RESTRICTED

PILOT'S HANDBOOK

FOR

MODEL F4F-4 AIRPLANE

RELEASED BY THE BUREAU OF AERONAUTICS, NAVY DEPARTMENT

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

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MODEL F4F-4 AIRPLANE

ENGINE R-1830-86

CONTRACT NO. 99340

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

FOREWORD

This Handbook is prepared for the purpose of familiarizing flying personnel with the take-off, flying and landing characteristics of this airplane; the functions of particular systems and installations, and the operation of the various automatic and manual controls.

For service and overhaul instructions, refer to the Erection and Maintenance Instructions Manual for this airplane.

This airplane is a single engine, single place, folding midwing monoplane carrier fighter. It is powered with a Pratt & Whitney two stage, 14 cylinder radial engine designed to operate on 100 octane fuel, with a take-off rating of 1200 BHP at 2700 RPM at sea level.

The total combined fuel capacity of both the main and emergency fuel tanks with self-sealing liners is 144 gallons. Equipment is provided for the installation of two (2) droppable tanks, of 50 gallons capacity each.

The wings are folded and spread manually, and locked in the spread position by manually operated locking pins. The landing gear is mechanically retractable by the action of a handcrank operated by the pilot.

This airplane carries six (6) .50 calibre machine guns, three (3) mounted in each outer wing panel. Provision is made for the installation of two (2) wing bomb racks. It is equipped with armor plate and bullet proof windshield.

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I
COCKPIT ARRANGEMENT AND CONTROLS

The arrangement of the cockpit and the locations of the various controls are shown on the accompanying photographic illustrations.

In general, the controls, and their operation, are indicated by adjacent nameplates.

FLYING CONTROLS

Aileron and Elevator Controls

Standard type stick.

Aileron Trimming Tab Control

On left aileron only. Handwheel on left hand shelf. Rotate to left to depress left wing. See Page 21.

Elevator Trimming Tabs Control

Handcrank on side of left hand shelf. Clockwise - Nose Down. See Page 21.

Rudder Control

Standard under-hung pedals.
Adjustable to four (4) positions by lever on each outer pedal arm. See Page 22.

Rudder Trimming Tab Control

Handwheel on left hand shelf.
Clockwise - Nose Right. See Page 21.

Altitude and Landing Flaps Control

Handle at center of left hand shelf.
Handle Inboard - Flaps Up
Handle Outboard - Flaps Down
See Page 22.

LANDING GEAR CONTROLS

Retracting Control

Handcrank on side of right hand shelf.
Clockwise rotation raises landing gear.
Handcrank release controlled by small lever just aft of handcrank.
Move lever aft to lower gear - Forward to raise.

Warning Indicators

Mechanical - Small arrow head pointer in slot on side of right hand shelf just forward of handcrank.

Electrical - The Howler, (Warning Horn) located on the side of the left hand shelf, is connected in series with the Throttle, Landing Gear and Check-Off Switches; and operates only when the engine is throttled below 1200 RPM and the landing gear is not fully extended.

Brake Control

The hydraulic brakes are operated by pressing on the upper part of the rudder pedals.

Tail Wheel Lock Control

Control lever on side of left hand shelf; when forward, it locks the wheel caster in the trailing position. When unlocked, the wheel can swivel through a radius of 360°.

Lock for land operation and unlock for carrier operation and taxiing.

POWER PLANT CONTROLS

Auxiliary Supercharger Control

Three position lever with lock on left hand cockpit shelf.

Full Forward - "Neutral"
Center Position - "Low Ratio - Aux. Stage"
Full Aft - "High Ratio - Aux. Stage"

Carburetor Air Control

A considerable increase in carburetor air temperature occurs when the auxiliary Supercharger is engaged, in either High or Low Blower Ratio, due to the heat of the compressed air If there is the slightest indication of carburetor icing, immediately engage the Auxiliary Supercharger. The same procedure should be used in shifting as described on Page 31. The power out-put with the Auxiliary Stage engaged shall not exceed the rating for that combination of superchargers (1050 BHP)

Cowl Flaps Control

Handcrank located on the right hand side of the instrument panel Operates engine cowling flaps for cylinder temperature control

Turn clockwise to Open cowl flaps.

Turn counter clockwise to Close flaps

Fuel Valve Control

Standard dial and handle, located on left hand cockpit shelf: five (5) positions -

Main	117 gals.
Emergency	27 gals.
Left Droppable	50 gals.
Right Droppable	50 gals.
Off	

Ignition Switch

Located on the left hand side of the main instrument panel.

Emergency Electric Fuel Pump

Control switch on left hand side of main instrument panel.

Propeller Control

Push-pull control knob located on the left hand side of the main instrument panel.

Push in to increase engine revolutions.

For close adjustment turn knob clockwise to increase revolutions.

