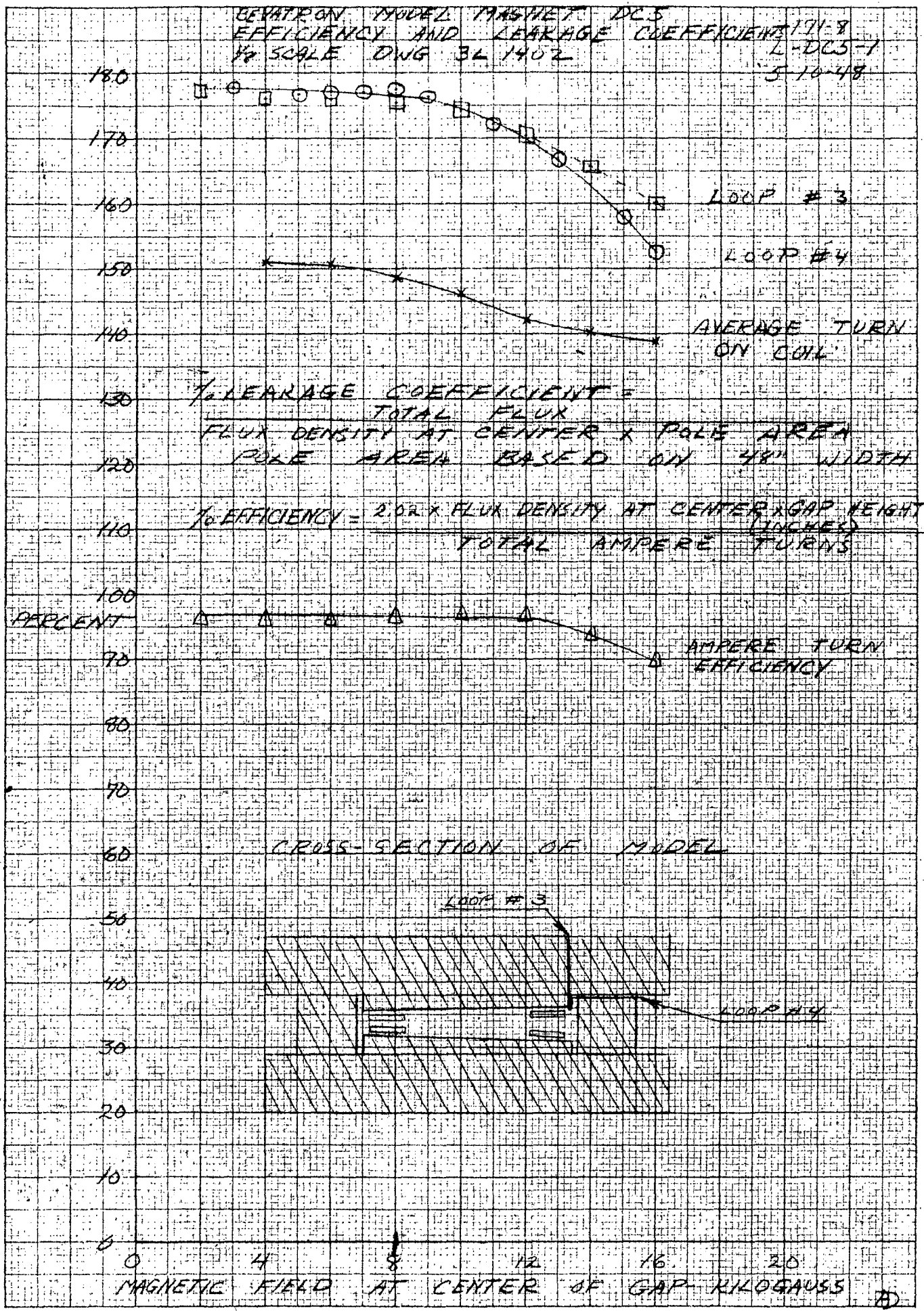
ASSEMBLY DWG. 3L1402



BEVA 23

Bevatron Model Magnet DC5

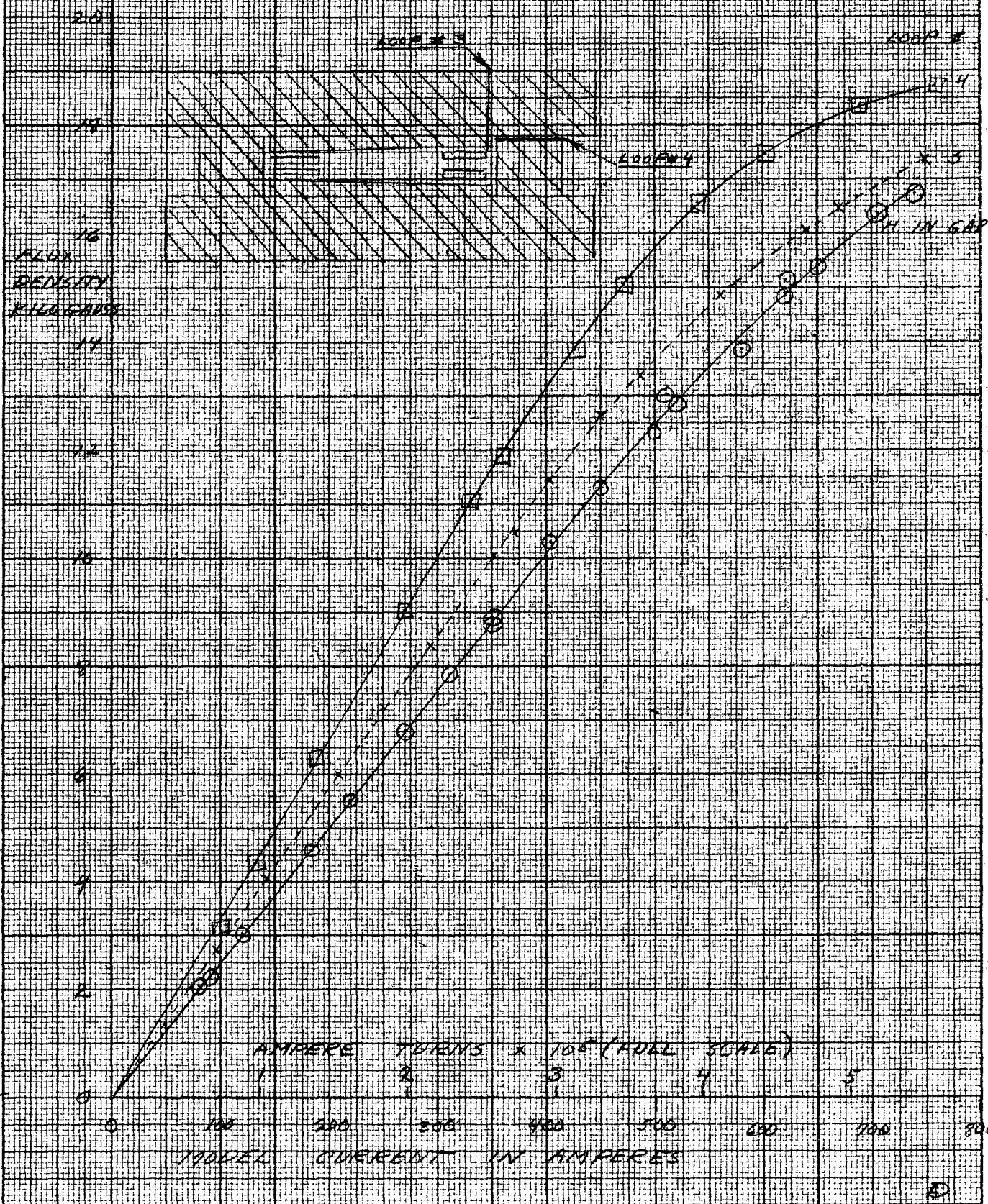
BEYATRON MODEL MAGNET DC5  
 EFFICIENCY AND LEAKAGE COEFFICIENTS  
 1/8 SCALE DWG 34 1402  
 L-DC5-1  
 5-10-48



KEUFEL & ESSER CO., N. Y. NO. 359-11G  
 10 X 10 to the 1/8 inch, 5th lines accounted.  
 Engraving 7 X 10 in.  
 MADE IN U. S. A.

REVOLUTION MODEL MAGNET 005  
 1/8 SLIP ON CORE 36 INCH  
 FLUX DENSITY AROUND MAGNETIC PATH 56 GAUSS  
 GAP 1/4 (FULL SCALE AT CENTER)  
 92 TURNS TOTAL ON MODEL COILS

171-8  
 H-005-1



BEVATRON MODEL MAGNET DCS

171-8  
4-DOS-1  
5-3-48

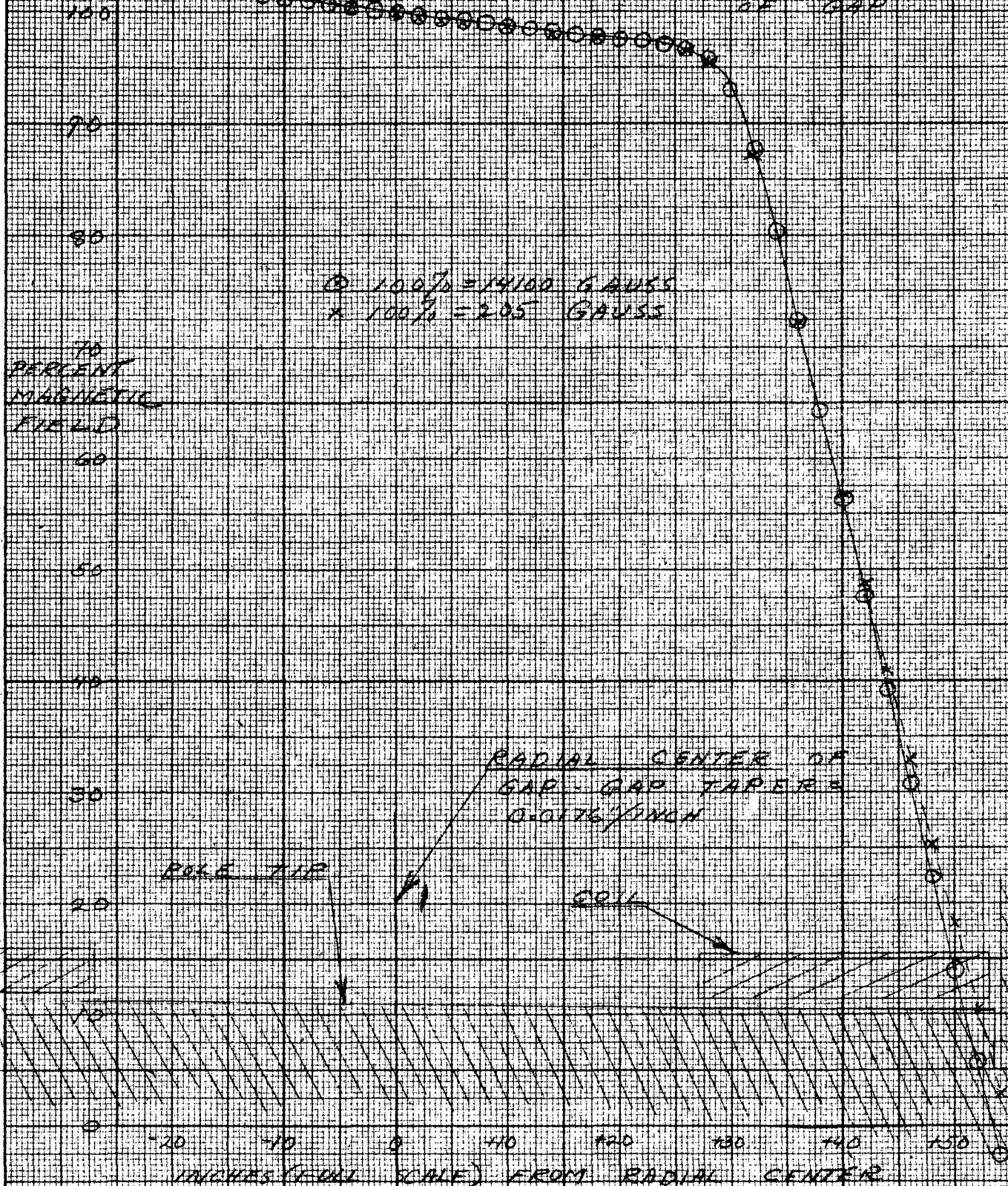
110 May 7, '48

RADIAL UNIFORMITY

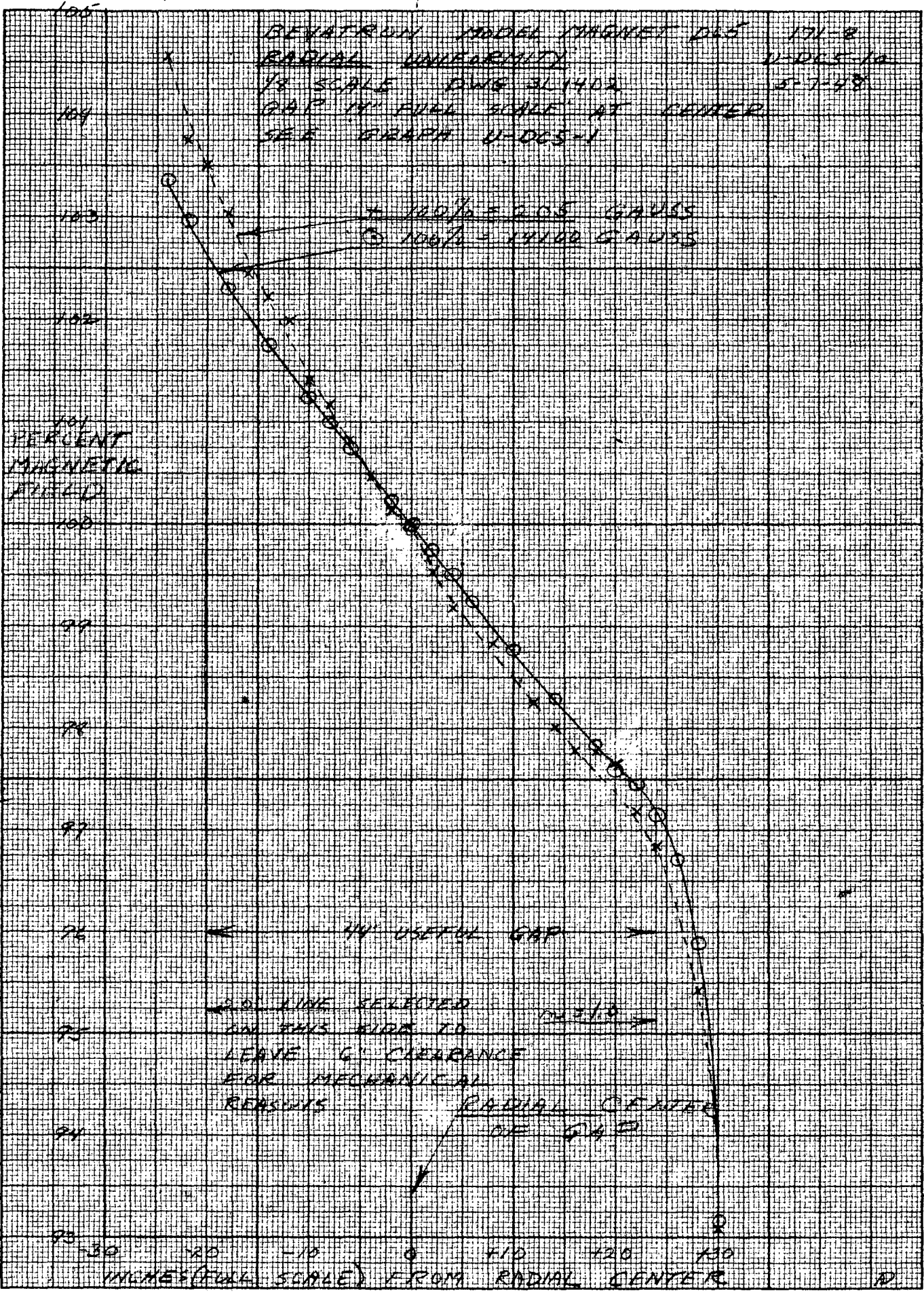
1/4 SCALE DWS 311409

GAP 19 1/2 (ES) AT GAP CENTER

MEASUREMENTS ON MEDIUM PLANE OF GAP







May 6, 1948

Bevatron Model Magnet DC 5

171-8  
E-105-1  
5-6-48

Coil Flux Linkage

1/8 Scale DWG 311402

Gap 14" at Center (Full Scale)

Flux Linkage on 5" Section of Model

Metal Coils 2 Coils 46 Turns Each

92 Turns Total

Each Loop Has 46 Turns

240  
Flux Linkage  
10<sup>6</sup>  
220  
Turns x 10<sup>6</sup>  
200  
180  
160  
140  
120  
100  
80  
60  
40  
20  
0

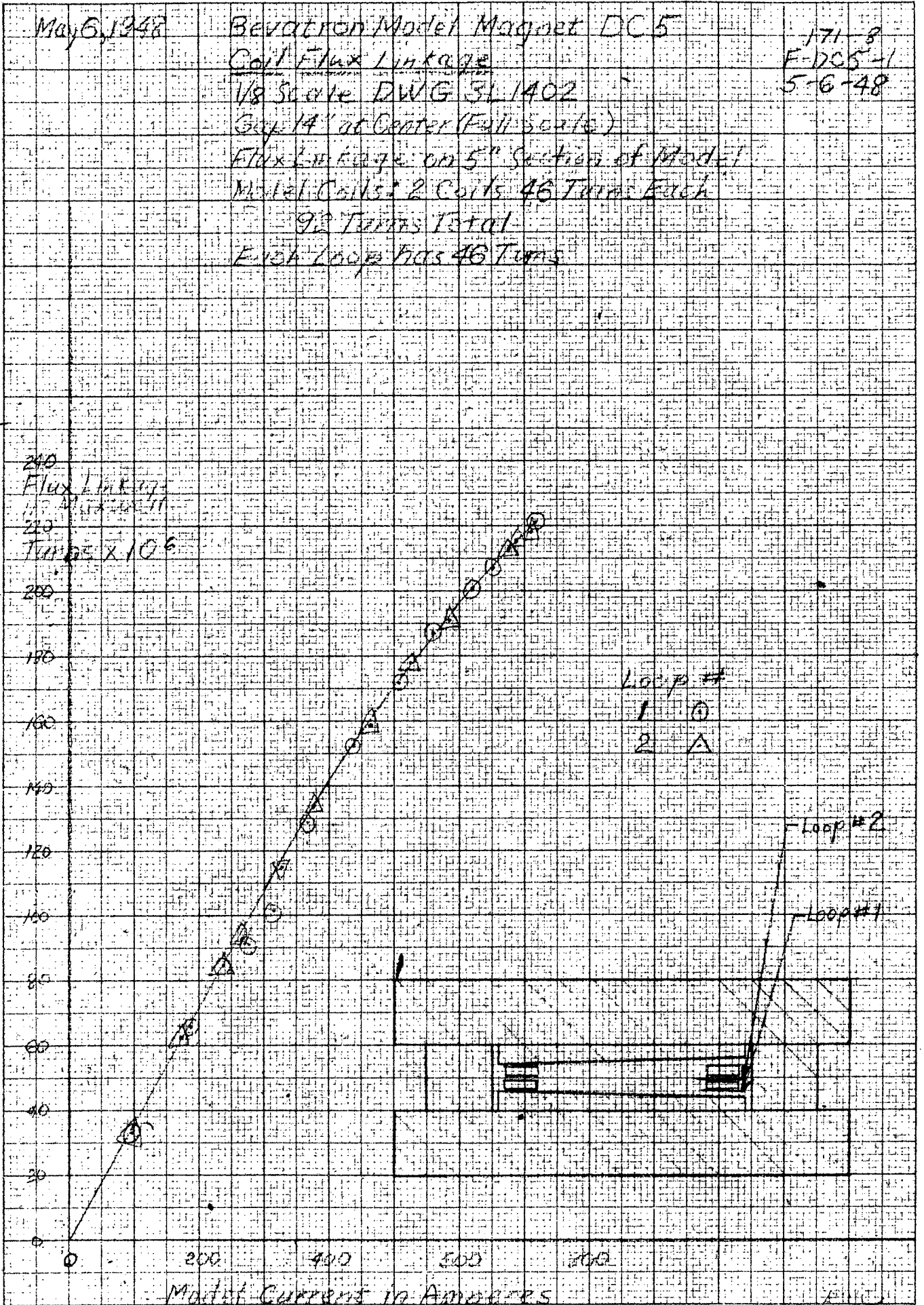
Loop #  
1 O  
2 Δ

Loop #2

Loop #1

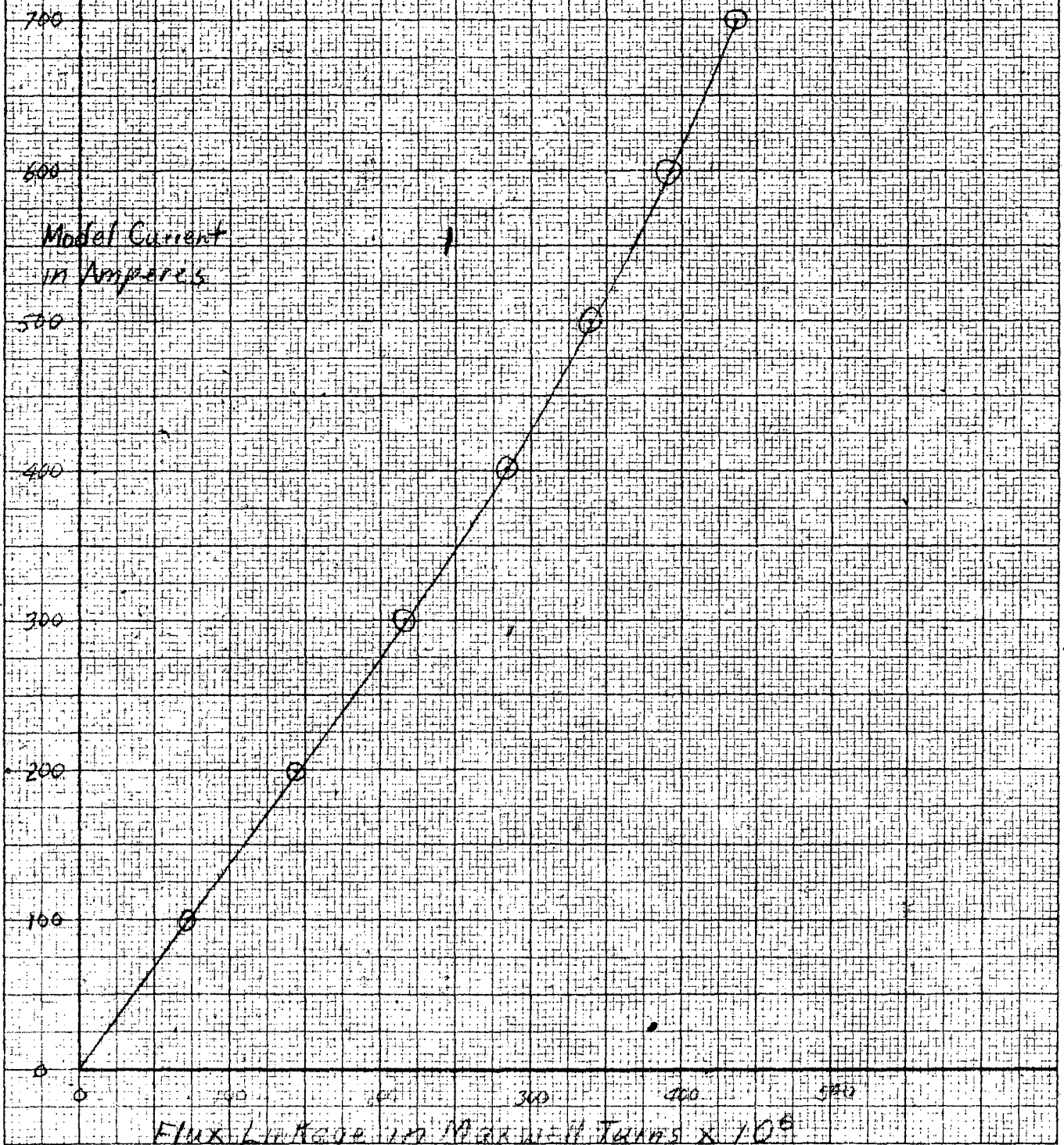
Model Current in Amperes

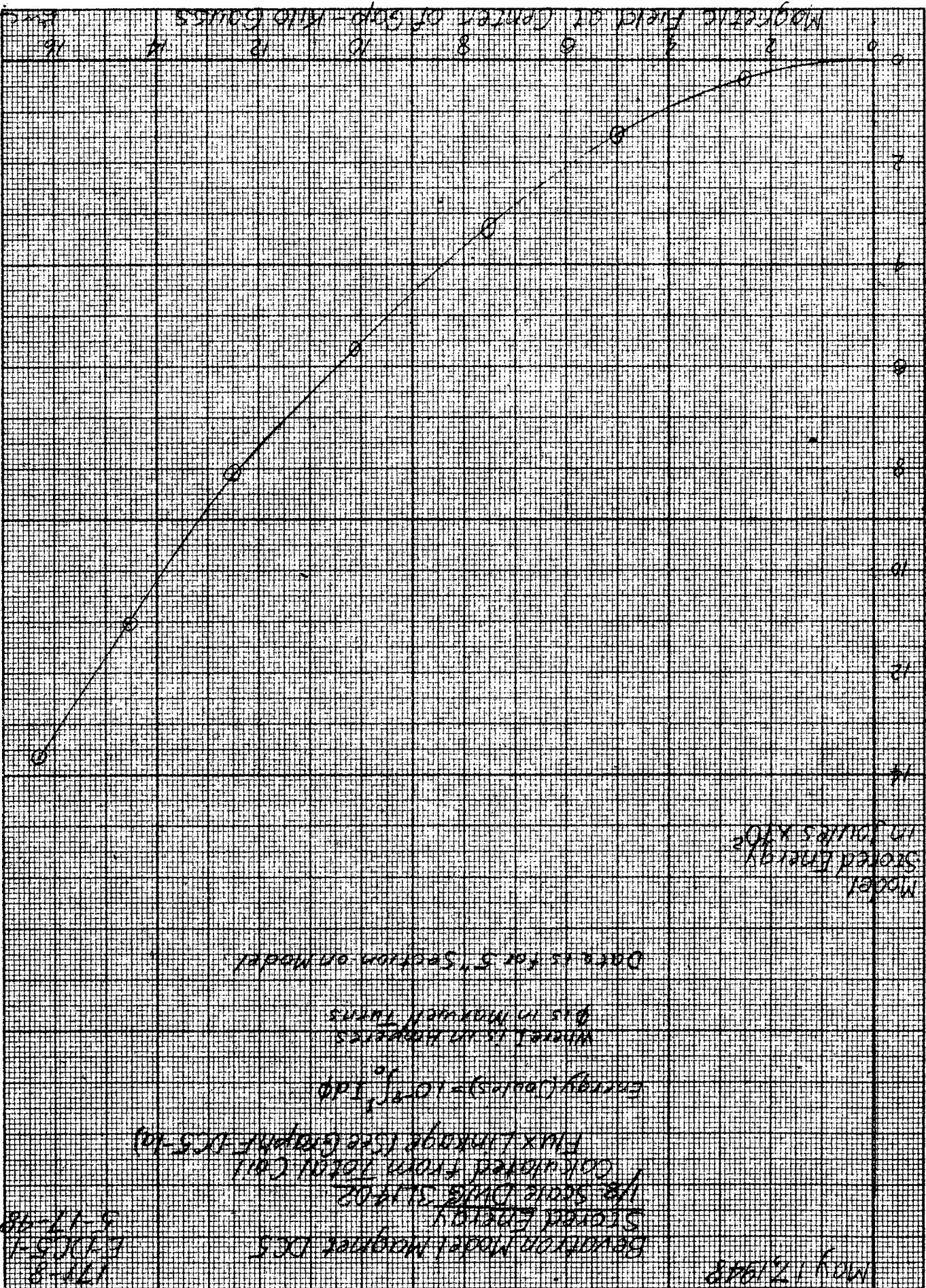
KEUFFEL & ESSER CO., N. Y. NO. 389-11G  
10 x 10 to the 1/4 inch, 3/16 inch accuracy  
Engraving 7 x 10 in.  
MADE IN U.S.A.



May 10, 1948

Benarion Model Magnet DC5 171-8  
Total Coil Flux Linkage F-DC5-1a  
1/8 Scale DWG 3L1402 5-10-48  
Gap 1/4" at Center (Full Scale)  
Flux Linkage on 5" Section of Model  
Model Coils: 2 Coils 46 Turns Each  
92 Turns Total  
Each Loop has 46 Turns  
See Graph F-DC5-1





Model  
Stored Energy  
IN JOULES X 10<sup>6</sup>

Data is for S<sup>1</sup> Section of Model

WIND IS IN AMPERES  
Φ IS IN MILLIWEBS

$$\text{Energy (Joules)} = 10^{-6} \int_0^{\Phi} i d\Phi$$

FLUX LINKAGE (See Graph DC5-10)  
CALCULATED FROM TOTAL C.M.I.  
1/2 SCALE DWG 311402

Stored Energy  
Beverton Model Magnet DC5

177-8  
E.D.S.-1  
5-17-48

May 12, 1948

8 Model Magnet DC5A Index

a. Discussion

b. Sketch

c. Photographs

BEVA 20

d. Graphs

L-DC5A-1

Efficiency and leakage coefficients

H-DC5A-1

Flux density around the magnetic path

U-DC5A-1

Radial uniformity

U-DC5A-1a

Radial uniformity - Expanded

F-DC5A-1

Coil flux linkage

F-DC5A-1a

Total coil flux linkage

E-DC5A-1

Stored energy

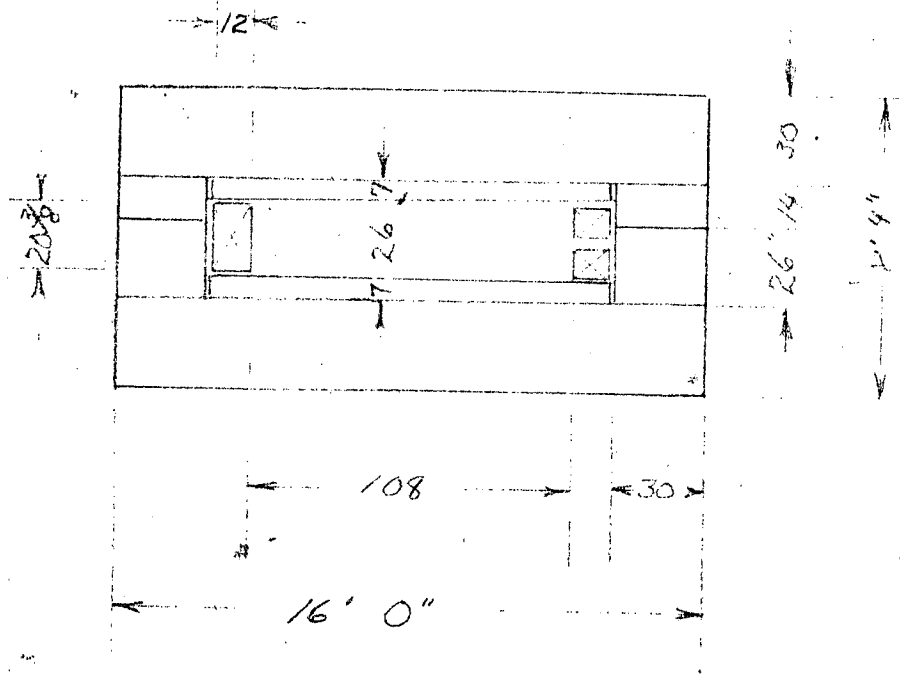
## 8 Model Magnet DC5A

### a. Discussion

Bevatron model magnet DC5A was designed to adapt model magnet DC5 to a larger aperture. The radial width between the inner edges of the coils was increased from 54 inches to 108 inches. The gap was increased from 14 inches to 26 inches. Extensions were added to the leg slabs to increase the distance between the yoke slabs, and the legs were moved out to increase the distance between leg slabs.

The  $n$  value in the model magnet design was changed from 0.40 on DC3A to 0.75 on DC5A. The exciting coil placement was changed in an effort to increase the useful gap width. These changes increased the useful width of the magnetic field at the injection field end at the higher fields from 73 inches to 94 inches. A decision was made at this time to design a model magnet with an even larger aperture, 4' x 14', as an initial stage in the development of the bevatron. This magnet was to be designed so that it could be converted to the 1' x 4' aperture at a later time. (See model DC6 and DC6A)

# BEVATRON MODEL MAGNET DC5A



GAP 26"

RADIUS 50"

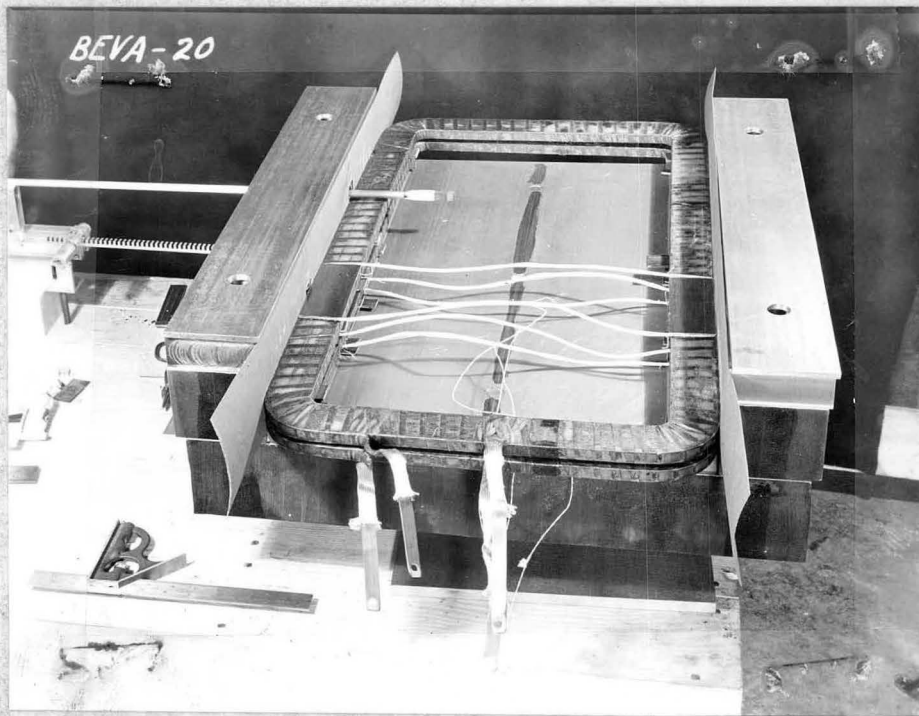
$n = 0.75$

MODEL COILS: 4 COILS 26 TURNS EACH = 104 TURNS

DIMENSIONS ARE FULL SCALE

MODEL IS  $1/8$  SCALE

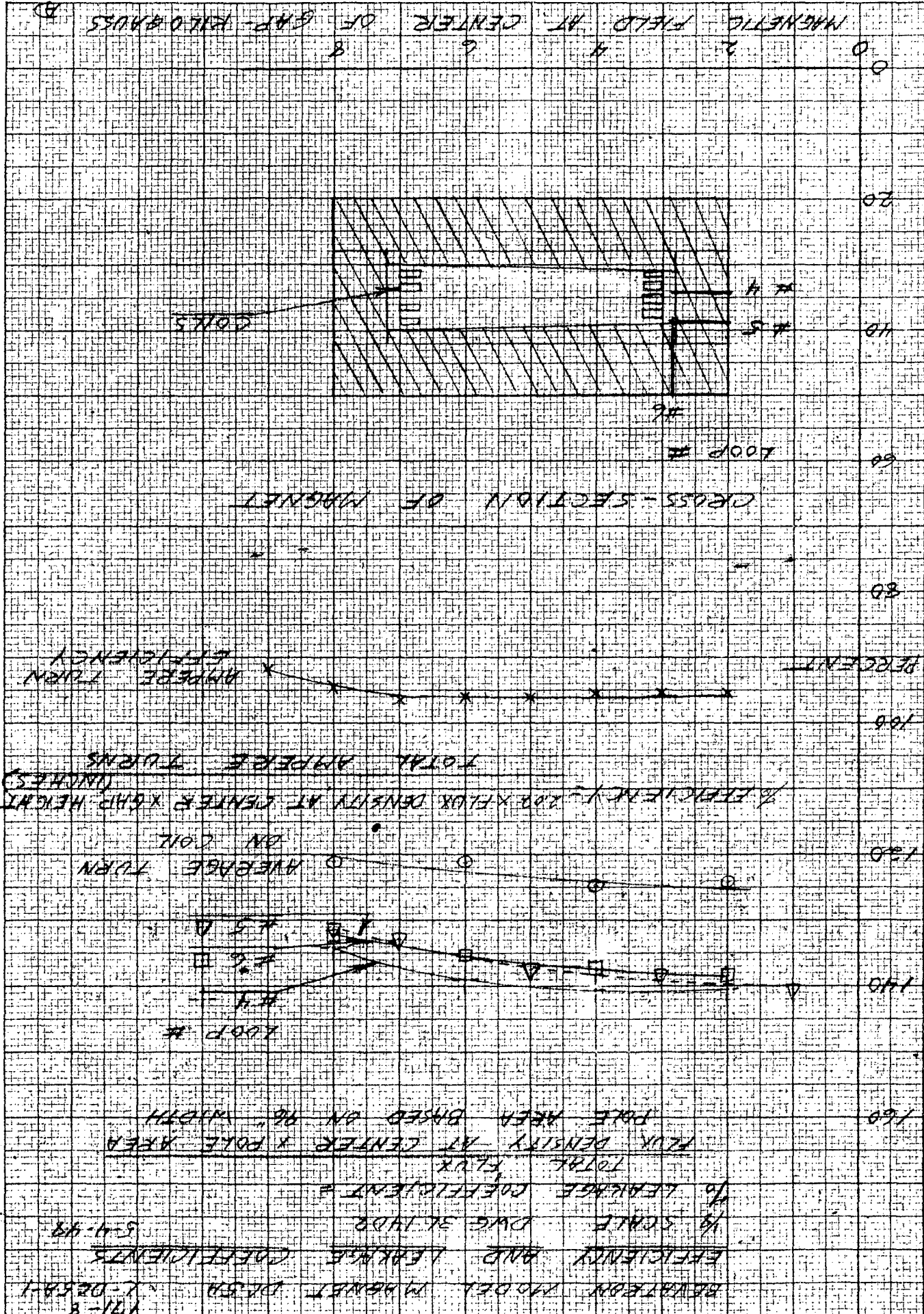
ASSEMBLY DWG. 31 1402



BEVA 20

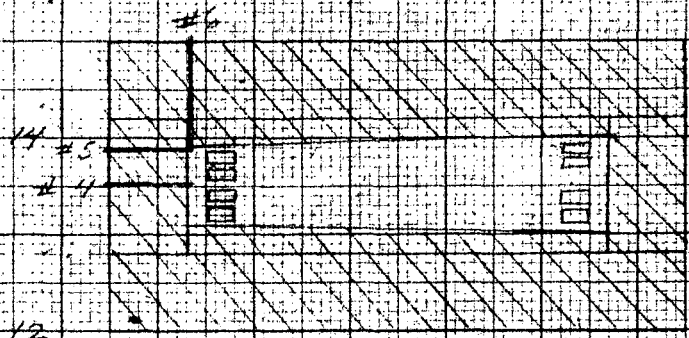
Bevtron Model Magnet DC5A





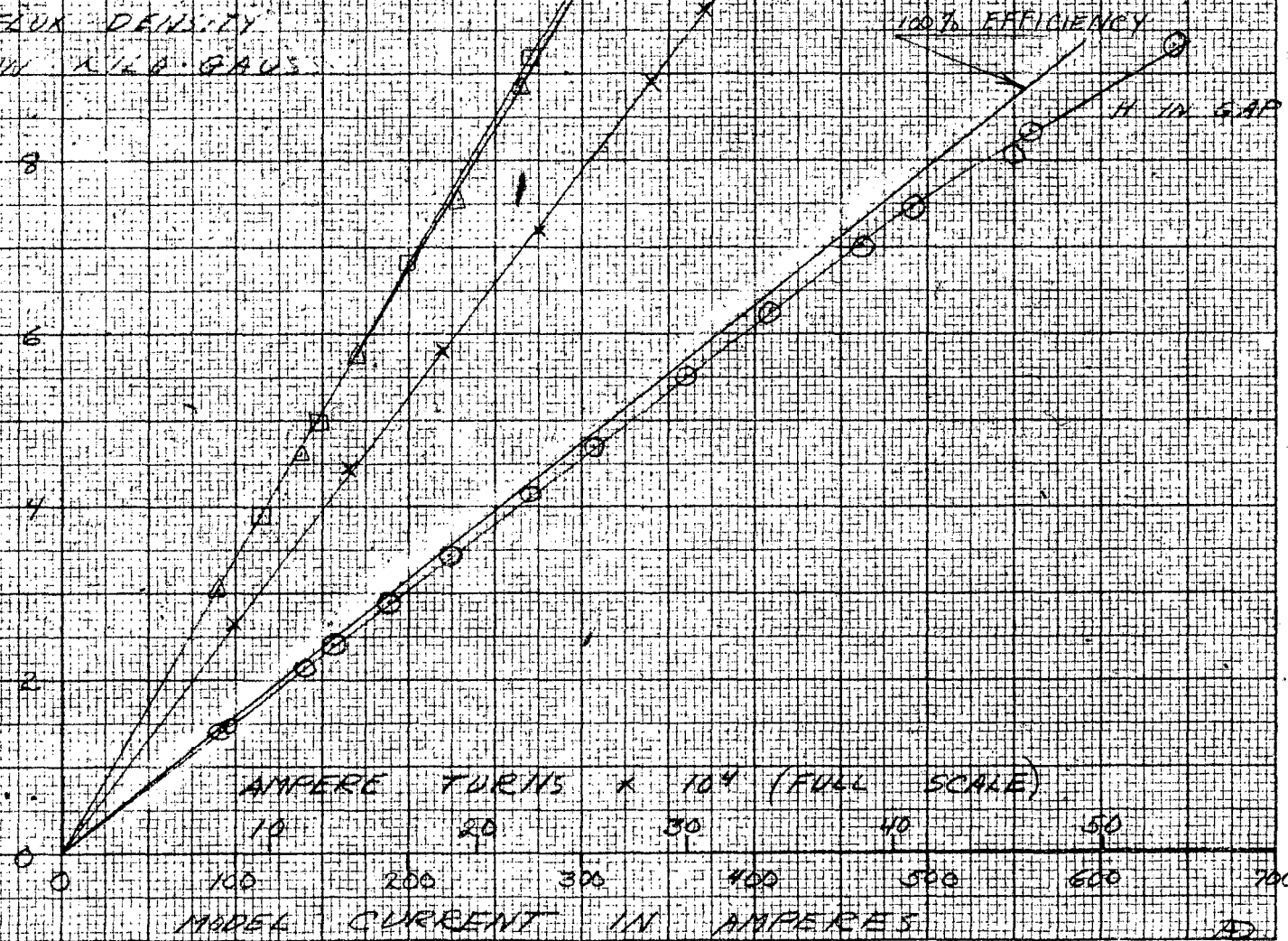
171-8  
H-DC5A-1  
4-29-48

BEVAFRON MODEL MAGNET DC 5A  
FLUX DENSITY AROUND MAGNETIC  
PATH  
V8 SCALE - DWG 3L 1402  
GAP .26" (FULL SCALE) - AT CENTER  
104 TURNS TOTAL - ON  
MODEL COILS



FLUX DENSITY  
IN KILO GAUSS

100% EFFICIENCY  
H IN GAP



May 20 1948

BEUMERSON MODEL MAGNET FLUX

101-B

RADIAL UNIFORMITY

11-0213-1

1/16 SCALE - DATE 24 1948

5-4440

GAP 25 AT CENTER (FULL SCALE)

MEASUREMENTS ON MEDIAN PLANE  
OF GAP

110

100

90

80

PERCENT  
MAGNETIC  
FIELD

70

60

50

40

30

20

10

0

100% 3000 GAUSS

100% 197 GAUSS

COIL  
POLE TIP  
RETURN PATH

RADIAL CENTER  
OF GAP  
GAP TAPER -  
0.036/inch

-60 -40 -20 0 +20 +40 +60 +80  
INCHES (FULL SCALE) FROM RADIAL CENTER

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NO. 340 - M DIETZEN GRAPH PAPER  
MILLIMETER

110  
108  
106  
104  
102  
100  
99  
98  
96  
94  
92  
90  
88  
86

MAY 31 1948

DEVIATION MODEL MAGNET DC 5A  
RADIAL UNIFORMITY  
76 SCALE DIA 3L 1402  
GAP 36" (55) AT CENTER  
SEE DRAWING U-DC5A-1

171-8  
U-DC5A-102  
5-4-48

100 PERCENT  
MAGNETIC  
FIELD

100% = 197 GAUSS

100% = 8000 GAUSS

THIS LINE SELECTED ON  
THIS SIDE TO BECAUSE  
OF CLEARANCE FOR  
MECHANICAL REASONS

92% USEFUL GAP

$D = 1.0$

95% USEFUL GAP

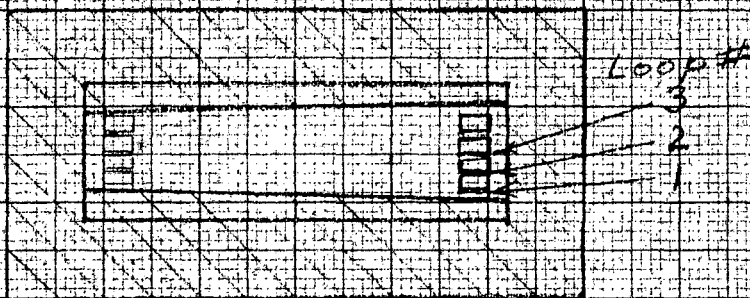
RADIAL CENTER  
OF GAP

100 90 80 0 120 140 160  
INCHES (FULL SCALE) FROM RADIAL CENTER OF GAP

EUGENE DIETZEN CO.  
PRINTED IN U.S.A.

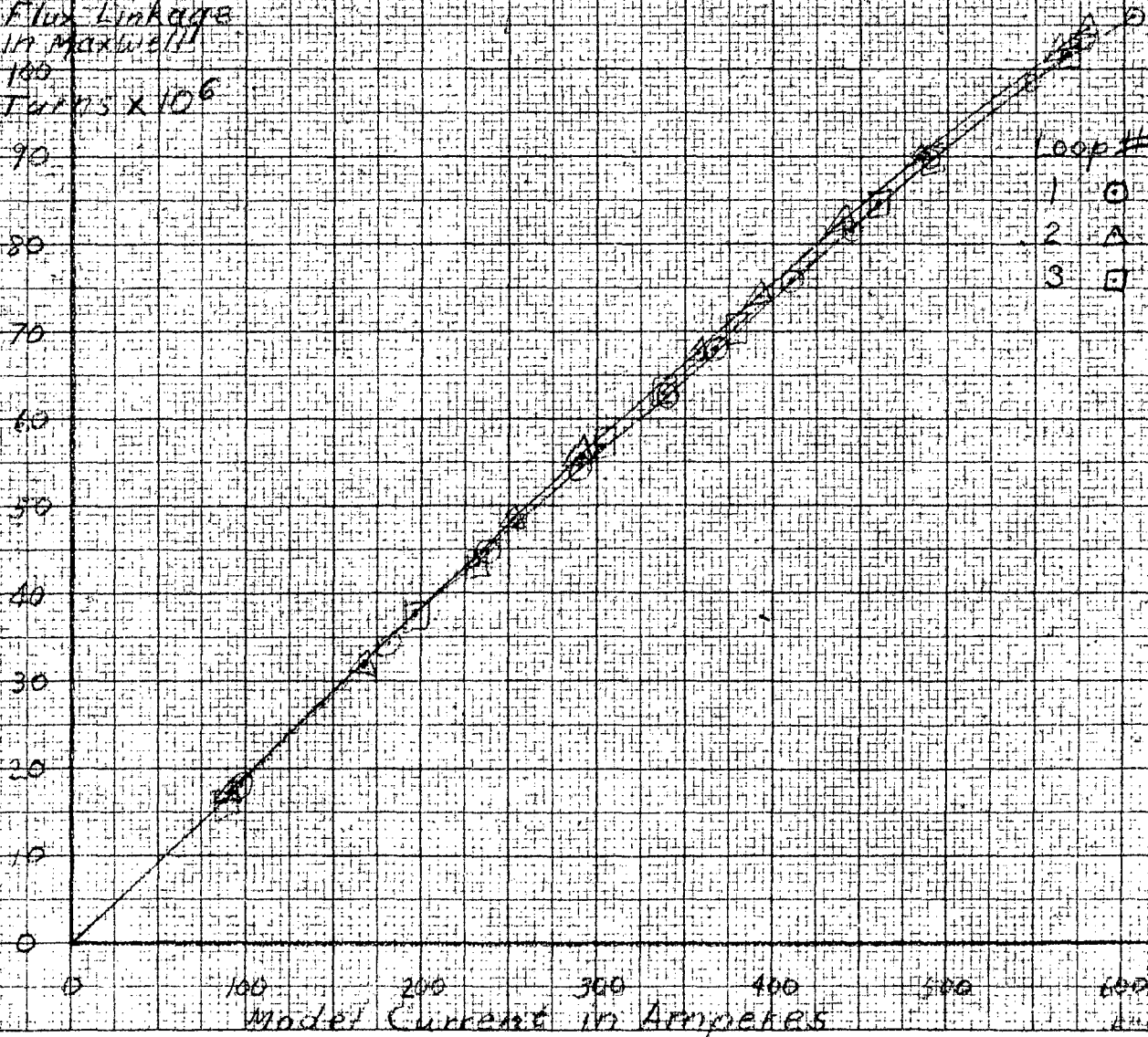
NO. 340 - M DIETZEN GRAPH PAPER  
MILLIMETER

Apr 29, 1948 Bevatron Model Magnet DC 5A  
 Coil Flux Linkage 171-B  
 1/8 Scale DWG # 3L 1402 F-DC5A-1  
 Gap 26" at Center (Full Scale) 4-29-48  
 Flux Linkage on 5" Section of Model  
 Model Coils: 4 Coils 26 Turns Each  
 104 Turns Total  
 Each Loop Has 26 Turns



110  
 Flux Linkage  
 in Maxwell  
 100  
 Turns x 10<sup>6</sup>  
 90  
 80  
 70  
 60  
 50  
 40  
 30  
 20  
 0

Loop #  
 1 ○  
 2 △  
 3 □



April 29, 1948

Bevatron Model Magnet DC5A

Total Coil Flux Linkage

171-9

1/8 Scale DWG #3L1402

F-DC5A-1a

Flux Linkage on 5" Section  
of Model

4-29-48

800

Model Coils: 4 Coils 26 Turns Each

104 Turns Total

Each Loop Has 26 Turns

See Graph F-DC5A-1

700

600

Model Current  
in Amps

500

400

300

200

100

0

100

200

300

400

500

600

Flux Linkage in Maxwell Turns x 10<sup>6</sup>

EWC

May 11, 1948

Bronatron Model Magnet DC 5A  
1/8 Scale DWG # 3L 1402

171-8  
E-DC5A-1  
5-11-48

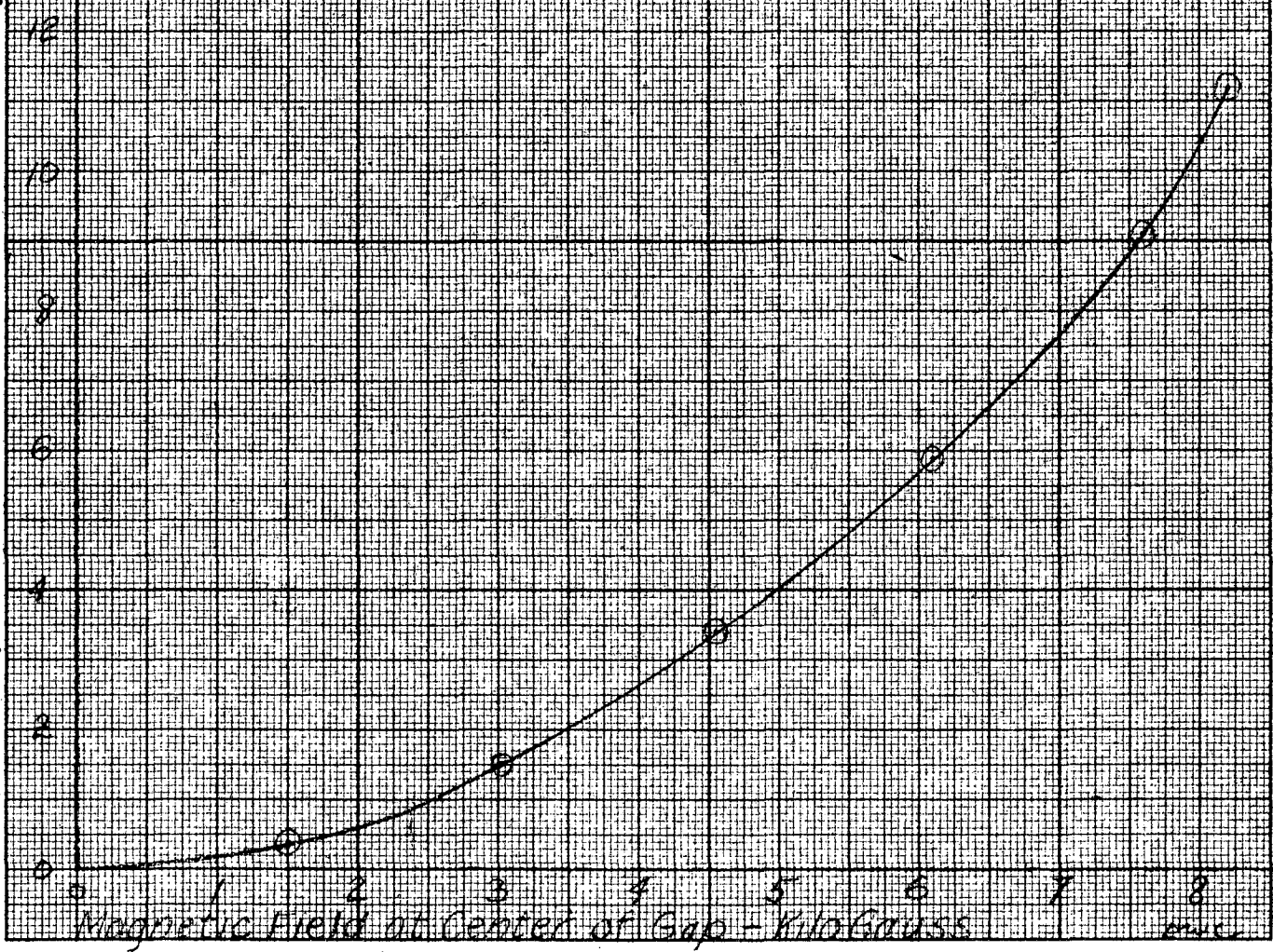
Stored Energy Calculated  
From Total Coil Flux Linkage  
(See Graph E-DC5A-1)

$$\text{Energy (Joules)} = 10^{-8} \int_0^{\phi} I d\phi$$

Where I is in Amperes and  
 $\phi$  is in Maxwell Turns

Data For 5" Section of Model

Model  
Stored Energy  
Joules x 10<sup>2</sup>



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NO. 340 - M DIETZEN GRAPH PAPER  
MILLIMETER

9 Model Magnets DC6 and DC6A series Index

- a. Discussion
- b. Sketches
- c. Photographs

BEVA 34

BEVA 35

BEVA 36

BEVA 37

d. Graphs

1) Model Magnets DC6 series

a) Model magnet DC6

- H-DC6-1 Magnetization at center
- H-DC6-2 Flux density around the magnetic path
- H-DC6-3 Flux density around the magnetic path
- H-DC6-4 Sketch showing location of flux loops
- H-DC6-5 Flux density around the magnetic path
- H-DC6-6 Magnetization at center - Low field
- F-DC6-1 Coil flux linkage
- F-DC6-1a Total coil flux linkage
- F-DC6-2 Coil flux linkage - Low field
- E-DC6-1 Stored energy

b) Model magnet DC6.1

- L-DC6.1-1 Efficiency and leakage coefficients
- H-DC6.1-1 (cor) Magnetization at gap center
- H-DC6.1-2 Flux density around the magnetic path
- H-DC6.1-3 Flux density around the magnetic path
- H-DC6.1-4 Flux density around the magnetic path
- H-DC6.1-5 Sketch showing location of the flux loops
- F-DC6.1-1 Coil flux linkage



- F-DC6.1-1a Total coil flux linkage
- F-DC6.1-2 Coil flux linkage - Low field
- E-DC6.1-1 (cor) Stored energy
- c) Model magnet DC6.2
- H-DC6.2-1 Magnetization at gap center
- H-DC6.2-2 Flux density around the magnetic path
- H-DC6.2-3 Flux density around the magnetic path
- H-DC6.2-4 Flux density around the magnetic path
- H-DC6.2-5 Sketch showing location of the flux loops
- d) Model magnet DC6.3
- H-DC6.3-1 Magnetization at gap center
- H-DC6.3-2 Flux density around the magnetic path
- H-DC6.3-3 Flux density around the magnetic path
- H-DC6.3-4 Flux density around the magnetic path
- H-DC6.3-5 Sketch showing the location of the flux loops
- e) Model magnet DC6.4
- H-DC6.4-1 Magnetization at gap center
- H-DC6.4-2 Flux density around the magnetic path
- H-DC6.4-3 Flux density around the magnetic path
- H-DC6.4-4 Flux density around the magnetic path
- H-DC6.4-5 Sketch showing the location of the flux loops
- f) Model magnet DC6.5
- H-DC6.5-1 Magnetization at gap center
- F-DC6.5-1 Coil loop flux linkage
- F-DC6.5-1a Total coil loop flux linkage
- E-DC6.5-1 Stored energy
- g) Model magnet DC6.6
- H-DC6.6-1 Magnetization at gap center
- H-DC6.6-2 Flux density around the magnetic path
- H-DC6.6-3 Flux density around the magnetic path

H-DC6.6-4	Flux density around the magnetic path
H-DC6.6-5	Sketch showing location of the flux loops
H-DC6.6-6	Magnetization at gap center - Low field
U-DC6.6-1	Radial uniformity
U-DC6.6-1a	Radial uniformity - Expanded.
h) Model magnet DC6.7	
H-DC6.7-1	Magnetization at gap center
i) Model magnet DC6.8	
H-DC6.8-1	Magnetization at gap center
j) Model magnet DC6.9	
H-DC6.9-1	Magnetization at gap center

2) Model magnet DC6A series

a) Model magnet DC6A

L-DC6A-1	Efficiency and leakage coefficients
H-DC6A-1	Flux density around the magnetic path
H-DC6A-2	Flux density around the magnetic path
H-DC6A-3	Flux density around the magnetic path
H-DC6A-4	Sketch showing location of flux loops
H-DC6A-5	Magnetization at gap center - Low field
F-DC6A-1	Coil flux linkage
F-DC6A-1a	Total coil flux linkage
E-DC6A-1 (cor)	Stored energy

b) Model magnet DC6A.1

H-DC6A.1-1	Magnetization at gap center
U-DC6A.1-1	Radial uniformity
U-DC6A.1-1a	Radial uniformity - Expanded
F-DC6A.1-1	Coil flux linkage
F-DC6A.1-1a	Total coil flux linkage
E-DC6A.1-1	Stored energy

c) Model magnet DC6A.2

H-DC6A.2-1	Magnetization at gap center
H-DC6A.2-2	Flux density around the magnetic path
H-DC6A.2-3	Flux density around the magnetic path
H-DC6A.2-4	Flux density around the magnetic path
H-DC6A.2-5	Sketch showing location of flux loops
H-DC6A.2-6	Magnetization at gap center - Low field

U-DC6A.2-1	Radial uniformity
U-DC6A.2-1a	Radial uniformity - Expanded
d) Magnet magnet DC6A.3	
H-DC6A.3-1	Magnetization at gap center
H-DC6A.3-2	Magnetization at gap center - Low field
H-DC6A.3-3	Flux density around the magnetic path
H-DC6A.3-4	Flux density around the magnetic path
H-DC6A.3-5	Flux density around the magnetic path
H-DC6A.3-6	Sketch showing the location of flux loops
U-DC6A.3-1	Radial uniformity
U-DC6A.3-1a	Radial uniformity - Expanded
F-DC6A.3-1	Coil loop flux linkage
F-DC6A.3-1a	Total coil loop flux linkage
E-DC6A.3-1	Stored energy
S-DC6A.3-29	Flux density on yoke
S-DC6A.3-30	Flux density on yoke
S-DC6A.3-31	Sketch showing location of flux loops on yoke
S-DC6A.3-32 (cor)	Flux density on coils
S-DC6A.3-33	Flux density on coils
S-DC6A.3-34	Flux density on coils
S-DC6A.3-35	Flux density on coils
S-DC6A.3-36	Flux density on coils
S-DC6A.3-41	Stray field - Azimuthal uniformity - 2100 gauss
S-DC6A.3-42	Stray field - Azimuthal uniformity - 5050 gauss
S-DC6A.3-43	Stray field - Azimuthal uniformity - 200 gauss
S-DC6A.3-44	Stray field - Radial uniformity - 200 gauss
S-DC6A.3-45	Stray field - Radial uniformity - 2100 gauss
S-DC6A.3-46	Stray field - Radial uniformity - 5050 gauss
S-DC6A.3-47	Leakage flux summary

e) Model Magnet DC6A.4

H-DC6A.4-1 Magnetization at gap center

H-DC6A.4-2 Magnetization at gap center - Low field

f) Model Magnet DC6A.5

H-DC6A.5-1 Magnetization at gap center

H-DC6A.5-2 Magnetization at gap center - Low field

g) Model Magnet DC6A.6

H-DC6A.6-1 Magnetization at gap center

H-DC6A.6-2 Magnetization at gap center - Low field

## 9 Model Magnets DC6 and DC6A Series

### a. Discussion

Bevatron model magnets DC6 and DC6A were designed to incorporate the best features observed on the previous DC model magnets of both type A and type B. A decision was made at this time to enlarge the aperture from 2' x 8' to 4' x 14' for the initial stage. These were the first models designed to accommodate both a large (4' x 14') and a small (1' x 4') aperture without leg extensions. It was decided to use pole pieces similar to those used on model DC5A for the larger aperture (model DC6A), and similar to those used on model DC4 for the smaller aperture (model DC6). It was decided that at a later date the actual shape of the wings could be determined to give the maximum width field at the injection field (see model DC4B). The radius of the initial stage (4' x 14' aperture) was set at 552 inches instead of 600 inches as on the models DC3A and DC5A. The radius on the final stage (1' x 4' aperture) remained at 600 inches. These were the first models built in  $2\frac{1}{2}^\circ$  sectors on the arc of a circle. This series was 1/12 scale.

#### (1) DC6 series

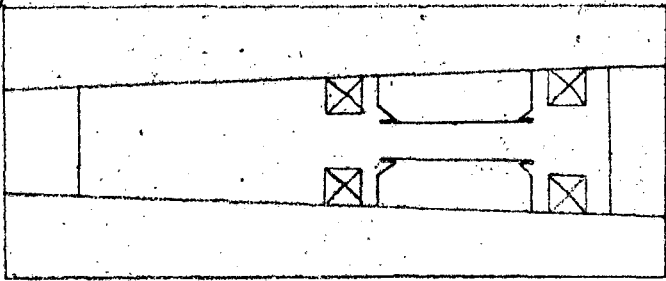
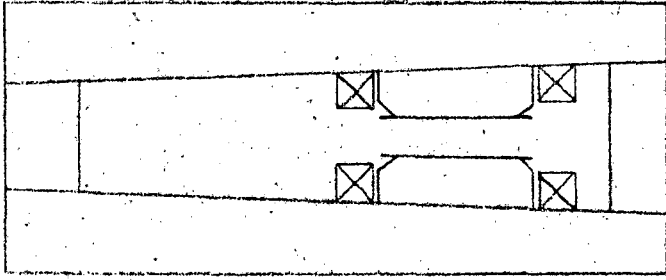
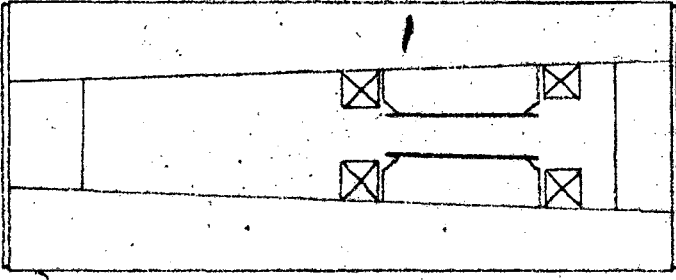
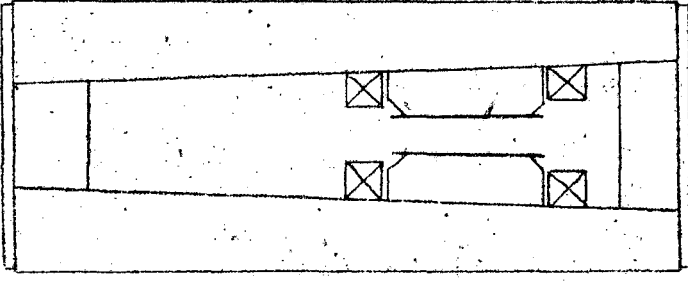
Bevatron model magnets DC6 through DC6.9 are the designs for the 1' x 4' aperture for this series. Small changes in the placement of the steel and the design of the coils were made on these models to obtain the maximum magnet efficiency for the minimum amount of steel and copper. (See sketches for the actual mechanical changes.) Model DC6.6 was chosen as the final design for this model.

