ADC TECHNICAL REPORT 52-190

ELECTRIC-MOTOR WHIRL TEST OF A FLOTTORP STANDARD TWO-BLADE PROPELLER AND A FLOTTORP STANDARD TWO-BLADE PROPELLER INCORPORATING NEMETH MODIFIED LEADING EDGE

(Whirl Test No. 2355)

NATHAN SHOWERS
PROPELLER LABORATORY

AUGUST 1952

WRIGHT AIR DEVELOPMENT CENTER

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Statement A
Approved for Public Release

WRIGHT AIR DEVELOPMENT CENTER

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FOREWORD

The test propellers were submitted by Nemeth Aeronautical Laboratory, Chicago, Illinois, for electric motor whirl test by Propeller Laboratory, Aeronautics Division, Wright Air Development Center. The test propellers were the property of Flottorp Manufacturing Company, Grand Rapids, Michigan. The whirl test program was completed on 15 and 16 May 1951, under Research and Development Order 587-141, "Propeller Aerodynamic Analysis," Whirl Test No. 2355. Mr. Nathan Showers was the project engineer.

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(Whirl Test No. 2355)

Nathan Showers
Propeller Laboratory

August 1952

RDO No. 587-141

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

ABSTRACT

The electric motor whirl test of a Flottorp "standard" two blade, six ft. diameter, wood, fixed-pitch propeller was conducted. An electric motor whirl test was then conducted on a similar "standard" Flottorp propeller that had been modified along the leading edge by the Nemeth Aeronautical Laboratory, Chicago, Illinois. The modification consisted of a series of smooth indentations, in wave form, from about the 0.3 radius out to the tip of the blade. It was claimed by Nemeth Aeronautical Laboratory that such modifications would increase thrust produced at any given horsepower and rpm condition.

Test data are presented covering static calibration of the two propellers for comparative purposes. Calibration consisted of the measurement of the values of the thrust produced and horsepower absorbed at various rpm. Results of the tests were inconclusive.

PUBLICATION REVIEW

This report has been reviewed and is approved.

L. E. TAYLOR
Colonel, USAF
Chief, Propeller Laboratory
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ILLUSTRATIONS

INTRODUCTION

The Nemeth Aeronautical Laboratory, in a period of time before the writing of this report, had been experimenting with various designs of propeller blades in an attempt to improve performance of propellers. Their experimentation consisted of systematically reducing the length of the chord of the blades at various stations along the radius of the blade. This gave a wavy leading edge planform to the blade.

Nemeth Aeronautical Laboratory, in conference with Propeller Laboratory personnel, did not give any sound theoretical reasoning for the improved performance claimed for this modification, but presented data on similarly modified model propellers. From their work with models, the Nemeth Aeronautical Laboratory concluded that such modifications would increase the thrust produced at any given horsepower and rpm condition. The limited facilities of Nemeth Aeronautical Laboratory prohibited them from making full scale investigation into the problem and they appealed to Propeller Laboratory to conduct the test of this report for them. Sufficient authoritative data were presented by Nemeth Aeronautical Laboratory to indicate that conduct of the test program would be of advantage to the Air Force.

PURPOSE OF TEST

The purpose of this test was to obtain the static calibration characteristics of the subject propellers, thus determining the relative value of the Nemeth modifications.

The "standard" Flottorp propeller was of Design No. 72A-43, Serial No. 8823Y. The propeller was wood, six ft. diameter, fixed pitch, with a tapered square tip planform. The tip and outer six in. of the leading edge of the blade were protected by a metal sheath. This propeller is illustrated by Figures 1, 3, and 5.

The second test propeller was a similar Flottorp propeller that had been modified along the leading edge by Nemeth Aeronautical Laboratory. The modifications consisted of a series of smooth indentations, in wave form, from approximately the 0.3 radius out to the tip of each blade. This propeller had a tapered round tip planform instead of the tapered square tip planform of the "standard" Flottorp propeller. The tip and outer six in. of the leading edge of the blade were protected by a metal sheath. This Propeller and the modified leading edge are illustrated by Figures 2, 4, and 6. A No. 3745, "0" taper hub was used with both propellers.

PROCEDURE OF TEST

The subject propellers were inspected and assembled in preparation for whirl testing. The whirl test program consisted of thrust, horsepower and sound calibrations at selected rpm. Calibration limits were 2800 rpm or the start of blade flutter, whichever was reached first.

TEST RESULTS

Two calibration runs were made on each propeller to assure that the most accurate data possible were being obtained. Calibration data on the test propellers are tabulated in Appendix I. Curves of corrected horsepower versus rpm and of corrected thrust versus rpm are plotted from these data in Figures 7, 8, 9 and 10. Sound levels recorded are presented in Table I and plotted in Figure 11. No blade flutter was encountered on either propeller. Inspection of the propellers after the completion of the test program revealed no defects.

CONCLUSIONS

The test data indicated the smooth modified propeller to be slightly inferior to the "standard" propeller. However, differences in the tips of the two propellers, illustrated by Figures 3 and 4, may have accounted for this. Further, the electric motor which may inaccuracy at relatively low power and low speed values obtained in this program makes test results inconclusive. Inspection of the sound level data, as plotted in Figure 11, shows little difference between the two propellers.

In view of conclusions reached above, it is currently being planned to modify a larger diameter dural propeller for similar tests.

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In view of conclusions reached above, it is currently being planned to modify a larger diameter Naval propeller for similar tests.

WHIRL TEST No. 2355

Appendix I

Time	R. P. M.	H. P.		Thrust Corrected	DEFLECTIONS			REMARKS*
		Actual	Corrected		L. E.	T. E.	Angle	

Calibration Data (First Run)
Flottorp "Standard" Propeller
Design No. 72A-18

5-15-51

1315	693	2.6	2.7	15.8
1318	1026	6.3	6.5	73.8
1321	1296	13.6	13.9	110.6
1324	1596	23.2	23.8	195.0
1327	1914	37.3	38.2	300.0
1330	2196	66.0	67.6	358.3
1333	2526	109.9	112.6	479.6
1336	2652	131.7	134.9	536.5
1339	2196	64.3	65.9	368.0
1342	2397	88.8	91.0	450.0
1345	1908	35.7	36.6	282.4
1348	1596	24.1	24.7	212.3

Calibration Data (First Run)
Flottorp Propeller
Nemeth Leading Edge Modification

5-16-51

0930	702	3.4	3.5	10.0
0933	1032	6.3	6.5	52.5
0936	1311	6.0	6.2	109.5
0939	1602	25.3	25.9	174.0
0942	1926	45.4	46.6	258.0
0945	2199	74.8	76.8	331.0
0948	2397	98.3	101.0	410.0
0951	2610	133.2	136.8	486.0
0954	2697	148.9	153.0	517.0
0957	2199	72.4	74.4	340.0
1000	1314	14.0	14.4	114.0

APPENDIX I (cont'd)

WHIRL TEST No. 2355

Time	R. P. M.	H. P.		Thrust Corrected	DEFLECTIONS			REMARKS*
		Actual	Corrected		L. E.	T. E.	Angle	

Calibration Data (Second Run)
Flottorp "Standard" Propeller
Design No. 72A-48

5-16-51

1450	741	3.1	3.2	3.0
1453	1002	4.5	4.6	42.8
1456	1308	14.1	14.4	100.5
1459	1629	20.1	20.9	187.1
1502	1878	33.0	34.3	262.0
1505	2190	63.5	66.0	369.0
1508	2400	89.3	92.8	432.0
1511	2610	121.9	126.6	508.0
1514	1926	35.7	37.1	283.0
1517	1626	19.8	20.6	192.5

Calibration Data (Second Run)
Flottorp Propeller
Nemeth Leading Edge Modification

5-16-51

1730	768	2.5	2.6	24.8
1733	999	5.1	5.2	57.1
1736	1338	15.5	15.9	121.6
1739	1704	28.4	29.1	201.3
1742	1704	26.8	28.0	201.3
1745	1896	39.0	40.8	256.2
1748	2190	70.5	73.7	342.5
1751	2406	99.1	103.5	428.5
1754	2592	129.0	135.0	509.0
1757	2760	159.6	167.0	563.0

TABLE 1

Sound Level at Various rpm
(Decibels)

rpm	Flottorp Standard	rpm	Nemeth Modified
1884	94	1926	96
2205	100	2199	100
2409	105	2397	104
2703	106	2697	107

