CHAPTER II - INSTALLATION TEST SPECIFICATION

The following Engine Installation Test Specification has been prepared after long experience with the test and service history of many installations of Wright Aircraft Engines. This experience has shown that the test demonstration outlined below is sufficient to thoroughly check an installation to insure that it will give satisfactory operation and maintenance under all operating conditions. These tests insure that in no way does either component of the engine-aircraft combination restrict the operation of the other.

A. FUEL SYSTEM FLOW TESTS

(1) Single Engine Airplanes

a. Engine Pump Operating

The fuel flow delivered to the carburetor shall not be less than that required for the maximum rated power, takeoff, emergency, or the maximum normal power, whichever is greatest, with the fuel pump operating at the RPM corresponding to this rating, using a factor of 0.90 lbs./HP/Hr. The discharge pressure shall not be more than the maximum recommended fuel pressure shown in the engine specification. Fuel supply shall be from the lowest fuel tank in the system, with an available fuel supply of not more than 15% of the normal tank capacity.

b. Emergency Operation

The fuel flow with the engine driven pump inoperative and with the use of a hand pump at not more than 120 strokes per minute or the normal speed of an auxiliary driven pump, shall be equal to that required for maximum rated power, take-off, emergency, or the maximum normal power, whichever is greatest, under the same conditions of discharge pressure and fuel supply as specified in (a), above.

c. Gravity Feed

In the case of gravity feed fuel systems, fuel flow shall be equivalent to that for Engine Pump Operating conditions, as outlined above. The discharge pressure shall not be less than the minimum specified pressure, with the minimum specified pressure, with the minimum gravity head available for any normal operation of the airplane.

(2) Multi-Engine Airplanes

a. Engine Pumps Operating

The fuel flow delivered to any one carburetor with all engine-driven fuel pumps operating, shall not be less than that required for the maximum rated power, take-off, emergency, or maximum normal power, whichever is greatest, with the fuel pumps operating at the R.P.M. corresponding to this rating, using a factor of 0.90 lbs./HP/Hr. The discharge pressures shall not be more than the maximum specified fuel pressure shown in the engine specification. Fuel supply shall be from the lowest fuel tank in the system, with an available fuel supply of not more than 15% of the normal tank capacity.

b. Emergency Operation

Crossfeed - With one engine-driven fuel pump inoperative, and fuel supplied to this engine by a cross feed, the fuel flow to any carburetor shall not be less than that specified in (2a) above. The discharge pressures shall not be less than the minimum specified fuel pressure shown in the engine specification with the fuel pump pressure adjustment unchanged from that for the flow test with all engine-driven fuel pumps operating.

Hand Pump - The fuel flow to each carburetor when using a hand pump at not more than 120 strokes per minute or the normal speed of an auxiliary driven pump, shall be equal to that required for maximum rated power, takeoff, emergency, or the maximum normal power, whichever is greatest, under the same conditions of discharge pressure and fuel supply as specified in (1a). It shall be assumed that not more than 50% of the engine driven fuel pumps will be inoperative at the same time.

B. INSTALLATION TEST OUTLINE

(1) Conditions for All Tests

a. All operating conditions must be continued long enough to allow all temperature readings to stabilize unless the allowable temperature limits are exceeded.

b. All operating conditions are to be conducted with the mixture control set in accordance with approved instructions.

c. Under no condition of test shall there be any visible or audible indication of detonation.

d. All flight operations shall be conducted with the airplane loaded at normal gross load unless otherwise noted.

e. All instruments shall be calibrated prior to the tests.

f. The carburetor air scoop shall be set in "full cold" position for all tests with exception of test on heater capacity.

(2) Single Engine Airplane

a. Ground Test

Power

1. 60% of normal rated RPM.

Conditions

1. Zero wind condition.
2. Propeller set in normal low-pitch position.

b. Taxiing Test (Seaplane or Amphibian)

Power

1. RPM necessary to taxi airplane at maximum speed off the step (maximum gross weight).

Conditions

1. Propeller set in normal taxiing-pitch position.

2. Up-wind.
3. Down-wind.
4. Cross-wind.

c. Full Power Climb Test

Power

1. Start climb with full take-off power and RPM, and maintain this condition for duration of time allowed on the engine specification.
2. Continue climb using emergency power and RPM for duration of time and/or altitude allowed for this rating.
3. Continue climb with normal rated power and RPM.
4. If engine has two-speed supercharger, continue climb in high blower at rated power and RPM.

Conditions

1. Climb test shall be preceded by the Ground or Taxi test.
2. Prior to take-off the cylinder head temperature shall be between 350 and 400° F. The oil temperature shall be above the desired oil temperature limit given in the engine specification.
3. Climb at the indicated air speed for best rate of climb.

d. Rated Power Level Flight Test at Altitude

Power

1. Full throttle at rated RPM.

Conditions

1. Conduct flight at altitude where rated manifold pressure is obtained in level flight.
2. If engine has two-speed supercharger, this test shall be conducted in both blower ratios at their respective critical altitudes.
3. If engine has an emergency power rating, this test shall be conducted at rated emergency power, RPM, and altitude.

e. Rated Power Level Flight Test at Sea Level

Power

1. Normal sea level rated power.

Conditions

1. Normal rated RPM.
2. At or near sea level.

f. Cruising Power Climb

Power

1. Maximum recommended cruising power.

Conditions

1. Maximum recommended cruising RPM.
2. Climb at indicated air speed for best rate of climb.
3. Mixture shall be set at a value established by the applicable operating instructions.

g. Cruising Power Level Flight

Power

1. Maximum cruising power at which leanest fuel consumption given in engine specification can be obtained.

Conditions

1. Maximum recommended cruising RPM.
2. At or near sea level.
3. Mixture set to give leanest fuel consumption given in engine specification.

h. Carburetor Air Heater Capacity Test

Power

1. Same as Test "g".

Conditions

1. Preheat System for Icing Carburetors - Apply full heat and fly at various altitudes in order to obtain sufficient test points to make a plot such as shown in Figure 98.

2. Preheat System for "Non-icing" Carburetors - Apply full heat while flying at or near sea level.
3. Set mixture at same setting as in Test "g".

(3) Multi-Engine Airplane

All the above tests shall be conducted, and, in addition, the following two tests are required:

a. <u>Full Power Climb Test with Minimum Number of Engines</u>

Power

1. Same as 1,2,3, and 4 of Test "2c".

Conditions

1. Same as 1,2, and 3 of Test "2c".
2. Take-off shall be made with all engines operating.
3. When take-off procedure has been completed, the climb test shall be conducted using the minimum number of engines allowable for such type of operation.

b. <u>Rated Power Level Flight with Minimum Number of Engines</u>

Power

1. Maximum allowable at altitude in question.

Conditions

1. Same as 1,2, and 3 in Test "2d".
2. Using minimum number of engines allowable for such type of operation.
3. At absolute ceiling.

C. ITEMS FOR TEST

Following is a list of items for test. The procedure for measurement of these data is outlined in Section F of the Test Outline, and the method for correction of these data is specified in Section D of the Test Outline.

(1) Cylinder Head Temperature

No individual cylinder head shall exceed the maximum temperature limitation given in the engine specification for the condition of test in question. Refer to Table VIII for application of allowable limits.

(2) Cylinder Base Temperature

No individual cylinder base shall exceed the maximum temperature limitation given in the engine specification for the condition of test in question. Refer to Table VIII for application of allowable limits.

