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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Life Tests on Type 864 Triodes

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Authorization: BuEng let.S67/38(11-7-W8) of 12 Nov.1931 and
BuEng let.S67/38/L5(5-21-W8) of 23 May 1934.

Date of Tests: August 1,1934 to January 1, 1935.

Prepared by: C. H. Williams, Asst.Radio Engr.; J. T. Fetsch, Asst.Radio Engr., Chief of Section

Reviewed by: A. Hoyt Taylor, Physicist, Supt.Radio Division

Approved by: J. B. Will, Commander, USN, Acting Director.

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N. Eng. 70-C

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SUBJECT

Life Tests on Type 864 Triodes

BY

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

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Appendices

AUTHORIZATION FOR TEST

1. This problem was authorized by the Bureau of Engineering in ref.(a) and modified by ref.(b). Other additional references pertinent to the problem are (c), (d), and (e).

Reference: (a) BuEng let.S67/38/L5(5-21-W8) of 23 May 1934.
(b) BuEng let.S67/38/L5(2-9-W8) of 23July 1934.
(c) Navy Specifications RE 13A 411E.
(d) Navy Specifications (Tentative) RE 13A 600A
(e) BuEng let.S67/38(5-28-W8) of 11 June 1934.

OBJECT OF TEST

2. The object of this test was to study the electrical performance of the Type 38064 triode in the first oscillator circuit of the Model RAB radio receiving equipment, to determine the cause of early tube failure therein, and to recommend remedial measures.

ABSTRACT OF TEST

3. A quantity of vacuum tubes, Type 38064 triodes, of various manufacture, comprising twelve groups consisting of a total of ninety tubes, were obtained for life tests and use in the first oscillator circuit of the Model RAB radio receiver to determine their electrical performance. After static and dynamic characteristics were taken, sixty-six were selected and placed in life test circuits, with their emission, transconductance, and oscillator operation noted every 50 hours during a 1,000 hour life test, the results of which are shown in Plates 1 to 12 inclusive. Plates 9, 10, and 11 are records of three groups of tubes which were placed on the life test circuit subsequent to the groups shown in Plates 1 to 8 inclusive and therefore show only part of 1,000 hours of operation.

4. An operation test was made which consisted of placing Type 38064 triodes in the first oscillator position of the Model RAB radio receiver to determine their oscillating ability with normal input potentials.

Conclusions

(a) The useful life obtained from the Type 38064 triode when used in the first oscillator circuit of the Model RAB radio receiver was found to be exceedingly short, being on the average approximately 550 hours per tube on a group of 66 tubes.

(b) Eight Type 38064 triodes did not oscillate on initial tests, despite the fact that all sixty-six of subject Type 38064 triodes were selected in accordance with ref.(c), specifications.

(c) The Type 38064 triodes of present design cannot be expected to give satisfactory performance or long life (over 500 hours) in the Model RAB receiver. The filament design used in the Type 38064 is quite inadequate to give sustained life under the conditions of operation.

(d) There is to be expected a wide variation in the electrical performance experienced in using the Type 38064 triode in the first oscillator circuit of the Model RAB receiver; some tubes will be found inoperative at the start; others will function partially over some frequency ranges; other tubes, though satisfactory initially, will not continue to perform; very few Type 38064 triodes will give useful life greatly in excess of 1,000 hours.

Recommendations

(a) It is recommended that the Type 38064 triode, which at present is used in the first oscillator circuit of the Model RAB radio receiver be replaced with a tube which will give better electrical performance and much longer life. It is preferable that the substituted tube be of the uni-potential cathode type and of equivalent electrical characteristics. As a suggestion, the Type 38056 triode may be found suitable for such use in the subject receiver, with slight circuit modifications.

DESCRIPTION OF MATERIAL UNDER TEST

5. From ninety Type 38064 triodes available for the tests outlined in this report, sixty-six were selected as satisfactory for life tests and oscillator tests. The remaining vacuum tubes were rejected for further use due to (a) open filaments, (b) doubtful history, and (c) failure by a large margin to meet ref.(c), specifications.

6. Table 1 gives information concerning the Type 38064 triodes used in obtaining the data for the graphic displays of Plates 1 to 12 inclusive.

METHOD OF TEST

7. The procedure followed in this investigation was first to obtain a quantity of Type 38034 triodes which were subjected to specification tests under RE 13A 411E so as to determine their condition. Ninety tubes were available whose average characteristics initially were as shown on Plate 12. Sixty-six of this total were selected for subsequent life tests and oscillator tests.

8. After initial characteristic tests, all sixty-six tubes were placed in the life circuits under conditions outlined in refs. (a) and (b). At approximately 50 hour intervals during the 1,000 hour life test, measurements of emission, grid-late transconductance, and oscillating ability were made on each tube.

9. In making the measurement on a tube's ability to oscillate in the first oscillator circuit of the Model RAB radio receiver, the set was adjusted for normal operation of CW signals with all controls set at approximately the same settings during each successive test. The frequency chosen was determined by experiment to be the setting where failure most often occurred with failing tubes; namely, at the low frequency end of the four megacycle band. The primary supply voltage was reduced to 90 volts and slowly increased one volt at a time with approximately a five second pause after each change in supply voltage. When the first oscillator began to function, the primary voltage was noted and recorded.

10. The end of useful tube life was considered reached when a tube required a set power supply potential of more than 110 volts to function as an oscillator in the Model RAB receiver during the successive tests separated by approximately fifty hours of life test. Tubes failing on this test or other required tests were continued in use on the life test rack until the 1,000 hours of operation had been obtained when all of the subject tests were terminated. During the early part of the life tests, the potentials impressed on the circuits were requested changed slightly; hence the break in the graphs at the 75 hour point. From here until the end of the 1,000 hour life test the potentials remained unaltered.

DATA RECORDED DURING TESTS

11. The data obtained during the tests were recorded graphically on Plates 1 to 12 inclusive. Plates 1 to 11 show the graphs plotted for each

of sixty-six tubes on (1) emission, (2) grid-plate transconductance, and (3) the set supply voltage at which a tube would begin to oscillate in the first oscillator circuit of the Model RAB receiver. Plate 12 gives a summary of the data recorded on the ninety triodes taken at the beginning of the investigation. Table 1 gives information concerning the vacuum tubes used during the subject tests.

PROBABLE ERROR IN RESULTS

12. The accuracy with which measurements on transconductance can be made is to 1%; that of emission is to 2%; that of meter readings of voltage and current is to 1/2 of 1%; and that of oscillating ability of the vacuum tube in the first oscillator circuit is to 5%. Life test voltages were maintained to within 2%.

RESULTS OF TESTS

13. Results of tests made on the Type 38064 triodes are portrayed in Plates 1 to 12 inclusive. Plates 1 to 11 inclusive show the characteristics of emission, transconductance, and oscillation ability on sixty-six tubes during a 1,000 hour life test.

14. On each of these plates, a vertical line indicates the end of useful life for each tube.

15. Initial characteristics on these tubes are shown in Plate 12. The data show, upon analysis, the following average useful hours on Type 38064 triodes of various manufacture, based on groups of six tubes each:

Plate No.	Group No.	Tube Desig.	Manufacturer	Total hours oper'n.	No. of premature failures	Average hours of useful operat'n per tube
1	#1	1 to 6	A	1000	1	847.5
2	1	7 to 12	A	1000	3	773
3	2	1 to 6	B	1000	2	812.5
4	2	7 to 12	B	1000	4	369
5	3	1 to 6	C	1000	3	615.8
6	3	7 to 12	D	1000	6	292.5
7	4	1 to 6	E	1000	5	312
8	5	1 to 6	C	1000	4	519
10	7	1 to 6	E	675	4	395.8
11	7	7 to 12	E	675	1	833.6

Average useful life per tube (of 66 tubes) 577 hours.
Average number of premature failures (of 66 tubes) - 33.

CONCLUSIONS

16. The useful life obtained from the Type 38064 triode when used in the first oscillator circuit of the Model RAB radio receiver was found to be exceedingly short, being on the average approximately 550 hours per tube on a group of sixty-six tubes.

17. Eight Type 38064 tricdes did not oscillate on initial tests, despite the fact that all sixty-six of subject Type 38064 triodes were selected in accordance with ref.(c), specifications.

18. The Type 38064 triodes of present design cannot be expected to give satisfactory performance or long life (over 500 hours) in the RAB receiver. The filament design used in the Type 38064 is quite inadequate to give sustained life under the conditions of operation.

19. There is to be expected a wide variation in the electrical performance experienced in using the Type 38064 triode in the first oscillator circuit of the Model RAB receiver; some tubes will be found inoperative at the start; others will function partially over some frequency ranges; other tubes, though satisfactory initially, will not continue to perform; very few Type 38064 triodes will give useful life greatly in excess of 1000 hours.

Table 1

Information Concerning Vacuum Tubes
Type 38064 Used in Tests
on Electrical Performance

Plate No.	Group No.	Quantity of vacuum tubes represented	Manufacturer	Date Received	Source of Supply
1	1(a)	6	A	7-9-34	Brooklyn Navy Yard
2	1(b)	6	A	7-9-34	" " "
3	2(a)	6	A	7-9-34	NRL stock
4	2(b)	6	A	7-9-34	" "
5	3(a)	6	B	2-24-34	Manufacturer
6	3(b)	6	B	3-5-35	"
7	4	6	E	12-1-31	"
8	5	6	C	2-17-34	"
9	6	6	D	No record	-
10	7(a)	6	E	8-1-34	Brooklyn Navy Yard
11	7(b)	6	E	8-1-34	" " "
	8	6	C	11-14-34	Manufacturer
	9	6	B	9-26-34	"
	10	6	A	10-25-34	"
	11	6	A	11-14-34	"

Table 2

Key to Manufacturers

A - RCA Radiotron Company
B - Hygrade Sylvania Corporation
C - Amperex Electronics Products
D - Deforest Radio Company
E - Duovac Radio Tube Corporation

