THESIS

THE TEST OF A SYNCHRONOUS CONVERTER

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CONTENTS

The Synchronous Converter ----------Page 1

Description of Machine Tested ---------- " 1

Resistances ---------- " 2

Calibration of instruments ---------- " 3

Stray power losses ---------- " 3

Ratio of Voltages ----------" 6

Efficiency ---------- " 9

Synchronous motor diagram ----------" 15

The Saturation Curve ----------" 18

The Synchronous Reactance Curve ----------" 19

Hunting of the Converter ----------" 19

Starting ----------" 20

The Heat Run ----------" 20

Curves ----------" 26 - 34

THE SYNCHRONOUS CONVERTER—

Consider two opposite commutator bars on an ordinary two-pole direct current dynamo. The E.M.F. between these two bars alternates as the armature rotates, and if these two commutator bars are connected to two collector rings, this same machine may be used to deliver alternating current. Such a machine may be belt driven and deliver direct current or alternating current or both. It may be driven as a direct-current motor and deliver mechanical power or alternating current or both. It may be driven as a synchronous motor and deliver mechanical power or direct current or both.

The ordinary use of this machine however, and the most important use is to convert from alternating current to direct current. For this purpose it is driven as a synchronous motor and loaded by delivering direct current.

DESCRIPTION OF THE MACHINE TESTED.-

The machine is a six ring, sixty cycle machine rated at seven and one-half K.W. The rated speed is 1800 R.P.M.; current output 47-68 amperes and corresponding voltage of 160-110. The machine has 96 commutator bars and 4 field spools. It has six collector rings so that different phase currents may be obtained. To do this taps are brought out to the rings at 0, 90, 120, 180, 240 and 270 electrical degrees apart. This gives symetrical two and three phase currents. Resistances of the armature and field are given in a table on page 2. These resistances were gotten by the drop of potential method, i.e. R = E/I (Ohm's Law)

RESISTANCE OF ARMATURE MEASURED FROM A.C. SIDE.

Amperes	Milli volts	Centigrade Temperature	R.(ohms.)
1.277	75.4	17.5	.0591
2.254	130.2	17.5	.0578
		Average	.0584

RESISTANCE OF ARMATURE INCLUDING BRUSHES, AND BRUSH CONTACT MEASURED FROM D. C. SIDE.

Amperes	Milli volts	R (ohms.)
1.23	144.3	.1172
1.62	187.0	.1152
1.81	209.3	.1152
2.54	282.1	.1110
	Average	.1141

RESISTANCE OF FIELD.

Amperes	Volts	R (ohms.)
2.30	88	38.2
2.90	110.8	38.2
	Average	38.2

During this test the machine was operated as a single phase synchronous converter and loaded by delivering direct current.

CALIBRATION OF THE D.C.INSTRUMENTS

The direct current instruments used were calibrated as follows:-millivoltmeters No.1 and 2 were calibrated by comparison with the potentiometer as a standard. These two instruments,i.e.millivoltmeters Nø.1 and 2,when used with their proper shunt boxes are used as standard ammeters, and other direct current ammeters were calibrated by comparison. The direct current voltmeters were calibrated by comparison with the potentiometer. Correction curves for these instruments may be found on page 26.

CALIBRATION OF THE A.C.INSTRUMENTS

The A.C.instruments were calibrated by comparison with the standard D.C.instruments,a multicellular voltmeter,which deflects the same amount for equal values of alternating and direct current,having been placed in parallel with the two instruments. Correction curves for these instruments are found on page 27.

THE STRAY POWER LOSSES

To determine the stray power losses, the machine is run as a direct current motor without load. The speed of the machine was held constant (at 1800 R.P.M.) while the field current varied. To do this a rheostat was placed in series with the machine and the speed adjusted by means of this rheostat. The vibrations of a tuning fork were watched through a hole in a disk on the end of the rotating shaft of the machine. In this way the variations of the speed were noticed.

MEASUREMENTS FOR STRAY POWER LOSSES.

Measured				Corrected for Instruments.			
Ex	Ia	If	Speed	No.	Ex	I total	If
110	7.7	1.7	1800	1	107.45	7.44	1.705
110	7.1	1.29	"	2	106.40	6.84	1.307
110	6.75	1.141	"	3	106.40	6.55	1.157
110.5	6.5	1.00	"	4	106.45	6.30	1.010
110.5	6.3	.88	"	5	106.45	6.10	.887
110	6.3	.76	"	6	106.40	6.10	.767
110	6.2	.622	"	7	106.40	6.00	.634
110	6.2	.56	"	8	106.40	6.00	.574
102.9	6.8	.825	"	9	99.7	6.30	.832
104.1	6.75	.725	"	10	100.84	6.55	.733
91	6.75	.695	"	11	88.40	6.55	.704
115	6.6	.91	"	12	111.20	6.40	.917
114	6.4	.92	"	13	110.25	6.20	.927
112.5	6.4	.89	"	14	109.05	6.20	.897
112.6	6.4	.90	"	15	109.15	6.20	.907

CALCULATIONS OF STRAY POWER BOSSES.

No.	Ia	Ra Ia^2	Rf If^2	RaIa^2+RfIf^2	ExI total	Stray power
1	5.735	3.74	110.3	114.04	789	675
2	5.533	3.48	64.6	68.08	728	660
3	5.393	3.31	50.5	53.81	697	643
4	5.290	3.20	39.0	42.20	671	629
5	5.213	3.10	29.6	32.70	650	617
6	5.333	3.24	22.5	25.74	650	624
7	5.366	3.29	15.3	18.59	639	620
8	5.426	3.37	12.6	15.97	639	623
9	5.468	3.42	26.5	29.92	628	598
10	5.817	3.85	20.5	24.35	660	636
11	5.846	3.90	19.0	22.90	579	556
12	5.483	3.43	32.2	35.63	712	676
13	5.273	3.18	32.8	35.98	684	648
14	5.303	3.22	30.7	33.92	677	643
15	5.293	3.20	31.4	34.60	680	655

Let E_x = Brush pressure

" I_a = Armature current

" I_f = Field current

" S = Stray power losses

" R_a = Armature resistance

" R_f = Field resistance

The resistance of the armature and field may be found on page 2. The total power delivered to the machine is E_xI in which I is equal to the sum of the armature and field currents, i.e. I is the total current delivered to the machine.

The armature copper losses are equal to $R_aI_a^2$, and the field losses are equal to $R_fI_f^2$. Since the machine is operated at no load, the total power delivered to the machine less the sum of the armature and field resistance losses, i.e. $E_xI - R_aI_a^2 - R_fI_f^2$, is lost in hysteresis, eddy current and friction. Now the stray power loss is the sum of the hysteresis, eddy current and friction losses.

Thus $S = E_xI - R_aI_a^2 - R_fI_f^2$

A curve is plotted on page 30 with field currents as abscissas and stray power losses as ordinates. Use is made of this curve in the calculation of the efficiency of the machine.

THE RATIO OF A.C. TO D.C. VOLTAGE.

The ratio of voltages was determined by driving the machine as a synchronous converter, and by measuring the A.C. impressed pressure, the D.C. load current and the D.C. pressure.

RATIO OF VOLTAGES.

60 Cycle.

	Observations.				Corrected for Instruments.		
No.	Volts A.C.	Volts D.C.	Current D.C.	Volts D.C?	Volts A.C.	Amp. D.C.	Ratio
1	85.7	122.5	0	118.6	85.2	0	.718
2	81.0	116.0	5.75	112.3	80.8	5.50	.719
3	82.2	115.5	10.60	111.7	81.9	10.40	.732
4	83.8	115.5	16.25	111.7	83.4	15.90	.746
5	84.5	116.0	19.00	112.3	84.	18.70	.747
6	85.0	115.5	25.00	111.7	84.5	24.55	.757
7	86.4	116.0	28.70	112.3	85.9	28.15	.764
8	87.0	115.0	35.50	111.7	86.55	35.20	.775
9	88.0	114.5	43.50	110.2	87.6	41.75	.794
10	88.3	114.6	48.5	110.3	87.65	46.30	.794

Ra = .1141

THEORETIC RATIO OF VOLTAGES.

No.	1.47 RaIa	D.C.E	D.C.E-1.47 RaIa	A.C.E	D.C.Ia	Ratio
1	0	120.9	120.9	85.5	0	.707
2	0	120.4	120.4	85.2	0	.707
3	.925	114.1	113.475	80.8	5.50	.712
4	1.745	115.7	113.955	81.9	10.40	.718
5	2.670	117.9	115.230	83.4	15.90	.713
6	3.140	118.7	115.560	84.0	18.70	.727
7	4.128	119.5	115.375	84.5	24.55	.732
8	4.720	121.3	116.570	85.9	28.15	.737
9	5.910	122.5	116.590	86.55	35.20	.742
10	7.010	124.	116.990	87.6	41.75	.751
11	7.770	124.1	116.330	87.65	46.30	.787

The ratio is found from zero to full load current output, and a curve is found on page 29 between load current and ratio of voltages. A tabulation of the measurements and results is found on page 7.