(3) Oil Inlet Temperature

The temperature of the oil passing into the engine shall not exceed the maximum oil temperature limitation given in the engine specification during any of the tests in the Test Outline. In case a thermostatic or other type of automatic by-pass is installed in the oil system, it shall be disconnected during the tests in order that a true indication of the capacity of the oil cooling system may be obtained.

(4) Spark Plug Elbow Temperature

No individual spark plug elbow temperature shall exceed 250^{0} F. during any of the tests in the Test Outline.

(5) Magneto Temperature

The magneto temperature shall not exceed 165^{0} F. during severe operating conditions, and shall not exceed 140^{0} F. during normal operating conditions. Refer to Table VIII for application of these allowable limits.

(6) Fuel Temperature

The fuel temperature shall not exceed the maximum allowable values shown on the curve in Figure 97 during any of the tests in the Test Outline. It is advisable, if possible, to maintain the fuel temperature below the values given as "recommended fuel temperature" on the curve in Figure 97, especially in the case of airplanes that climb faster than 2000 ft./min.

(7) Fuel-Air-Ratio Analyzer Temperature

During any of the tests in the Tests Outline, with exception of the ground or taxiing tests, the temperature of the fuel-air-ratio analyzer cell shall not exceed 125^{0} F. A maximum temperature of 150^{0} F. is allowed during ground or taxiing operations.

A minimum temperature limitation of 32^{0} F. is required during all the tests.

(8) Rubber Engine-Mount Bushing Temperatures

The temperature of any engine-mount rubber bushing shall not exceed 160^{0} F. during any of the tests in the Test Outline.

(9) Fuel-Air Ratio Analyzer Pressure Drop

During all flight tests in the Test Outline, the pressure drop across the analyzer cell shall not be less than 2 inches of water and not more than the analyzer manufacturer's high limit.

(10) Exhaust Back Pressure

No individual cylinder shall have an exhaust back pressure in excess of 12 inches of water, nor shall there be more than 24 inches of water difference between the highest and lowest pressures measured under any one condition during any of the tests in the Test Outline.

(11) Carburetor Air Temperature

The carburetor air temperature shall not exceed the outside air temperature by more than 10^{0} F. during any of the tests in the Test Outline, with exception of those tests where use of preheat is specified.

(12) Carburetor Preheater

The carburetor preheater, as installed for an "icing type" carburetor, shall be capable of maintaining a mixture temperature of 35^{0} F. when the outside air temperature is -20^{0} F., on airplanes equipped with radio and wing de-icing equipment, while operating in accordance with Test "2h" of the Test Outline. All other airplanes shall meet this requirement on a zero degree day.

The carburetor preheater, as installed for "non-icing type" carburetors, shall be capable of providing a temperature rise of not more than 60° F. in the carburetor air temperature, while operating in accordance with Test "2h" of the Test Outline.

(13) Baffle Pressures

The static pressure fore and aft of the engine cylinder baffles serves as an index of the volume of air passing through the engine, and is a necessary indication for establishment of the effectiveness of an engine cowl design. See p. 14

(14) Static Pressure Drop across Oil Cooler

The effectiveness of an oil cooler installation can be determined by measurement of the static pressure fore and aft of an oil cooler.

(15) Carburetor Ram

The static pressure at the carburetor top deck should be measured to determine the effectiveness of the carburetor air scoop installation.

(16) Fuel Pressure

During all tests in the Test Outline, the fuel pressure, measured at the carburetor, shall be within the limits given in the engine specification.

(17) Oil Pressure

During all tests in the Test Outline, the engine oil pressure, measured at the point designated on the engine installation drawing, shall be within 5 pounds of the maximum pressure limit given in the engine specification.

(18) Oil Inlet Suction

During all tests in the Test Outline, the suction measured at the oil pump inlet shall not exceed 6" Hg., with the oil inlet temperature at 140° F. and the engine operating at rated power and RPM.

(19) Warning Lights

The satisfactory operation of warning lights for fuel pressure, oil pressure, and any others pertaining to the operation of the engine shall be checked during the ground cooling tests.

(20) Special Test Data

In some installations where there are variations from established installation practice, it may be desirable to obtain test data that are not listed above and which are not absolutely essential for the approval of the installation, but which will greatly assist in the determination of possible causes and effects resulting from these variations. In such cases, the Aircraft Manufacturer's cooperation is requested to facilitate securing such data.

D. METHOD FOR CORRECTION OF DATA

Since the flight tests on an airplane are usually conducted in atmospheric temperature conditions which are not representative of the most severe temperature conditions that it is likely to encounter, a method must be established whereby the observed data can be corrected to enable prediction of the results that will be obtained during operation in severe temperature conditions.

Following is a method for correction of data used by the Air Corps, Bureau of Aeronautics, Civil Aeronautics Authority and the Wright Aeronautical Corporation.

Corrected Temperature = observed temperature + K (correction temperature - strut temperature)

where K = correction factor.

The above mentioned authorities have established values for the factor, K; but unfortunately, they are not entirely in agreement. To justify the values specified in this Manual, the Wright Aeronautical Corporation has conducted a series of tests on their engines and the features of the installation that involve temperature correction, and have gathered test data to substantiate the correction factors established. Also, the validity of these values has been well demonstrated by actual flight tests in a wide range of atmospheric temperatures. The values selected are given in Table VII, below.

Table VII

Items	Correction Factor, K.
Cylinder heads	1.0
Cylinder bases	0.7
Oil inlet	1.0
Spark plug elbow	0.6
Magneto	0.6
Exhaust analyzer cell	0.6
Engine mount rubber bushing	0.6
Fuel line	0.6

The "Correction Temperature" line shown on Figure 96 has been established after an analysis of extensive temperature data obtained in flight during summer operation over a wide area within the Temperate Zone. Inasmuch as it is intended that the engine installation shall permit satisfactory engine operation during all atmospheric conditions likely to be encountered during its life, the Wright Aeronautical Corporation has established this "Correction Temperature" line as being the most severe condition to be encountered within the Temperate Zones.

Prior to correction of any test data, the observed readings should be corrected for errors in instrument calibration.

The Wright Aeronautical Corporation approval of the operation of an engine in any installation is based upon the "Correction Temperatures" as given in Figure 96. If it is anticipated that the engine will operate at any time in its life in higher or lower atmospheric temperature conditions than defined by this "Correction Temperature" curve, it may be desirable to deviate from the line as drawn in order to obtain suitable correction for the installation in question. It is essential, however, that such deviation be agreed upon mutually by the Airplane Manufacturer, the ultimate operator, and the Wright Aeronautical Corporation, at the time of sale of the engines involved.

Special treatment is given to correction of fuel line temperatures, carburetor preheat performance, and oil inlet line suction. These items are therefore covered individually below.

(1) Correction of fuel line temperature

Corrected Temperature = observed temperature + correction factor (Correction temperature - fuel tank temperature)

The corrected fuel temperature shall be less than the maximum allowable fuel temperatures shown on the curve in Figure 97. It should be noted that the lower curve, labeled "recommended maximum fuel temperature", is a plot of the temperatures at which vaporization of the fuel will begin, therefore fuel temperatures higher than this may cause vapor lock troubles in some airplanes, particularly those with high rates of climb. It is, therefore, desirable to maintain fuel temperatures during all conditions of test lower than defined by the "recommended maximum fuel temperature" line.

(2) Correction of carburetor preheater performance

Figure 98 shows a typical plot of the performance of a carburetor preheater. A preheater for a carburetor subject to ice formation must meet the requirement defined by the full line on this plot. This line is established by the requirement for 35^{0} F. in the carburetor adapter when the outside air temperature is -20^{0} F. The actual test points should be spotted on this curve sheet, and by extrapolation, the heater capacity at -20^{0} F. outside air can be predicted.

