

REPORT NO. 4342

DATED September 14, 1943

C O N F I D E N T I A L

LOCKHEED AIRCRAFT CORPORATION

BURBANK, CALIFORNIA



TITLE

PRELIMINARY SPECIFICATION FOR
EXHAUST DRIVEN TURBO SUPERCHARGER

SUBMITTED UNDER

PROCUREMENT DATA

MODEL 89-29 REFERENCE None

PREPARED BY P. A. Beck GROUP Technical Contract Power Plant

CHECKED BY J. C. Duffendack APPROVED BY Hall L. Hibbard
Philip Colman C. I. Johnson

NO. PAGES 8 NO. PICTURES None

NO. DRAWINGS 6

REVISIONS

DATE	REV. BY	PAGES AFFECTED	REMARKS

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By SG NARA Date 10/24/03

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C O N F I D E N T I A LPRELIMINARY SPECIFICATION FOR
EXHAUST DRIVEN TURBO SUPERCHARGER

1. TYPE

1.01 This specification covers requirements of the Lockheed Aircraft Corporation for an exhaust driven turbo supercharger suitable for the power plant installation of a Pratt and Whitney R-4360 Wasp Major engine in the Lockheed Model 89 Airplane.

2. REFERENCE

2.01 The current issue of Army Air Forces Specification No. R-28500-A, "Turbo Supercharger, Aircraft, General Specification For", in effect on the date of issuance of a proposal under this specification, shall be used as a general guide for items not covered by this specification.

2.02 The provisions of this specification shall govern in the event of conflicting requirements between specifications.

2.03 All appendices to this specification, and drawings listed herein, are hereby made a part of this specification.

3. MATERIALS AND WORKMANSHIP

3.01 Materials used shall be the lightest practicable, consistent with strength and service requirements for safety, reliability, and long service life.

3.02 Workmanship shall conform with high grade commercial practice in the manufacture of exhaust driven turbo superchargers for military aircraft.

4. GENERAL REQUIREMENTS

4.01 Dimensions, points of attachments, location of joints and contours shall conform to the Drawing No. 89-473 (Fig. 6, Appendix B) appended to this specification.

4.02 The turbine supercharger shall be designed for efficient operation at cruising powers to 25,000 ft. in conjunction with the single stage, single speed, supercharger model Pratt and Whitney XR-4360 Engine. The performance of the turbine-engine combination shall be as summarized herein.

4.03 The design, calibration and service tests of the supercharger shall be performed by the manufacturer, and it shall be his responsibility.

4.031 The manufacturer shall submit installation and detail drawings of the proposed design for review by the Lockheed Aircraft Corporation.

4.032 Approval of the manufacturer's design by the Lockheed Aircraft Corporation shall not relieve the manufacturer from

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4. GENERAL REQUIREMENTS (Contd.)

4.032 (Contd.) - satisfactory performance or delivery of all items in conformance with the specifications.

4.04 Interchangeability - Practical interchangeability shall be established and maintained for all units of an item released for production under this specification.

4.05 Weight - The maximum dry weight of the supercharger shall be 155 pounds. The minimum weight shall be consistent with the requirements of this specification.

4.06 Marking

4.061 Each complete turbo supercharger assembly shall be provided with a suitable identification plate which shall be marked permanently and legibly with the assembly number, name of manufacturer, and date of manufacture. This identification plate shall be attached permanently to the assembly in such a location as to insure that it will remain legible throughout the service life of the supercharger assembly.

4.062 Each detail part and sub-assembly shall be marked permanently for identification with the same number as the drawing from which it was made. The method of marking shall not impair the strength nor shall it promote deterioration of the part.

4.07 Drawings and Performance Curves

4.071 Drawings to be furnished by the manufacturer shall consist of two vandyke sets of the necessary assembly drawings. Two vandyke sets of all changed drawings shall be furnished within 30 days following each change.

4.072 Estimated performance curves similar to Fig. 5 and 6 of N.A.C.A. Restricted Report #ARR No. 3F22", "Recommended Test Procedure for Aircraft Engine Turbo Supercharger Power Plants", shall be furnished to the Engineering Department of Lockheed Aircraft Corporation.