The ratio of voltages is also calculated, by assuming a theoretic ratio .707 at no load. For any other load up to full load, were it not for the losses that occur in the machine this ratio would be constant and the D.C. voltage is corrected for different A.C. voltages, assuming this constant ratio. From the D.C. voltages gotten in this way the armature RI drop, which is equal to $1.47R_aI_a$, is subtracted, I_a being the D.C. load current and R_a the resistance of the armature measured from the D.C. side. The reason for using the factor 1.47 is explained in the efficiency calculations. Thus instead of the D.C. voltage being equal to the A.C. voltage divided by .707, it is equal to the A.C. voltage divided by .707 less $1.47 R_aI_a$. The corresponding A.C. voltage divided by this value of the D.C. voltage for this load current gives the correct ratio. A table of the data and results of this calculation is given on page 8 and a curve between ratio of voltages and load currents is found on page 29.

EFFICIENCY BY MEASURING INPUT AND OUTPUT

The efficiency of the machine is determined by measuring the input and output, and calculated by the equation:-

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

The tabulation of the measurements and results of this calculation are given on page 11&12. A curve is also drawn on page 33 between output in K.W. and per cent efficiency

Since the losses which occur in the machine are known, the efficiency at different outputs is calculated from the equation:-

$$\text{Efficiency} = \frac{\text{Input} - \text{losses}}{\text{Input}}$$

The losses are - the armature losses ($1.47\ R_a I_a^2$), the field losses ($R_a I_a^2$), and the stray power losses. The armature losses are determined from the equation $RI^2 = 1.47\ R_a I_a^2$ in which RI^2 is the true armature resistance loss, and R_a is the resistance as measured from the D.C. side and I_a is the D.C. load current. The $R_a I_a^2$ losses are multiplied by 1.47 this being a factor by which these losses must be multiplied to get the total armature resistance loss. The factor 1.47 is gotten as follows:- RI^2 is the true armature resistance loss, in which I is the square root of the average square of the resultant currents of the A.C. and D.C. currents in the armature. R is the effective armature resistance for this resultant current. This value RI^2 divided by $R_a I_a^2 = 1.47$

The efficiency is calculated for constant A.C. impressed pressure, and the D.C. pressure is found by multiplying the impressed A.C. pressure by the ratio of voltages at different loads given by the curve on page 29. Different load currents are assumed and a field current of 1.6 amperes is assumed for the maximum load current. At this load the D.C. voltage is lowest and as the load current decreases the D.C. voltage increases. Now the field current varies directly as the D.C voltage. Thus different values of the field current are gotten for different values of the load current, the field losses being $R_f I_f^2$.

MEASUREMENTS NOT CORRECT FOR INSTRUMENTS.

	A.C. Input			D.C. Output			
No.	I/20	E	Watts/20	I	E	I Field	Speed
1	.47	85.5	34	1.10	126	1.10	1800
2	.84	81.5	57	4.00	119.5	1.05	"
3	1.90	85.7	150	18.00	121.	1.05	"
4	2.28	85	182	23.20	120.5	1.05	"
5	2.48	87.5	210	27.50	120	1.05	"
6	3.20	91	268	37.50	120	1.05	"
7	3.72	91.5	320	44.50	119.5	1.05	"
8	3.95	91.5	330	45.60	119.0	1.05	"
9	4.00	91.5	345	48.6	118.5	1.04	"
10	4.05	91.5	345	49.7	118.5	1.03	"
11	4.07	92	350	50.	119.	1.04	"

MEASUREMENTS CORRECTED FOR INSTRUMENTS.

1	.465	85	34	1.00	121.8	1.00	121.8
2	.795	81.3	57	3.85	115.7	1.01	460
3	1.91	85.20	150	17.65	117.1	1.01	2060
4	2.32	84.4	182	22.70	116.6	1.01	2620
5	2.52	87.1	210	27.05	117.1	1.01	3170
6	3.185	90.8	268	37.40	117.1	1.01	4380
7	3.65	91.3	320	42.65	115.7	1.01	4940
8	3.93	91.3	330	43.65	115.2	1.01	5040
9	4.00	91.3	345	46.50	114.7	1.00	5340
10	4.045	91.3	345	47.60	114.7	.99	5460
11	4.065	91.85	350	47.80	115.2	1.00	5500

EFFICIENCY BY INPUT OUTPUT METHOD.

No.	True A.C.I	True E	True Watts	E If	Total output	Eff.	p.f.
1	9.3	85	680	129	121.8	17.9	.814
2	15.9	81.3	1140	117	460	40.3	.882
3	38.2	85.20	3000	118	2060	68.7	.920
4	46.4	84.40	3640	118	2620	72.0	.930
5	50.4	87.1	4200	118	3170	75.5	.958
6	63.7	90.8	5360	118	4380	81.8	.927
7	73.0	91.3	6400	117	4940	77.2	.961
8	78.6	91.3	6600	117	5040	76.3	.920
9	80.0	91.3	6900	116	5340	77.4	.945
10	80.8	91.3	6900	116	5460	79.2	.935
11	81.2	91.85	7000	117	5500	78.5	.949

EFFICIENCY CALCULATIONS.

No.	A.C. I	A.C. E	Watts	D.C. E	D.C. Ia	D.C. If
1	17.6	90	1370	121.7	3.85	1.725
2	40.4	"	3360	120.5	17.65	1.708
3	49.5	"	4180	119.0	22.70	1.689
4	60.8	"	5180	117.9	27.05	1.872
5	63.2	"	5390	115.6	36.70	1.640
6	65	"	5550	115.2	37.40	1.635
7	77.5	"	6620	114.0	42.65	1.619
8	79	"	6750	113.7	43.65	1.615
9	80	"	6830	113.2	46.50	1.609
10	80.2	"	6850	112.8	47.80	1.600

R_a = .1141 ohms

R_f = 38.2

EFFICIENCY CALCULATED.

No.	1.47 $Ra Ia^2$	$Rf If^2$	Stray power	Total Losses	Input	Input-losses	Eff.%
1	2.48	114.5	676	793	1370	577	42.2
2	52.40	110.4	675	838	3360	2522	45.1
3	86.40	109.0	674	869	4180	3311	79.1
4	123	106.5	673	902	5180	4278	82.6
5	226	102.9	671	1000	5390	4390	81.5
6	234	102.0	670	1006	5550	4544	81.7
7	306	101.0	670	1077	6620	5543	83.7
8	321	100.0	670	1091	6750	5659	83.7
9	363	99.1	670	1132	6830	5698	83.3
10	385	97.8	669	1152	6850	5698	83.0

The stray power losses for different field currents are found from the curve on page 30. The total losses, i.e. 1.47 $R_a I_a^2$, the $R_f I_f^2$ and the stray power losses are subtracted from the input and the efficiency is determined by the equation stated is the outset,

$$\text{Efficiency} = \frac{\text{Input - losses}}{\text{Input}}$$

A curve between output (input - losses) and per cent efficiency is found on page 33. A tabulation of the data and results of this calculation is given on pages 13&14.

SYNCHRONOUS MOTOR CIRCLE DIAGRAM

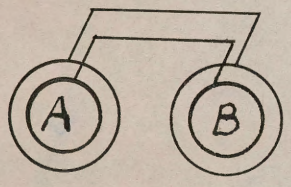


Fig 1

If two alternators A and B are connected in parallel, their E.M.F.s are in phase as regards the external circuit but opposed as regards the local circuit of the two machines

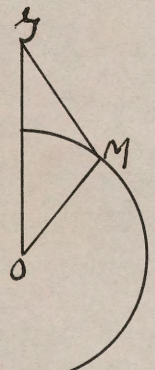


Fig 2

Suppose B drops back in phase, then a current circulates due to the difference in E.M.F. of the two machines. Let the line OG represent the generator E.M.F. Let the line OM represent the motor E.M.F. Then the difference is MG. (Fig. 2) The current that circulated due to this difference in pressure is I = MG/Z Z being the impedance of the motor.

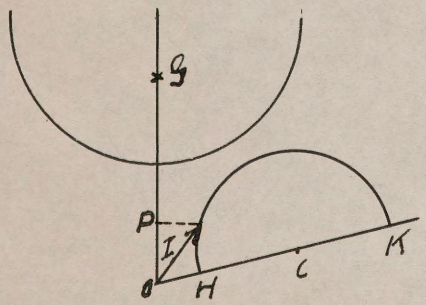


Fig 3.