(3) Correction of oil inlet line suction

Oil inlet line suction can be corrected for 140^{0} F. oil temperature by using the plot on Figure 99. The presence of reducing fittings, valves, etc., in this line will not seriously effect the correction if the check temperature is within $\pm 10^{0}$ of 140^{0} F.

STANDARD AND CORRECTION TEMPERATURES VS. ALTITUDE

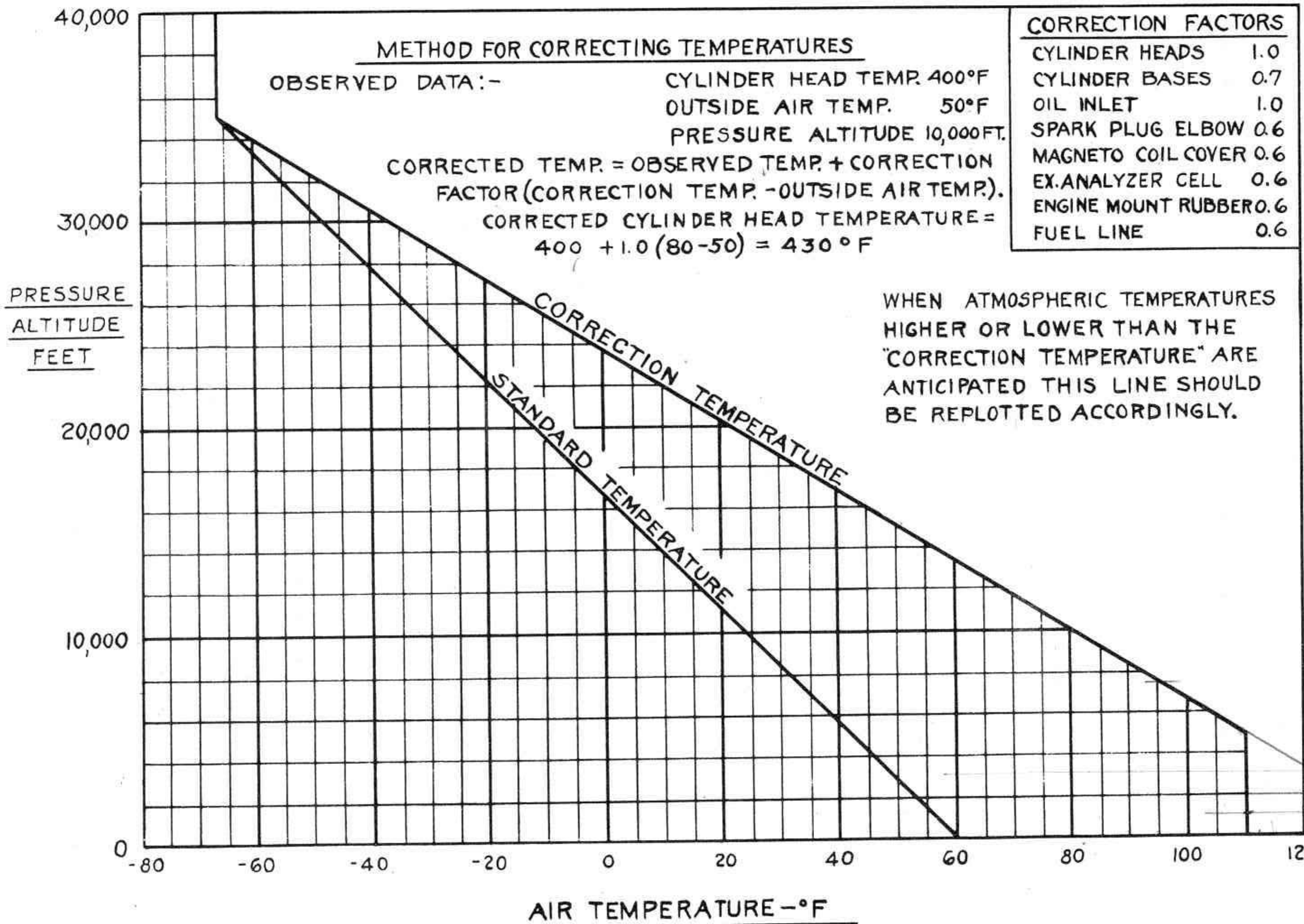


Figure 96

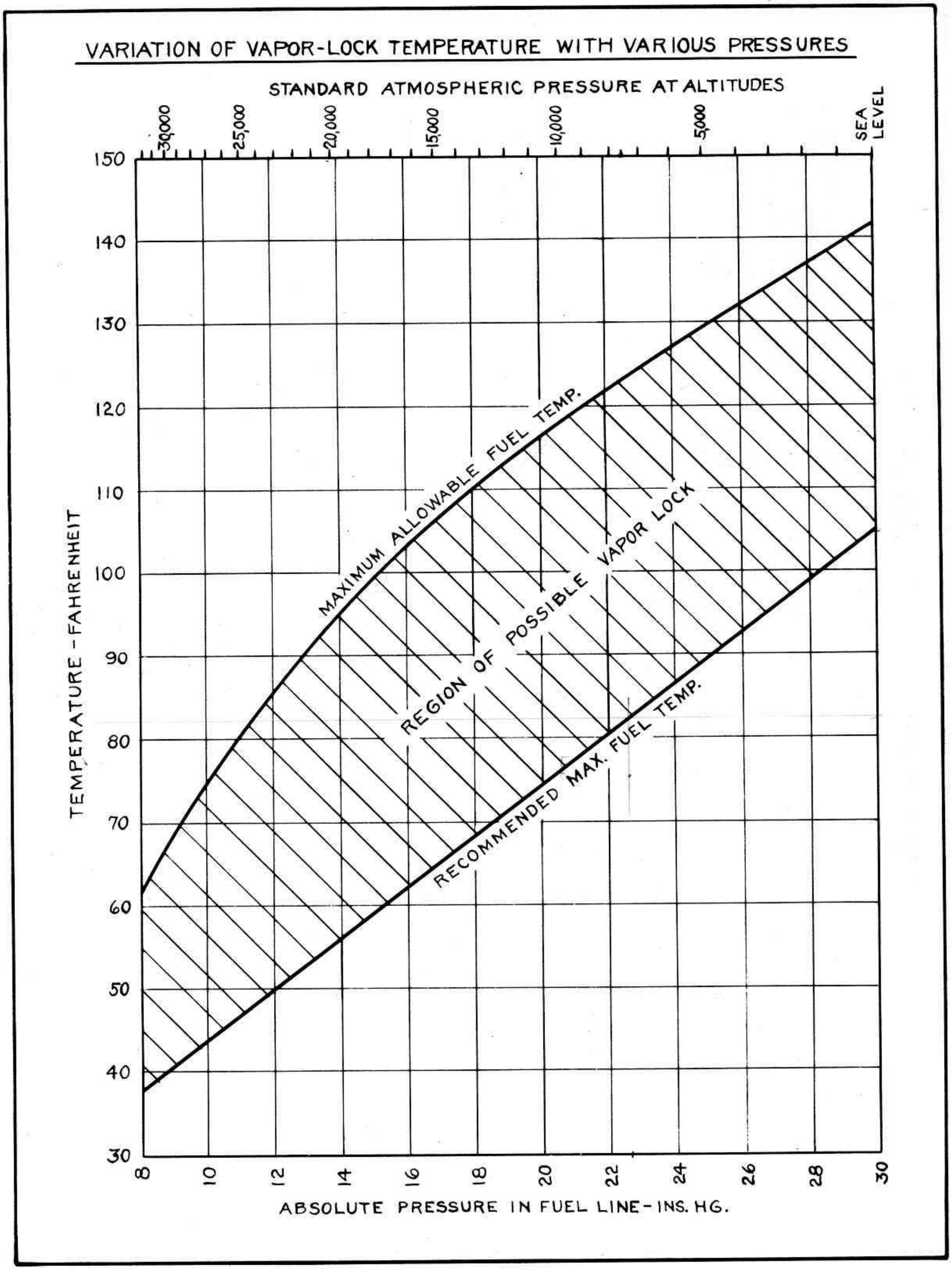
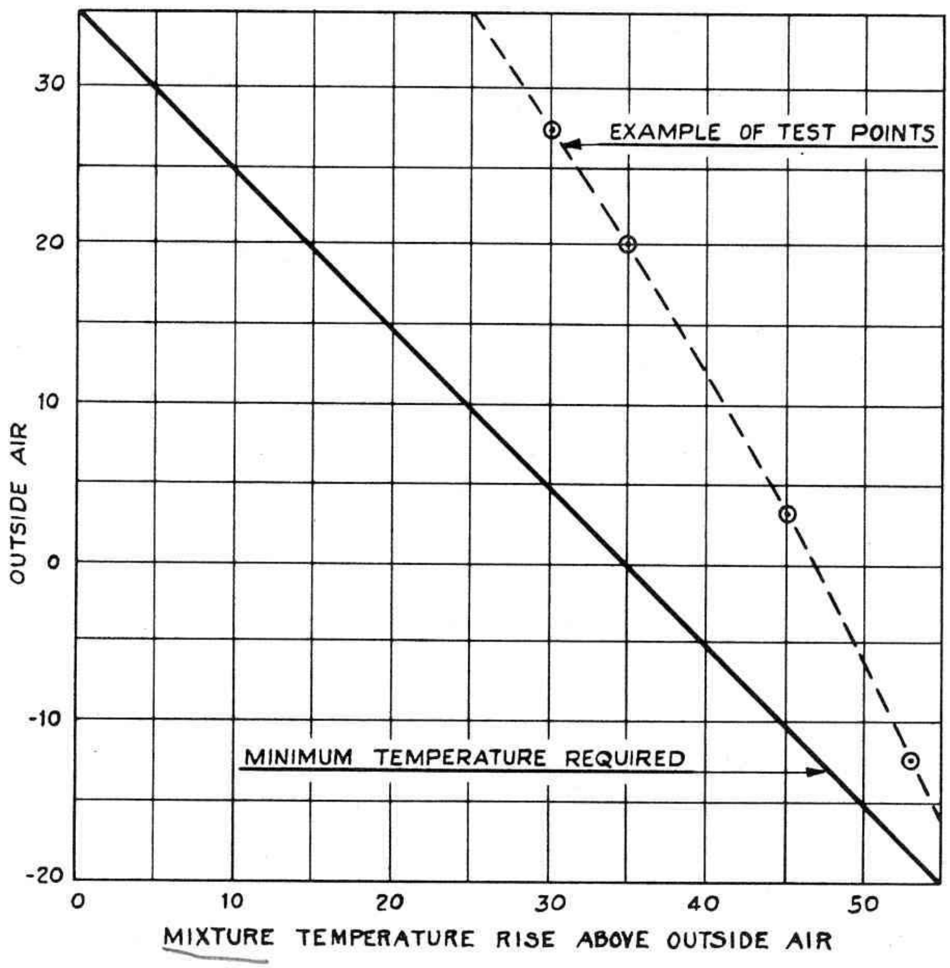

VARIATION OF VAPOR-LOCK TEMPERATURE WITH VARIOUS PRESSURES
STANDARD ATMOSPHERIC PRESSURE AT ALTITUDES