Electric propeller control switches on left hand side of main instrument panel above propeller push-pull control knob.

See Pages 29 and 30 for propeller operating instructions

Toggle switch is located on the aft end of the pilot's distribution panel.

Starter cartridge container located on the engine mount just to the right of the generator.

Throttle & Mixture Controls

On engine control quadrant on left hand cockpit shelf.

Knurled knob, on side of control quadrant, adjusts friction on levers.

AUXILIARY CONTROLS

Arresting Hook Control

Large control handle in a slide on the left hand side of the cockpit under the cabin rail.

WARNING: Pilot shall insure that control handle is in the hook-down position prior to landing aboard a carrier.

Cockpit Ventilator Valve

Disc type ventilator valve on fixed section of cockpit enclosure above pilot's head.

Cockpit Enclosure Operating Control

Large handle in slide on right side of cockpit under cabin rail. Handle may be latched in any one of four positions: Closed, 1-1/4" Open, 5-3/8" Open and Full Open.

Angle clip on lower left corner of cabin enclosure may be used to assist in opening and closing hood.

Cabin enclosure may be locked or unlocked from the outside while in the closed position by access through the door on the right hand side of the fuselage below the windshield.

Emergency Release

The enclosure is equipped with quick release latches, consisting of release pins with red painted finger rings attached, at the forward end of the track.

To release, grasp the rings to pull out the

pins, and push the enclosure up into the air-stream.

NOTE: Keep these release pins lubricated with a thin coating of grease to permit easy removal.

Electrical Distribution Panel & Switch Box

The distribution panel and switch box, located on the right hand side of the cockpit, contains the following:

Switches

Landing Light
Section Light
Approach Light
Wing & Tail Running Lights
Formation Lights
Cockpit Lights Master
Remote Compass
Battery
Gun Camera
Gun Selector
Gun Master
Pitot Tube Heat
Panel Receptacle
Starter Cartridge Firing

Rheostats

Panel Light
Projection Light
Compass Light
Chartboard Light
Instrument Lights

Instructions for the operation of the above items are on their adjacent name plates. Spare fuses and bulbs are located in the top of the box.

The recognition lights toggle switches and key switche are on the forward end of the left hand cockpit shelf.

A volt-ammeter with a selector switch for checking the generator voltage and amperage and battery voltage is located on the distribution panel.

The circuit breaker reset buttons are located on the side of the main junction box.

A panel receptacle is located on the aft end of the panel, with a switch adjacent.

The battery switch must be "ON" in order to operate any of the electrical units with the exception of:

Radio Equipment
Landing Gear Howler

To render the radio inoperative, the switch on the radio control box must be turned "OFF".

NOTE: Do not lower the landing light at speeds above 120 knots.

Emergency Life Raft

In the turtleback between Sta #7 and Sta #10 Automatic actuator, at the forward end of the landing gear support structure, releases and inflates the raft when airplane lands on water.

The raft is equipped with a kit containing repair equipment, a first aid kit, emergency rations, water, smoke grenades and a sea marker.

The raft is attached to the airplane by a 25 ft length of line with a breaking strength of 100# minimum 250# maximum. The line is attached to the raft and to the airplane by snap clips,

quickly detachable.

Manual Control

"T" handle, painted blue, at right hand side of pilot's headrest bulkhead. Pull to release and inflate raft.

Emergency Release

Projecting rod on turtleback, just forward of Sta. #8. Pull to release raft. Inflate raft by turning clockwise and pushing in red plastic compression knob on the inflating cylinder on the raft. Knob is marked "Turn and Push".

Signalling Device

The "T" handle control for the Molin Signal Discharger is located on the right hand side of the cockpit, at the seat.

Windshield Heat Control

The control handle is located above the left rudder pedal and just forward of the instrument panel. Pull to Open - Turn Clockwise to Lock.

Wing Folding Controls

The wings are folded and spread manually from the ground and held in the spread position by locking pins which are operated by handcranks. The handcranks are stowed in the leadinging edges of the wing at the folding axes, and are reached through doors secured by latches. As the locking pins are withdrawn, red metal flags are raised above the upper surface of the stub panel skin in EACH WING.

Jury struts, to hold the wings in the folded position, are stowed in the baggage compartment.

To Fold Wings

Open doors in wings, set handcranks, and turn counterclockwise to withdraw locking pins. Move wings to folded position and set jury struts in fittings in wing tips and stabilizers.

To Spread Wings

Remove jury struts, move wings up to spread position. Turn cranks clockwise to move locking pins into place.

USEFUL LOAD CONTROLS

Bomb Release Control

Standard Mark IV unit below left hand shelf. Control shall be in outboard position when not in use.

Chartboard

Located directly beneath the main instrument panel and is equipped with a clip to hold board in place when the airplane is catapulted.