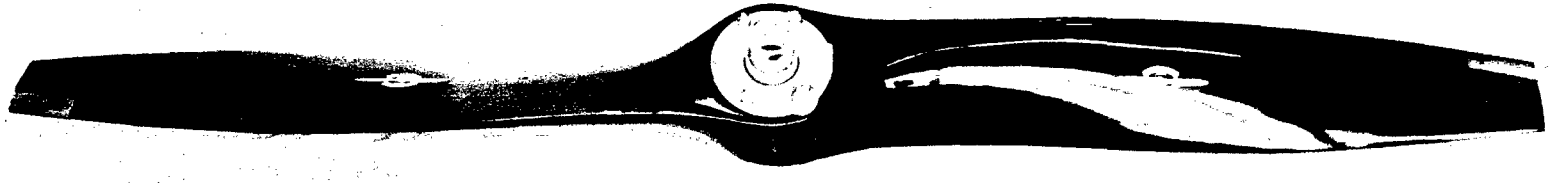

Fig 1 - Front View Flottorp Standard Propeller

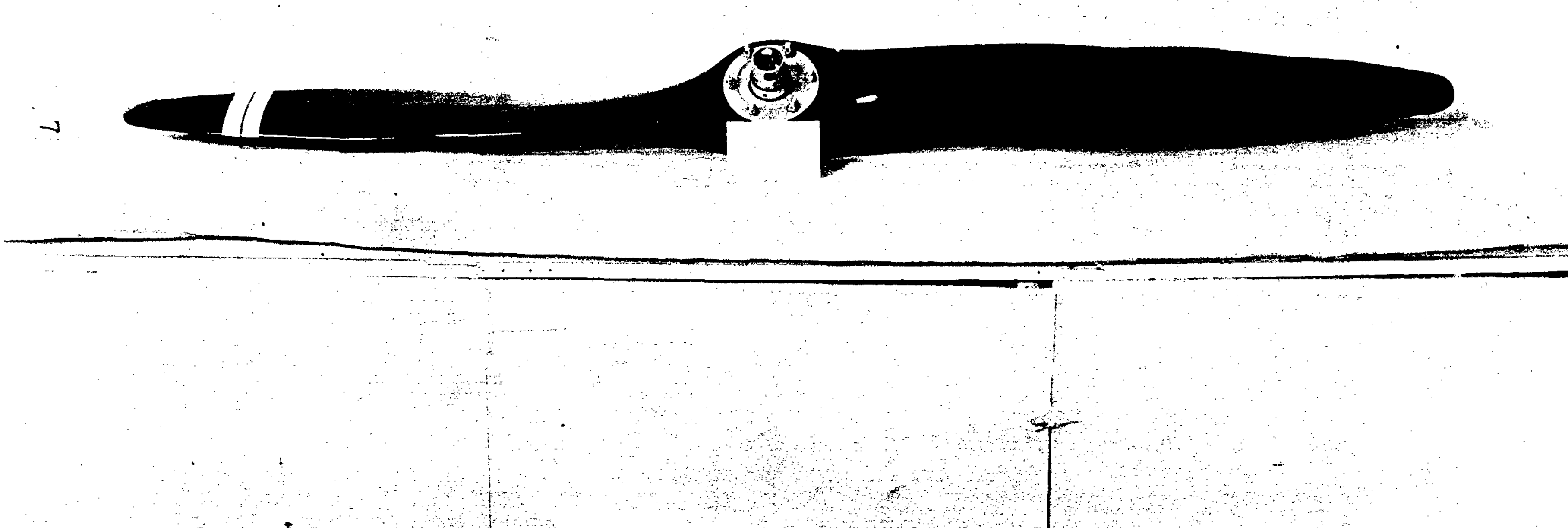

Fig 2 - Front View Flottorp Standard Propeller Incorporating Nemeth Modified Leading Edge

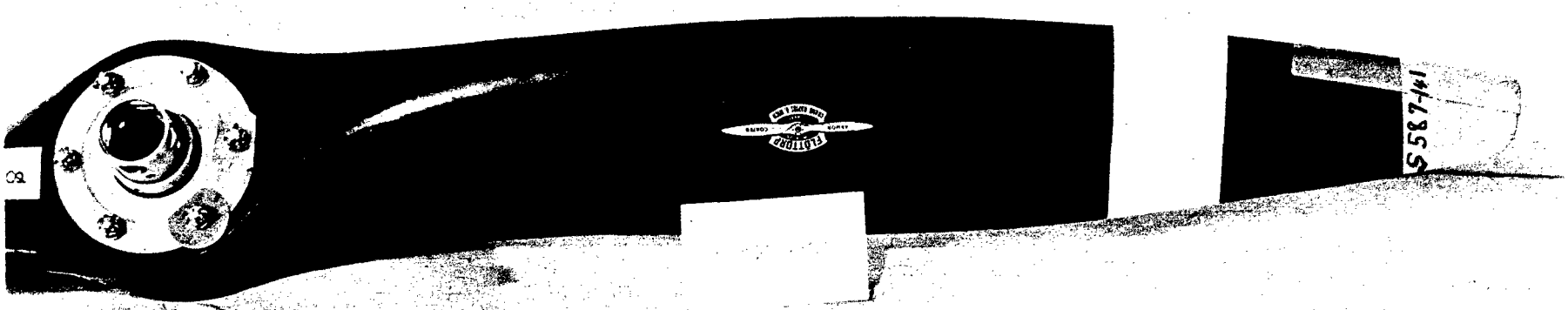

Fig 3 - Front View Close-Up of Blade - Flottorp Standard Propeller

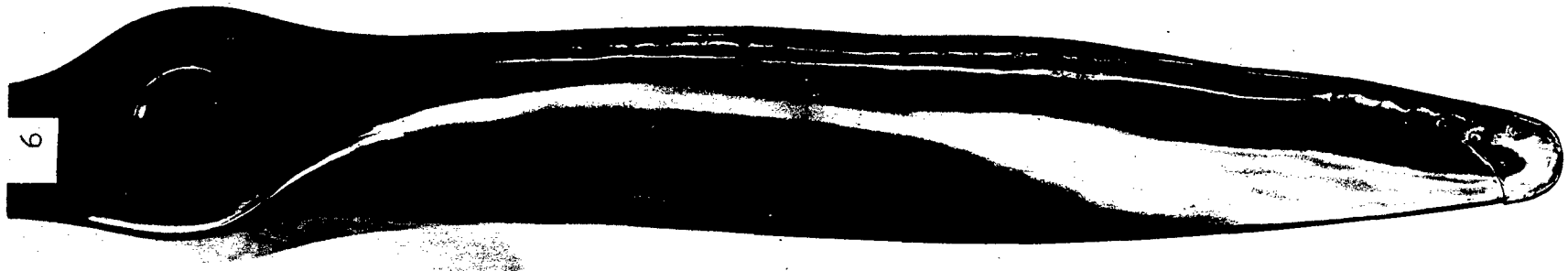

Fig 4 - Front View Close-Up of Blade - Flottorp Standard Propeller Incorporating Nemeth Modified Leading Edge

Fig 5 - Edge View of Blade - Flottorp Standard Propeller

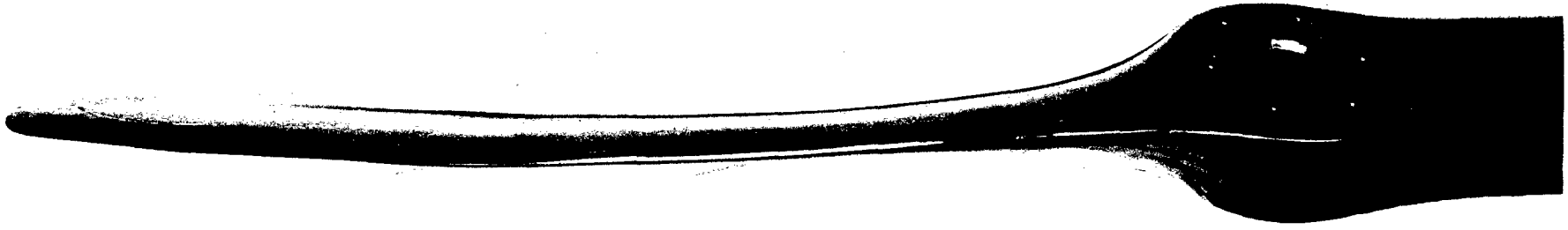

Fig 6 - Edge View of Blade - Flottorp Standard Propeller
Incorporating Nemeth Modified Leading Edge