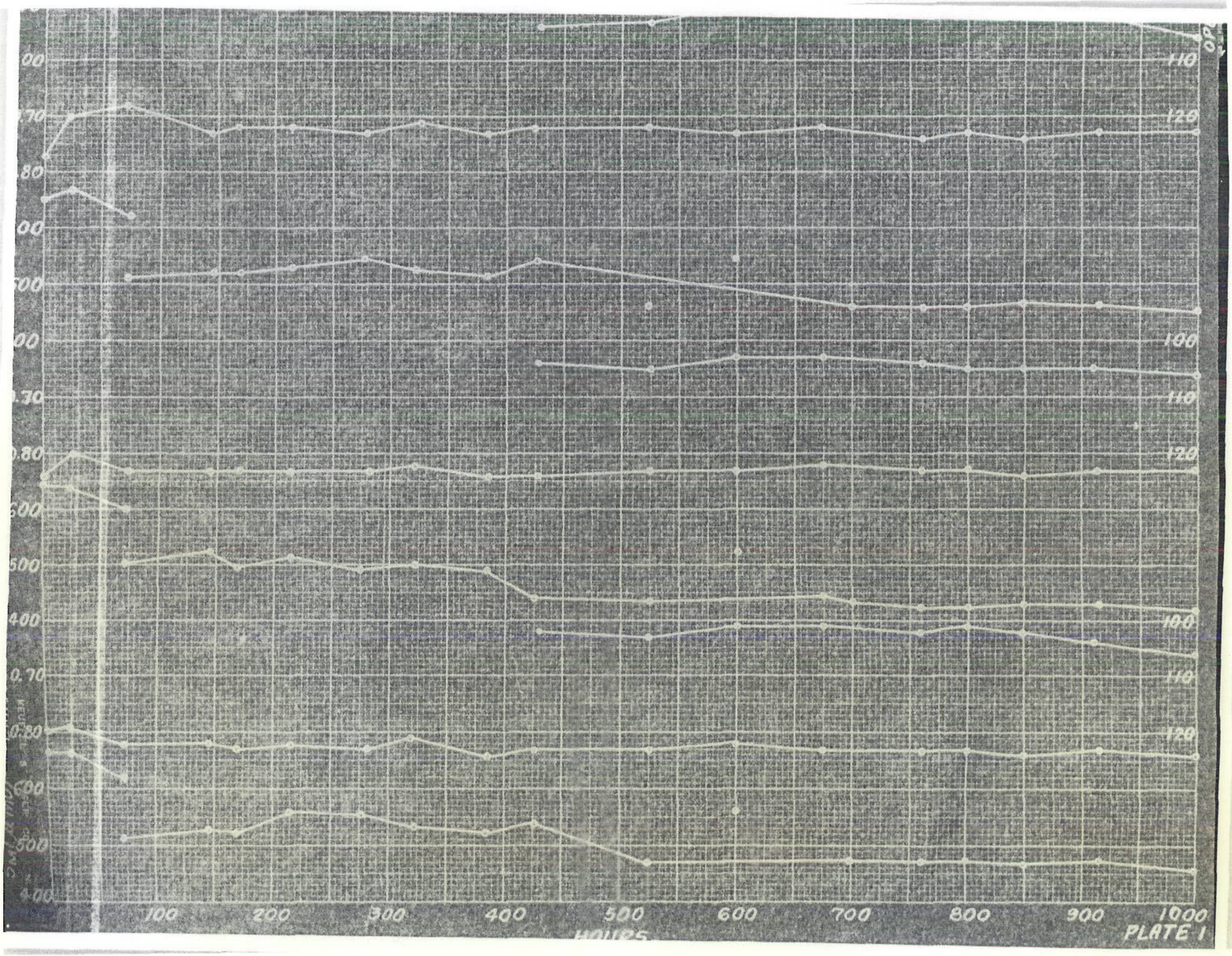
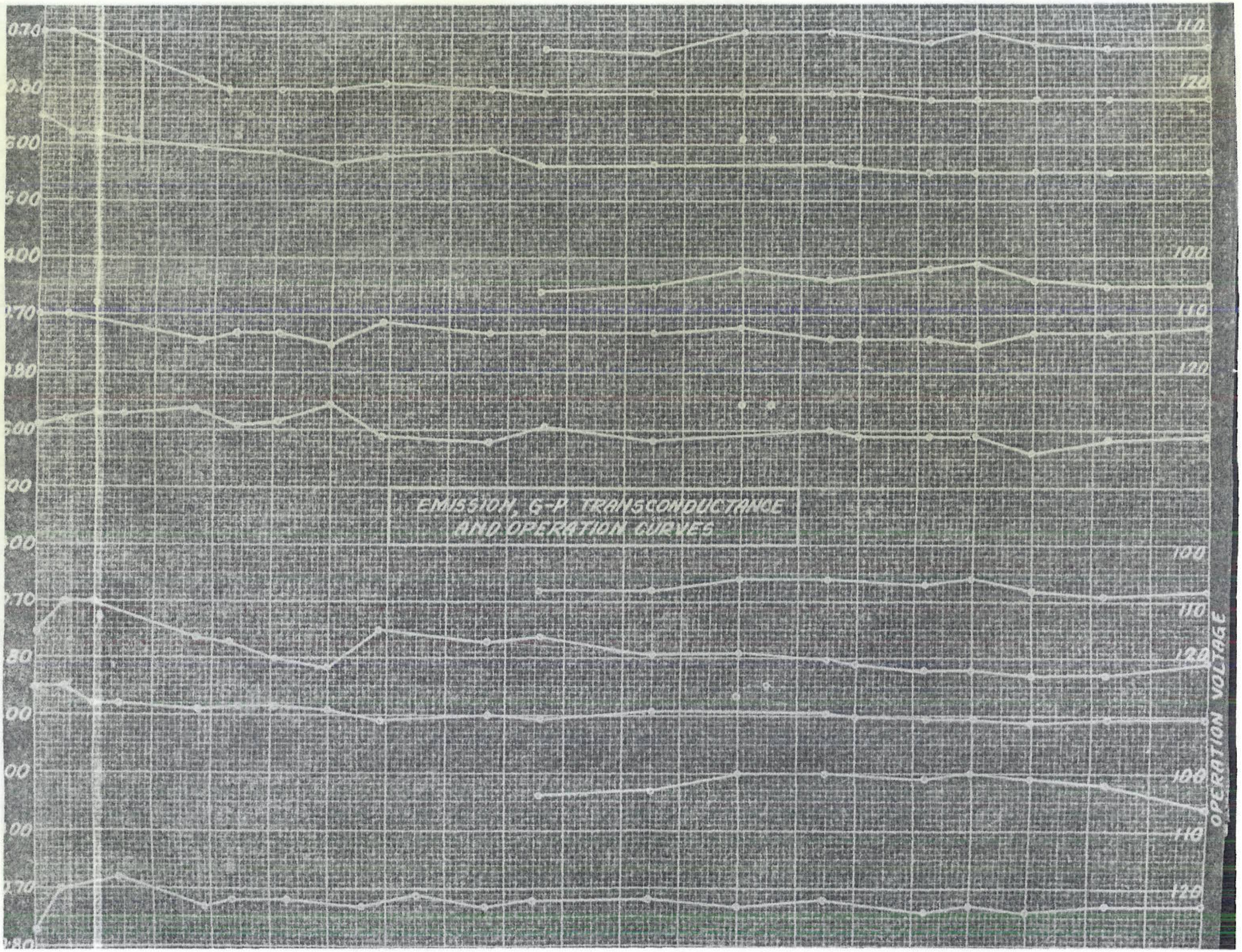
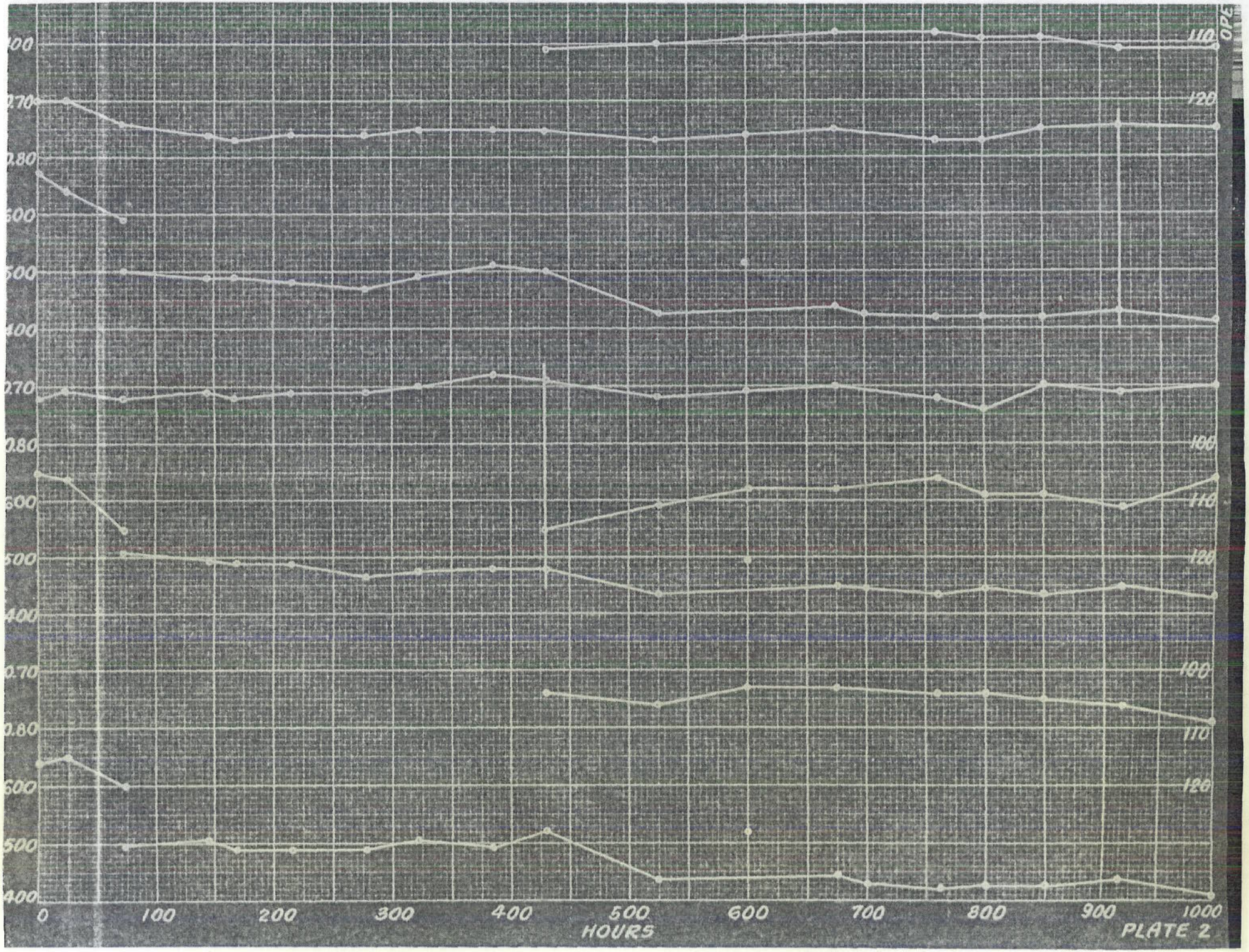
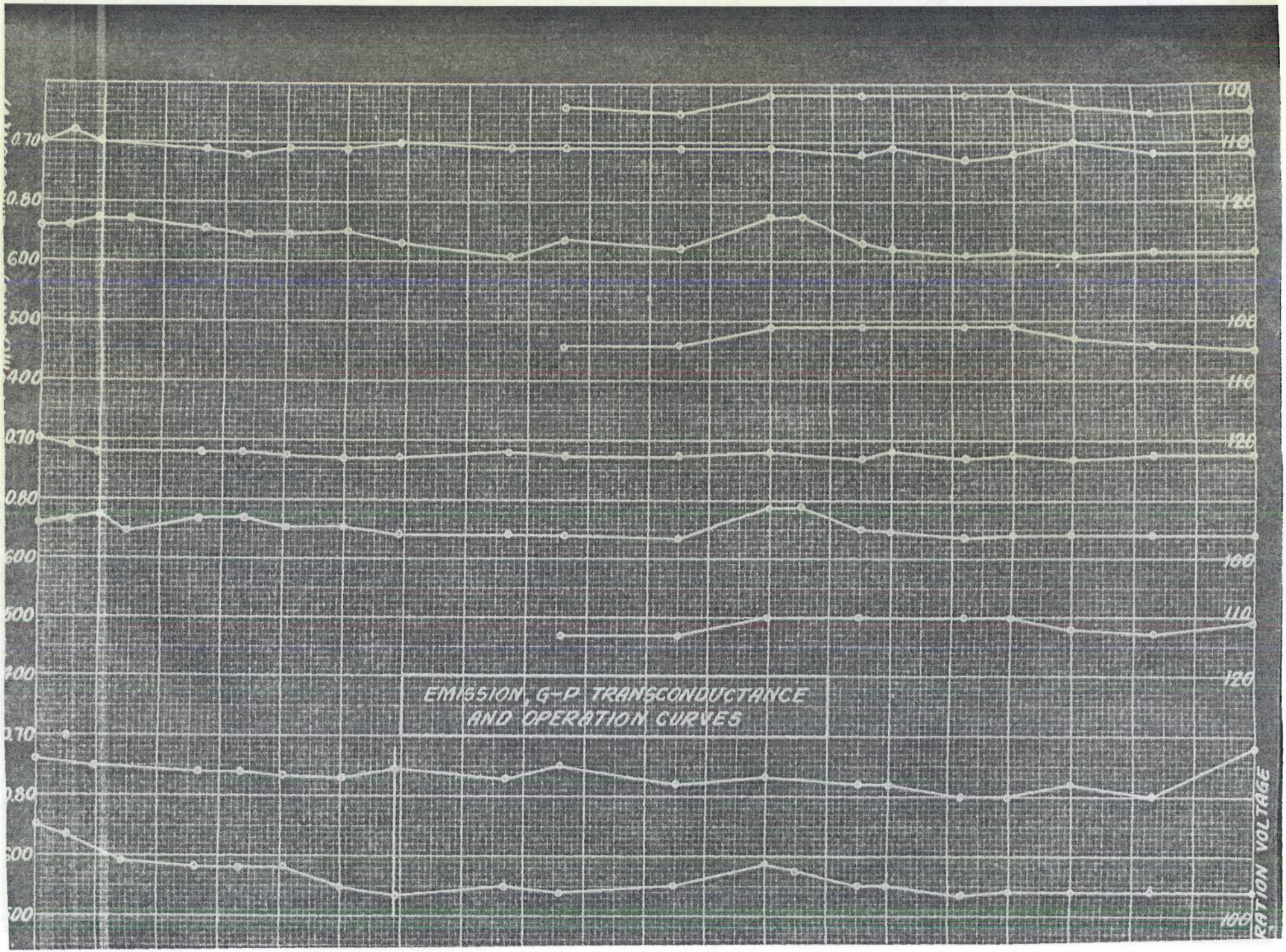
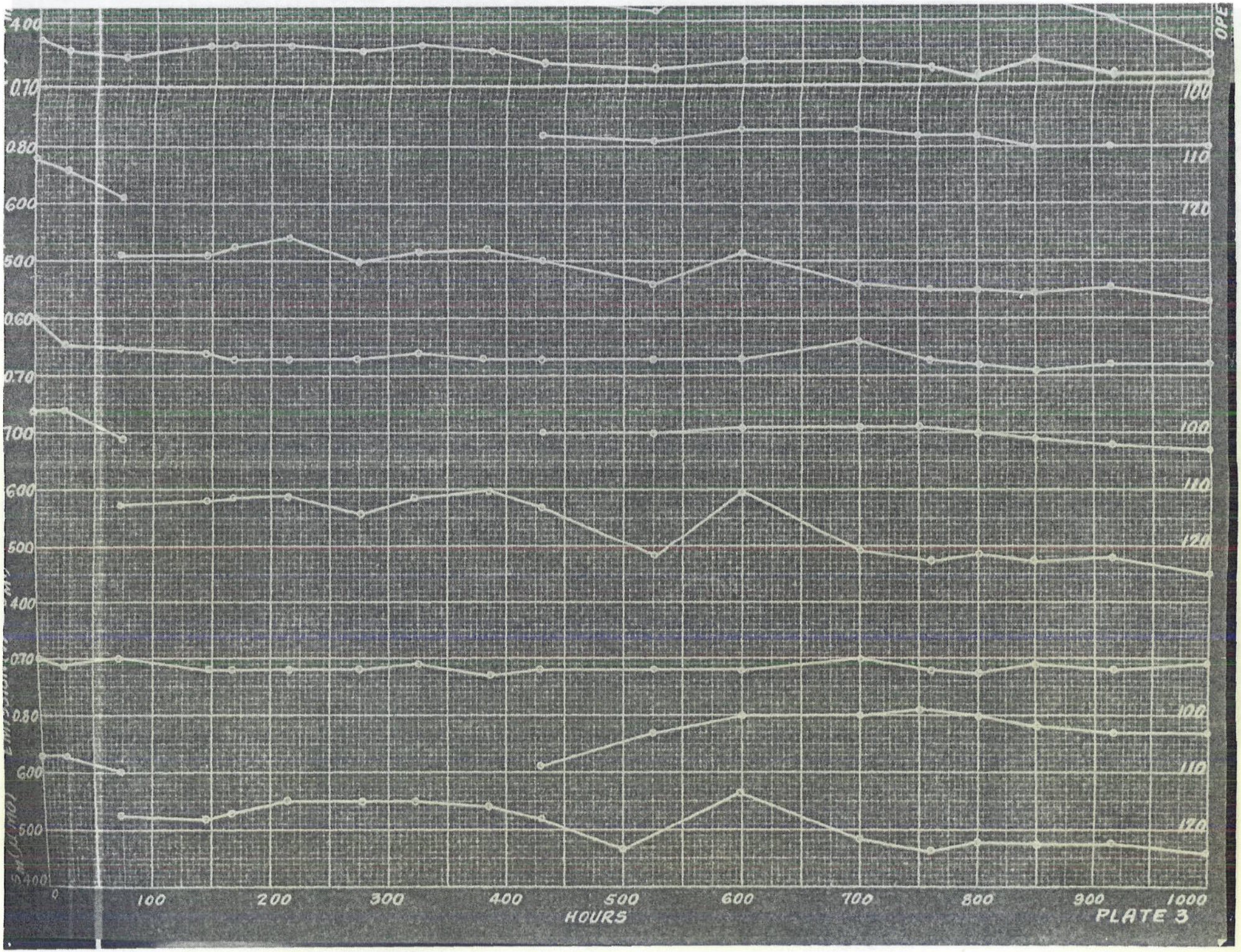