4.08 Reliability

4.081 The reliability of the unit is paramount and must be consistent with the requirements of commercial operation of a long range transport airplane.

4.09 Maintenance and Accessibility

4.091 Adequate provisions shall be made for the easy inspection and servicing of attachments, mechanisms, bearings, brackets, joints, fittings, etc.

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4. GENERAL REQUIREMENTS (Contd.)

4.09 Maintenance and Accessibility (Contd.)

4.092 The supercharger unit shall be designed and constructed in a manner such as to simplify inspection, maintenance and repair.

5. DETAIL REQUIREMENTS

5.01 Performance

5.011 The turbine supercharger shall be designed for efficient operation for all cruising powers to 25,000 ft. in conjunction with a single stage, single speed model of the Pratt and Whitney XR-4360 Engine. The performance of the turbine-engine combination is summarized in Fig. 1 of Appendix A. Peak efficiency should be obtained at 1300 bhp. at 25,000 feet. The following table summarizes the required critical altitudes (minimum requirements).

<u>BHP/Engine</u>	<u>Eng. RPM</u>	<u>Critical Altitude Required</u>
3000	2700	7,000 ft.
2500	2550	20,000 ft.
2100	2300	25,000 ft.
1600	2000	25,000 ft.
1000	1300	25,000 ft.
900	1200	25,000 ft.

5.012 Information necessary for the determination of the turbine and compressor performance is supplied on Figs. 2, 3, and 4 of Appendix A. Engine airflow and carburetor pressures versus engine power are shown on Fig. 2. The performance shall be obtained with the supercharger installed in a system, as shown on Appendix B, Fig. 5. A heat exchanger and an exhaust tail pipe nozzle are installed in series with the turbo wheel on the downstream side. Exhaust gas pressure drop data are given on Fig. 3. Intercoolers and suitable ducts are installed on the downstream side of the compressor. Estimated air pressure drop data for the intercooler and ducts are given on Fig. 4.

5.013 The exhaust back pressures on the engine must be kept to a minimum. For the design condition of 1300 BHP at 25,000 ft. under N.A.C.A. standard atmospheric conditions, the nozzle box pressure shall not exceed 23.5" Hg absolute. For the design condition of 3000 BHP at 7,000 ft. under N.A.C.A. standard atmospheric conditions, the nozzle box pressure shall not exceed 40" Hg absolute. Both of the above conditions are with exhaust heat exchanger and tail pipe nozzle installed.

5.014 The unit shall operate satisfactorily, meeting all conditions of this specification when supplied with exhaust from a lean mixture and at temperatures as high as 1700° F.

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5. DETAIL REQUIREMENTS (Contd.)

5.02 Cooling Provisions

5.021 The design of the supercharger shall include adequate provisions for cooling of the turbine and moving parts.

5.022 A radiation type cooling cap combined with a diffuser shall be installed on the downstream side of the exhaust wheel.

5.023 Provisions for cooling the interior of the unit just ahead of the exhaust wheel shall be provided. This should include bearing cooling and a radiation type cooling baffle on the upstream side of the exhaust wheel. The air passages shall be adequately sealed so that cooling air cannot enter the exhaust stream.

5.024 Exhaust back pressures as imposed on the turbo wheel by the heat exchanger and tail pipe nozzle shall not impair the operation of the unit.

5.025 The outer case of the compressor shall be properly finned so that it may be air cooled.

5.03 Controls

5.031 Suitable waste gate controls shall be provided.

5.032 An automatically operated overspeed control shall be installed as an integral part of the unit. This control shall operate to safeguard the unit from failure due to overspeeding.

5.04 Exhaust Wheel Inspection

5.041 Suitable provisions shall be made for the inspection of the exhaust wheel.

5.05 Mounting Provisions

5.051 Suitable connections for mounting and handling shall be provided.

5.06 Exhaust Connections

5.061 Straight cylindrical sections shall be provided for exhaust pipe connections. One connection downstream from the turbo wheel shall be provided for the connection of a tail pipe or flight hood. Two other connections shall be provided for the attachment to the exhaust collector system.