#### (2) DC6A series

Bevatron model magnet DC6A was the original design of the larger aperture (4' x 14') in this series. On model DC6A.1, the end of the exciting coil was bent up closer to the edge of the yoke for mechanical reasons. On model magnet DC6A.2 the parallel sided yoke slabs used on

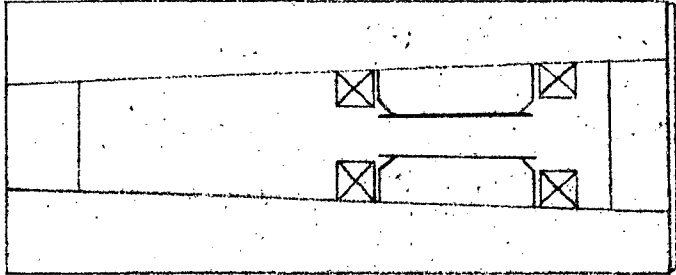
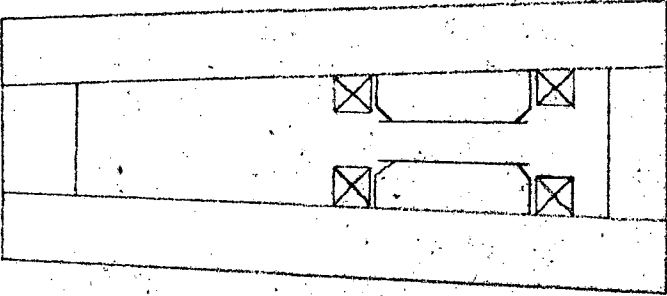
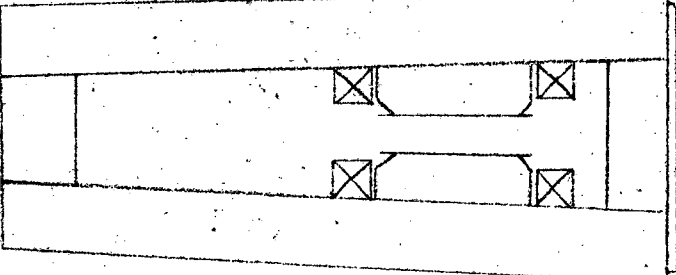
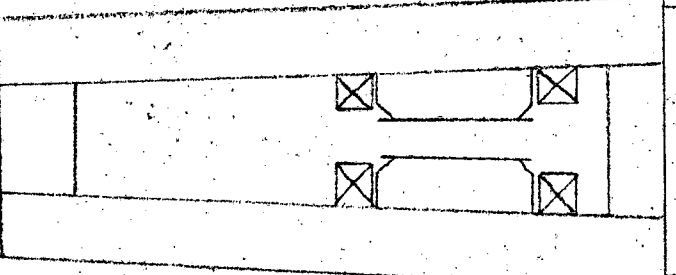
model DC6.5 were substituted for the original tapered yoke slabs. Model magnet DC6A.3 had three inches of steel added to the outer leg slabs to conform to model DC6.6. Various copper to copper spacings on the exciting coils were tested to observe the changes in magnet efficiency on models DC6A.4, DC6A.5, and DC6A.6. The vertical spacing of 19-7/8" on model DC6A.3 gave an efficiency of 83% as compared to 86% to 87.5% on models DC6A.4, DC6A.5, and DC6A.6 which had closer spacing. Model magnet DC6A.3 was chosen as the final design for this model.

# DC6 SERIES BEVATRON MAGNET

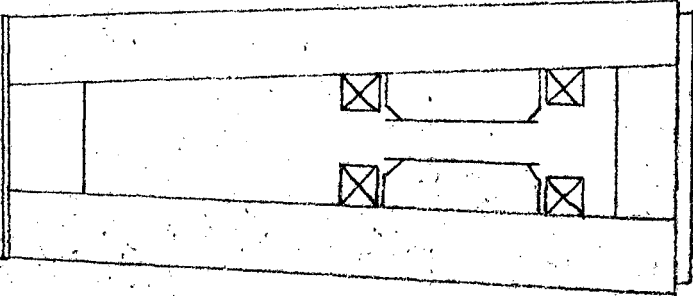
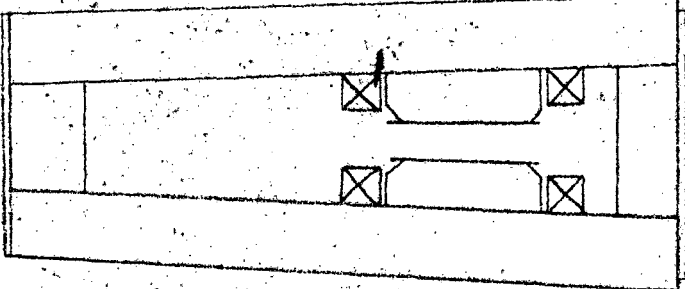
MODEL NUMBER	CROSS SECTION	REMARKS
DC6		AS SHOWN ON DWG 3L1635
DC6.1		SAME AS DC6 EXCEPT COILS ARE CLOSER TO POLES - COIL TO POLE CLEARANCE IS 1" (WAS 8")
DC6.2		SAME AS DC6.1 EXCEPT 3" (F.S.) STEEL PLATE ADDED TO EACH LEG SLAB
DC6.3		SAME AS DC6.1 EXCEPT 6" (F.S.) STEEL PLATE ADDED TO EACH LEG SLAB



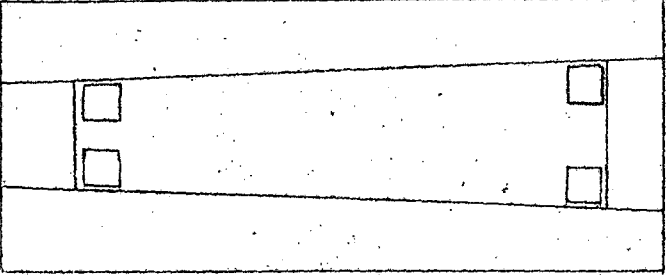
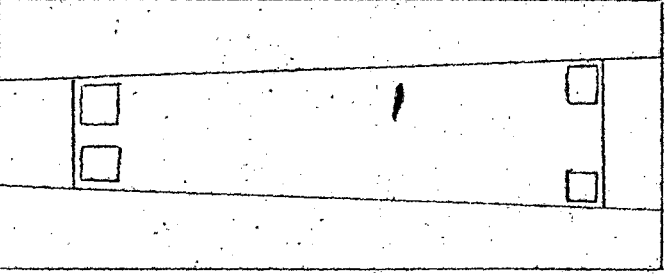
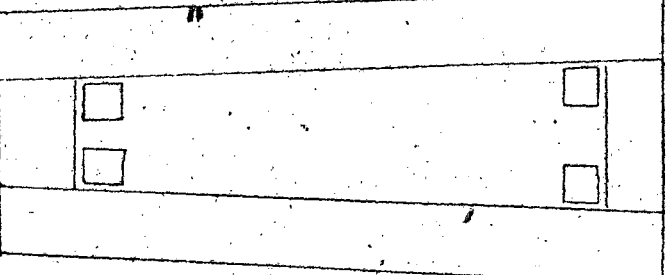
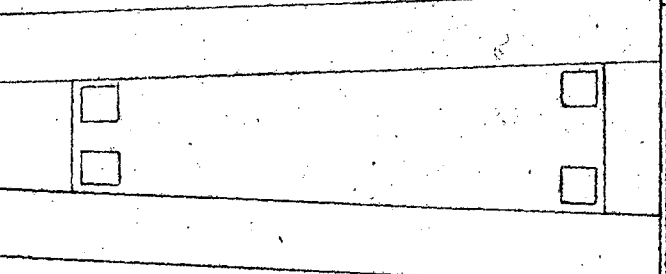
# DC6 SERIES BEVATRON MAGNET

MODEL NUMBER	CROSS SECTION	REMARKS
DC6.4		<p>SAME AS DC6.1 EXCEPT 3" (F.S.) STEEL PLATE ADDED TO OUTER LEG SLAB</p>
DC6.5		<p>SAME AS DC6.1 EXCEPT TOP &amp; BOTTOM YOKE SLABS HAVE UNIFORM HEIGHT.</p>
DC6.6		<p>SAME AS DC6.5 EXCEPT 3" (F.S.) STEEL PLATE ADDED TO OUTER LEG SLAB SEE FOLLOWING SKETCH FOR DIM. OF THIS MODEL</p>
DC6.7		<p>SAME AS DC6.5 EXCEPT 6" (F.S.) STEEL PLATE ADDED TO OUTER LEG SLAB.</p>

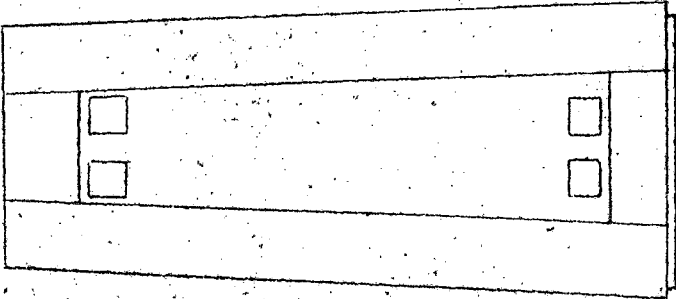
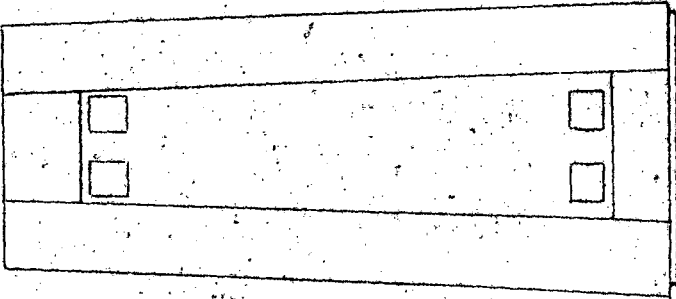
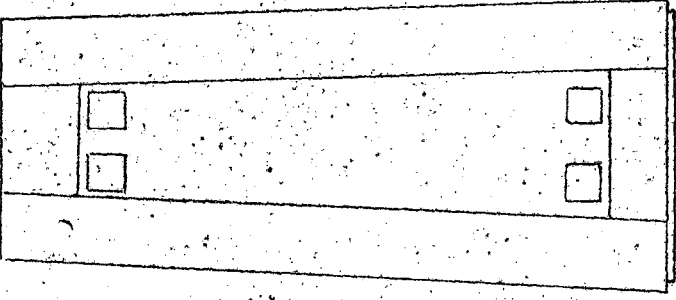
# DC6 SERIES BEVATRON MAGNET

MODEL NUMBER	CROSS SECTION	REMARKS
DC6.8		<p>SAME AS DC6.5 EXCEPT 6" (F.S.) STEEL PLATE ADDED TO OUTER LEG SLAB AND 3" (F.S.) STEEL PLATE ADDED.</p>
DC6.9		<p>SAME AS DC6.5 EXCEPT 3" (F.S.) STEEL PLATE ADDED TO EACH LEG SLAB</p>

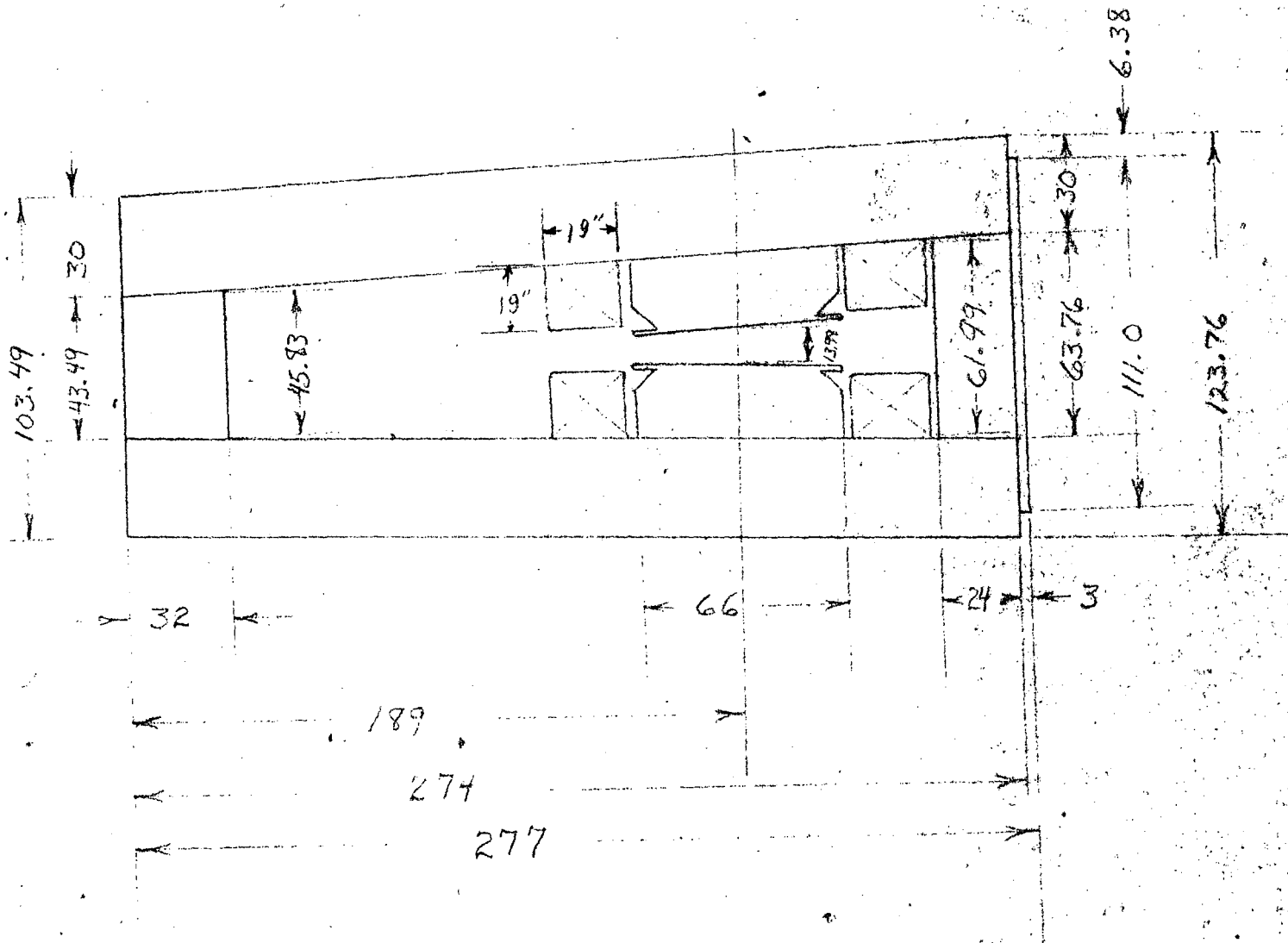
# DC6A SERIES BEVATRON MAGNET

MODEL NUMBER	CROSS SECTION	REMARKS
DC6A		AS SHOWN ON DWG. 3L1635
DC6A.1		SAME AS DC6A EXCEPT COIL ENDS HAVE A LONGER BEND DWG. 3L1703C
DC6A.2		SAME AS DC6A.1 EXCEPT TOP & BOTTOM YOKE SLABS HAVE PARALLEL SIDES. DWG. 3L1962
DC6A.3		SAME AS DC6A.2 EXCEPT 3" STEEL PLATE ADDED TO OUTER LEG SLAB. OUTER SIDE OF EXCITING COIL SPACED 19 7/8" COPPER TO COPPER SEE FOLLOWING SKETCH FOR DIM. OF THIS MODEL

# DC6A SERIES BEVATRON MAGNET

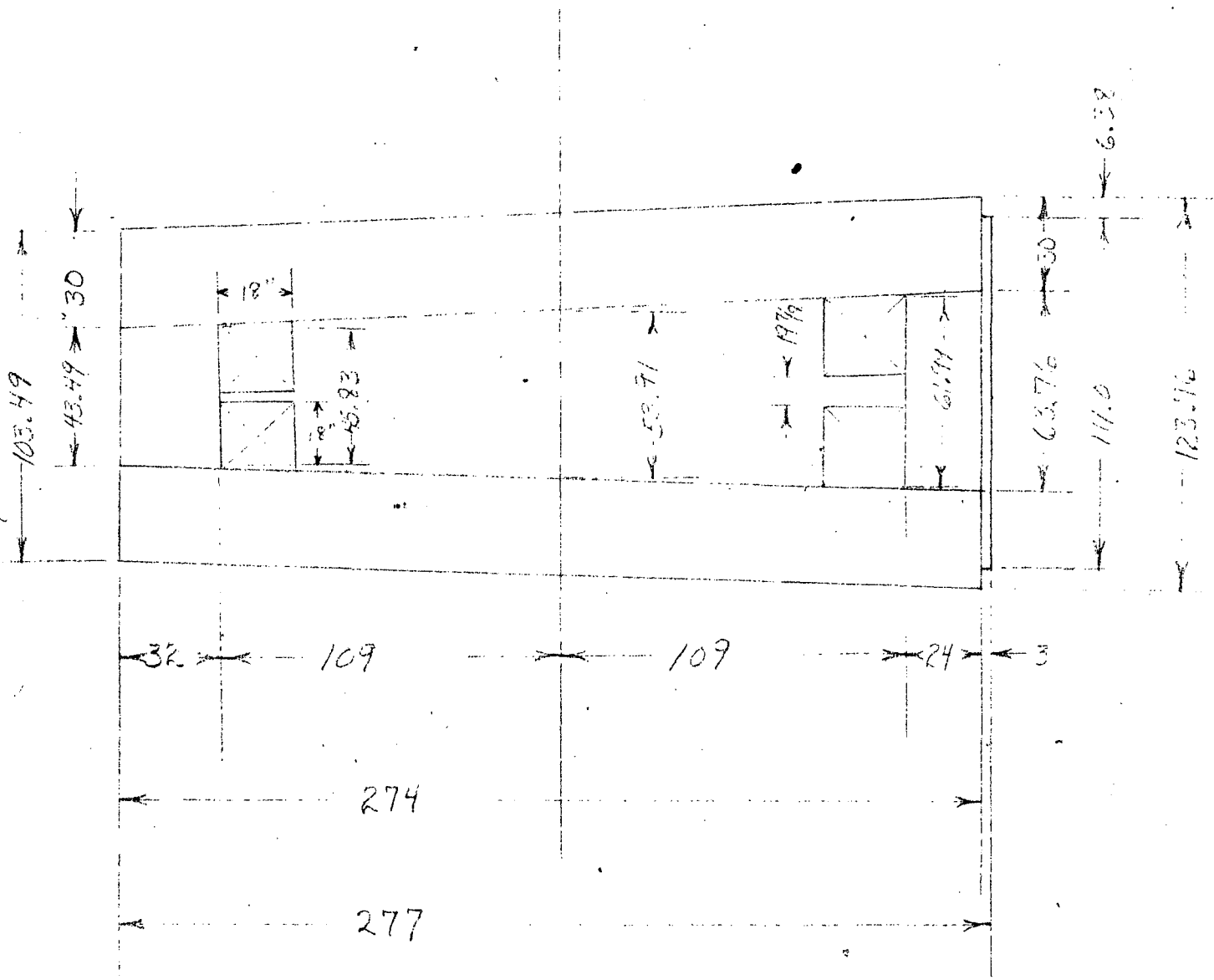
MODEL NUMBER	CROSS SECTION	REMARKS
DC6A.4		<p>SAME AS DC6A.3 EXCEPT OUTER SIDE OF EXCITING COIL SPACED 8 5/8" COPPER TO COPPER</p>
DC6A.5		<p>SAME AS DC6A.3 EXCEPT OUTER SIDE OF EXCITING COIL SPACED 13 1/8" COPPER TO COPPER</p>
DC6A.6		<p>SAME AS DC6A.3 EXCEPT OUTER SIDE OF EXCITING COIL SPACED 10 7/8" COPPER TO COPPER</p>

# BEVATRON MODEL MAGNET DC 6.6

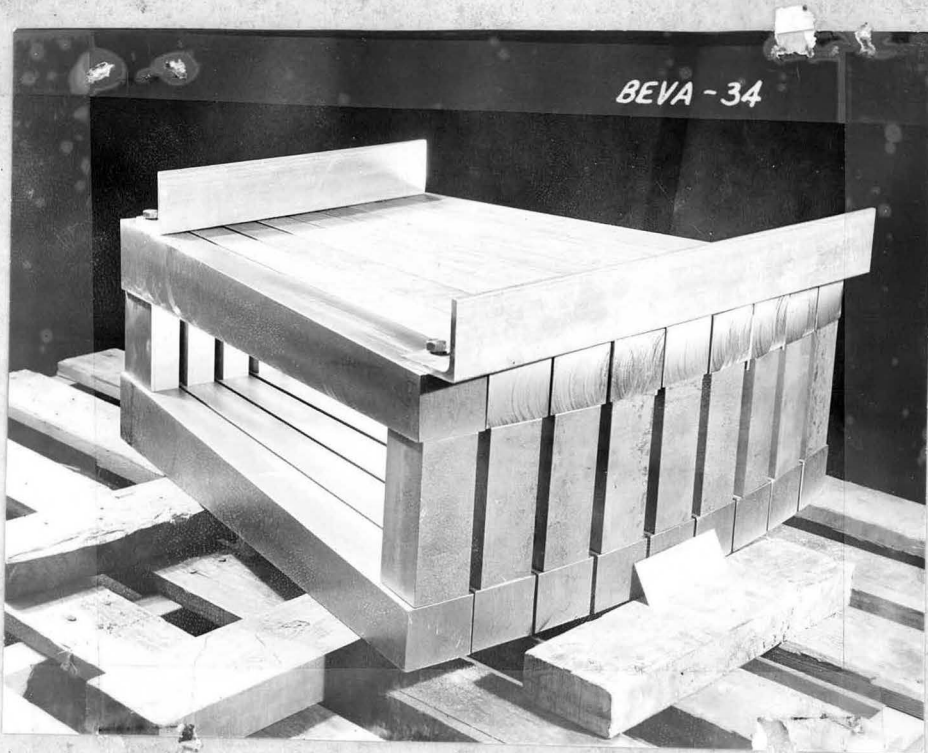


GAP 13.98"  
 RADIUS 600"  
 $m = 0.77$   
 MODEL COILS: 4 COILS 21 TURNS EACH = 84 TURNS  
 DIMENSIONS ARE FULL SCALE INCHES  
 MODEL IS 1/12 SCALE  
 ASSEMBLY DWG. 3L1635  
 COIL DWG. 3L1923  
 YOKE DWG. 3L1962  
 3" STEEL PLATE ADDED TO OUTER LEG SLAB

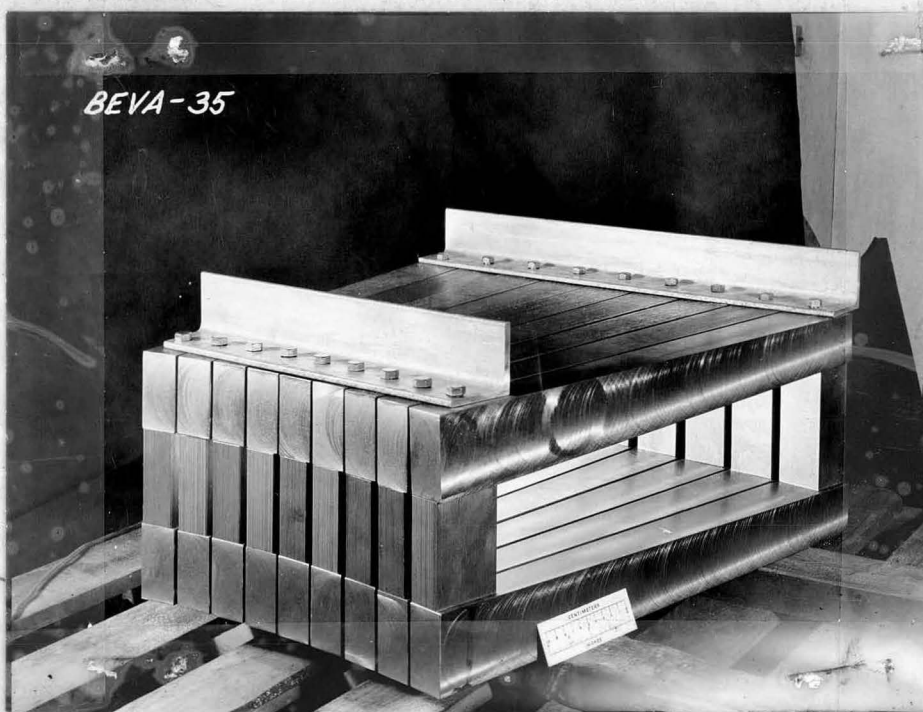
# BEVATRON MODEL MAGNET DC 6A.3



GAP 53.91  
 RADIUS 552  
 $m = 0.76$   
 MODEL COILS : 2 COILS 49 TURNS EACH = 98 TURNS  
 DIMENSIONS ARE FULL SCALE  
 MODEL IS 1/2 SCALE  
 ASSEMBLY DWG 3L 1635  
 COIL DWG. 3L 1703C \*  
 YOKE DWG. 3L 1962  
 3" STEEL PLATE ADDED TO OUTER LEG SLAB  
 OUTER COIL SPACING 19 7/8" COPPER TO COPPER

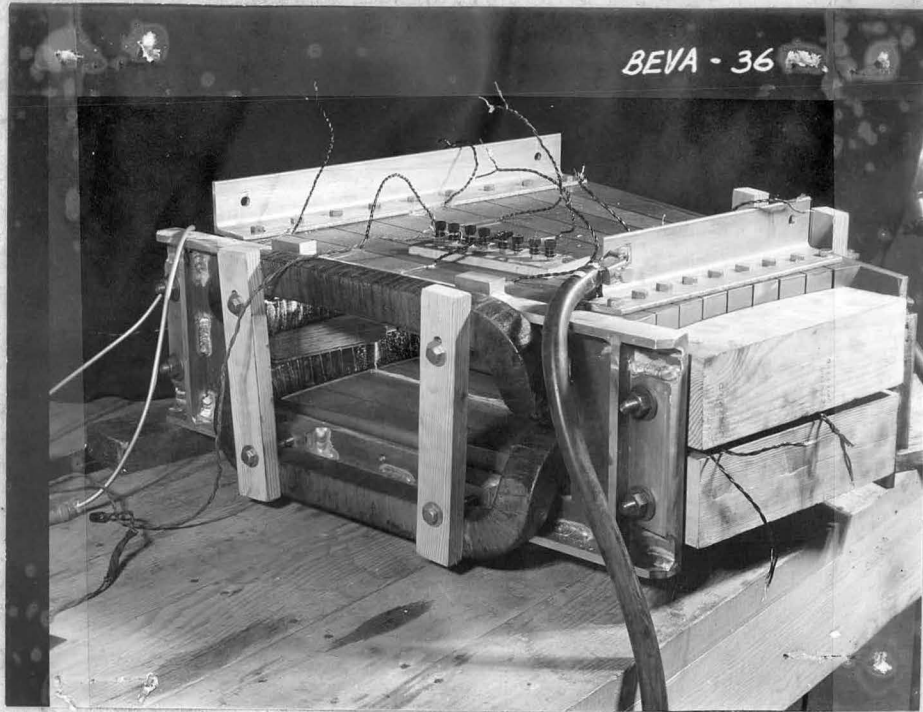


BEVA 34

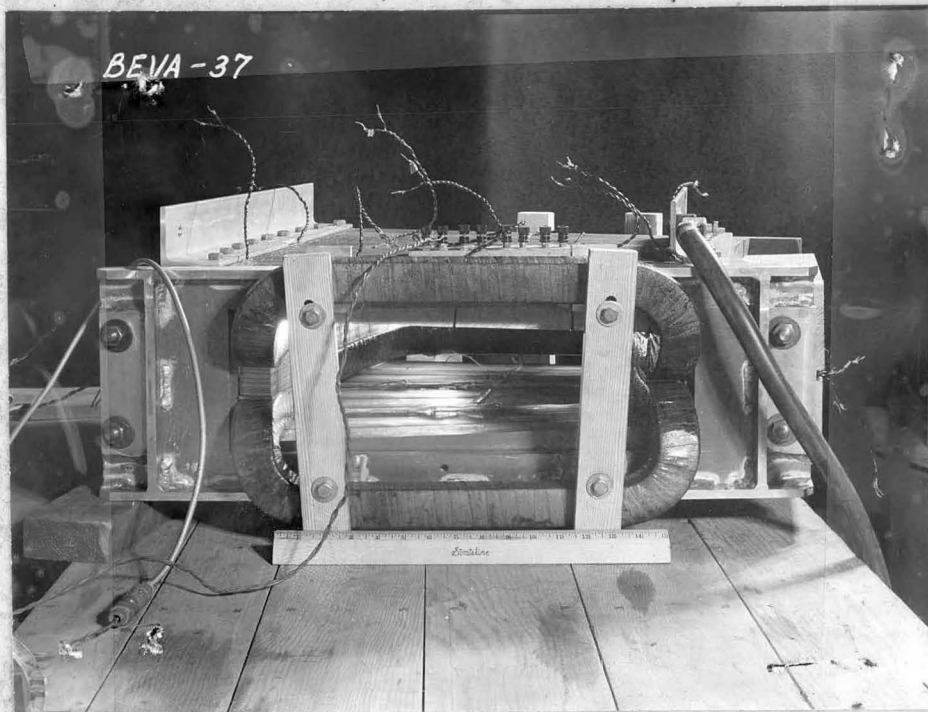


BEVA 35

Bevatron Model Magnet DC6A



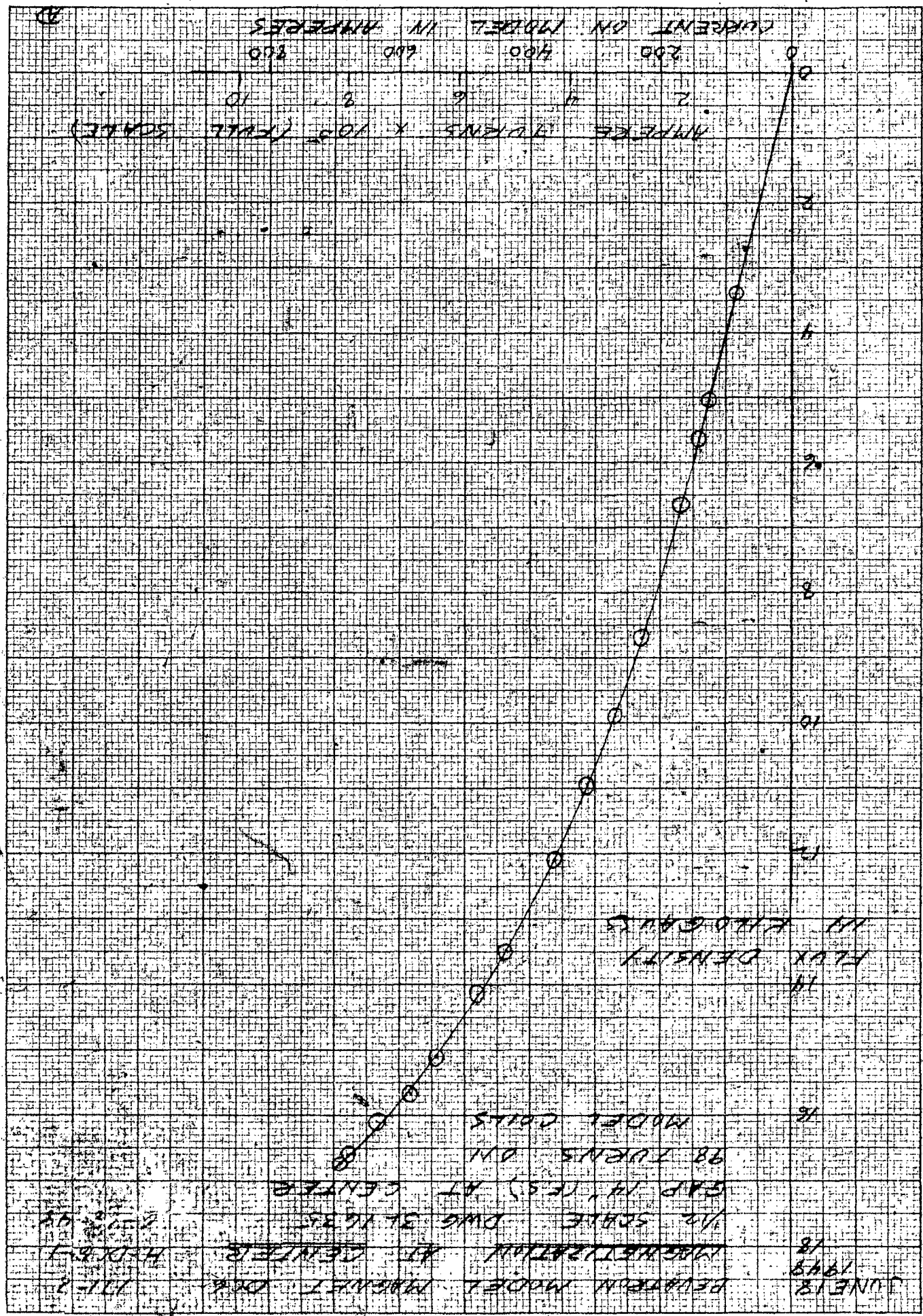
BEVA 36



BEVA 37

Bevatron Model Magnet DC6A





BEYATRON MODEL MAGNET DC6  
 FLUX DENSITY AROUND THE  
 MAGNETIC PATH  
 1/2" SCALE DWG. 3L1635  
 GAP 14" (E.S.) AT CENTER  
 94 TURNS ON MODEL COILS  
 SEE A-DC6-4 FOR  
 LOCATION OF TAPPS

11-8  
 DC6-2  
 6-21-48

FLUX DENSITY  
 IN KILO-GAUSS

24

20

16

12

0

MODEL CURRENT IN AMPERES

100

200

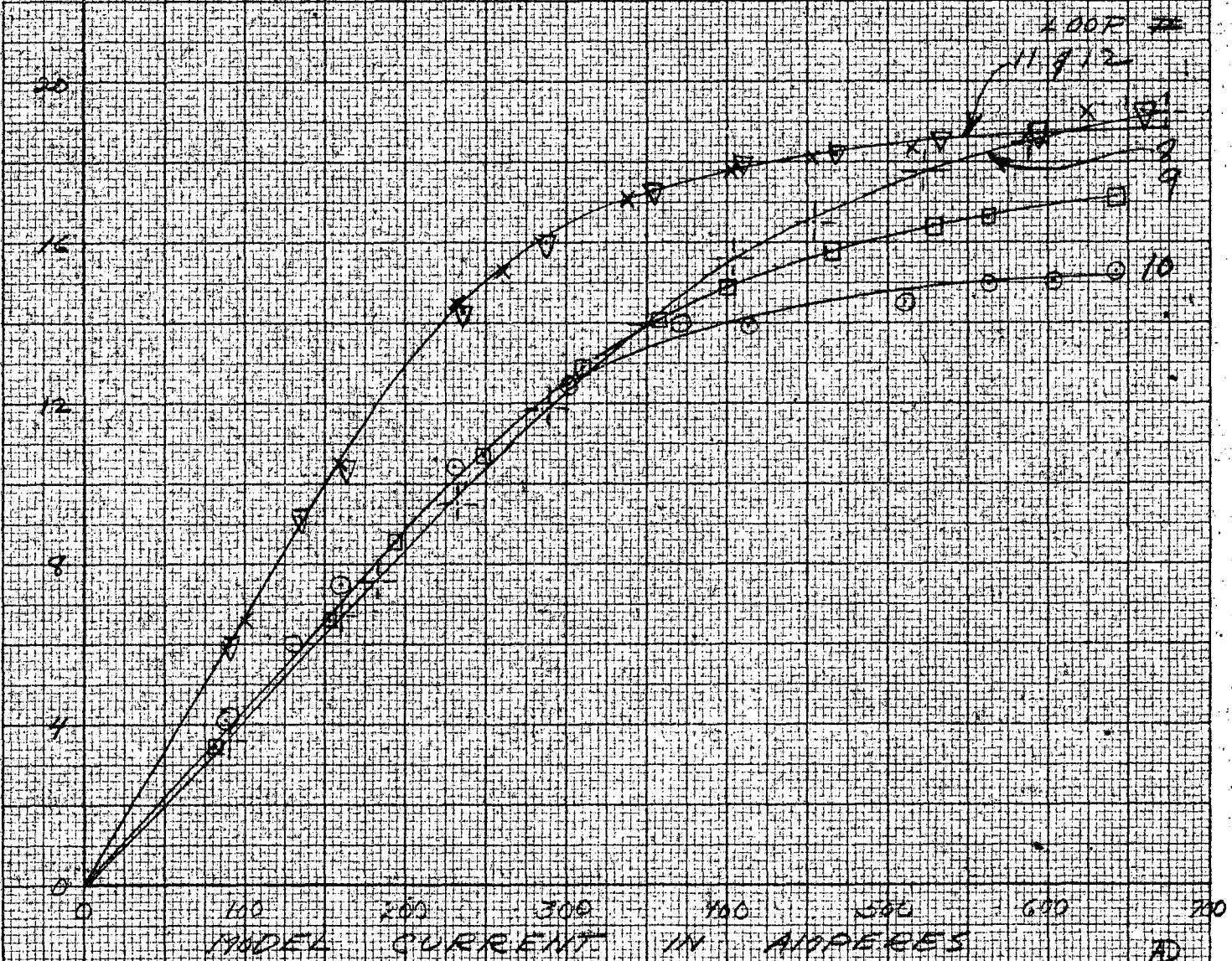
300

400

500

600

700



KEUFFEL & ESSER CO., N. Y. NO. 3597-120  
 10 X 10 to the 1/2 inch, 5th lines spaced.  
 Engraving 7 1/2" X 10 in.  
 MADE IN U.S.A.

DEVIATION MODEL MAGNET OCG  
 JUNE 23 1948 FLUX DENSITY AROUND THE  
 MAGNETIC PATH  
 1/2 SCALE DUNE 31 1935  
 GAP 1/4" (PS.) AT CENTER  
 OF GAP  
 99 TURNS ON MODEL  
 SEE H-DCG-4 FOR LOCATION  
 OF LOOPS

17-8  
 H-DCG-3  
 6-21-48

28  
 FLUX DENSITY  
 IN KILD-GAUSS

24

20

16

12

8

4

0

100 200 300 400 500 600 700  
 MODEL CURRENT IN AMPERES

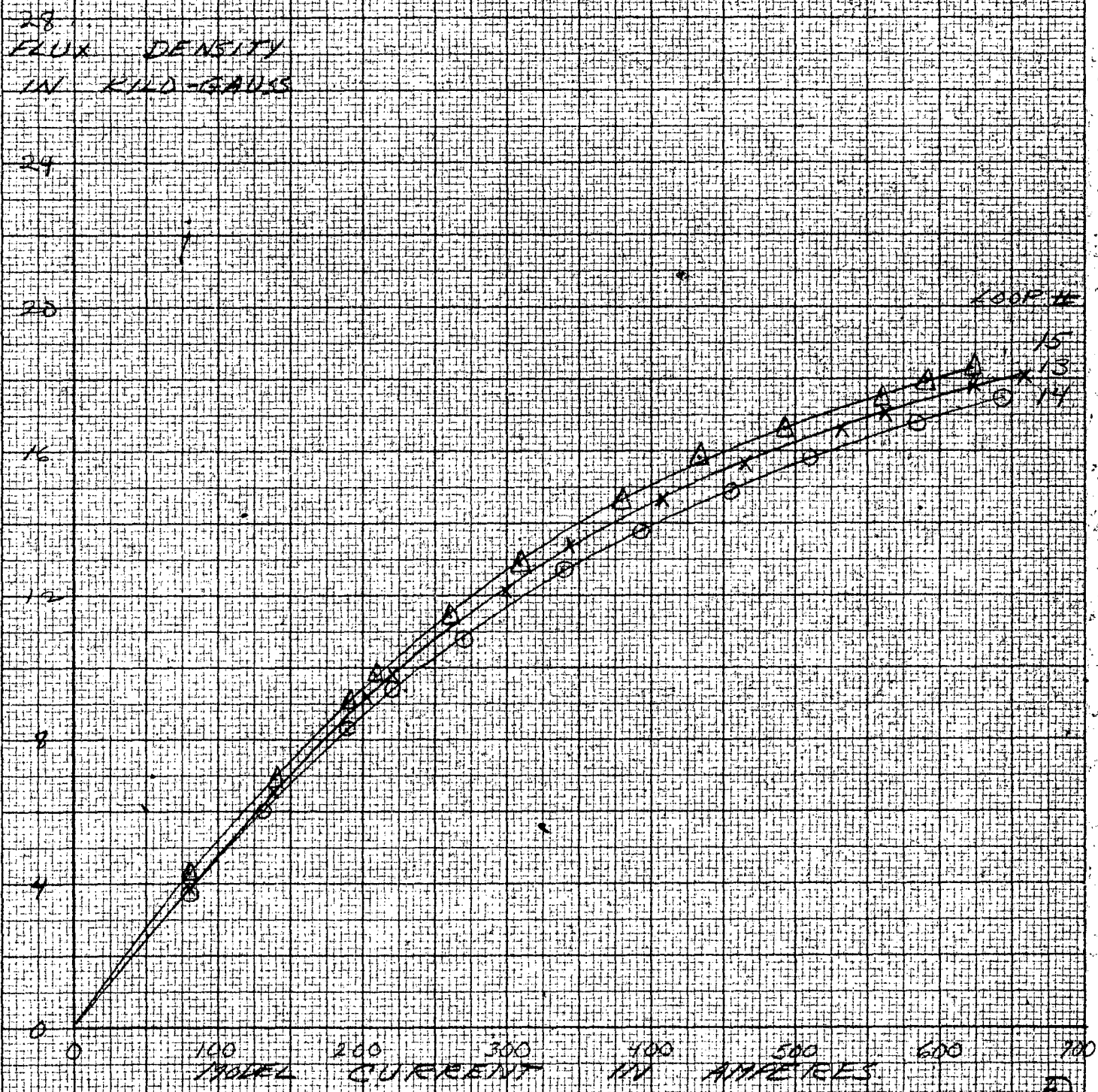
LOOP 14

15

13

14

REUFEL & ESSER CO., N. Y. NO. 3987-120  
 10 X 10 to the 3/4 inch, 25h lines spaced.  
 Engraving 7 1/2 X 10 in.  
 MADE IN U.S.A.



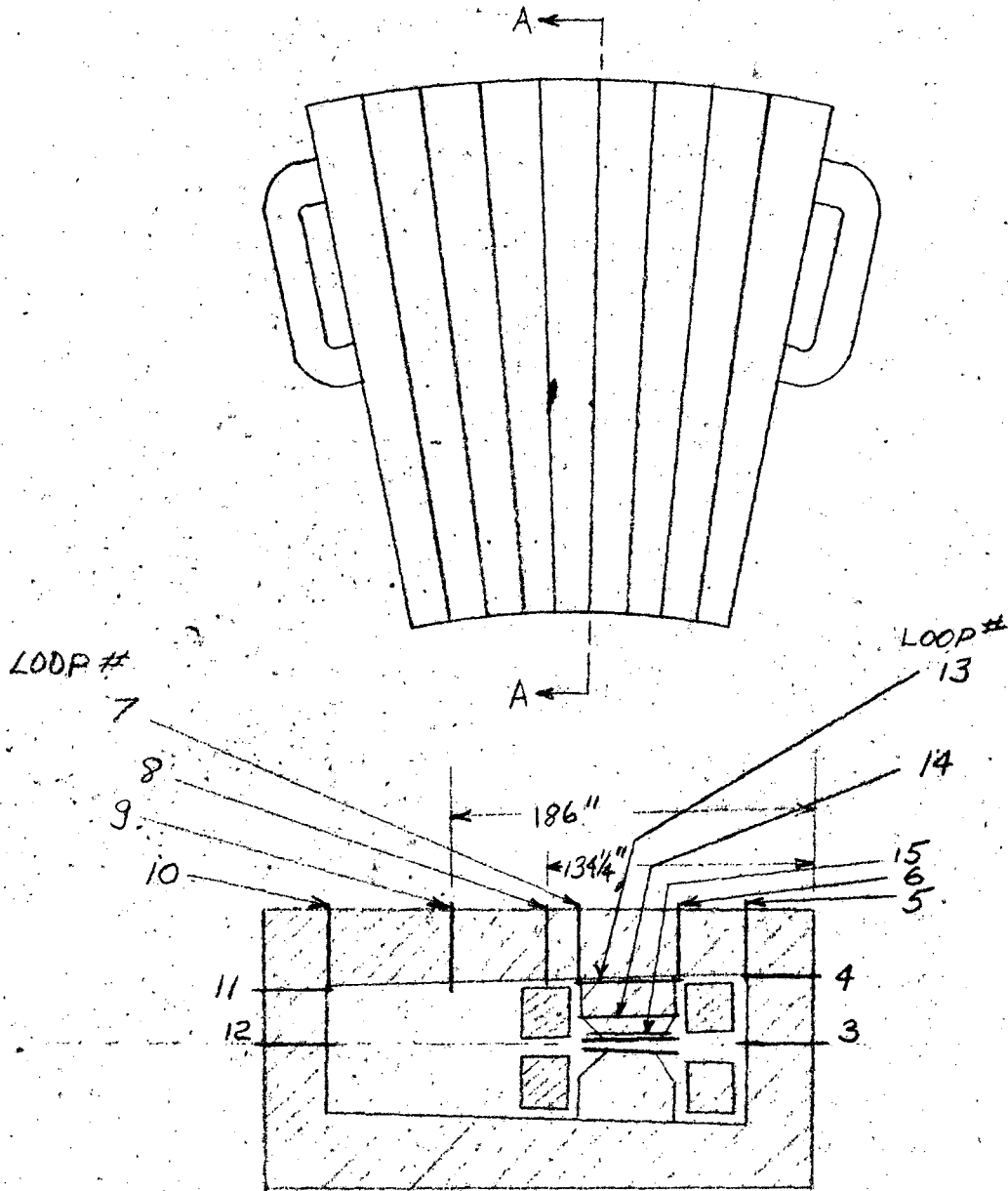
JUNE 21, 1948

BEVATRON MODEL MAGNET DC6  
LOCATION OF FLUX LOOPS  
1/2 SCALE DWG 3L1635

171-8  
H-DC6-4  
6-21-48

GAP 14" (FS) AT CENTER  
98 TURNS ON MODEL

SEE GRAPHS H-DC6-2  
H-DC6-3  
H-DC6-5

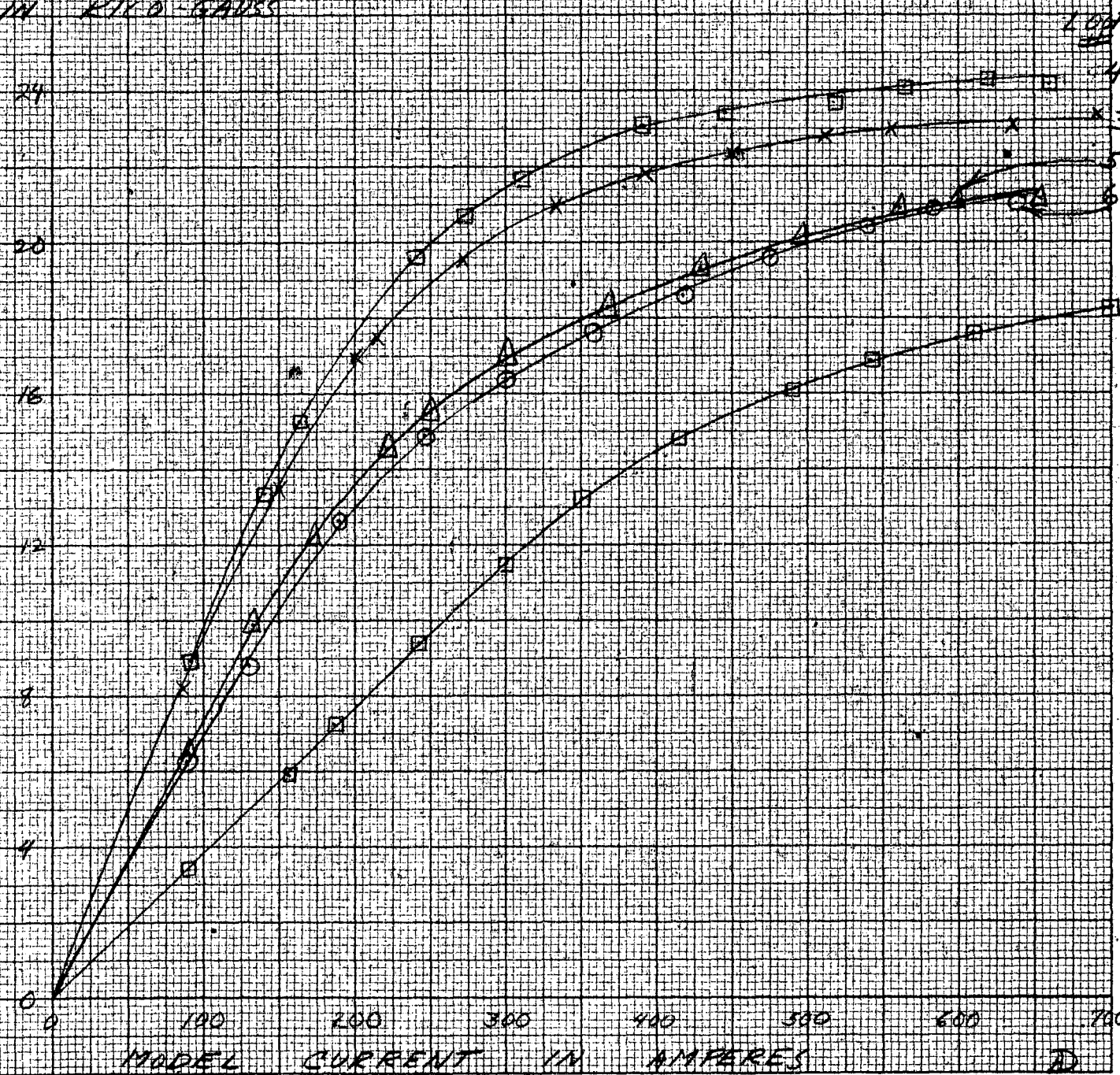


CROSS SECTION AT AA

BEVINGTON MODEL MAGNET DC6  
 JUNE 21 1948  
 FLUX DENSITY AROUND MAGNETIC PATH  
 1/2 SCALE DWG 36-1635  
 GAP 14" (FS) AT CENTER OF GAP  
 98 TURNS ON MODEL  
 SEE H-DC6-4 FOR LOCATION OF LOOPS

H-DC6-5  
 6-21-48

58  
 FLUX DENSITY  
 IN KILOGAUSS



KEUFFEL & ESSER CO., N. Y. NO. 397-120  
 10 x 10 mm 1/4 inch with lines accented.  
 Engraving 1/2 x 10 in.  
 MADE IN U.S.A.

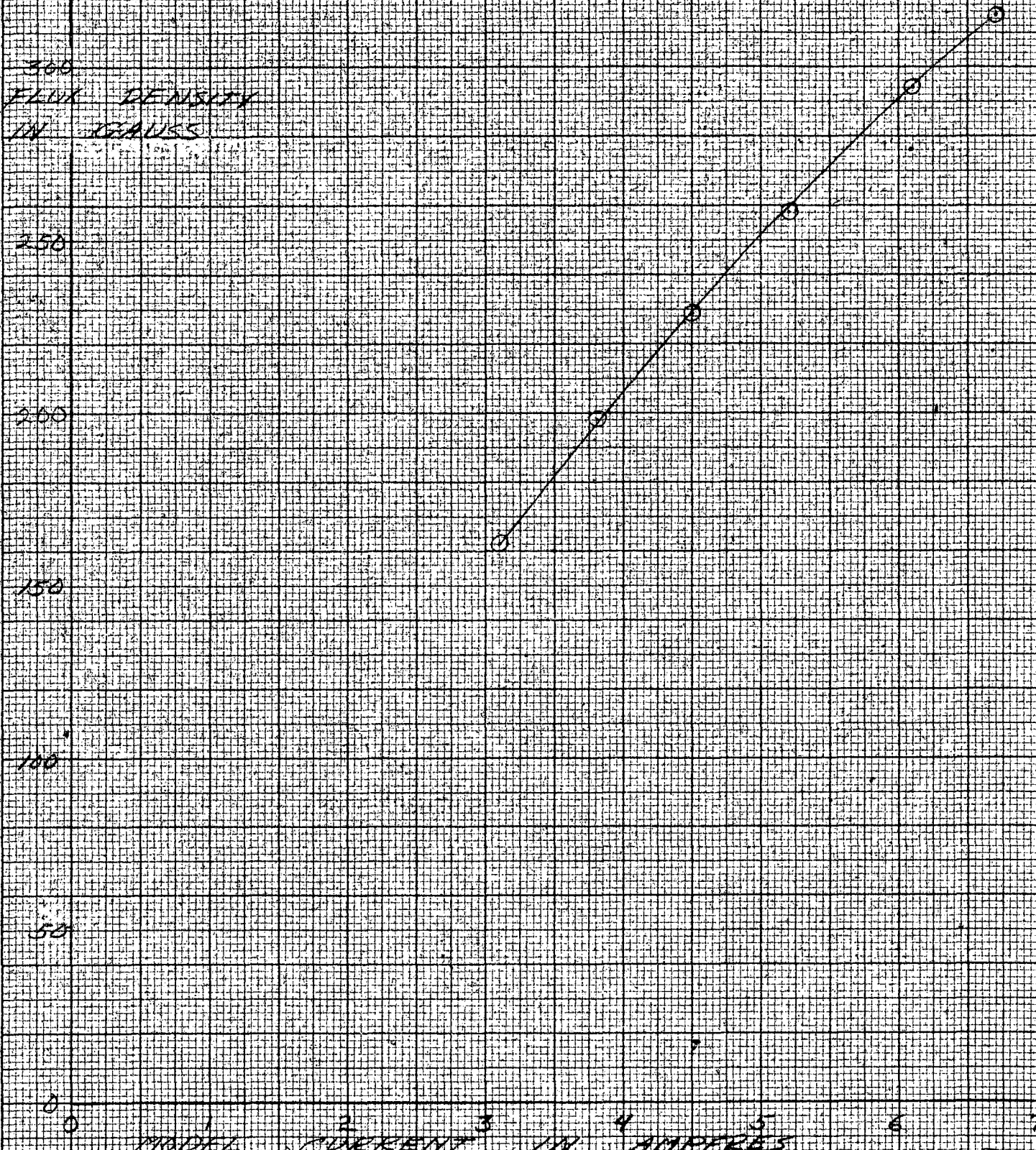
JUNE 21  
1948

BEVATRON MODEL MAGNET DC6  
MAGNETIZATION

171-8  
H DC6-6  
6-21-48

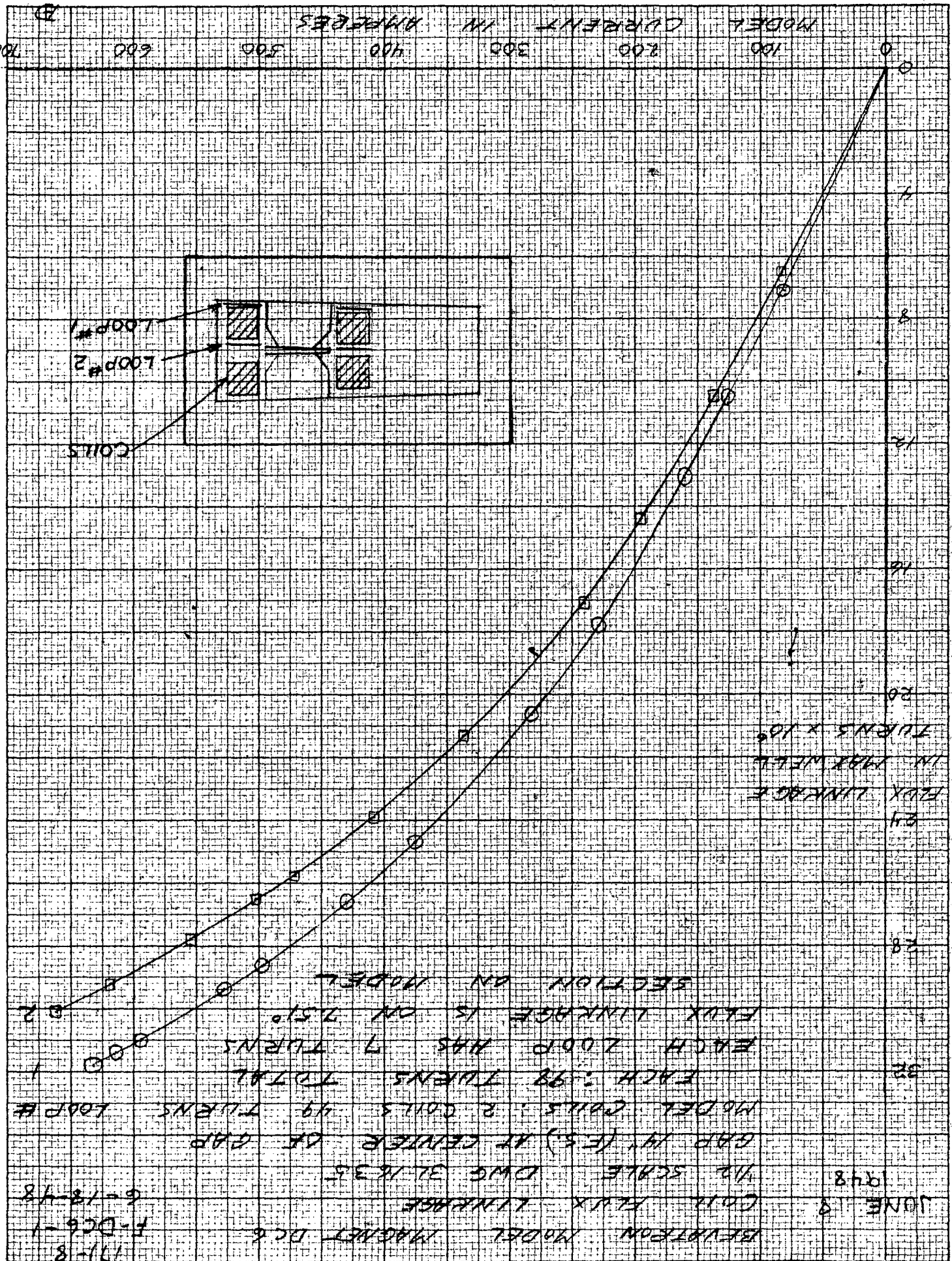
1/2 SCALE DWG 3L1635  
GAP IN (ES) AT CENTER  
MODEL COILS - 98 TURNS TOTAL

FLUX DENSITY  
IN GAUSS



KEUFFEL & ESSER CO., N. Y. NO. 3597-123  
10 X 10 to the 1/4 inch, 5/16 lines accented.  
Engraving 1/4 X 10 in.  
MADE IN U.S.A.

KUFFEL & ESSER CO., N. Y. NO. 358-152  
 IN X 10 TO THE 1/8 INCH. FIN. LINES SCHEMATIC.  
 DRAWING 7 1/2 X 10 IN.  
 MADE IN U.S.A.

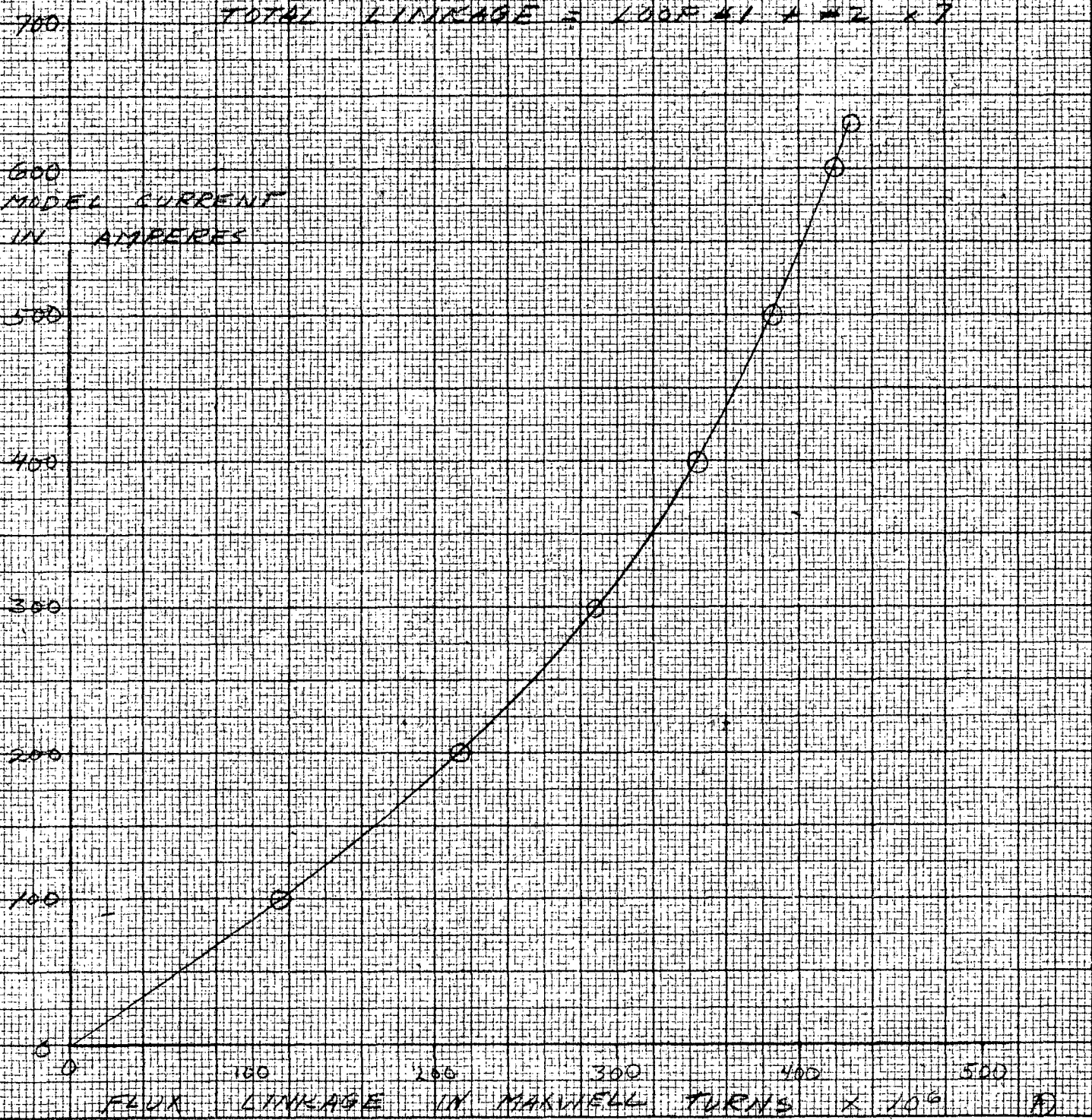


BEURTON MODEL MAGNET DC  
 F-DC6-1  
 6-18-48  
 COIL FLUX LINKAGE  
 1/2 SCALE DWS 31635  
 GAP IN (E) AT CENTER OF GAP  
 MODEL COILS: 2 COILS 49 TURNS  
 EACH LOOP #  
 EACH LOOP HAS 7 TURNS  
 FLUX LINKAGE IS ON 7.5%  
 SECTION ON MODEL  
 32  
 24  
 21  
 IN MAXWELLS  
 FLUX LINKAGE  
 IN MAXWELLS  
 TURNS x 10<sup>5</sup>

1711-8  
F-DC6-10  
6-18-48

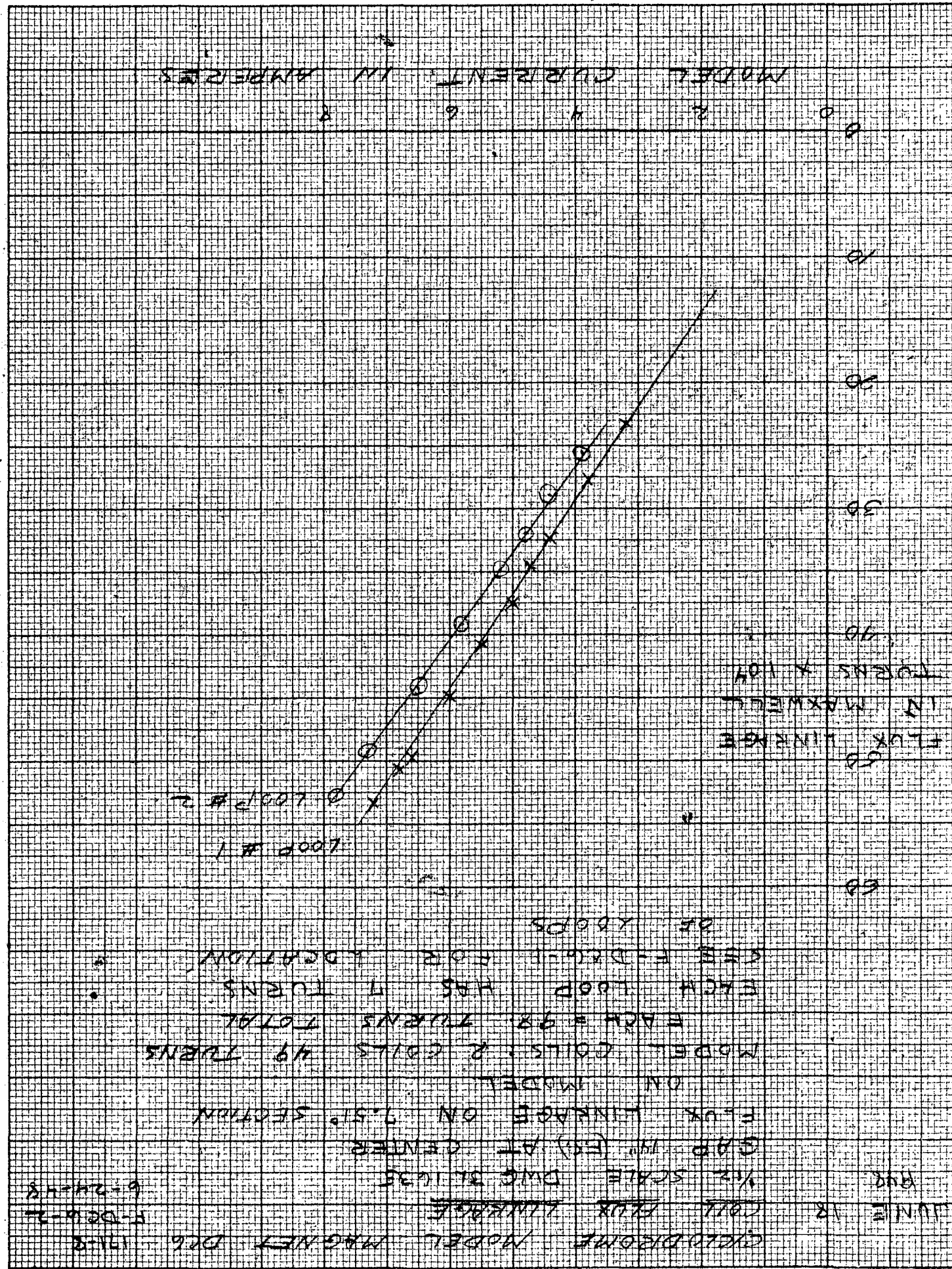
JUNE 18,  
1948

BEVATRON MODEL MAGNET DC6  
TOTAL COIL FLUX LINKAGE  
1/2 SCALE DWG 3L1635  
GAP 14" (FEED) AT CENTER OF GAP  
MODEL COILS - 49 TURNS EACH  
ON 2 COILS = TOTAL 98 TURNS  
SEE GRAPH F-DC6-1  
FLUX LINKAGE IS FOR 7.51°  
SECTION OF MODEL  
TOTAL LINKAGE = LOOP #1 + #2 x 7



KEUFFEL & ESSER CO., N. Y. NO. 3597-126  
10 X 10 to the 1/2 inch 5th lines accentuated.  
Engraving 7/8 X 10 in.  
MADE IN U.S.A.