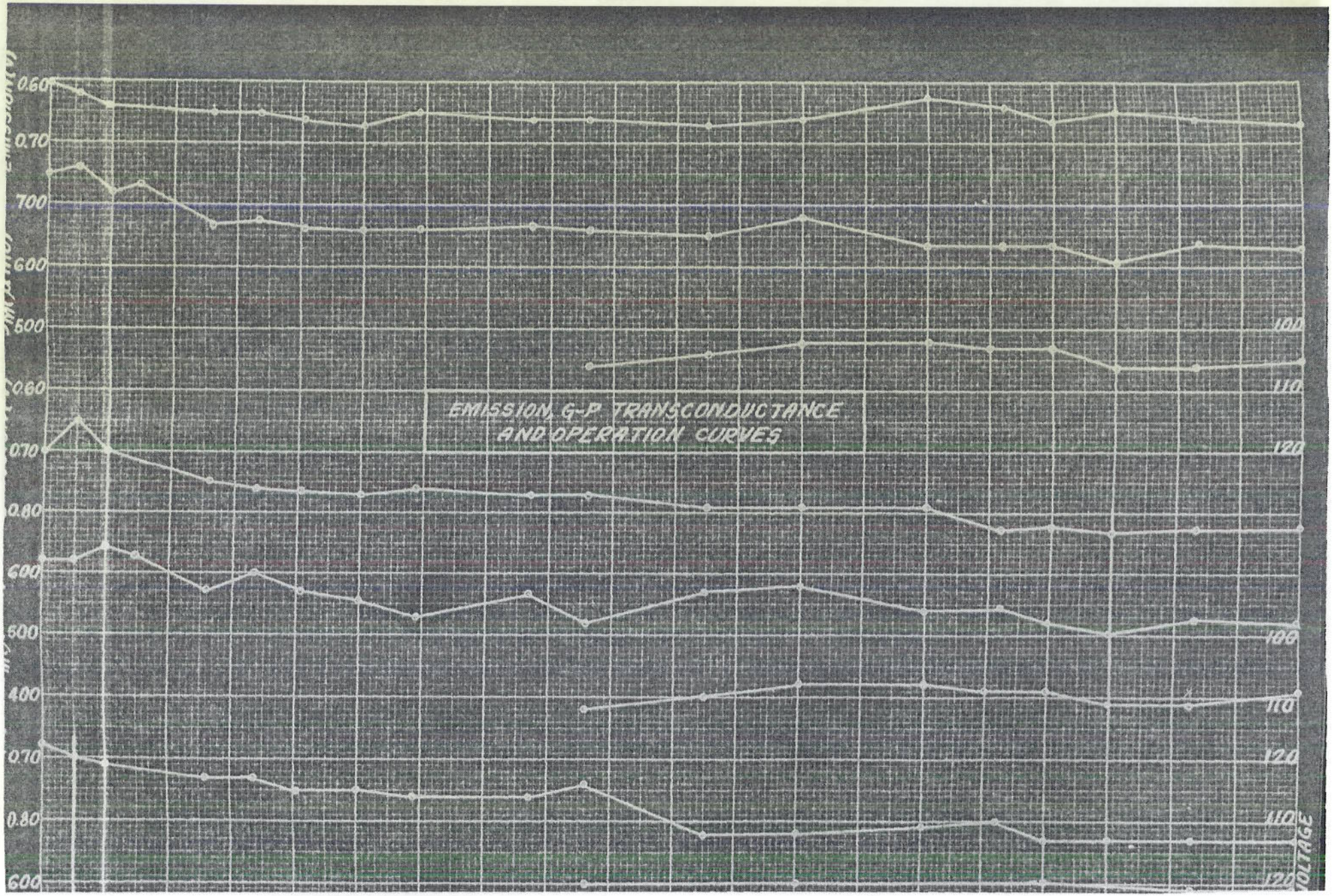
PLATE 1

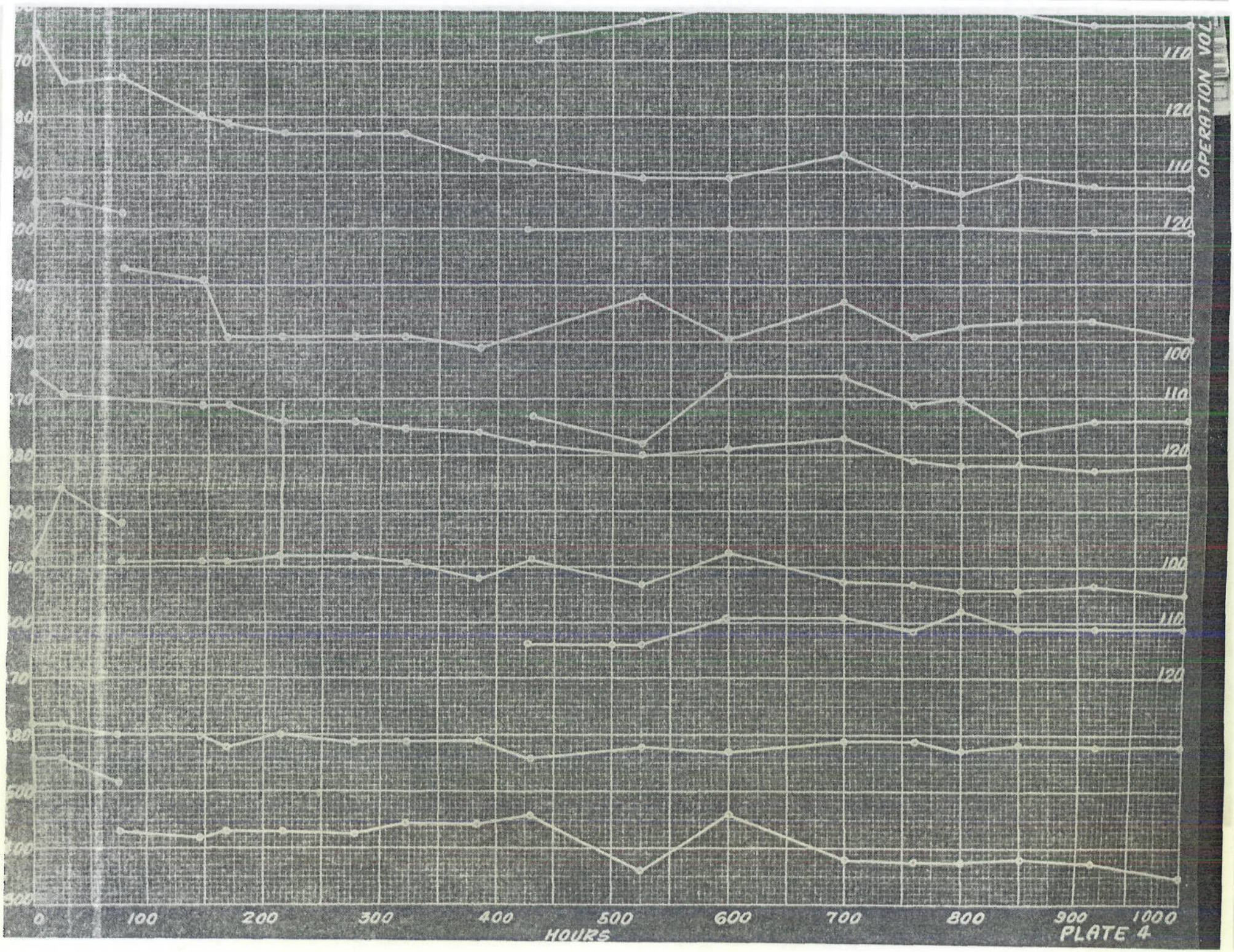

EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
OPERATION VOLTAGE

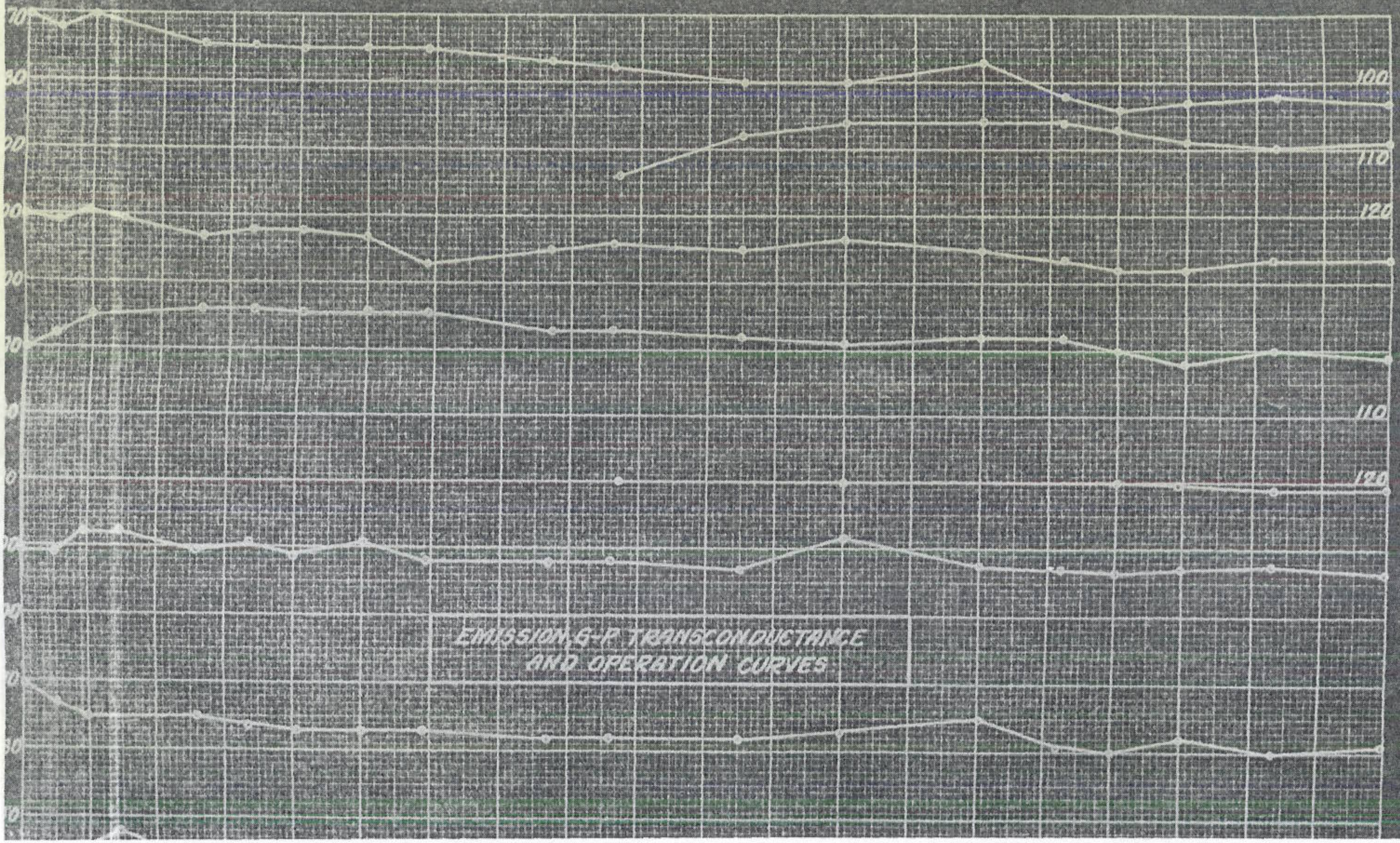

110
120
166
116
120
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 2

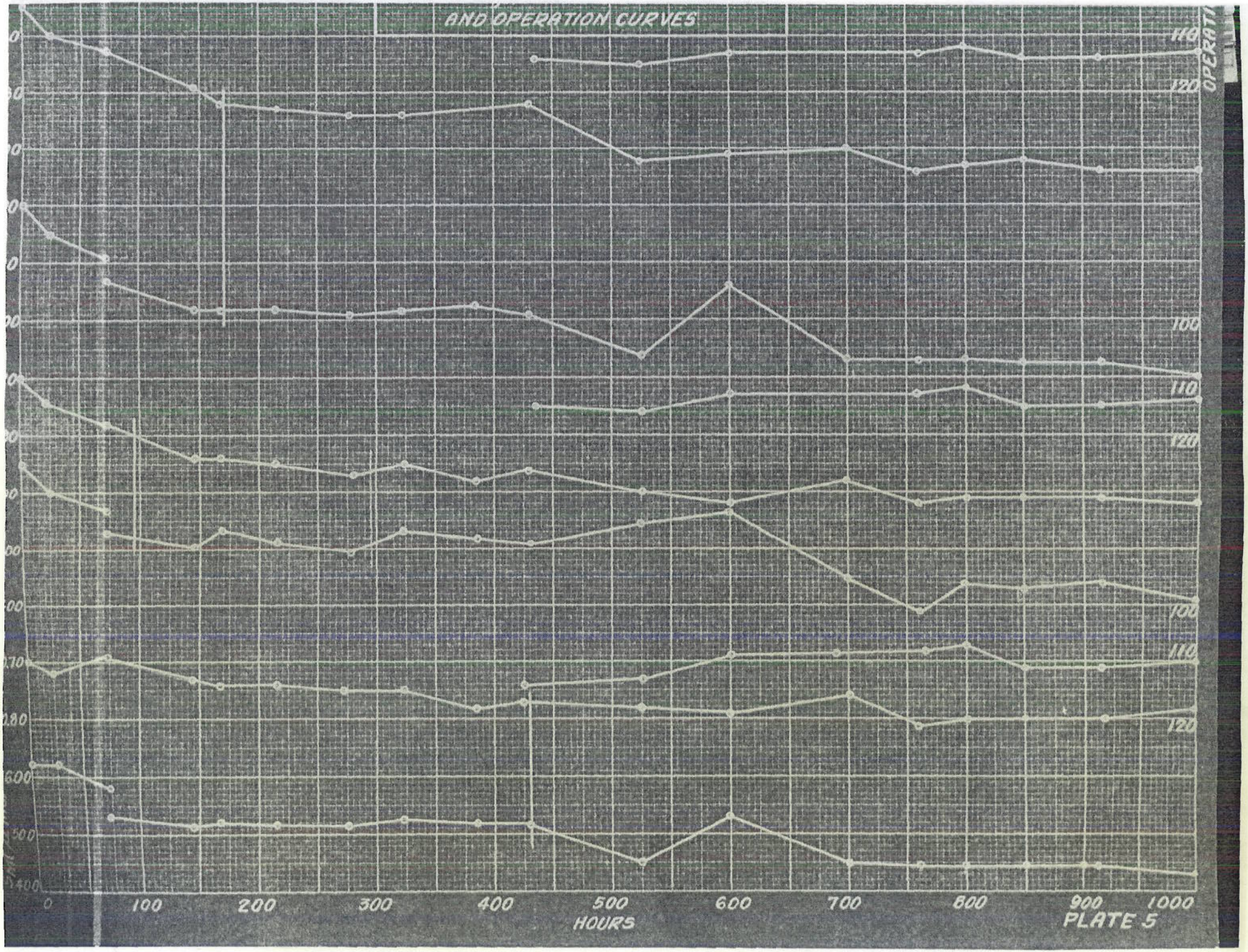

EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
0.70
0.80
600
500
400
0.70
0.80
600
500
400