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5. DETAIL REQUIREMENTS (Contd.)

5.06 Exhaust Connections (Contd.)

5.062 All three exhaust connections shall be capable of supporting small sections of exhaust pipes without impairing the operation or dependability of the unit.

5.07 Tachometer Connection

5.071 Suitable gearing and connections for a tachometer drive shall be provided. In lieu of this, consideration may be given to an integral A.C. tachometer if a suitable indicating instrument is available.

5.08 Lubricating System

5.081 The unit shall have a suitable lubricating system. The complete installation including oil tanks, lines and connections shall be an integral part of the supercharger. The lubricating system shall be designed so that auxiliary oil coolers will not be necessary.

5.082 The lubrication system shall be designed to meet the latest requirements or recommendations of the Army Air Forces concerning Winterization.

5.083 The turbo supercharger shall perform satisfactorily when suitable oil is applied at turbosupercharger ambient temperatures from minus 60 degrees F to plus 100 degrees F.

5.09 Gyroscopic Stresses

5.091 The turbosupercharger shall withstand for at least one minute the gyroscopic torque imposed at the rated speed of the turbosupercharger, and at the rate of precession 0.5 radians/sec.

5.10 Protectors

5.101 Suitable protection from bucket failures shall be installed as an integral part of the unit.

6. METHOD OF INSPECTION AND TESTS

6.01 The supercharger shall be subject to inspection and calibration by Lockheed Aircraft Corporation inspectors.

6.02 Acceptance of material or parts in course of manufacture shall not be construed as a guarantee of acceptance of the finished part or assemblies thereof.

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6. METHOD OF INSPECTION AND TESTS (Contd.)

6.03 Tests

- 6.031 The turbo assembly shall be examined to determine that the design and workmanship conform to this specification.
- 6.032 The complete turbo assembly shall be weighed accurately. The dry weight shall not exceed the weight specified herein.
- 6.033 The manufacturer shall make suitable tests to prove the performance, the operating characteristics and the reliability of the unit. These tests must prove that the unit is designed in accordance with requirements of commercial operation of long range transport airplanes and will not require service overhauls more frequent than 1000 hours of flight time. The details of these tests shall be subject to further negotiation. Reports of tests shall be furnished to the Lockheed Aircraft Corporation.

6.04 Rejection

- 6.041 Each turbo assembly which does not fulfill the requirements of this specification shall be subject to rejection.
- 6.042 A rejected assembly may be resubmitted by the manufacturer for inspection and test within 20 days from the date of completion of the tests, providing that it is accompanied by a statement of changes or modifications.

6.05 Status of Specification

- 6.051 This specification is subject to cancellation or revision.
- 6.052 No deviations from this specification shall be issued except as an amendment, which shall have the approval of the Engineering Department of the Lockheed Aircraft Corporation.
- 6.053 The data contained in this specification are "Confidential", and all Federal and Lockheed Instructions and Regulations concerning confidential data shall apply to this specification.

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APPENDIX A

- Fig. 1 "Maximum Engine Power Versus Altitude"
Fig. 2 Air Consumption Versus Engine Brake Horsepower
Fig. 3 Estimated Back Pressure on Exhaust-Driven Turbine,
Due to Heat Exchanger and Exhaust Nozzle.
Fig. 4 Estimated Engine - Air Pressure Drop Thru
Intercooler and Ducts