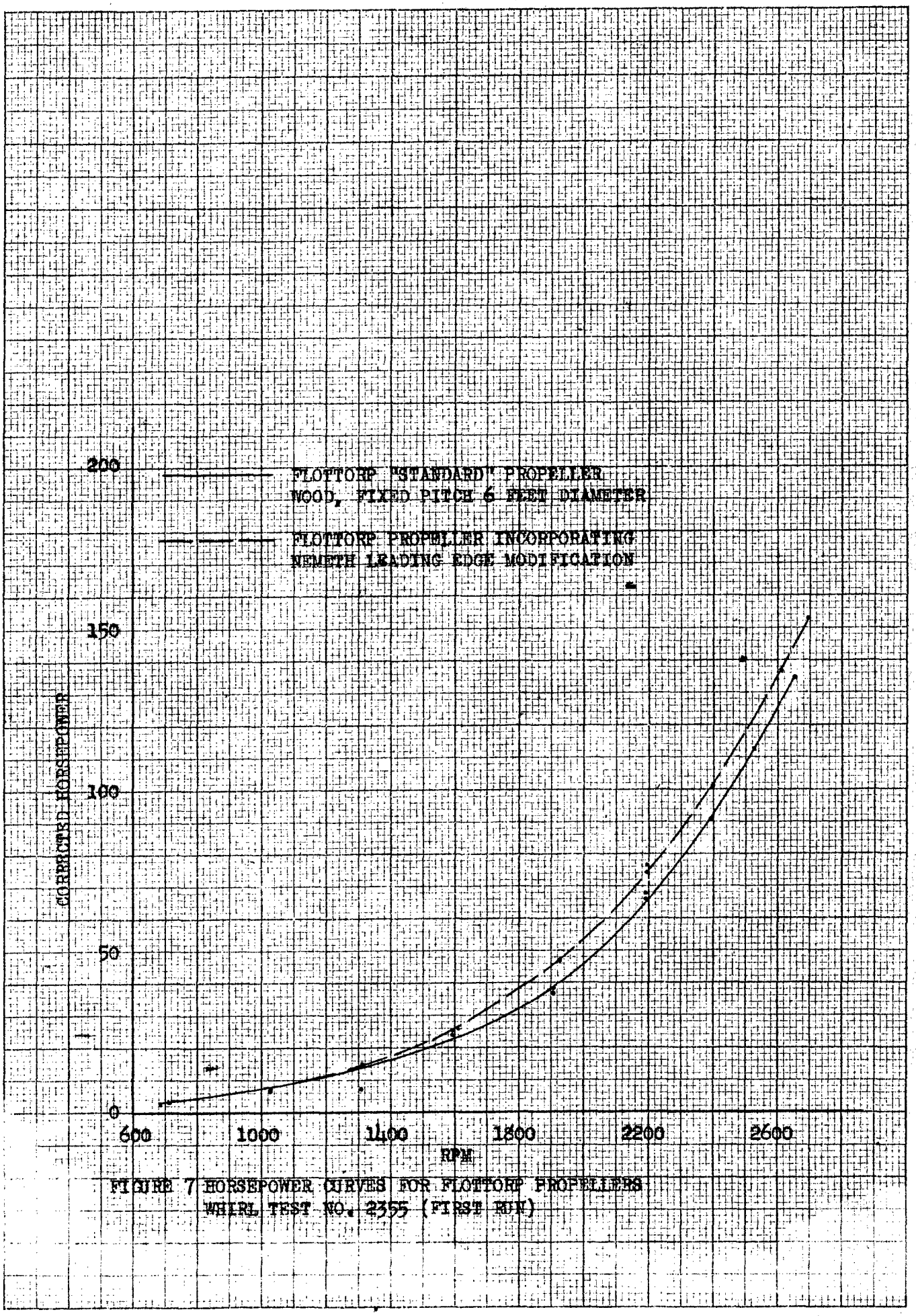

FIGURE 7 HORSEPOWER CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355 (FIRST RUN)

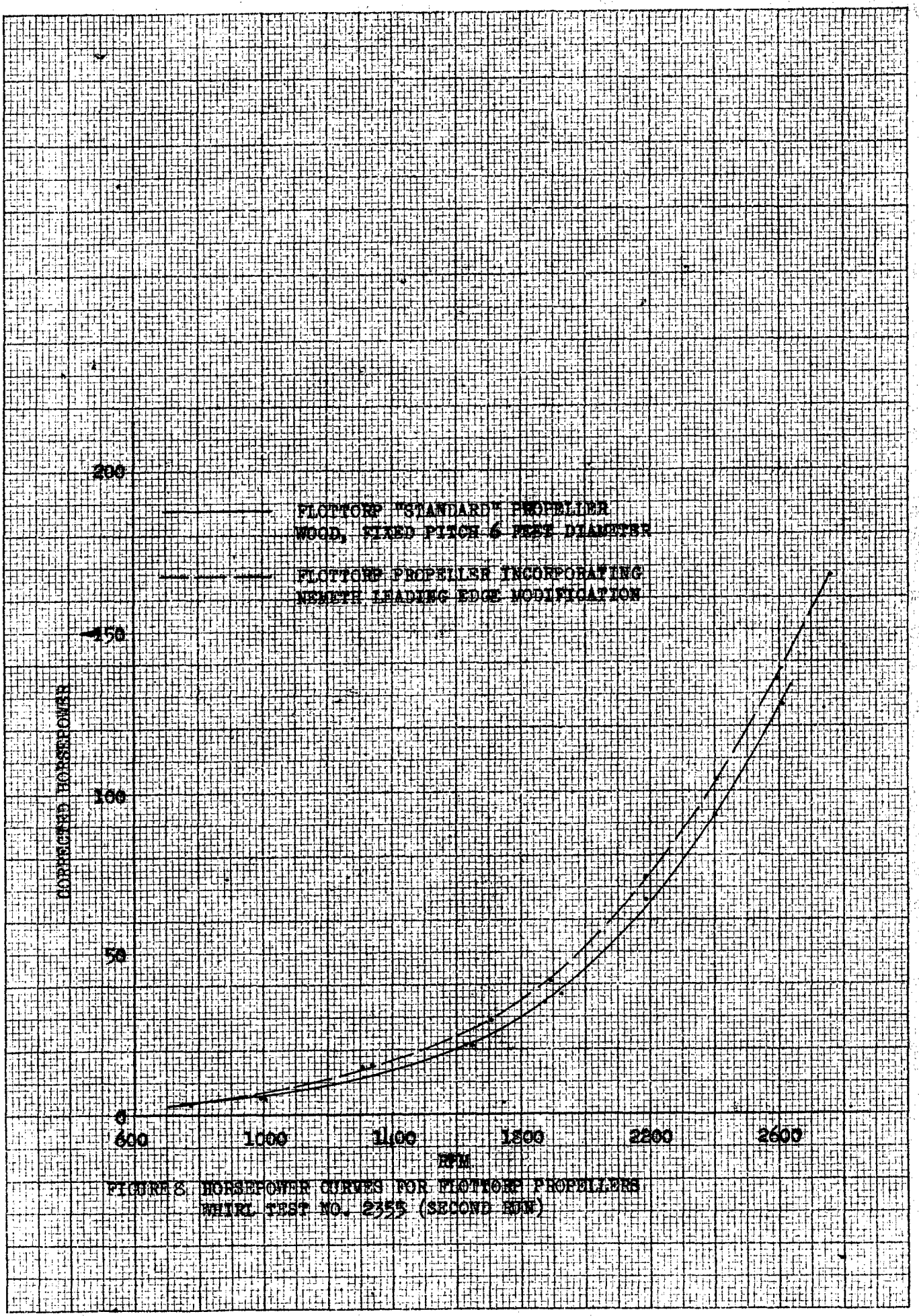

FIGURE 8. HORSEPOWER CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355 (SECOND RUN)