0.70
0.80
600
100
110
120
100
110
120
100
RATION VOLTAGE

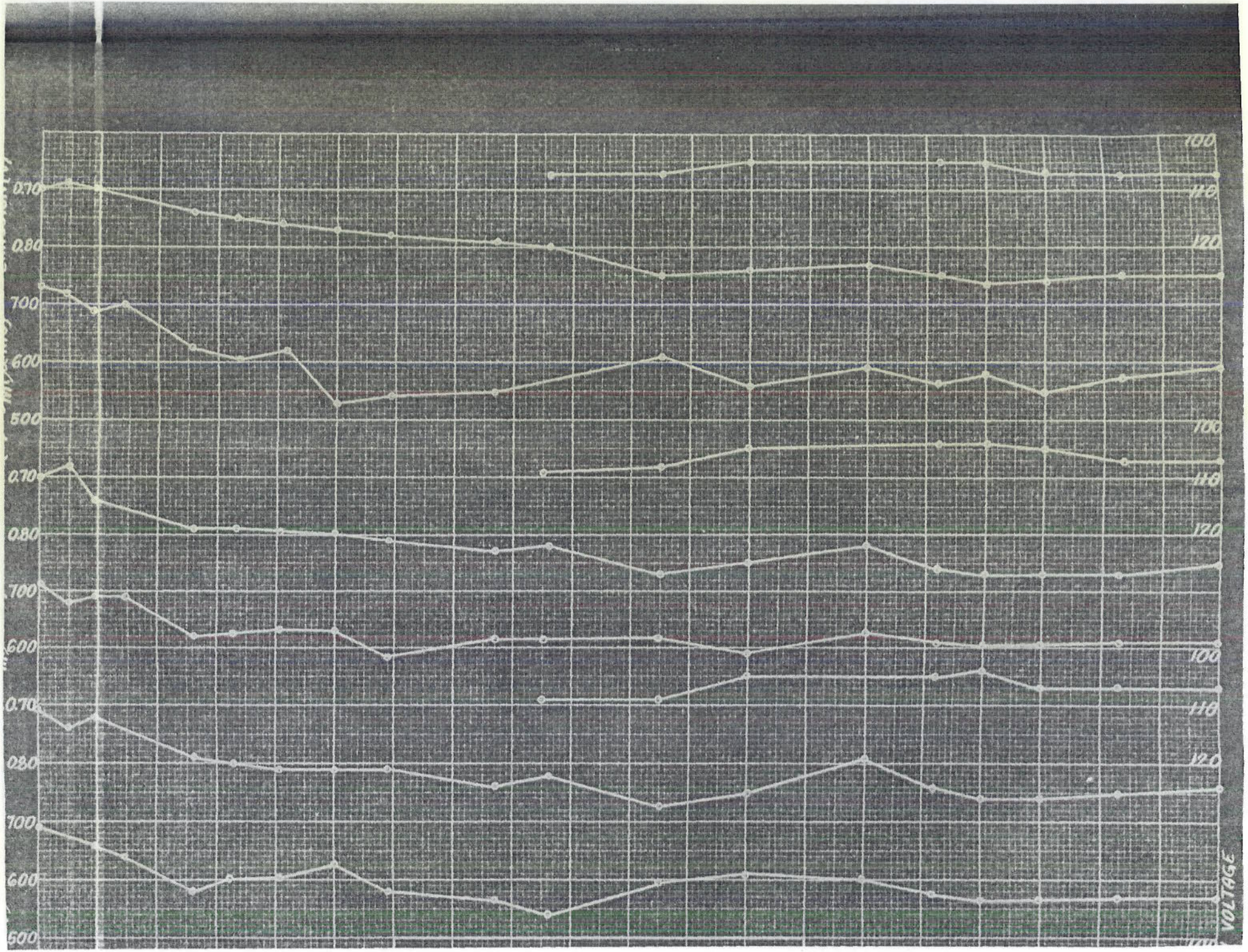

0.70
0.80
600
500
0.60
0.70
700
600
500
400
0.70
0.80
600
500
400
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 3

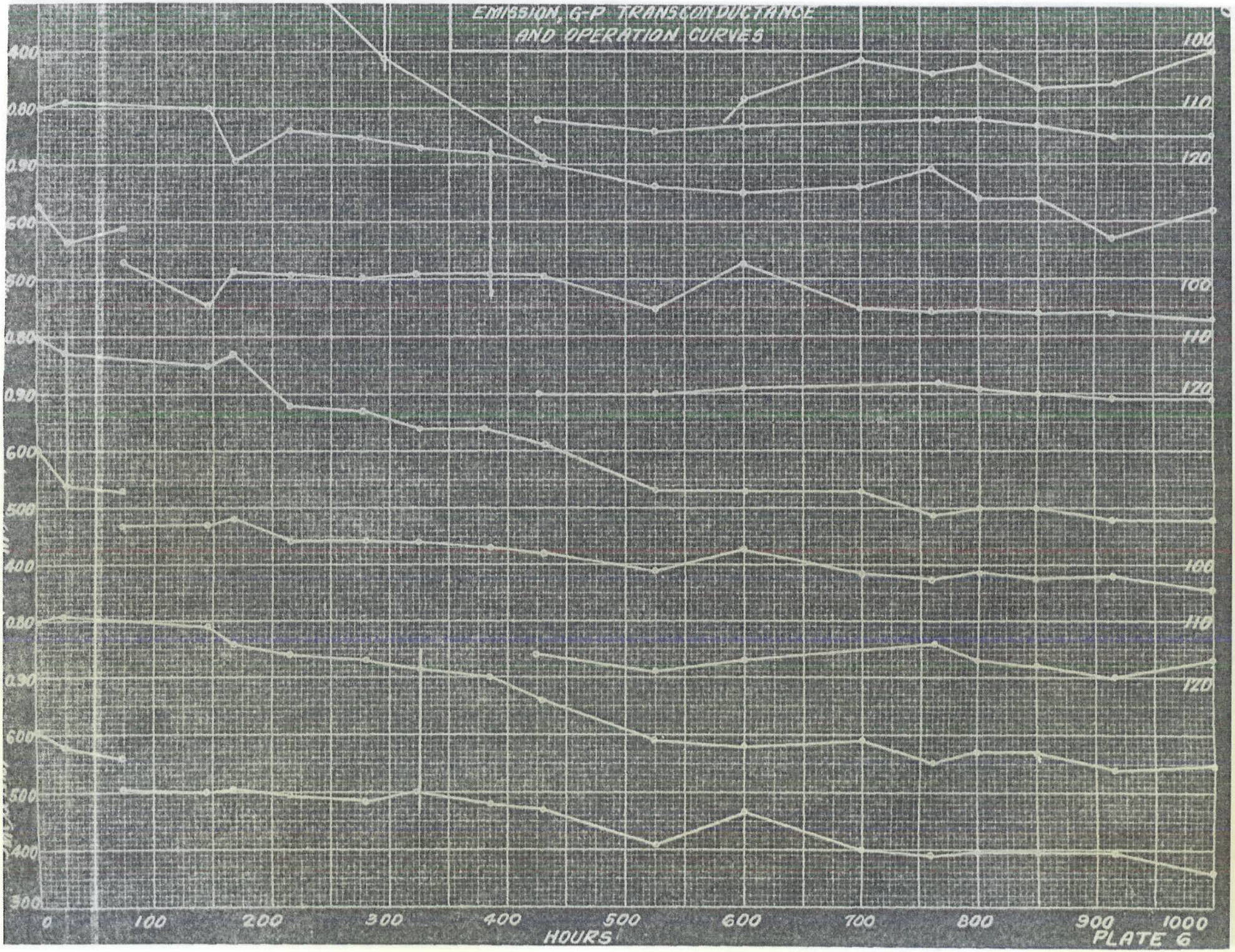

EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
0.60
0.70
700
600
500
0.60
0.70
0.80
600
500
400
0.70
0.80
600
100
110
120
100
110
120
110
120
VOLTAGE