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APPENDIX B

SKETCH 89-474 - Fig. 5

SKETCH 89-473 - Fig. 6

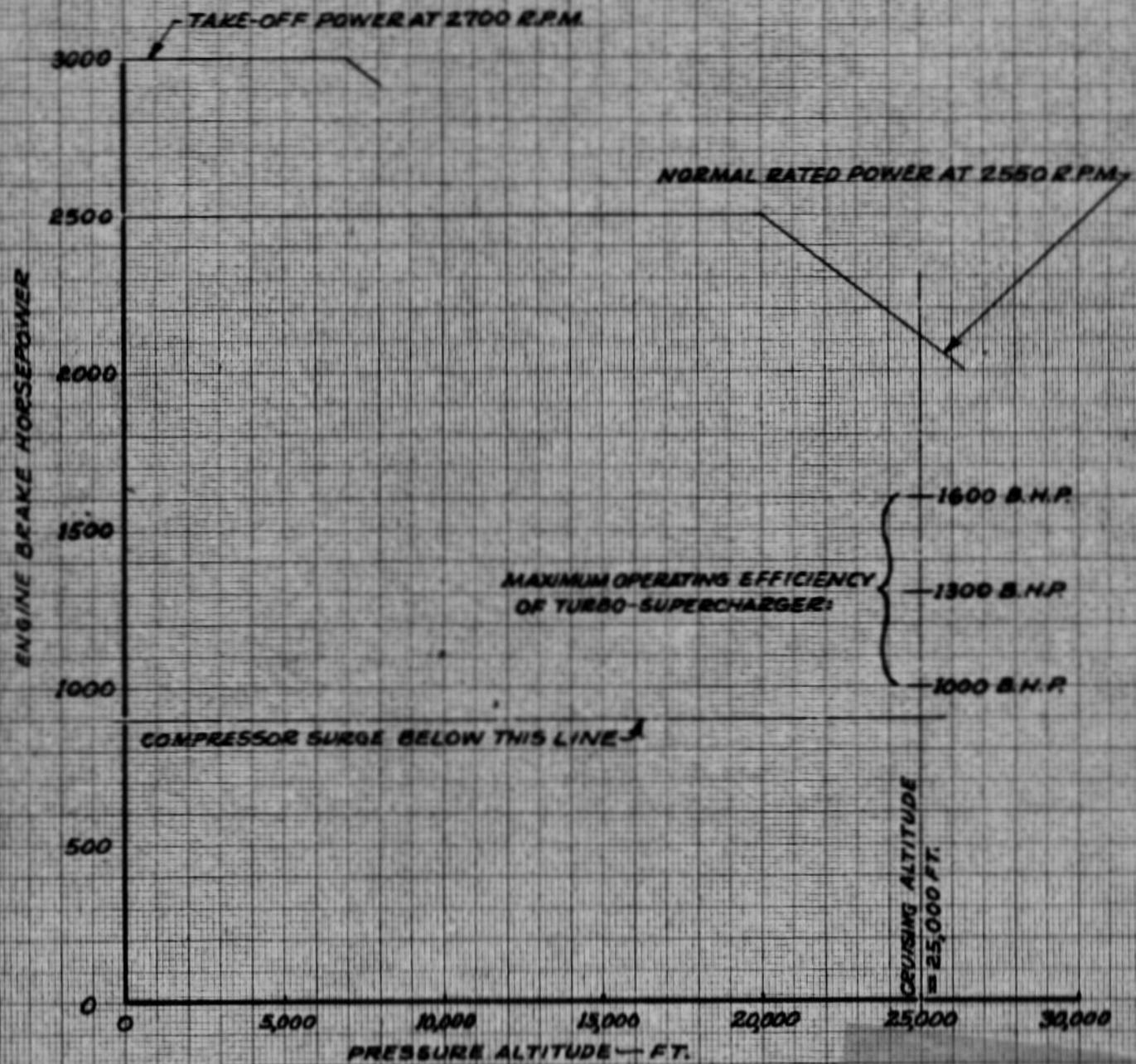
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LOCKHEED AIRCRAFT CORP.