30,000
25,000
20,000
15,000
10,000
5,000
SEA LEVEL
150
140
130
120
110
100
90
80
70
60
50
40
30
TEMPERATURE - FAHRENHEIT
MAXIMUM ALLOWABLE FUEL TEMP.
REGION OF POSSIBLE VAPOR LOCK
RECOMMENDED MAX. FUEL TEMP.
8
10
12
14
16
18
20
22
24
26
28
30
ABSOLUTE PRESSURE IN FUEL LINE - INS. HG.

Figure 97



CARBURETOR PRE-HEATER REQUIREMENTS

Figure 98

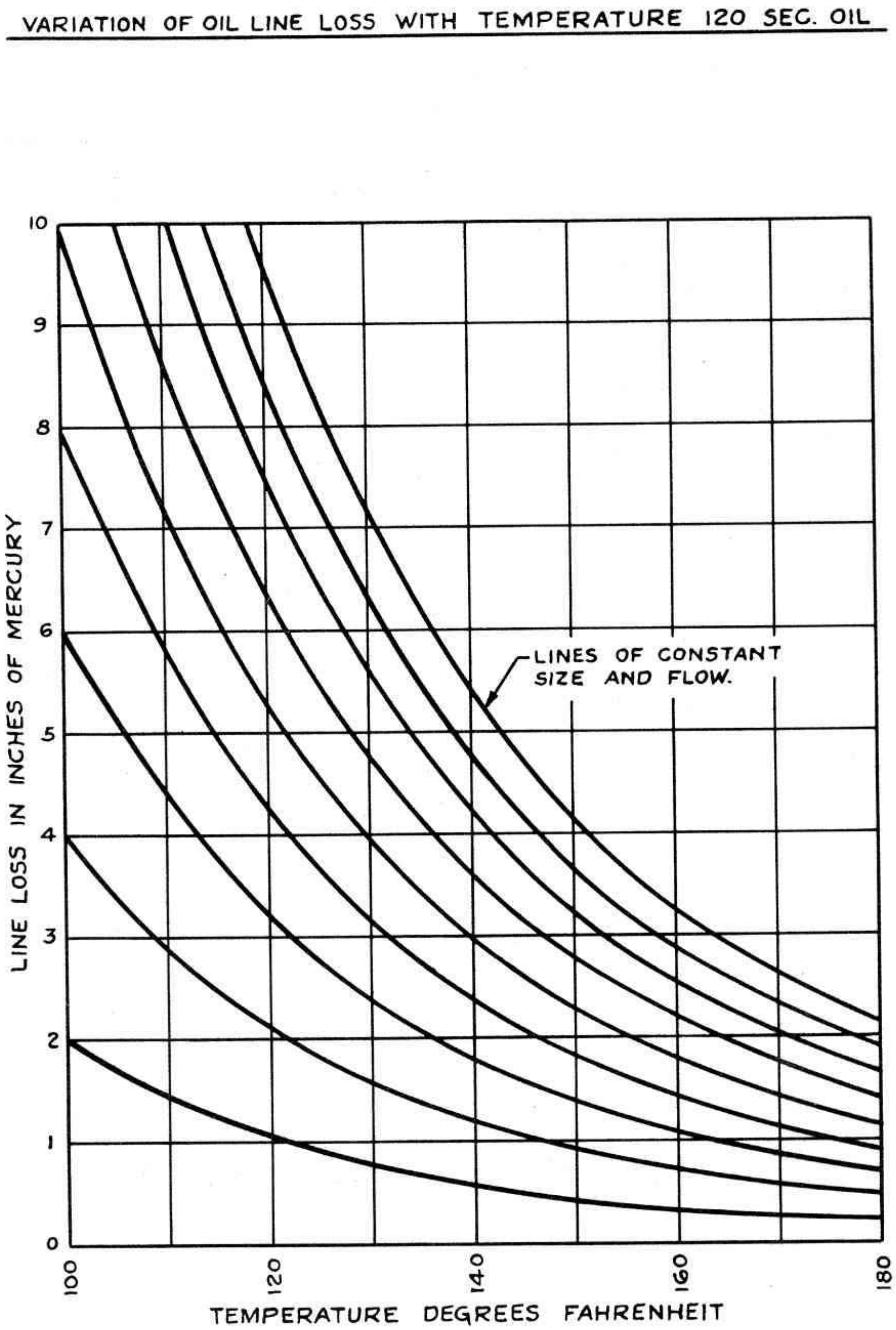

VARIATION OF OIL LINE LOSS WITH TEMPERATURE 120 SEC. OIL
LINE LOSS IN INCHES OF MERCURY
0
1
2
3
4
5
6
7
8
9
10
100
120
140
160
180
TEMPERATURE DEGREES FAHRENHEIT
LINES OF CONSTANT SIZE AND FLOW.