JUNE 22, 1948

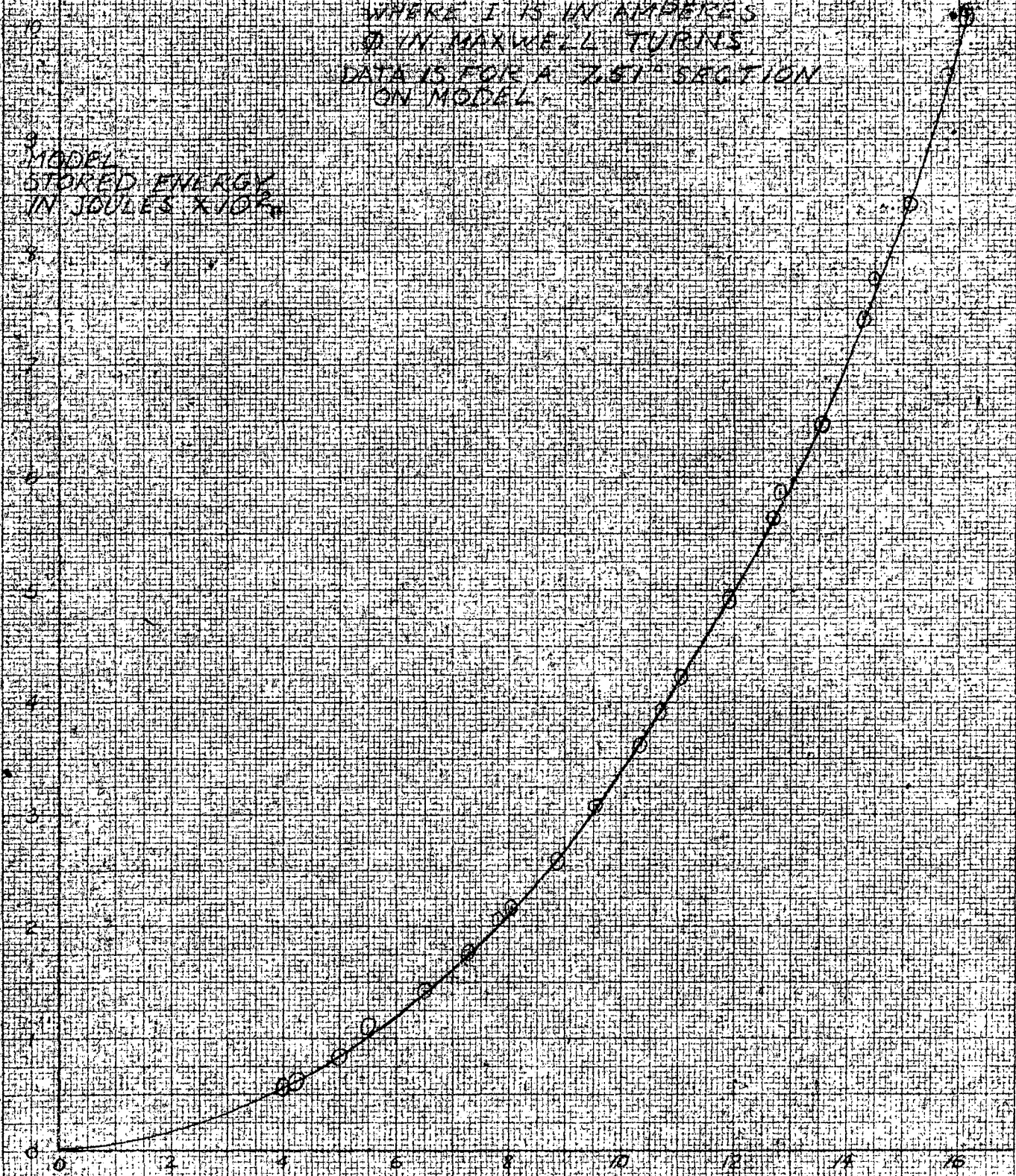
BEVATRON MODEL MAGNET DC6  
1/16" SCALE DWG 311635

171-8  
E-DC6-1  
6-22-48

STORED ENERGY ON MODEL

CALCULATED FROM TOTAL COIL  
FLUX LINKAGE - SEE GRAPH F-DC6-10  
ENERGY (JOULES) =  $10^{-8} I^2 \Phi$   
WHERE I IS IN AMPERES  
 $\Phi$  IN MAXWELL TURNS  
DATA IS FOR A 7.51" SECTION  
ON MODEL

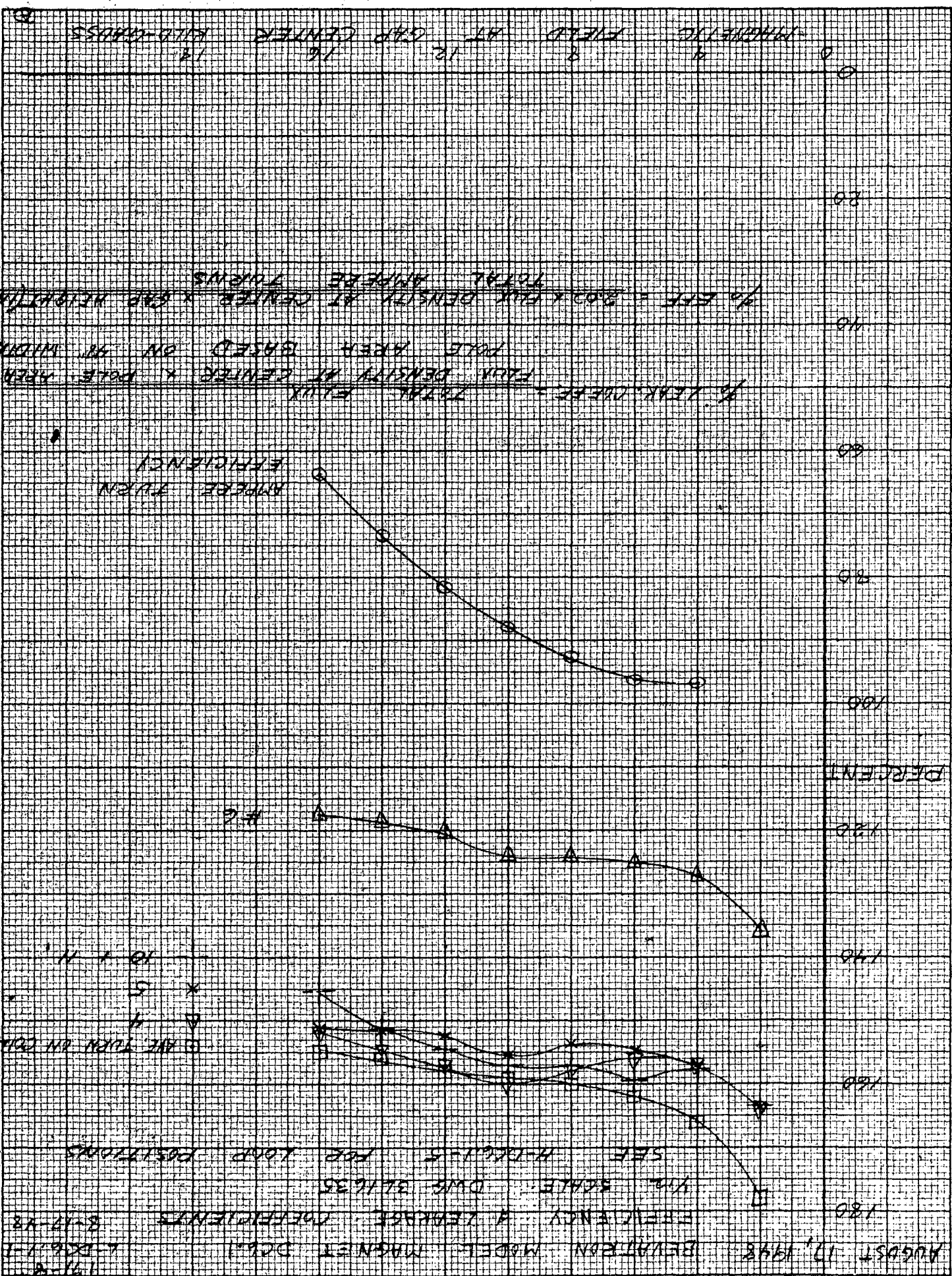
MODEL  
STORED ENERGY  
IN JOULES X  $10^8$



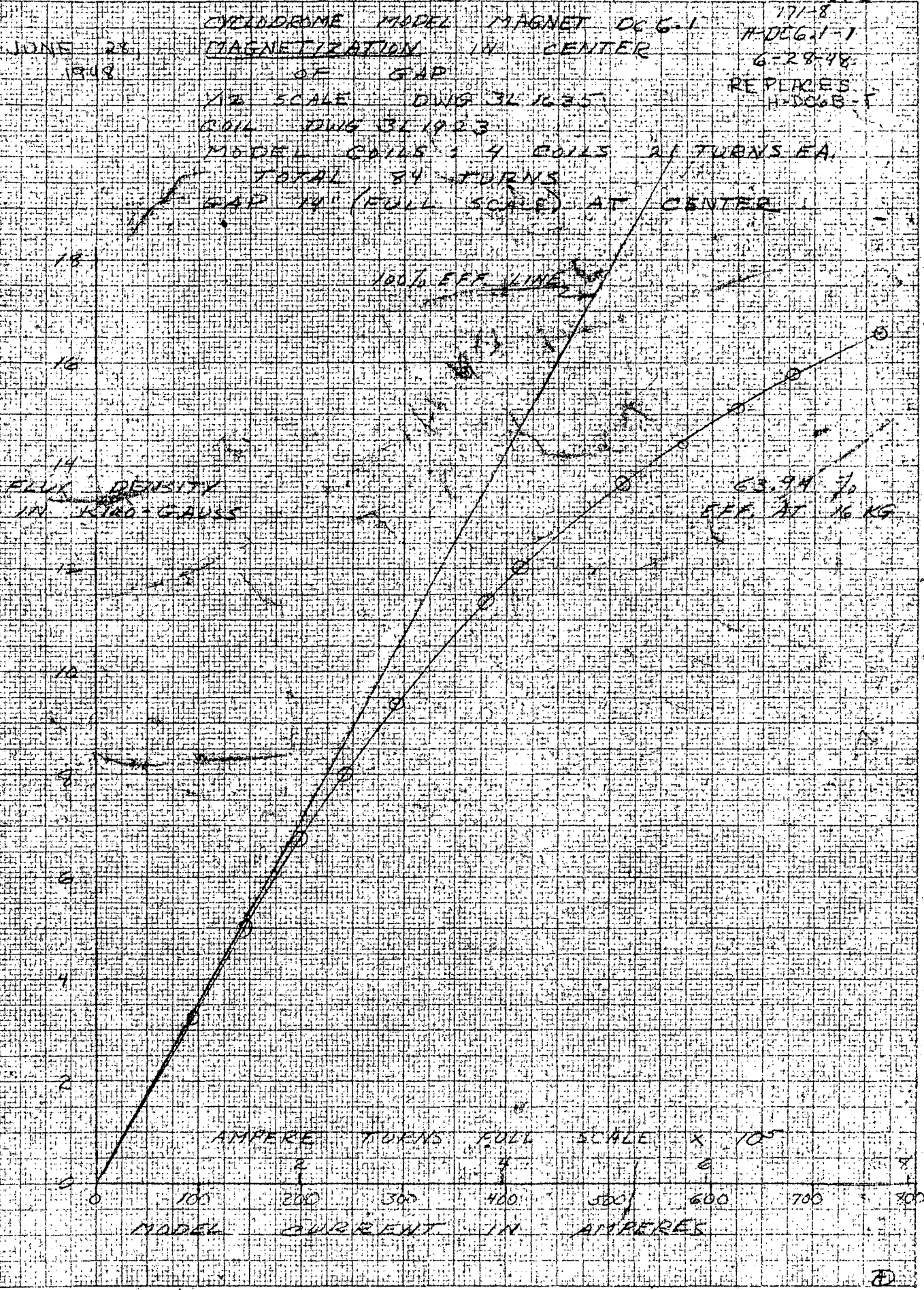
MAGNETIC FIELD AT CENTER OF GAP IN KILO GAUSS

PWC

KEUFFEL & ESSER CO. N.Y. NO. 259-115  
Milligrams, mm. linear scale; 25 lines/mm.  
MADE IN U.S.A.



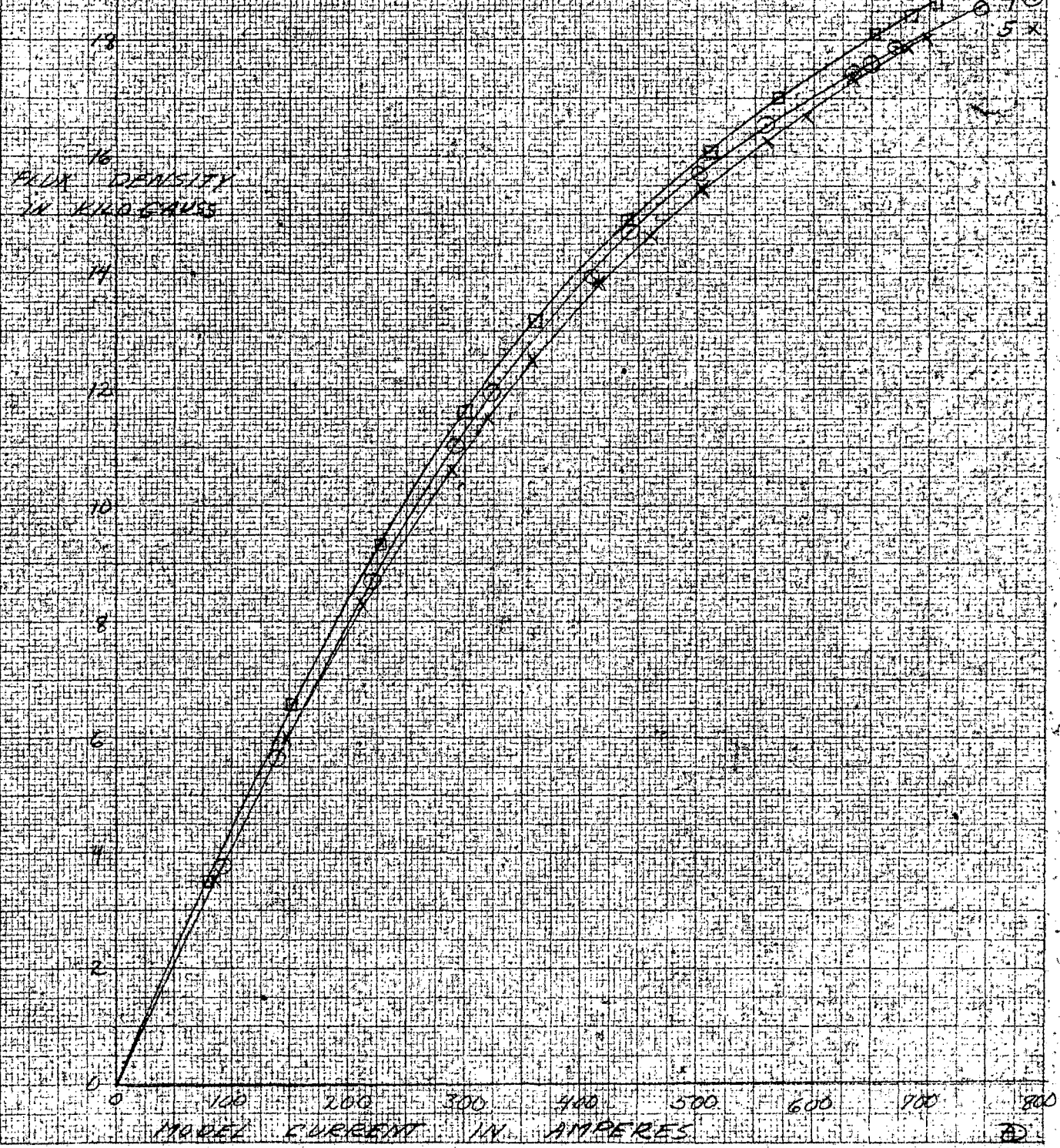
CORRECTED



KEUFFEL & ESSER CO., N. Y. NO. 350-140  
 Millimeters, 5 mm. lines spaced, exp. lines heavy.  
 Made in U. S. A.

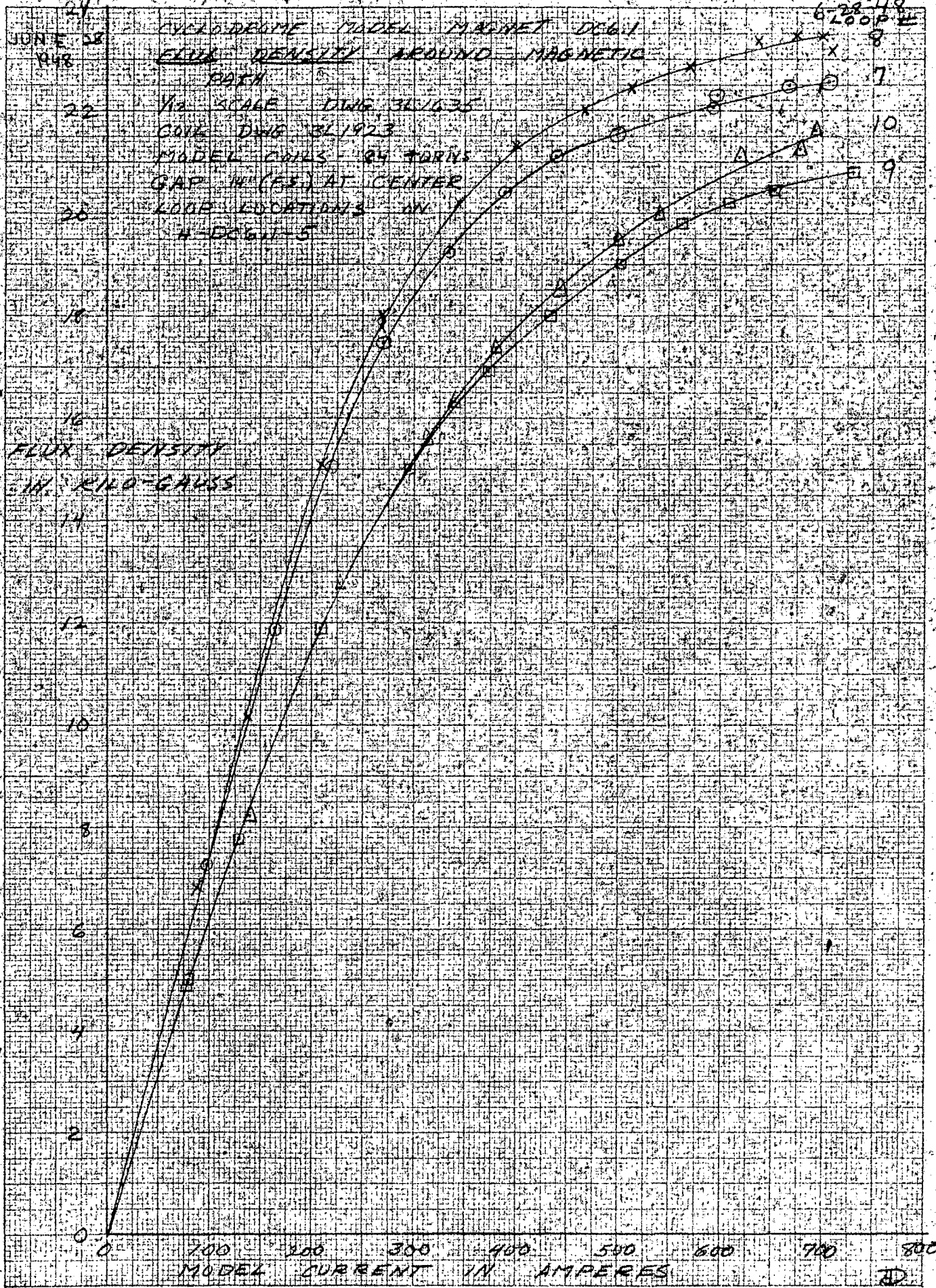
Ⓜ

JUNE 26, 1948 CYCLODROME MODEL MAGNET DCG-1 171-8  
 FLUX DENSITY AROUND MAGNETIC H-DCG-1-2  
 PATH 6-29-48  
 1/2 SCALE DWG 311635  
 COIL DWG 311923  
 MODEL COILS 4 COILS 21 TURNS EACH  
 TOTAL 84 TURNS  
 GAP 14" (FIS) AT CENTER  
 LOCATION OF LOOPS SHOWN LOOP #  
 ON H-DCG-1-5

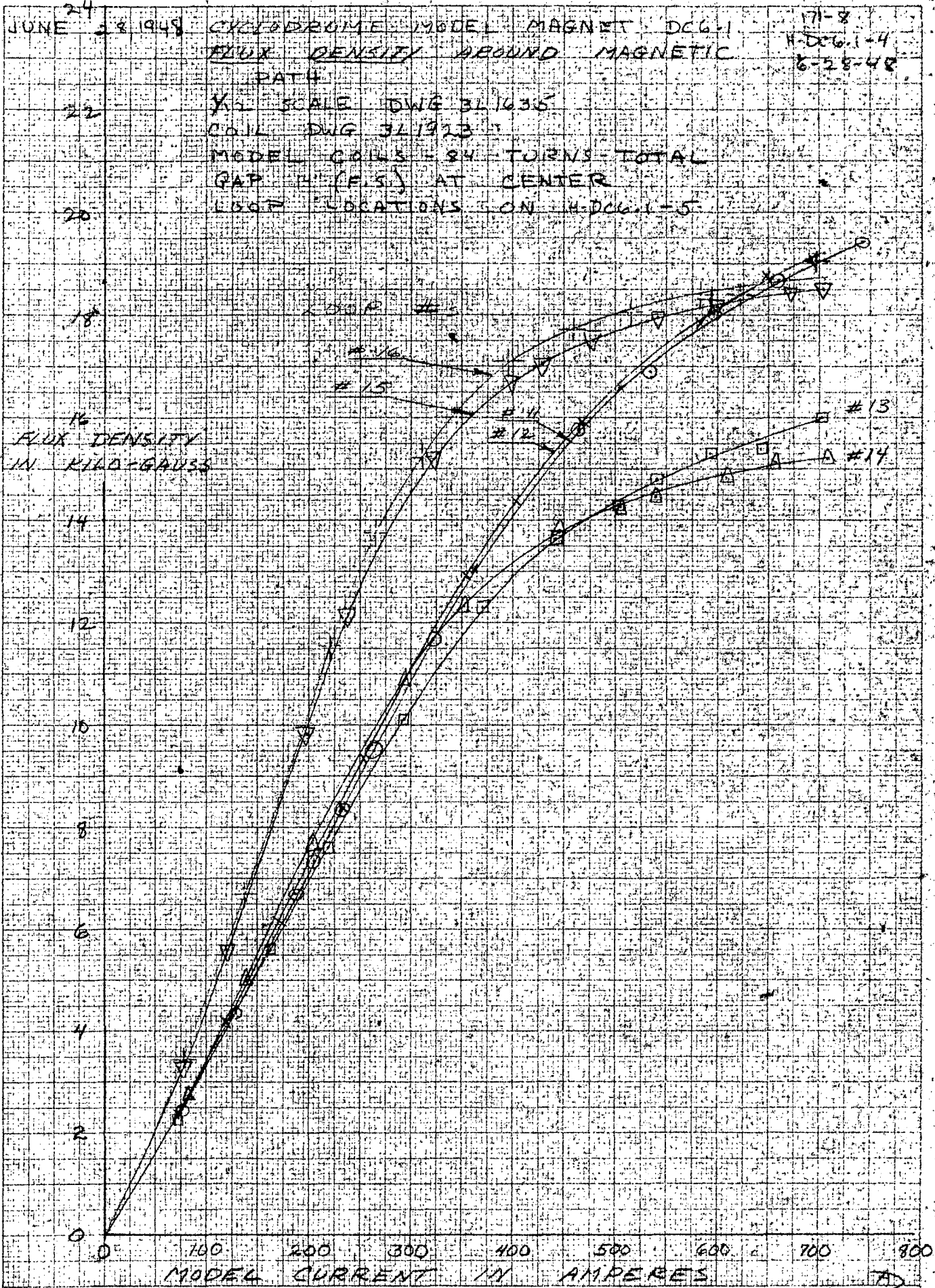


KEUFFEL & ESSER CO., N. Y. NO. 389, 1-C  
 Millimeter, 5 mm. lines spaced; cm. lines heavy.  
 MADE IN U.S.A.

171-8  
H-DC6.1-3  
6-28-48  
6-200P-2



KLUPPEL & ESSER CO., N. Y., NO. 385, 14-G  
 Millimeter, 1 mm. lines included, and 1 mm. base  
 MADE IN U.S.A.



KEUFFEL & ESSER CO., N. Y. NO. 359 1-A  
 Millimeter, 5 mm. lines standard, cm. lines heavy.  
 MADE IN U.S.A.

JUNE 28, 1948

CYCLODROME MODEL MAGNET DC6.1

LOCATION OF FLUX LOOPS

1/2 SCALE DWG 3L1635

GAP 14" FULL SCALE AT CENTER

COIL DWG 3L1923

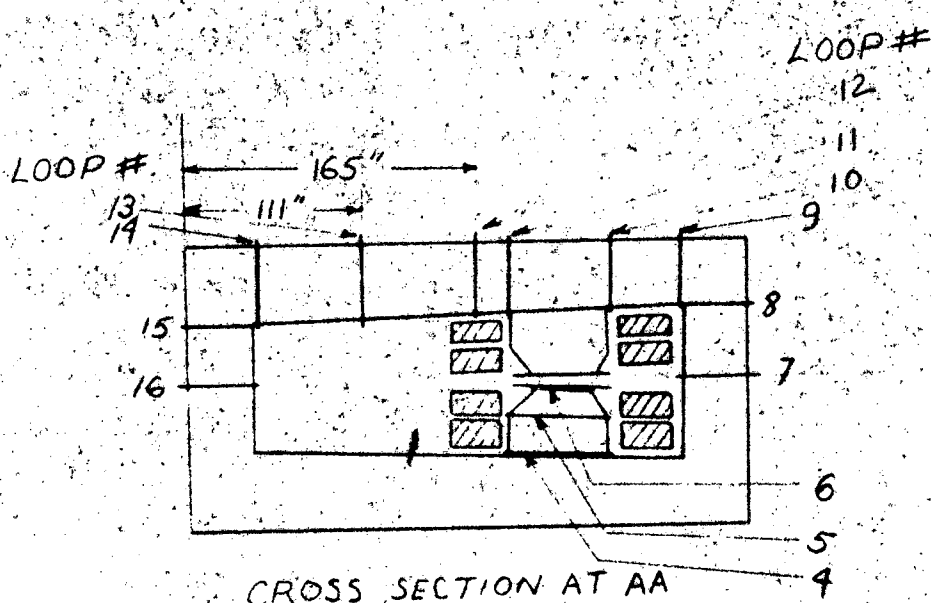
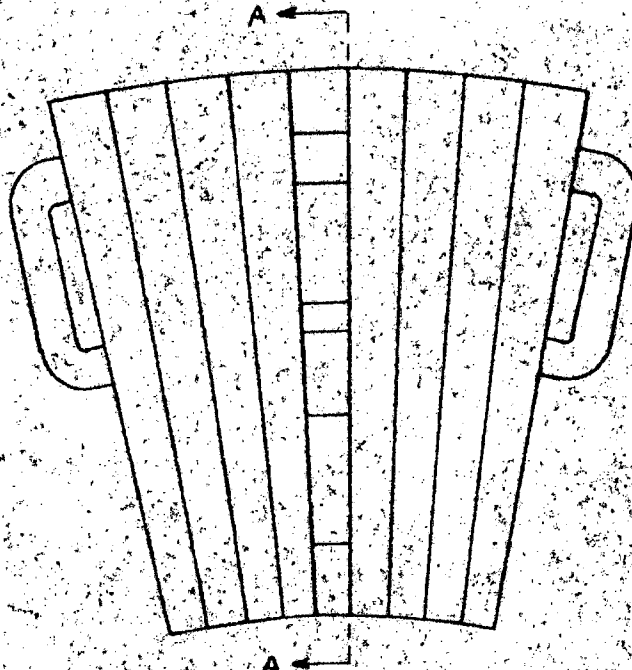
84 TURNS TOTAL ON MODEL COILS

SEE GRAPHS H-DC6.1-2, H-DC6.1-3, H-DC6.1-4

171-8

H-DC6.1-5

6-28-48



FWC



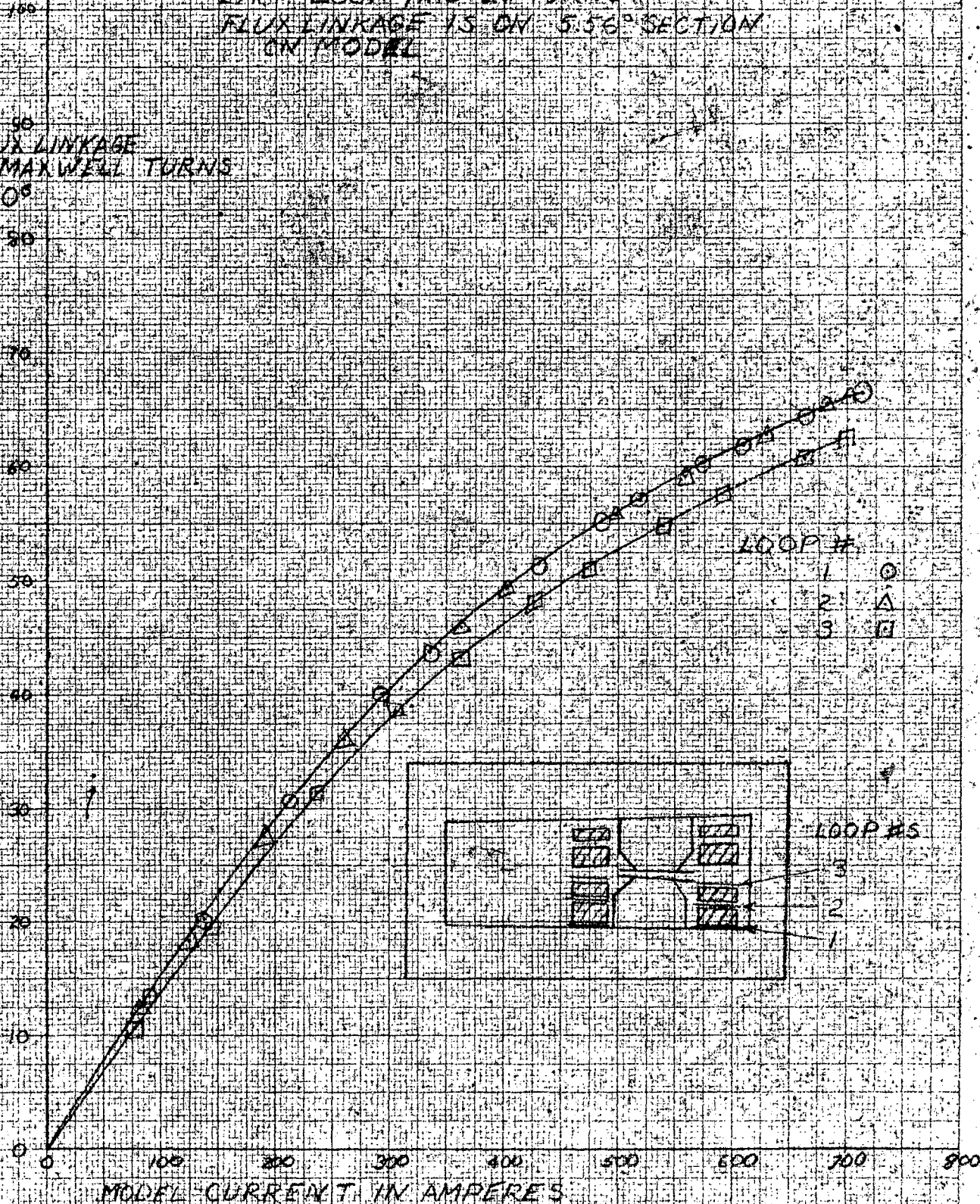
JUNE 30, 1948

CYCLODROME MODEL MAGNET DC61

171-8  
F-006.1-1  
6-30-48

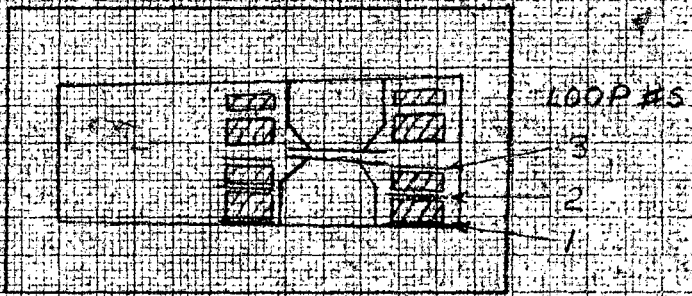
COIL FLUX LINKAGE  
1/2 SCALE DWG 311635  
COIL DRAWING 311923  
MODEL COILS: 4 COILS: 21 TURNS EACH  
TOTAL 84 TURNS  
GAP 14" (15) AT CENTER  
EACH LOOP HAS 21 TURNS  
FLUX LINKAGE IS ON 5.56° SECTION  
ON MODEL

FLUX LINKAGE  
IN MAXWELL TURNS  
X 10<sup>6</sup>



LOOP #

1	○
2	△
3	□



KEUFEL & ESSER CO., N.Y., NO. 369 1/2 G  
Millimeter, 6 mm. lines, acetate, cm. lines heavy.  
4057 IN U.S.A.

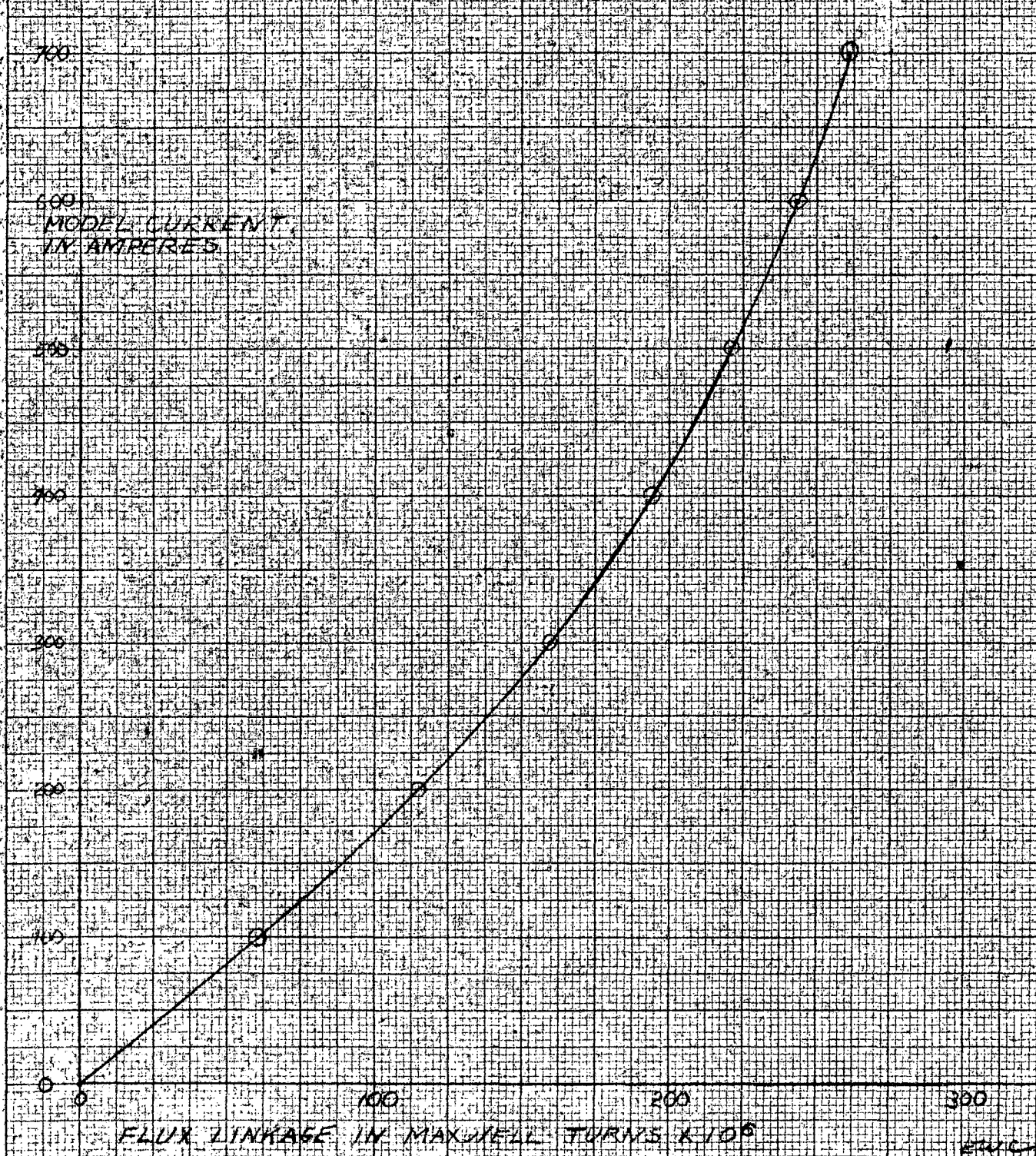
ENC

JUNE 30, 1948

CYCLOTRONE MODEL MAGNET DC611  
TOTAL COIL FLUX LINKAGE

171-8  
F-DC6.1-1a  
6-30-48

1/2 SCALE DWG 3L1635  
COIL DWG 3L1923  
MODEL COILS 4 COILS 21 TURNS EACH  
TOTAL 84 TURNS  
GAP 1/4 (FS) AT CENTER  
SEE GRAPH F-DC6.1-1  
FLUX LINKAGE IS FOR 5.56° SECTION  
ON MODEL  
TOTAL LINKAGE = LOOP #1 + #2 + #3 + #4



CEUFEL & ESSER, CO., N. Y. NO. 989-116  
10 X 10 to the 4 inch. 8th lines accented.  
Engraving 7 X 10 in.  
MADE IN U.S.A.



JULY 19, 1948

CYCLODRONE MODEL MAGNET DCG.1

171-8

1/2 SCALE DWG 3L1635

E-DCG.1-1

STORED ENERGY ON MODEL

7-19-48

CALCULATED FROM TOTAL COIL FLUX

CORRECTED

LINKAGE - SEE GRAPH F-DCG.1-14

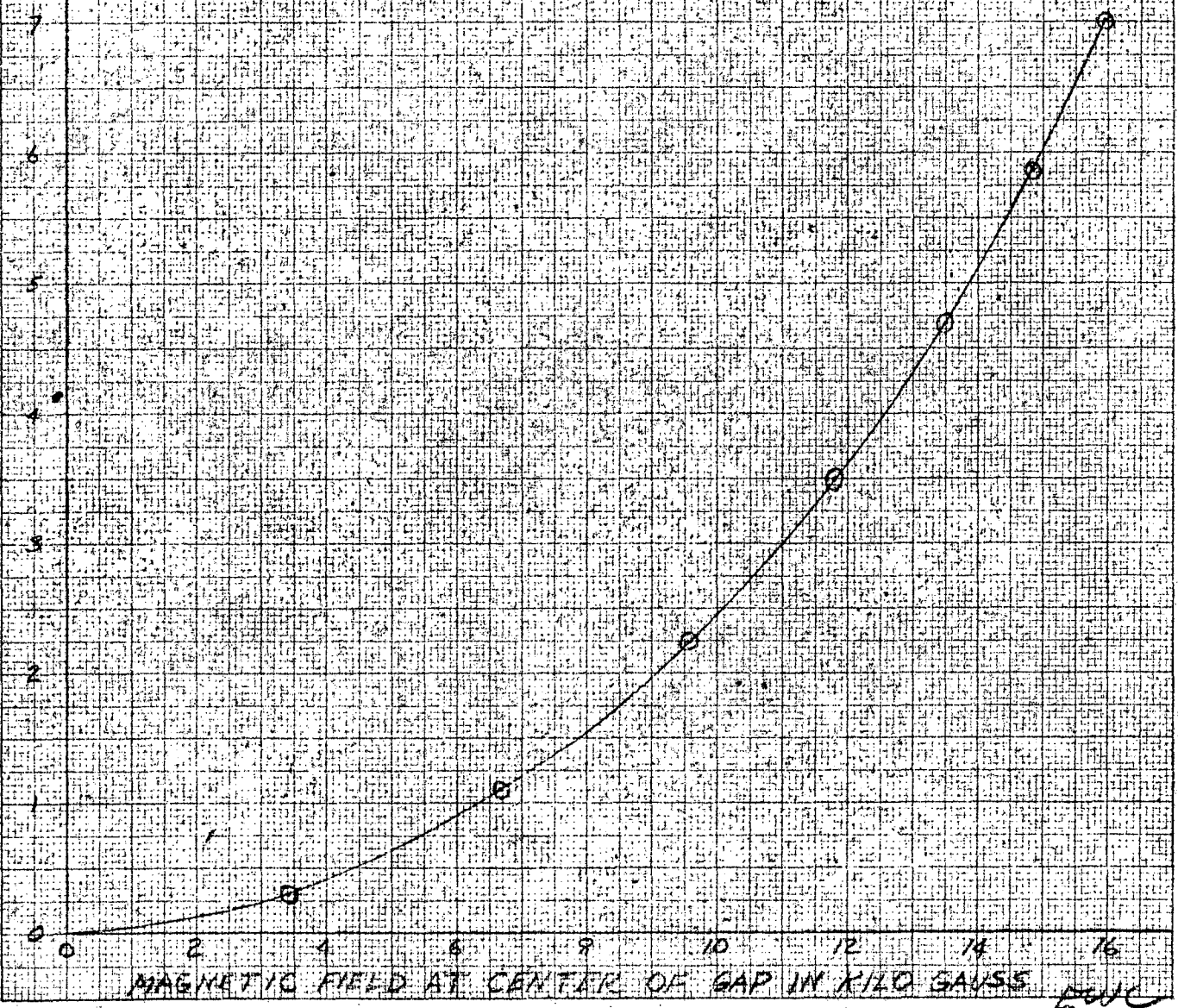
ENERGY (JOULES) =  $10^{-8} I^2 \phi$

WHERE I IS IN AMPERES

$\phi$  IS IN MAXWELL TURNS

DATA IS FOR A 5.56° SECTION ON MODEL

MODEL STORED ENERGY IN JOULES X 10<sup>2</sup>



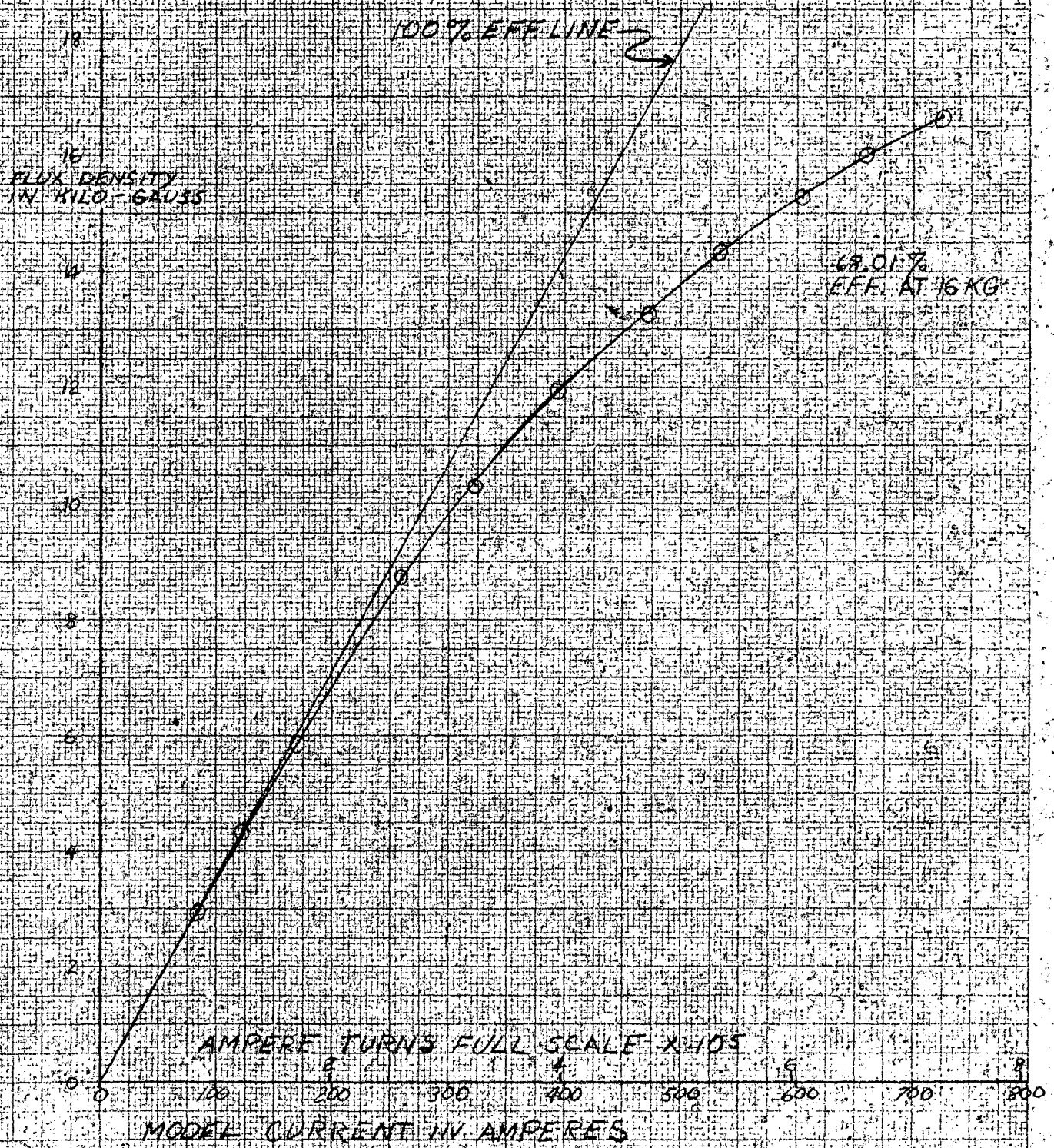
ESUPPEL & ESER CO., N. Y. NO. 382-146  
3111th St. 5th Fl. New York, N. Y.  
MADE IN U.S.A.

ENC

JUNE 28, 1948

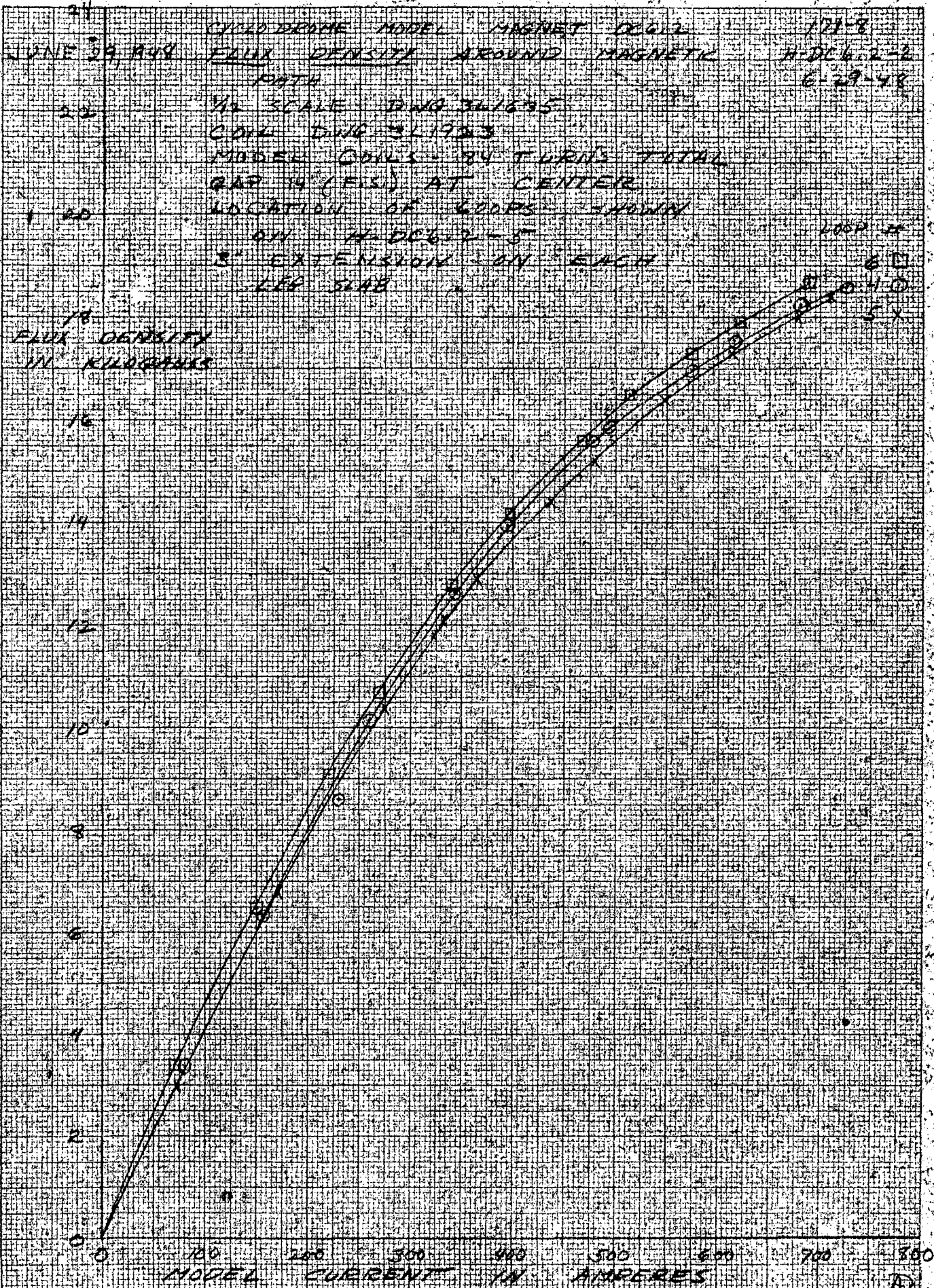
CYCLODROME MODEL MAGNET DC6.2  
MAGNETIZATION IN CENTER OF GAP  
1/2 SCALE DWG 3L1635  
COIL DWG 3L1923  
MODEL COILS: 4 COILS 21 TURNS EACH  
TOTAL 84 TURNS  
GAP 14" (FULL SCALE) AT CENTER  
3" (KGS) ADDED TO EACH LEG SLAB

171-8  
H-DC6.2-1  
6-29-48



KUOFFEL & ESSER CO., N. Y. - NO. 389 14 G  
Millimeter, 5 mm. files accepted, cm. files heavy.  
Made in U. S. A.

EWL



KEUFFEL & ESSER CO., N. Y., NO. 369 14.0  
 Millimeter, 5 mm. lines spaced, and three heavy  
 lines spaced 10 mm. lines spaced 20 mm. lines spaced 40 mm. lines spaced 80 mm. lines spaced 160 mm. lines spaced 320 mm. lines spaced 640 mm. lines spaced 1280 mm. lines spaced 2560 mm. lines spaced 5120 mm. lines spaced 10240 mm. lines spaced 20480 mm. lines spaced 40960 mm. lines spaced 81920 mm. lines spaced 163840 mm. lines spaced 327680 mm. lines spaced 655360 mm. lines spaced 1310720 mm. lines spaced 2621440 mm. lines spaced 5242880 mm. lines spaced 10485760 mm. lines spaced 20971520 mm. lines spaced 41943040 mm. lines spaced 83886080 mm. lines spaced 167772160 mm. lines spaced 335544320 mm. lines spaced 671088640 mm. lines spaced 1342177280 mm. lines spaced 2684354560 mm. lines spaced 5368709120 mm. lines spaced 10737418240 mm. lines spaced 21474836480 mm. lines spaced 42949672960 mm. lines spaced 85899345920 mm. lines spaced 171798691840 mm. lines spaced 343597383680 mm. lines spaced 687194767360 mm. lines spaced 1374389534720 mm. lines spaced 2748779069440 mm. lines spaced 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JUNE 29 1948

CYCLOTRONE MODEL MAGNET DC62  
FLUX DENSITY AROUND MAGNETIC PATH

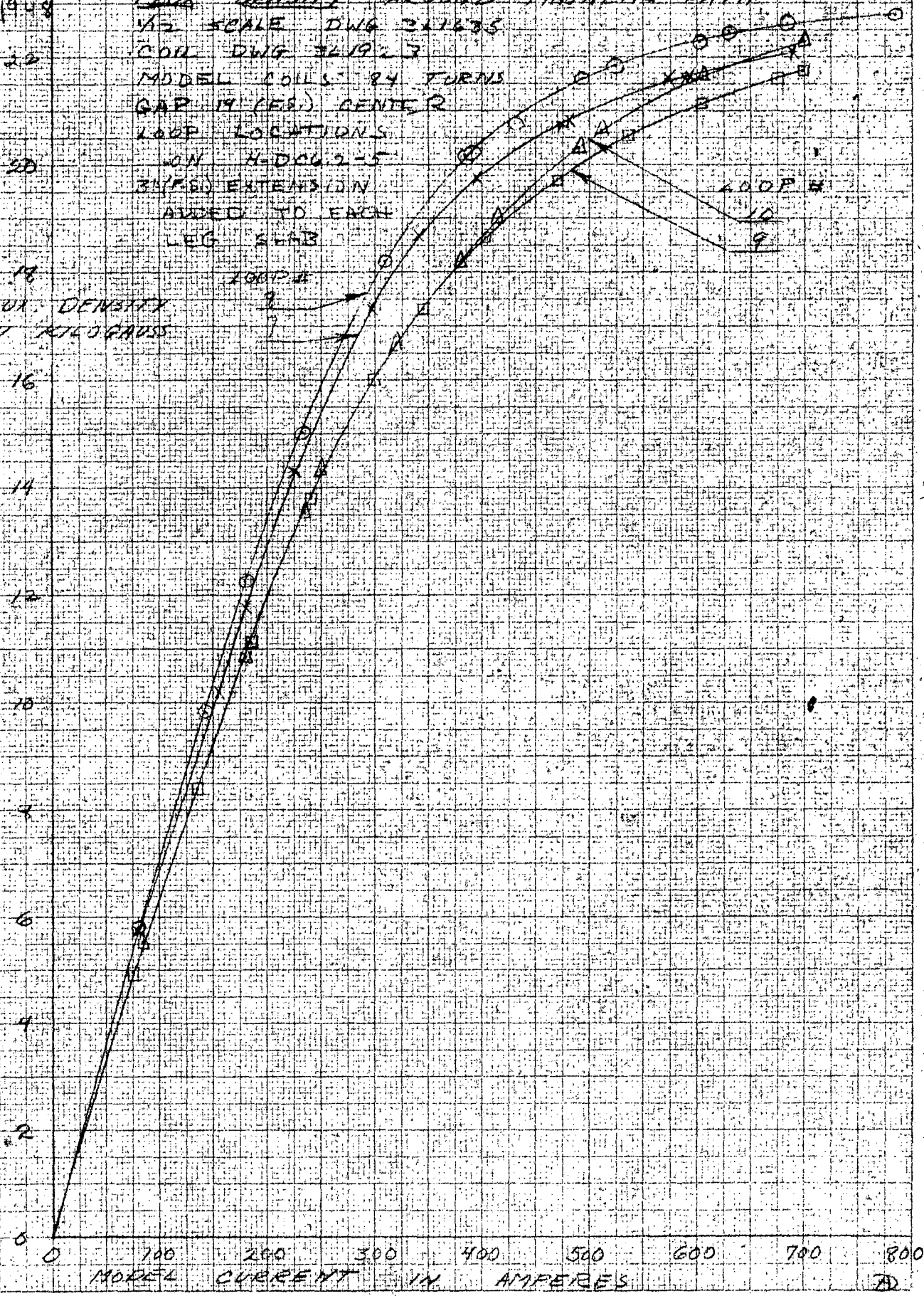
H-DC62-3  
6-29-48

1/2 SCALE DWG 341635  
COIL DWG 341923

MODEL COILS 24 TURNS  
GAP 19 (IN) CENTER

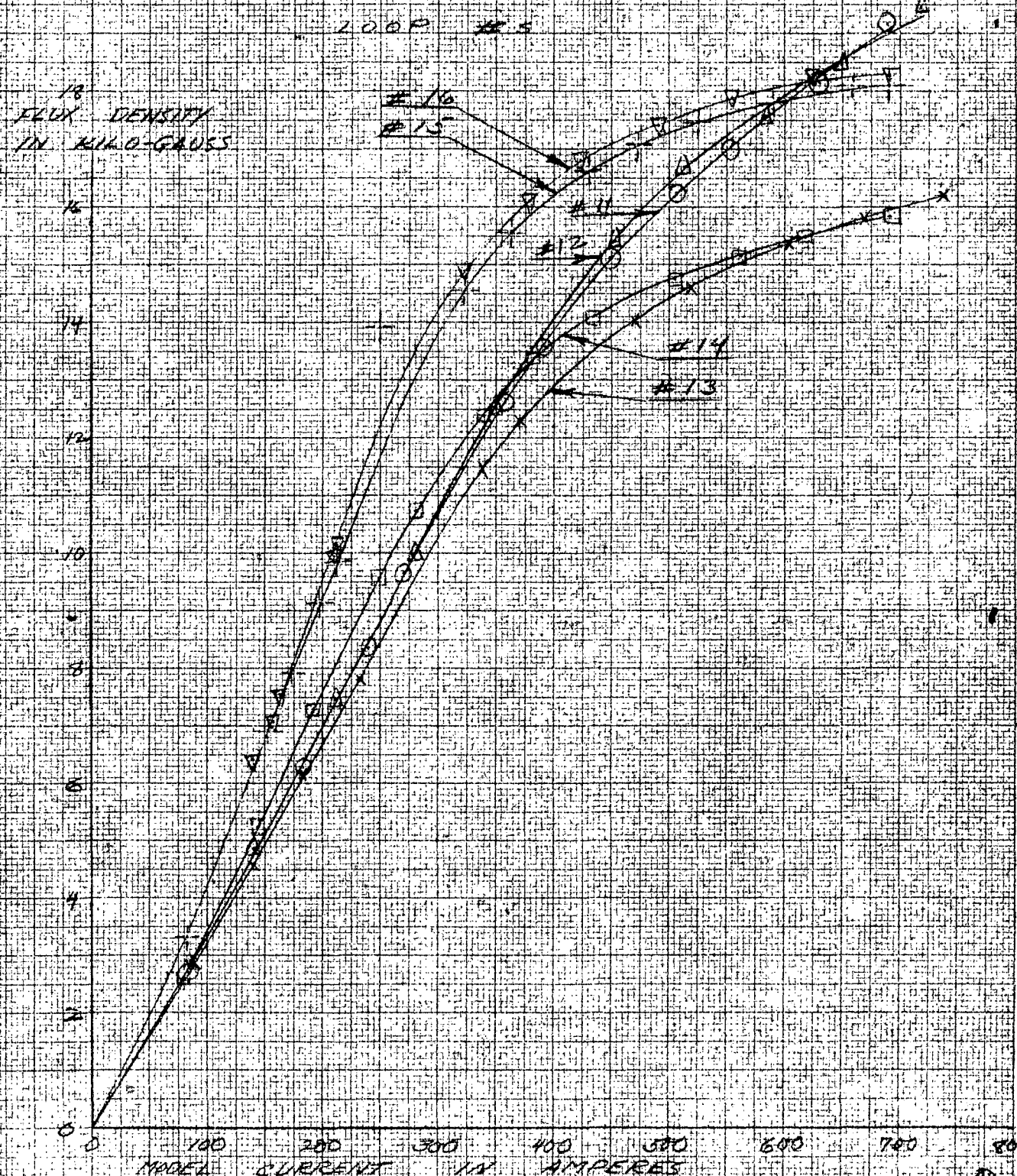
LOOP LOCATIONS  
ON H-DC62-5  
3 (IN) EXTENSION  
ADDED TO EACH  
LEG SLAB

FLUX DENSITY  
IN KILO GAUSS



KEUFFEL & ESSER CO., N. Y., NO. 359 140  
Millimeter, 5 mm. lines spaced, cm. lines heavy.  
MADE IN U. S. A.

24  
 CYCLOTRONE MODEL MAGNET DCG-2 171-8  
 JUNE 29, 1948 FLUX DENSITY AROUND MAGNETIC PATH H-DCG-2-4  
 VIA SCALE DWG 34-1635 6-29-48  
 22 COIL DWG 34-1733  
 MODEL COILS - 84 TURNS TOTAL  
 GAP 14 (E.S.) AT CENTER  
 LOOP LOCATIONS ON H-DCG-2-5  
 20 EXTENSION ADDED TO EACH LEG SLAB



KEUFFEL & ESSER CO., N. Y., NO. 959 14 G  
 Millimeters, 6 mm. lines spaced, end. lines heavy;  
 MADE IN U. S. A.