**PRATT & WHITNEY WASP MAJOR XR-4360
WITH SINGLE-STAGE, SINGLE-SPEED BLOWER
PLUS LOCKHEED TURBO-SUPERCHARGER**

**MAXIMUM ENGINE POWER VERSUS ALTITUDE
FROM L.R. 4289**



PRATT & WHITNEY WASP MAJOR XR-4360
AIR CONSUMPTION VS. ENGINE BRAKE HORSEPOWER
 FROM P&W CURVE T-834

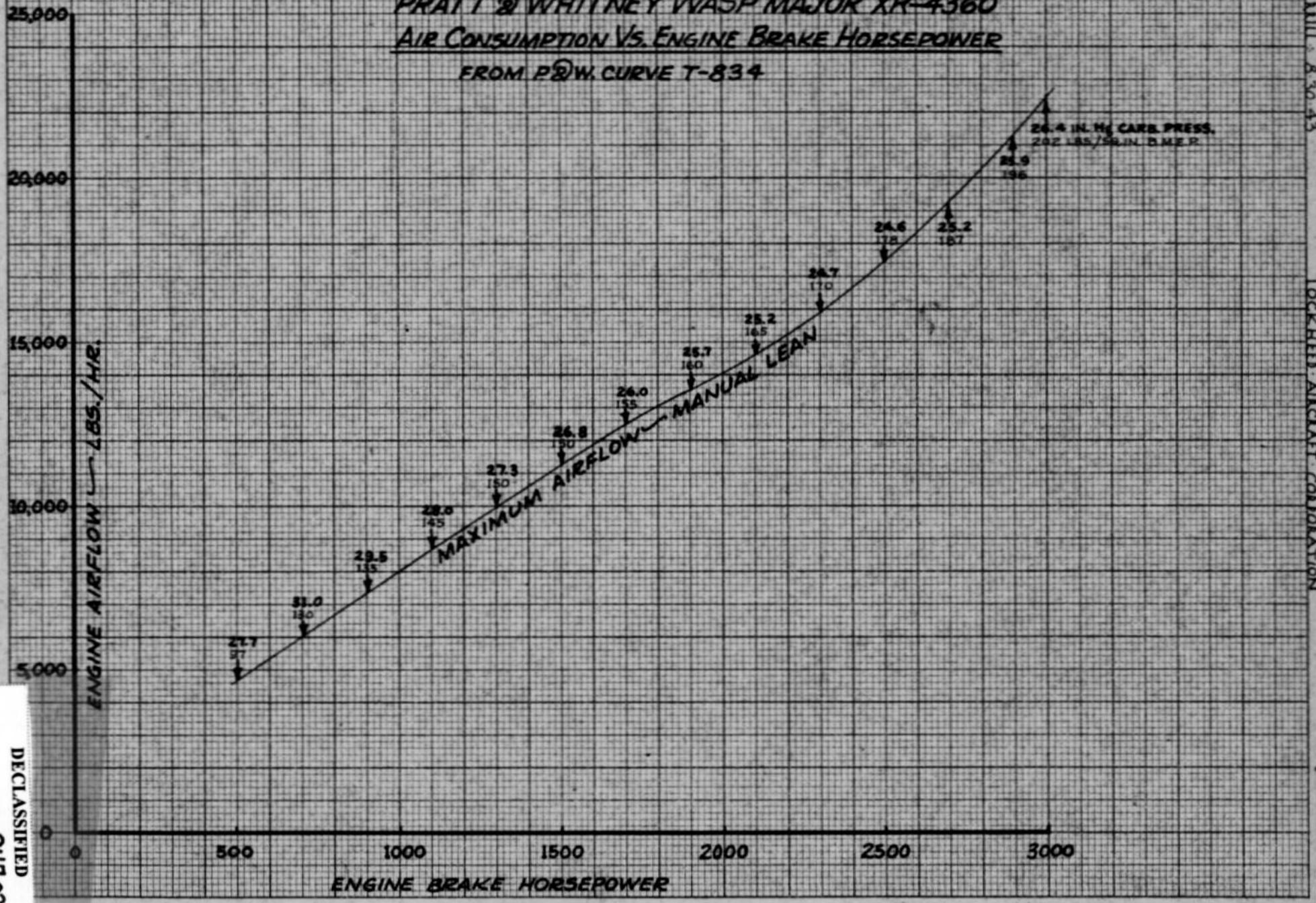


Fig. 2

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Fig. 3