Figure 99

E. APPLICATION OF TEMPERATURE LIMITS

On the following page Table VIII shows the application of the temperature limitations for the tests as given in the Test Outline. The values given in this Table for cylinder heads, cylinder bases and oil inlet are not to be misconstrued as specific values for all engines. They simply represent a typical example. For specific values of these limitations refer to the specification on the engine in question. Where only one cylinder base or oil inlet temperature is given on the engine specification this limitation then applies to all the tests in the Test Outline.

Wright Engine Specifications give the cylinder head and base temperature limitations in the following manner. They are applied as shown in Table VIII.

Cylinder Head - Using Spark Plug Washer Type Thermocouple

Continuous Operation Maximum .... 400° F.
Take-off - 5 Minutes Duration Maximum .... 450° F.
Climb - 15 Minutes Duration Maximum .... 450° F.

Cylinder Barrel - Using Embedded Type Thermocouple

Maximum Permissible .... 325° F.
Continuous Operation Maximum .... 300° F.

It should be noted that these values are representative and vary with different engines. Refer to the engine specification for specific values on the engine in question.

TABLE VIII

TYPICAL EXAMPLE OF Maximum Allowable Temperature Limitations

	Test Number	2a	2b	2c	2d	2e	2f	2g	2h	3a	3b
*	Cylinder head	450	450	450	400	400	400	400	400	450	450
**	Cylinder base	325	325	325	300	300	300	300	300	325	325
	Spark plug elbow	250	250	250	250	250	250	250	250	250	250
	Fuel			Refer to Figure ~~103~~ 97							
	Magneto	165	165	165	140	140	140	140	140	165	165
***	Oil inlet	190	190	220	190	190	190	190	190	220	220
	F/A analyzer	150	150	125	125	125	125	125	125	125	125
	Mount rubber bushing	160	160	160	160	160	160	160	160	160	160

* Refer to the engine specification for specific values of this limitation on the engine in question.

** Some engines have only one maximum limitation on base temperatures. Refer to the engine specification.

*** Some engines have only one maximum limitation on oil inlet temperature. Refer to the engine specification.

F. PROCEDURE FOR MEASUREMENT OF TEST DATA

(1) Thermocouple Equipment

All temperatures obtained by means of thermocouples are best measured with a thermo-electric pyrometer, using a potentiometer circuit not requiring individually calibrated leads. Thermocouples can be used for measurement of such temperatures as cylinder heads, cylinder bases, spark plug elbows, magneto, fuel, engine mount rubber bushings, and in some cases for Cambridge cell, carburetor air, and oil temperatures.

Figure 100 illustrates a cylinder head and base thermocouple installation with a measuring unit which has been found most satisfactory for this type of work. The spark plug washer type thermocouple and embedded type base thermocouple used should be approved by the Wright Aeronautical Corporation.

A magneto thermocouple and spark plug elbow thermocouple installation is illustrated in Figure 101. Thermocouple installations for measuring fuel and Cambridge cell temperatures are also shown on this Figure.

The temperature of the engine mount rubbers can be measured by means of either a thermocouple silver soldered to the bushing retainer, or a thermocouple clamped under the socket attaching nut.

Care should be taken to insure that all connections in the thermocouple leads provide tight and positive contact, and proper support should be given to the leads to prevent breaking or chafing.

(2) Pressure Measurements

Two methods for measuring the pressure drop across the engine cylinder baffles are illustrated in Figure 100. The intercylinder type measures the static pressure at the front and at the rear of the intercylinder baffles. This pitot tube, which the Wright Aeronautical Corporation will furnish, should be located in an intercylinder baffle on a line with the thick fin at the bottom of the cylinder head. It is desirable to locate one of these tubes at the top of the engine and another at the bottom. The overhead type of pitot tube which is used on twin-row engines measures the total pressure in the baffle passage and the static pressure at the rear of the engine.

Exhaust back pressures can be measured as illustrated in Figure 102. Care must be taken when locating the hole in the exhaust manifold at each cylinder outlet, to insure that the reading obtained will be true static pressure with no velocity head. The edges of the hole should be free from burrs, and, to reduce pulsations in the reading, the size of the hole should not be larger than a No. 50 drill.

A pitot device similar to that used in the intercylinder baffles is suitable for measurement of the pressure drop in airflow across an oil cooler. This installation is illustrated in Figure 103.

Carburetor ram, or static pressure at the top deck of the carburetor, can be measured at the tapped hole provided for this purpose in the carburetor. Figure 104 illustrates this installation.

The pressure drop across the exhaust gas analyzer cell can be measured as shown in Figure 101.

All the above mentioned pressure indications should be carried to a suitable panel where a selector and indicator, calibrated in inches of water, are installed. The Wright Aeronautical Corporation will furnish all the equipment necessary for measurement of this pressure data.

(3) Oil System Temperature and Pressure Survey

Oil inlet temperature can be measured by means of a capillary or resistance bulb thermometer inserted in the fitting provided in the oil pump for this purpose. However, Figure 103 illustrates a special fitting provided with a thermocouple and a bleed hole for pressure or suction measurement. The same fitting can be used in the oil outlet line where it is desired to check the oil temperature rise through the engine. The pressure connection can be used for measuring the oil inlet line suction or the back pressure on the scavenging pump. This fitting is available in several sizes and forms to fit all Wright engines.

Where oil cooling is critical, or in oil system research, it is often desirable to check the efficiency of the cooler exclusive of the rest of the system. In such a case, a similar fitting is installed in the oil outlet fitting on the cooler. Installation of a pressure gage at this fitting will give the pressure drop through the cooler when used with the scavenge pressure.

All oil system tests should be conducted with the auxiliary oil temperature control devices both operative and disconnected.

Figure 103 illustrates a typical oil system fitted with the necessary equipment to check its efficiency.