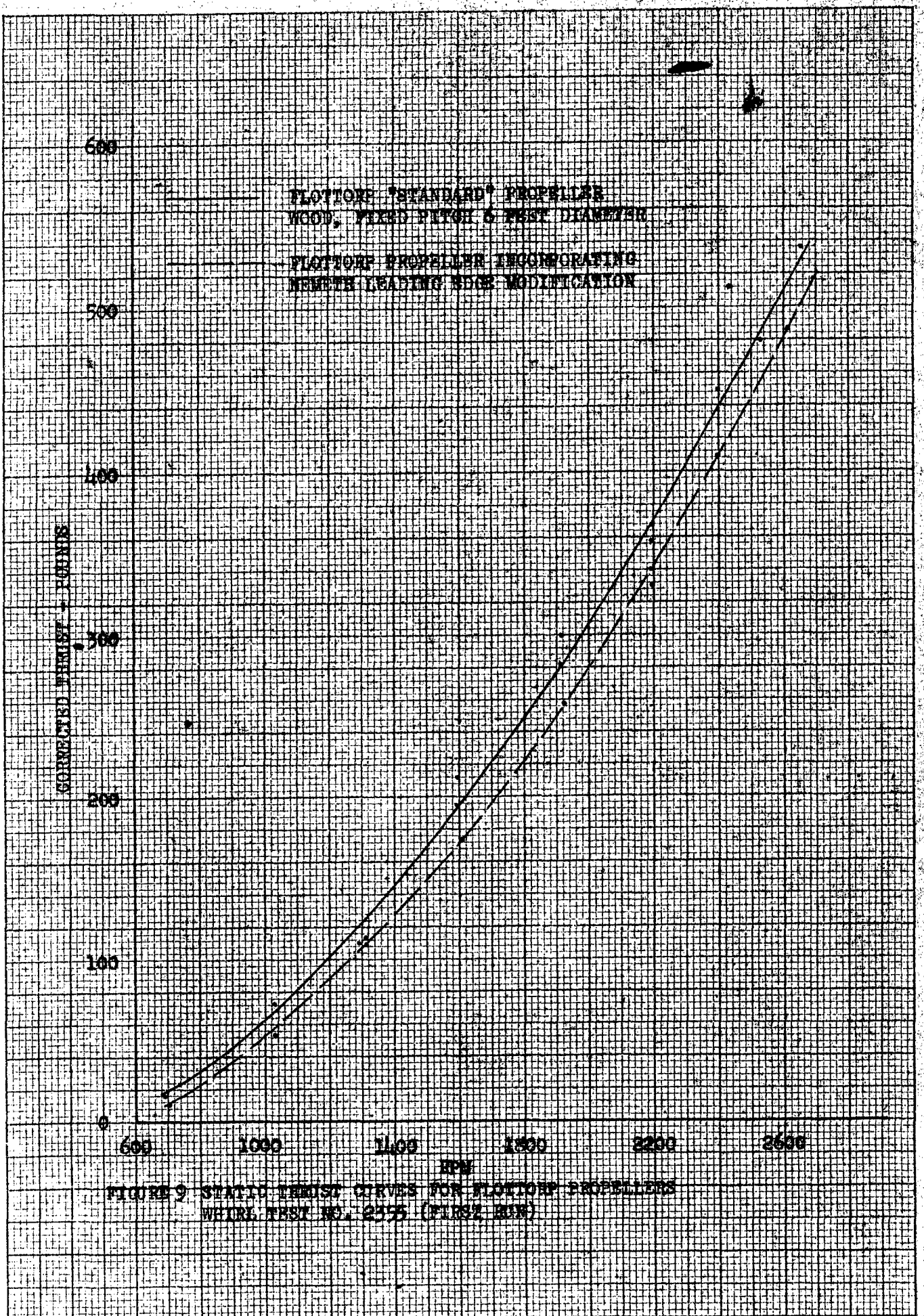

FIGURE 9 STATIC THRUST CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355 (FIRST RUN)

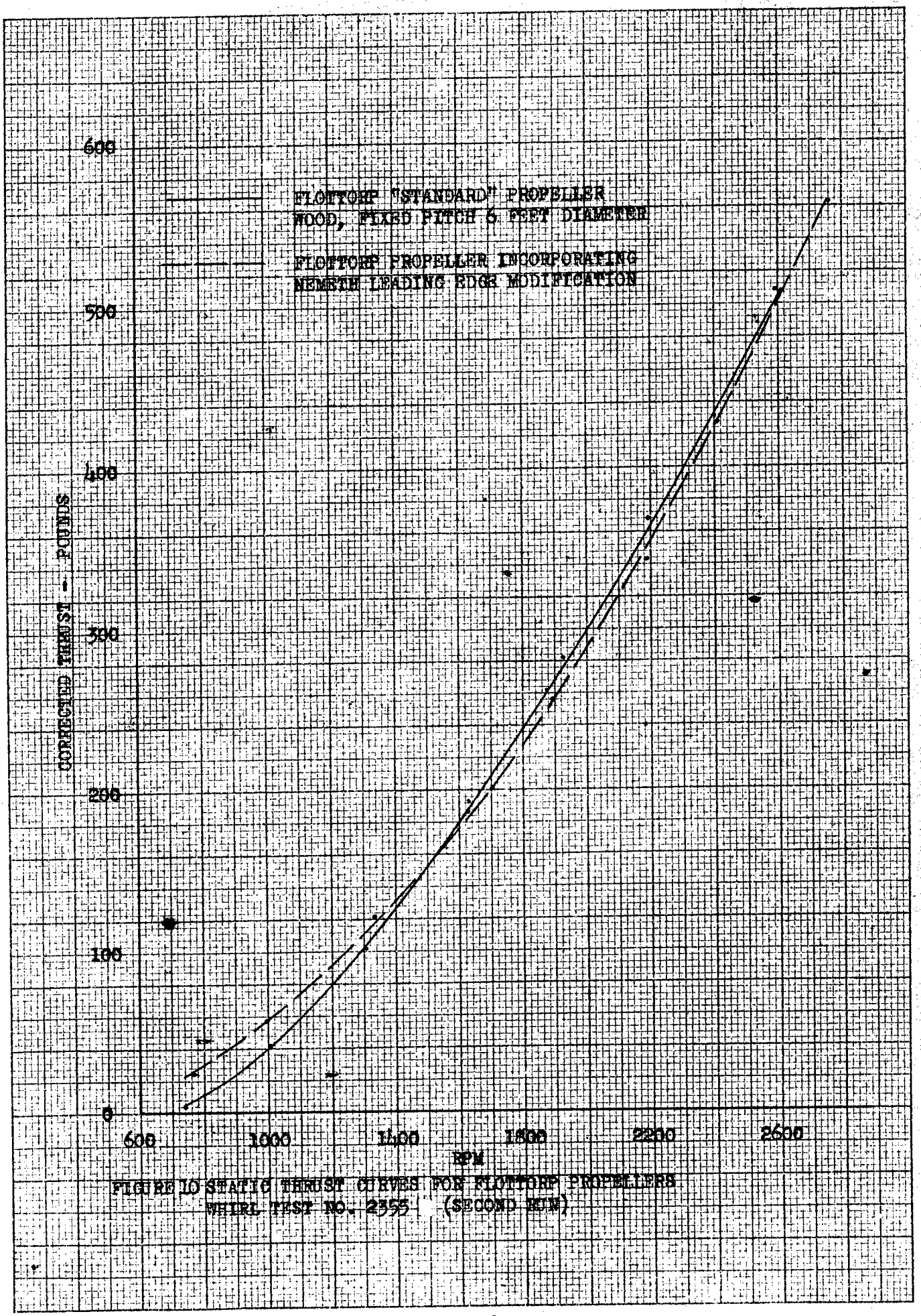

FIGURE 10 STATIC THRUST CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355 (SECOND RUN)

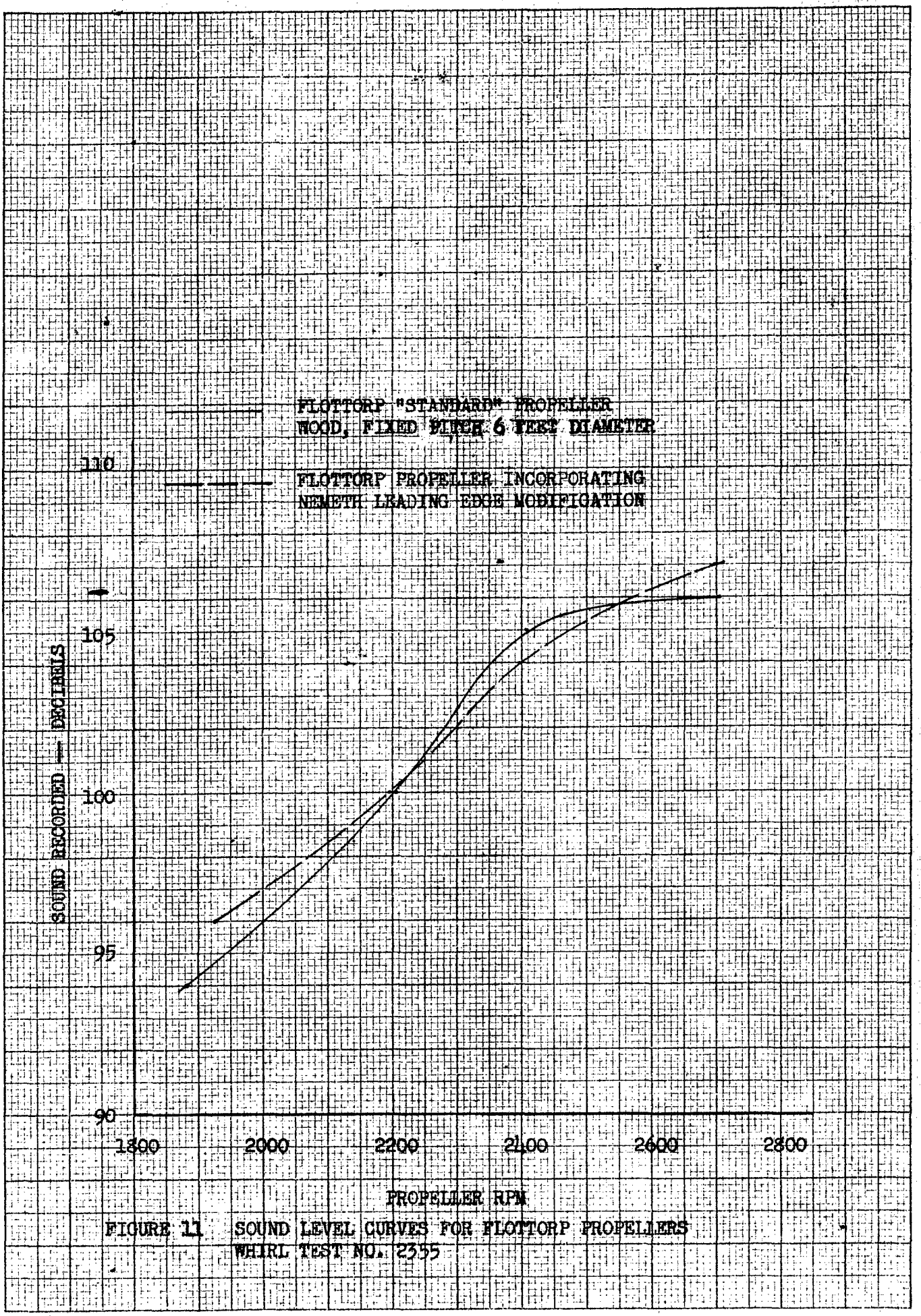

FIGURE 11 SOUND LEVEL CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355

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WHIRL TEST No. 2355

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		Actual	Corrected		L. E.	T. E.	Angle	