ESTIMATED BACK PRESSURE ON EXHAUST-DRIVEN TURBINE,
DUE TO HEAT EXCHANGER AND EXHAUST NOZZLE



ENGINE B.H.P. = 2000

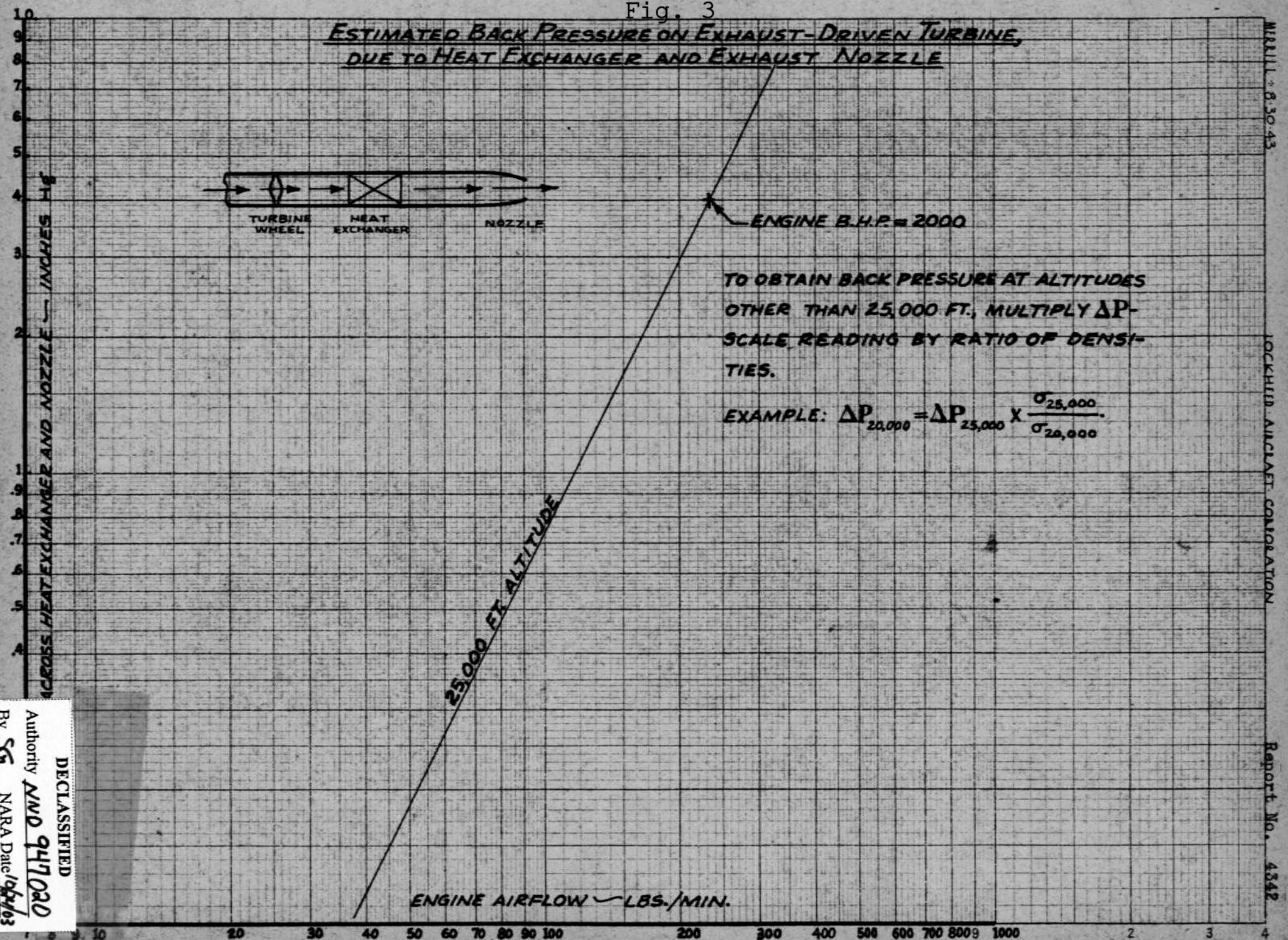
TO OBTAIN BACK PRESSURE AT ALTITUDES
OTHER THAN 25,000 FT., MULTIPLY ΔP -
SCALE READING BY RATIO OF DENSI-
TIES.

EXAMPLE: $\Delta P_{20,000} = \Delta P_{25,000} \times \frac{\sigma_{25,000}}{\sigma_{20,000}}$

25,000 FT. ALTITUDE

ENGINE AIRFLOW ~ LBS./MIN.