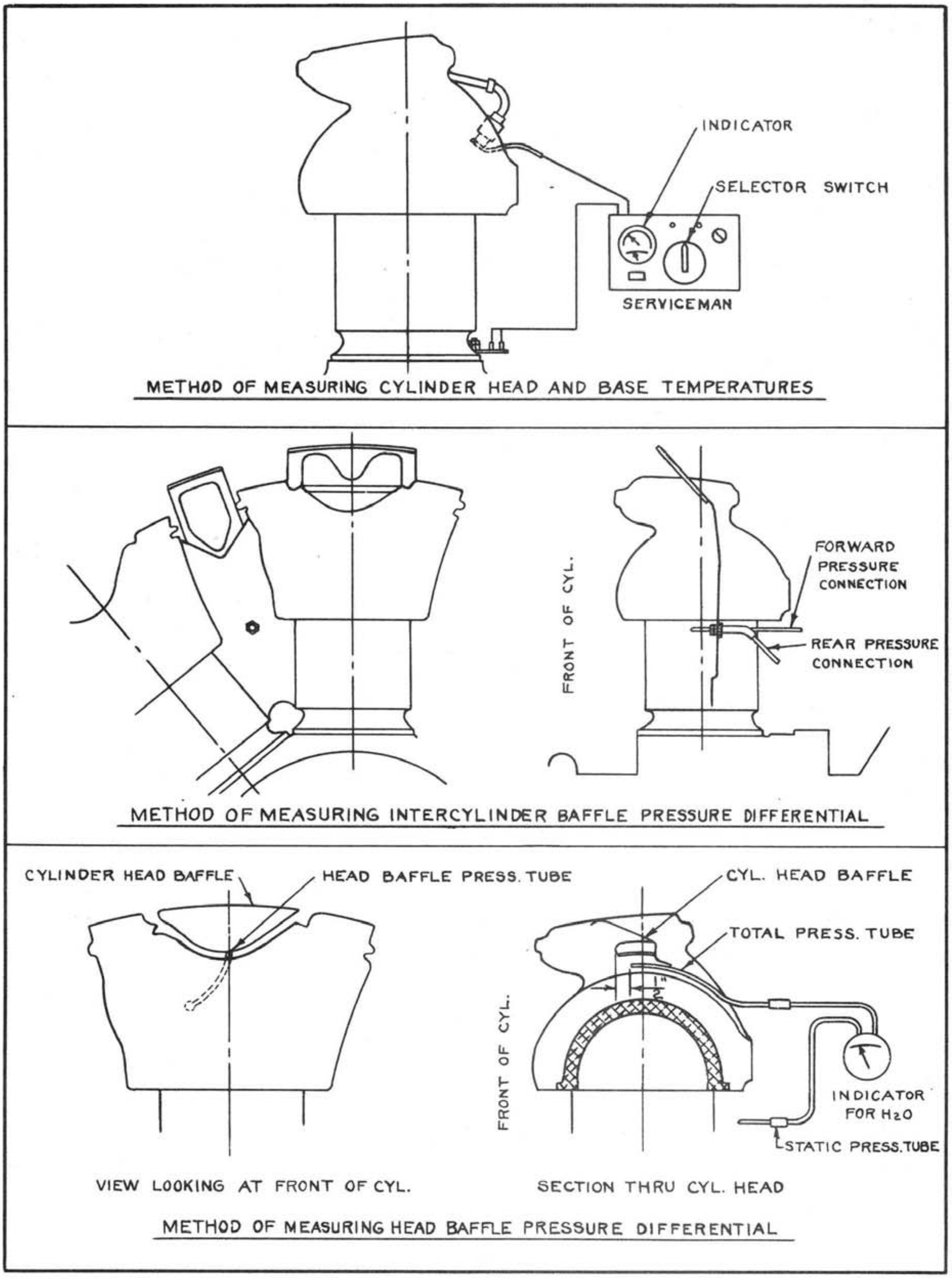

INDICATOR
SELECTOR SWITCH
SERVICEMAN
METHOD OF MEASURING CYLINDER HEAD AND BASE TEMPERATURES
FRONT OF CYL.
FORWARD PRESSURE CONNECTION
REAR PRESSURE CONNECTION
METHOD OF MEASURING INTERCYLINDER BAFFLE PRESSURE DIFFERENTIAL
CYLINDER HEAD BAFFLE
HEAD BAFFLE PRESS. TUBE
CYL. HEAD BAFFLE
TOTAL PRESS. TUBE
FRONT OF CYL.
INDICATOR FOR H2O
STATIC PRESS.TUBE
VIEW LOOKING AT FRONT OF CYL.
SECTION THRU CYL. HEAD
METHOD OF MEASURING HEAD BAFFLE PRESSURE DIFFERENTIAL

Figure 100

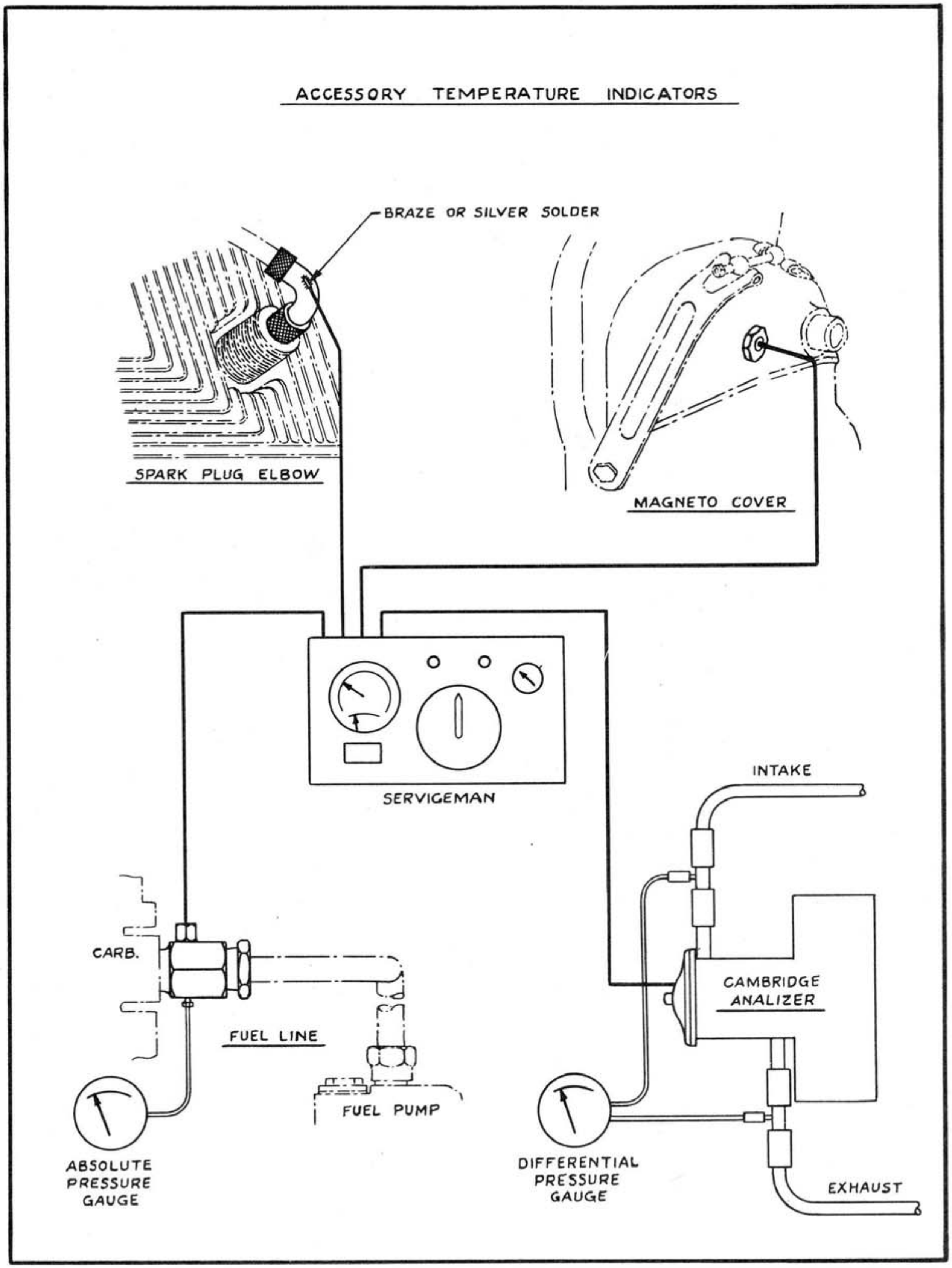
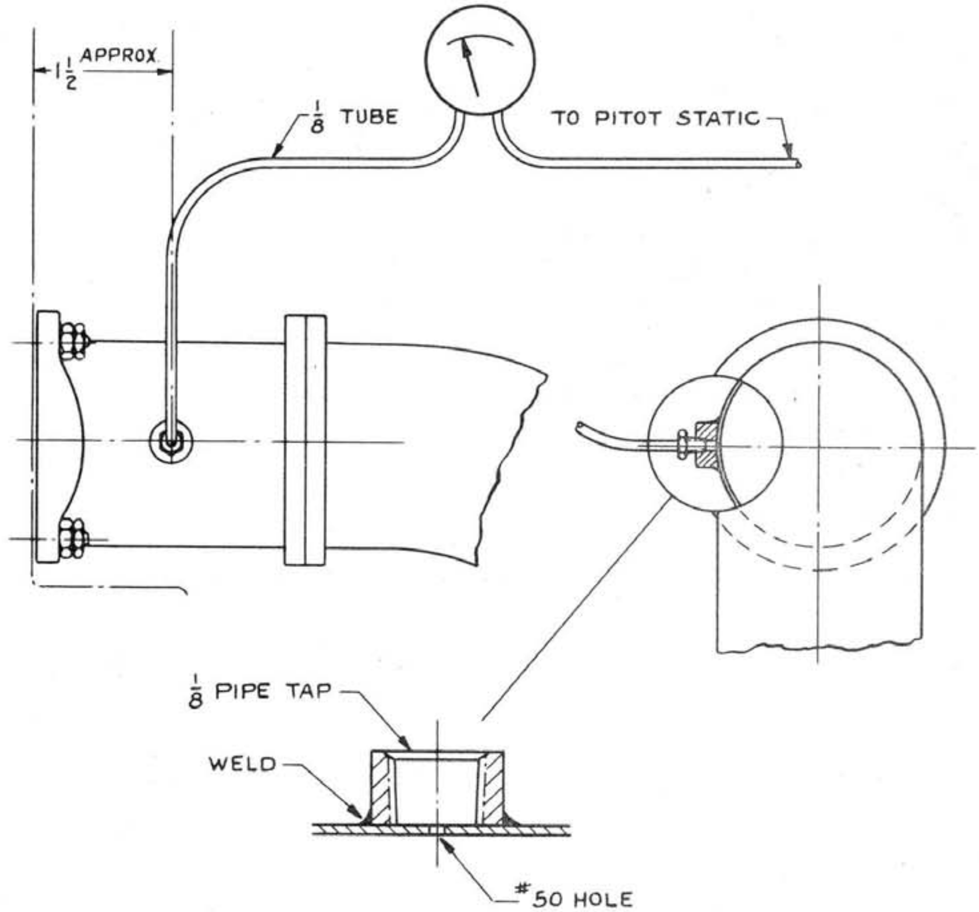