If Z is considered constant (a thing never true of circuits containing iron) the locus of I is found as follows, lines drawn from G to different positions of M evidently have a circle for a locus of the limit of E but this

is the limit of -E, thus the limit of E is the same circle rotated 180° about the point G.

I is proportional to E and at an angle Tan^{-1} X/R behind it. X and R being the reactance and resistance of the motor armature. A line OC Fig. 3 making this angle with OG is drawn. OG represents impressed pressure in amount and phase. The maximum value E (Fig.2) i.e. Mg = OG + OM The minimum value of E is Og - OM. Thus the minimum value of I is OG - OM/Z = OH and the maximum value of I is OG + OM/Z and other values of I lie on the circle as shown. The center of the circle lies at a distance OC = OH + OK/2 = OG + OM + OG - OM/2Z = OG/Z

If the motor excitation equals the generator excitation, H and O coincide. Call this 100% excitation Then other per cent excitation can be laid off from C toward O and a series of concentric circles give the current loci of I for different excitations.

The RI^2 losses are the only ones that can be calculated and are the only ones that will be considered and thus output will be considered equal to armature input less RI^2 losses.

Og is brush pressure in amount and phase

OP x OG is power input. The projection of I on OG remains constant for different field excitations but with different power factor and current.

Let R = The resistance (Ohms)

" I = The current (Amperes)

To find the locus of I for 100% loss.

E_g is impressed pressure in amount and phase.

$\overline{OI}^2 = X^2 + Y^2$

$OP \times OG = RI^2$

$Y = OP = RI^2/E_g$

$I^2 = E_gY/R$

$X^2 + Y^2 = E_gY/R$

$X^2 - (E_g/R)Y + Y^2 = 0$

Equation of the circle

$(x - a)^2 + (y - b)^2 = r^2$

a and b are coordinates to the center.

$x^2 - 2ax + a^2 + y^2 - 2by + b^2 = r^2$

$x^2 - 2ax + y^2 - 2by = r^2 - (a^2 + b^2)$

Comparing - $a = 0$

$b = E_g/2R$

$r = b$

Thus the center of the circle is on the Y axis and passes through the origin.

The radius of the zero output circle $= E_g/2R$

Suppose the loss instead of being total is only partial, then

$OP \times OG = RI^2 + C$

$Y = RI^2 + C/OG$

$I^2 = E_gY - C/R$

$x^2 - (E_g/R)Y + Y^2 = - C/R$

C being the output

The center is at the same point as before but $r^2 = (E_g/2R)^2 - C/R$

From the table of results of the calculation for the diagram of the machine tested, given on page 23 the circle diagram may be drawn. In these calculations X is taken from the synchronous reactance curve on page 32 Ordinates being XI. I being current input.

From page 2 R = .0584 Ohms.

The circle diagram is given on page.24.

The red lines (Current lines) represent values which were gotten by actual experiment. A table of the measurements of these current values phase angle i.e.power factor = cos of phase angle is given on page 24a.

From the saturation curve on page 31 the field

current for different per cent field excitations, is found. 110 volts is taken as 100% excitation.

Thus by measuring, watts input, current input, and the impressed pressure the power factor and angle θ may be determined. By measuring the field current the per cent excitation is ascertained. Output is measured from D.C. voltage and D.C. load current and thus r may be calculated for this particular output.

The experimental determinations do not agree with the values of current as calculated for the same output in the theroretical case. The reason for this is that the armature losses are greater in the case of a converter than in the case of a simple synchronous motor. The true RI^2 losses of the machine are given in the efficiency calculations and these are greater than the RI^2 losses in the calculations for the circle diagram the R in these calculations being the resistance of the armature measured from the A.C. side. Thus for 100% excitation the power factor at 2.7 K.W. output according to the theoretical case is .99 approx. and the value of the load current is about 23.4 amperes whereas in the actual case the power factor for this same output is .904 and the value of the current is 41 amperes.

THE SATURATION CURVE.

The saturation curve given on page 31 is gotten by belting the machine to a motor and driving it at normal speed i.e. 1800 R.P.M. and observing the field currents for different A.C. voltages. The speed is kept constant by means of a field rheostat on the driving machine, and it is watched by comparison with the vibrations of a tuning fork as in the

case of the stray power determinations.

A tabulation of the data and results is given on page 22 and a curve between A.C. terminal voltage (No load) and field currents is plotted on page 31

THE SYNCHRONOUS REACTANCE CURVE

This curve is gotten by driving the machine as above by another motor,at 1800 R.P.M. The A.C. side is shortcircuited through an ammeter,and the field excitation is adjusted until full load current (or any desired fraction thereof) flows. The ammeter reading is taken and the short-circuit opened and with unchanged speed and field excitation the voltage across the A.C. terminals is taken.

Ammeter readings are plotted as abscissas and open circuit volts as ordinates. This curve is found on page 32.A tabulation of the data and results of this test is found on page 21.

HUNTING OF THE CONVERTER

The machine is not subject to hunting under ordinary stable running conditions. It has copper damping rods or grids in the field pole faces and the currents induced in these grids,by the shifting of the field flux over the pole faces caused by hunting oscillations,opposes the shifting of flux and thus dampens the hunting oscillations.

A resistance between the generator and motor increases the tendency to hunt and the machine began hunting when under a load the resistance was put in.

STARTING.

The machine will not start as an induction motor. Several attempts were made to start the machine by supplying a three - phase current at low voltage to three phase terminals of the machine with the field open but it would not start.

The machine is started by first starting the machine from the D.C.side and getting its speed nearly equal that of the generator and by watching a lamp which was placed in series with motor and generator as shown in the diagram of connections on page 20, and at the proper time pulling the switch which leads in the D.C supply and closing the switch S in the diagram.

THE HEAT RUN

The machine was run at normal speed under full load current output and the temperature rise of the armature and field were measured by means of a thermometer Results were corrected to 25° C. room temperature. A correction 1/2% for each degree rise of room temperature was made in order to correct to 25°C. That is for each degree above 25°C room temperature.

A tabulation of the measurements and results of this run is given on page 25 and a curve is plotted on page 34 with time as ordinates and rise of temperatures as abscissas. As seen from the table the temperature rise comes within the prescribed limits of armature and field winding heating. The bearings do not get hot when the machine is run under full load for 7 hours.

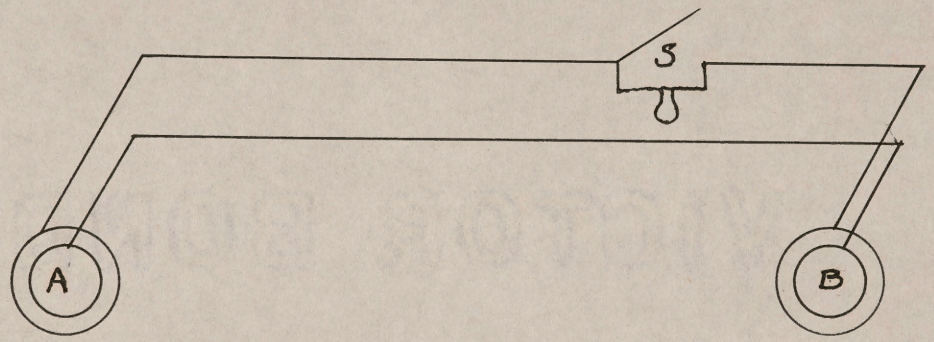


Diagram of Connections for starting

SYNCHRONOUS REACTANCE CURVE OBSERVATIONS.

	Measurements				Corrected for Instruments.	
No.	Open Circuit Volts	Ia	If	Speed	Open circuit Volts	Short circuit Amperes
1	6	.6	Residual	1800	6.5	8.25
2	11.2	1.00	.04	"	11.7	14.25
3	15.	1.28	.11	"	15.5	18.90
4	17.5	1.57	.15	"	18.	23.58
5	23.	1.93	.21	"	24.	29.25
6	25.7	2.19	.255	"	26.2	33.20
7	30.75	2.58	.33	"	31.25	39.30
8	33.2	2.89	.38	"	33.7	43.60
9	40.7	3.41		"	41.2	50.80
10	40.8	3.49	.45	"	41.3	51.90
11	43.5	3.75		"	45.1	55.10
12	45.8	3.82		"	45.85	66.40
13	46.5	4.37		"	47.00	65.25
14	49.0	4.58		"	49.5	68.25
15	51.0	4.78		"	51.5	70.50
16	52	4.88	.67	"	52.50	72.50

SATURATION CURVE OBSERVATIONS.