Calibration Data (First Run)
Flottorp "Standard" Propeller
Design No. 72A-48

5-15-51

1315	693	2.6	2.7	15.8
1318	1026	6.3	6.5	73.8
1321	1296	13.6	13.9	110.6
1324	1596	23.2	23.8	195.0
1327	1914	37.3	38.2	300.0
1330	2196	66.0	67.6	358.3
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5-16-51

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Nathan Showers
Propeller Laboratory

August 1952

RDO No. 587-141

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

FOREWORD

The test propellers were submitted by Nemeth Aeronautical Laboratory, Chicago, Illinois, for electric motor whirl test by Propeller Laboratory, Aeronautics Division, Wright Air Development Center. The test propellers were the property of Flottorp Manufacturing Company, Grand Rapids, Michigan. The whirl test program was completed on 15 and 16 May 1951, under Research and Development Order 587-141, "Propeller Aerodynamic Analysis," Whirl Test No. 2355. Mr. Nathan Showers was the project engineer.

ABSTRACT

The electric motor whirl test of a Flottorp "standard" two blade, six ft. diameter, wood, fixed-pitch propeller was conducted. An electric motor whirl test was then conducted on a similar "standard" Flottorp propeller that had been modified along the leading edge by the Nemeth Aeronautical Laboratory, Chicago, Illinois. The modification consisted of a series of smooth indentations, in wave form, from about the 0.3 radius out to the tip of the blade. It was claimed by Nemeth Aeronautical Laboratory that such modifications would increase thrust produced at any given horsepower and rpm condition.

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PURPOSE OF TEST

The purpose of this test was to obtain the static calibration characteristics of the subject propellers, thus determining the relative value of the Nemeth modifications.

The "standard" Flottorp propeller was of Design No. 72A-48, Serial No. 8823Y. The propeller was wood, six ft. diameter, fixed pitch, with a tapered square tip planform. The tip and outer six in. of the leading edge of the blade were protected by a metal sheath. This propeller is illustrated by Figures 1, 3, and 5.

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TEST RESULTS

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WHIRL TEST No. 2355

Appendix I

Time	R. P. M.	H. P.		Thrust Corrected	DEFLECTIONS			REMARKS*
		Actual	Corrected		L. E.	T. E.	Angle	

Calibration Data (First Run)
Flottorp "Standard" Propeller
Design No. 72A-1/8

5-15-51

1315	693	2.6	2.7	15.8
1318	1026	6.3	6.5	73.8
1321	1296	13.6	13.9	110.6
1324	1596	23.2	23.8	195.0
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APPENDIX I (cont'd)

WHIRL TEST No. 2355

Time	R. P. M.	H. P.		Thrust Corrected	DEFLECTIONS			REMARKS*
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Calibration Data (Second Run)
Flottorp "Standard" Propeller
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TABLE 1

Sound Level at Various rpm
(Decibels)

rpm	Flottorp Standard	rpm	Nemeth Modified
1884	94	1926	96
2205	100	2199	100
2409	105	2397	104
2703	106	2697	107

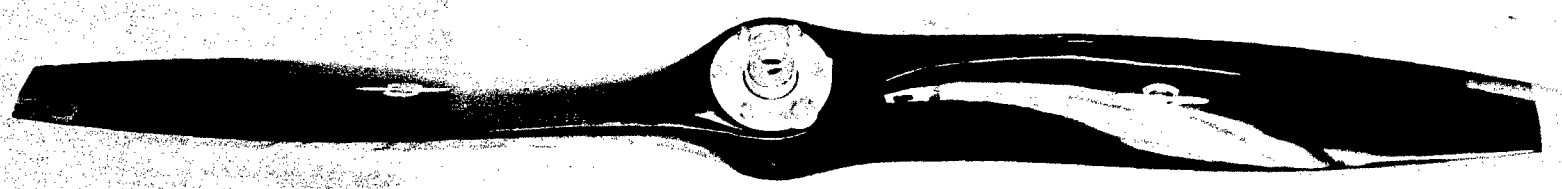

Fig 1 - Front View Flottorp Standard Propeller

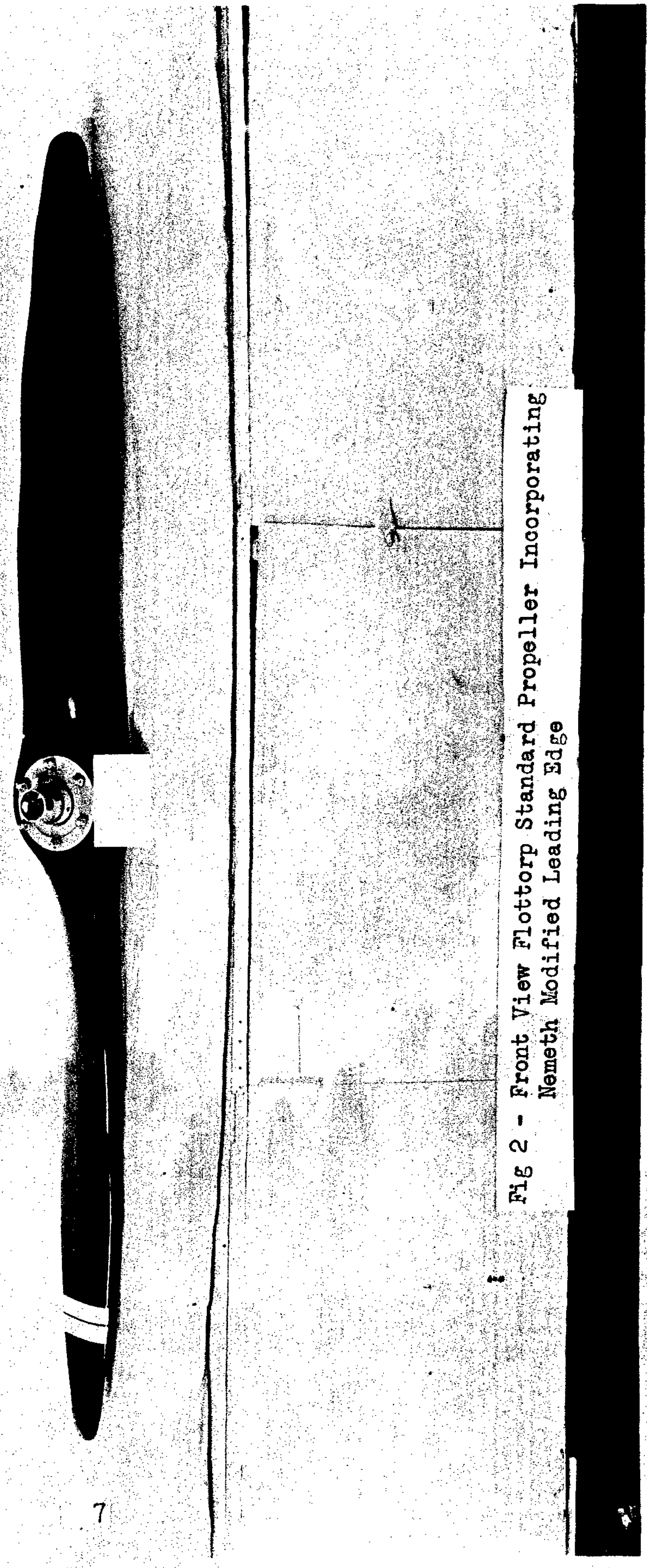

Fig 2 - Front View Flottorp Standard Propeller Incorporating Nemeth Modified Leading Edge