Gun Charging Controls

Charging handles located outboard of the left and right hand floor channels, forward of the seat.

Gun Firing Control

Gun selector and master toggle switches on distribution panel.

Electric trigger switch button on control stick.

Gun Sights

A Mark 8 electric and an auxiliary ring and bead sight are installed. The sight rheostat and switch are on the left hand side of the main instrument panel. The switch has three positions:

Left - On
Center - Off
Right - On - Alt.

To use the sight, set switch to On and turn On rheostat. If bulb does not illuminate, set

switch to On-Alt. to use spare.

Oxygen Regulator

On the right hand side of the pilot's rear bulkhead.

Oxygen Shut-Off Control

Handwheel located on oxygen cylinder at right hand side of pilot's seat.

CAUTION: Oxygen equipment must be kept free from oil and grease.

Gun Camera

Provision is made for the installation of a Mark 7-1 gun camera in the leading edge of the left wing. The control switch is on the pilot's distribution panel.

Headrest Adjustment

The headrest is adjustable to any one of five (5) positions forward from the bulkhead. To bring the headrest forward, turn counter-clockwise, and then pull out. Notches in the shaft at 1-1/4" intervals hold the headrest in the selected position.

Radio Controls

Microphone switch on top of throttle arm. The radio controls are located on the right hand side of the cockpit.

Seat Adjustment

Standard: Control lever on right hand side of seat.

Tow Target

There is provision for the installation of a tow target release control on the cockpit floor (marked with a name plate) at the right hand side of the pilot's seat, and for a release latch on the bottom of the fuselage.

MISCELLANEOUS EQUIPMENT

Map Case

A canvas map case, including a pad and pencil holder is installed on the left hand side of the cockpit under the cabin rail.

Baggage Container

A canvas bag for baggage and miscellaneous articles is stowed in the after part of the fuselage.

NOTE: The installation of each of the foregoing items is further described in the Erection and Maintenance Instructions for this airplane.

1. CLOCK
2. CYLINDER HEAD TEMPERATURE GAGE
3. RUDDER PEDAL ADJUSTMENT LEVER
4. PROPELLER CONTROL
5. IGNITION SWITCH
6. GUN SIGHT LIGHT SWITCH
7. EMERGENCY ELECTRIC FUEL PUMP SWITCH
8. CHECK-OFF SWITCH
9. WINDSHIELD DEFROSTER
10. ALTIMETER
11. DIRECTIONAL GYRO
12. PADDED ELECTRIC GUN SIGHT MOUNT
13. AIRSPEED INDICATOR
14. TURN & BANK INDICATOR
15. RATE OF CLIMB INDICATOR
16. GYRO HORIZON
17. MANIFOLD PRESSURE GAGE
18. TACHOMETER
19. OUTSIDE AIR TEMPERATURE
20. FUEL QUANTITY GAGE
21. PRIMER PUMP
22. COWL FLAPS HANDCRANK
23. ENGINE GAGE UNIT
24. COMPASS
25. OIL DILUTION SWITCH
26. RADIO SIGNAL LIGHT