ACCESSORY TEMPERATURE INDICATORS
BRAZE OR SILVER SOLDER
SPARK PLUG ELBOW
MAGNETO COVER
SERVICEMAN
INTAKE
CARB.
CAMBRIDGE ANALIZER
FUEL LINE
FUEL PUMP
ABSOLUTE PRESSURE GAUGE
DIFFERENTIAL PRESSURE GAUGE
EXHAUST

Figure 101

EXHAUST MANIFOLD BACK PRESSURE CONNECTION



INSTALL BOSS AS SHOWN AT ABOUT THE MID POINT OF CYLINDER COUPLING ON ALL CYLINDERS TO BE TESTED.

DRILL A #50 HOLE IN EXHAUST MANIFOLD AS SHOWN, BEING CAREFUL TO REMOVE THE BURR ON THE INNER SURFACE BUT NOT TO DESTROY THE SHARP CORNER.

Figure 102

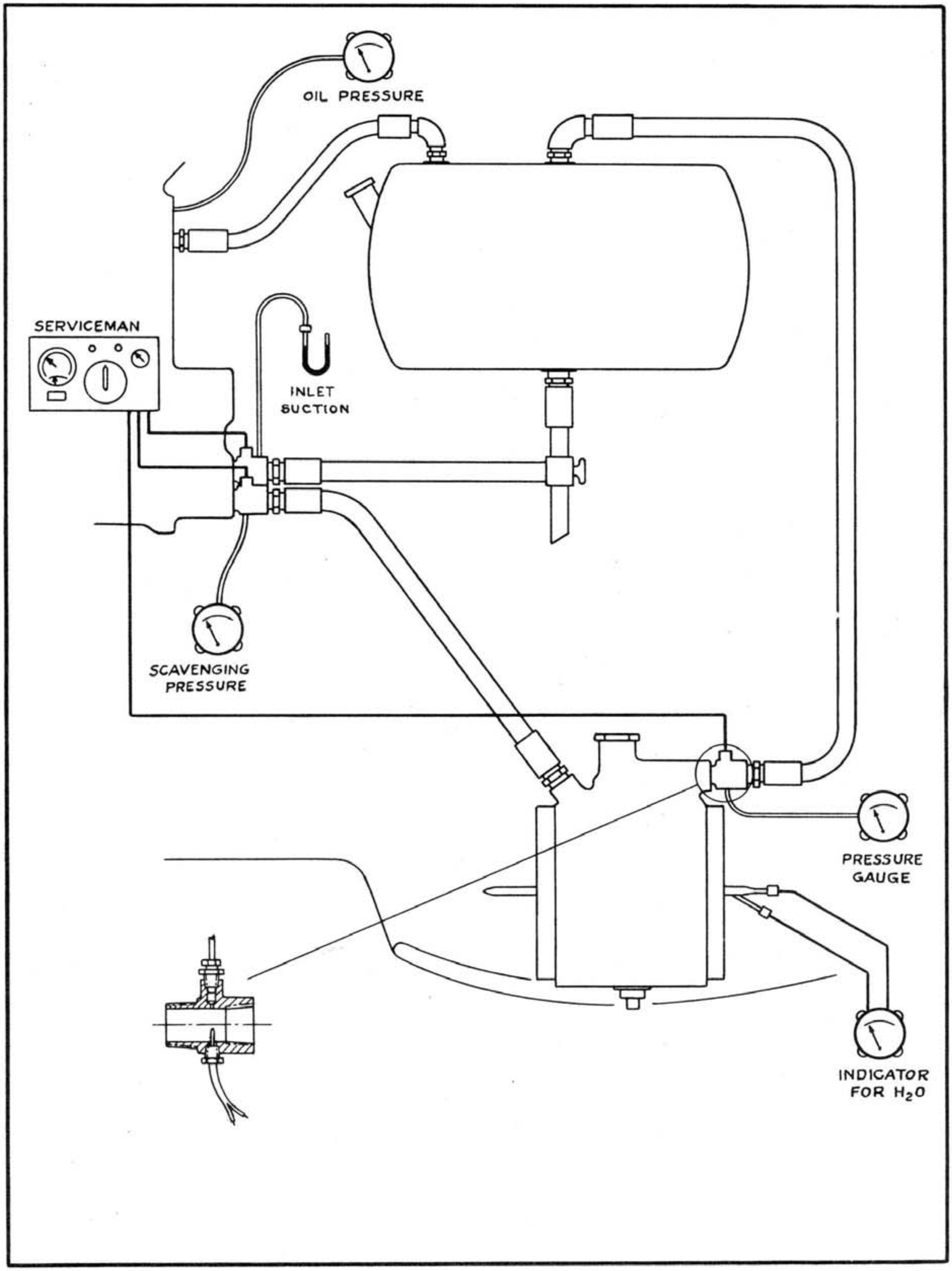
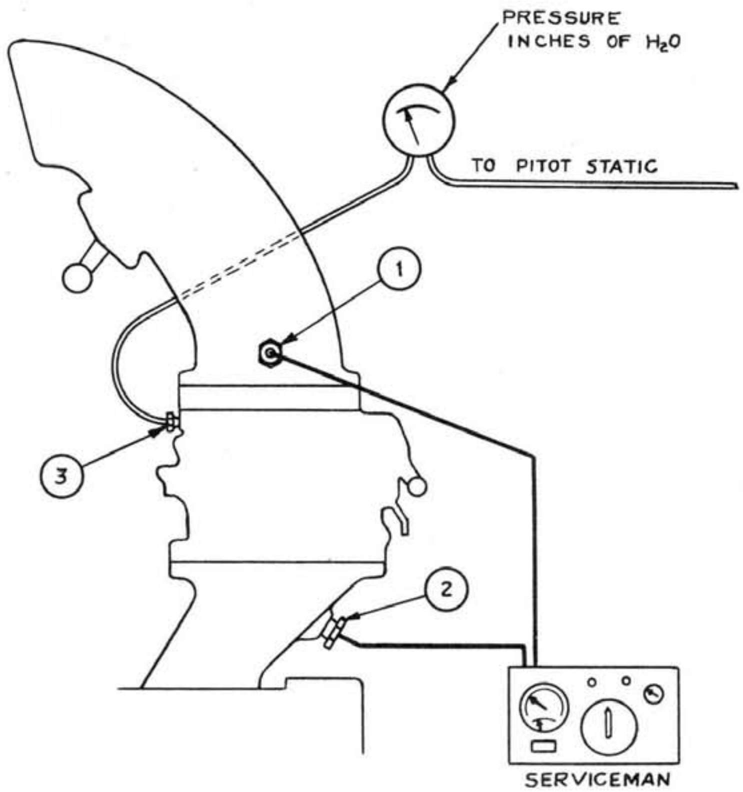