JUNE 28, 1948

CYCLODROME MODEL MAGNET DC6.2  
LOCATION OF FLUX LOOPS  
1/2 SCALE DWG 3L1635

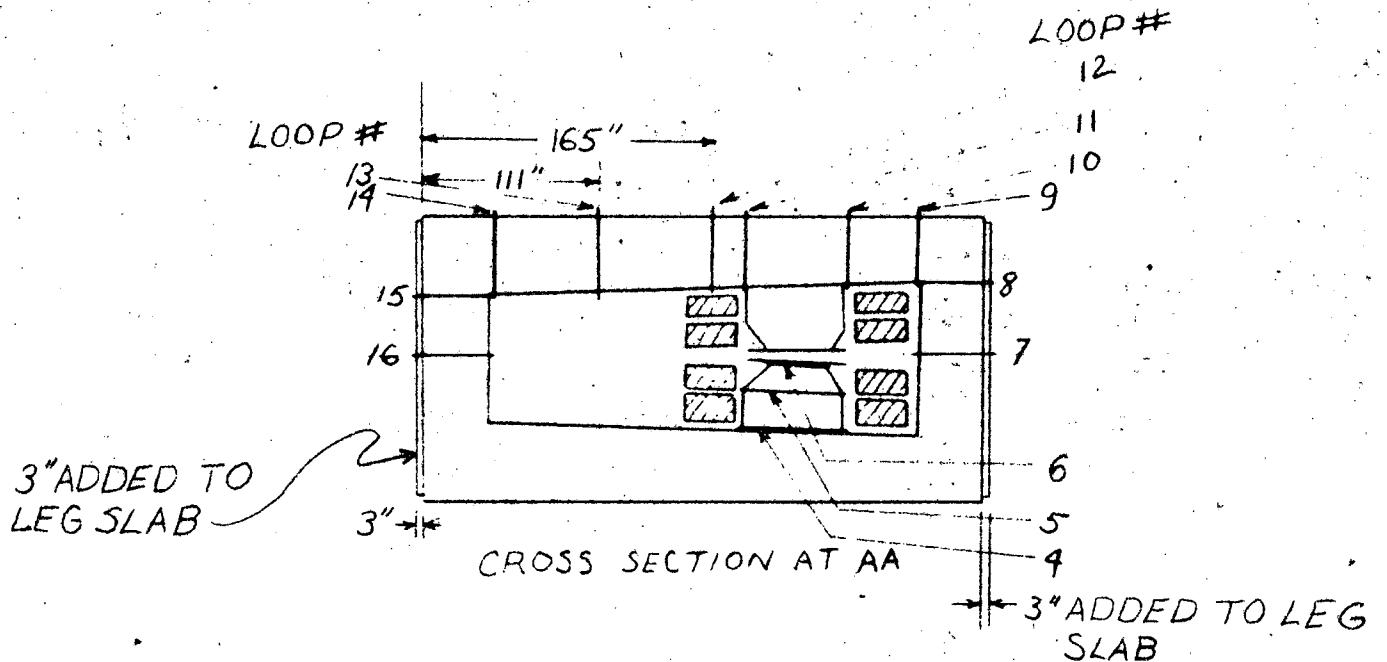
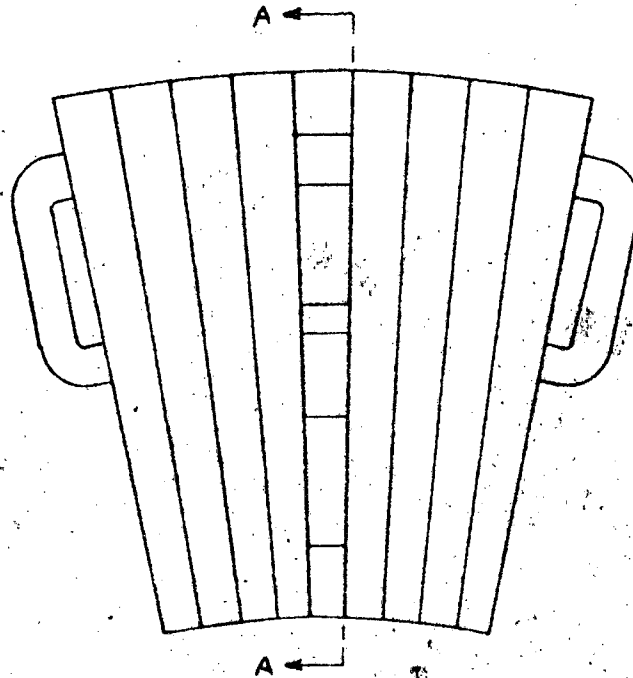
171-8  
H-DC6.2-5  
6-28-48

GAP 14" FULL SCALE AT CENTER

COIL DWG 3L1923

84 TURNS TOTAL ON MODEL COILS

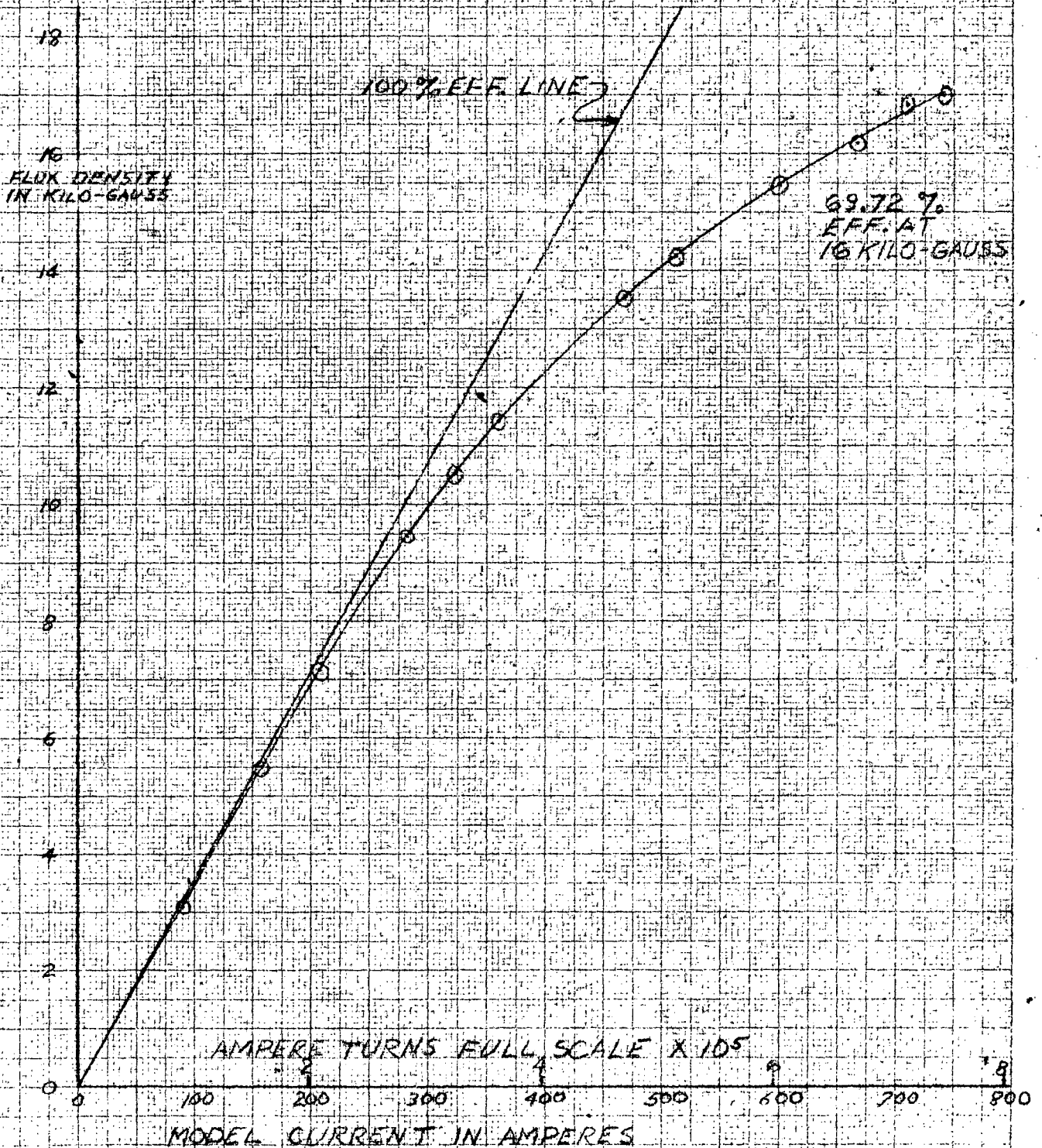
SEE GRAPHS H-DC6.2-2, H-DC6.2-3, H-DC6.2-4



JUNE 29, 1948

CYCLODROME MODEL MAGNET DCB.3  
MAGNETIZATION IN CENTER OF GAP  
1/2 SCALE DWG 3L 1635  
COIL DWG 3L 1923  
MODEL COILS: 4 COILS 21 TURNS EACH  
TOTAL 84 TURNS  
GAP 14" (FULL SCALE) AT CENTER  
6" (FULL SCALE) ADDED TO EACH LEG SLAB

171-8  
H-DCB.3-1  
6-29-48



KEUFFEL & ESSER CO., N. Y., NO 369 14 G  
Millimeters, 5 mm lines accented, cm lines heavy.  
U.S.G. M. D. S. A.

P.V.C.

JUNE 30, 1948

CYCLOTRONE MODEL MAGNET DC6.3

171-8  
H-DC6.3-2  
6-30-48

FLUX DENSITY AROUND MAGNETIC PATH

1/2 SCALE DWG 3L1635

COIL DWG 3L1923

MODEL COILS - 84 TURNS TOTAL

GAP 14" (E.S.) AT CENTER

LOCATION OF DE LOOPS SHOWN ON

GRAPH H-DC6.3-5

6" (E.S.) ADDED TO EACH LEG SLAB

20

FLUX DENSITY  
IN KILO-GAUSS

18

16

14

12

10

8

6

4

2

0

100

200

300

400

500

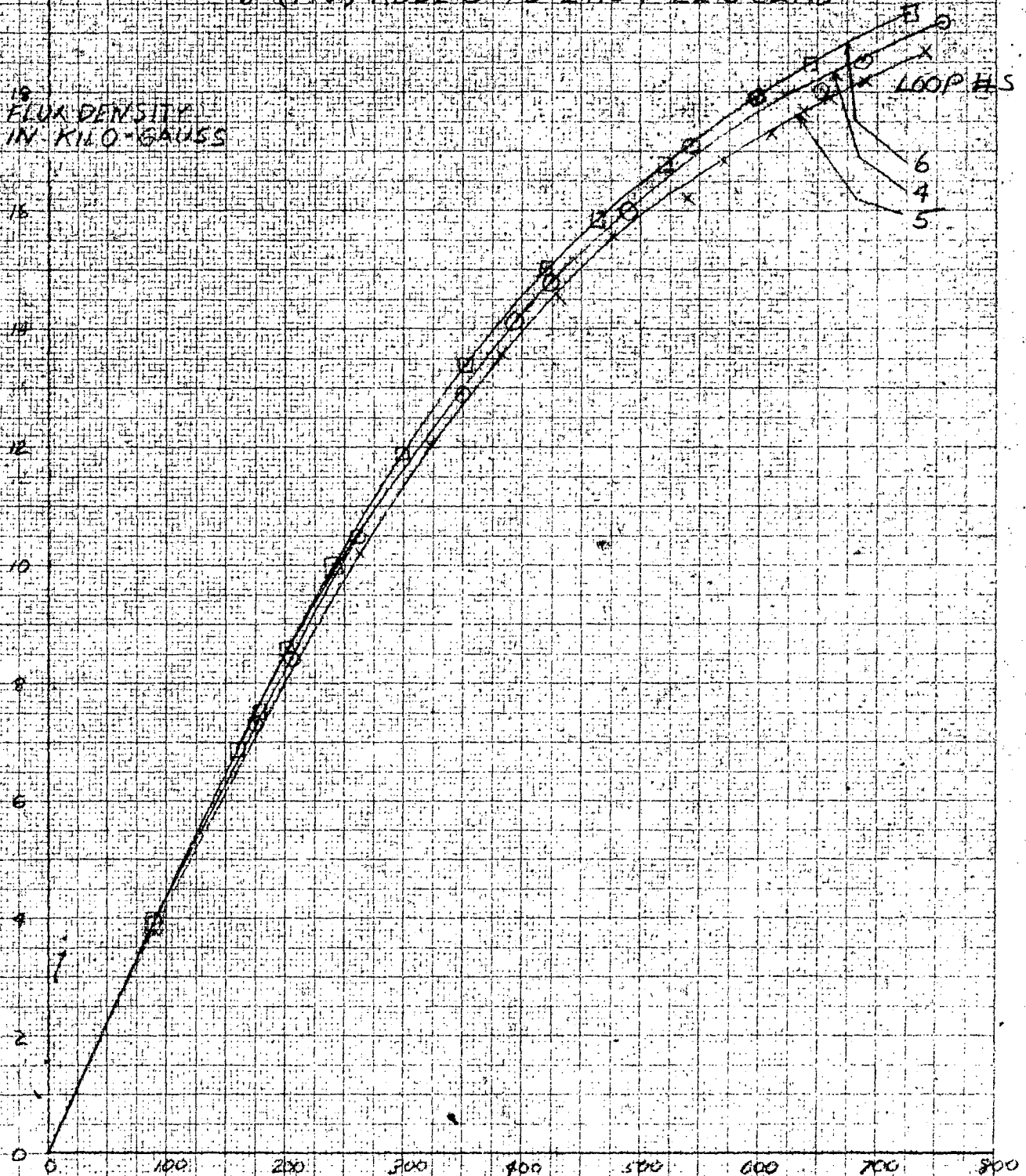
600

700

800

MODEL CURRENT IN AMPERES

BWC



JUNE 29, 1948

CYCLODROME MODEL MAGNET DC6.3  
FLUX DENSITY AROUND MAGNETIC PATH

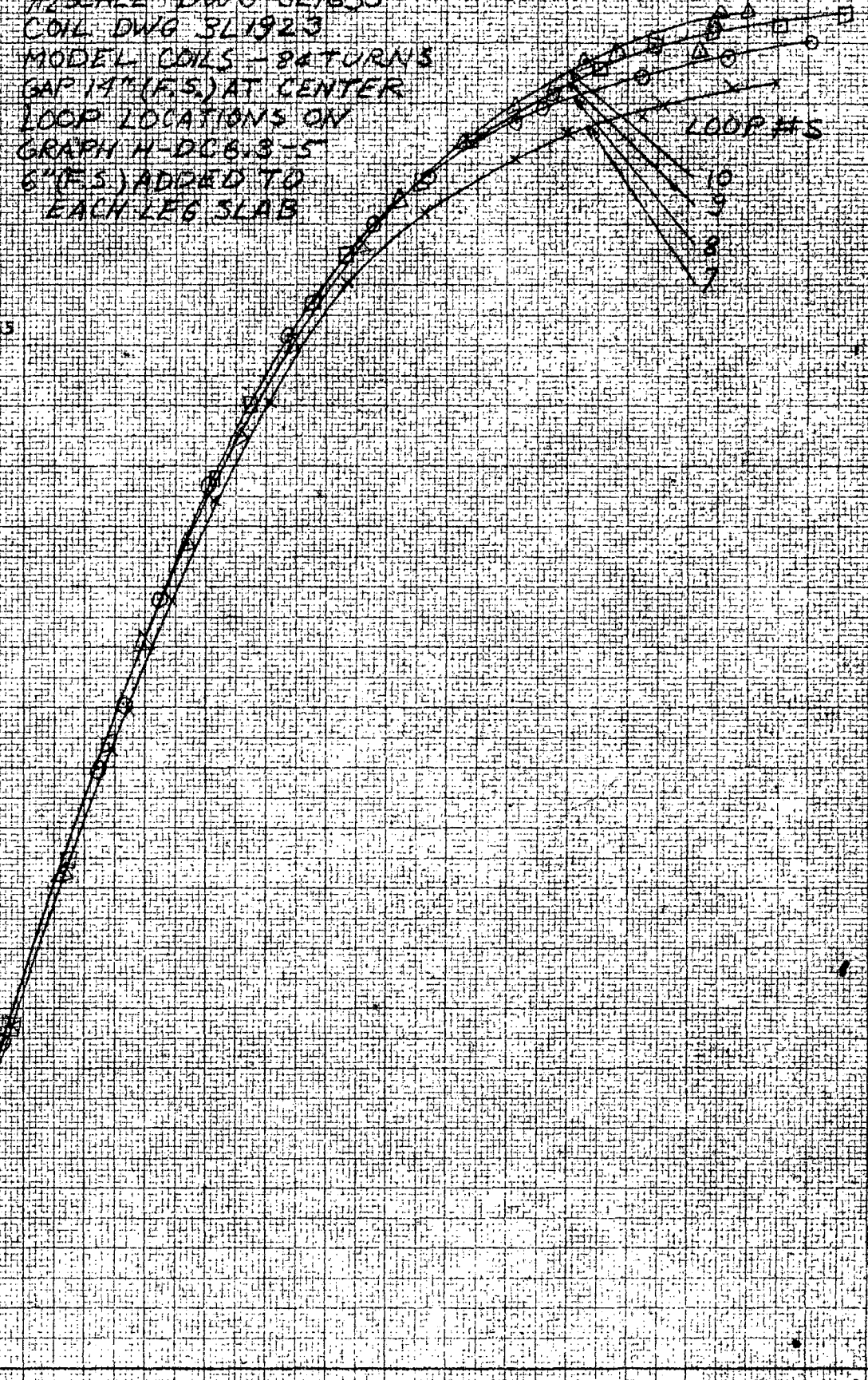
171-P  
H-DC6.3-3  
6-29-48

1/2 SCALE DWG 3L1635  
COIL DWG 3L1923  
MODEL COILS - 94 TURNS  
GAP 17" (F.S.) AT CENTER  
LOOP LOCATIONS ON  
GRAPH H-DC6.3-5  
6" (F.S.) ADDED TO  
EACH LEG SLAB

FLUX DENSITY  
IN KILO-GAUSS

22  
10  
18  
16  
14  
12  
10  
8  
6  
4  
2  
0

MODEL CURRENT IN AMPERES



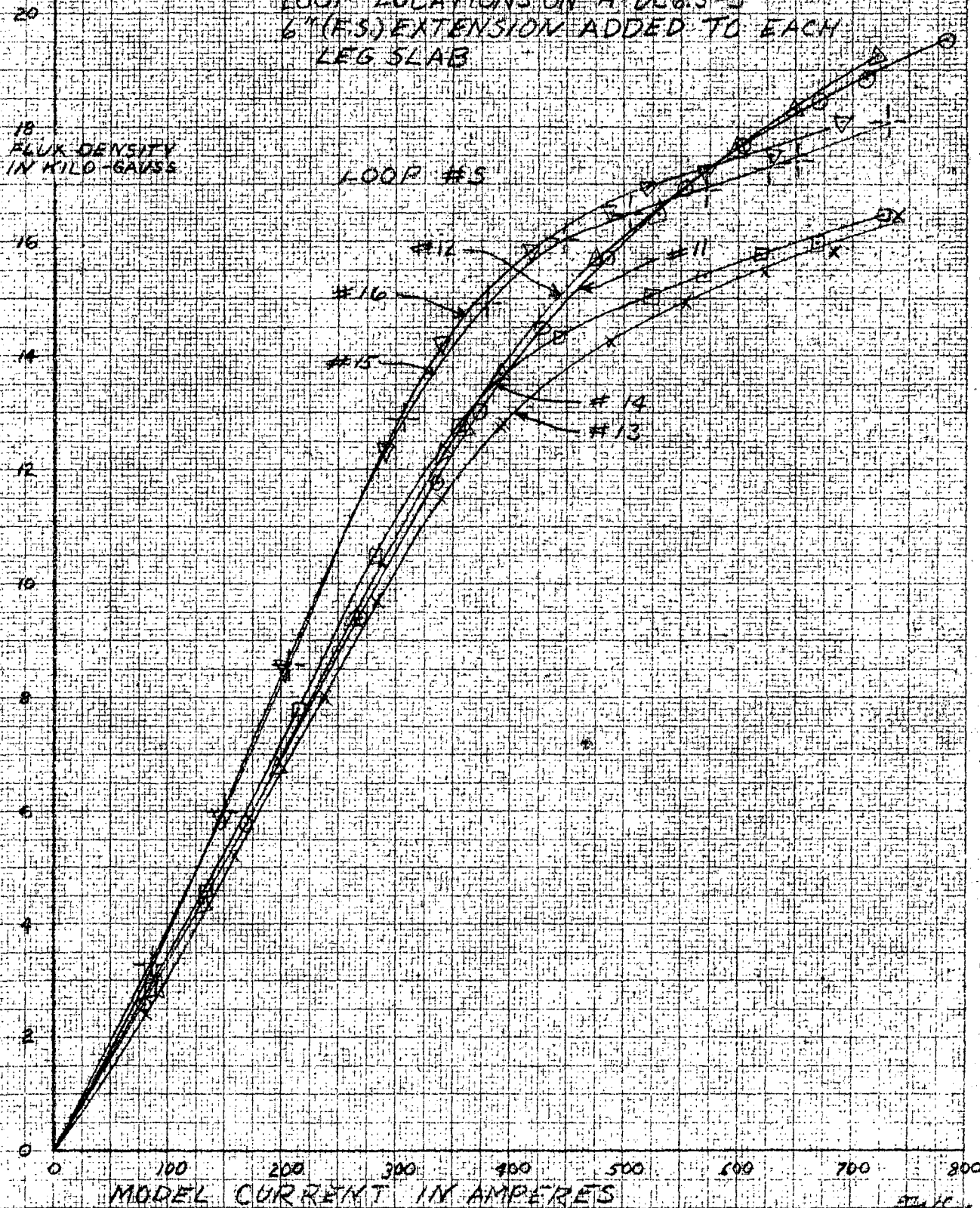
REUFEL & ESSER CO., N. Y. NO. 369-14 G  
Millimeter, 5 mm. lines accepted, cm. lines heavy.  
MADE IN U. S. A.

JUNE 29, 1948

CYCLOTRONE MODEL MAGNET DC6.3  
FLUX DENSITY AROUND MAGNETIC  
PATH

171-81  
H-DC6.3-4  
6-29-48

1/2 SCALE DWG 34 1635  
COIL DWG 3L 1923  
MODEL COILS - 84 TURNS TOTAL  
GAP 14" (F.S.) AT CENTER  
LOOP LOCATIONS ON H-DC6.3-5  
6" (F.S.) EXTENSION ADDED TO EACH  
LEG SLAB



KEUFFEL & ESSER CO., N. Y., NO. 288-14 G  
Millimeters, 5 mm. lines accentuated, cm. lines heavy.  
MADE IN U. S. A.

JUNE 28, 1948

CYCLODROME MODEL MAGNET DC6.3

LOCATION OF FLUX LOOPS

1/2 SCALE DWG 3L1635

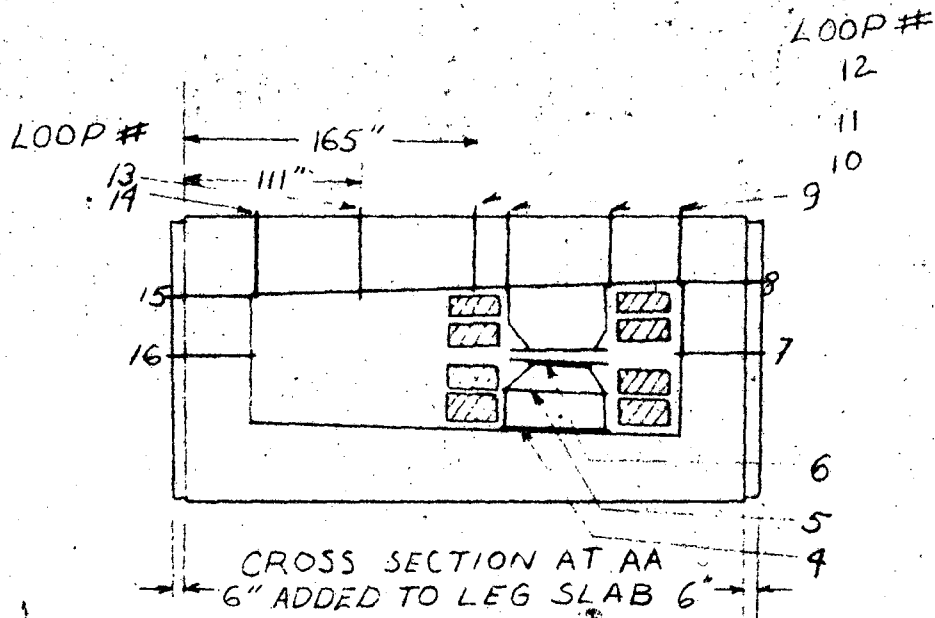
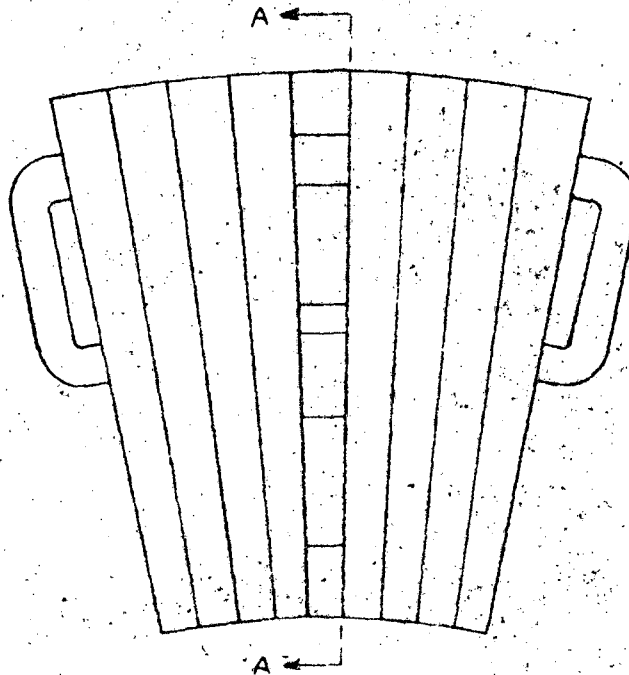
GAP 14" FULL SCALE AT CENTER

COIL DWG 3L1923

84 TURNS TOTAL ON MODEL COILS

SEE GRAPHS H-DC6.3-2, H-DC6.3-3, H-DC6.3-4

171-8  
H-DC6.3-5  
6-28-48



JUNE 30, 1948

CYCLOTRONE MODEL MAGNET D.C.G. 4  
MAGNETIZATION IN CENTER OF GAP

171-8  
H-DC6.4-1  
6-30-48

1/2 SCALE DWG 3L 1635

COIL DWG 3L 1923

MODEL COILS: 4 COILS 21 TURNS EACH  
TOTAL 84 TURNS

GAP 14" (F.S.) AT CENTER  
3" (F.S.) ADDED TO LEG SLAB ON WIDE GAP SIDE

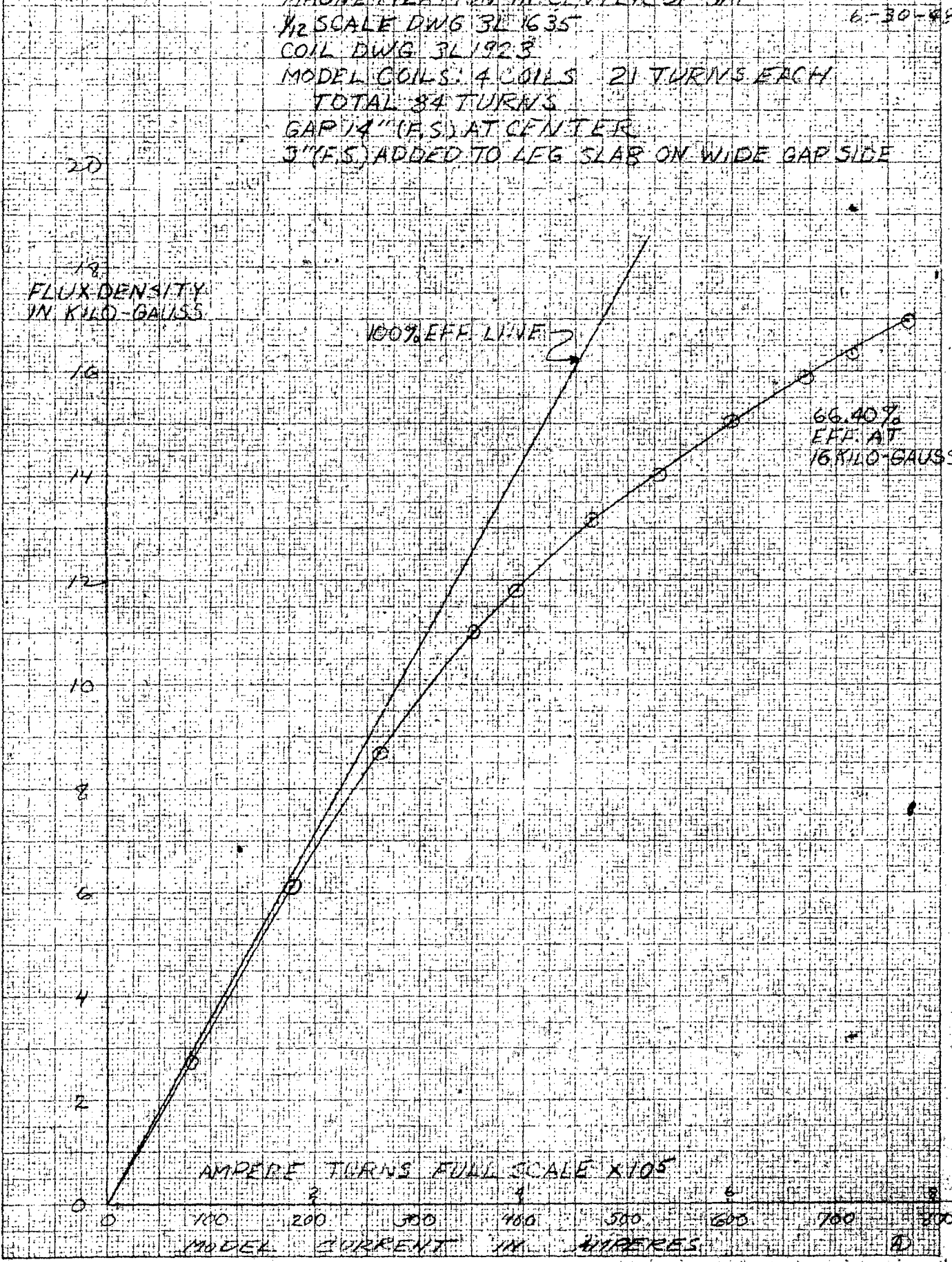
FLUX DENSITY  
IN KILO-GAUSS

100% EFF. LINE

66.40%  
EFF. AT  
16 KILO-GAUSS

AMPERE TURNS FULL SCALE X 105

MODEL CURRENT IN AMPERES



NEUFEL & ESSER CO., N. Y. NO. 359-146  
Manufact. 5 mil. brass sprocket, etc. lines heavy,  
MADE IN U.S.A.

24  
 JULY 1, 1948

CYCLODRONE MODEL MAGNET DC6.4  
 FLUX DENSITY AROUND MAGNETIC PATH  
 1/2 SCALE DWG 3L1835  
 COIL DWG 3L1823  
 MODEL COILS - 84 TURNS TOTAL  
 GAP 14" (F.S.) AT CENTER  
 LOCATION OF LOOPS SHOWN ON  
 GRAPH H-DC6.4-5  
 3" (F.S.) ADDED TO LEG SLAB ON  
 WIDE GAP SIDE ONLY

171-8  
 11-DC6.4-2  
 7-1-48

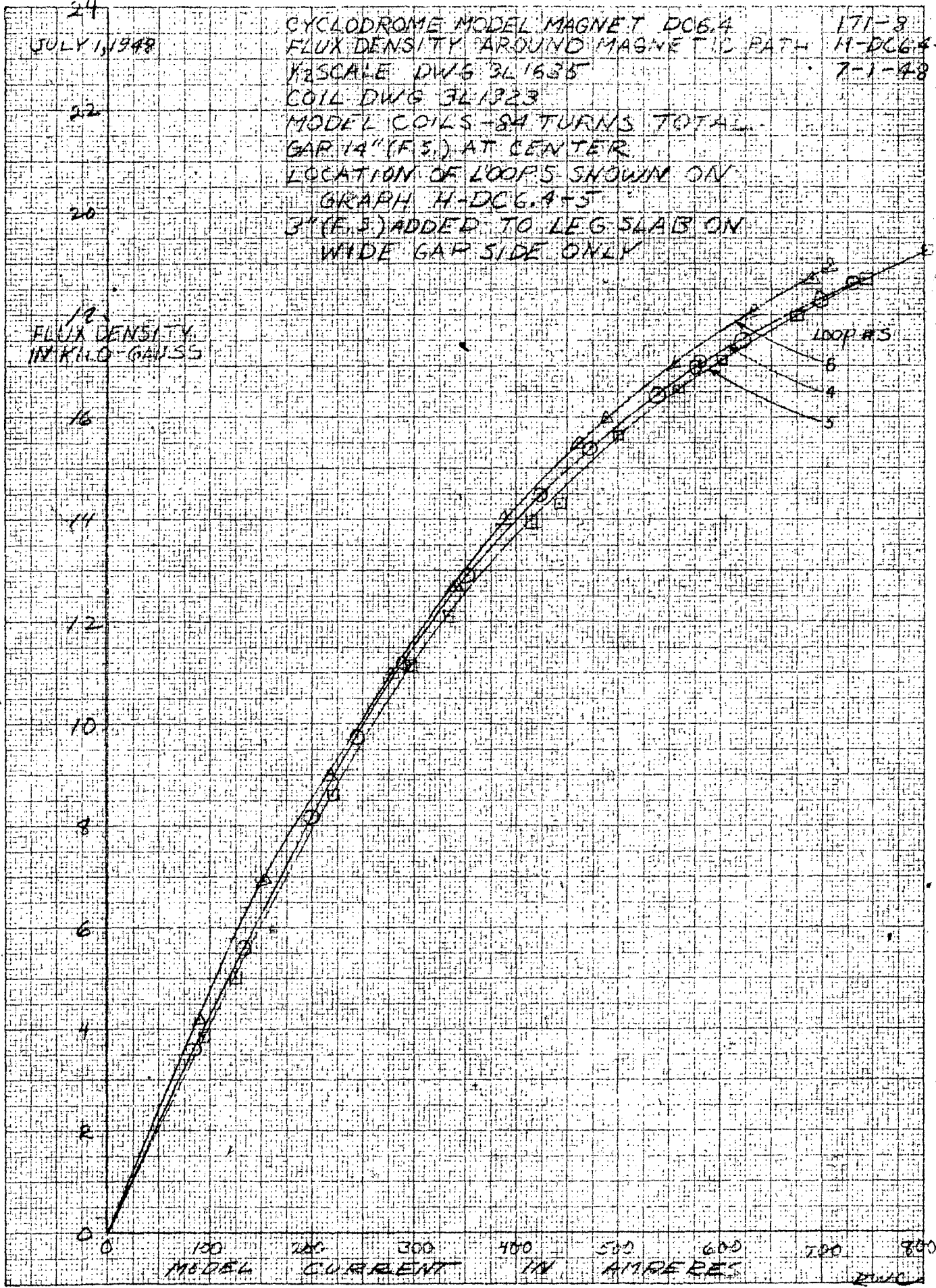
FLUX DENSITY  
 IN K.I.L.O.-GAUSS

18  
 16  
 14  
 12  
 10  
 8  
 6  
 4  
 2  
 0

100 200 300 400 500 600 700 800  
 MODEL CURRENT IN AMPERES

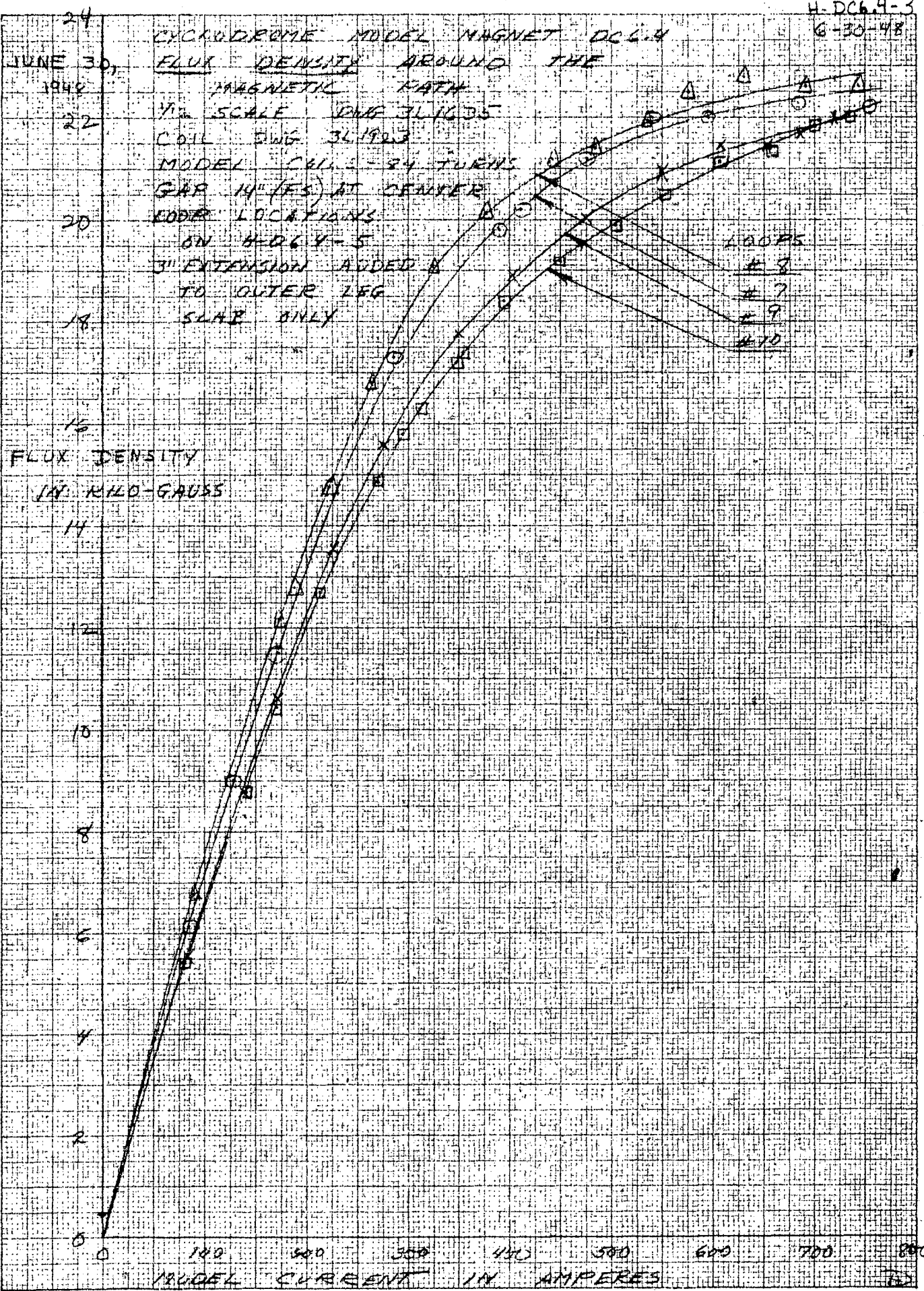
LOOPS  
 6  
 4  
 3

APPROX. 6 EIGHT CO. N. Y. NO. 339-146  
 MILL. FACTS, 5 and 10 in S. (approx.) and 1000 in S. (approx.)  
 MADE IN U. S. A.

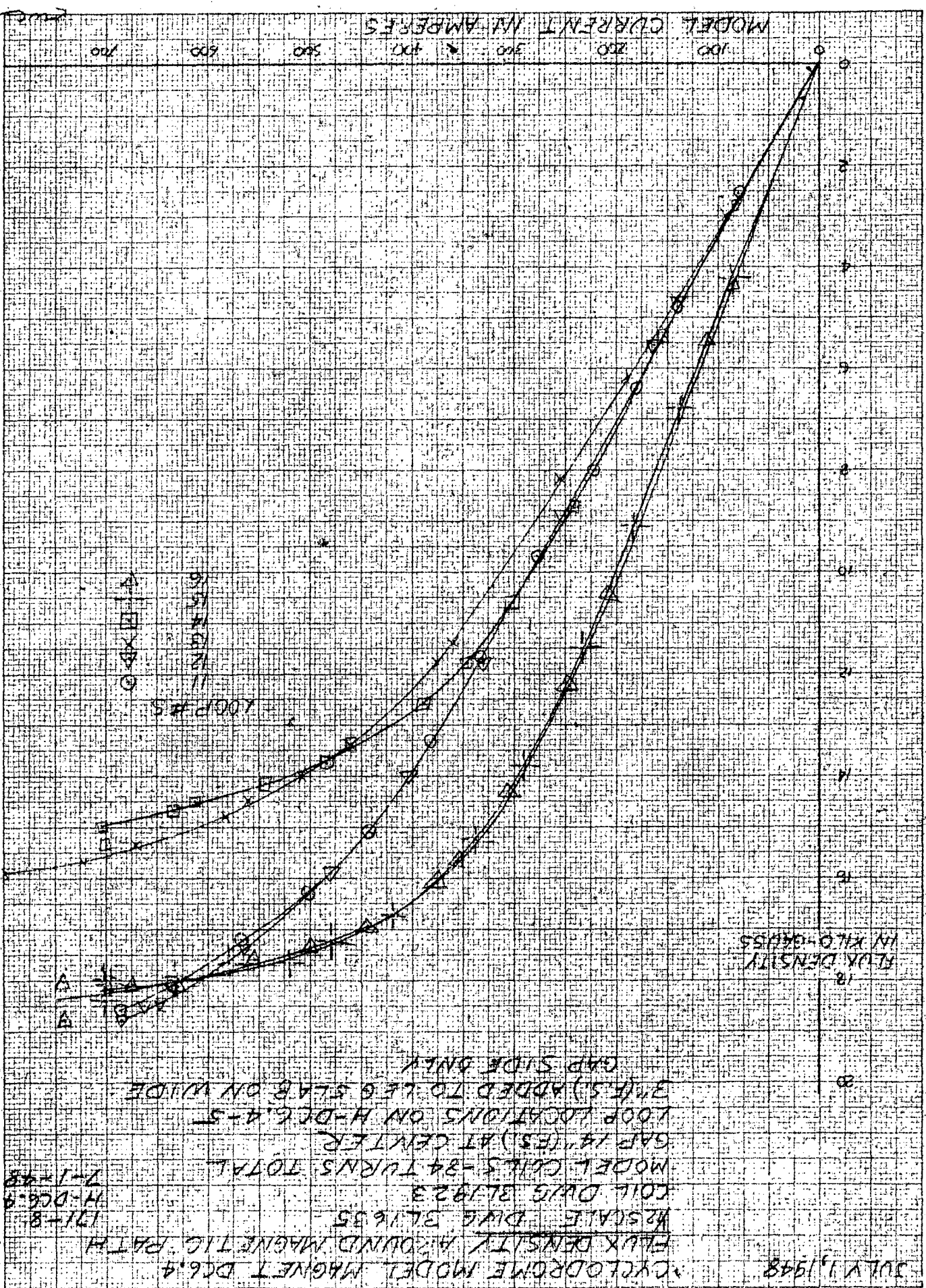




171-8  
H-DC64-3  
6-30-48



ACUFFEL & ESSER CO., N. Y. NO. 355-145  
MILWAUKEE 5  
MADE IN U. S. A.



JULY 1, 1948

JULY 1, 1948

CYCLODROME MODEL MAGNET DC6.4  
LOCATION OF FLUX LOOPS  
1/2 SCALE DWG 3L1635

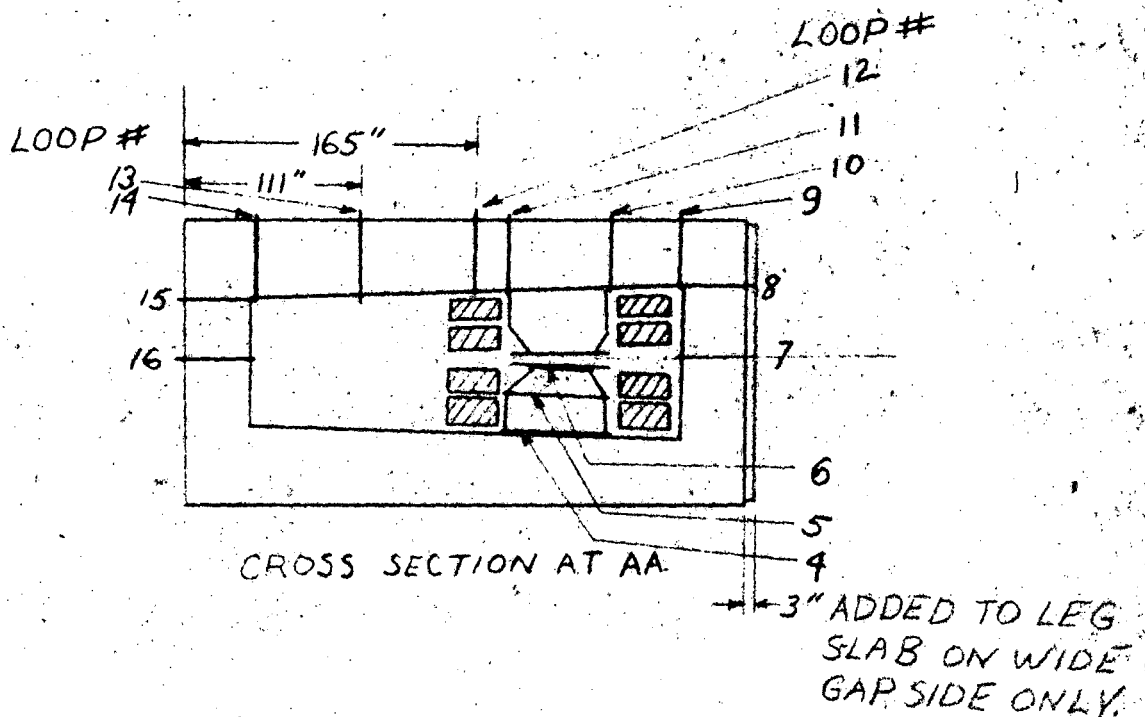
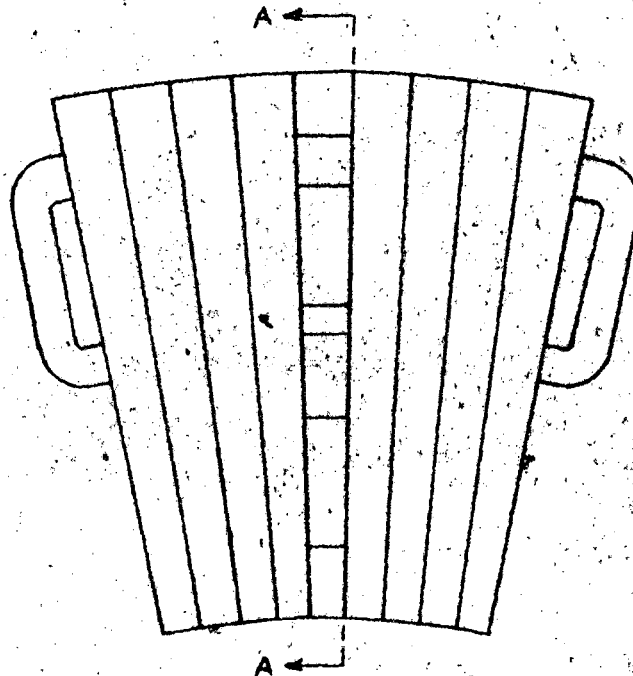
171-8  
H-DC6.4-  
7-1-48

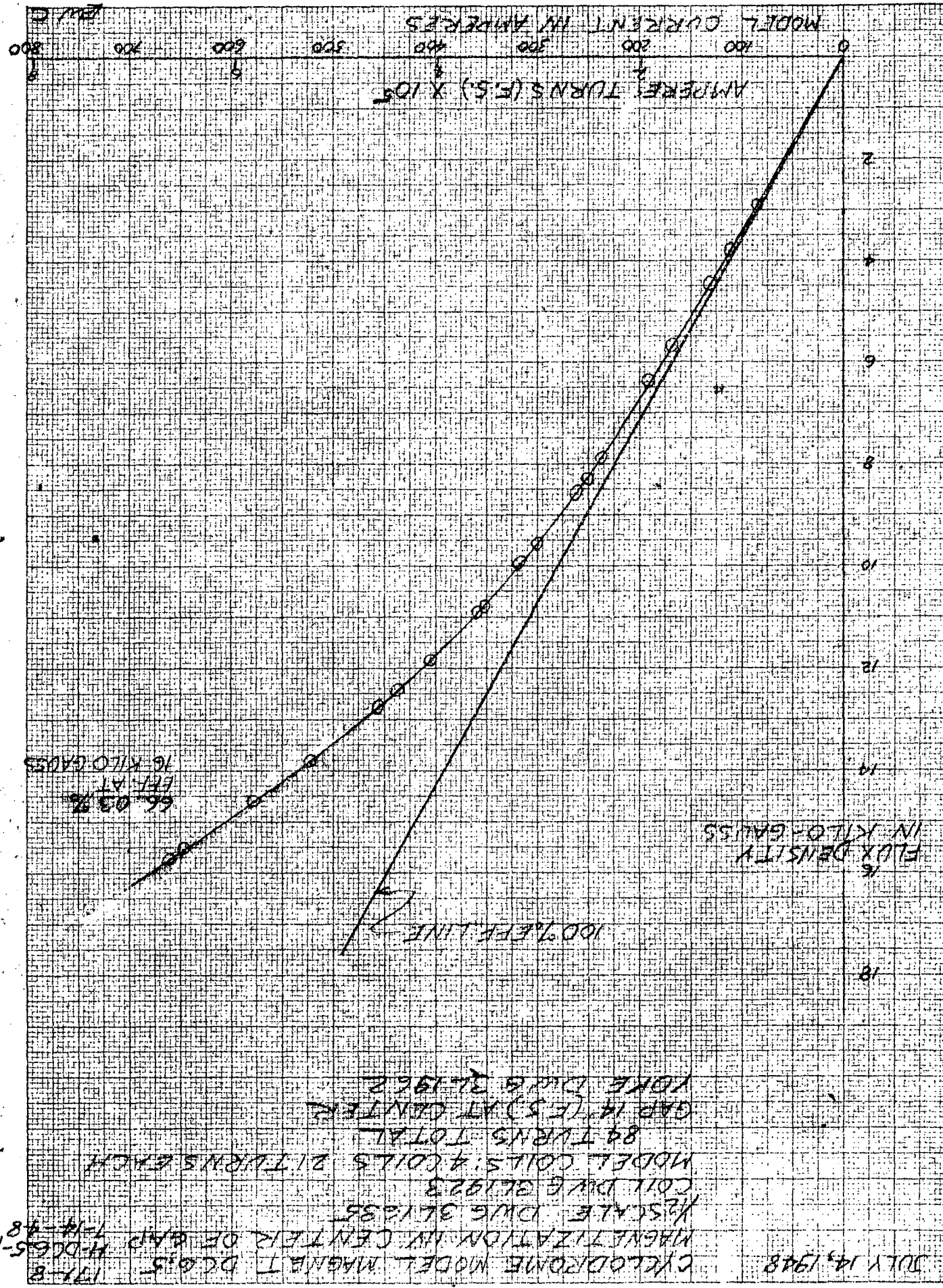
GAP 14" FULL SCALE AT CENTER

COIL DWG 3L1923

84 TURNS TOTAL ON MODEL COILS

SEE GRAPHS H-DC6.4-2, H-DC6.4-3, H-DC6.4-4





JULY 14, 1948  
 CYCLODROME MODEL MAGNET DATA  
 MAGNETIZATION BY CENTER OF GAP  
 H-0065-1  
 171-8  
 MAGNETIZATION BY CENTER OF GAP  
 H-0065-1  
 171-8  
 SCALE DWG 31135  
 COIL DWG 31123  
 MODEL COILS: 4 COILS 21 TURNS EACH  
 84 TURNS TOTAL  
 GAP 14 (E-S) AT CENTER  
 YOKE DWG 31162

66.03 GAUSS  
 16 KILO GAUSS

100% ERROR LINE

FLUX DENSITY IN KILO-GAUSS

MODEL CURRENT IN AMPERES

0 100 200 300 400 500 600 700 800

0 2 4 6 8 10 12 14 16 18

JULY 19, 1948

CYCLOTRONE MODEL MAGNET DC 6.5  
COIL LOOP FLUX LINKAGE

171-8  
F-DC65-1  
7-19-48

1/2 SCALE

COIL DRAWING 3L1923

MODEL COILS 4 COILS 21 TURNS EACH  
84 TURNS

GAP 14" (F.S.) AT CENTER

YOKE DWG 3L1962

EACH LOOP HAS 21 TURNS

FLUX LINKAGE IS ON 5.56 SECTION  
OF MODEL

10  
FLUX LINKAGE  
IN MAXWELL TURNS  
X 10<sup>6</sup>

60

50

40

30

20

10

0

100

200

300

400

500

600

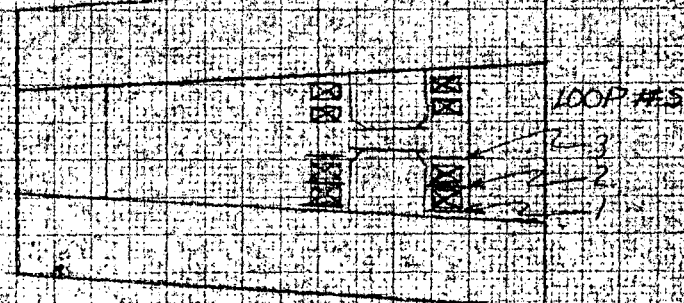
700

800

MODEL CURRENT IN AMPERES

LOOP #	
1	○
2	△
3	□

LOOP #	
3	□
2	△
1	○



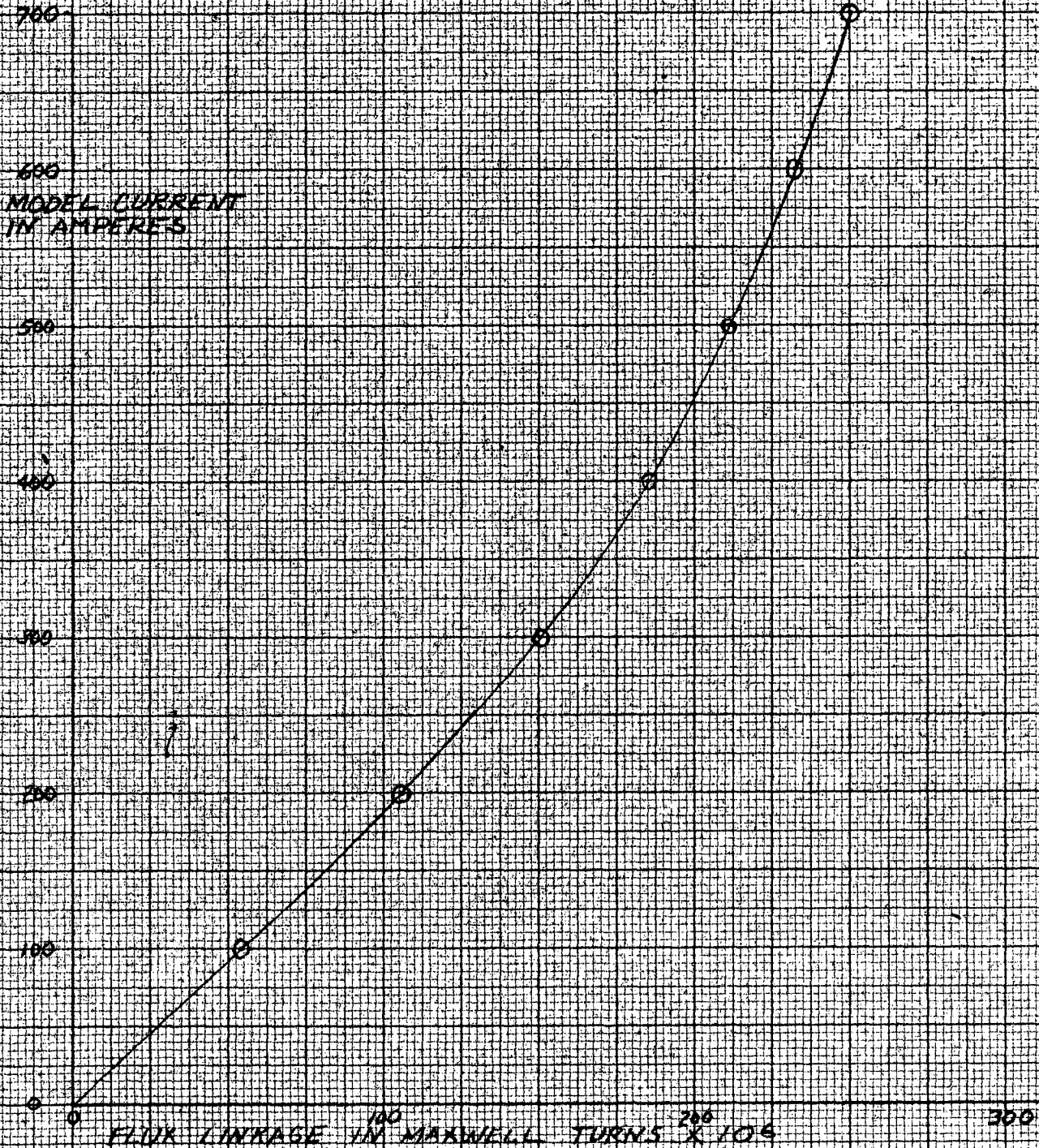
KRUPP & ESSER CO., N.Y. NO. 88-140  
MILWAUKEE 2, WIS. PAPER MANUFACTURING CO. LIGHT DIV.  
MADE IN U.S.A.

EWC

JULY 20, 1948

CYCLODRONE MODEL MAGNET DEG. 5  
TOTAL COIL LOOP FLUX LINKAGE  
1/2 SCALE DWG TL 1635  
COIL DWG 3L1923  
YOKE DWG 3L1462  
GAP 1/4" (E.S.) AT CENTER  
MODEL COIL 5 - 88 TURNS TOTAL  
SEE GRAPH F-DEG. 5-1  
FLUX LINKAGE IS FOR 5.56° SECTION ON MODEL  
TOTAL LINKAGE = LOOP #1 + #2 + #2 + #3

171-8  
F-DEG. 5-1a  
7-20-48



KEUFFEL & ESSER CO., N. Y. NO. 3487-126  
10 X 10 to the 1/4 inch, 5th lines centered.  
Engraving 7/8 X 10 in.  
MADE IN U.S.A.

DWG

JULY 20, 1948

CYCLODROME MODEL MAGNET DC65

171-8

STORED ENERGY ON MODEL

E-DC65-1

1/2 SCALE DWG 3L1635

7-20-48

COIL DWG 3L1023

YOKE DWG 5L1962

CALCULATED FROM TOTAL COIL LOOP

FLOX LINKAGE - SEE GRAPH

E-DC65-1a

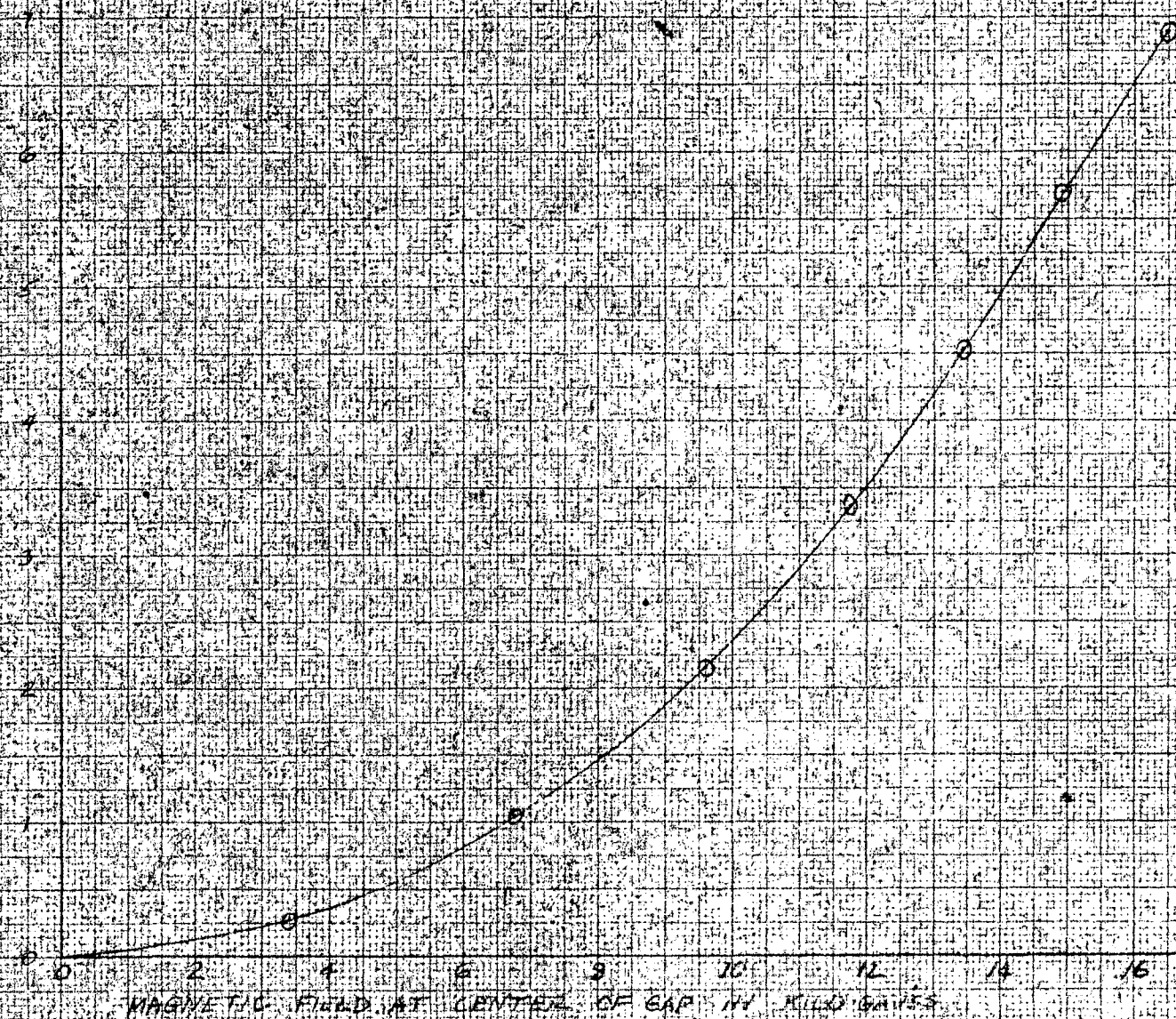
ENERGY (JOULES) =  $10^{-3} I^2$

WHERE I IS IN AMPERES

D IS IN MAXWELL TURNS

DATA IS FOR A 56° SECTION OF MODEL

MODEL STORED  
ENERGY IN  
JOULES X 10<sup>2</sup>



MAGNETIC FIELD AT CENTER OF GAP IN KILO GAUSS

BWC

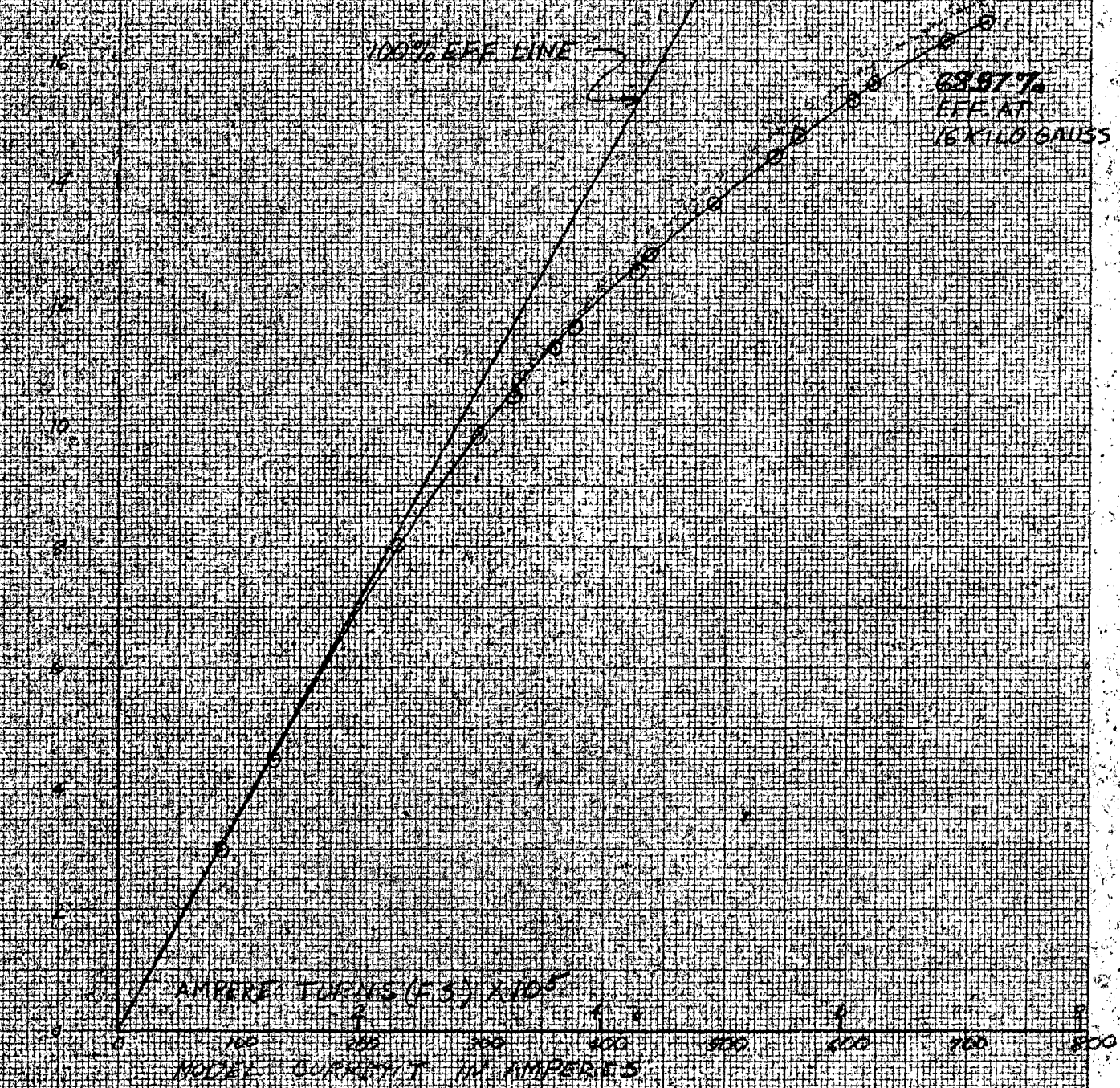
KEUFFEL & ESSER CO., N. Y. NO. 238 140  
Manufacturers of the "Line" type  
graph paper

JULY 15, 1948

CYCLOTRONE MODEL MAGNET DCG.6  
MAGNETIZATION IN CENTER OF GAP  
1/2 SCALE DWG 3L1635  
COIL DWG 3L1923  
MODEL COILS 4 COILS 2 TURN EACH  
TOTAL TURNS 84  
GAP 14" (E.S.) AT CENTER  
3" (E.S.) ADDED TO LEG SLAB ON  
WIDE GAP SIDE  
YOKE DWG 3L1962

17A-8  
H-DCG.6-1  
7-15-48

FLUX DENSITY  
IN KILO GAUSS



McGraw-Hill Electric & Electronic Co., Inc. No. 33-484  
This drawing is a reproduction of the original drawing.  
MADE IN U.S.A.