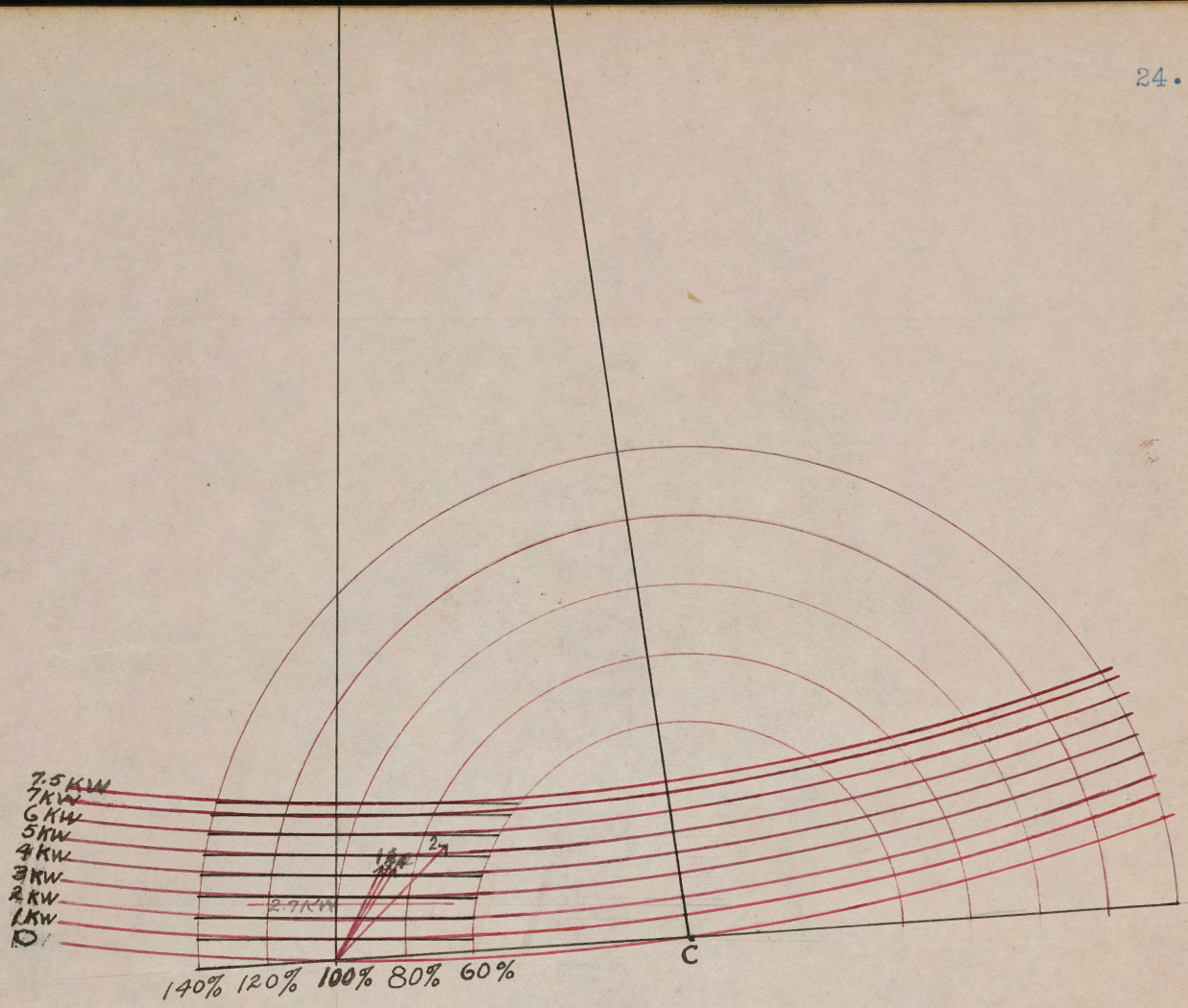
	Measurements			Corrected for Instruments.	
No.	If	E	Speed	E	If
1	2.4	126	1800		
2	3.4	141.6	"	142.1	3.70
3	2.7	134.	"	134.5	3.02
4	2.3	126.7	"	127.2	2.61
5	1.95	120.2	"	120.7	2.16
6	1.70	114.7	"	114.7	2.03
7	1.55	110.1	"	110.65	1.90
8	1.35	105.4	"	105.9	1.74
9	1.15	98.4	"	98.4	1.69
10	1.01	95	"	95.	1.48
11	1.00	90.6	"	90.8	1.47
12	.84	84.4	"	84.9	1.36
13	.75	79.2	"	79.35	1.28
14	.65	74.6	"	74.85	1.20
15	.60	64	"	64.5	1.16
16	.84	60.2	"	60.7	.856
17	.72	54.4	"	54.9	.738
Taken from Syn. Reactance Data				40.7	.47
19	"			33.7	.38
20	"			31.5	.35
21	"			23	.23
22	"			18	.15
23	"			11.7	.08
24	"			6.4	Residual

CALCULATIONS FOR CIRCLE DIAGRAM.

Excitation	60%	80%	100%	120%	140%
Eg	66	88	110	132	154
Eg/z	83.6	111	139.5	167	195

R	X	$\frac{X}{R}$	θ
.0584	.7895	13.5	$85^{\circ}45'$

Output	$r^2 = (\frac{Eg}{2R})^2 - \frac{C}{R}$
0	942
1 K W	933
2 K W	924
3 K W	914
4 K W	905
5 K W	895
6 K W	886
7 K W	876
7.5 K W	871



Scale- $1\frac{1}{2}$" = 100 amps

- $1\frac{1}{2}$" = 100 Volts

- $1\frac{1}{2}$" = 100 Watts

The red current lines indicate current values in order 1, 2, 3 & 4 as they occur in the table page

Measurements.

A.C I.	A.C.E.	Watts	D.C.Ia	D.C.If.
1.95	111.	205	18.55	1.90
3.59	111.	250	19.0	2.79
2.05	110.	196	18.00	1.42
2.05	109.5	194	18.00	1.14

Corrected for Instruments.

A.C.I.	A.C.E.	Watts	Power Factor	D.C.Ia	D.C.If	D.C.E.	Output	Excitation %
41	110.45	4100	.904	18.25	1.9	147.8	2700	100
61.8	110.45	5000	.731	18.75	2.75	147.5	2760	119
41.4	109.3	3920	.875	17.65	1.43	146.5	2590	80.8
41.4	108.8	3880	.8625	17.65	1.16	145.9	2570	68.2

HEAT RUN.

Measurements.

	Time	Armature Temp.	Ia	E	Temp. Room	Temp. Field
1.	9:15	24.5 C	50	118	24.5 C	24.5 C
2.	9:45	44 C	49	118	77 F	29 C
3.	10:15	46 C	48.5	121	77 F	30.5 C
4.	10:45	47 C	46.5	123	78 F	31.5 C
5.	11:30	52 C	48	121.5	79 F	32 C
6.	12:05	54 C	46	120	79.5 F	33 C
7.	12:45	55 C	47	121	81 F	33 C

Temperatures.

Corrected to 25° Centigrade.

	Room	Armature	Field	Armature Rise	Field Rise
1.					
2.	24.5 C	24.5 C	24.5 C		
3.	25 C	44 C	29 C	19	4
4.	25 C	46 C	30.5 C	21	5.5
5.	25.5 C	47 C	31.5 C	21.4	6
6.	26.6 C	52 C	32 C	24.81	6
7.	26.8 C	54 C	33 C	27	6.2
8.	27.2 C	55 C	33 C	27	6

Instrument Calibrations.

D.C. Voltmeter No. 16901 calibrated by J.M. Harris.

D.C. Ammeter No. 2909 calibrated by F.A.Smith.

Millivoltmeter No. 2 calibrated by J.M. Harris.