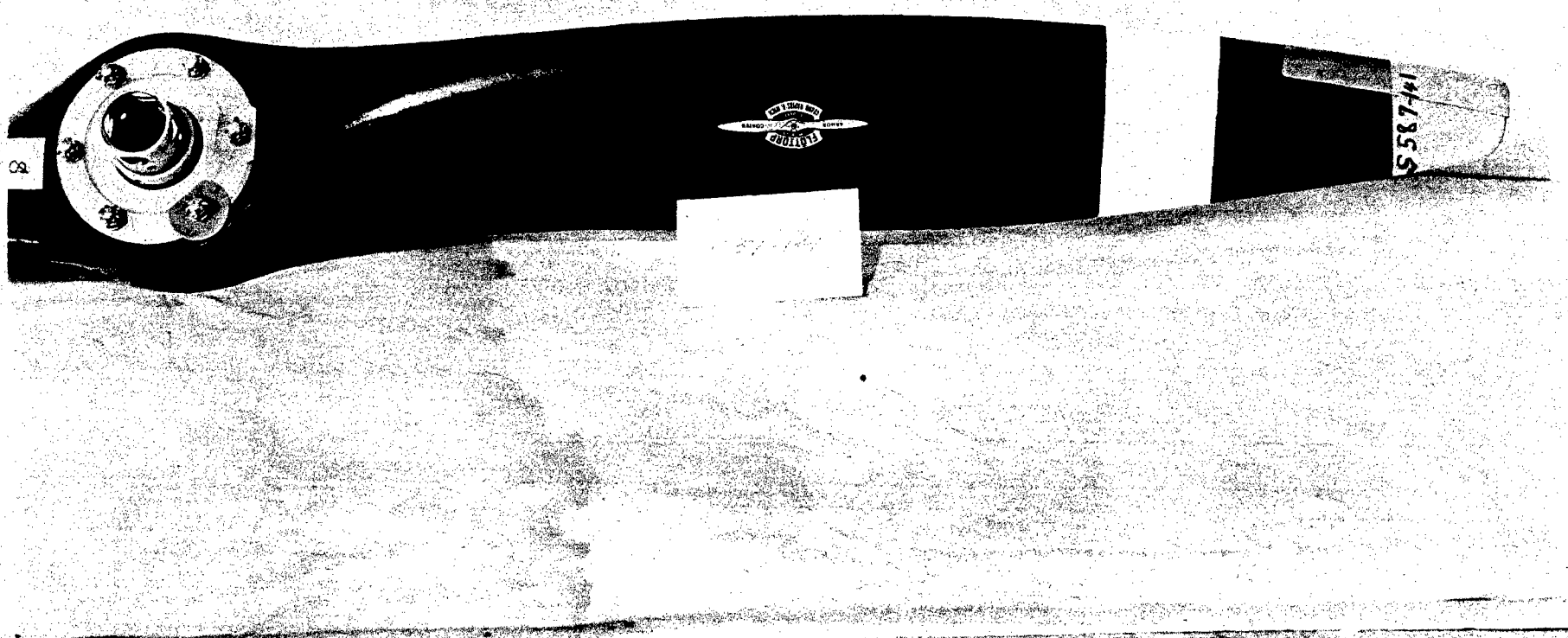

Fig 3 - Front View Close-Up of Blade - Flottorp Standard Propeller

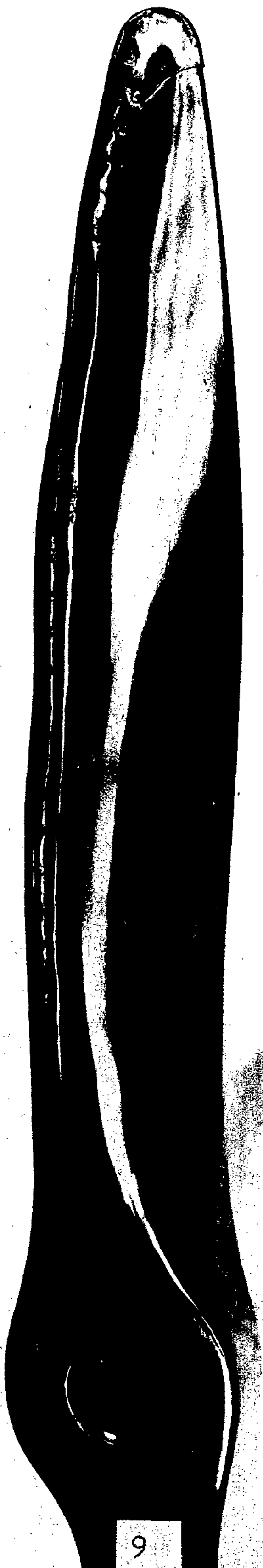

Fig 4 - Front View Close-Up of Blade - Flottorp Standard Propeller Incorporating Nemeth Modified Leading Edge

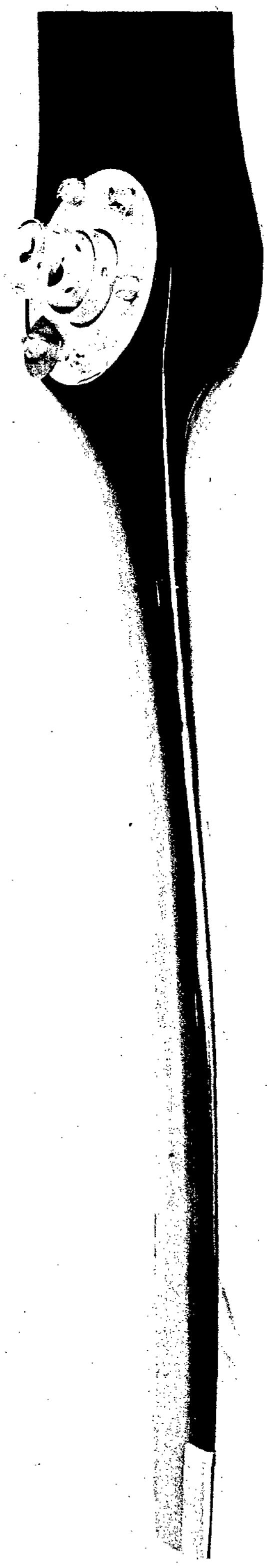

Fig 5 - Edge View of Blade - Flottorp Standard Propeller

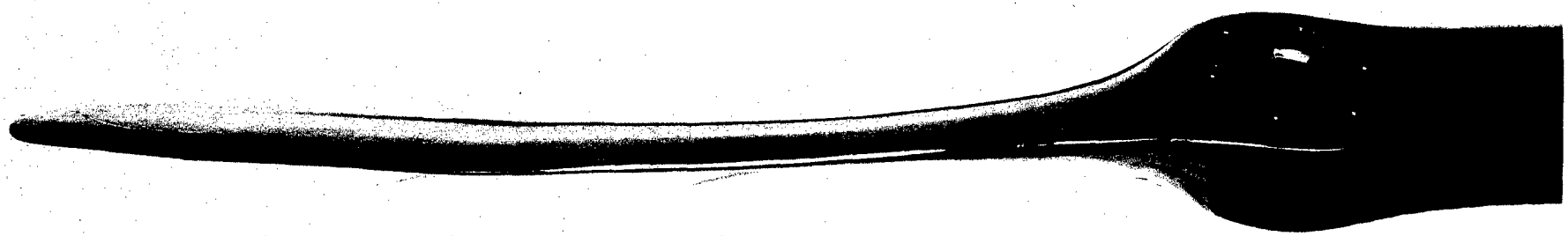

Fig 6 - Edge View of Blade - Flottorp Standard Propeller
Incorporating Nemeth Modified Leading Edge