EW C



JULY 16, 1948

CYCLOTRONE MODEL MAGNET DC 6.6  
FLUX DENSITY AROUND MAGNETIC  
PATH

171-8  
H-DC6.6-2  
7-16-48

1/2 SCALE DWG 311735

GAP 14" (F.S.) AT CENTER

COIL DWG 311923

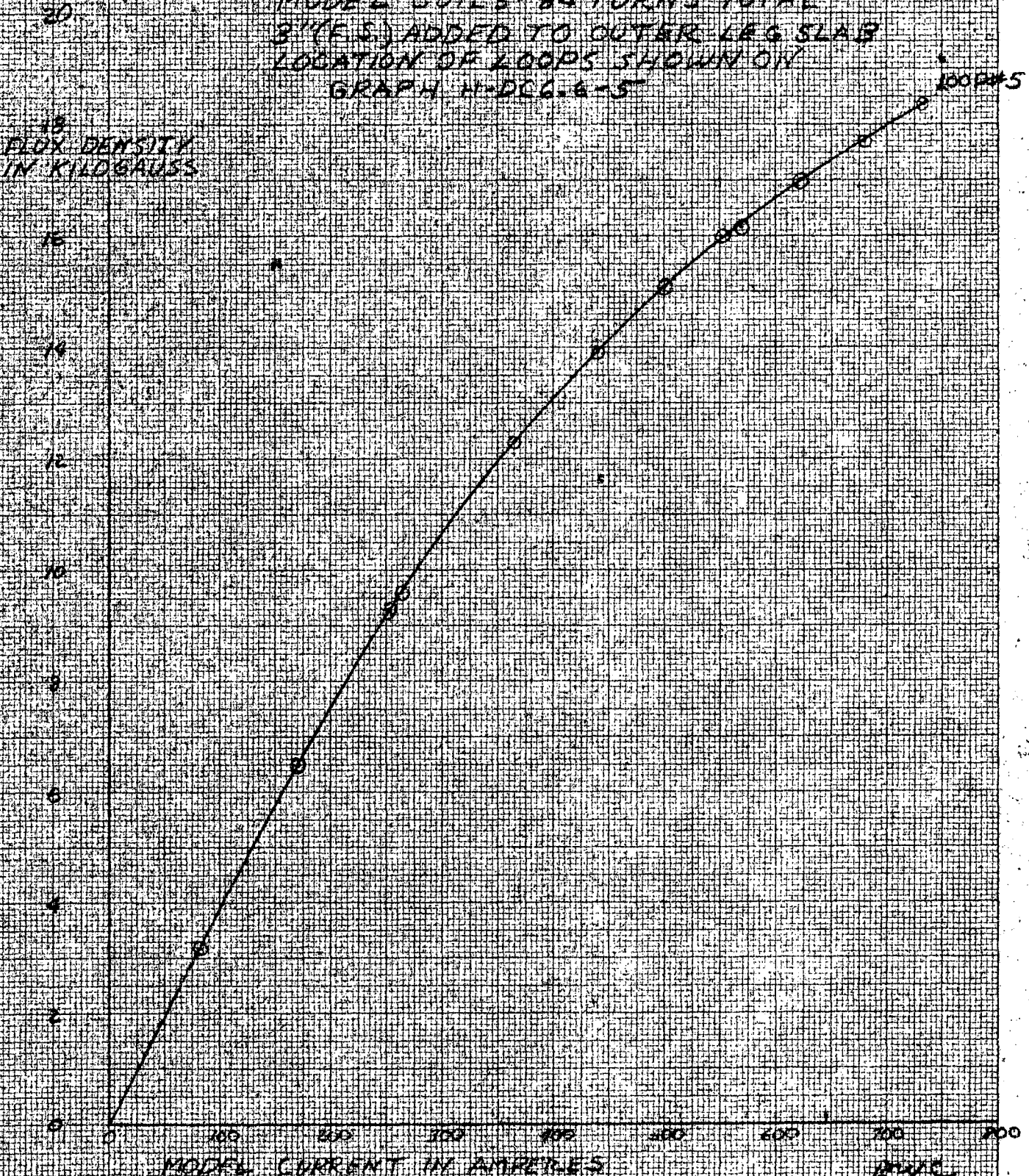
YOKE DWG 311962

MODEL COILS - 84 TURNS TOTAL

3" (F.S.) ADDED TO OUTER LEG SLAB  
LOCATION OF LOOPS SHOWN ON

GRAPH H-DC6.6-5

FLUX DENSITY  
IN KILOGAUSS



MODEL CURRENT IN AMPERES

SCALE

KRUPP & SONS CO. N.Y. NO. 125-126  
Millwrights & Iron Works, Newark, N.J.  
MADE IN U.S.A.

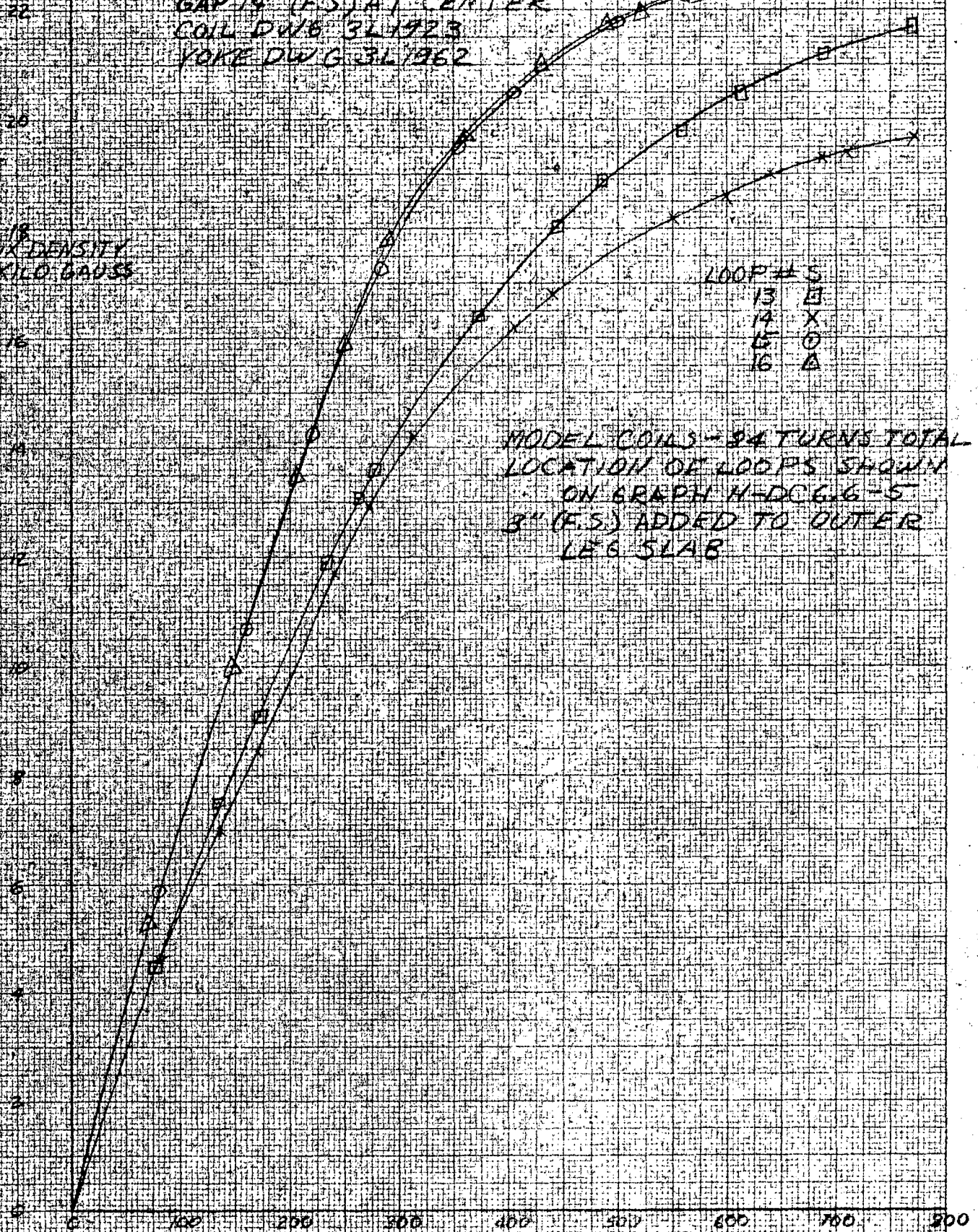
171-8  
H-DC6.6-3  
7-19-48

JULY 18, 1948 CYCLODROME MODEL MAGNET DC6.6  
FLUX DENSITY AROUND MAGNETIC PATH  
1/2 SCALE DWG 3L1635  
GAP 14" (F.S.) AT CENTER  
COIL DWG 3L1923  
YOKE DWG 3L1962

FLUX DENSITY  
IN KILO GAUSS

LOOP #S  
13 □  
14 X  
15 ○  
16 △

MODEL COILS - 24 TURNS TOTAL  
LOCATION OF LOOPS SHOWN  
ON GRAPH H-DC6.6-5  
3" (F.S.) ADDED TO OUTER  
LEG SLAB



MODEL CURRENT IN AMPERES

KEUFFEL & ESSER CO. - N. Y. NO. 355-1245  
 Millimeter, 5 mm. Jims. Accred. Co. Inc. Agency  
 MADE IN U. S. A.

JULY 19, 1948

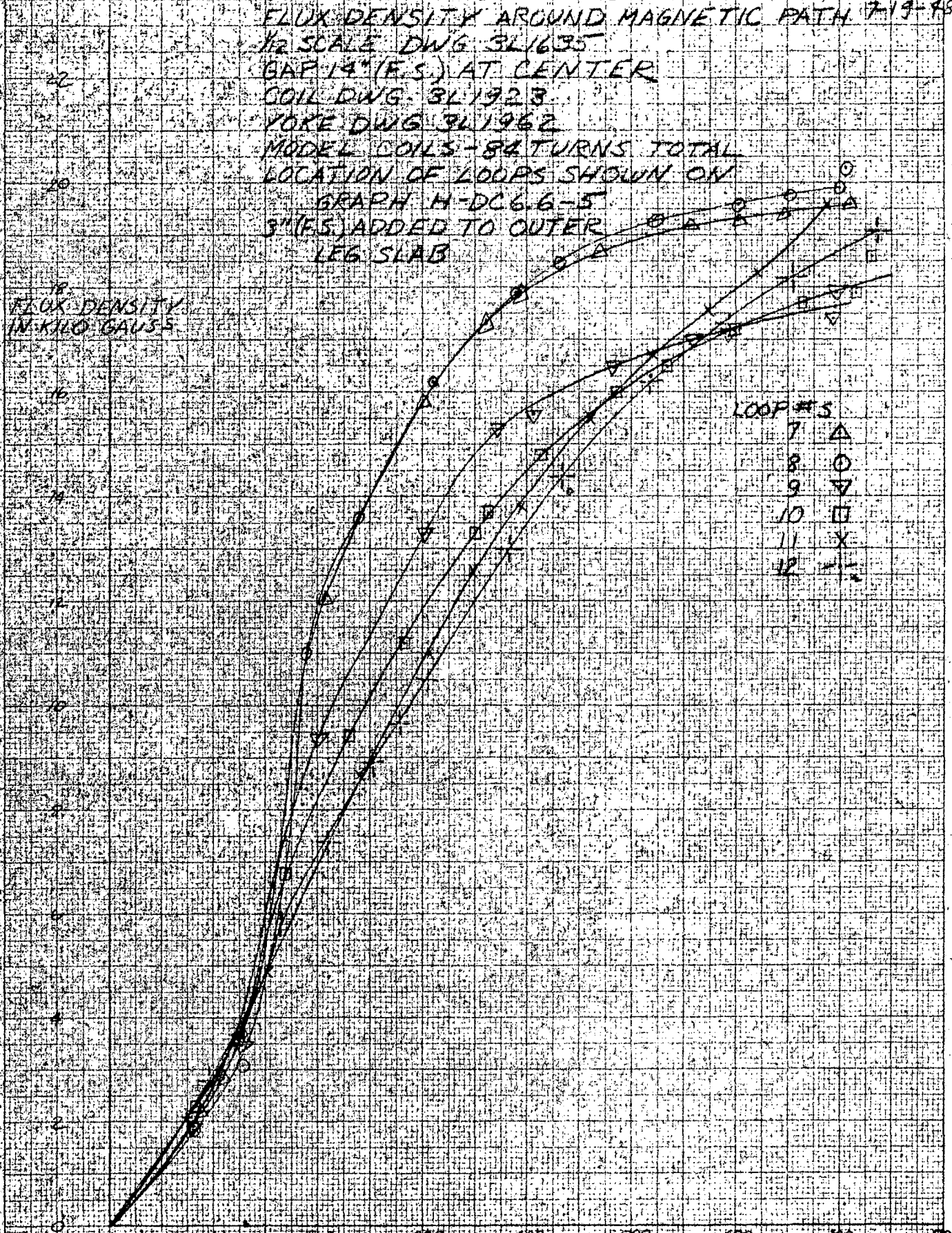
CYCLODROME MODEL MAGNET DC6.6  
FLUX DENSITY AROUND MAGNETIC PATH  
1/2 SCALE DWG 3L1635  
GAP 14" (F.S.) AT CENTER  
COIL DWG. 3L1923  
YOKE DWG 3L1962  
MODEL COILS - 84 TURNS TOTAL  
LOCATION OF LOOPS SHOWN ON  
GRAPH H-DC6.6-5  
5" (F.S.) ADDED TO OUTER  
LEG SLAB

171-8  
H-DC6.6-4  
7-19-48

FLUX DENSITY  
IN KILO GAUSS

LOOP #S

- 7 Δ
- 8 ○
- 9 ▽
- 10 □
- 11 X
- 12 +



MODEL CURRENT IN AMPERES

210

KODAK SAFETY FILM CO. No. 1635  
MILWAUKEE 8 mm. film developed by Eastman  
KODAK SAFETY FILM CO.

JULY 19, 1948

CYCLODROME MODEL MAGNET DC6.6  
LOCATION OF FLUX LOOPS  
1/2 SCALE DWG 3L1635

171-8  
H-DC6.6-5  
7-19-48

COIL DWG 3L1923

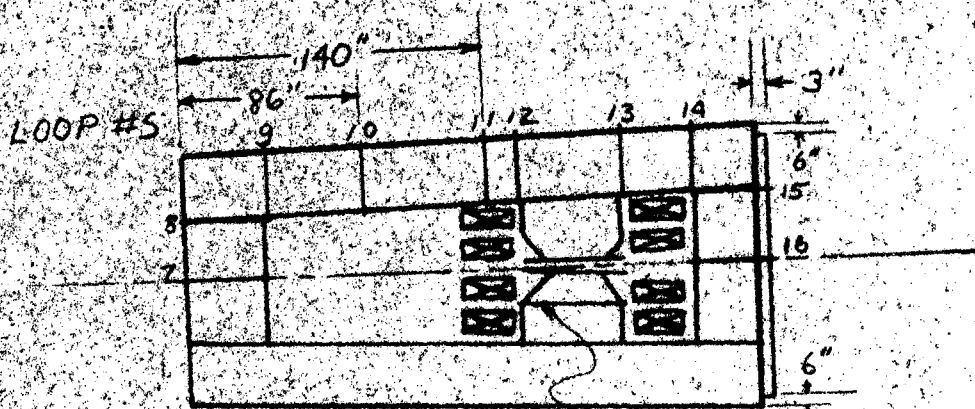
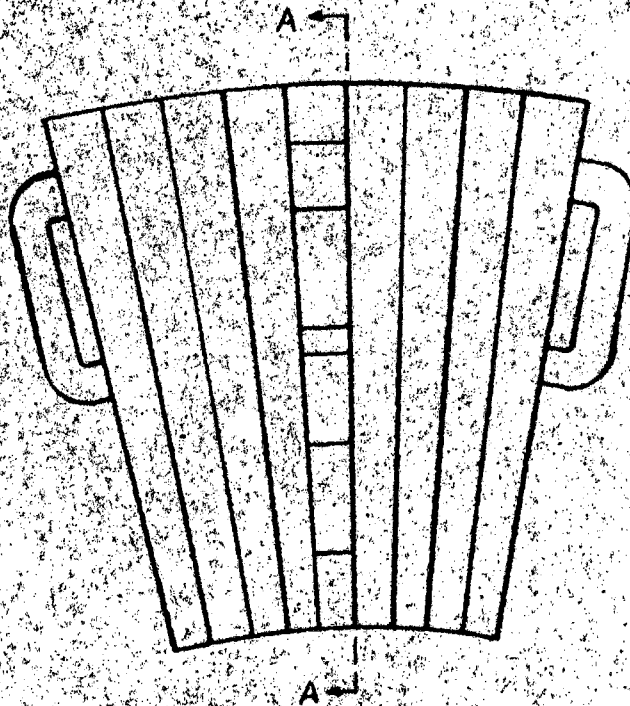
YOKE DWG 3L1962

84 TURNS TOTAL ON MODEL COILS

3" (F.S.) ADDED TO OUTER LEG SLAB

GAP 14" (F.S.) AT CENTER

SEE GRAPHS H-DC6.6-2 H-DC6.6-3 H-DC6.6-4



CROSS SECTION AT AA

EWC

171-8

DOC 6.076

7-19-48

CYCLADROME MODEL MAGNET DC 6.6

JULY 1948

MAGNETIZATION

1/2 SCALE DWG 31 1635

100

GAP 1/4" (FULL SCALE) AT CENTER

MODEL COILS 91 TURNS TOTAL

20% DWG 34 1923

Yoke DWG 34 1962

3" (F.S.) ADDED TO OUTER LEG SLAB

FLUX DENSITY  
IN GAUSS

300

200

100

0

MODEL CURRENT IN AMPERES

0

1

2

3

4

5

6

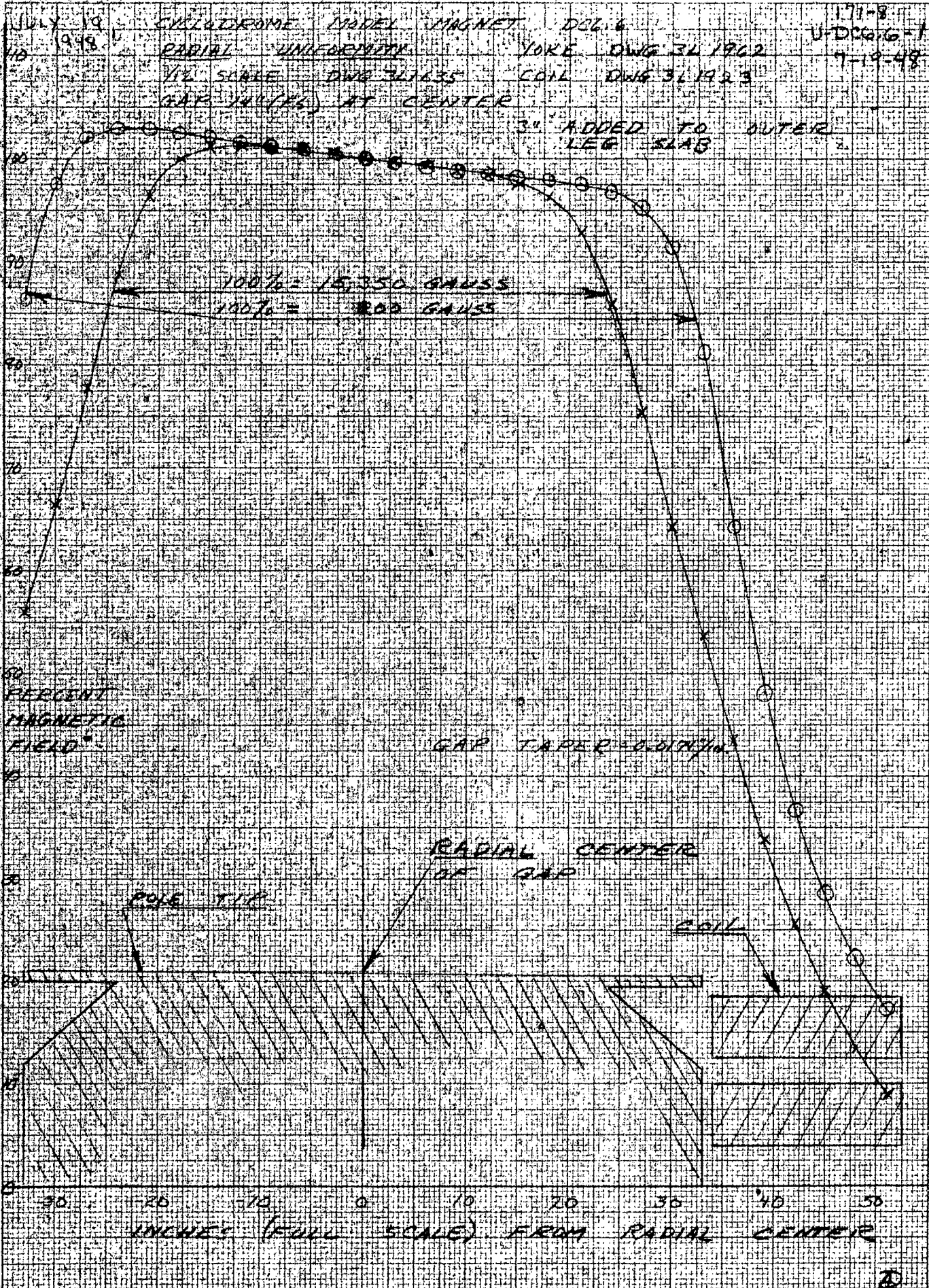
7

8

9

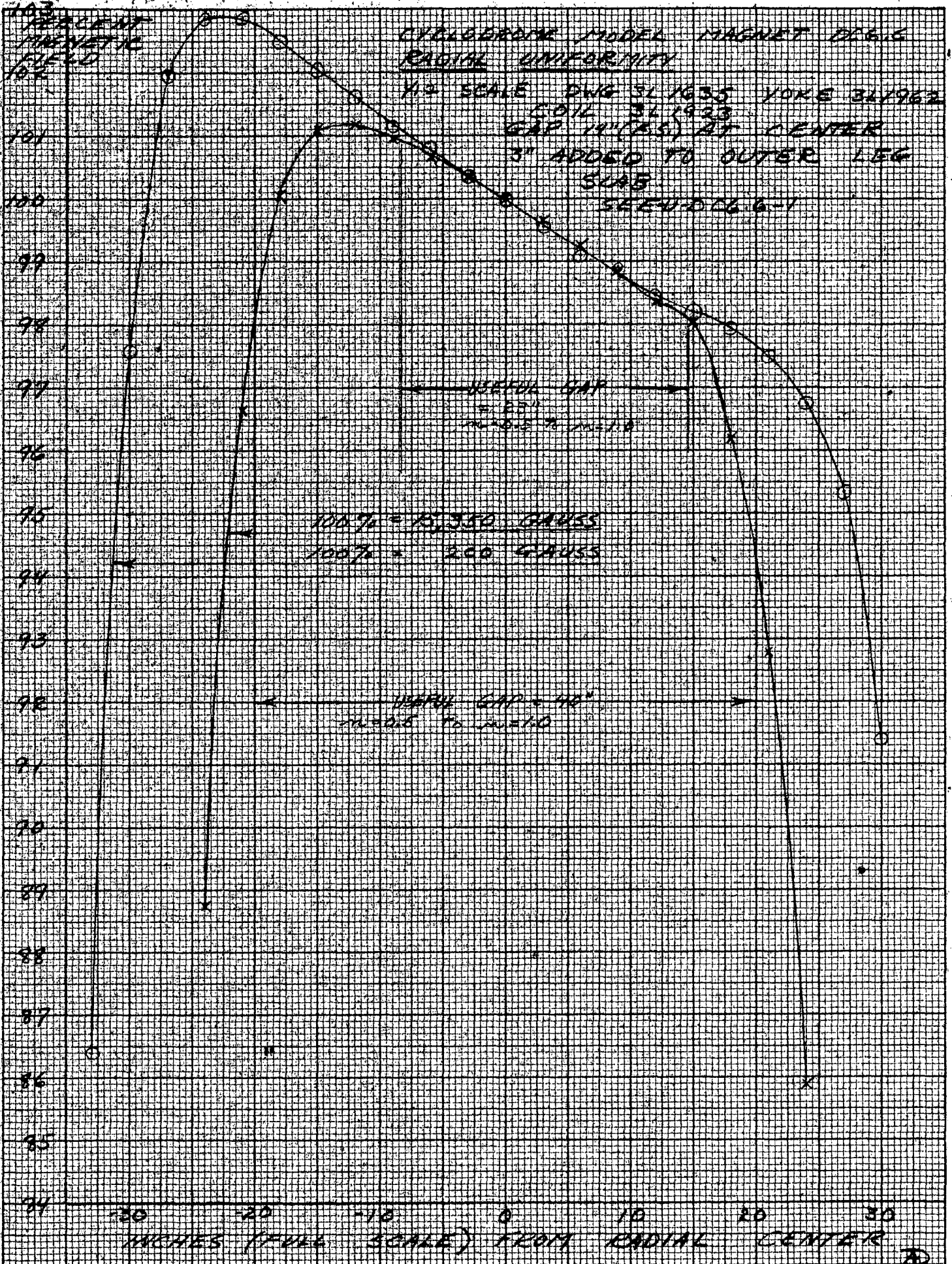
EUGENE DIETZGEN CO  
PRINTED IN U.S.A.

NO. 34620 DIETZGEN GRAPH PAPER  
20 x 30 PER INCH



GEORGE B. LESTER CO., INC. NO. 380-146  
 1000 W. 10th St., Lincoln, Nebraska

171-8  
U-DCG.6-10  
7-19-48



KEUFFEL & ESSER CO., N. Y. - NO. 3597-10  
18 X 10 to the 1/4 inch; 5th lines counted.  
Engraving 7/8" X 10 in.  
MADE IN U.S.A.

JULY 15, 1948

CYCLODROME MODEL MAGNET DC 6.7 171-8  
MAGNETIZATION IN CENTER OF GAP H-DC 6.7-1  
1/2 SCALE DWG 3116.35 7-15-48  
COIL DWG 3119.23  
MODEL COILS: 4 COILS 21 TURNS EACH  
84 TURNS TOTAL  
GAP 14" (F.S.) AT CENTER  
6" (F.S.) ADDED TO LEG SLAB ON WIDE SIDE  
YORE DWG 3119.62

FLUX DENSITY  
IN KILOG. GAUSS

18

16

14

12

10

8

6

4

2

0

100% EFF. LINE

70.16% EFF.  
AT 16 KILO GAUSS

AMPERE TURNS (E.S.) X 10<sup>5</sup>

MODEL CURRENT IN AMPERES

0

100

200

300

400

500

600

700

800

FWC

KEUFFEL & ESSER CO. N. Y. NO. 5434-100  
3 1/2" x 5 1/2" 5 mil. film engraved, chemically etched  
MAY 19 1948



JULY 15, 1948

CYCLOTRONE MODEL MAGNET DC6.8  
MAGNETIZATION IN CENTER OF GAP

171-B  
H-DC6.8-1  
7-15-48

1/2 SCALE DWG 3L1635  
COIL DWG 3L1823  
MODEL COILS: 4 COILS, 21 TURNS EACH  
84 TURNS TOTAL  
GAP 14 (F.S.) IN CENTER  
YOKE DWG 3L1962  
6" (F.S.) ADDED TO LEG SLAB ON WIDE  
GAP SIDE  
8" (F.S.) ADDED TO LEG SLAB ON NARROW  
GAP SIDE

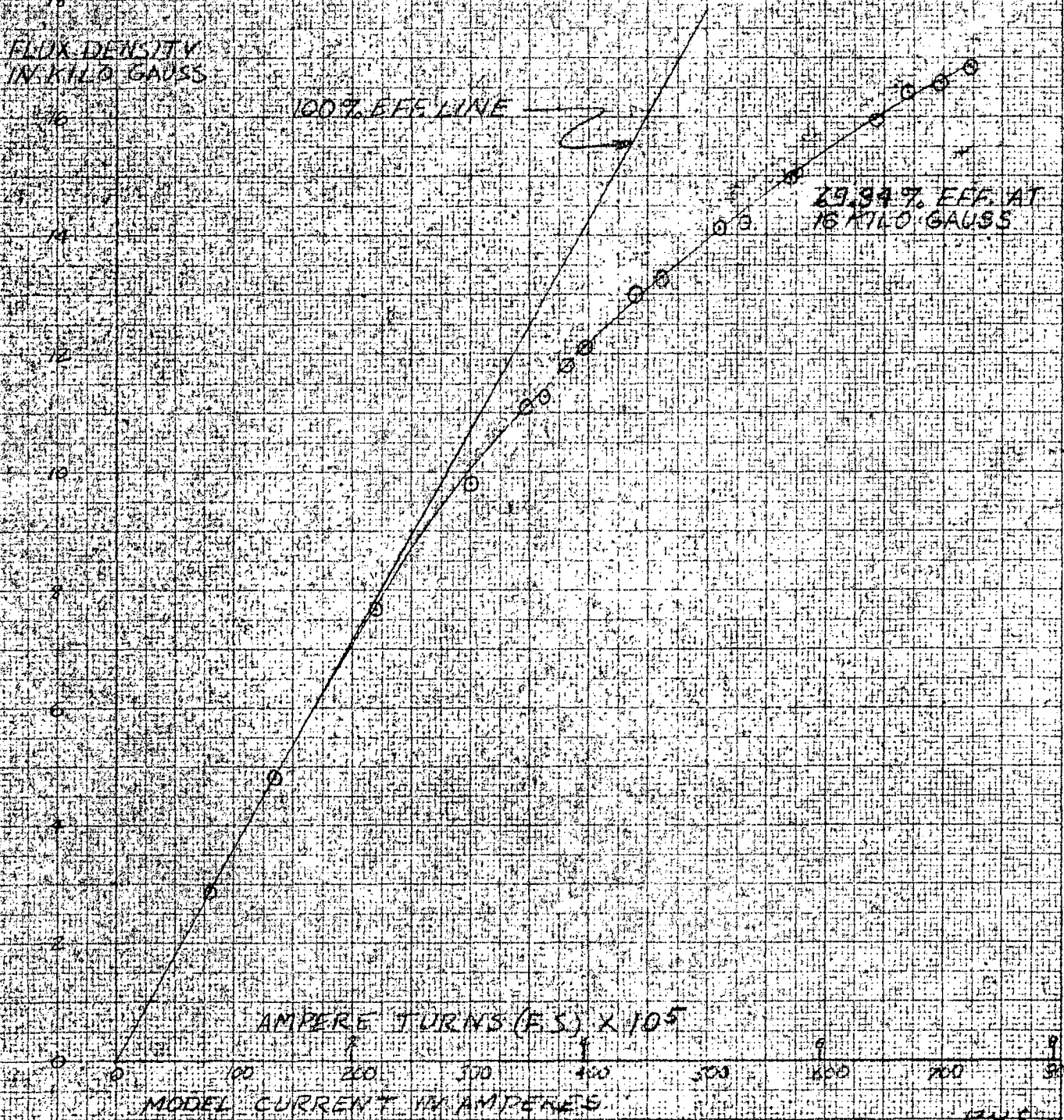
FLUX DENSITY  
IN KILO GAUSS

100% EFF. LINE

29.94% EFF. AT  
16 KILO GAUSS

AMPERE TURNS (F.S.) X 10<sup>5</sup>

MODEL CURRENT IN AMPERES



KEUFEL & ESSER CO. INC. NO. 555-10  
MILWAUKEE 2, WIS. PHONE 2-2111

JULY 15, 1949

CYCLOTRONE MODEL MAGNET DCG.9

171-8

MAGNETIZATION IN CENTER OF GAP

H-DC6.9-1

1/2 SCALE DWG 3L1635

7-15-48

COIL DWG 3L1923

MODEL COILS 2 COILS 21 TURNS EACH

84 TURNS TOTAL

GAP 14" (F.S.) AT CENTER

YOKE DWG 3L1962

3" (F.S.) ADDED TO EACH LEG SLAB

FLUX DENSITY  
IN KILO GAUSS

100% EFF. LINE

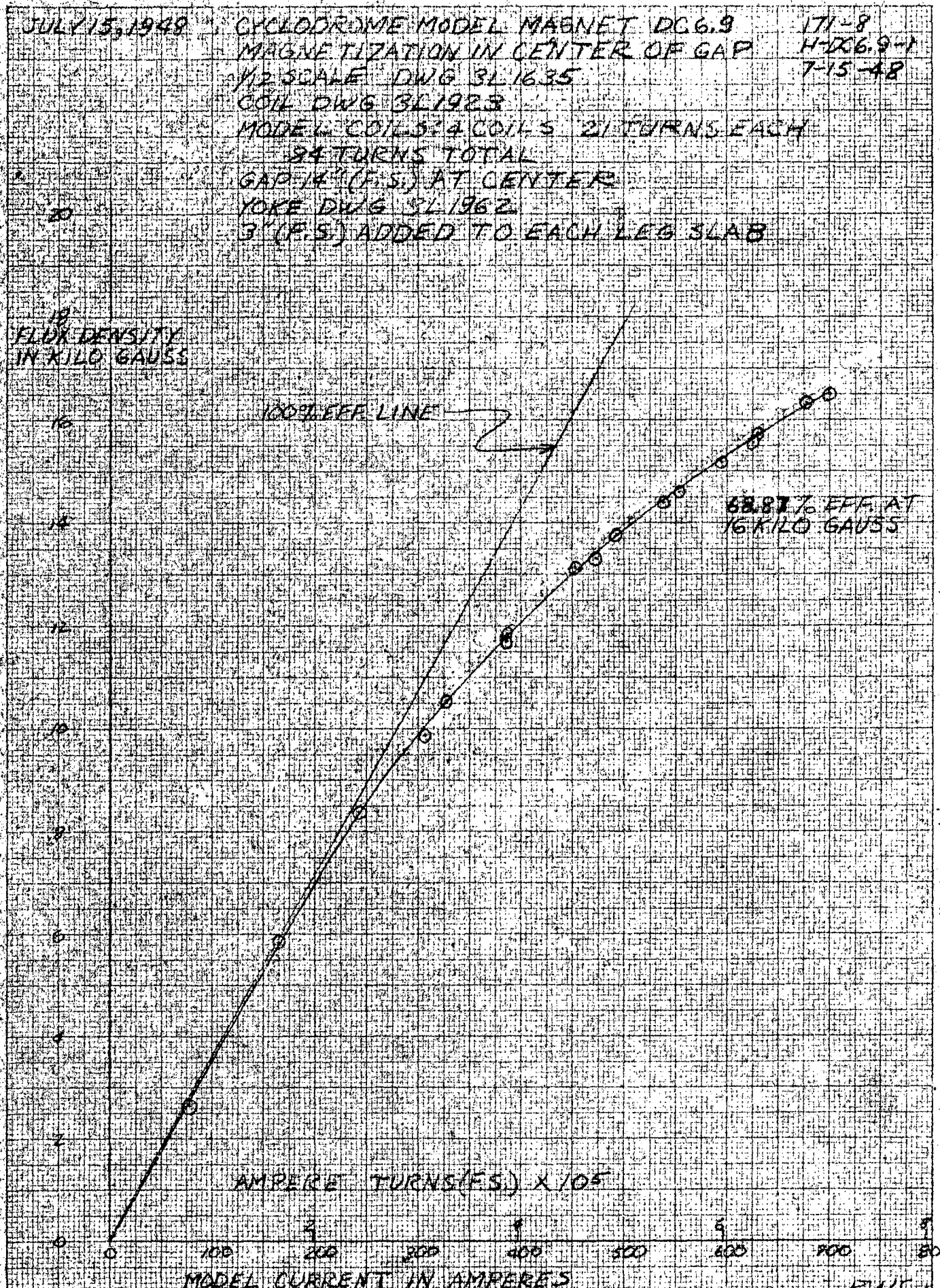
68.8% EFF. AT  
16 KILO GAUSS

AMPERE TURNS (F.S.) X 10<sup>5</sup>

MODEL CURRENT IN AMPERES

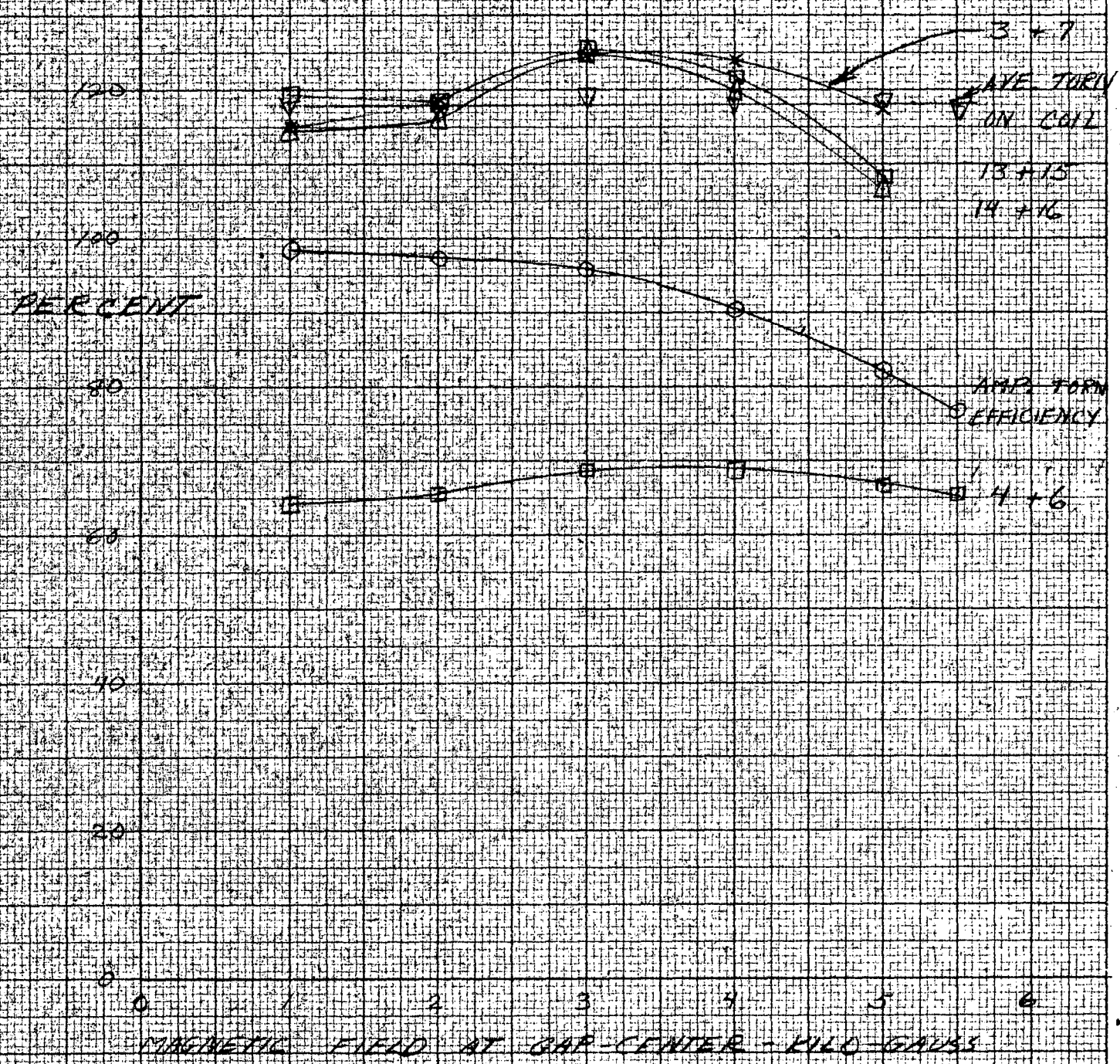
ENC

STUFFEL'S ESSEX CO. N.Y. INC. 355 W 46  
STREET NEW YORK 18 N.Y. U.S.A.



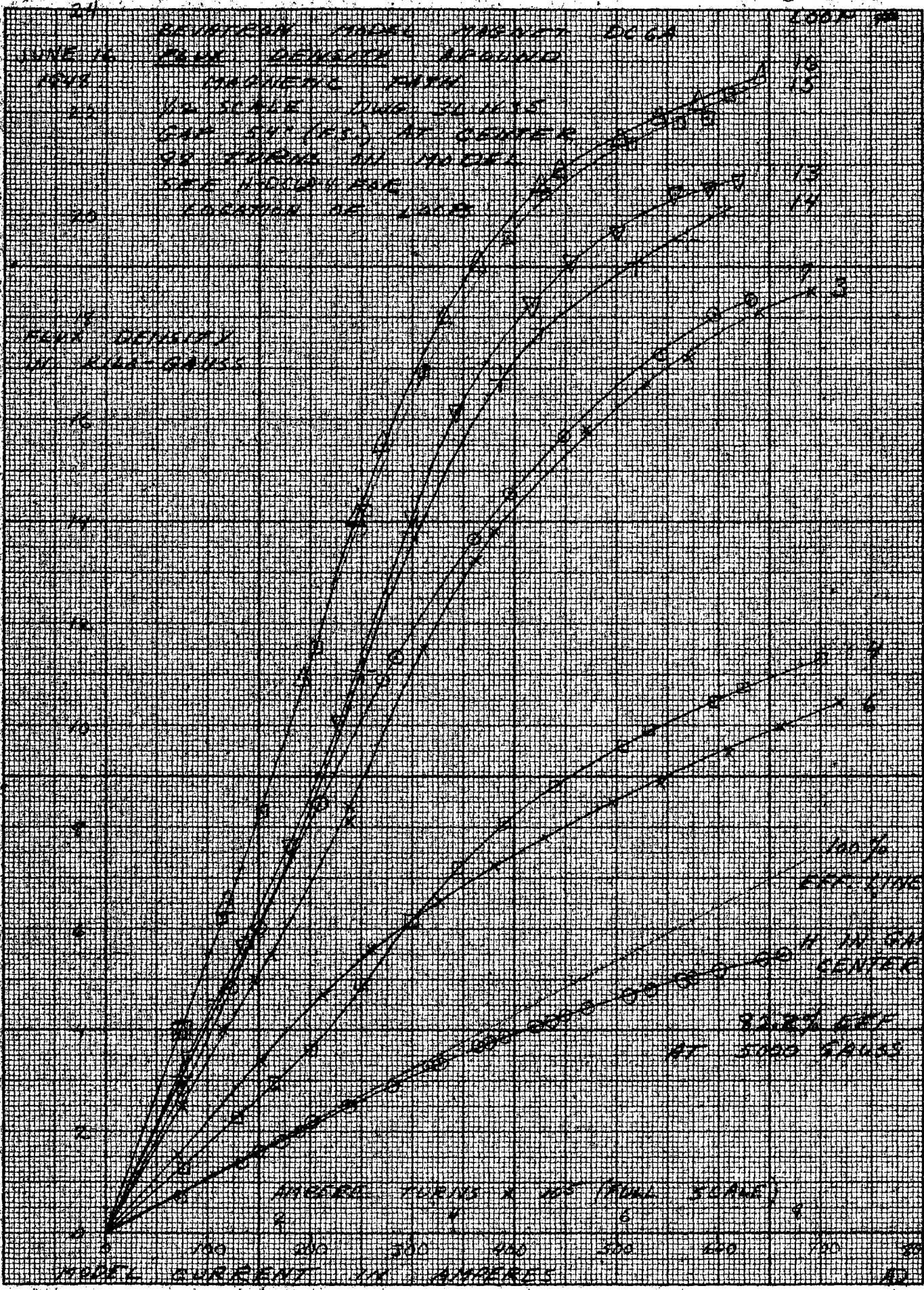
BEVATRON MODEL MAGNET DCWA  
 JUNE 21, 1945 EFFICIENCY & LEAKAGE COEFFICIENTS

1/2 SCALE DWG 311635  
 $\frac{1}{10} \text{ LEAK COEFF} = \frac{\text{TOTAL FLUX} \times 100}{\text{FLUX DENSITY AT CENTER} \times \text{POLE AREA}}$   
 POLE AREA BASED ON 14 FOOT WIDTH  
 $\frac{1}{10} \text{ EFF} = \frac{\text{FLUX DENSITY AT CENTER} \times \text{GAP HEIGHT (IN.)}}{\text{TOTAL AMPERE TURNS}}$   
 SET H-DCWA-4 FOR LOOP LOCATIONS



ENGINEER, GEORGE CO. N. Y. NO. 5997-156  
 IN ACC. TO THE 1/4 INCH 5th LINE ANNOTATED.  
 GENERATING 7/4 X 10 IN.  
 MADE IN U.S.A.

171-8  
H-DCLA-1  
6-16-48

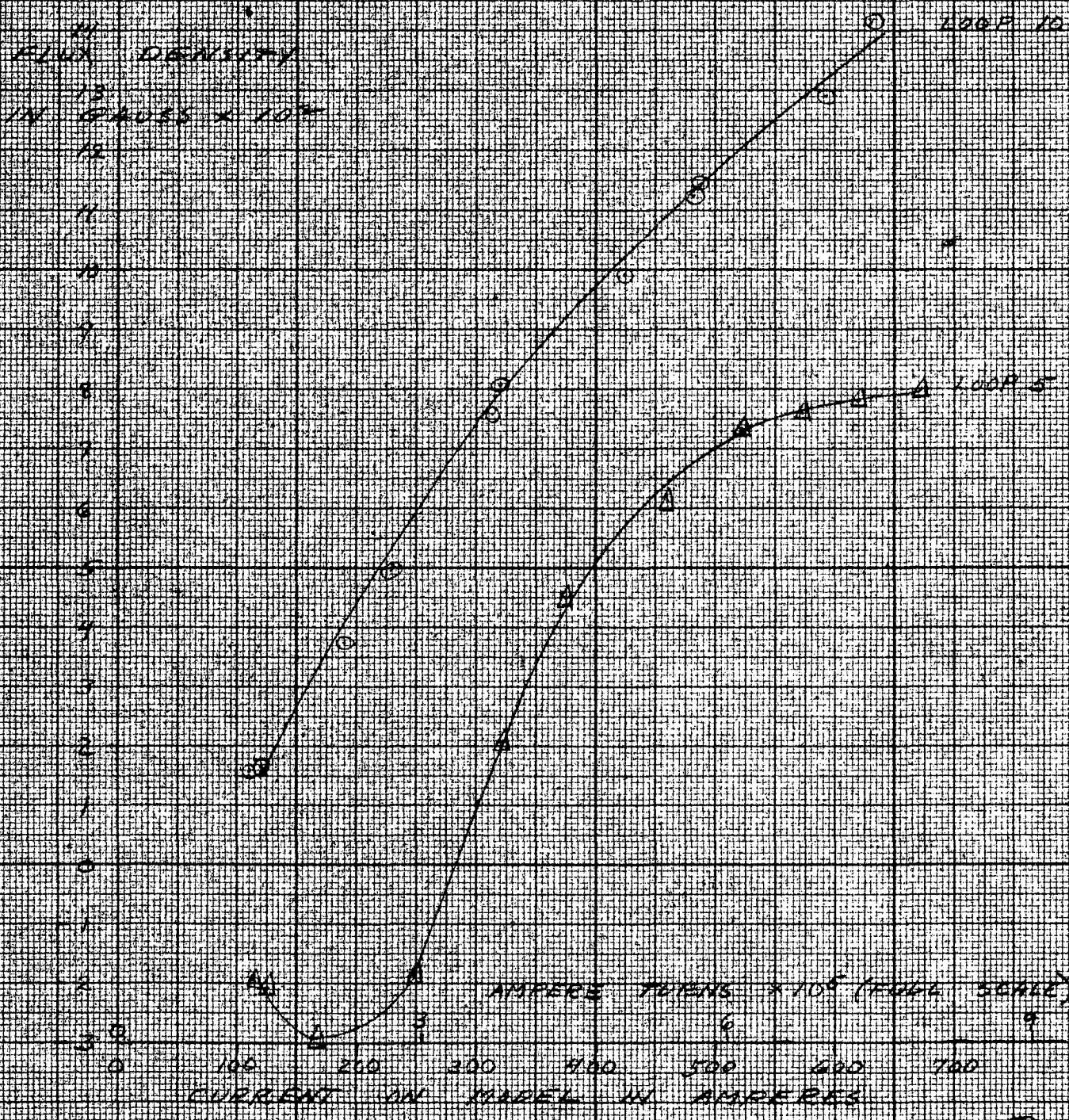


NO. 340 M DIETZGEN GRAPH PAPER  
EUGENE DIETZGEN CO.  
MILLIMETER

NO. 340 M DIEZIGEN GRAPH PAPER  
EUGENE DIEZIGEN CO.  
MILLIMETER

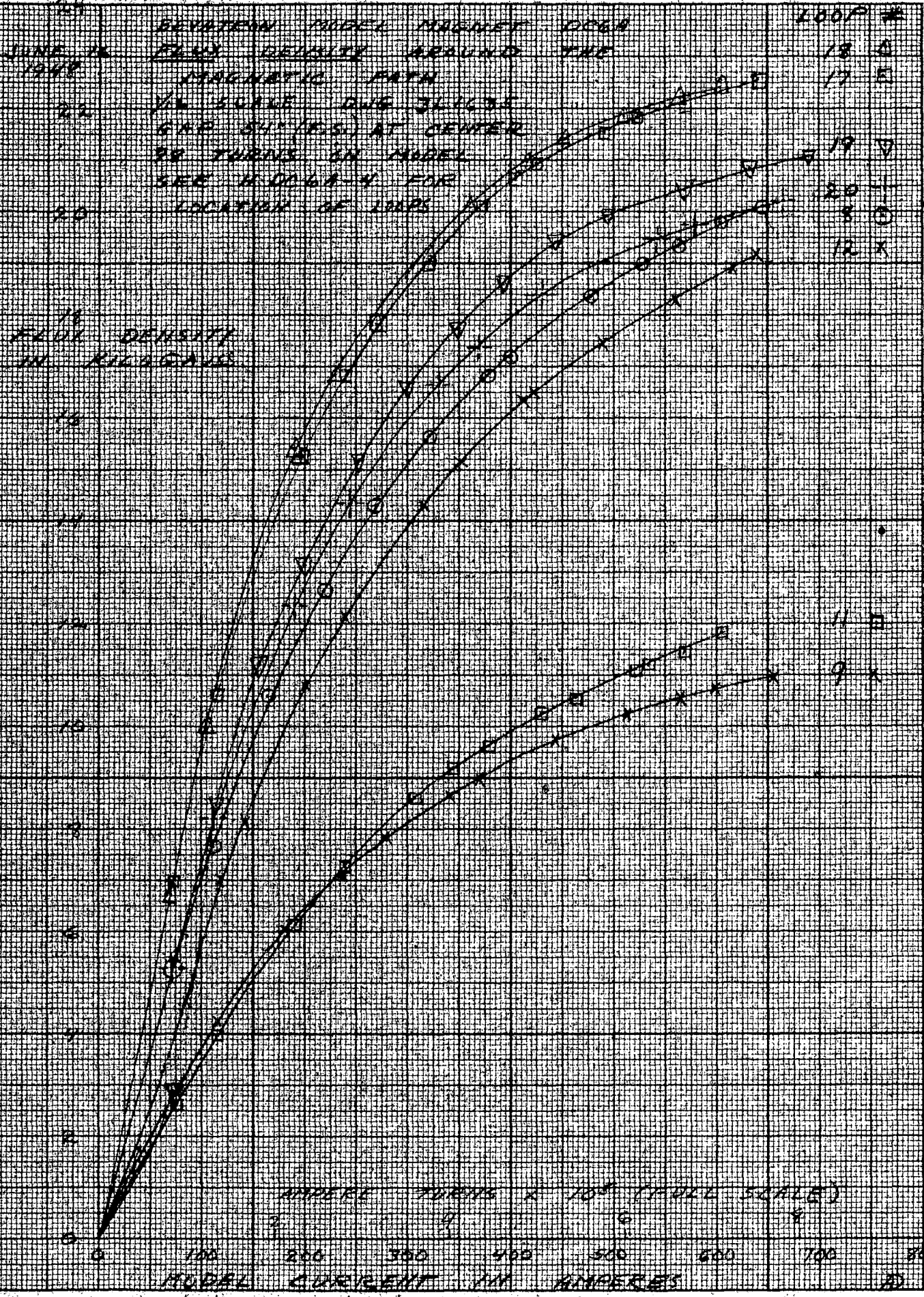
BEHAVIOR MODEL MAGNET CORE  
JUNE 10, 48 FLUX DENSITY AROUND THE  
MAGNETIC TOOTH  
IN SCALE ONE IN 1635  
GAP 54 (G.S.) AT CENTER  
98 TURNS ON MODEL COILS  
SEE W-DC-64-4 FOR LOCATION  
OF THE LOOPS  
POSITIVE H-POLARITY IS SAME  
AS LOOP 4 SEE W-DC-64-1

1711-9  
W-DC-64-2  
6-16-49



①

171-8  
H-DC6A-3  
6-16-48



NO. 340 - M. DIETZGEN GRAPH PAPER  
EUGENE DIETZGEN CO.  
MILLIMETER  
PRINTED IN U.S.A.

JUNE 16, 1949

BEVATRON MODEL MAGNET DC6A  
FLUX DENSITY AROUND THE  
MAGNETIC PATH

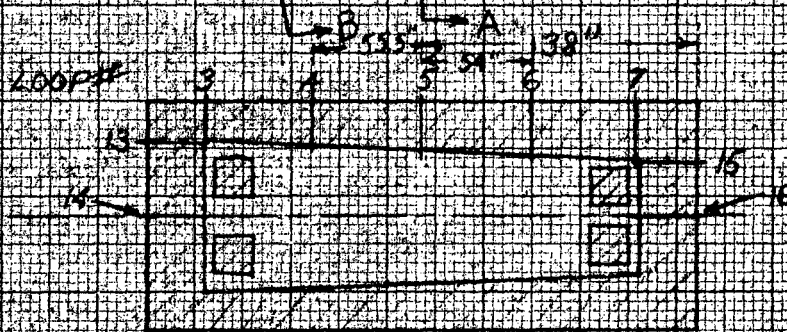
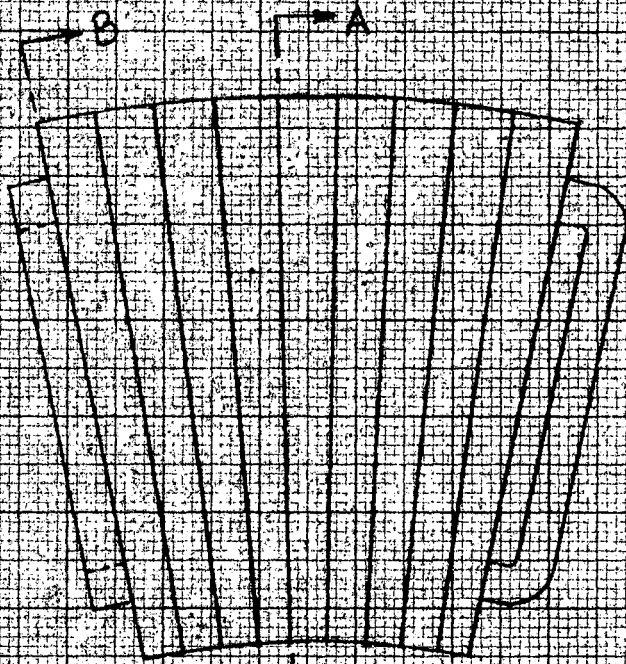
171-9  
H-DC6A-4  
6-16-49

1/2 SCALE DWG 3L1635

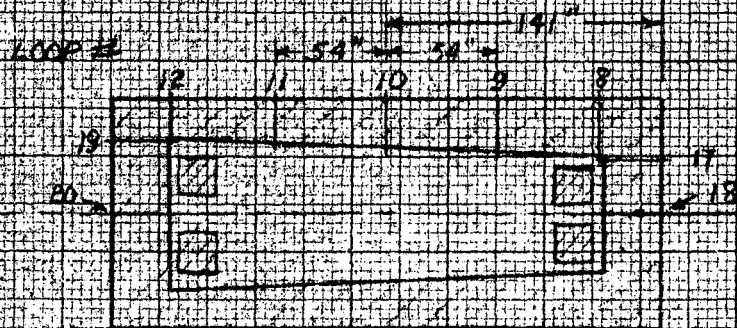
GAP 54" (F.S.) AT CENTER

LOCATION OF FLUX LOOPS

SEE GRAPHS H-DC6A-1  
H-DC6A-2  
H-DC6A-3



CROSS SECTION AT AA



CROSS SECTION AT BB

SCURRY & ESSER CO. N. Y. NO. 359-L10  
10 X 10 to 100 X 100 inch 3th line enameled  
Engraving 2 X 10" min.  
MADE IN U.S.A.

VENTURON MODEL CURRENT DATA  
 DATE 17 APR 1942  
 MAGNETIZATION AT CENTER OF GAP  
 IN GAUGE COIL 301625  
 GAP 60 (1/2) AT CENTER  
 92 TURNS IN MODEL COILS

FLUX DENSITY  
 IN GAUSS

400

300

200

100

0

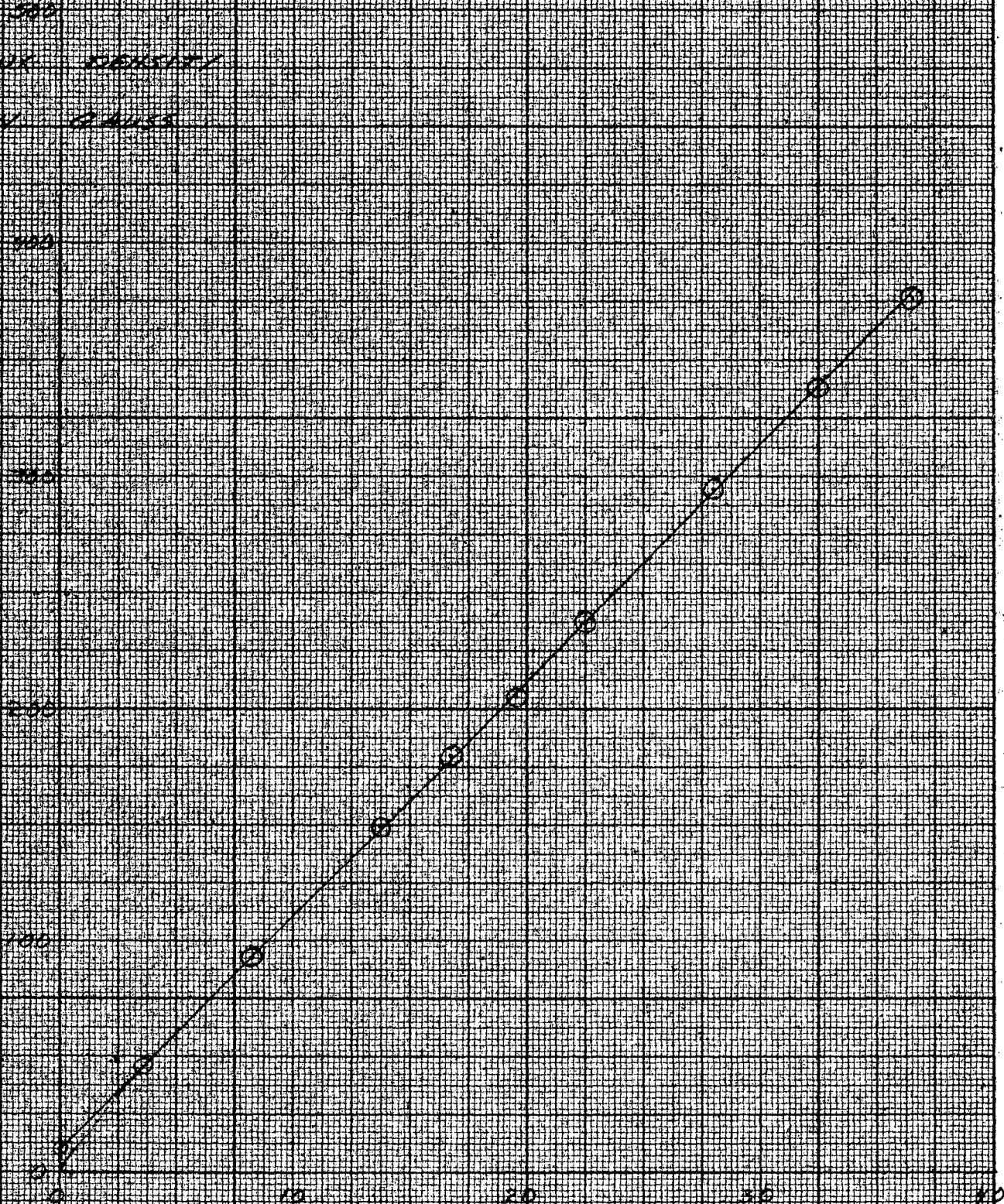
10

20

30

40

CURRENT ON MODEL IN AMPERES

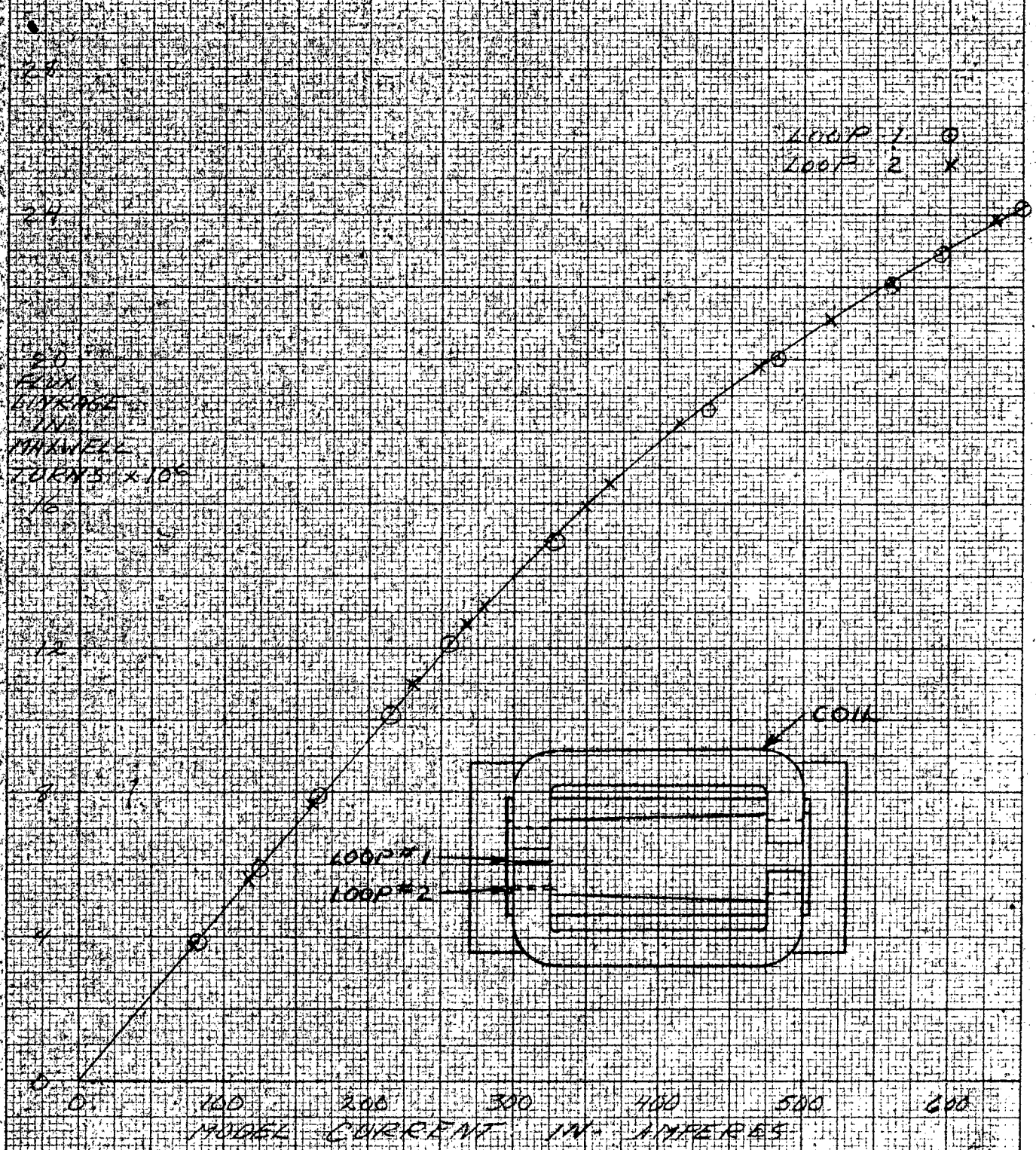


EUGENE DIETZGEN CO.  
 PRINTED IN U.S.A.