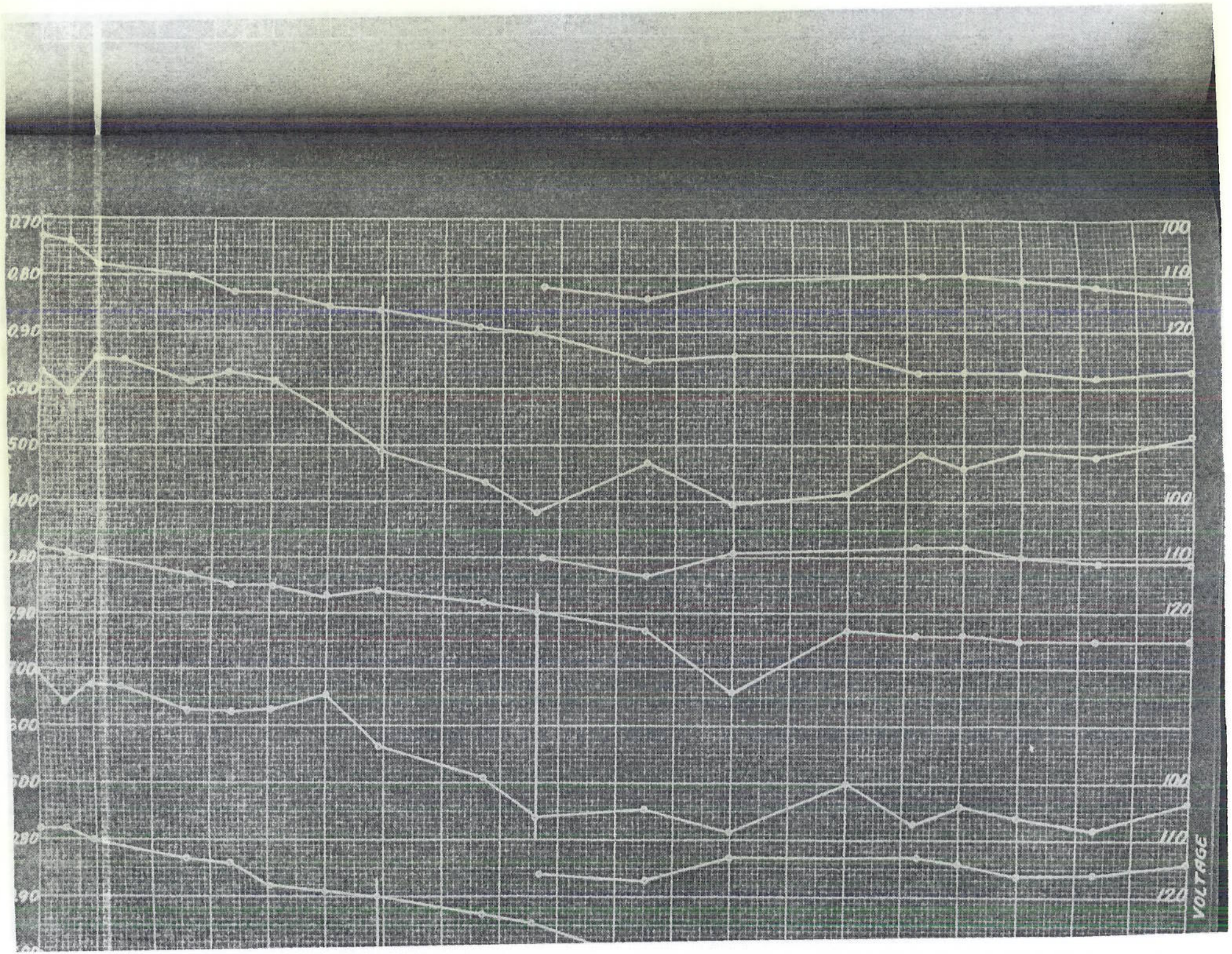

OPERATION VOLTS
110
120
110
120
100
110
120
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 4

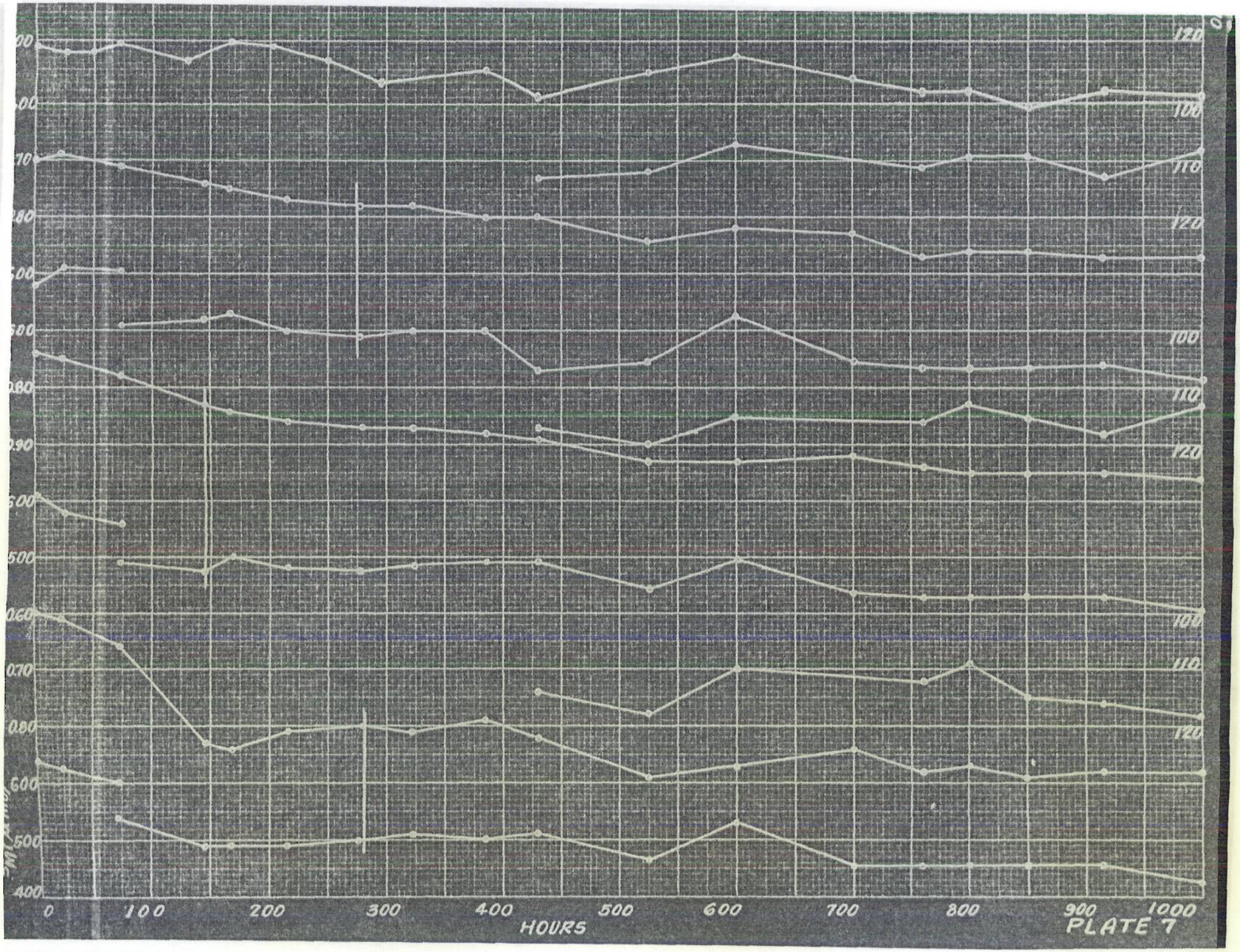

EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
100
110
120
110
120

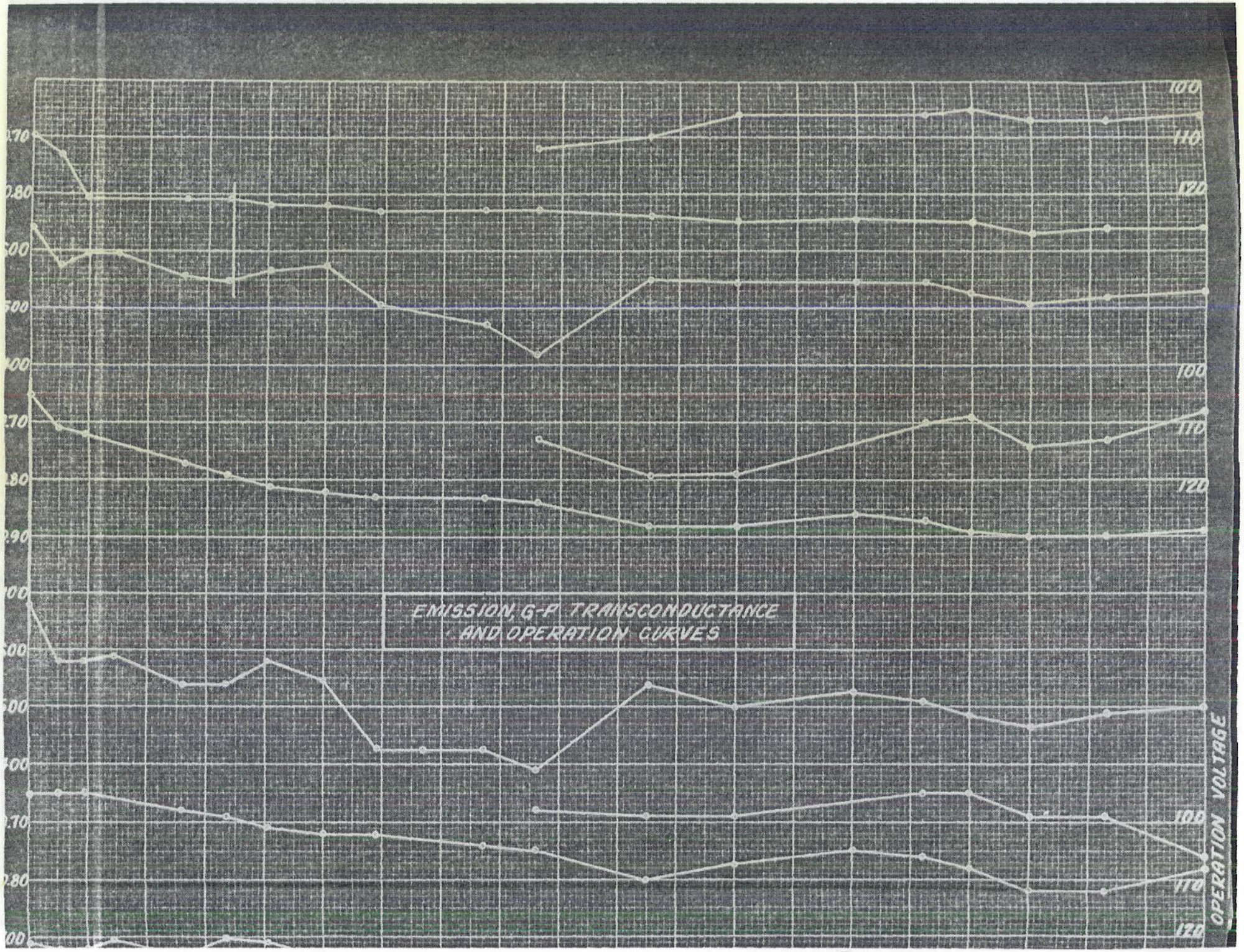

AND OPERATION CURVES
OPERATI
110
120
100
110
120
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 5