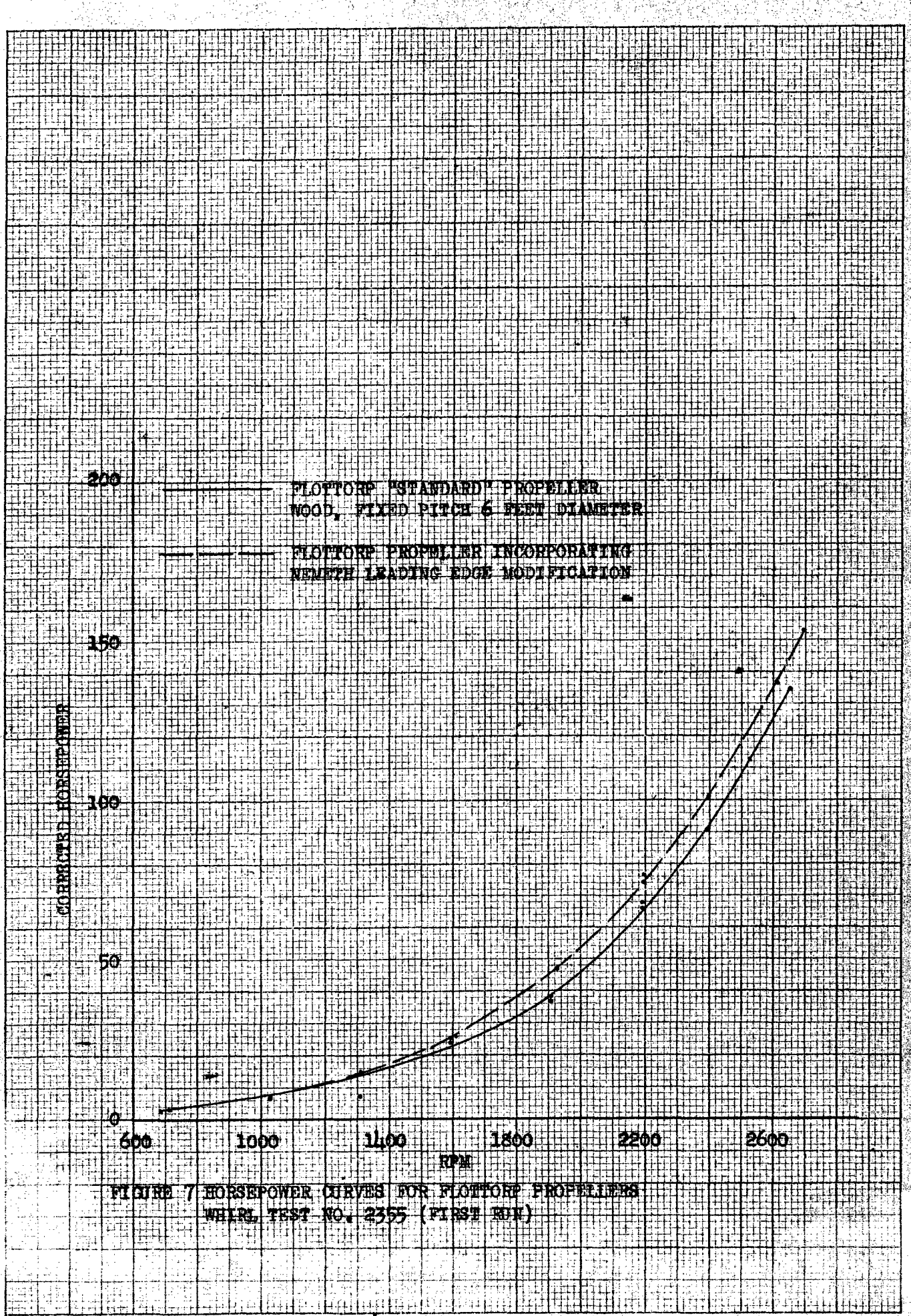

FIGURE 7 HORSEPOWER CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355 (FIRST RUN)

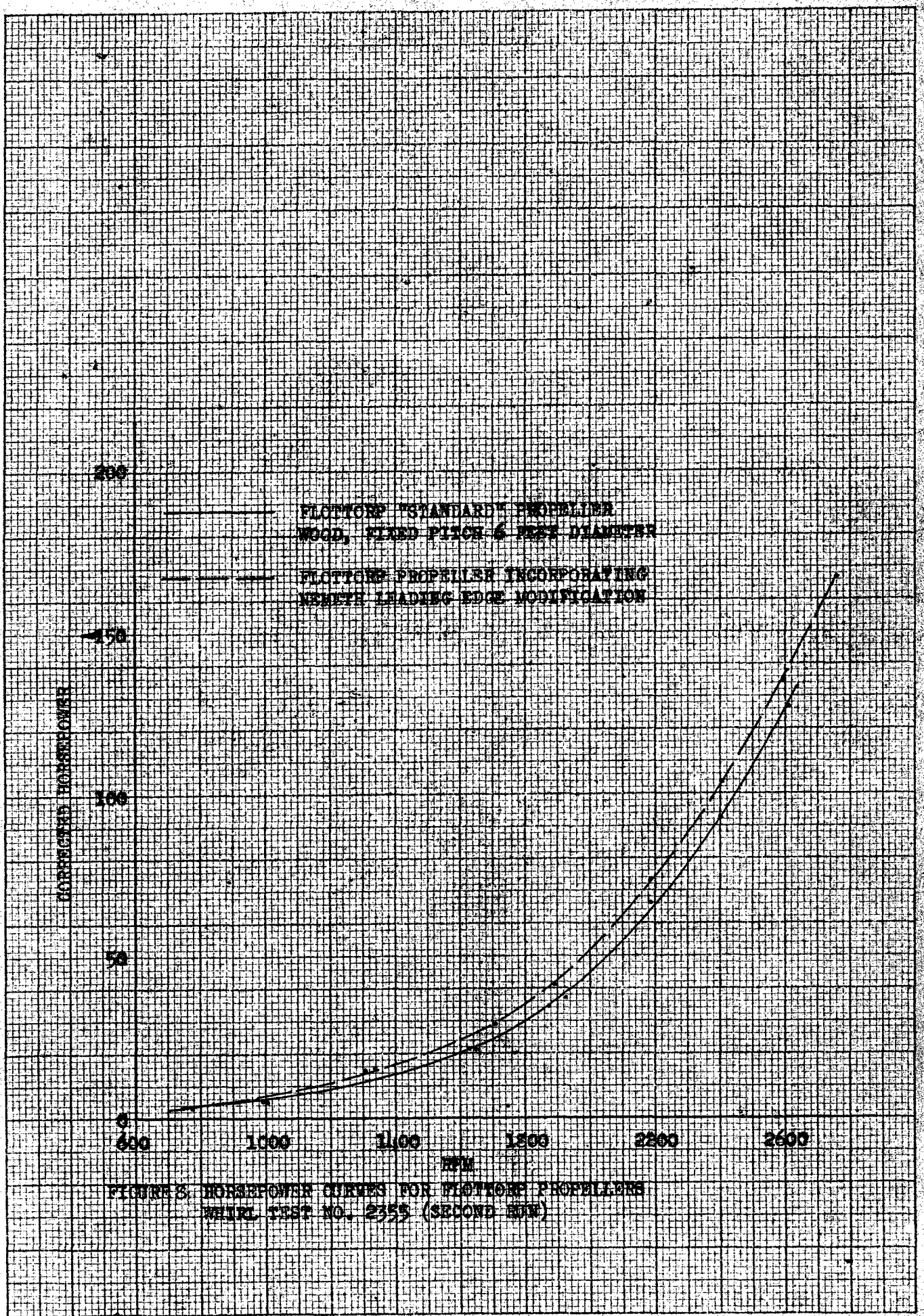

FIGURE 8. HORSEPOWER CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355 (SECOND RUN)

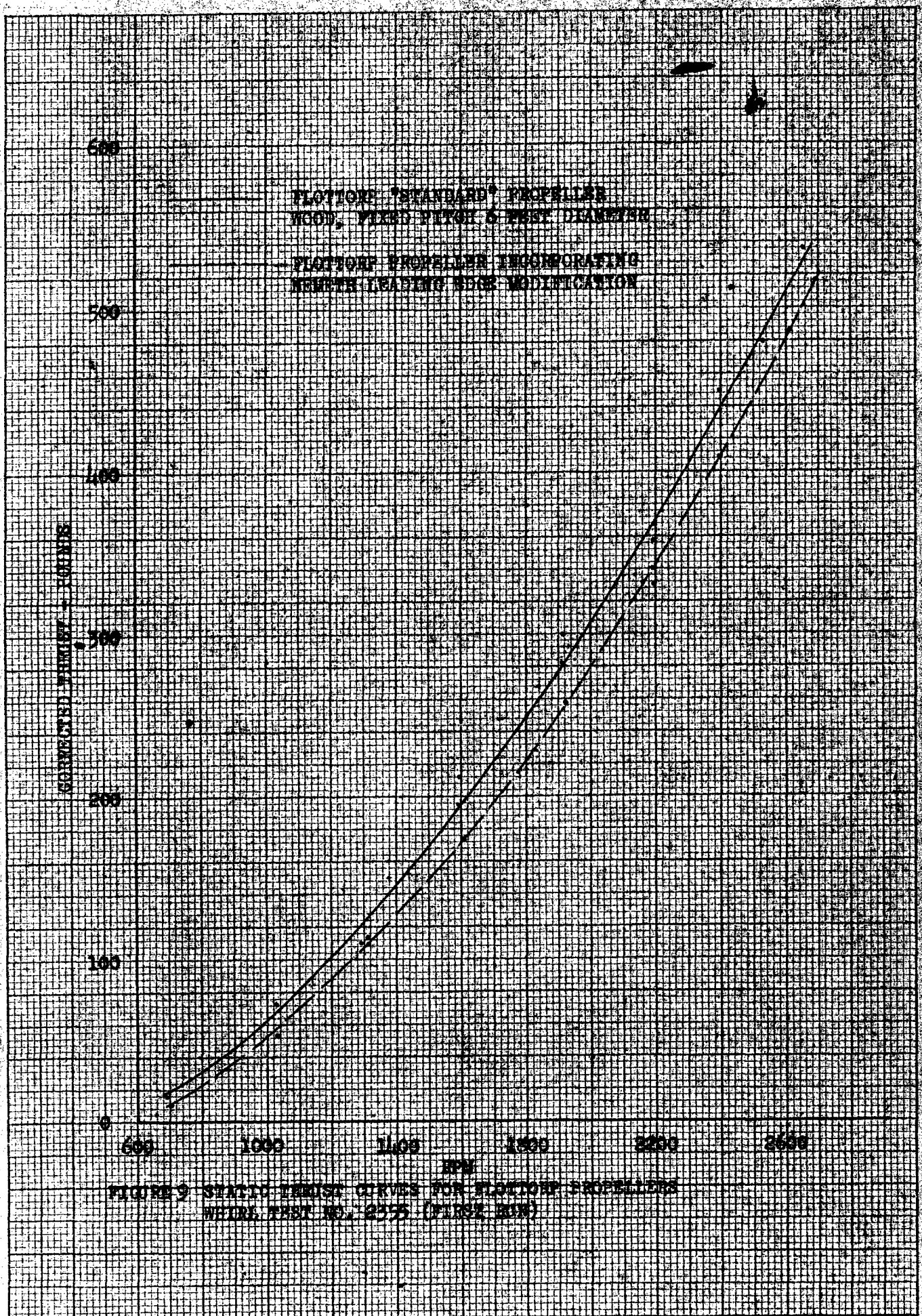

FIGURE 9 STATIC THRUST CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2375 (FIRST RUN)