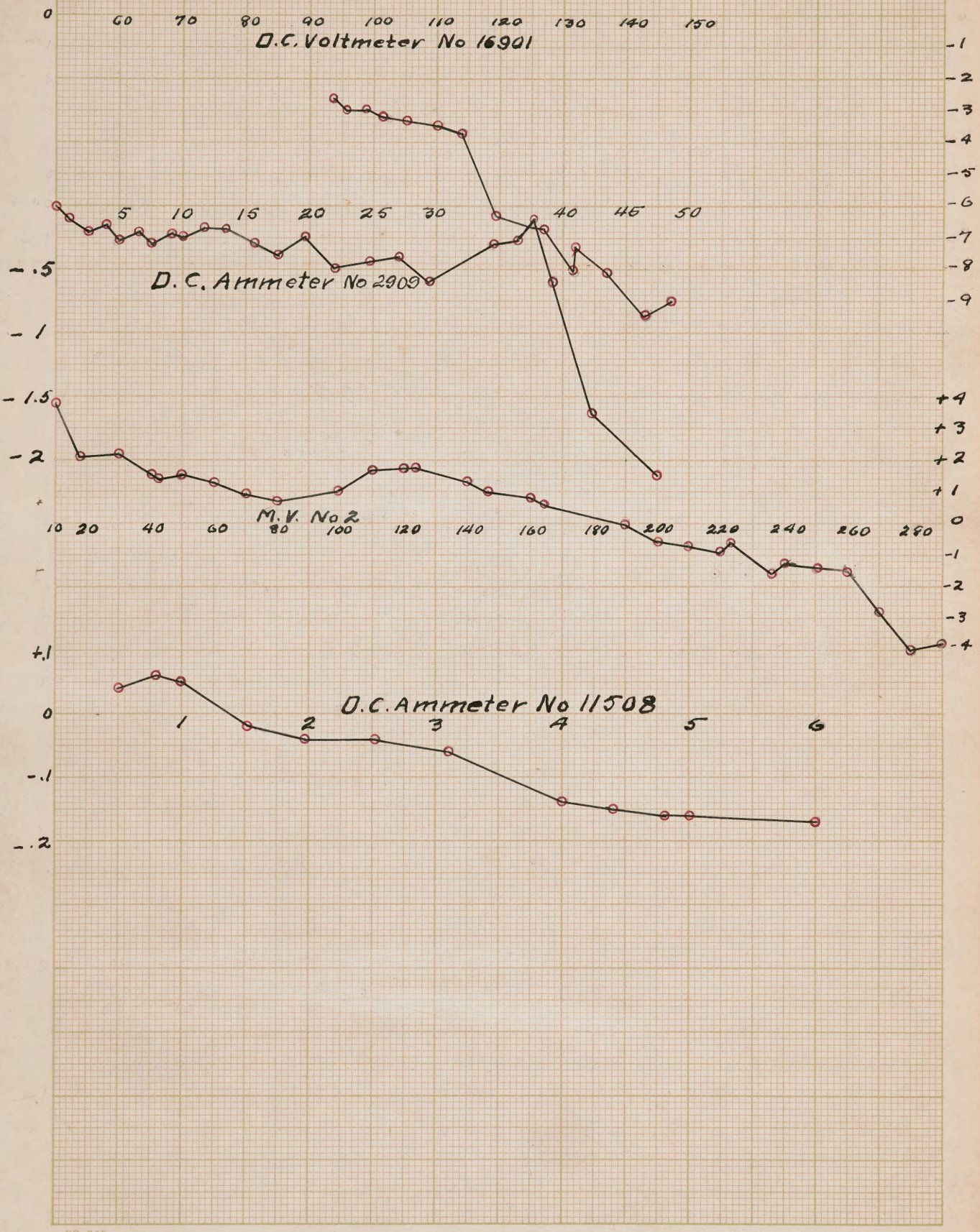
D.C. Ammeter No. 11508 calibrated by E.J.Leach.

A.C.Voltmeter No. 6202 calibrated by G.T.Ford.

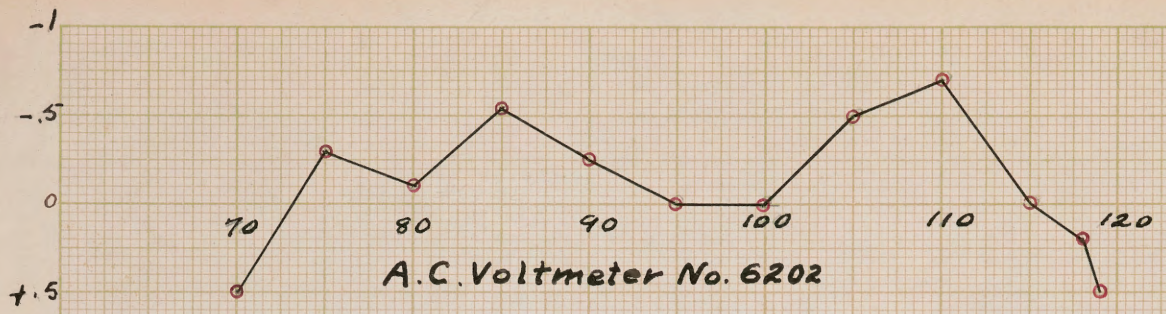
A.C. Simplex Voltmeter calibrated by J.M.Harris.

A.C.Ammeter No. 2405 calibrated by J.M.Harris.

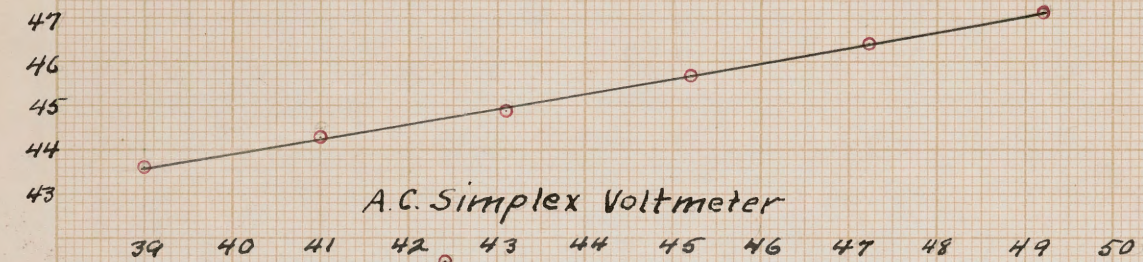
A.C.Ammeter No. 113 calibrated by G.T.Ford.