NO. 3403-M DIETZGEN GRAPH PAPER  
 MILLIMETER



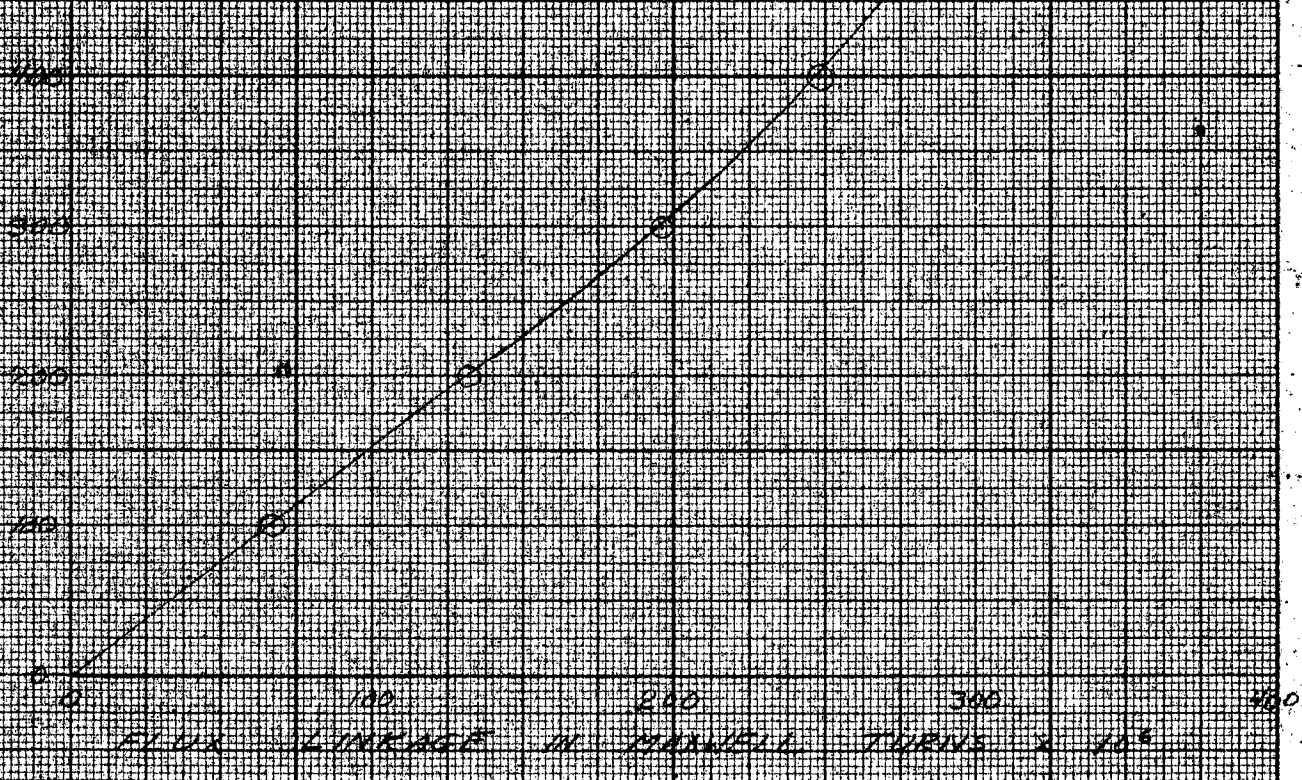
BEVATRON MODEL MAGNET DCCG 171-7  
 JUNE 1948 COIL FLUX LINKAGE F DCCG-1  
 1/4 SCALE DING 311635 6-14-48  
 GAP 54 INCHES (FULL SCALE)  
 MODEL COILS 2 COILS 49 TURNS  
 EACH = 98 TURNS TOTAL  
 EACH LOOP HAS 7 TURNS  
 FLUX LINKAGE IS ON 7.433° SECTION OF MODEL



KEUFFEL & ESSER CO., N. Y., NO. 885-70  
 10 X 10 (6) 1/2 Inch 5th Line Assorted  
 Engraving 7 X 10 1/2  
 MADE IN U.S.A.

DEUTERON PAIRED MAGNET MODEL 191-4  
 TOTAL COIL FLUX LINKAGE F-1000-10  
 1/2 SCALE DWG 32-1635 6-14-48  
 GAP 3/4 INCHES (FULL SCALE)  
 AT CENTER  
 MODEL COILS: 2 COILS 49 TURNS  
 EACH = 98 TURNS TOTAL  
 SEE GRAPH (E-1000-1)  
 TOTAL LINKAGE = 14 x AREA OF LOOP 1 & 2  
 LOOP 1 & 2 EACH HAS 9 TURNS  
 FLUX LINKAGE IS ON 7433° SECTION OF MODEL

400  
 300  
 200  
 100  
 0  
 CURRENT  
 IN AMPS



NO. 340. M. DIETZGEN GRAPH PAPER  
 EUGENE DIETZGEN CO.  
 PRINTED IN U.S.A.  
 MILLIMETER

JULY 24, 1948

CYCLOTRONE MODEL MAGNET DC6A

171-E

1/2 SCALE - DWG 3L1635

E-DC6A-1

STORED ENERGY ON MODEL

7-14-48

CALCULATED FROM TOTAL COIL

CORRECTED

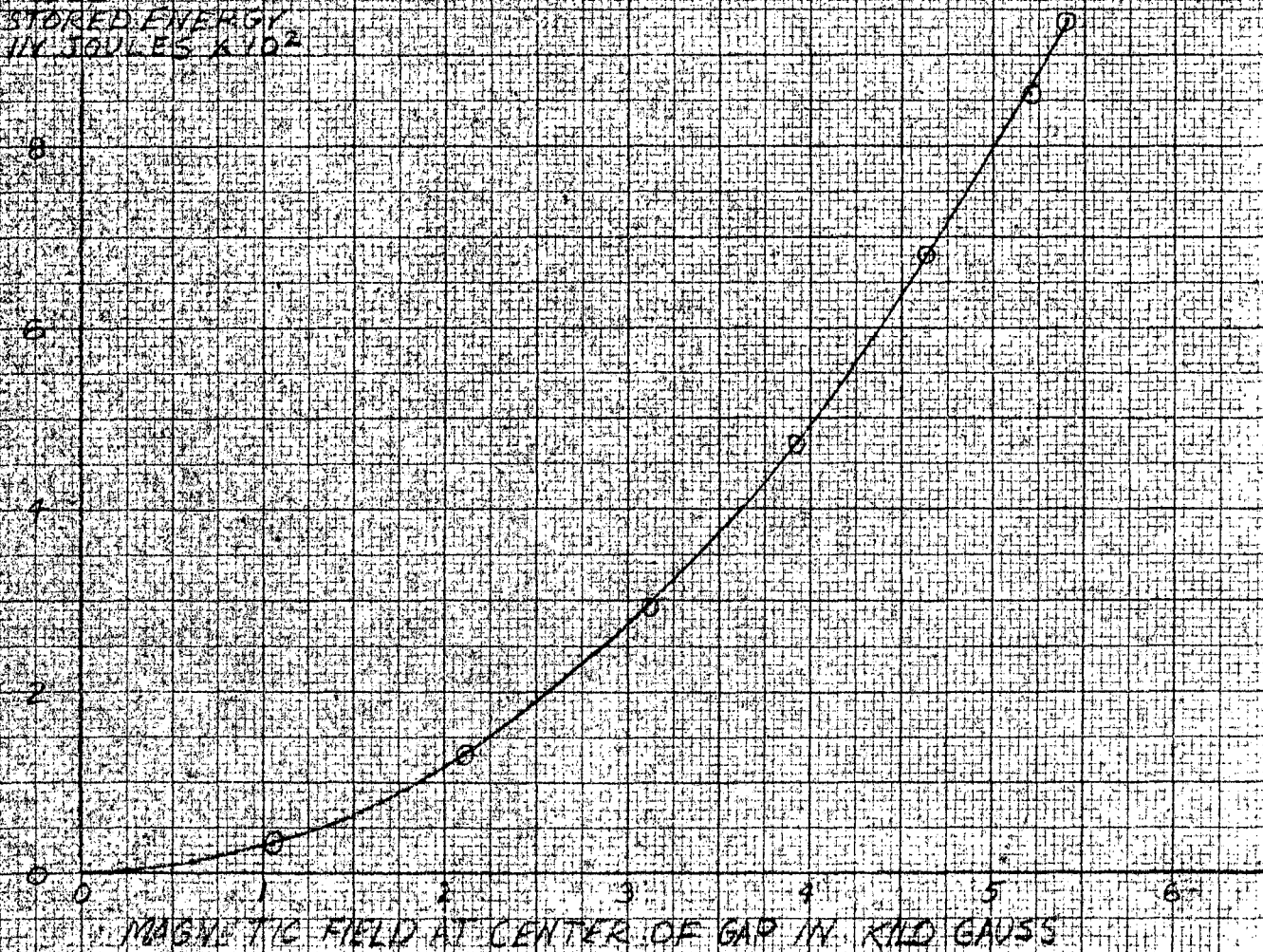
FLUX LINKAGE  $\Phi$  DC6A-1

ENERGY (JOULES) =  $10^{-8} \Phi^2 / \mu$

WHERE  $I$  IS IN AMPERES AND

$\Phi$  IS IN MAXWELL TURNS  
DATA IS FOR A 7.433° SECTION ON MODEL

10  
MODEL  
STORED ENERGY  
IN JOULES  $\times 10^2$



MAGNETIC FIELD AT CENTER OF GAP IN KILD GAUSS

LWC

KAUFER & ESSER, CO. N. Y. NO. 259-110  
16 X 19 to the 1/2 inch mesh, 5th Street Building  
Engraving X 10 mm  
MADE IN U.S.A.

JULY 2, 1948

CYCLOTRONE MODEL MAGNET DCGA-1  
MAGNETIZATION IN GAP CENTER  
1/2 SCALE DWG 317035  
GAP 54° (2) AT CENTER  
MODEL COILS 98 TURNS TOTAL  
COIL DIMS 31.70x50.00

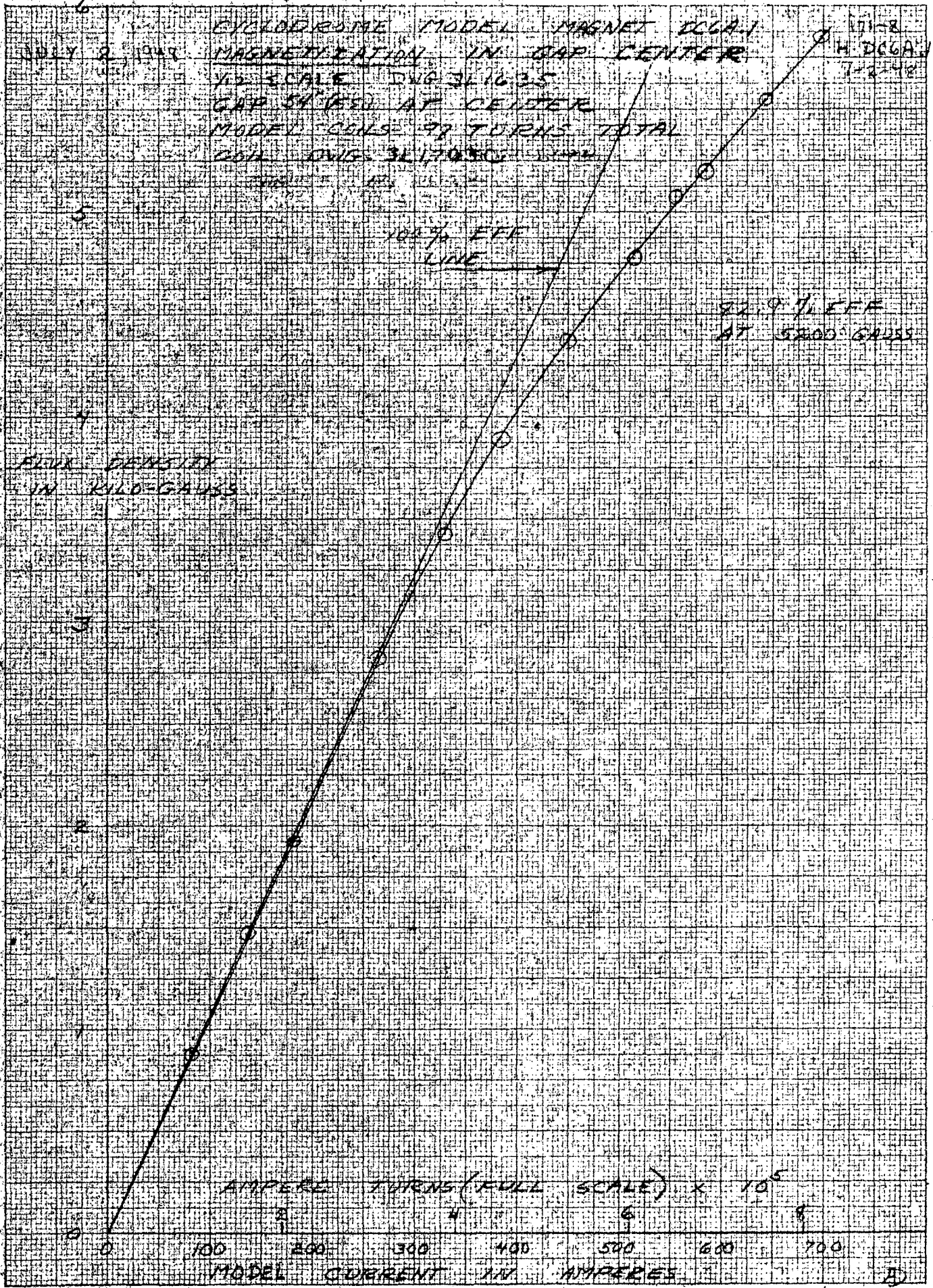
171-2  
H DCGA-1  
7-2-48

FLUX DENSITY  
IN KILO-GAUSS

104% EFF  
LINE

82.9% EFF  
AT 5200 GAUSS

AMPERE TURNS (FULL SCALE) x 10<sup>5</sup>  
0 100 200 300 400 500 600 700  
MODEL CURRENT IN AMPERES



KODAK SAFETY FILM CO. MADE IN U.S.A.

JULY 8, 1948

CYCLODROME MODEL MRSNET DOGAI  
RADIAL UNIFORMITY  
1/2 SCALE DWG 341635  
GAP 84 AT CENTER (E.S.)  
COIL DWG 341703

171-B  
U-DOGAI-1  
7-8-48

110

100

90

80

70

60

50

40

30

20

10

0

0

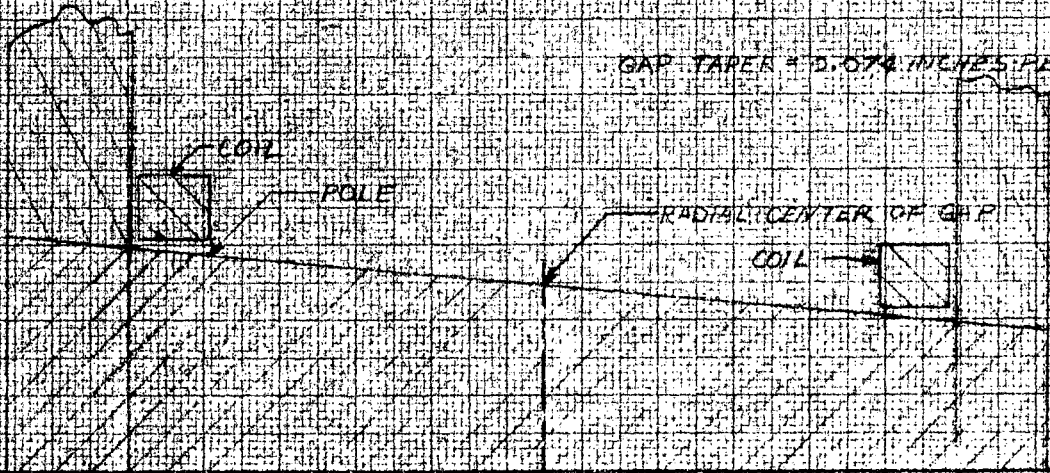
0

PERCENT  
MAGNETIC  
FIELD

100% = 5000 GAUSS

MEASUREMENTS TAKEN ON MEDIUM  
PLANE OF GAP

GAP TAPER = 0.074 INCHES PER INCH

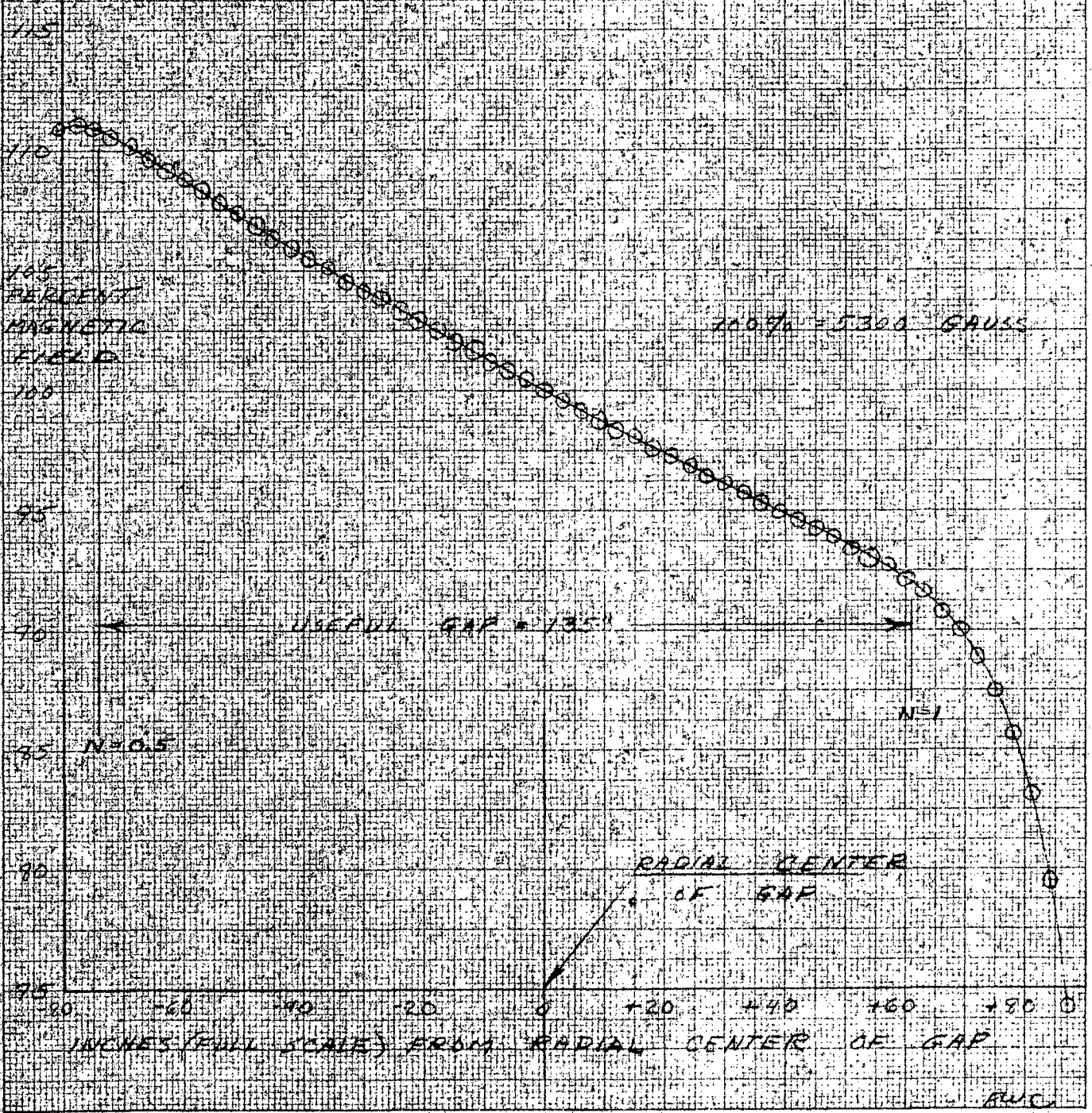


120 100 80 60 40 20 0 20 40 60 80 100 120  
INCHES FULL SCALE FROM RADIAL CENTER

EWG

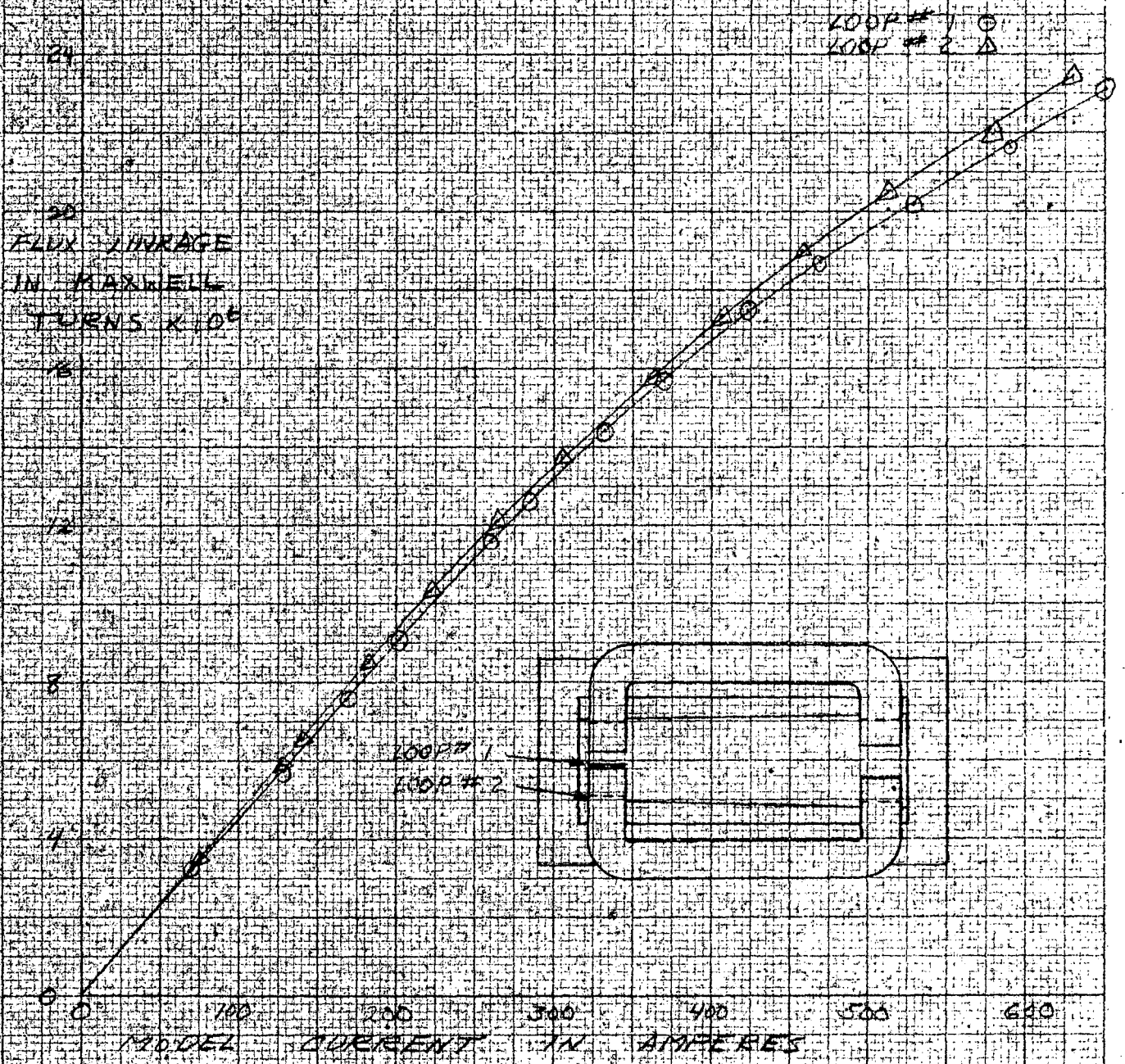
KEUFFEL & ESSER CO., N.Y. NO. 250-146  
Millimeters & Inch lines available, gap lines 1 inch  
MADE IN U.S.A.

JULY 3 CYCLOTRONE MODEL MAGNET DC6A-1 171-8  
 1948 RADIAL UNIFORMITY U-DC6A-1-12  
 1/2 SCALE DWG 317035 11-8-44  
 GAP 54 (1/2") AT CENTER  
 SEE CURVE U-DC6A-1  
 COIL DWG 317035



KAUFERT & ESSER CO. N. Y. NO. 389-148  
 Manufacturers of mm. lines accepted, only lines heavy  
 MADE IN U. S. A.

CYCLOTRONE MODEL MAGNET  
 COIL FLUX LINKAGE  
 1/2 SCALE DWG 311035  
 GAP 3/4" (FULL SCALE) AT CENTER  
 MODEL COILS 2 COILS 49 TURNS  
 EACH 28 TURNS TOTAL  
 EACH LOOP HAS 7 TURNS  
 FLUX LINKAGE IS ON 7.433" SECTION  
 OF MODEL  
 COIL DWG 3117030



KEUFFEL & ESSER CO., N.Y.C. 40, 50th St.  
 Eng'g. & Drafting  
 1945

CYCLOTRONE MODEL MAGNET (26A)

171-2

JULY 3, 1948 TOTAL COIL FLUX LINKAGE

E. DUBOIS

1/2 SCALE DWG 311635

7-8-48

2 1/2" DIA (FULL SCALE) AT CENTER

MODEL COILS - 2 COILS 49 TURNS

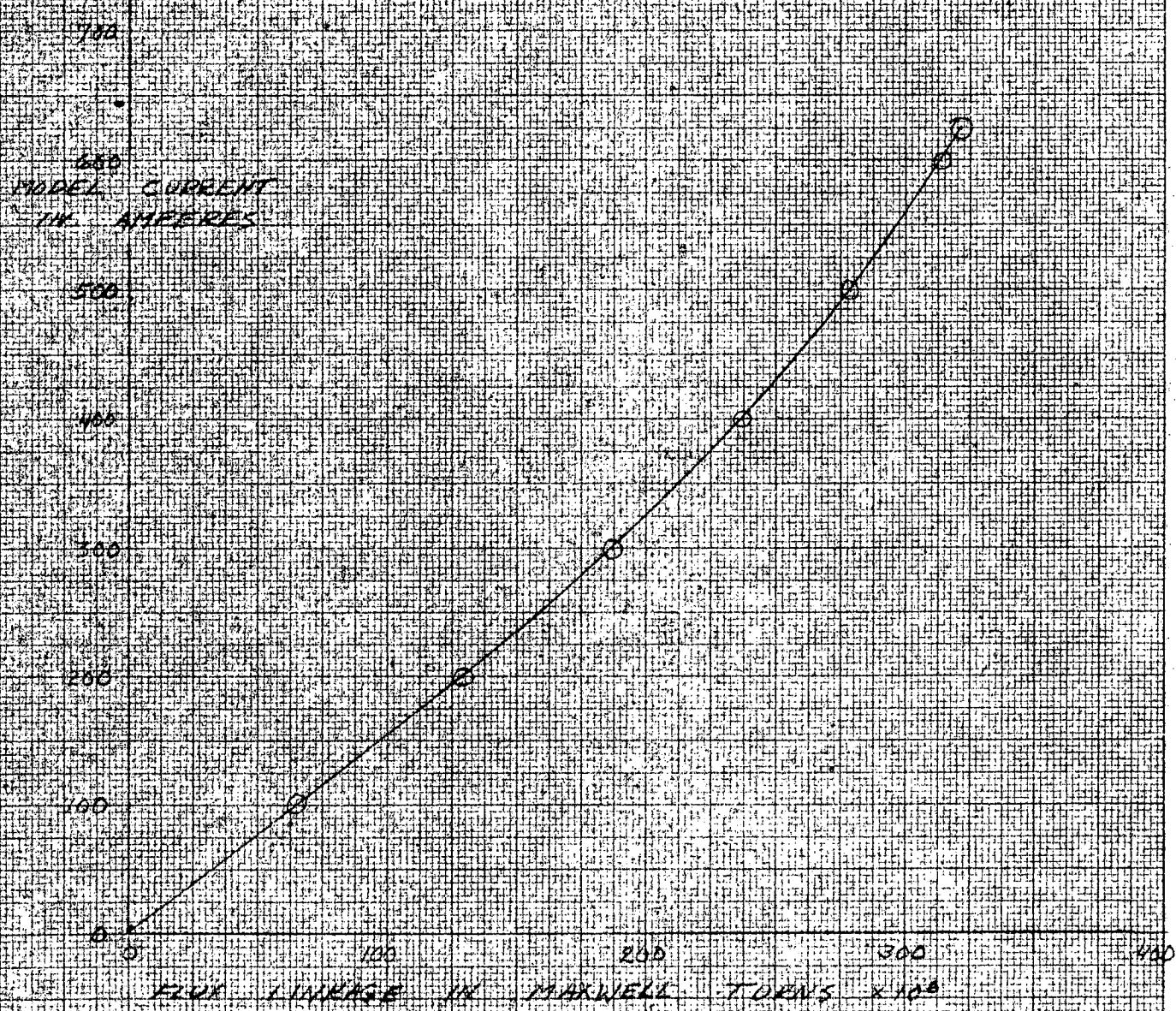
EACH - 99 TURNS TOTAL

SEE GRAPH F-DCWA-1-1

FLUX LINKAGE IS ON 7.933°

SECTION OF MODEL

COIL DWG 311703A

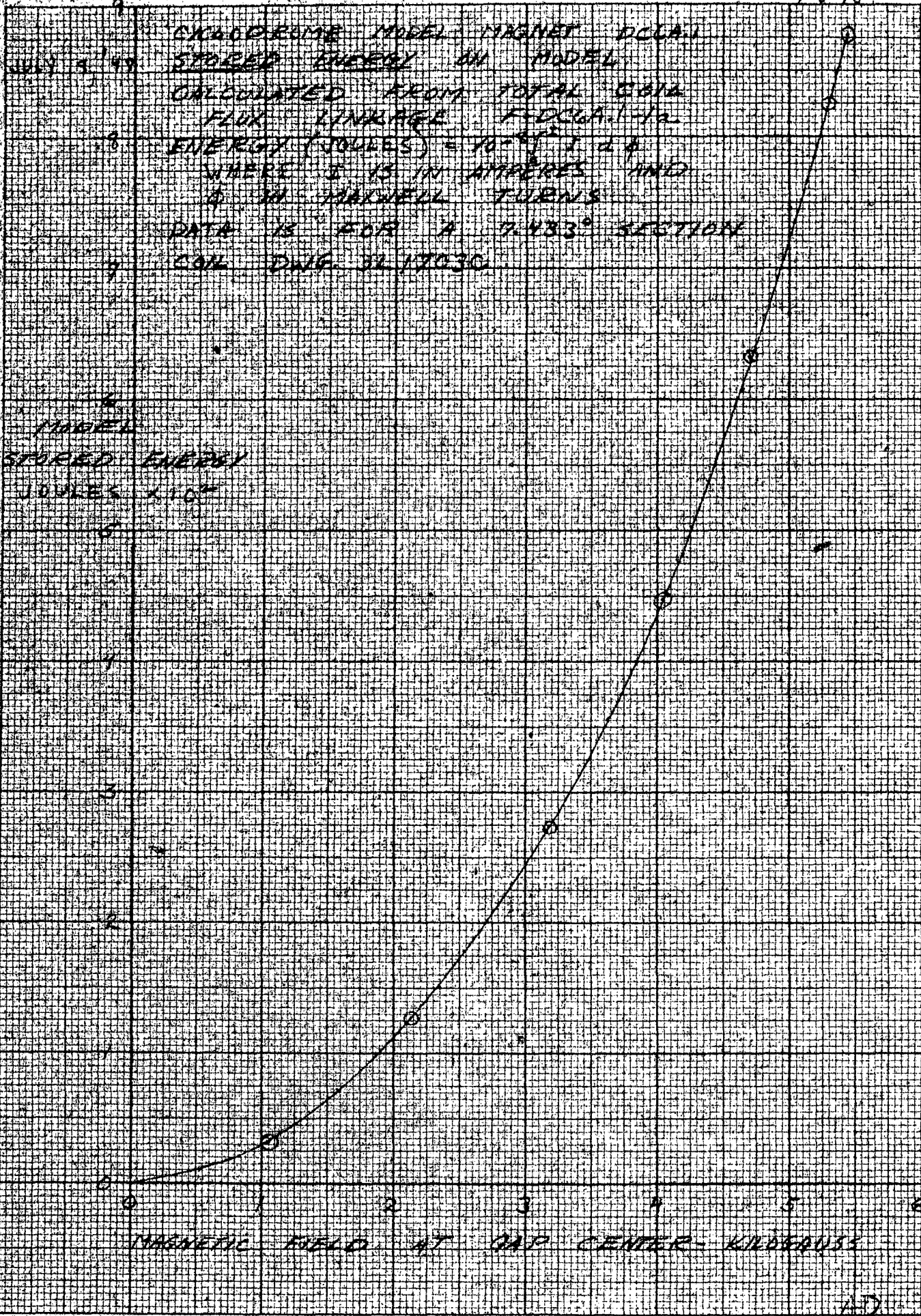


KUPPER & ESSER CO., N. Y. NO. 285-110  
Millimeter, 5 mm. Lines spaced; all. Thus 1000  
MADE IN U.S.A.

EWC



171-8  
E-DC6A.1-1  
7-8-48



CYCLOTRONE MODEL MAGNET DC CIRCUIT  
STORED ENERGY IN MODEL  
CALCULATED FROM TOTAL COIL  
FLUX LINKAGE FEDERAL-12  
ENERGY (JOULES) =  $10^{-4} I^2 L$   
WHERE  $I$  IS IN AMPERES AND  
 $L$  IN MAXWELL TURNS  
DATA IS FOR A 7.433° SECTION  
COIL DWG. 3117030

MODEL  
STORED ENERGY  
JOULES / GCF

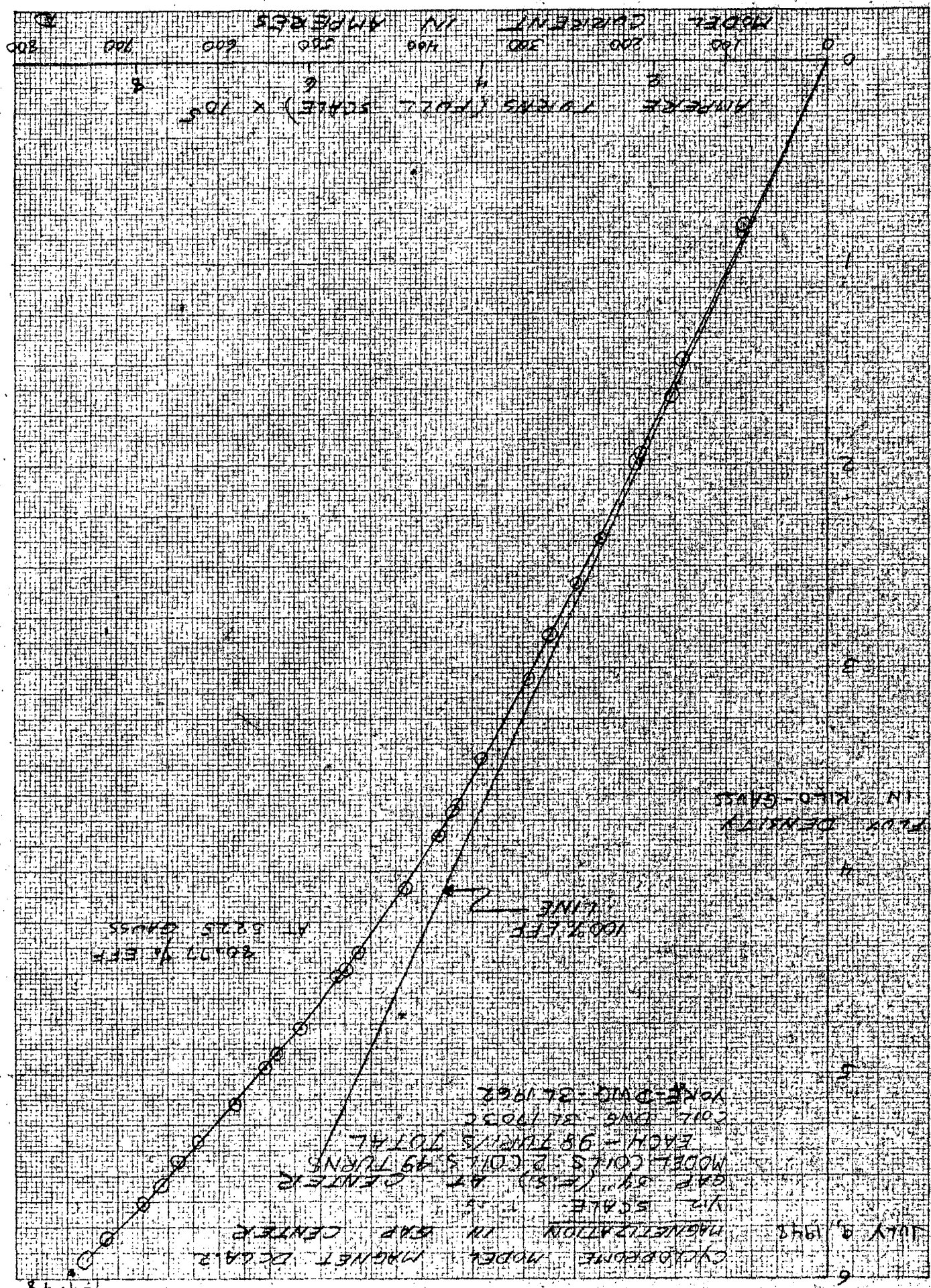
MAGNETIC FIELD AT GAP CENTER - KILOGAUSS

AD

EUGENE DIETZEN CO  
PRINTED IN U.S.A.

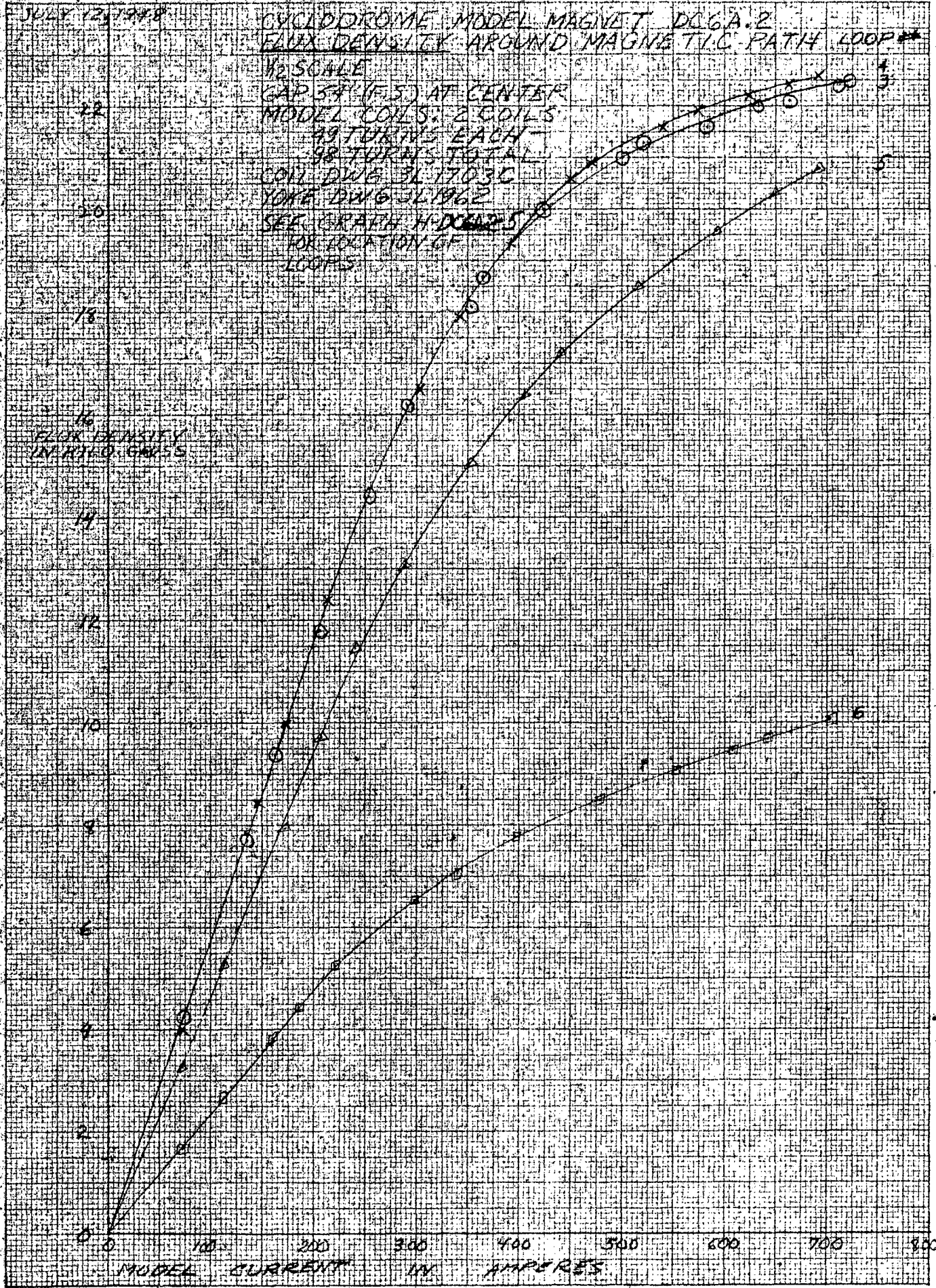
NO. 340-20 DIETZEN GRAPH PAPER  
20 X 20 PER INCH

177



171-8  
 H-DC6A.2-1  
 7-9-48

171-8  
H-DC6A.2-2  
7-12-48



REPRODUCED FROM THE ORIGINAL COPY OF THIS REPORT  
 MADE AT THE NATIONAL BUREAU OF STANDARDS  
 WASHINGTON, D. C.

EWC

JULY 12, 1948

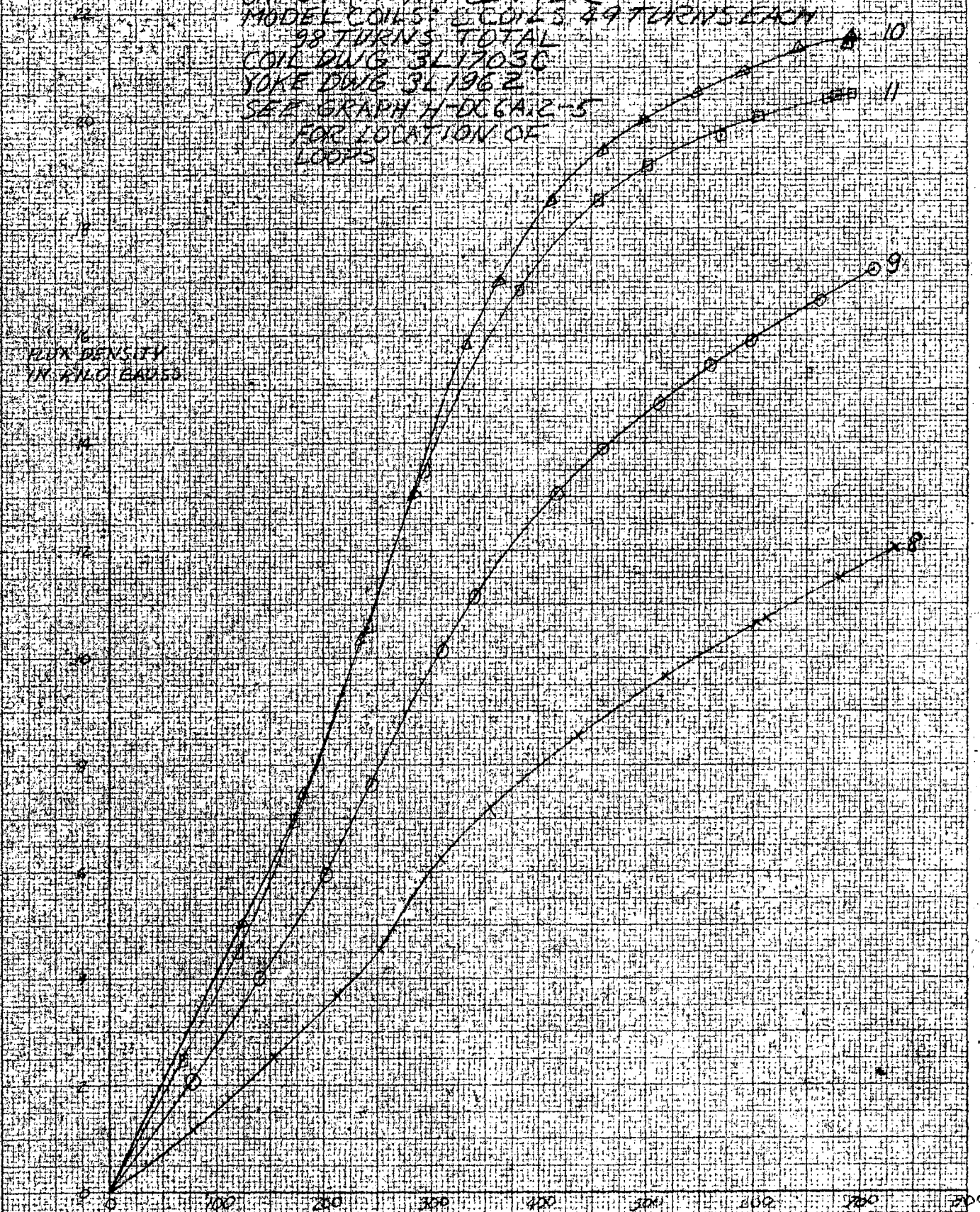
CYCLOTRONE MODEL MAGNET DCGA.2  
FLUX DENSITY AROUND MAGNETIC PATH

171-8  
H-DC6A.2-3  
7-12-48

1/2 SCALE  
GAP 5/8" (F.S.) AT CENTER  
MODEL COILS 5 COILS 49 TURNS EACH  
98 TURNS TOTAL  
COIL DWG 3L17030  
YOKE DWG 3L1962  
SEE GRAPH H-DC6A.2-5  
FOR LOCATION OF  
LOOPS

LOOP #  
10  
11

FLUX DENSITY  
IN KILO GAUSS



MODEL CURRENT IN AMPERES

FWC

KUPFER & ESSER CO., N. Y. NO. 28-46  
MILLBURN, N. J. MILBURN, N. J. MILBURN, N. J.  
MAY 1943

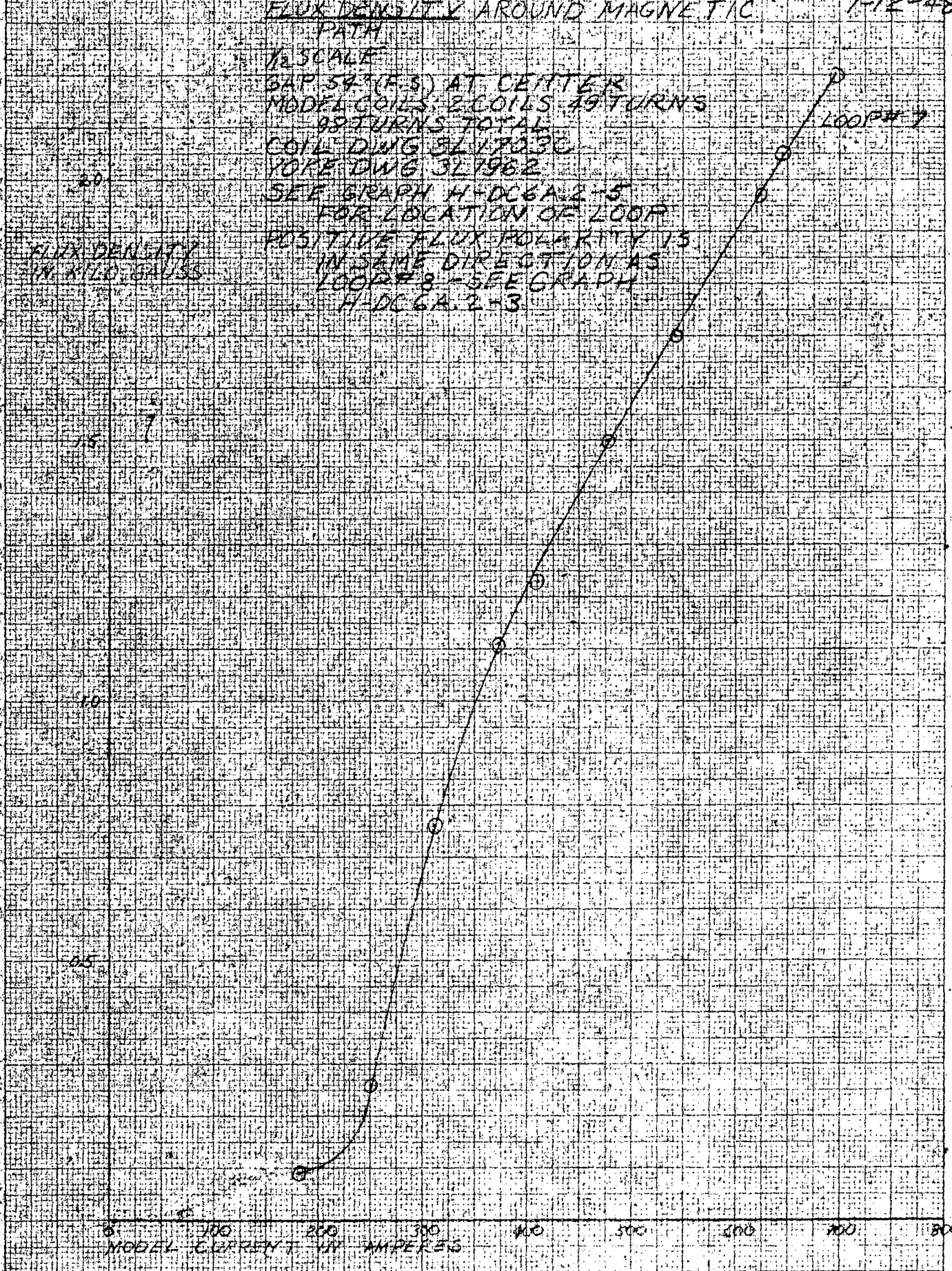
JULY 12, 1948

# CYKODROME MODEL MAGNET DCGA.2 FLUX DENSITY AROUND MAGNETIC

171-8  
H-DCGA.2-4  
7-12-48

PATH  
1/2 SCALE  
GAP .59" (F.S) AT CENTER  
MODEL COILS: 2 COILS 49 TURNS  
98 TURNS TOTAL  
COIL DWG 3L1703C  
YORE DWG 3L1962  
SEE GRAPH H-DCGA.2-5  
FOR LOCATION OF LOOP  
POSITIVE FLUX POLARITY IS  
IN SAME DIRECTION AS  
LOOP #3 - SEE GRAPH  
H-DCGA.2-3

FLUX DENSITY  
IN KILO GAUSS



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BWC

JULY 12, 1948

CYCLODROME MODEL MAGNET DCGA:2  
FLUX DENSITY AROUND MAGNETIC PATH

171-8  
H-DC6A.2-5  
7-12-48

1/2 SCALE

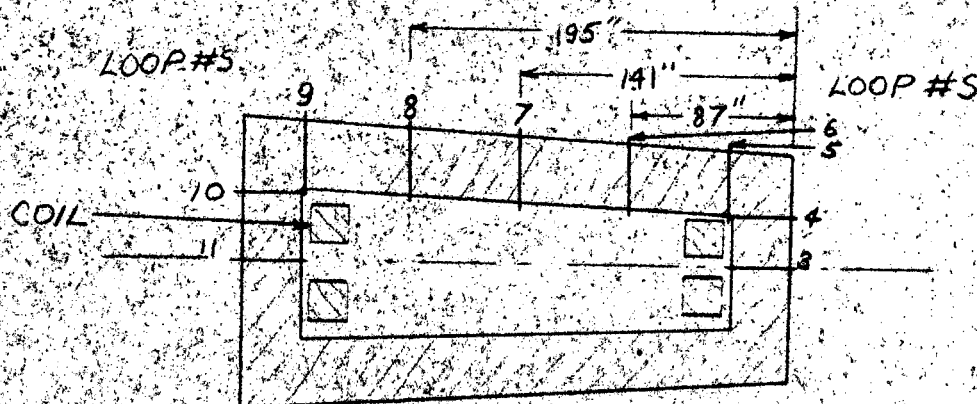
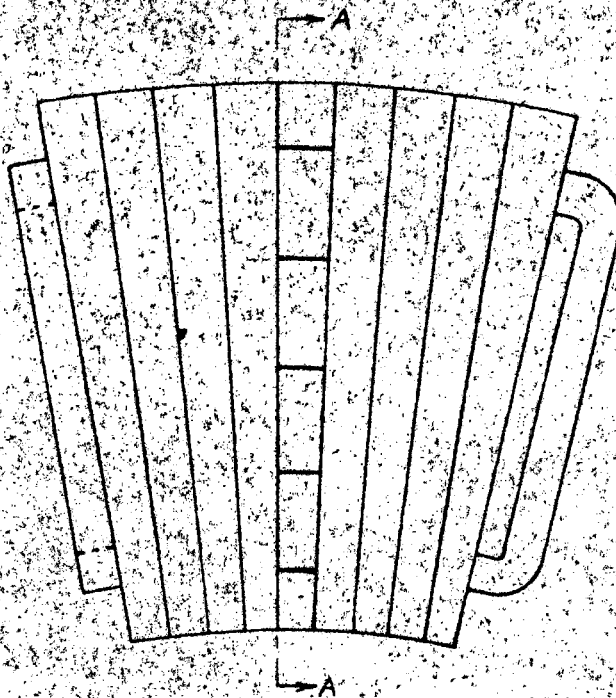
GAP 54" (FS) AT CENTER

LOCATION OF FLUX LOOPS

SEE GRAPHS H-DC6A.2-2

H-DC6A.2-3

H-DC6A.2-4



CROSS SECTION AT AA

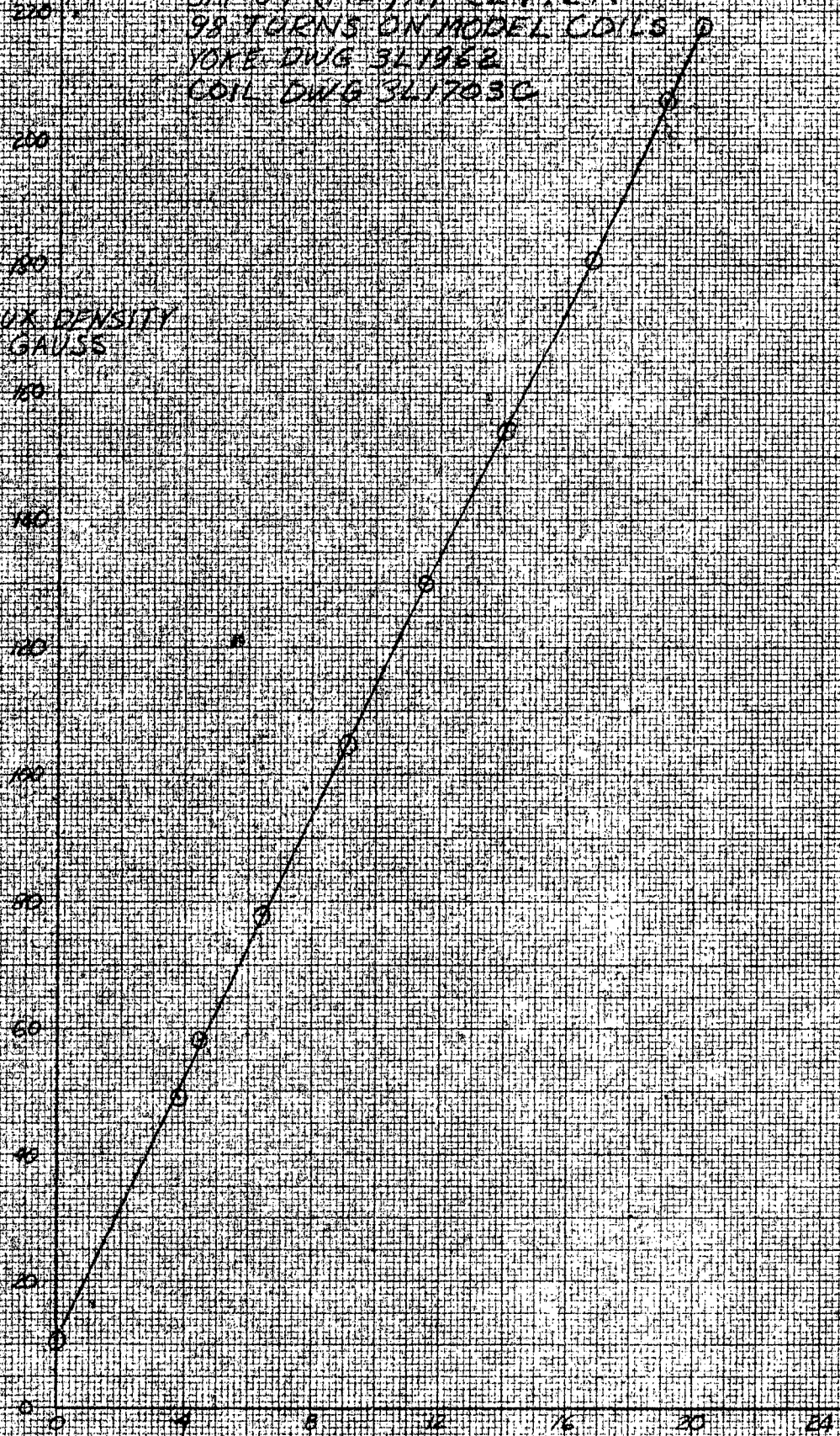
PWC

JULY 12, 1948

CYCLOTRONE MODEL MAGNET DC6A.2  
MAGNETIZATION AT CENTER OF GAP  
1/2 SCALE  
GAP 54" (A.S.) AT CENTER  
98 TURNS ON MODEL COILS  
YOKE DWG 3L19E8  
COIL DWG 3L1703C

171-8  
H-DC6A.2-6  
7-12-48

FLUX DENSITY  
IN GAUSS



MODEL CURRENT IN AMPERES

EWC

KEUFFEL & ESSER CO., N.Y. 201-38-140  
Manufactured 5 years being accurate to 0.1% in this type  
MADE IN U.S.A.

JULY 13, 1948

CYCLOTRONE MODEL MAGNET DC6A.2

171-8  
0-DC6A.2-  
7-13-48

RADIAL UNIFORMITY  
1/2 SCALE DWG 341635

GAP 54" AT CENTER (F.S.)  
MODEL COILS 92 TURNS TOTAL

COIL DWG 341703C

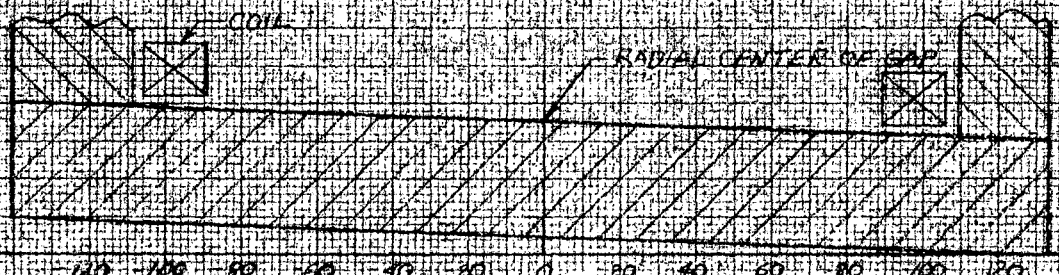
YOKES DWG 341942

MEASUREMENTS  
TAKEN ALONG  
MEDIAN PLANE  
OF GAP

PERCENT  
MAGNETIC  
FIELD

o 100% = 196 GAUSS  
x 100% = 5225 GAUSS

GAP TAPER 0.0734 INCHES PER INCH



INCHES (F.S.) FROM RADIAL CENTER OF GAP

EWC

KEUFFEL & ESSER CO., N. Y. NO. 385-146  
Millimeter, 5 mm. lines spaced, cm. lines heavy.  
MADE IN U.S.A.