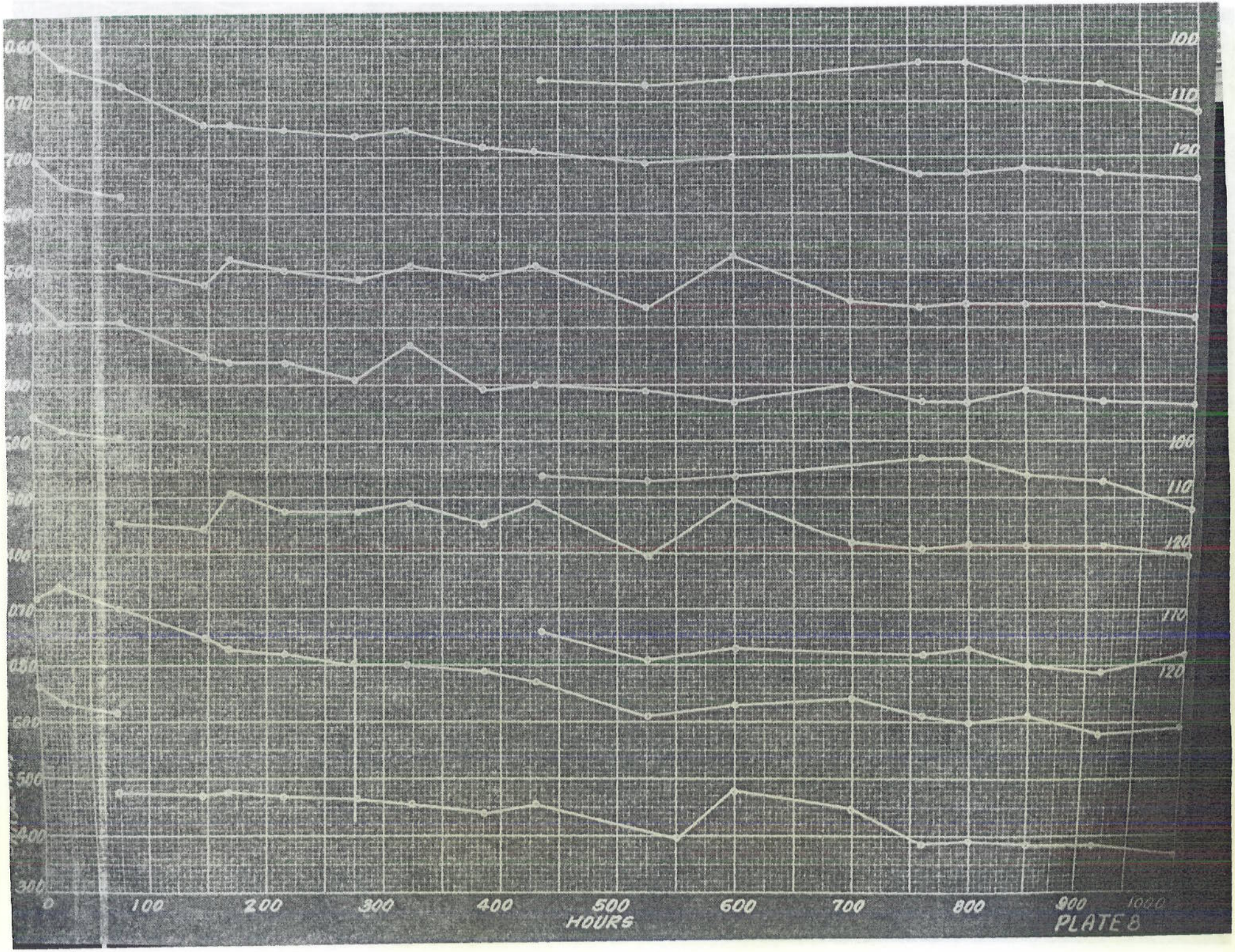

0.70
0.80
700
600
500
0.70
0.80
700
600
0.70
080
700
600
500
100
110
120
100
110
120
100
110
120
VOLTAGE

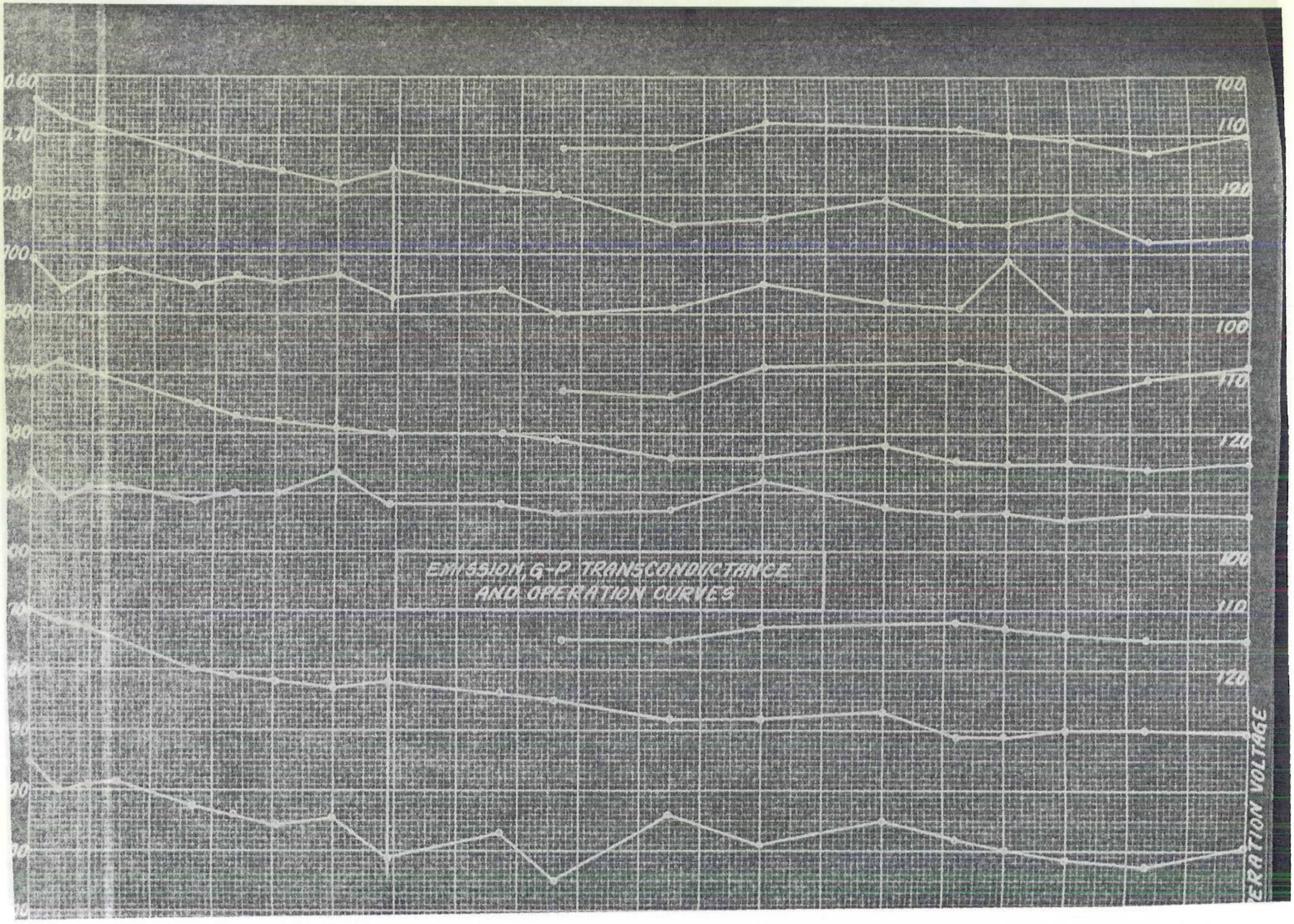

EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
400
0.80
0.90
600
500
0.80
0.90
600
500
400
0.80
0.90
600
500
400
300
100
110
120
100
110
120
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 6


0.70
0.80
0.90
100
110
120
VOLTAGE


0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 7


EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
OPERATION VOLTAGE


100
110
120
100
110
120
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 8


EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
100
110
120
100
110
120
100
110
120
ERATION VOLTAGE