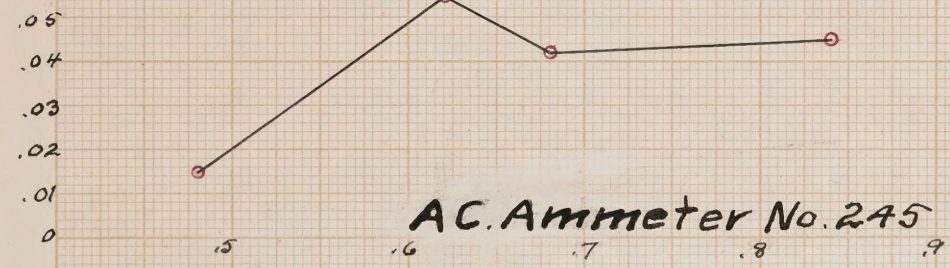
EUGENE DIETZGEN CO., CHICAGO-NEW YORK



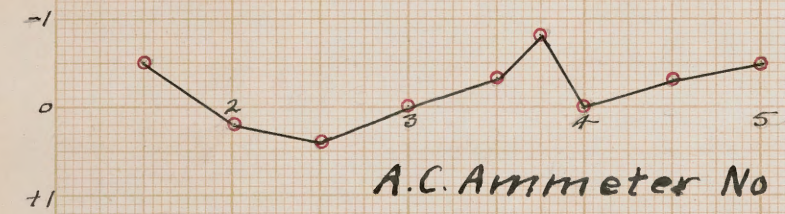
A.C. Voltmeter No. 6202



A.C. Simplex Voltmeter

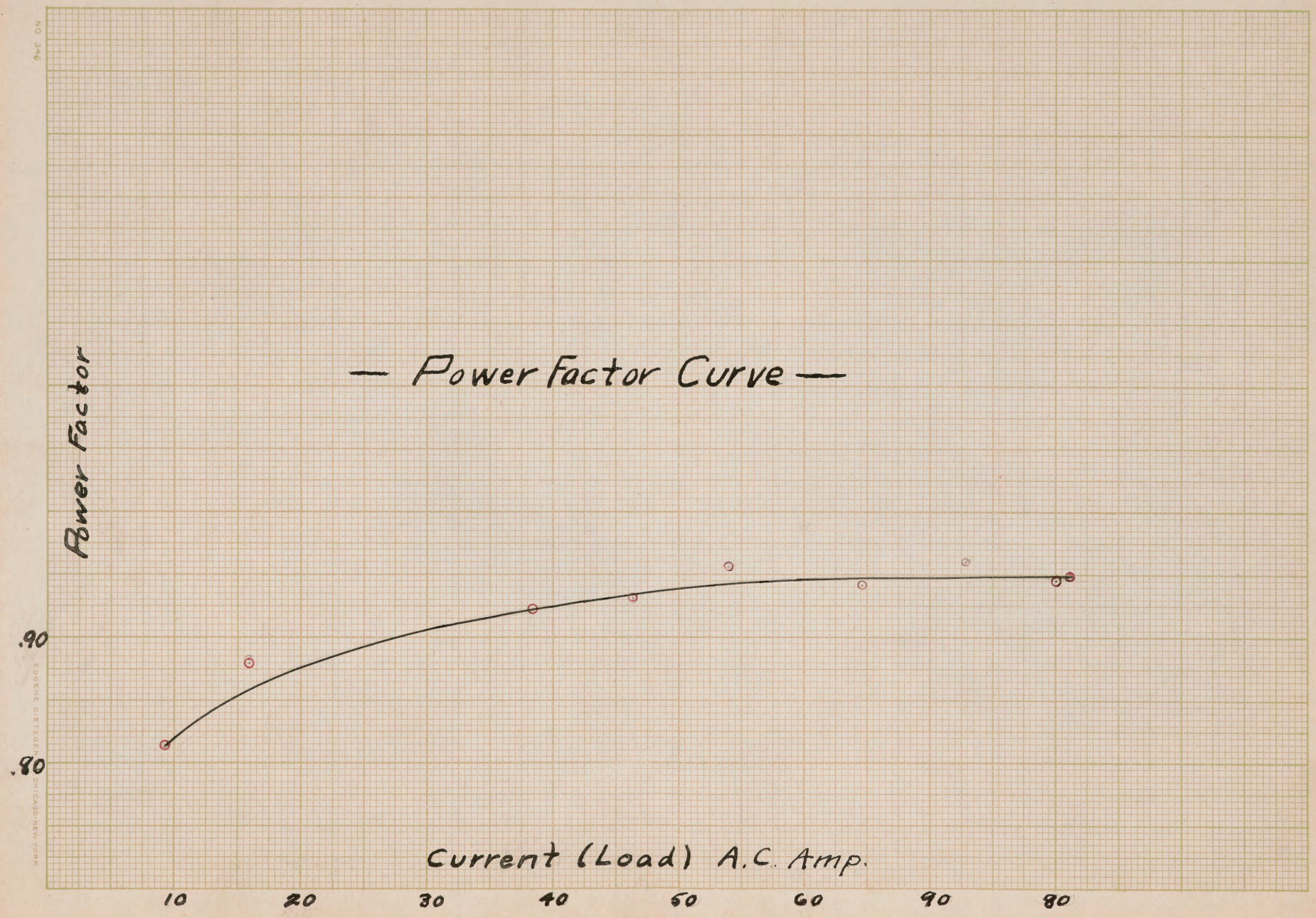


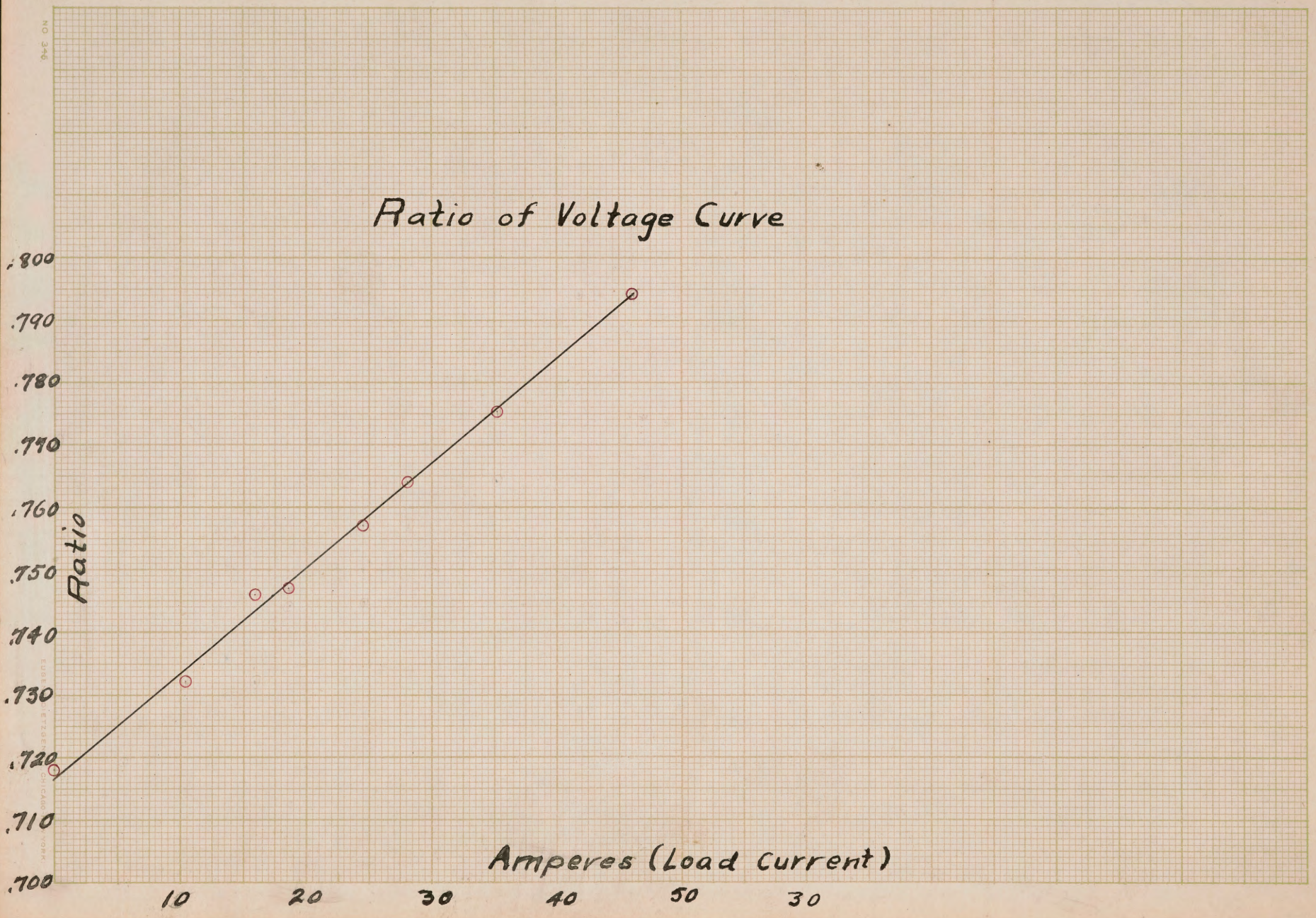
A.C. Ammeter No. 245

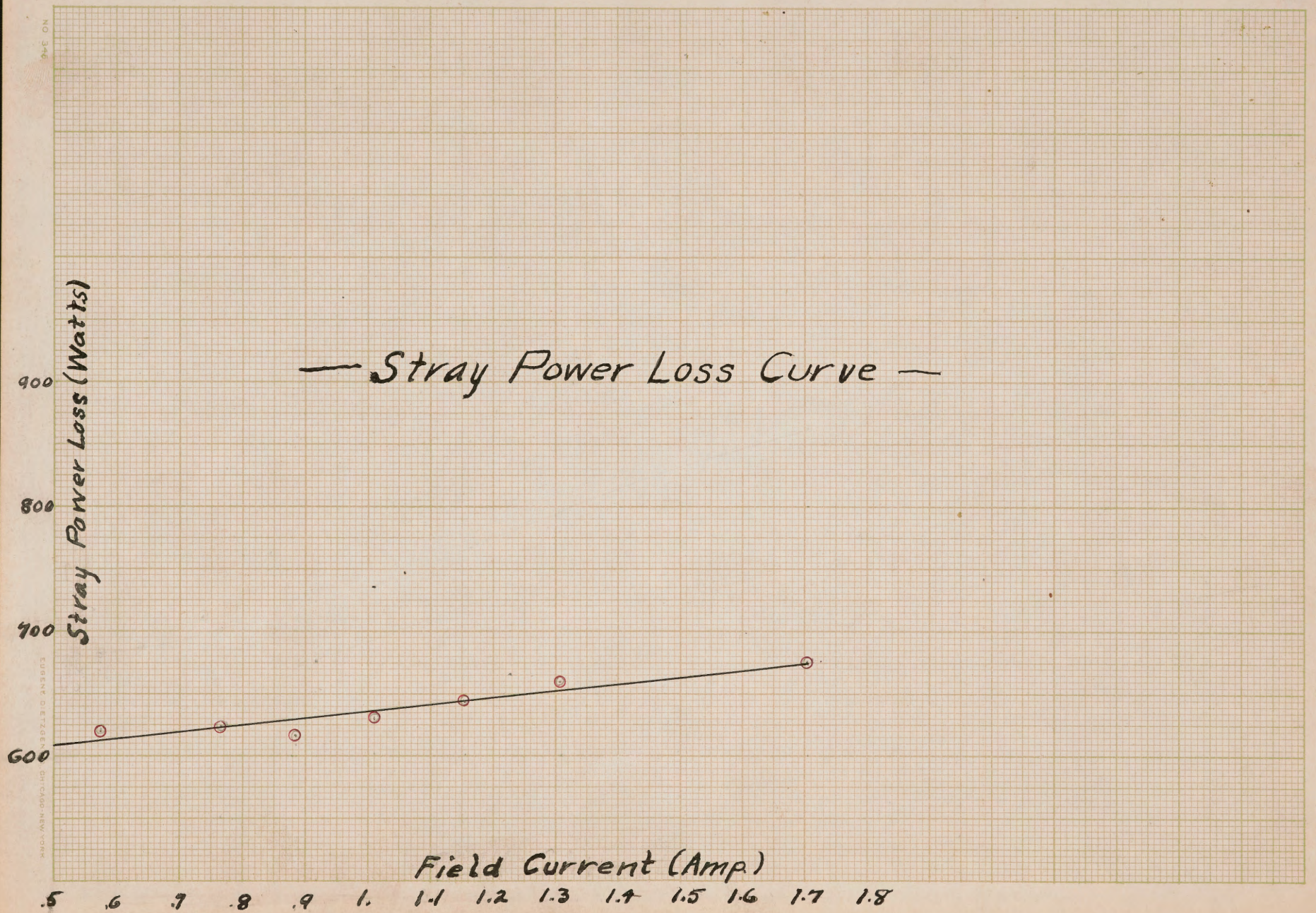


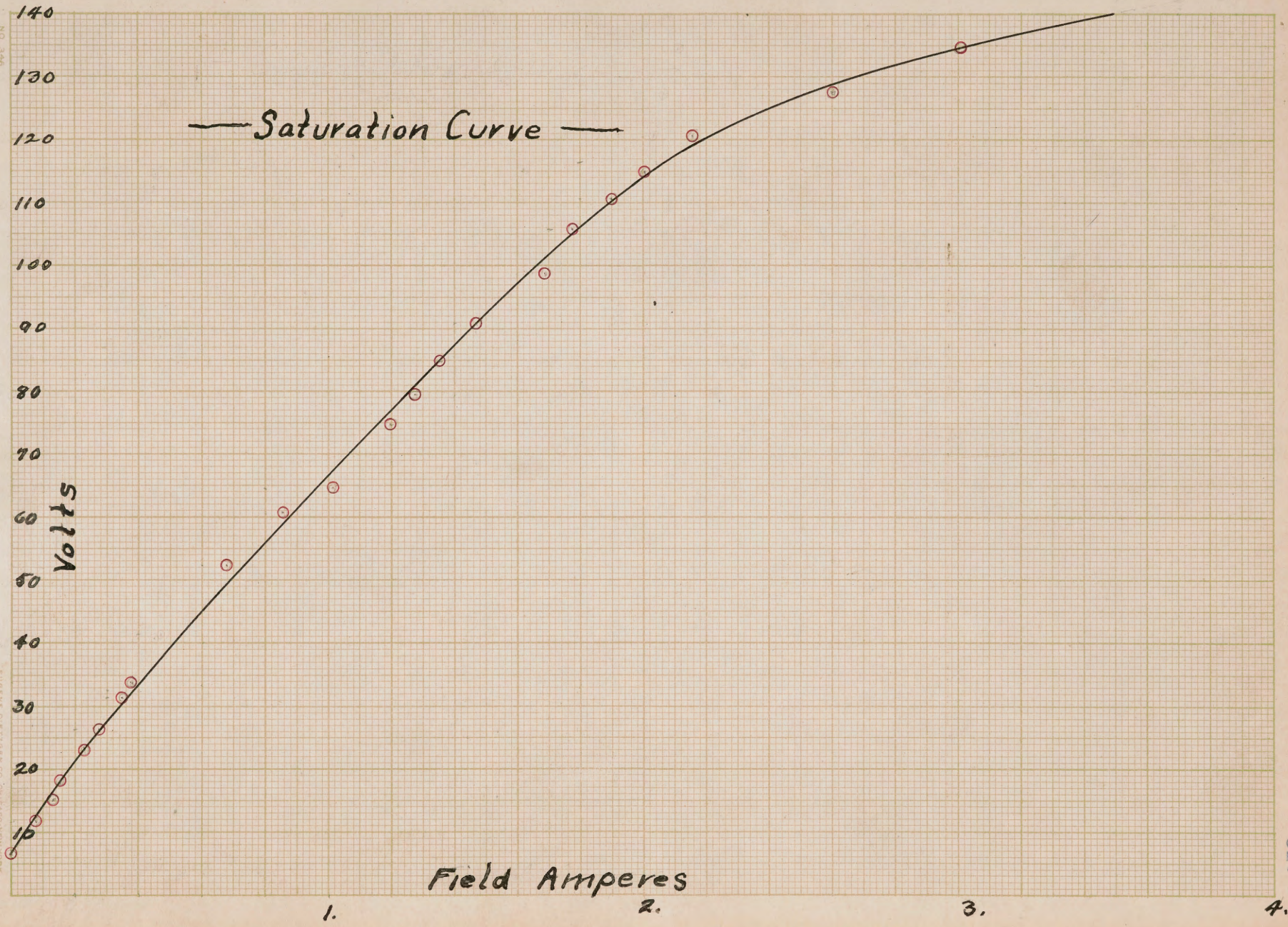
A.C. Ammeter No 113

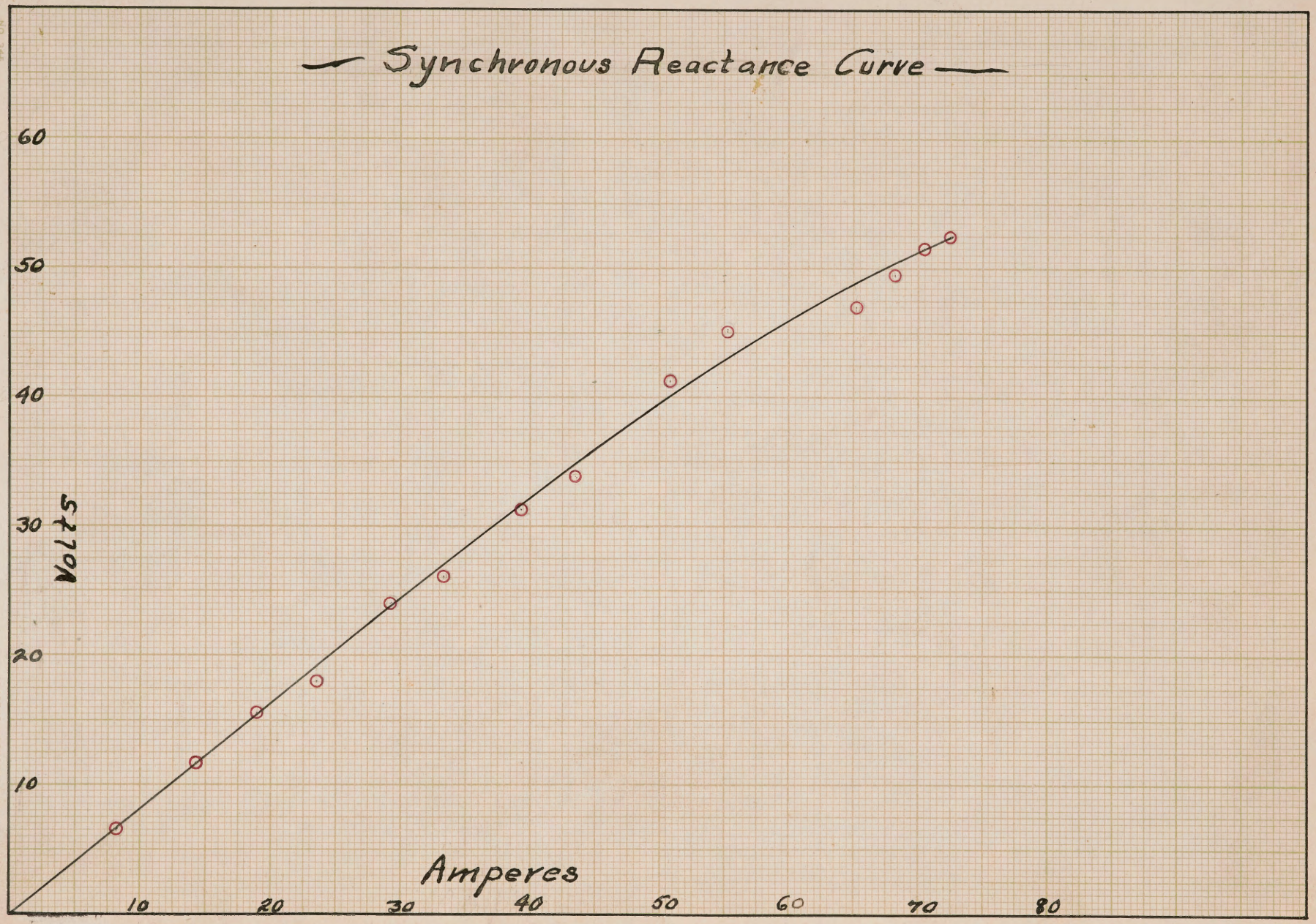
EUGENE DIETZGEN CO., CHICAGO-NEW YORK

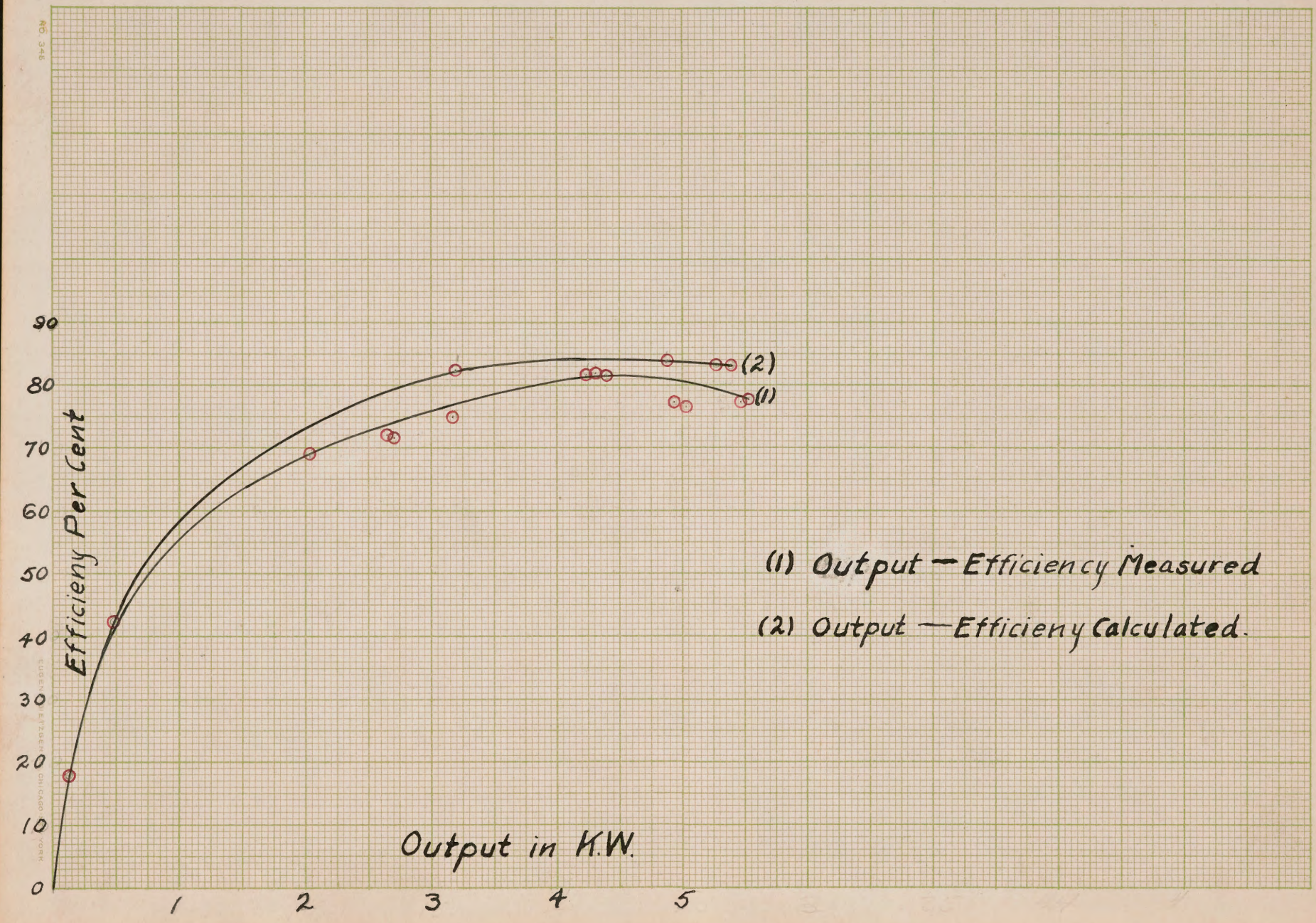