JULY 13, 1948

CYCLODRONE MODEL MAGNET DC6A.2

171-8

RADIAL UNIFORMITY

U-DC6A.2-1a

1/2 SCALE DWG 3L1635

743-48

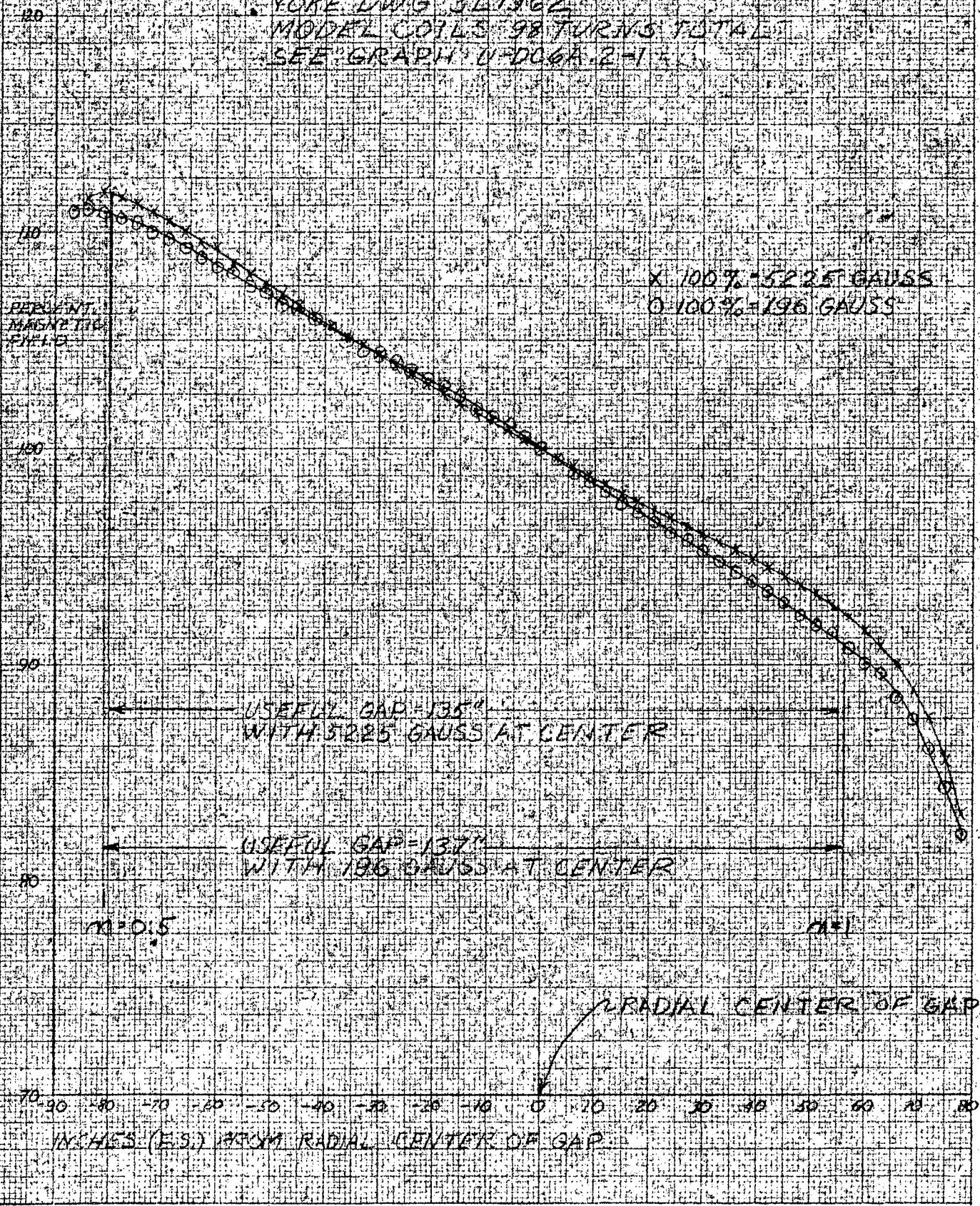
GAP 54" (E.S.) AT CENTER

COIL DWG 3L1703C

YORK DWG 3L1962

MODEL COILS 98 TURNS TOTAL

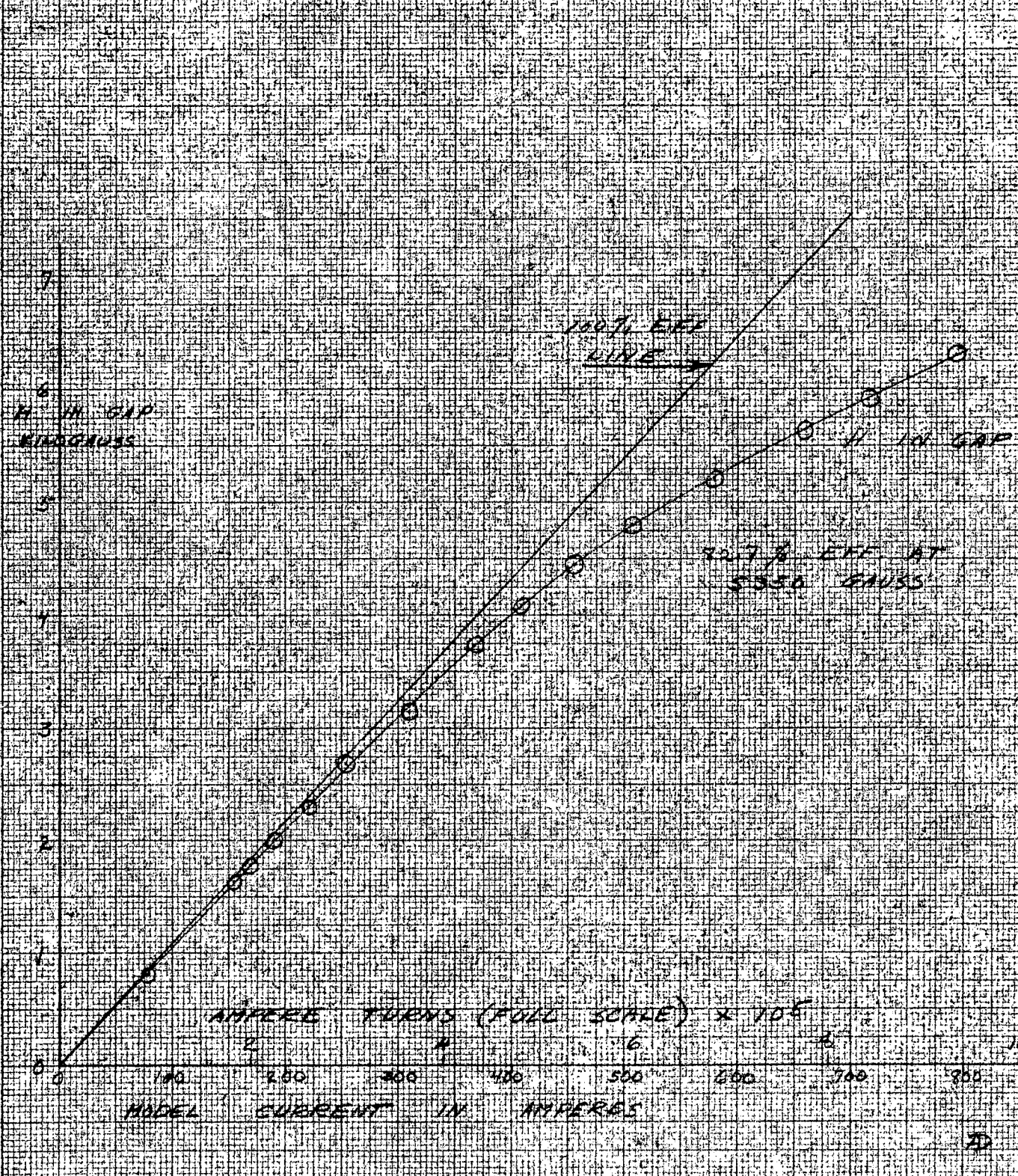
SEE GRAPH U-DC6A.2-1



REUFEL & ESSER CO., N. Y. NO. 135, 140  
Manufacturers of mill. Gauss magnets, etc. 1000  
W. 42nd St. N. Y. C.

FWC

CYCLOTRONE MODEL MAGNET DELA 3 171-8  
 JULY 23 H IN GAP CENTER H DELA 3-4  
 1948 1/2 SCALE ONE 311835 COIL 311923 7-13-48  
 YOKE 311961  
 GAP 54 (FS) AT CENTER  
 31 (FS) ADDED TO OUTER LEG  
 88 TURNS TOTAL ON MODEL

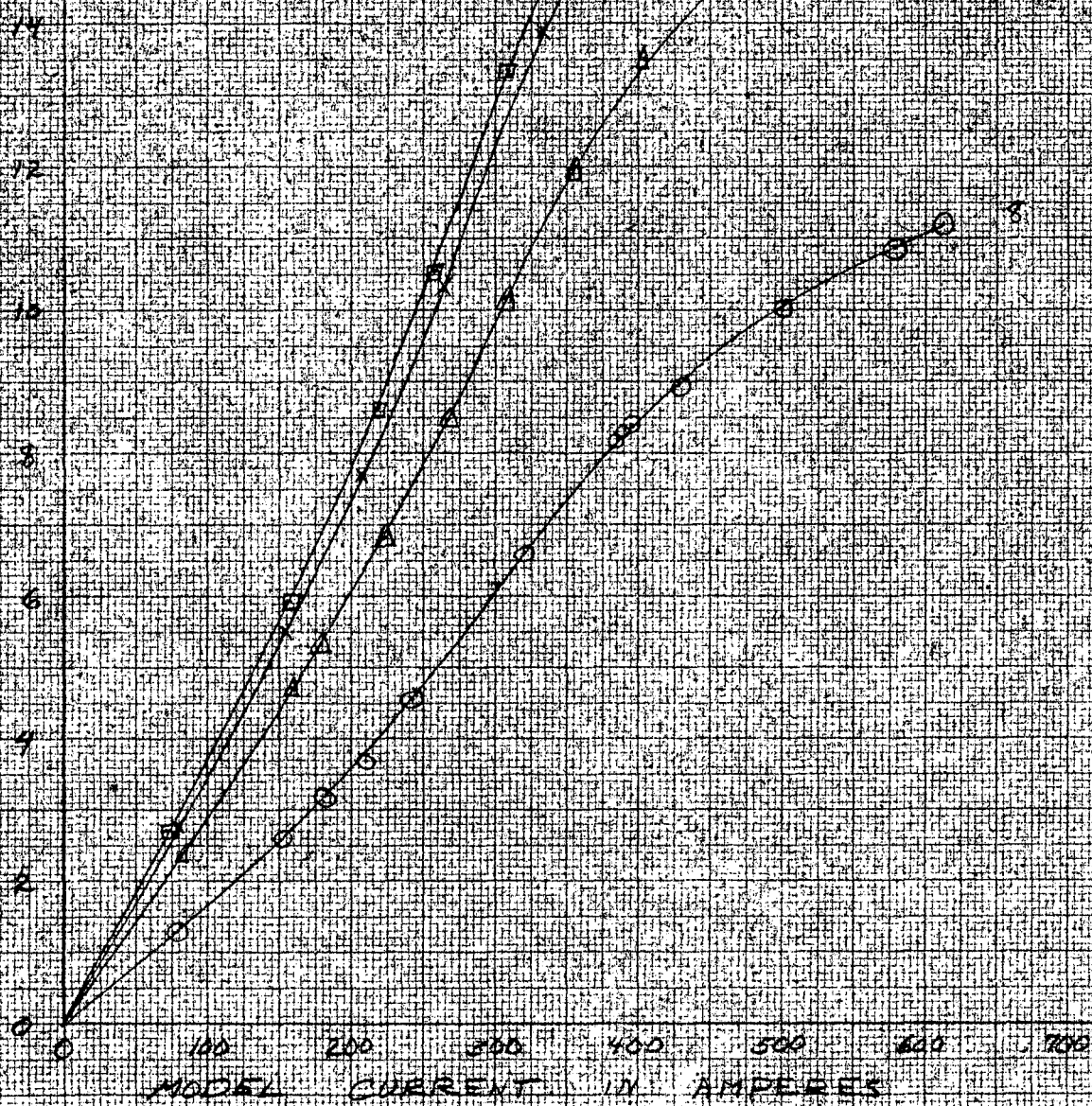


KEUFFEL & ESSER CO. N. Y. 30-35 HART  
 MANHATTAN, CHINA WALLS AT W. 4TH ST. N. Y.  
 MADE IN U. S. A.

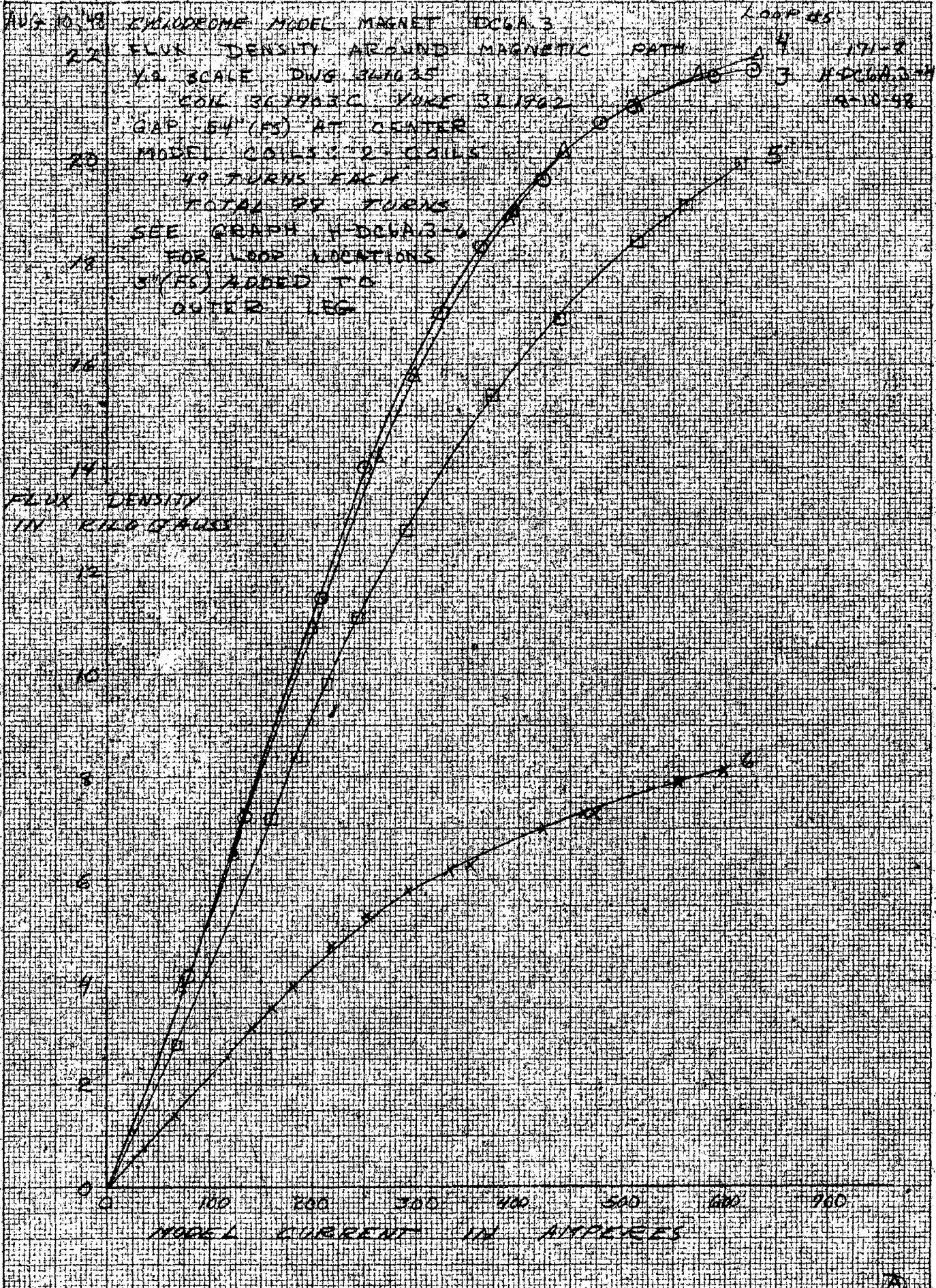


AUG 10 1949 CYCLOTRONE MODEL MAGNET DC6A3 171-8  
 22 FLUX DENSITY AROUND MAGNETIC H DC6A3-3  
 PATH 3-10-48  
 1/2 SCALE DWG 3L1635 LOOP 25  
 GAP 5/16" AT CENTER  
 20 MODEL COILS 3L1780 2 COILS  
 19 TURNS EACH - 38 TURNS TOTAL  
 18 YORE DWG 3L1902  
 SEE DRAWING DC6A3-6  
 FOR LOOP LOCATION  
 3 (PS) ADDED TO  
 OUTER LEG

16 FLUX DENSITY  
 IN KILOGAUSS



KEUFFEL & ESSER CO., N. Y. NO. 355-160  
 Milliammeters, 5 mm. lines accurate, esp. lines heavy  
 MADE IN U. S. A.



KUFFER & ROFFER CO., N. Y. NO. 358-1425  
 MANHATTAN, 5th Ave. (at 100th St.)  
 MADE IN U.S.A.

AUG 10 1949 CYCLOTRONE MODEL MAGNET DC6A3  
 FLUX DENSITY AROUND MAGNETIC  
 PATH

171-8  
 H DC6A3-5  
 8-10-48

VIZ SCALE 3L635  
 RAR 54" (FS) AT CENTER  
 MODEL COILS DWG 3L703C  
 2 COILS 42 TURNS EACH  
 84 TURNS TOTAL  
 YORE DWG 3L1962  
 SEE GRAPH H-DE6A3-6  
 FOR LOOP LOCATION  
 3" (FS) ADDED TO OUTER  
 LEG SLAB  
 POLARITY IS SAME AS LOOP #8

LOOP #7

FLUX  
 DENSITY  
 IN  
 GAUSS

2500

2000

1500

1000

500

0

MODEL CURRENT IN AMPERES

100

200

300

400

500

600

700

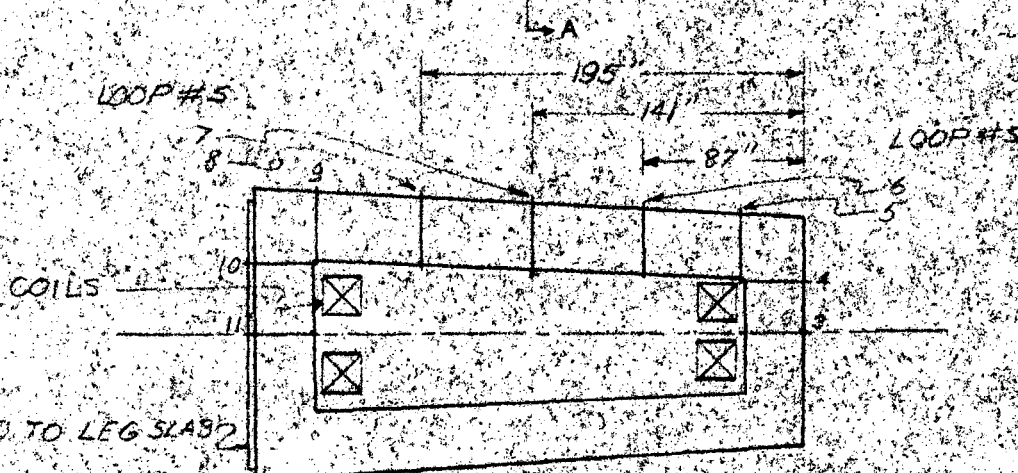
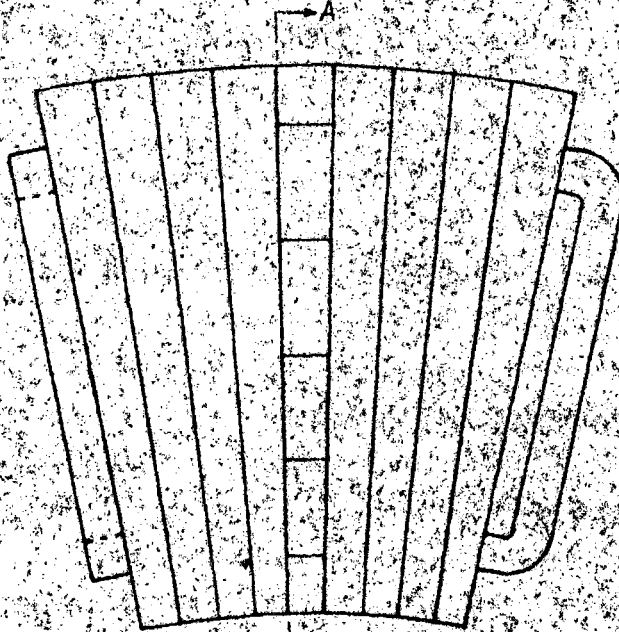
KEUFFEL & ESSER CO., N. Y. NO. 385-146  
 Millimeters, 5 mm. lines spaced, 1/16" lines heavy.  
 MADE IN U. S. A.

20

AUGUST 10, 1948

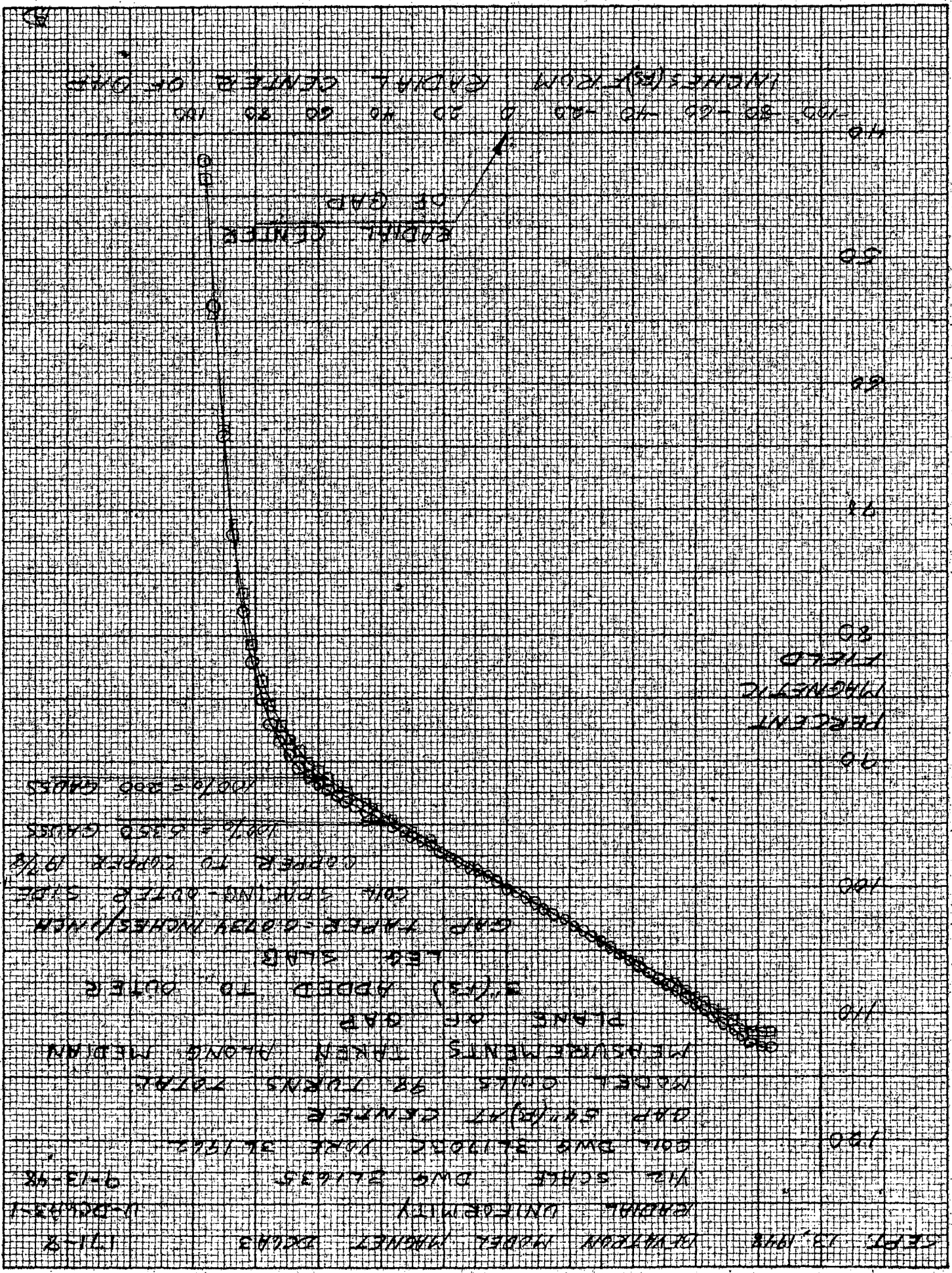
CYCLODROME MODEL MAGNET DCGA.3  
FLUX DENSITY AROUND MAGNETIC PATH  
1/2 SCALE DWG 3L1635  
GAP 54" (FS) AT CENTER  
YOKE DWG 3L1962  
COILS DWG 3L1703C - 38 TURNS TOTAL  
SEE GRAPHS H-DCGA.3-3  
H-DCGA.3-4  
H-DCGA.3-5

171-B  
H-DCGA.3-6  
8-10-48



CROSS SECTION AT AA

EWC

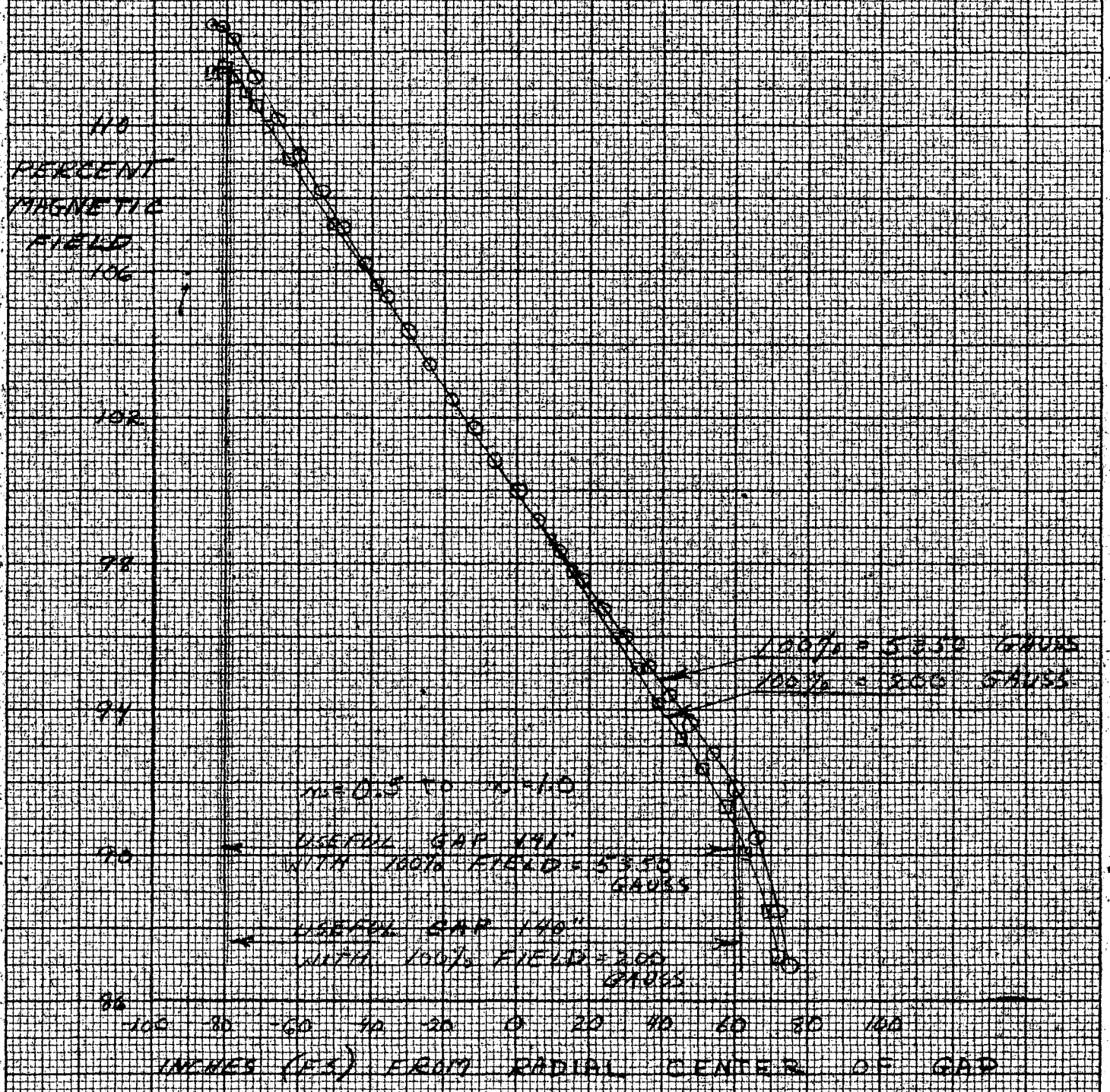




SEPT 13, 1948 BEVATRON MODEL MAGNET DESIGN  
 RADIAL UNIFORMITY  
 1/16 SCALE DWG 341635

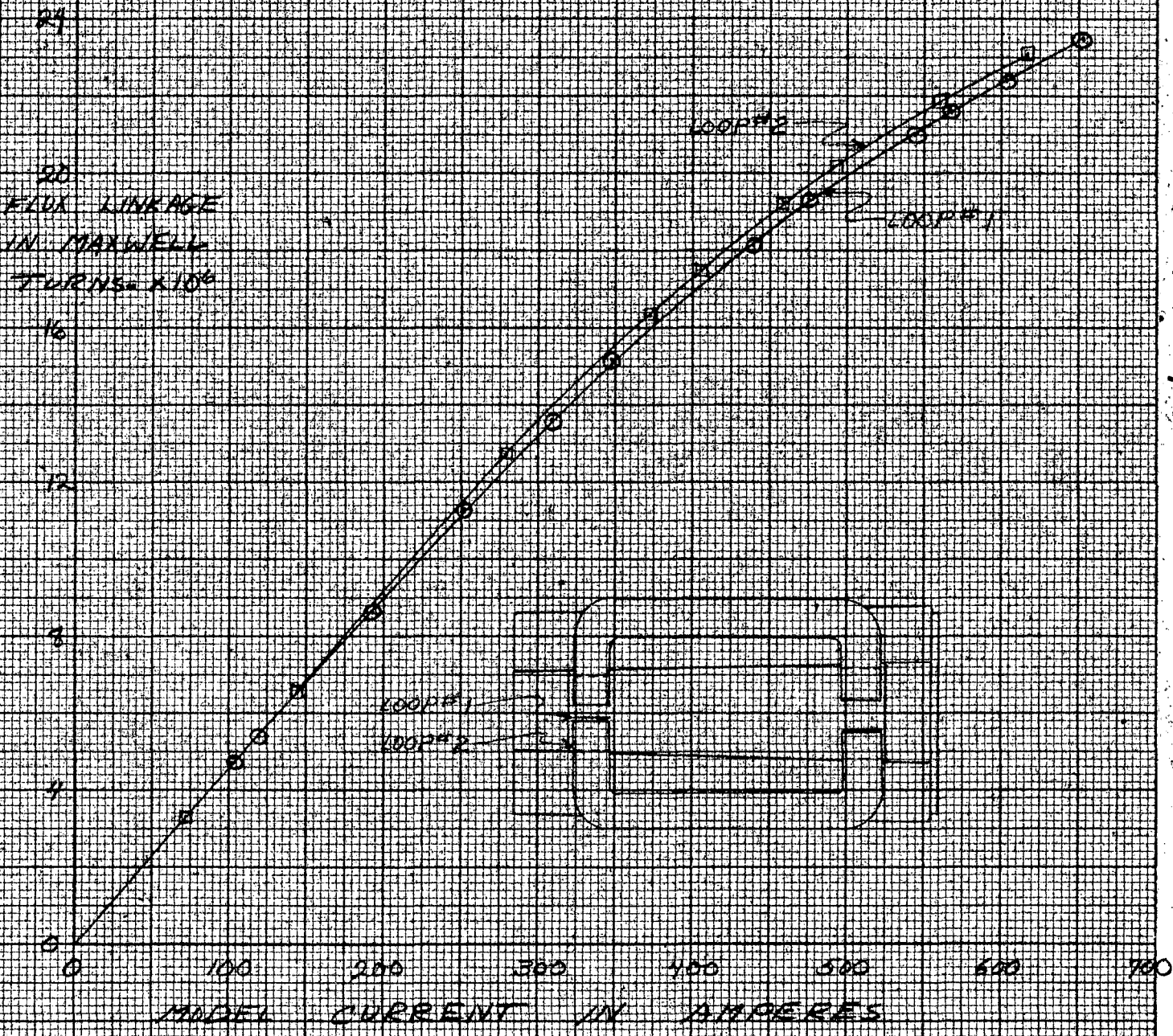
71-3  
 J. SELLERS  
 9-13-48

116 COIL DWG 3417030 Yoke 341967  
 MODEL COILS 92 TURNS TOTAL  
 GAP 54" (FS) AT CENTER  
 3" (FS) ADDED TO OUTER LEG  
 114 COIL SPACING 19 3/8 COPPER TO COPPER OUTER SIDE



KEUFFEL & ESSER CO., N. Y. NO. 3951-150  
 10 X 10 to the 1/4 inch, 5th lines counted.  
 Engraving 7/8 X 10 in.  
 MADE IN U.S.A.

AUG 10, 48 CYCLODROME MODEL MAGNET COILS  
 COIL LOOP FLUX LINKAGE  
 1/2 SCALE DWG 3L1635  
 GAP 5/16" AT CENTER  
 MODEL COILS: DWG 3L19030 - 2 COILS  
 49 TURNS EACH - TOTAL 98 TURNS  
 EACH LOOP HAS 7 TURNS  
 FLUX LINKAGE IS IN 94.33° SECTION  
 OF MODEL  
 3/16" ADDED TO OUTER LEG SLAB



KEUFFEL & ESSER CO., N. Y. NO. 3587-150  
 10 X 10 1/2 IN. 1/2 IN. 5th LINE SCOTTED  
 PAPERWEIGHT 7 1/4 X 10 IN.  
 MADE IN U.S.A.

AUGUST 10, 1948

CYCLOTRONE MODEL MAGNET D66A.3

171-2  
E-DEKA-3-1a  
9-10-48

TOTAL COIL LOOP FLUX LINKAGE

SCALE DWG 3L1635

MODEL COILS DWG 3L1703C

2 COILS 49 TURNS EACH

99 TURNS TOTAL

YOKE DWG 3L1862

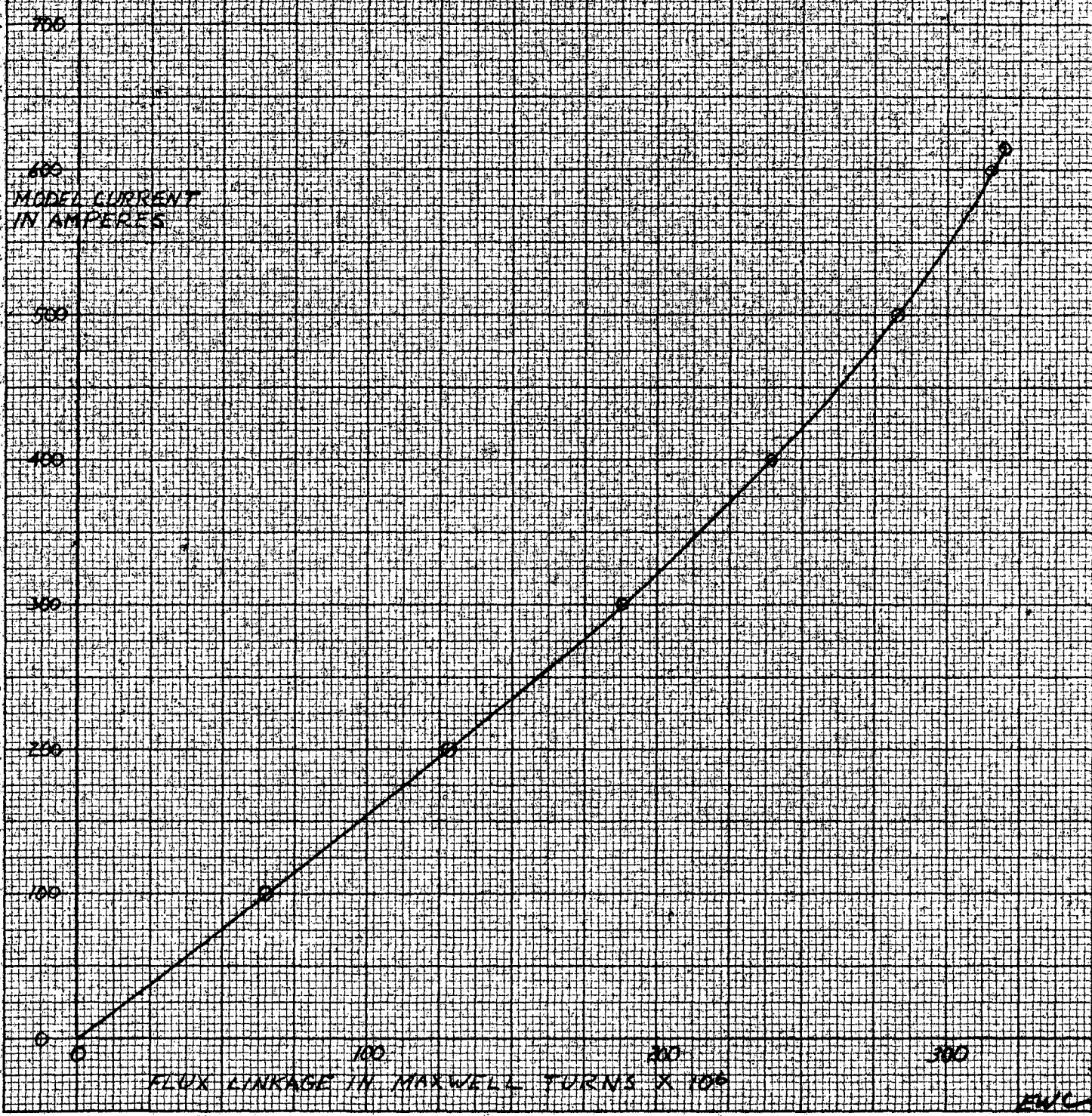
GAP 5.4" (E.S.)

FLUX LINKAGE IS ON 7.435° SECTION

ON MODEL

3" (E.S.) ADDED TO OUTER LEG SLAB

SEE GRAPH D66A.3-1



KEUFFEL & ESSER CO., N. Y. NO. 3887120  
10 X 10 to the 1/4 inch, 5th lines spaced.  
Engraving 7/8 X 10 in.  
MADE IN U.S.A.

AUGUST 10, 1948

CYCLOTRONE MODEL MAGNET DCL.A.3

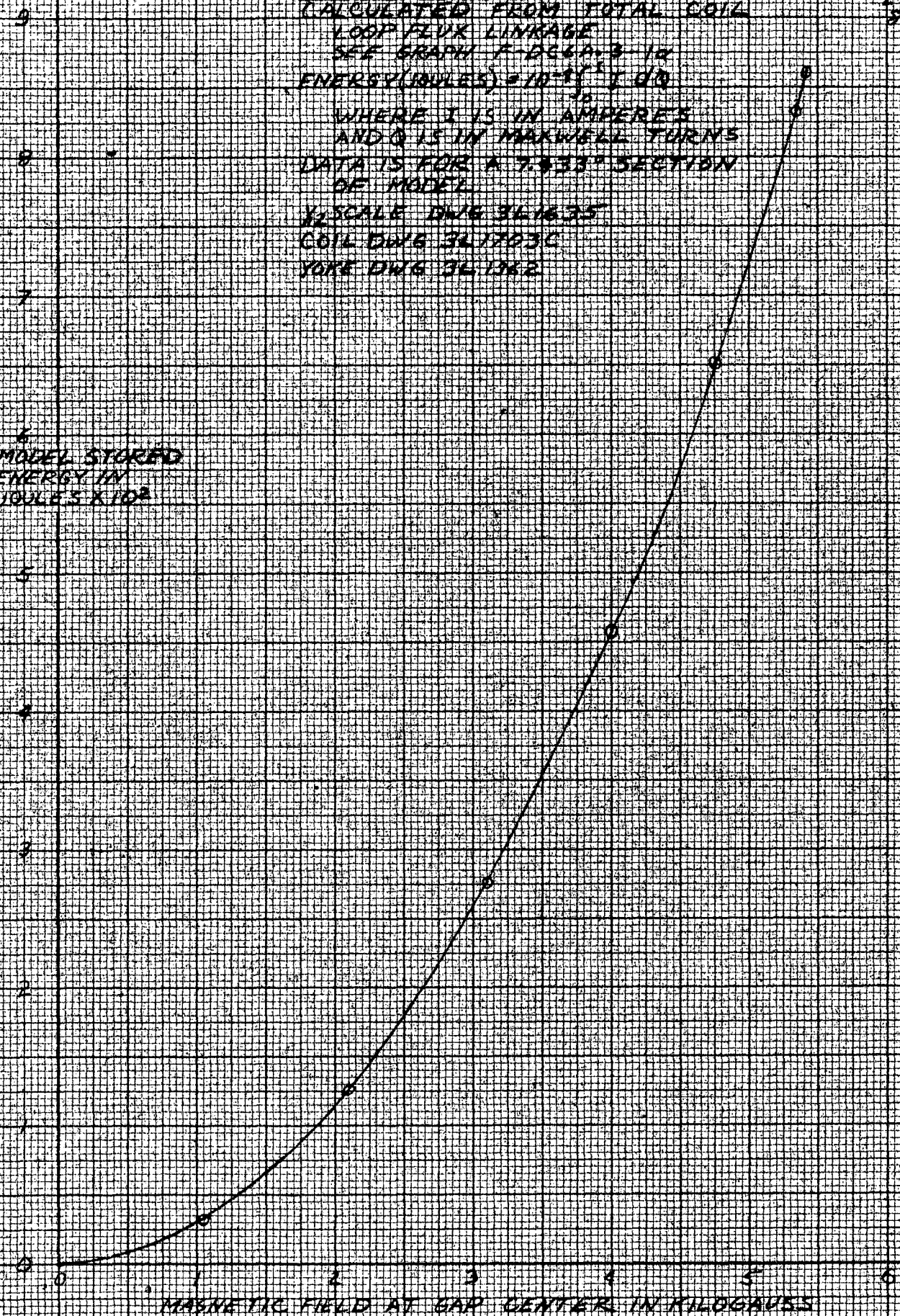
171-8  
E.DCL.A.3-1  
9-10-48

STORED ENERGY ON MODEL  
CALCULATED FROM TOTAL COIL  
LOOP FLUX LINKAGE  
SEE GRAPH F-DCL.A.3-10  
ENERGY (Joules) =  $10^{-4} I^2 \Phi$

WHERE I IS IN AMPERES  
AND  $\Phi$  IS IN MAXWELL TURNS  
DATA IS FOR A 7.933" SECTION  
OF MODEL

INSIDE DIA 3L1635  
COIL DIA 3L1703C  
YOKE DIA 3L1362

MODEL STORED  
ENERGY IN  
Joules X 10<sup>2</sup>

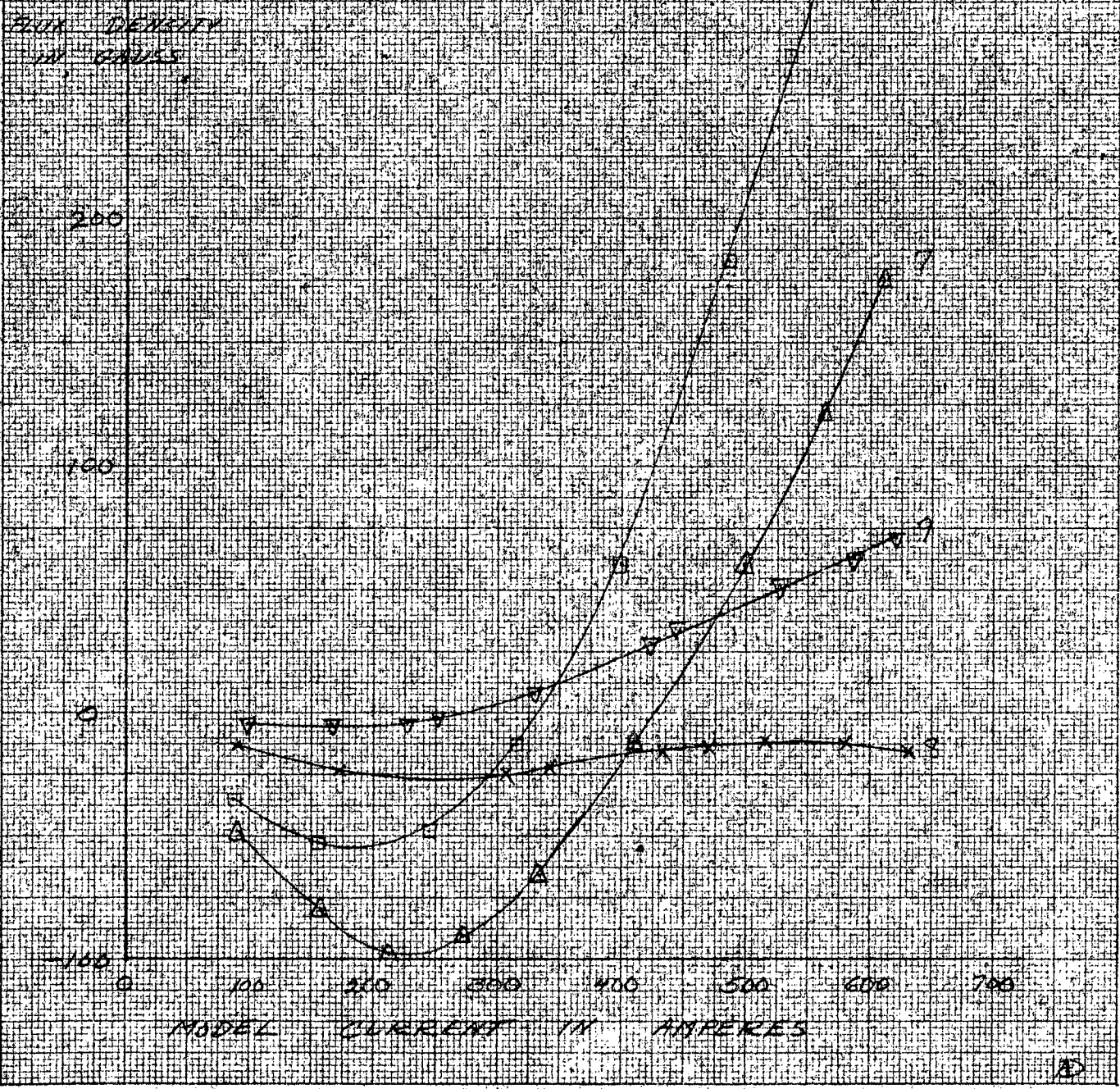


MAGNETIC FIELD AT GAP CENTER IN KILOGAUSS

RUC

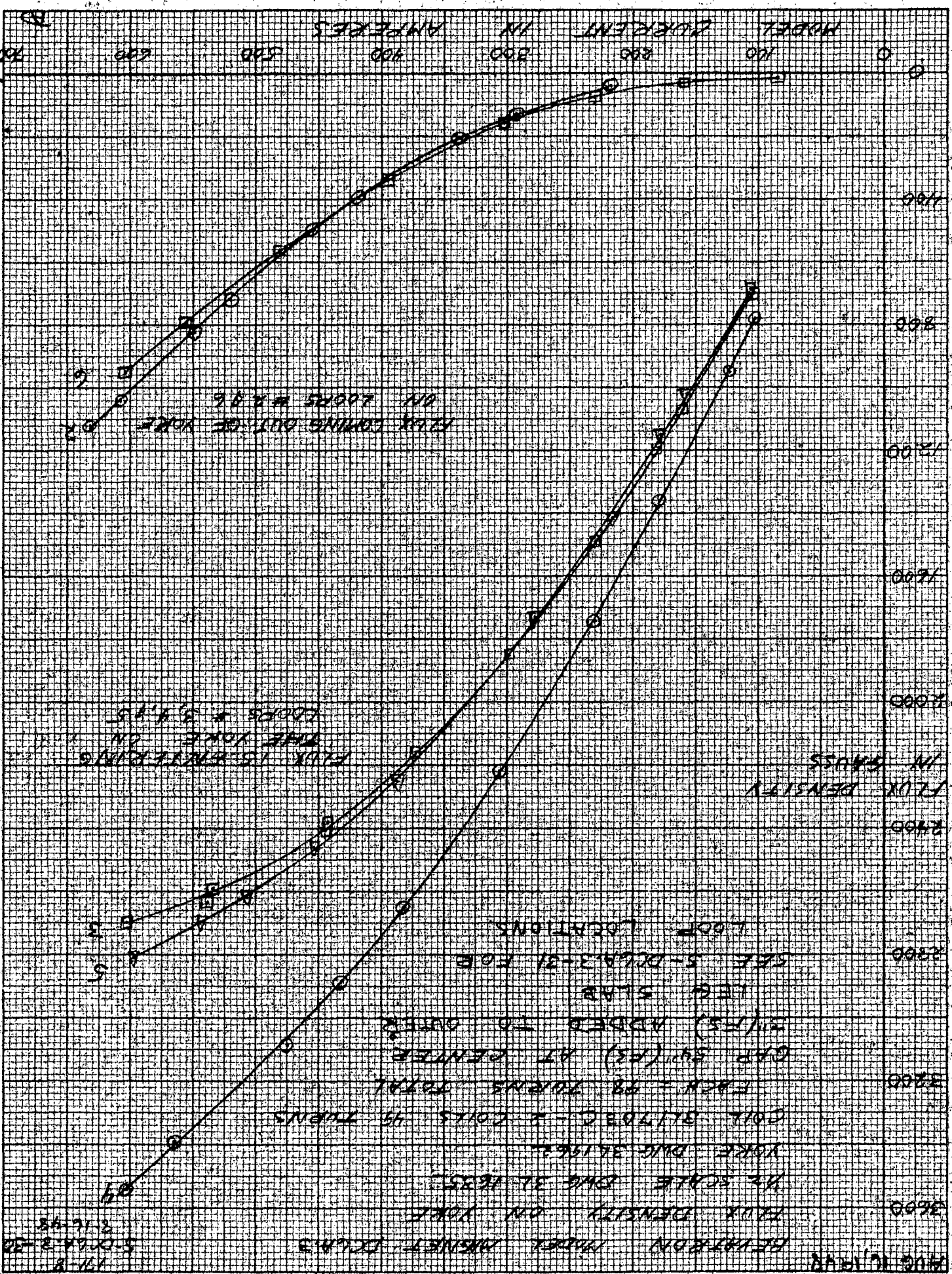
KEEFE & ESSEN CO., N. Y. NO. 557-120  
1/8" X 10" to the 1/4" Inch, 5th lines centered.  
Engraving 7/8" X 10 1/2"  
MADE IN U.S.A.

AUGUST 16 BEVATRON MODEL MAGNET DCLAR3 171-B  
 1948 FLUX DENSITY ON YOKE S-DCLAR3-29  
 1/2 SCALE DNG 3L17035 2-16-48  
 2 ON 3L17035 - 21 COILS 49 TURNS  
 EACH 21 TURNS TOTAL  
 GAP 54 (1%) AT CENTER  
 3 (1%) ADDED TO ANTER LEG  
 YOKE 3L1762  
 POSITIVE FLUX IS FLUX COMING  
 OUT OF YOKE  
 "NEGATIVE" FLUX IS FLUX ENTERING  
 THE YOKE  
 SEE S-DCLAR3-31 FOR LOOP  
 LOCATIONS



ROBERT E. SHAW CO., N. Y. INC. 415 5th Ave.  
 MILLIMETERS - Your Lines ascertained, why lines heavy  
 MADE IN U. S. A.

KUPFER, A. ESSER CO., N. Y. NO. 3997-12A  
 10 X 10 to the 1/2 inch, 5th lines extended.  
 Divisions 7/16 X 1/16 in.  
 MADE IN U.S.A.



400 300 200 100 0  
 MODEL CURRENT IN AMPERES  
 0 100 200 300 400  
 FLUX DENSITY IN GAUSS

AUGUST 16, 1948

171-8

BEVATRON MODEL MAGNET DC6A.3

S-DC6A.3-31

FLUX DENSITY ON YOKE

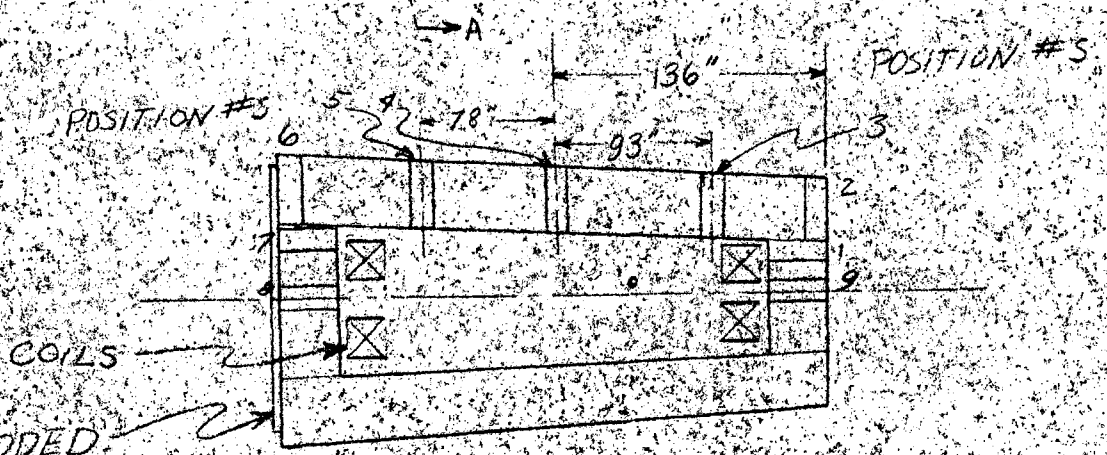
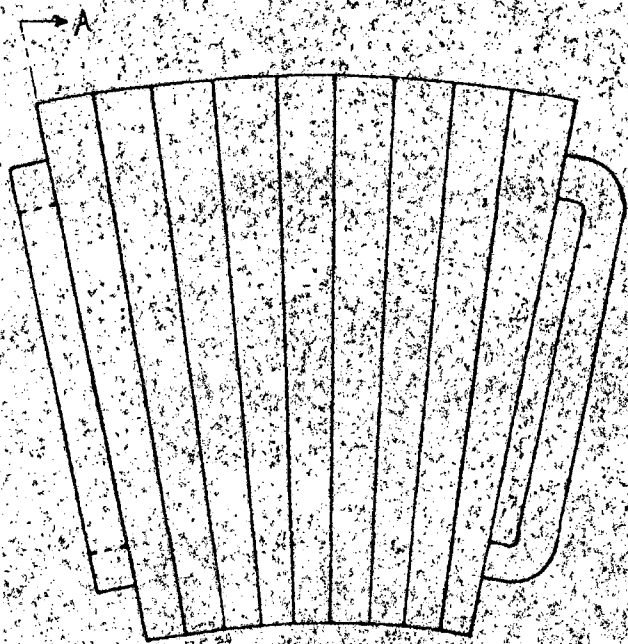
8-16-48

1/2 SCALE DWG 3L1635

YOKE DWG 3L1962 COIL DWG 3L1703C

GAP 54" (F.S.) AT CENTER

3" (F.S.) ADDED TO OUTER LEG SLAB



CROSS SECTION AT AA

SEE GRAPHS S-DC6A.3-29

S-DC6A.3-30

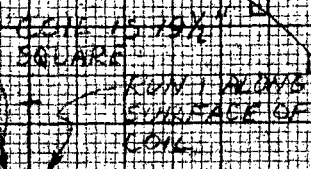
EWC

AUGUST 1948

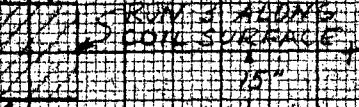
BEYATRON MODEL MAGNET DESIGN  
FLUX DENSITY ON COILS  
KESCALE DWG 3L1635  
YORK DWG 3L1962  
COIL DWG 3L1703G

TM-8  
5-DR-64-9-32  
8-19-48  
CORRECTED  
9-1-48

RUN 4  
ALONG  
SURFACE



RUN 3 ALONG  
SURFACE OF  
COIL



RUN 2  
ALONG  
SURFACE



2 COILS - 40 TURNS EACH  
92 TURNS TOTAL  
GAP 5 1/2" (F.S.) AT CENTER  
3" (F.S.) ADDED TO OUTER LEG SLAB

POSITIVE FLUX DENSITY INDICATES  
FLUX LEAVING SURFACE  
NEGATIVE FLUX DENSITY INDICATES  
FLUX ENTERING SURFACE  
FIELD AT GAP CENTER 5350 GAUSS

GAP  
CROSS SECTION  
OF COIL AND  
UPPER YORE  
SLAB AT RADIAL  
CENTER OF GAP

RUN 3

RUN 2

FLUX DENSITY  
IN GAUSS

RUN 1

RUN 4

COIL CENTER LINES

DISTANCE IN INCHES (F.S.) FROM COIL CENTER LINES

KEFFEL & ESSER CO., N. Y., NO. 5987-120  
10 X 10 to the 1/4 inch, 6th lines spaced.  
Engraving 7 1/2 X 10 in.  
MADE IN U.S.A.



AUGUST 23, 1948

BEVATRON MODEL MAGNET DC6A-3

171-9  
5 DC6A-3-33  
8-23-48

FLUX DENSITY ON COILS  
1/2 SCALE DWG 3L1635  
YORK DWG 3L1962  
COIL DWG 3L1703C  
2 COILS 49 TURNS EACH  
38 TURNS TOTAL

FIELD AT GAP CENTER 5350 GAUSS  
GAP 5" (F.S.) AT CENTER  
3" (F.S.) ADDED TO OUTER LEG SLAB

POSITIVE FLUX DENSITY INDICATES FLUX LEAVING SURFACE  
NEGATIVE FLUX DENSITY INDICATES FLUX ENTERING SURFACE

17500

11000

1500

500

1900

1300

FLUX DENSITY IN GAUSS

0

RUN 5

RUN 7

3" ADDED

RUN 5 ALONG COIL SURFACE

RUN 6 ALONG COIL SURFACE

RUN 7 ALONG COIL SURFACE

COIL IS 1 9/16" SQUARE

COIL CENTER

GROSS SECTION OF COIL AND UPPER YORK SLAB 45° ABOVE MEDIUM PLANE OF GAP ON OUTER LEG SIDE

TOWARD RADIAL CENTER OF GAP

F.S. DISTANCE IN INCHES FROM COIL CENTER LINES

ENC

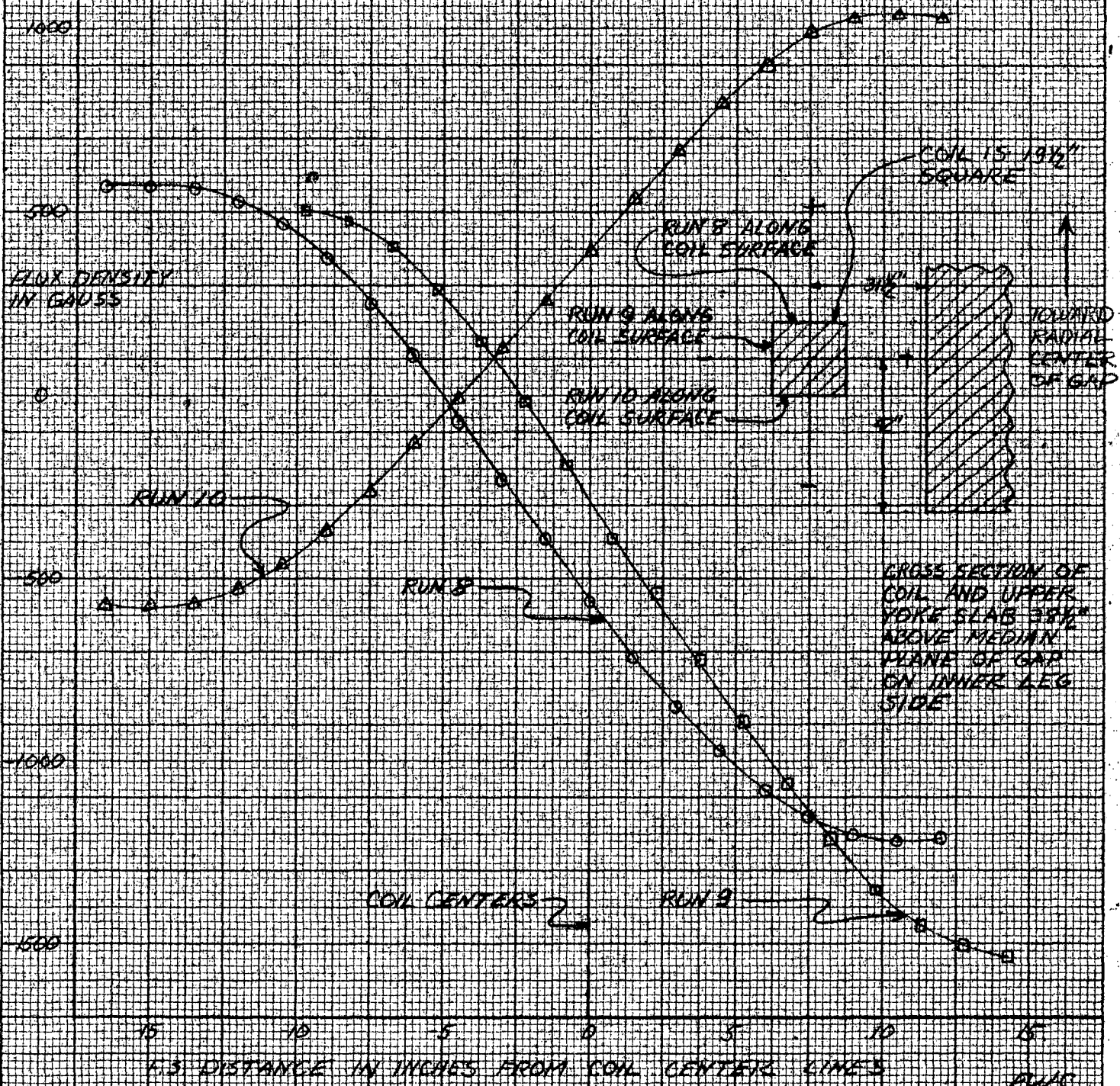
KEUFFEL & ESSER CO., N. Y. NO. 3597-2d  
10 X 10 to the 1/4 inch, 5th lines omitted.  
Paper 7 1/4 X 10 in.  
MADE IN U.S.A.

AUGUST 23, 1948  
2000

BEUTRON MODEL MAGNET DCGA.3  
FLUX DENSITY ON COILS  
N. SCALE DWG 3L 1435

171-B  
5-DCGA.3-39  
8-23-48

YOKE DWG 3E1982  
COIL DWG 5A1703C  
2 COILS - 49 TURNS EACH  
98 TURNS TOTAL  
FIELD AT GAP CENTER 3350 GAUSS  
GAP 5/16" AT CENTER  
3" (F.S.) ADDED TO OUTER LEG SLAB  
POSITIVE FLUX DENSITY INDICATES FLUX  
LEAVING SURFACE  
NEGATIVE FLUX DENSITY INDICATES FLUX  
ENTERING SURFACE



KUFFEL & ESSER CO., N.Y. NO. 3597-125  
 10 X 10 to the 1/4 inch, 6th lines omitted  
 Engraving 7 1/2 X 10 in.  
 MADE IN U.S.A.

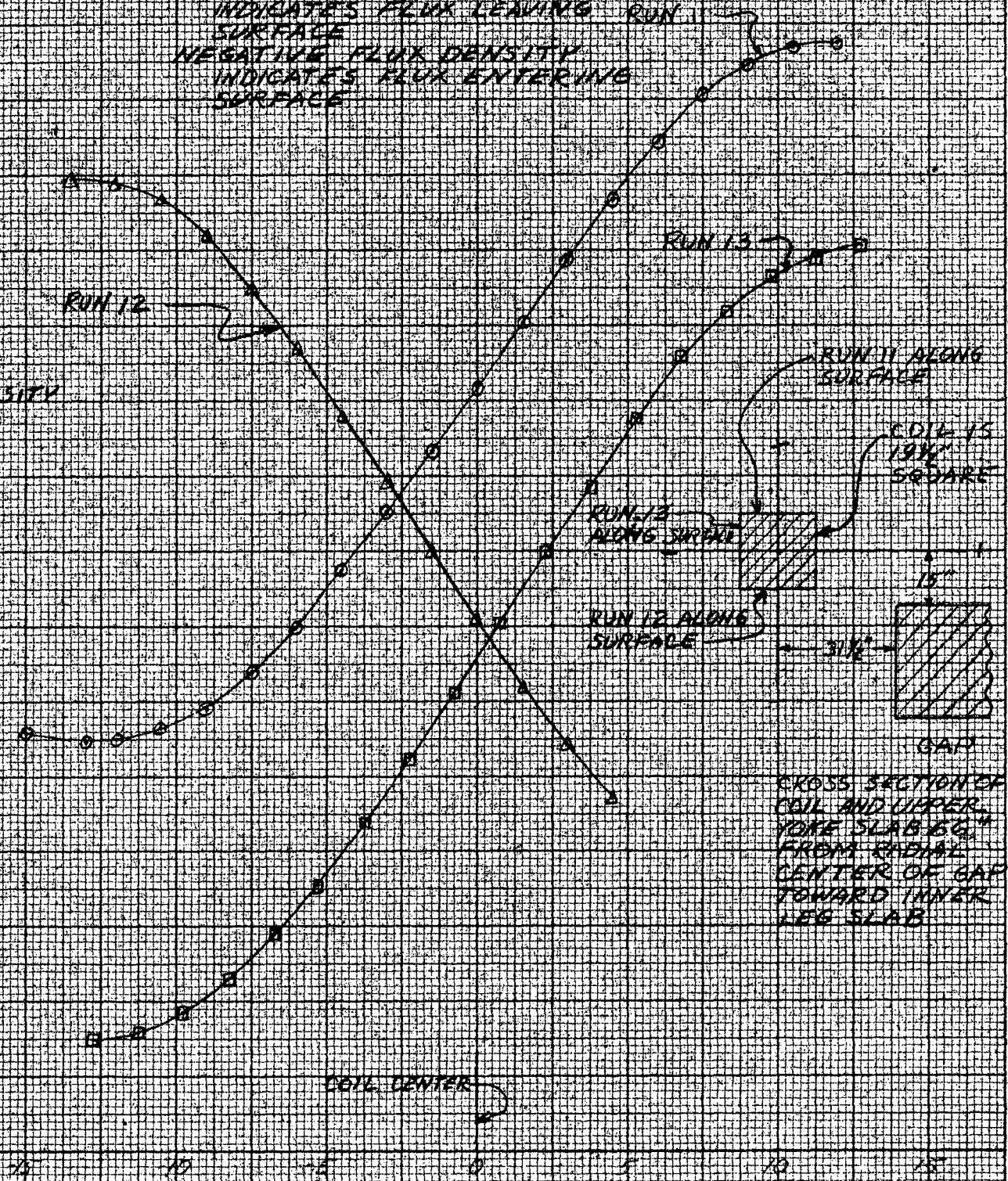
AUGUST 28, 1949

BEVATRON MODEL MAGNET DEGA-3  
 FLUX DENSITY ON COILS  
 1/2" SCALE DRAW 341635  
 YOKE DWG 34196E  
 COIL DWG 341703C  
 2 COILS 49 TURNS EACH  
 98 TURNS TOTAL  
 FIELD AT GAP CENTER 5750 GAUSS  
 GAP 2" (F.S.) AT CENTER  
 3" (F.S.) ADDED TO OUTER LEG SLAB  
 POSITIVE FLUX DENSITY  
 INDICATES FLUX LEAVING SURFACE  
 NEGATIVE FLUX DENSITY  
 INDICATES FLUX ENTERING SURFACE

171-8  
 5-106613-35  
 8-22-48

1500  
 1000  
 500  
 0  
 -500  
 -1000  
 -1500

FLUX DENSITY  
 IN GAUSS



15 10 5 0 5 10 15  
 F.S. INCHES FROM COIL CENTER LINES

R.S.C.