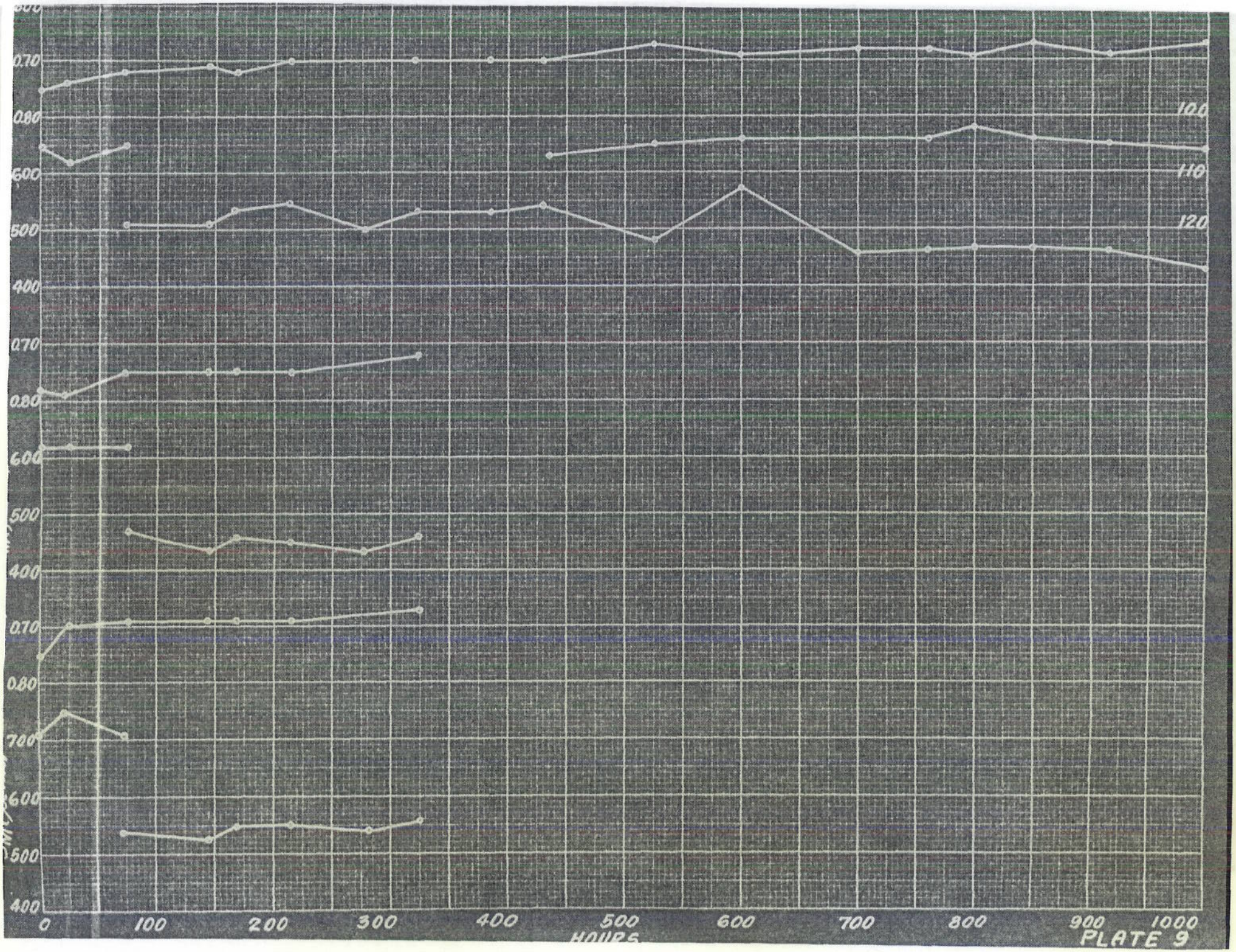
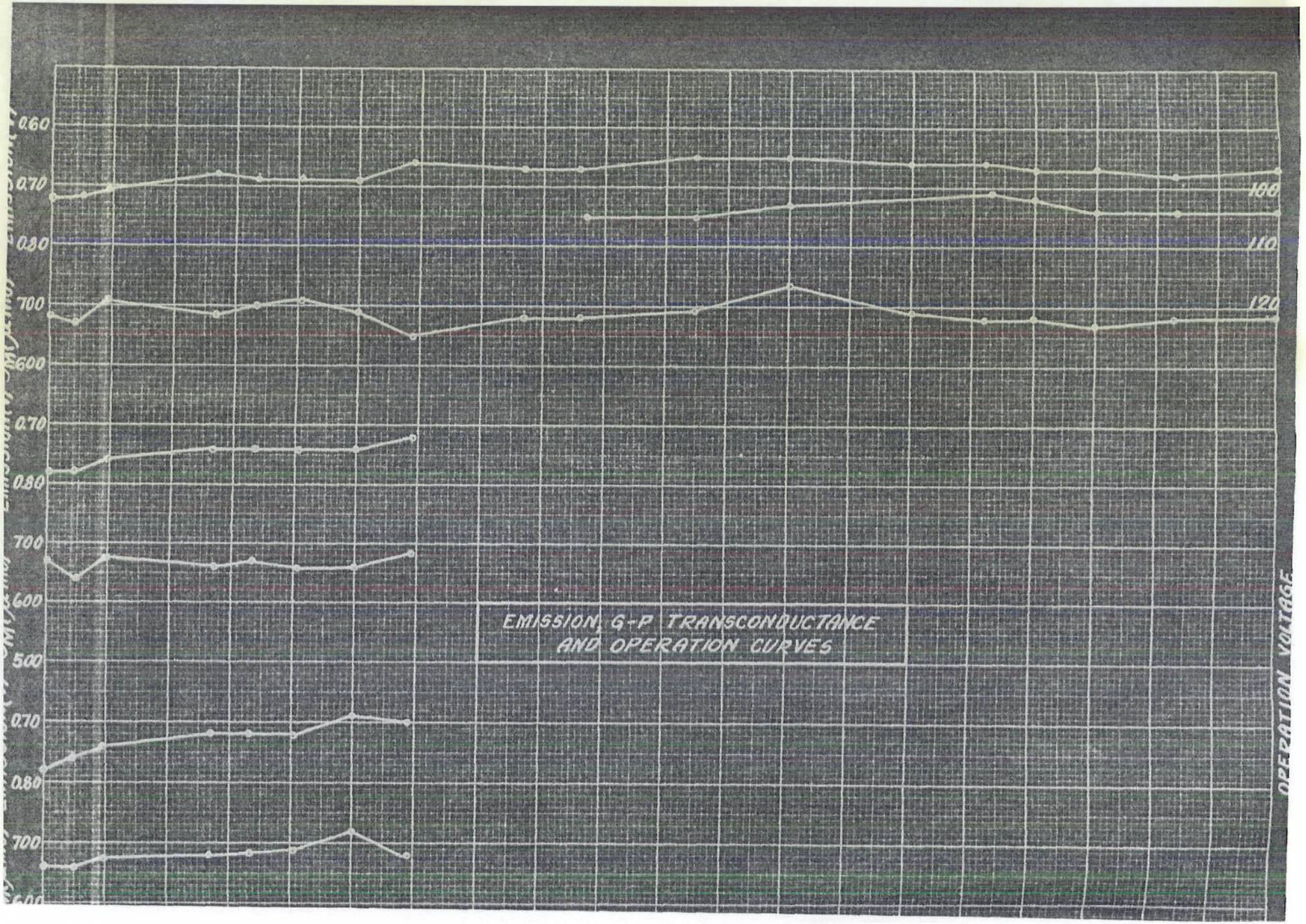
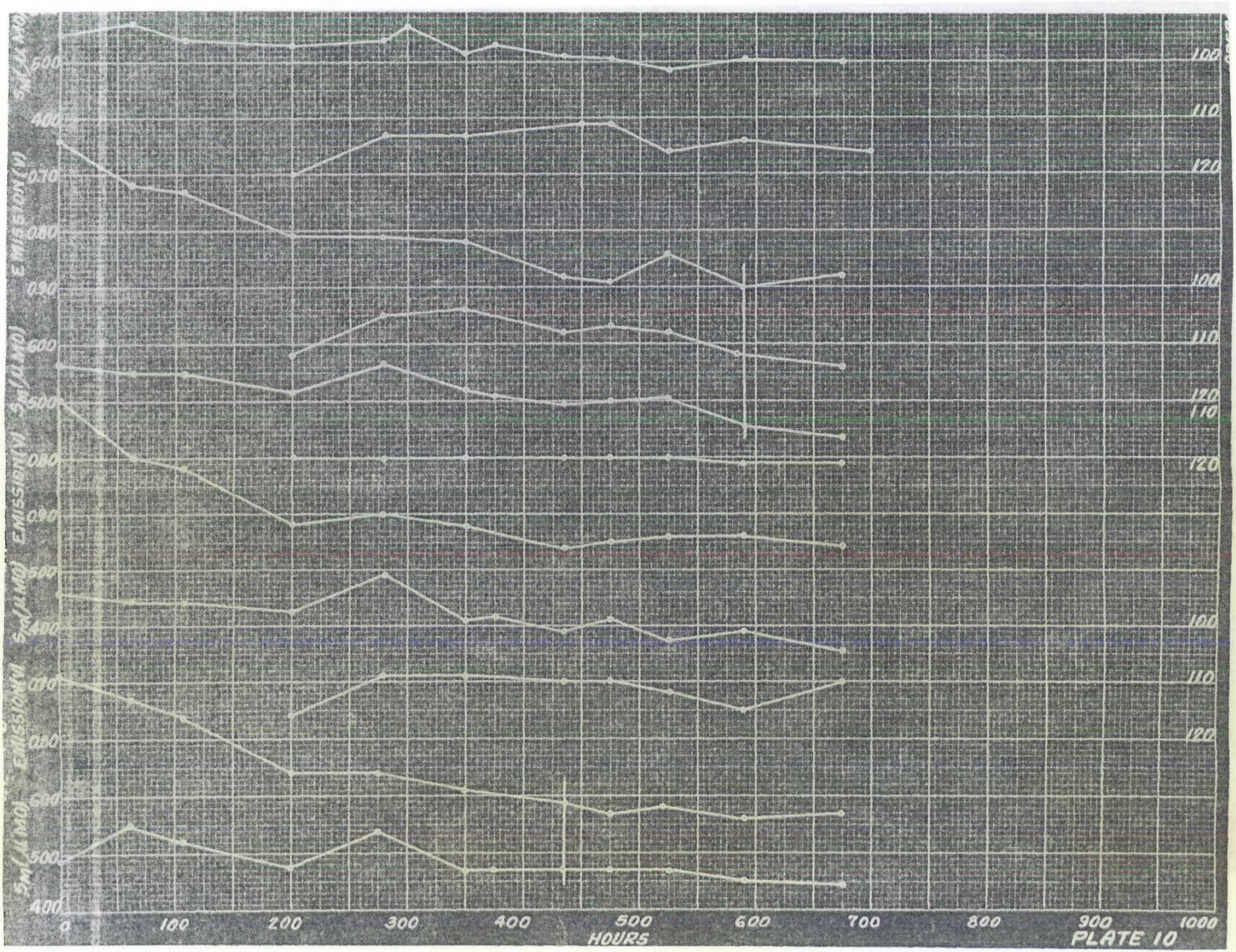
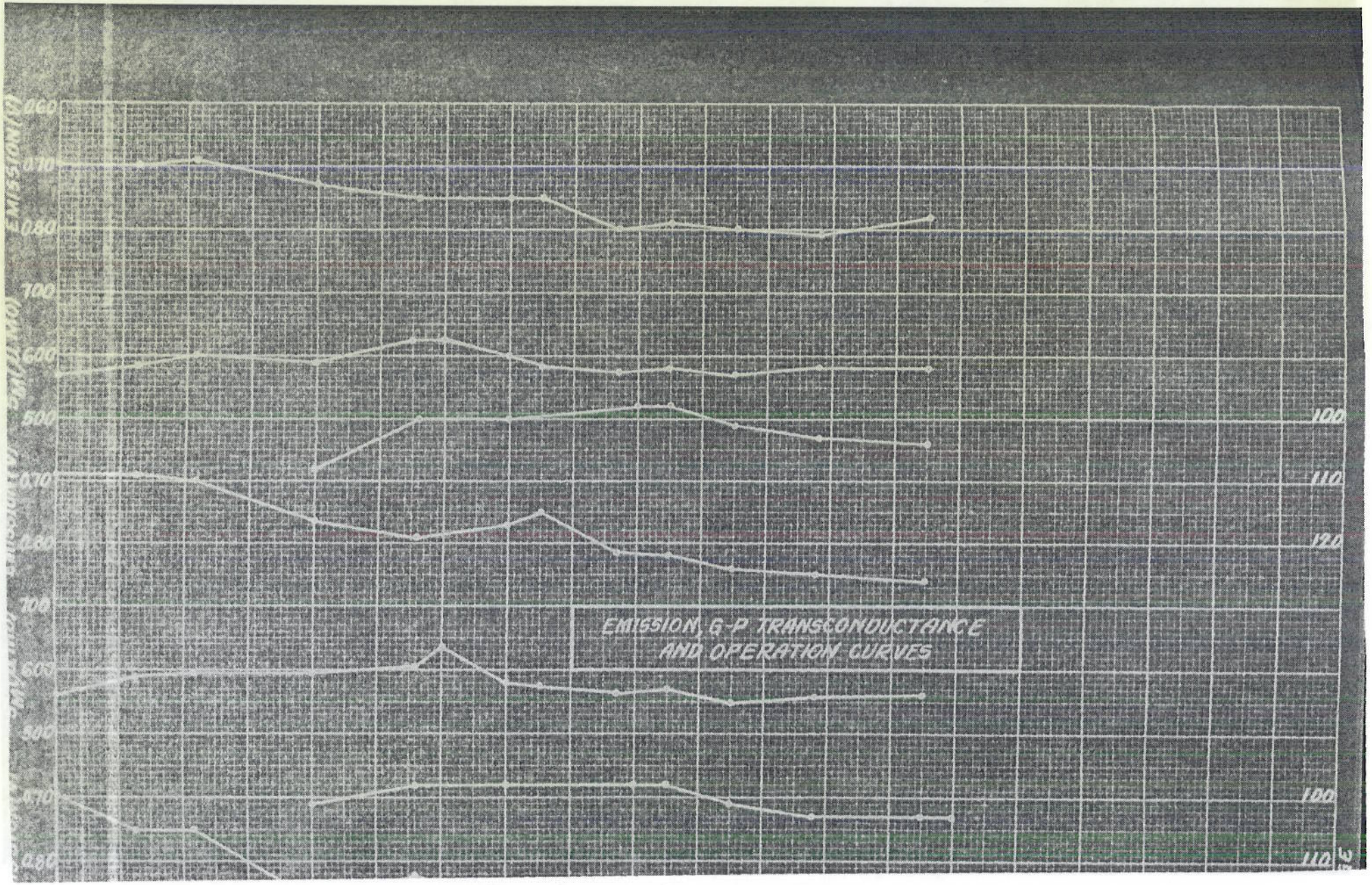
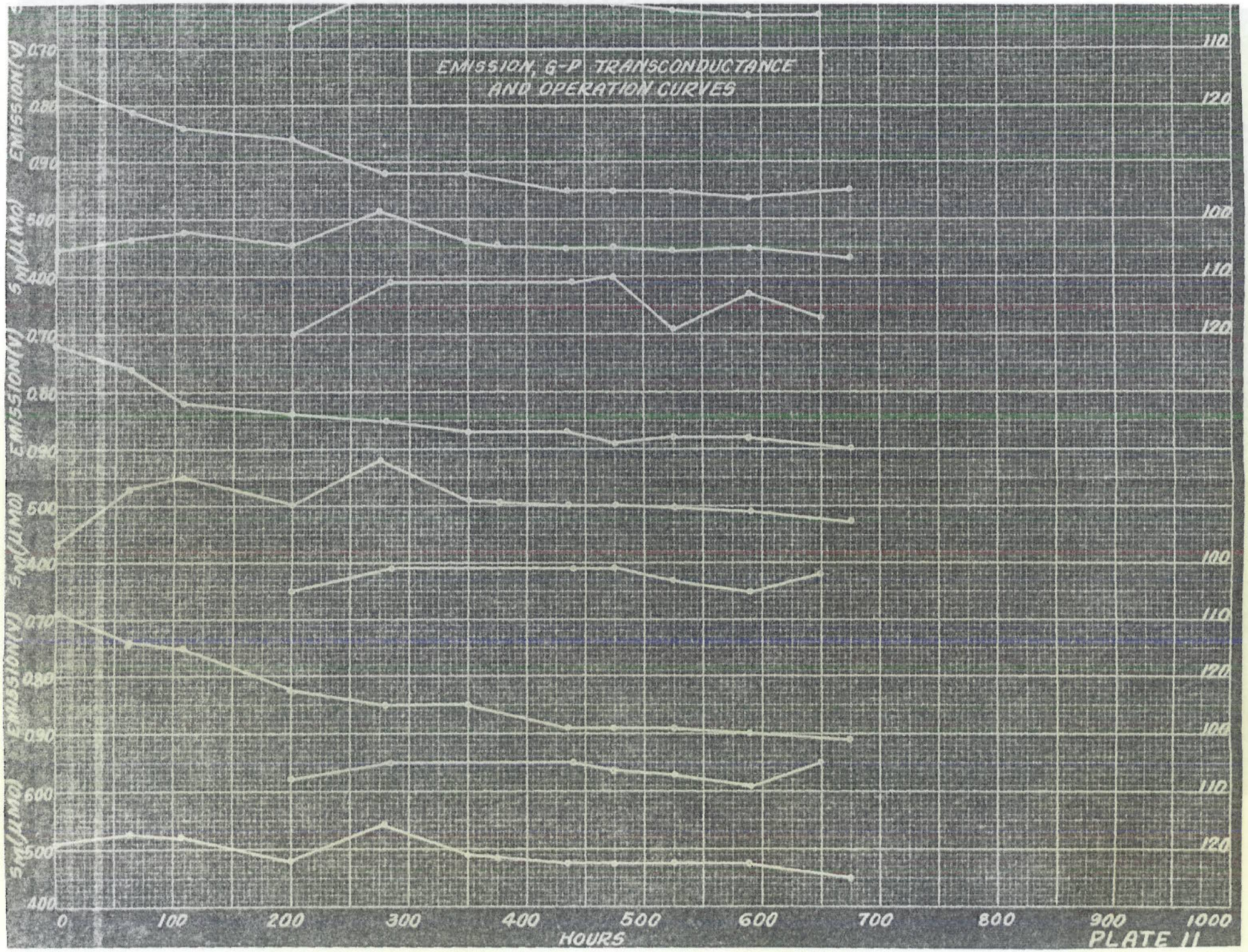

0.70
0.80
600
500
400
0.70
0.80
600
500
400
0.70
0.80
700
600
500
400
10.0
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS

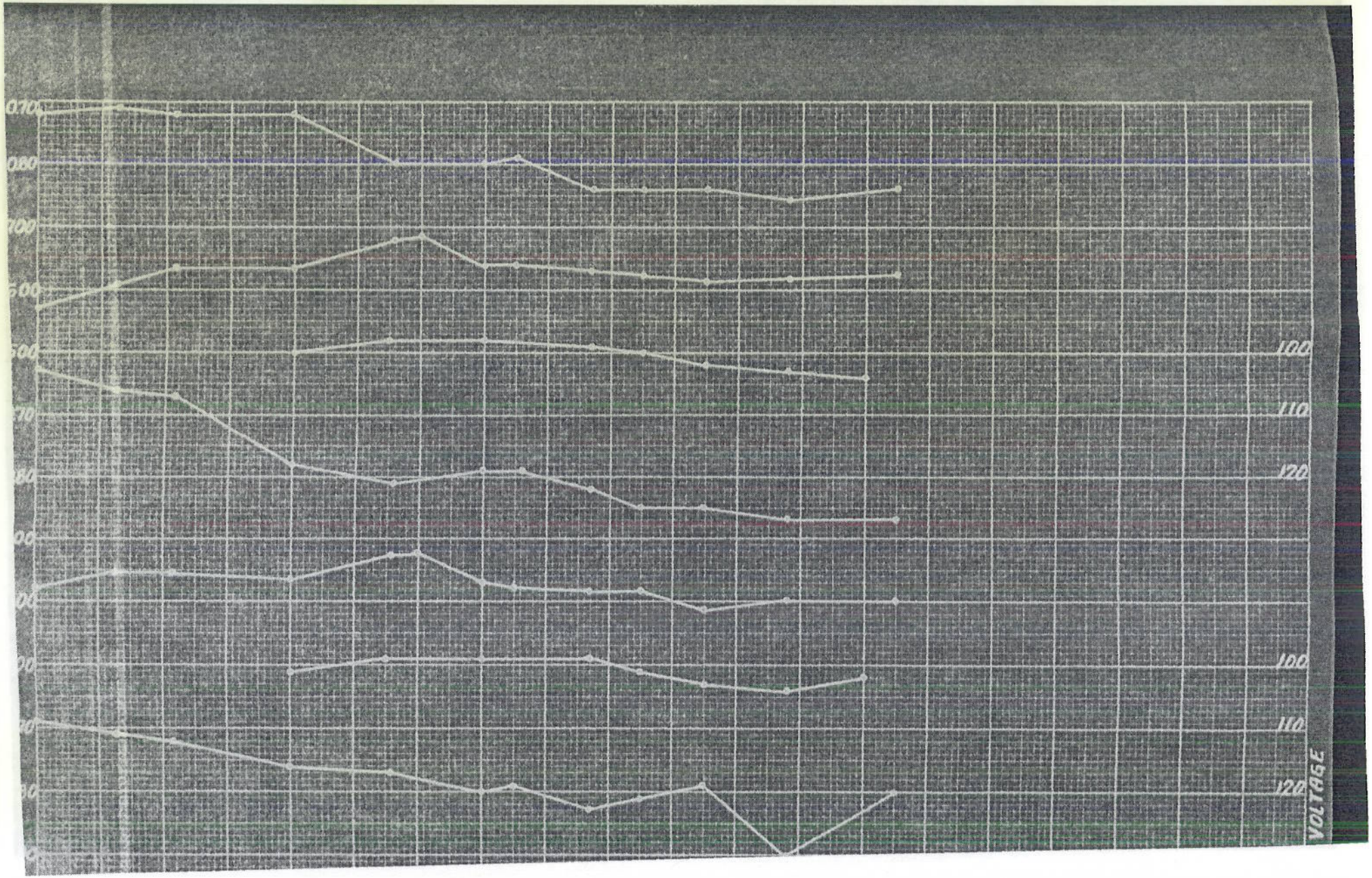
PLATE 9


EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
0.60
0.70
0.80
700
600
500
100
110
120
OPERATION VOLTAGE