CROSS HEAT EXCHANGER AND NOZZLE INCHES

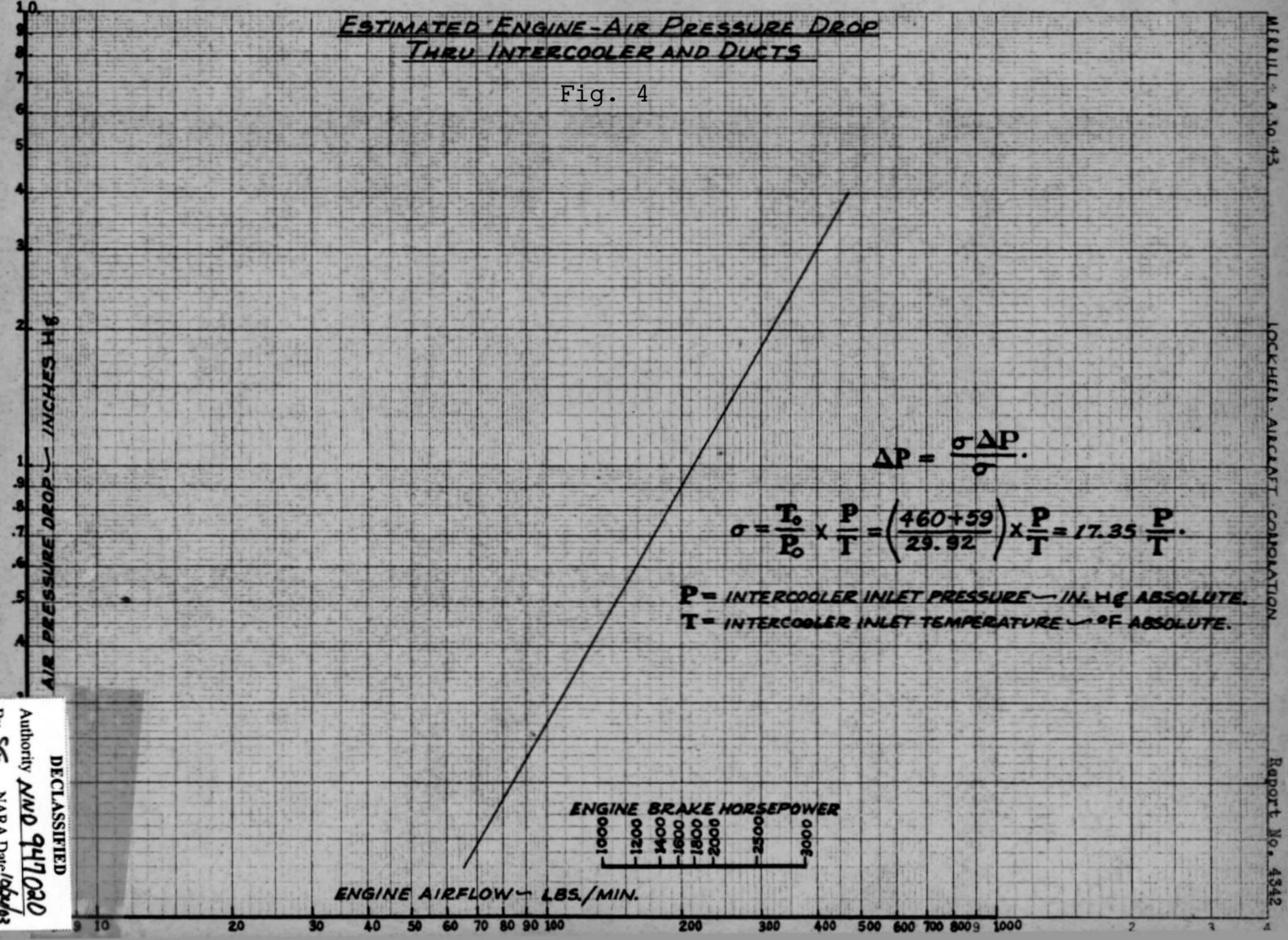


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ESTIMATED ENGINE-AIR PRESSURE DROP
THRU INTERCOOLER AND DUCTS

Fig. 4



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