KEUFFEL & ESSER CO., N. Y. NO. 2597-150  
 10 X 10 to the 1/2 inch. 5th line centered.  
 Engraving 7/8 X 10 in.  
 MADE IN U.S.A.

AUGUST 24, 1948

REVIATRON MODEL MAGNET DC66A.3

171-B

FLUX DENSITY ON COILS

5-DC66A.3.36

1/2 SCALE DWG 311635

5-27-48

KOKE DWG 311962

COIL DWG 311703C

2 COILS - 43 TURNS EACH

38 TURNS TOTAL

FIELD AT GAP CENTER 5350 GAUSS

GAP 3/4" (E-S) AT CENTER

3" (E-S) ADDED TO OUTER LEG SLAB

POSITIVE FLUX DENSITY INDICATES

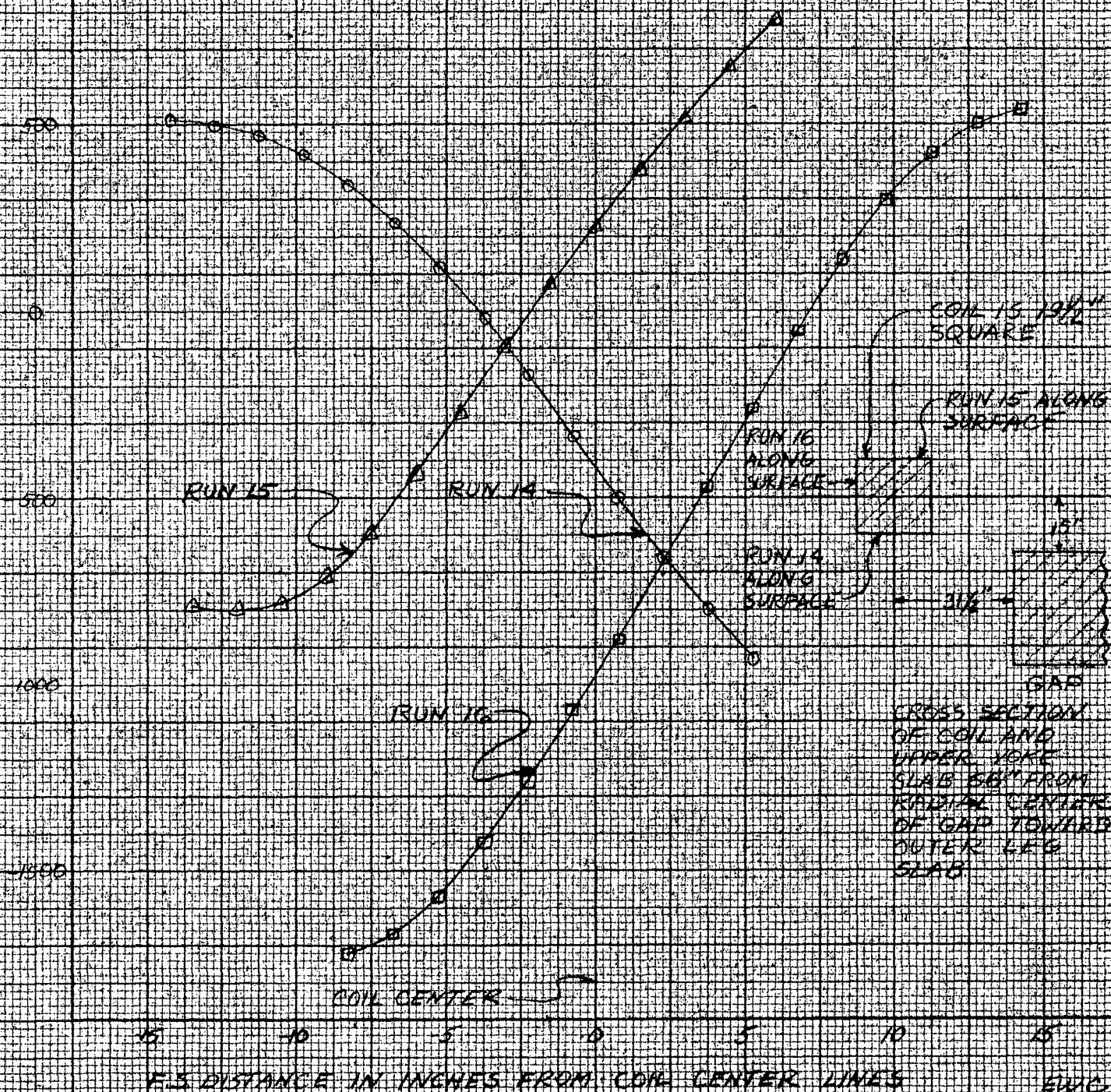
FLUX LEAVING SURFACE

NEGATIVE FLUX DENSITY INDICATES

FLUX LEAVING SURFACE

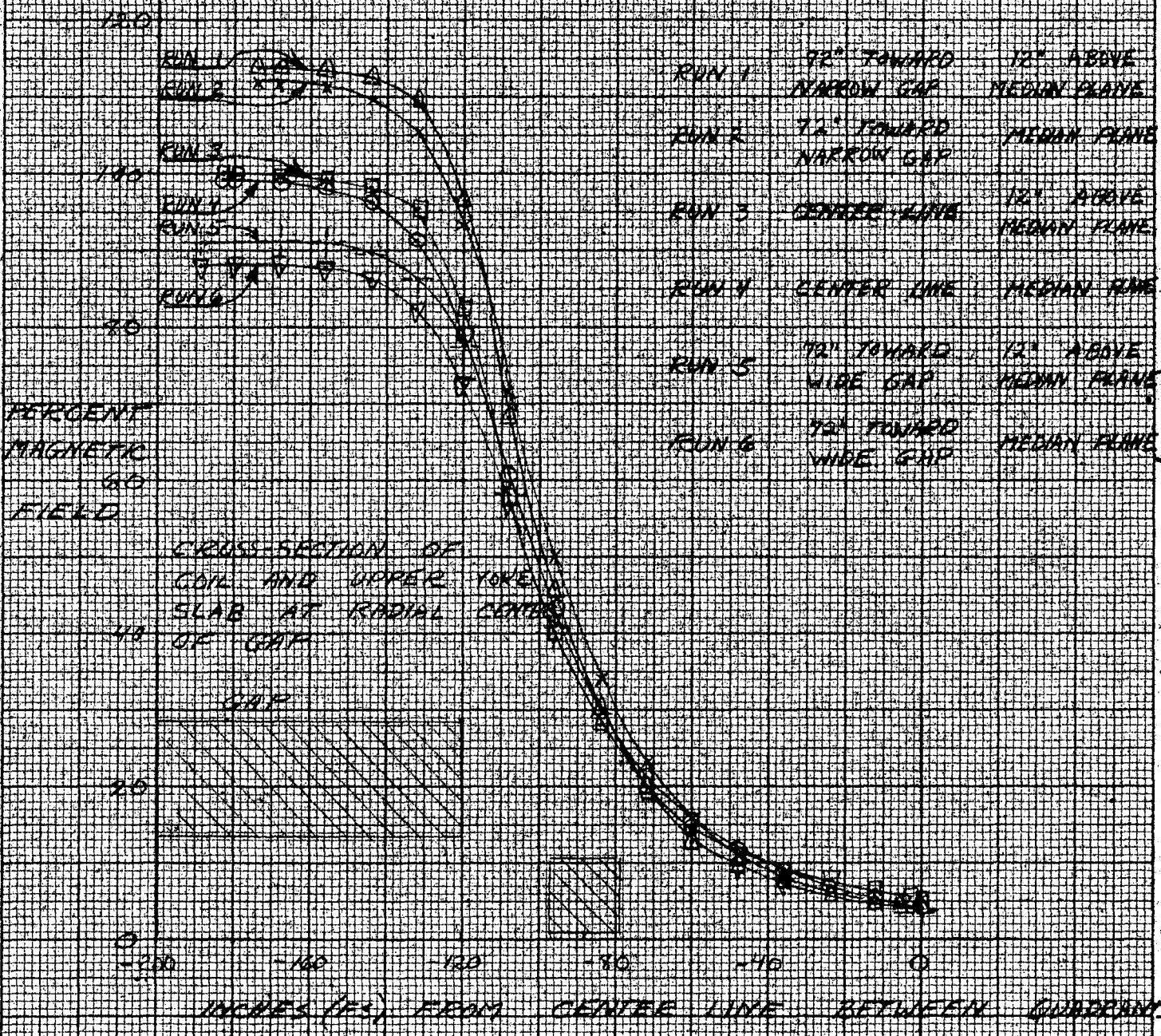
FLUX DENSITY  
IN GAUSS

(1000)

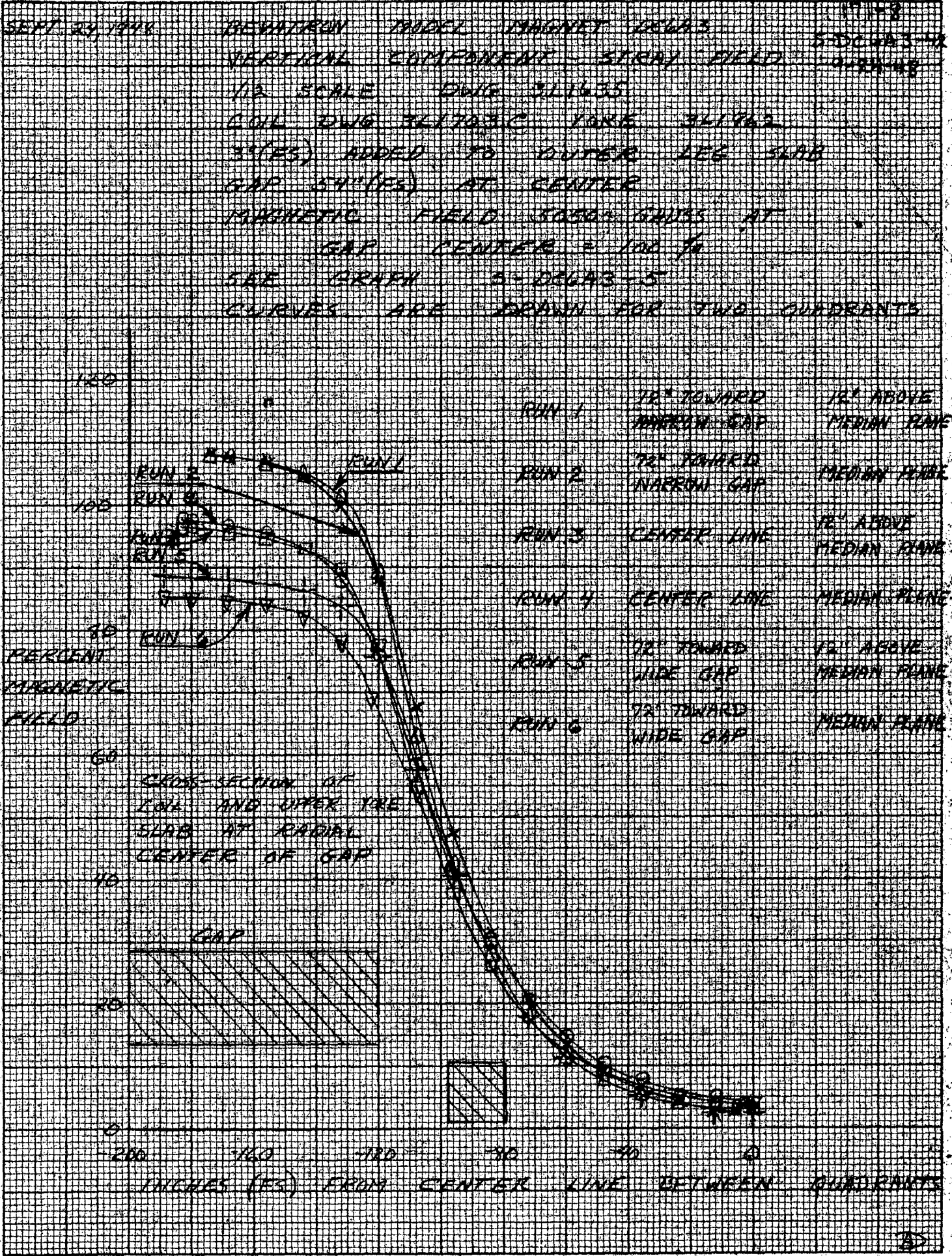


KEUFFEL & ESSER CO., N. Y. NO. 397-120  
10 X 10 to the 1/4 inch, 5th lines counted.  
Engraving 7 1/2 X 10 in.  
MADE IN U.S.A.

SEPT 23, 1948 BEVATRON MODEL MAGNET DC643  
 VERTICAL COMPONENT STRAY FIELD  
 1/2 SCALE DWG 3L1635  
 COIL DWG 3L1631 IONIC DWG 3L1642  
 3" (FS) ADDED TO OUTER LEG SLAB  
 GAP 54" (FS) AT CENTER  
 MAGNETIC FIELD 3100 GAUSS AT  
 GAP CENTER = 100%  
 SEE GRAPH S-DC643-5  
 CURVES ARE DRAWN FOR TWO QUADRANTS



REUFFEL & ESSEB CO., N. Y. NO. 3587-120  
 10 X 10 to the 1/4 inch, 50k lines acetized  
 Engraving 7 1/4 X 10 in.  
 MADE IN U.S.A.



KEUFFEL & ESSER CO., N. Y. NO. 3857-100  
 10 X 10 to the 1/4 inch, 5th lines accounted.  
 Engraving 1/4 X 10 in.  
 MADE IN U.S.A.

SEPT 24, 1948

GRAVITRON MODEL MAGNET IC6A3

5-DC6A3-13

VERTICAL COMPONENT - STRAY FIELD

9-24-48

1/16" SCALE DWG 3L1635

COIL DWG 3L1763C YORE 3L1962

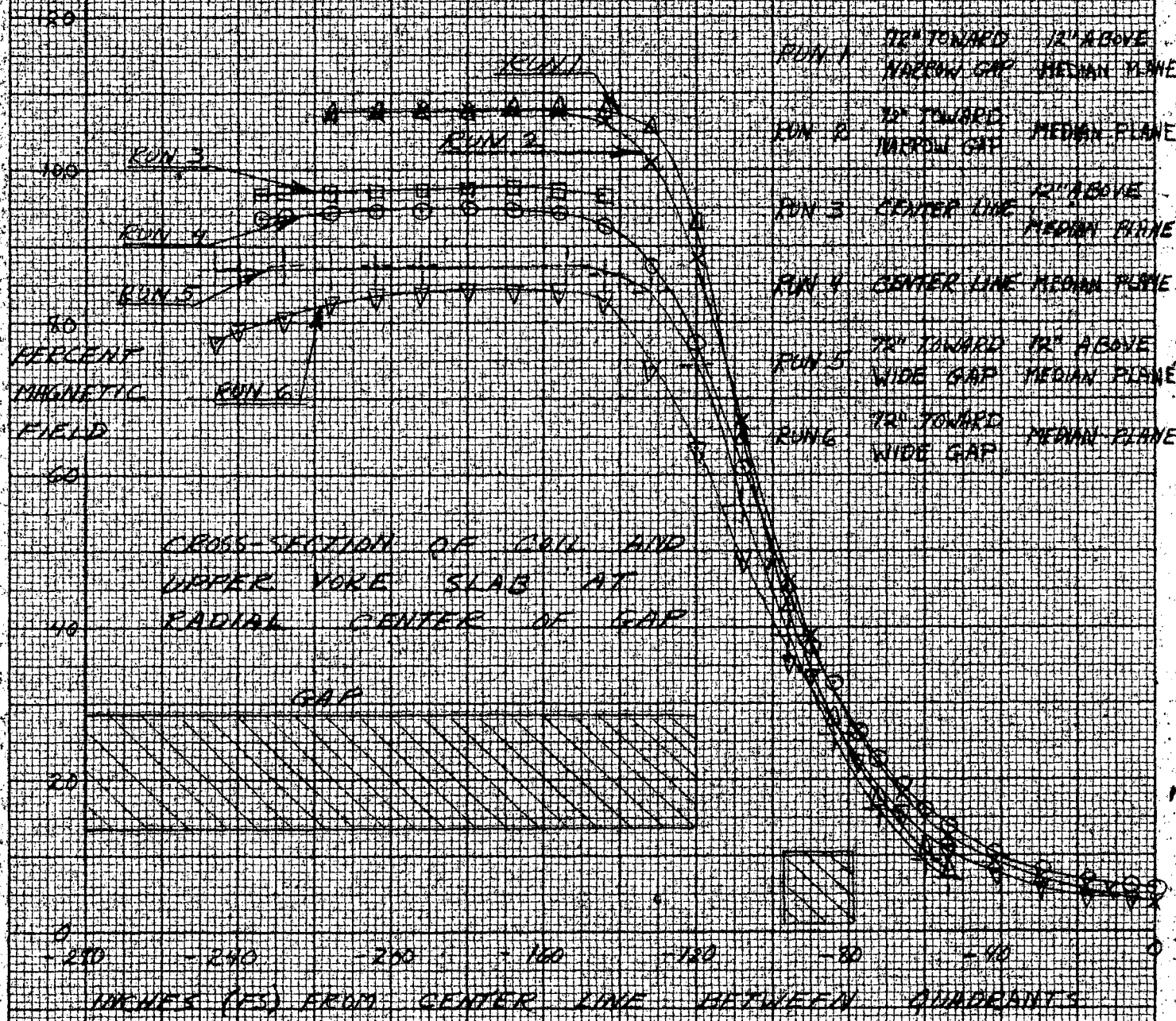
3" (FS) ADDED TO OUTER LEG SLAB

GAP 54" (FS) AT CENTER

MAGNETIC FIELD 200 GAUSS AT GAP CENTER = 100%

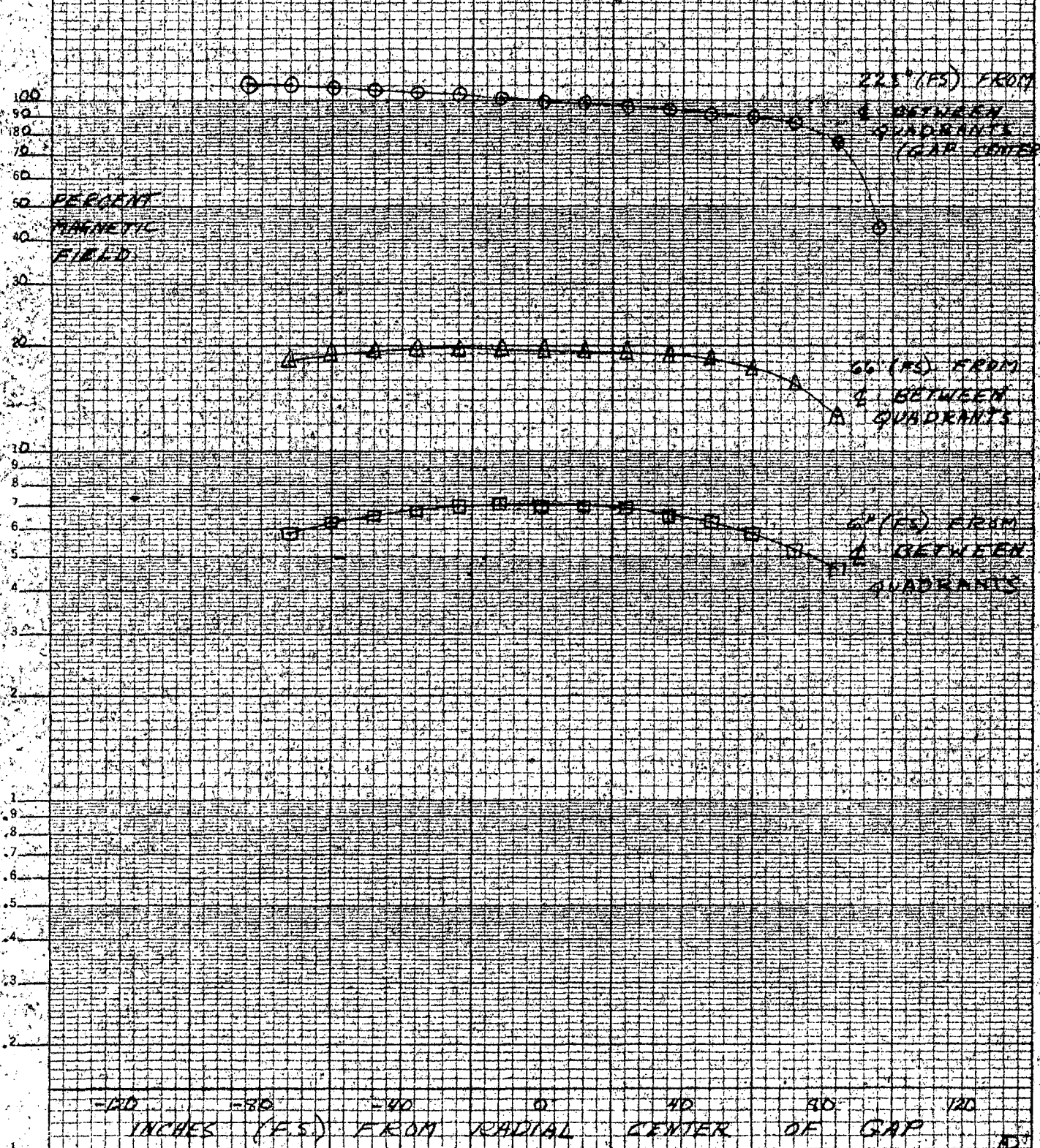
SEE GRAPH 5-DC6A3-5

CURVES ARE DRAWN FOR TWO QUADRANTS



KEUFFEL & ESSER CO., N.Y. NO. 3587-120  
10 x 10 to the 1/4 inch. 50 lines counted.  
Engraving 7/8 x 10 in.  
MADE IN U.S.A.

DEVIATION MODEL CURRENT DEVIATION  
 SEPT. 27 1948 VERT. COMP. - STRAY FIELD  
 TO SCALE DWG. 311035  
 CAIN DWG. 311038 YOKES DWG. 311039  
 3" GRADDED TO ENTER LEG SABB  
 GAP 54" (FS) AT CENTER  
 MAGNETIC FIELD 200 GAUSS AT  
 GAP CENTER = 100 GAUSS  
 CURVES ARE DRAWN FOR TWO QUADRANTS  
 MEASUREMENTS MADE ON MEDIAN PLANE



KEUFEL & ESSER CO., N. Y. NO. 29-5112  
 Semi-Logarithmic, 1 Cycle X 10 to the Inch.  
 MADE IN U. S. A.



1000  
 9 SEPT 27 48 DEVIATION MODEL MAGNET 0 GAUSS 1071 8  
 8 VERTICAL COMPONENT - STRAY FIELD 3-DC-103-95  
 7 1/2" SCALE DWF 31.16.75 9-27-48  
 6 GOLF DWF 31.16.75 YARD DWF 7.1265  
 5 3/4" (FS) ADDED TO OUTER LEG SLAB  
 4 GAP 5/4" (FS) AT CENTER  
 3 MAGNETIC FIELD 100 GAUSS AT GAP CENTER = 100%  
 CURVES ARE DRAWN FOR TWO QUADRANTS

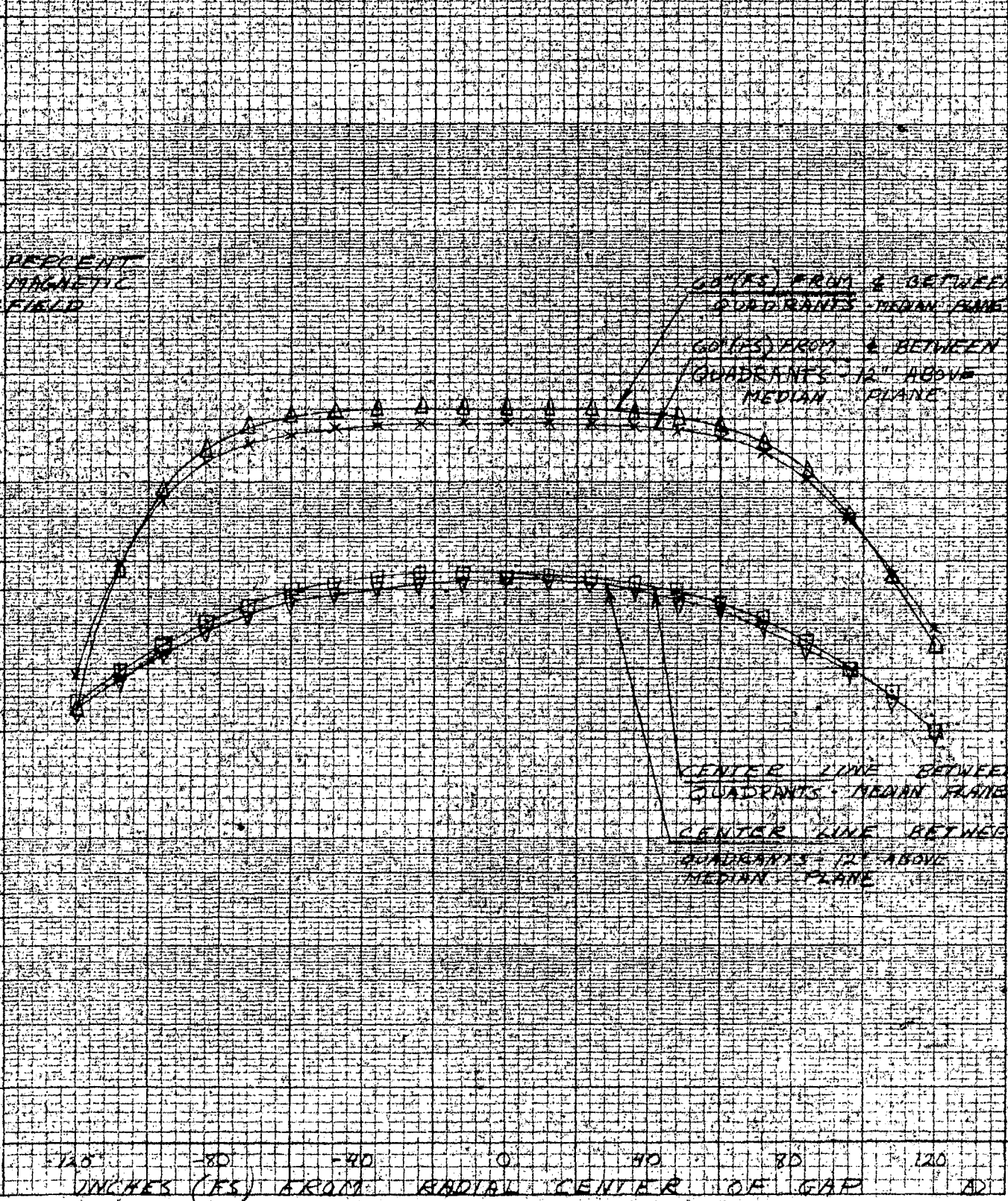
PERCENT  
MAGNETIC  
FIELD

60% (FS) FROM & BETWEEN  
QUADRANTS - 12" ABOVE  
MEDIAN PLANE

60% (FS) FROM & BETWEEN  
QUADRANTS - 12" ABOVE  
MEDIAN PLANE

CENTER LINE BETWEEN  
QUADRANTS - MEDIAN PLANE

CENTER LINE BETWEEN  
QUADRANTS - 12" ABOVE  
MEDIAN PLANE

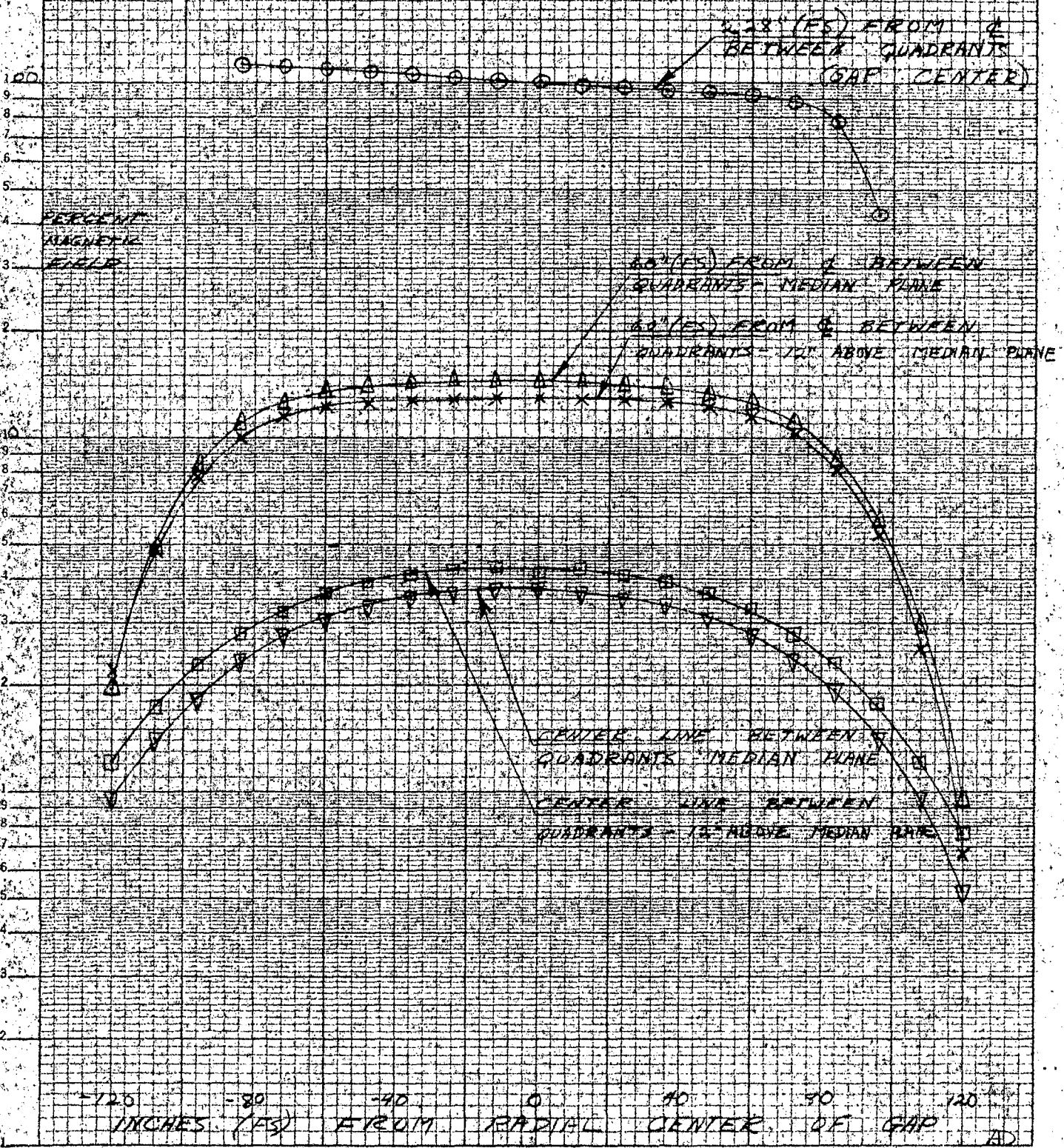


KUPPEL & ERBE CO., N. Y. NO. 550-010  
 Semi-Logarithmic, 4 Cycles x 10 to the inch.  
 MADE IN U.S.A.

INCHES (FS) FROM RADIAL CENTER OF GAP

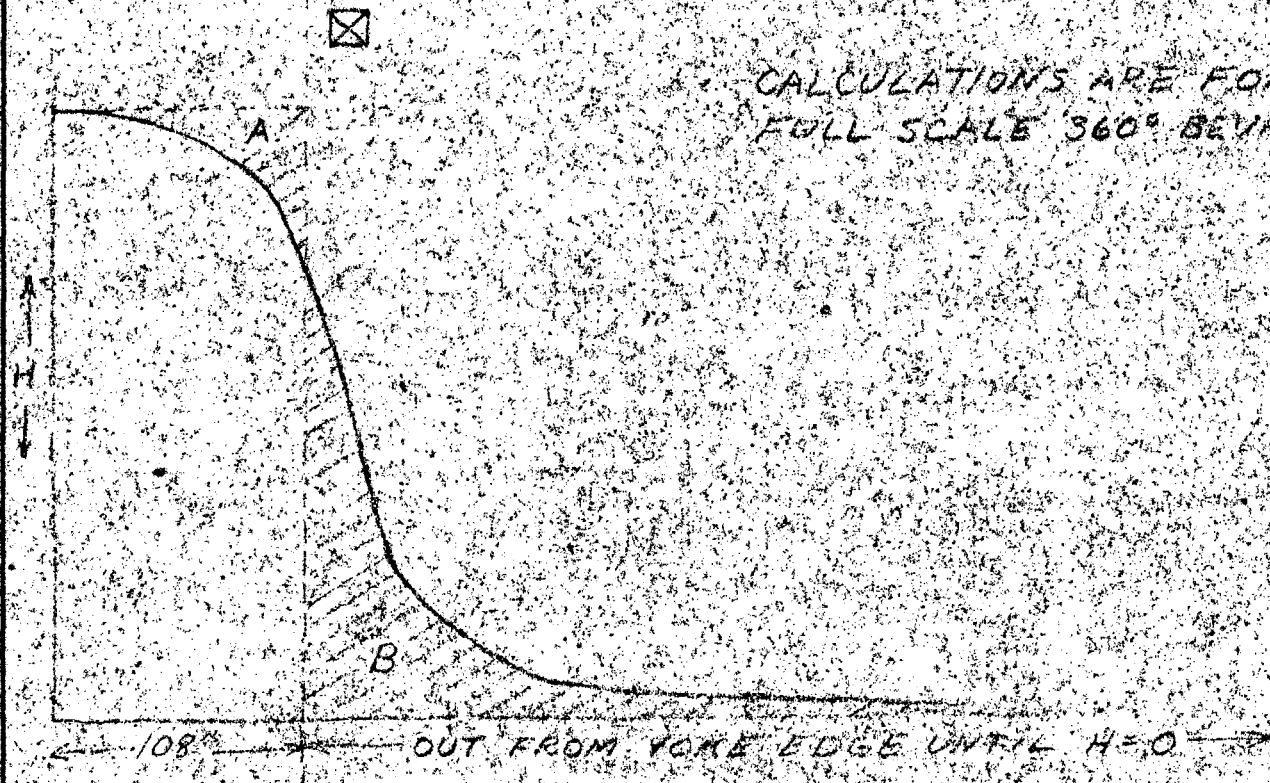
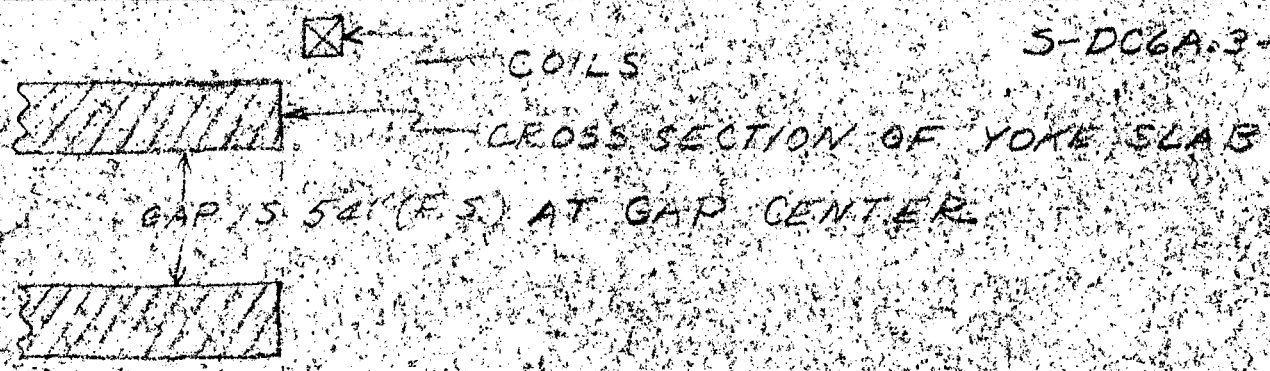
1000  
 9  
 8  
 7  
 6  
 5  
 4  
 3  
 2

SEPT 27, 48 REVISION MODEL MAGNET CORE STRAY FIELD 1718  
 VERTICAL COMPONENT S-DRAWN-48  
 1/2 SCALE DWG 52 1035 9-27-48  
 COIL DWG 34 10030 YOKI DWG 16192  
 3"(FS) ADDED TO OUTER LEG SLAB  
 GAP 64"(FS) AT CENTER  
 MAGNETIC FIELD 5050 GAUSS AT GAP CENTER  
 \* 100%  
 CURVES ARE DRAWN FOR TWO QUADRANTS



KEUFFEL & ESSER CO., N. Y. - INC. 300-5100  
 Semi-logarithmic Cycles X 10 to the Inch  
 MADE IN U.S.A.

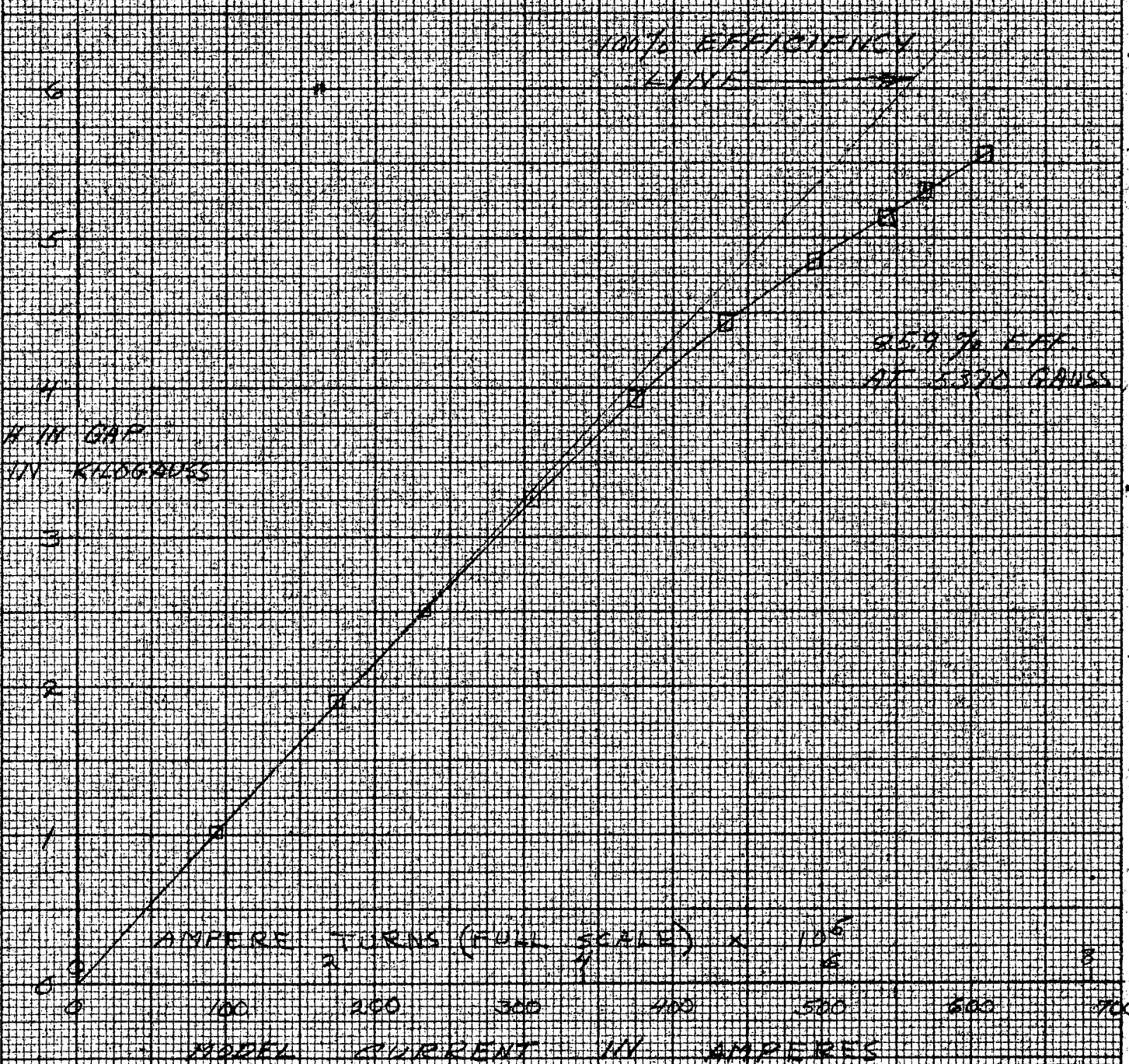
5-DC6A.3-97



CALCULATIONS ARE FOR FULL SCALE 360° BEVATRON

- ① MAXWELLS IN GAP @ 5050 GAUSS (ASSUMING FIELD UNIFORMITY IS CONSTANT TO EDGE OF YOKE - SEE GRAPH F-DC6A.3-12) =  $21.4 \times 10^9$
- ② MAXWELLS IN AREA "A" (INTEGRATED BETWEEN MAGNET COILS) =  $0.244 \times 10^9 = \frac{0.244 \times 10^9 \times 100}{21.4 \times 10^9} = 1.1\%$  OF ①
- ③ MAXWELLS IN AREA "B" (INTEGRATED TO H=0 OUTSIDE GAP) =  $1.53 \times 10^9 = \frac{1.53 \times 10^9 \times 100}{21.4 \times 10^9} = 7.2\%$  OF ①
- ④ TOTAL % LEAKAGE FLUX = ③ - ② = 7.2 - 1.1 = 6.1

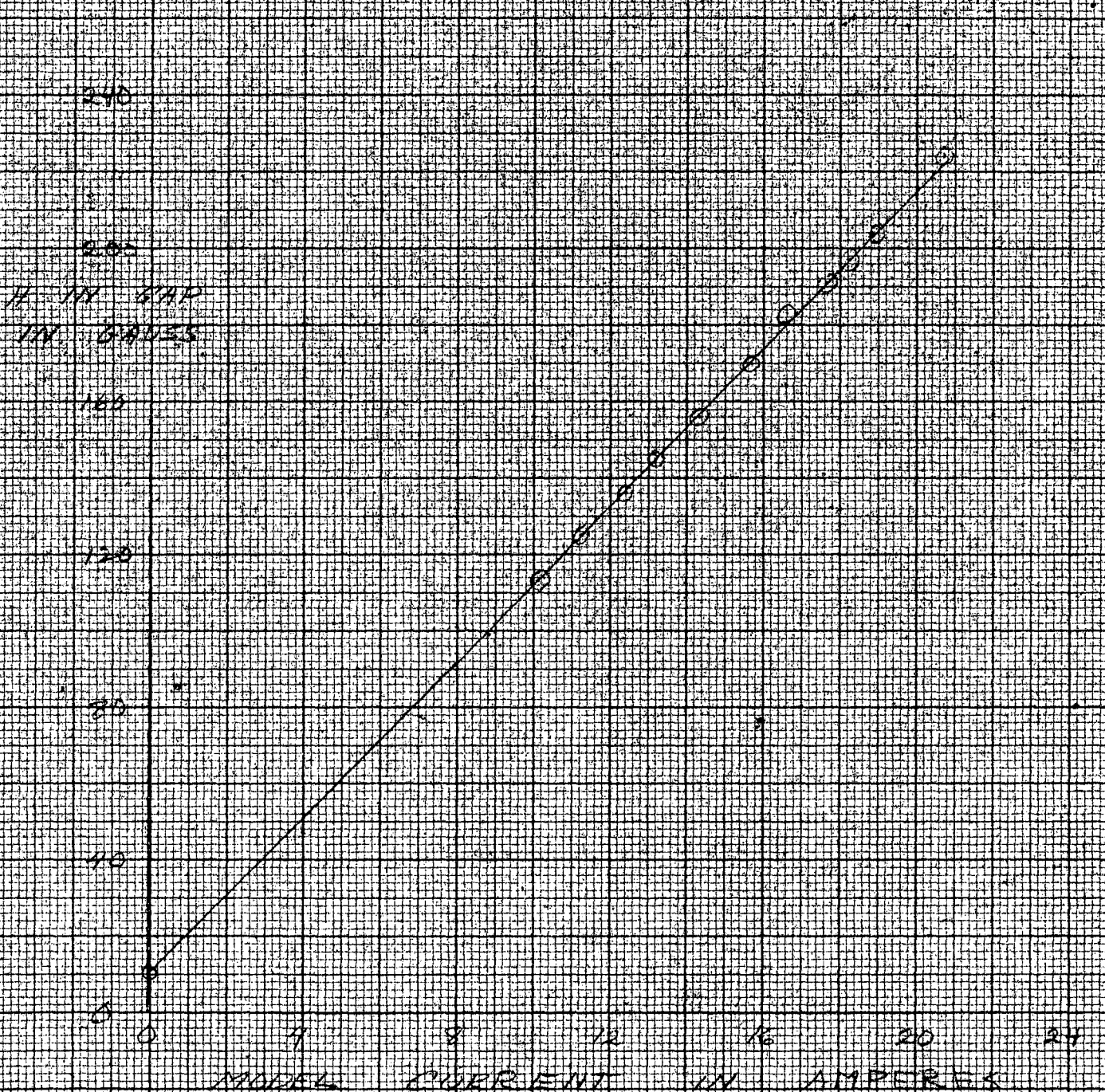
SEPT 3, 1948 BEVATRON MODEL MAGNET COILS  
 MAGNETIZATION AT GAP CENTER  
 1/2 SCALE DWG 341635  
 GAP 25" (FS) AT CENTER  
 98 TURNS ON MODEL COILS  
 3 (FS) ADDED TO OUTER LEG  
 SEE GRAPH UBEV-3



KEUFEL & ESSER CO. N.Y. NO. 3597-100  
 1) X 19 to the 1/4 inch. 6th lines accounted.  
 Shriveling 7% X 10<sup>10</sup>  
 MADE IN U.S.A.

SEPT 2, 48 BEVATRON MODEL MAGNET DOLAN  
 MINIMIZATION AT GAP CENTER  
 1/2 SCALE DWS 30135  
 GAP 54 (FS) AT CENTER  
 ON TURNS ON MODE 20110  
 31 ADJUST ON OUTER LEG  
 SET GRAB 1 BEV 3

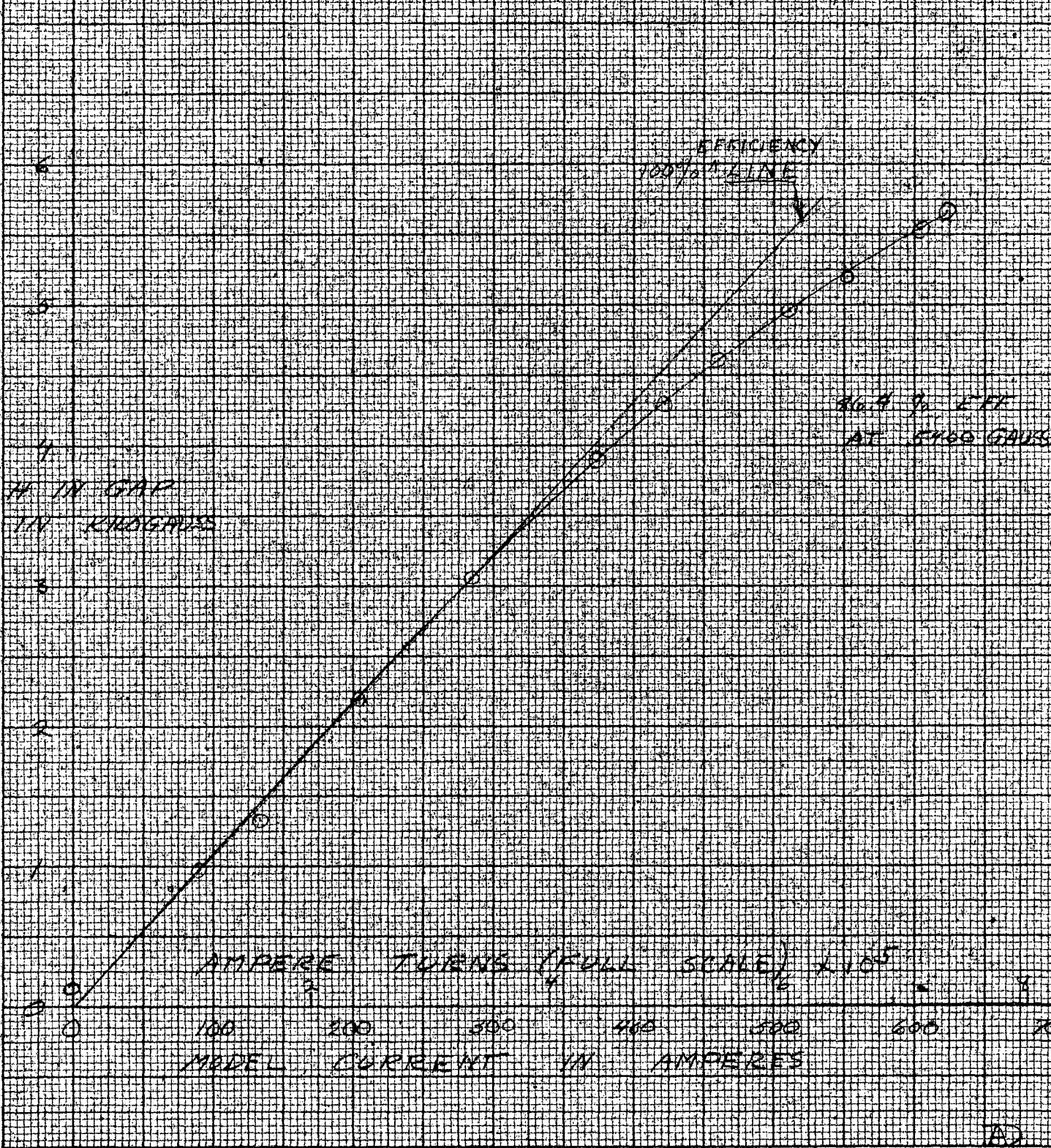
1712  
 H. DOLAN  
 9-2-48



KEUFFEL & ESSER CO., N. Y. NO. 3537-120  
 10 X 10 to the 3/4 inch, 6th lines counted.  
 Engraving 7/8 X 10 1/2  
 MADE IN U.S.A.

7D

DEVIATION MODEL MAGNET COILS  
 SEPT. 3, 1948 MAGNETIZATION AT GAP CENTER  
 1/100 SCALE DANG SLIDES  
 GAP 54 (FS) AT CENTER  
 98 TURNS ON MODEL COILS  
 33 (FS) ADDED TO OUTER LEG  
 SEE GRAPH UNDER-3

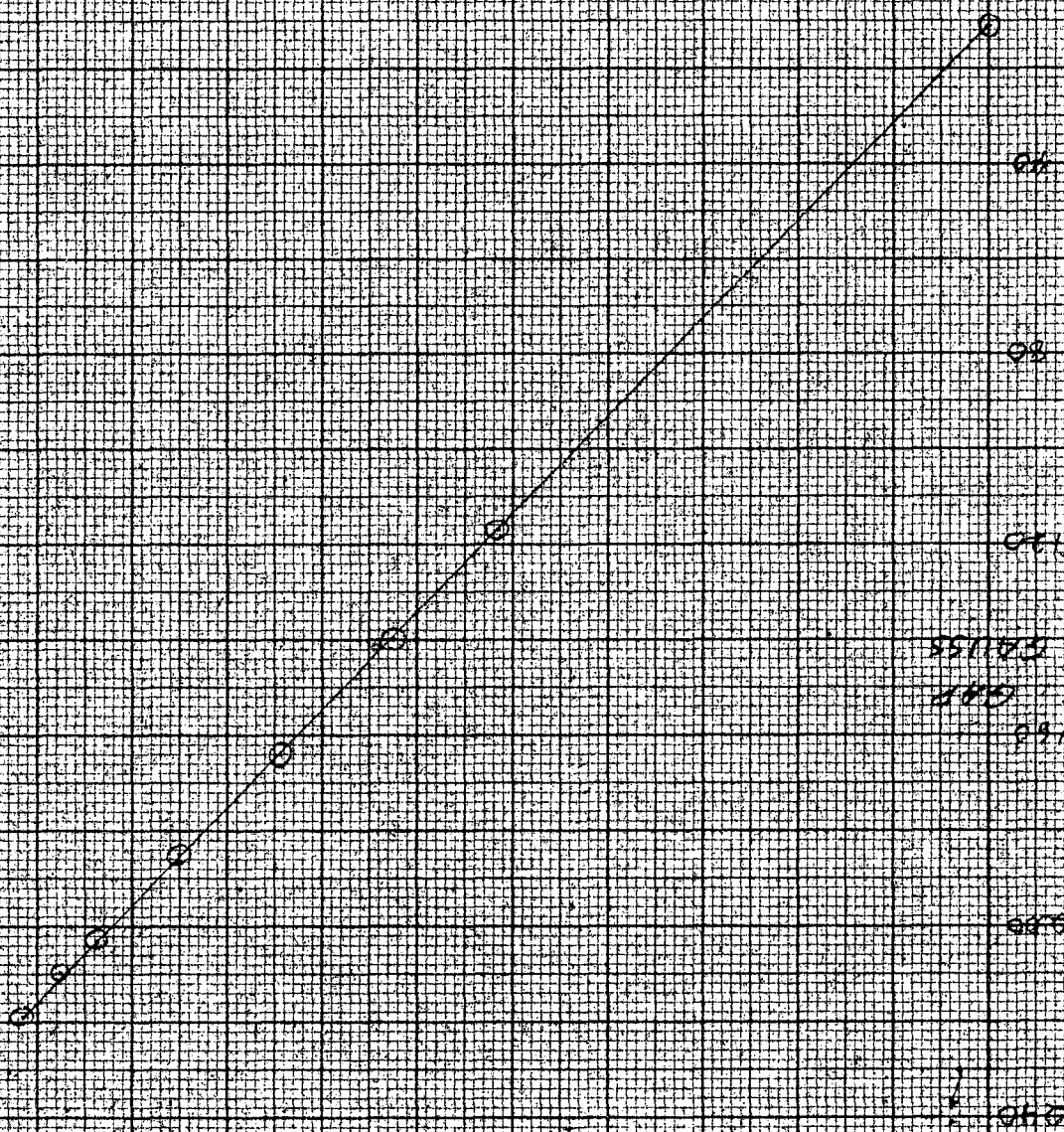


KRUEFFEL'S ESSER CO., N. Y. NO. 385120  
 10 X 10 to the 1/2 inch, 5th class Accredited.  
 Engraving 7/4 X 10 IN.  
 MADE IN U.S.A.

TAD

MODEL CURRENT IN AMPERES

0 4 8 12 16 20 24

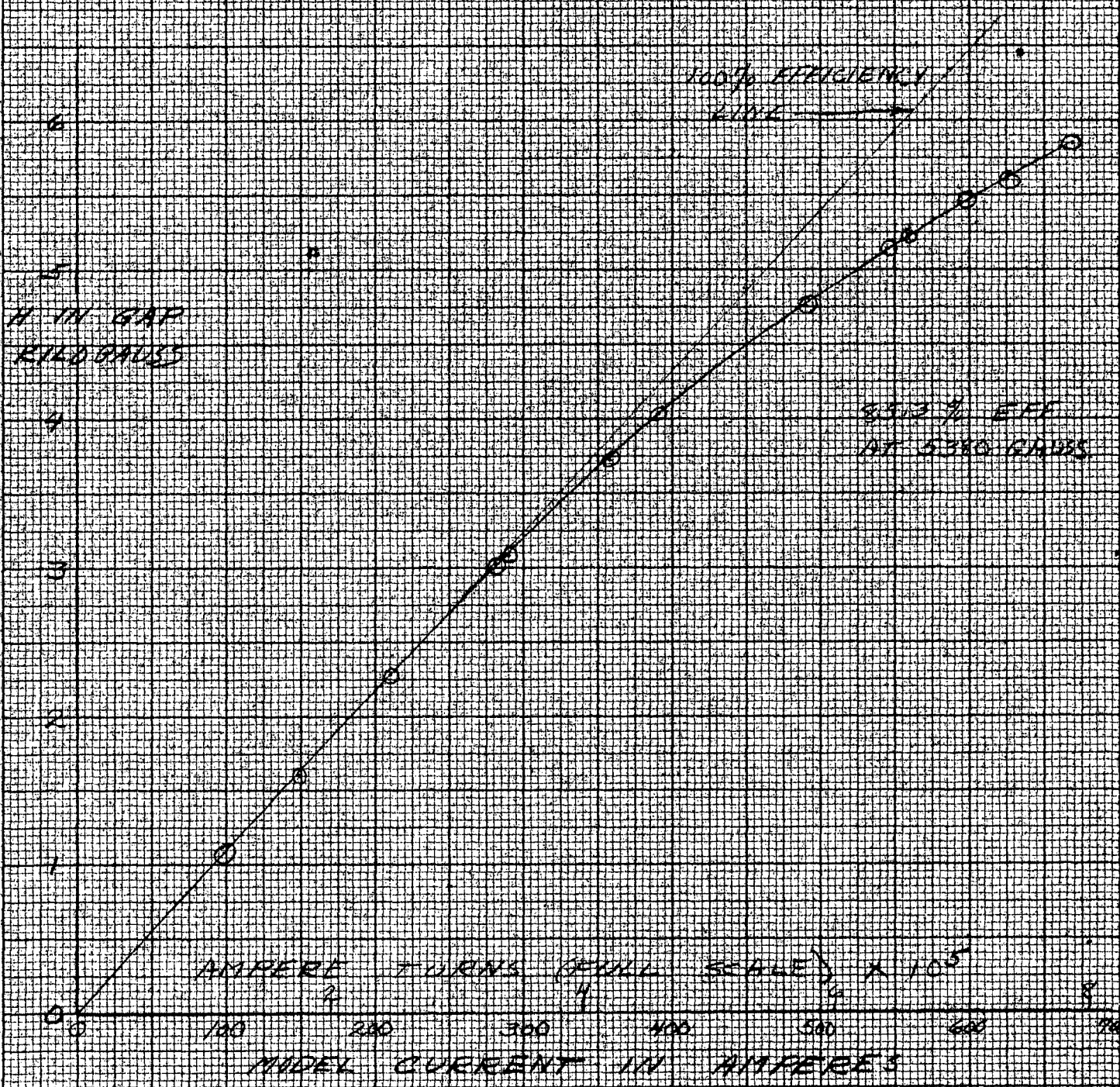


H IN GAUSS

SEPT 3 1918  
 MODEL MAGNET COILS  
 MOUNTED ON AT GHT CENTER  
 1/2 IN. SCALE THIS SCALE  
 GHT CENTER  
 08 TURNS ON MODEL COILS  
 3 1/2 IN. ADDED TO OUTER LEG  
 SEE GRID W-BE-3

1918  
 W-6005-1  
 9-2-18

SEPT 1948 BEVATRON MODEL MAGNET DESIGN  
 MAGNETIZATION AT GAP CENTER  
 1/2 SCALE DATA 341535  
 GAP 54" (FS) AT CENTER  
 98 TURNS ON PADDEL COILS  
 30" (FS) ADDED TO OUTER LEG  
 COILS EQUALLY SPACED  
 SEE GRAPH U-BE-13

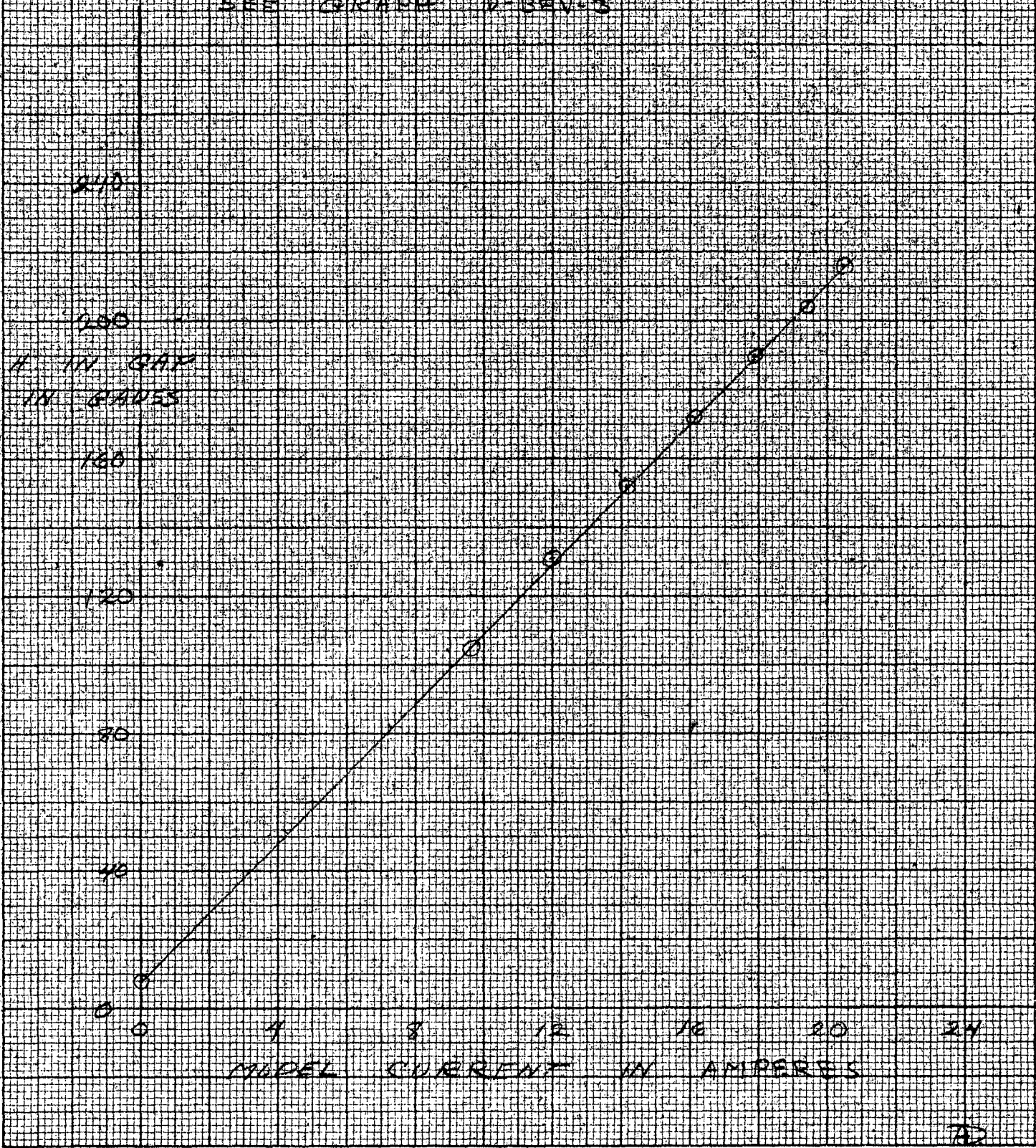


KEUFFEL & ESSER CO., N. Y. NO. 3387-122  
 10 x 10 to the 1/4 inch, 5th lines omitted.  
 Engraving 7/8" x 10 in.  
 MADE IN U.S.A.

AD



SEPT 3, 1948 BEHAVIOR MODEL MAGNET DESIGN 171-8  
 MAGNETIZATION AT GAP CENTER 440646-2  
 1/12 SCALE DWG 31635 9-3-48  
 GAP 5" (1.5") AT GAP CENTER  
 94 TURNS ON MODEL COILS  
 31 ADDED ON OUTER LEG  
 SEE GRAPH V SEN. 3



KEUFFEL & ESSER CO., N.Y. NO. 387-120  
 10 X (10 to the 1/2 inch, 5th lines accounted.  
 Engraving 7/8 X 10 in.  
 MADE IN U.S.A.