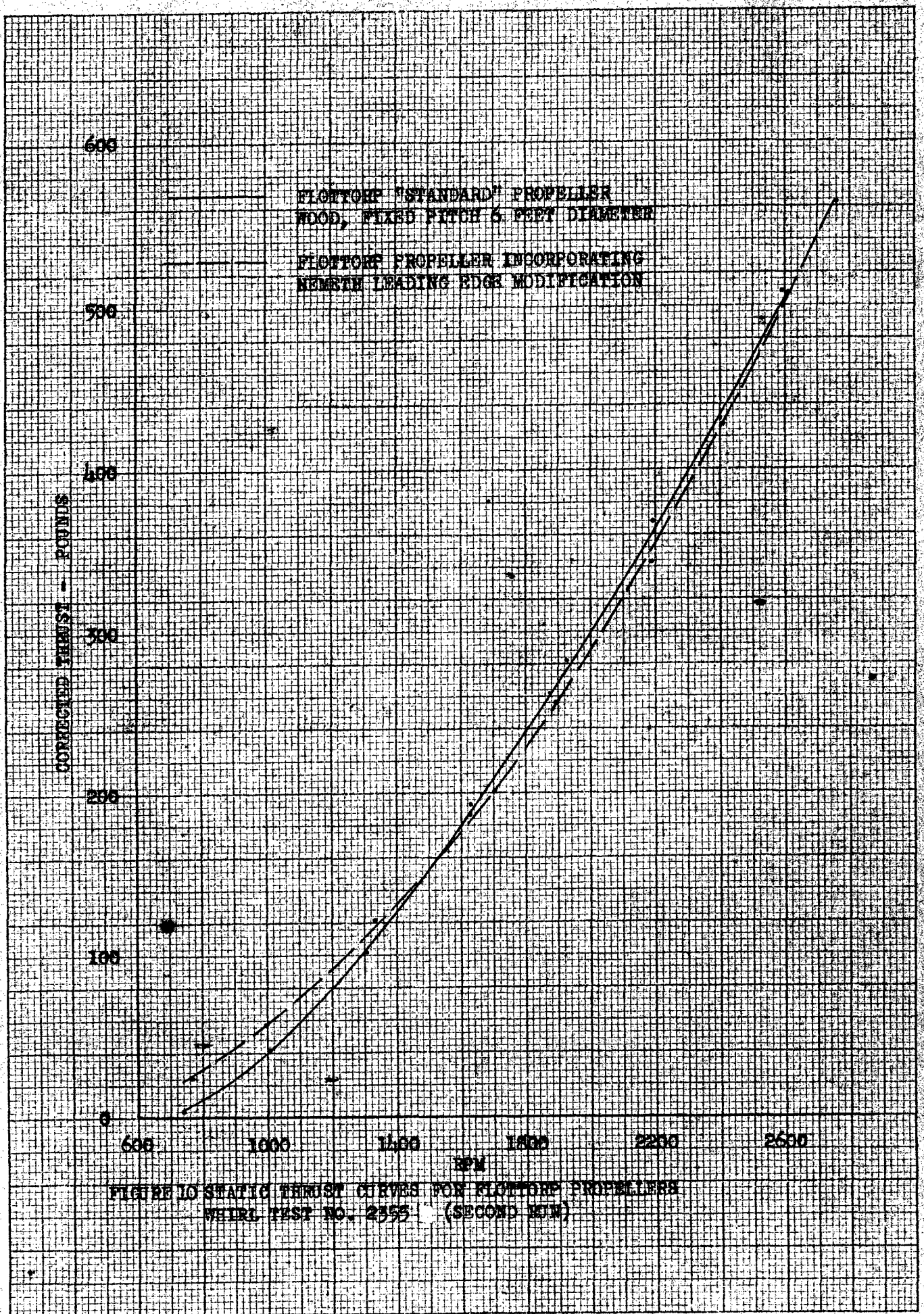

FIGURE 10 STATIC THRUST CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2555 (SECOND RUN)

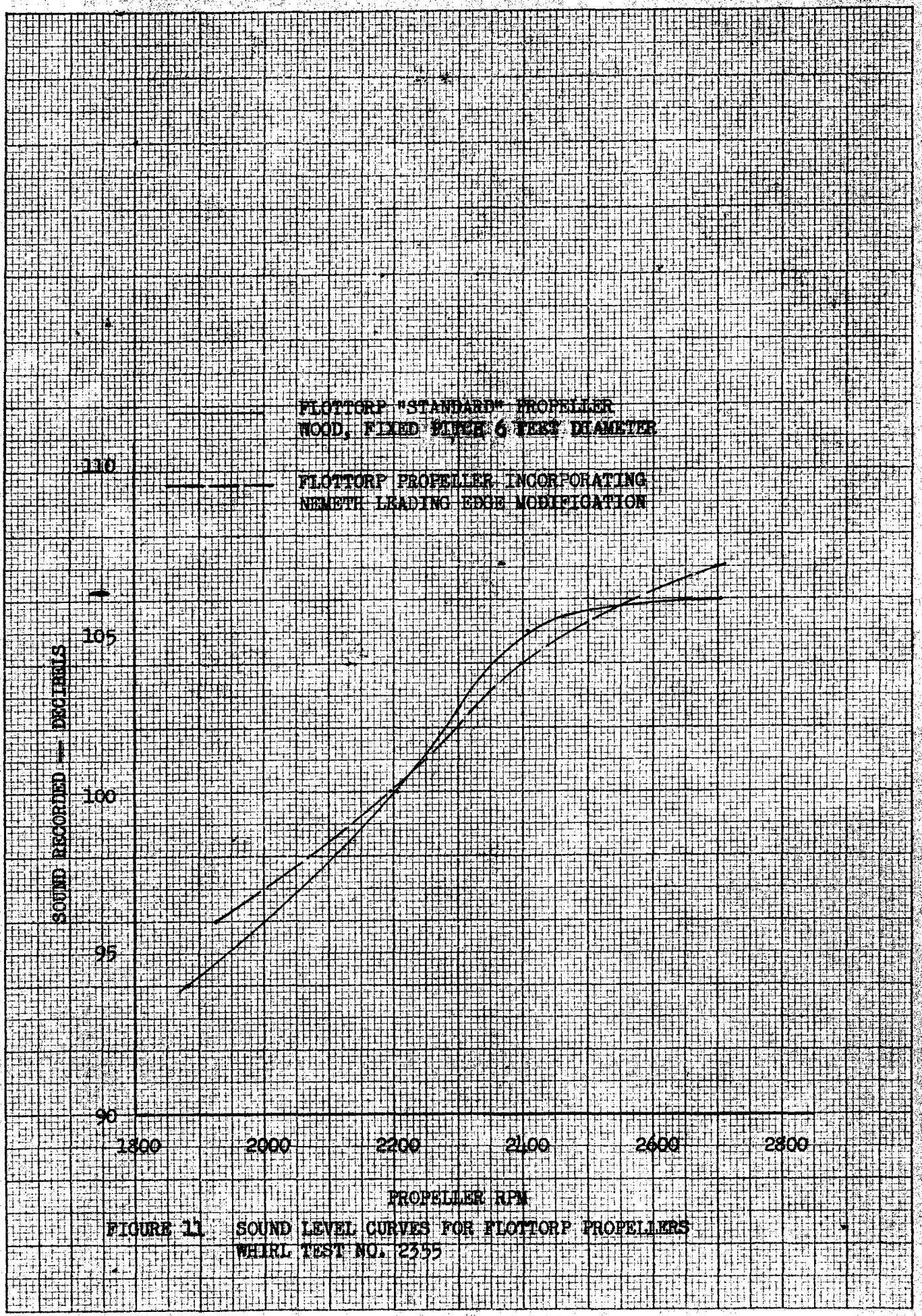

FIGURE 11 SOUND LEVEL CURVES FOR FLOTTORP PROPELLERS
WHIRL TEST NO. 2355

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