EMISSION (V)
5M (UMHO)
0.70
0.80
0.90
500
400
600
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE 10


EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES


EMISSION, G-P TRANSCONDUCTANCE
AND OPERATION CURVES
EMISSION(V)
SM(μMO)
0.70
0.80
0.90
500
400
110
120
100
110
120
0.70
0.80
0.90
500
400
100
110
120
0.70
0.80
0.90
600
500
400
110
120
0
100
200
300
400
500
600
700
800
900
1000
HOURS
PLATE II


100
110
120
100
110
120
VOLTAGE

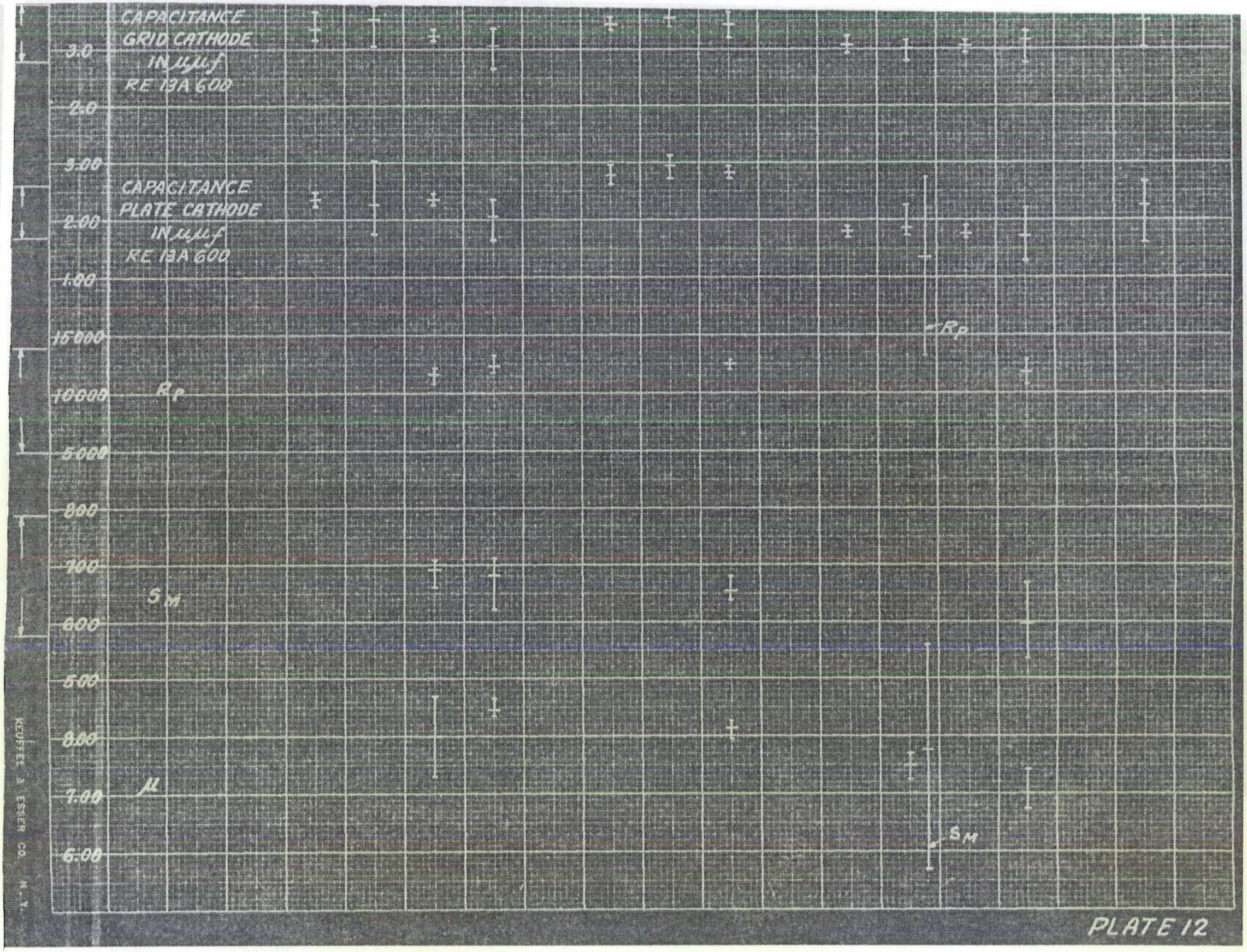
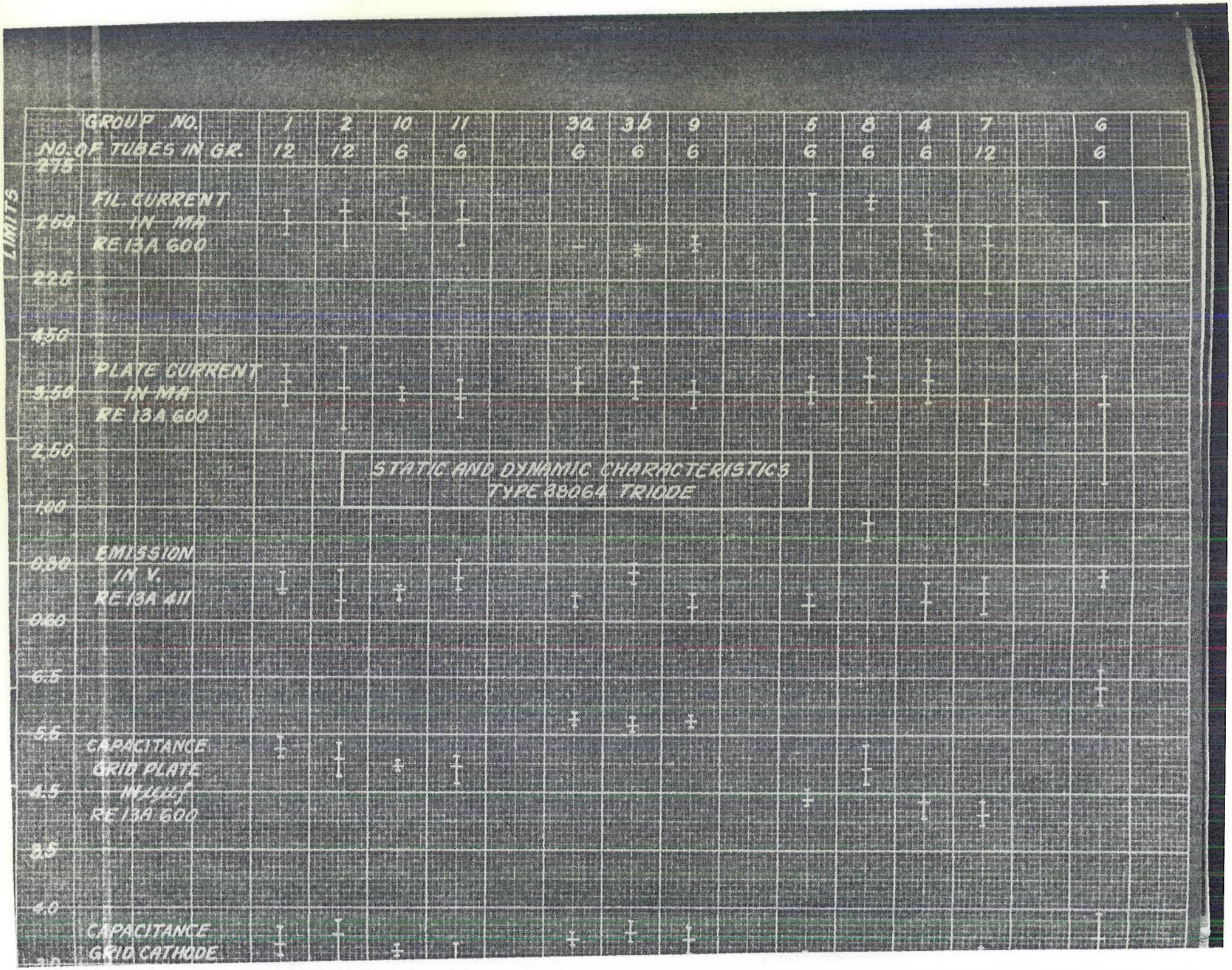
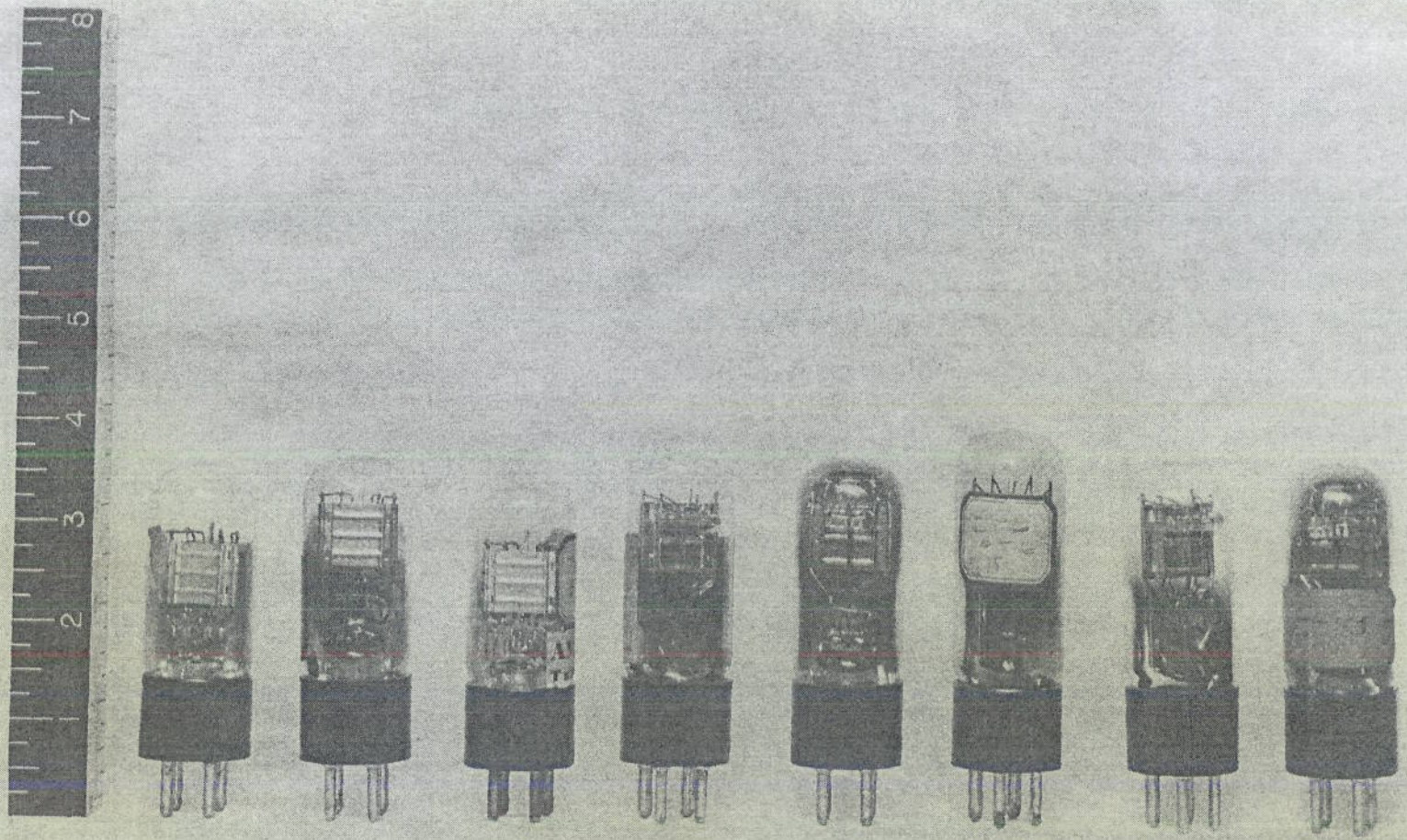

CAPACITANCE
GRID CATHODE
IN μμf
RE 19A 600
3.0
2.0
3.00
CAPACITANCE
PLATE CATHODE
IN μμf
RE 19A 600
2.00
1.00
15000
10000
R_P
5000
800
700
S_M
600
500
800
μ
7.00
6.00
R_P
S_M
KEUFFEL & ESSER CO. N.Y.

PLATE 12


GROUP NO. 1 2 10 11 3a 3b 9 5 8 4 7 6
NO. OF TUBES IN GR. 12 12 6 6 6 6 6 6 6 6 12 6
LIMITS
2.75
2.60
2.25
FIL. CURRENT IN MA RE 13A 600
4.50
3.50
2.50
PLATE CURRENT IN MA RE 13A 600
STATIC AND DYNAMIC CHARACTERISTICS TYPE 8B064 TRIODE
1.00
0.90
0.60
EMISSION IN V. RE 13A 411
6.5
5.6
4.5
CAPACITANCE GRID PLATE MMFD RE 13A 600
3.5
4.0
CAPACITANCE GRID CATHODE



Duovac Old design | Duovac New design | Amperex | Hygrade-Syl. Old design | RCA Radiotron Old design | Deforest | H-S New design | RCA Radiotron New design

TYPE 864 TRIODES

Plate 13