— Power Factor Curve —
Power Factor
.90
.80
Current (Load) A.C. Amp.
10
20
30
40
50
60
90
80

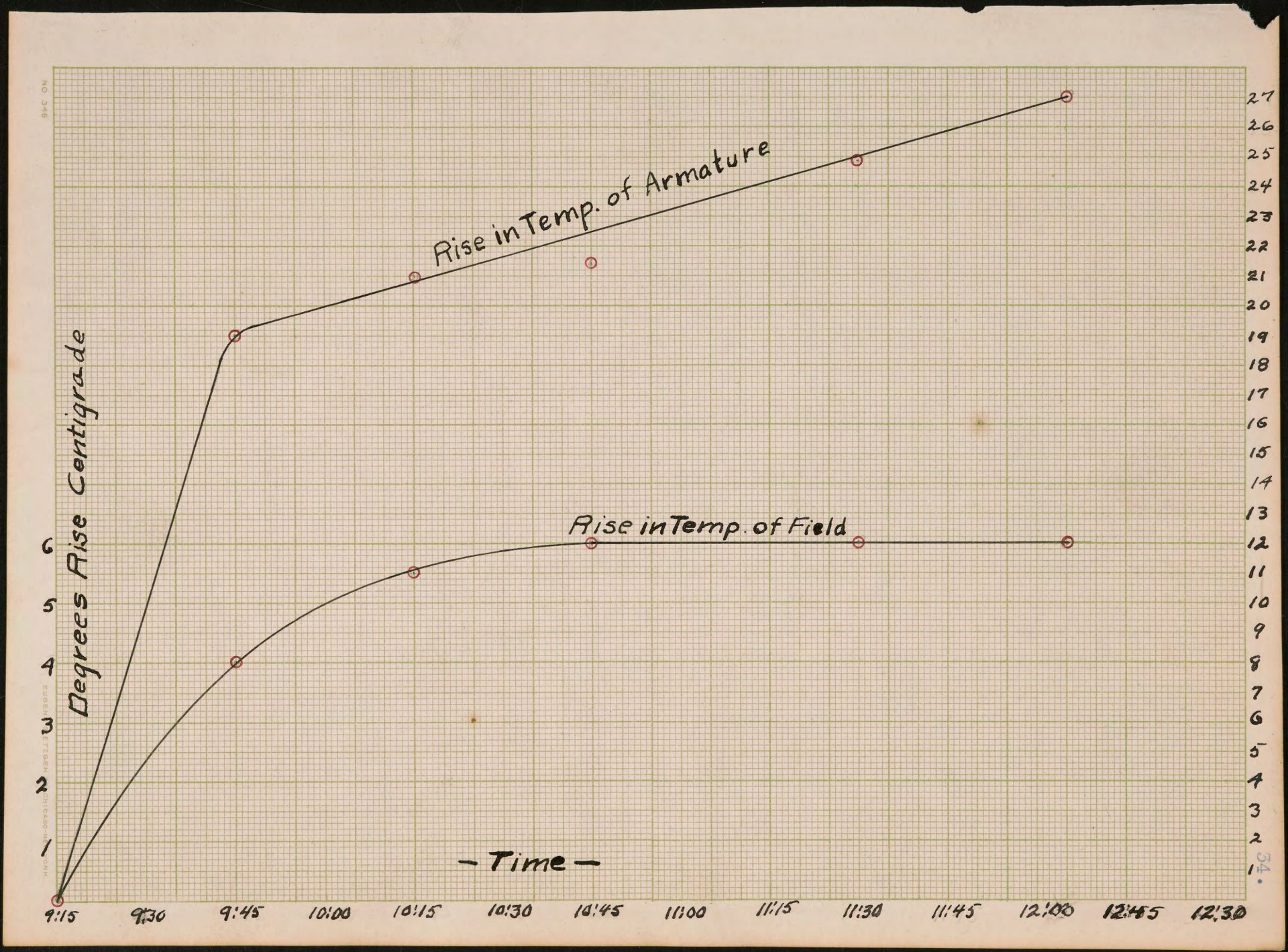

Ratio of Voltage Curve
.800
.790
.780
.770
.760
.750
.740
.730
.720
.710
.700
Ratio
10
20
30
40
50
30
Amperes (Load Current)


— Stray Power Loss Curve —
Stray Power Loss (Watts)
900
800
700
600
Field Current (Amp.)
.5
.6
.7
.8
.9
1.
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8


Saturation Curve
Volts
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Field Amperes
1.
2.
3.
4.


Synchronous Reactance Curve
60
50
40
30
20
10
Volts
10
20
30
40
50
60
70
80
Amperes


Efficieny Per Cent
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
Output in K.W.
(2)
(1)
(1) Output — Efficiency Measured
(2) Output — Efficieny Calculated.


Rise in Temp. of Armature
Rise in Temp. of Field
Degrees Rise Centigrade
- Time -
9:15
9:30
9:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
12:00
12:15
12:30
1
2
3
4
5
6
7
8
9
10
11
12
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