OIL PRESSURE
SERVICEMAN
INLET
SUCTION
SCAVENGING
PRESSURE
PRESSURE
GAUGE
INDICATOR
FOR H_2O

Figure 103

INSTALLATION OF INDUCTION SYSTEM TEST EQUIPMENT



1 AIR SCOOP TEMPERATURE
2 ADAPTER TEMPERATURE
3 CARBURETOR RAM

Figure 104

G. GROUND TEST RIG

A practice recently established by leading aircraft manufacturers is that of building a complete ground test rig, duplicating in every detail the actual engine installation as it will ultimately be in the finished airplane. This test rig then provides an authentic mock-up of the complete engine installation enabling the proper setting of devices for controlled cooling, oil cooler duct locations, locations of flow meters and exhaust gas analyzers, and determination of the natural response frequency of the power plant group, and enumerable other details of design of the installation, before the ship ever flies. Figure 105 illustrates two typical types of ground test rigs. Such a test rig can be built of structural steel, so arranged as to receive as large a portion of the engine installation as is possible. On nacelle installations this should include the nacelle and a portion of the wing, as this will permit the solution of control problems as well as determining the accessibility behind the firewall. For single engine ships there is little need for the engine installation to extend beyond the firewall. The test rig should be so located in space so that the fuel system, as will be ultimately used, can be built in conjunction with the test rig, thus permitting a ground test of the fuel system.

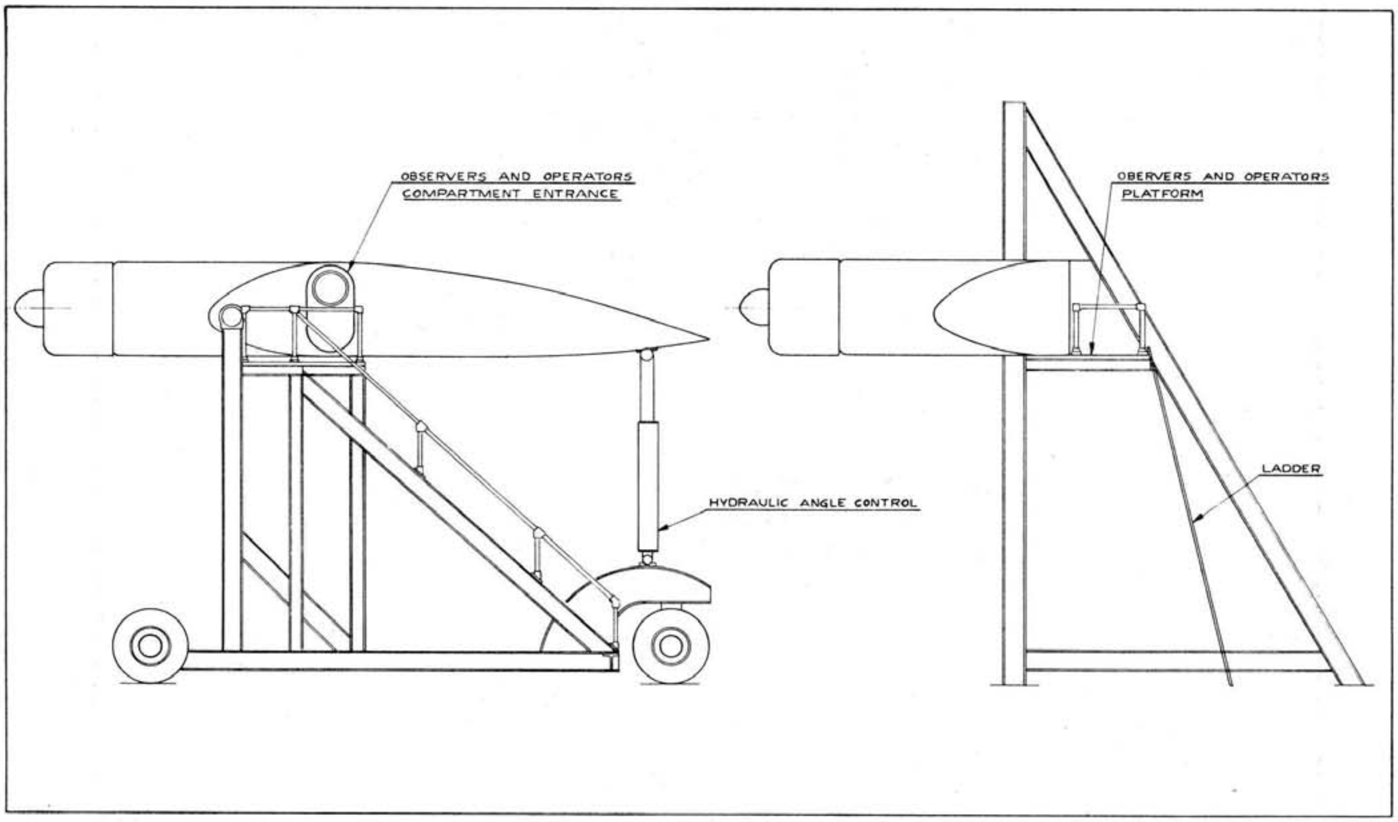


Figure 105