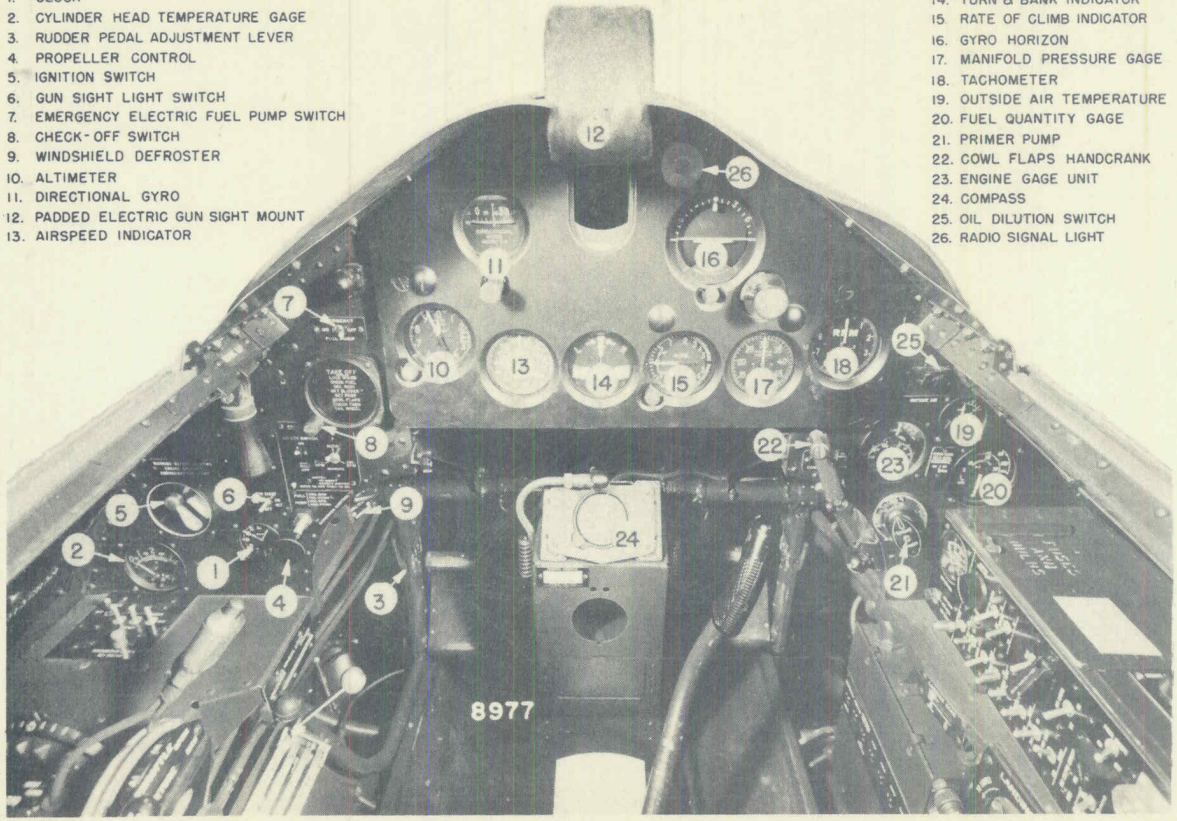
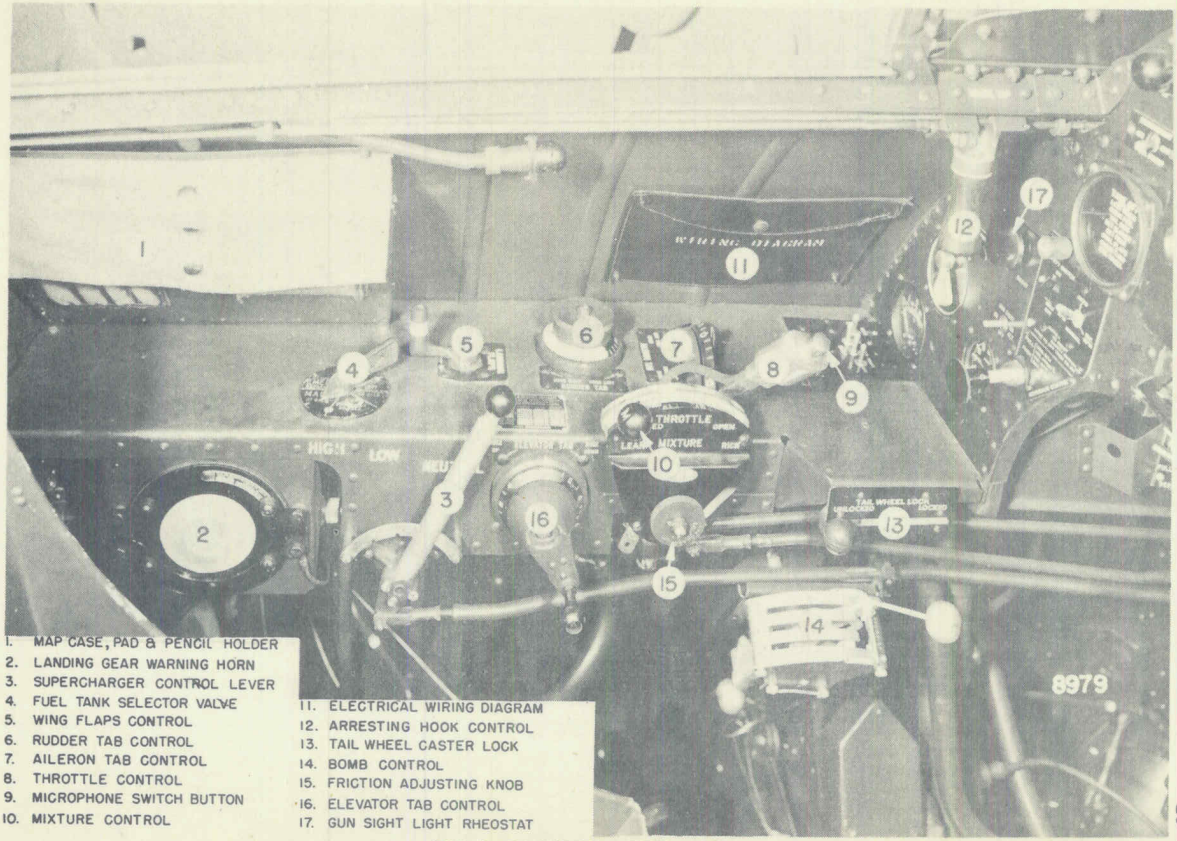
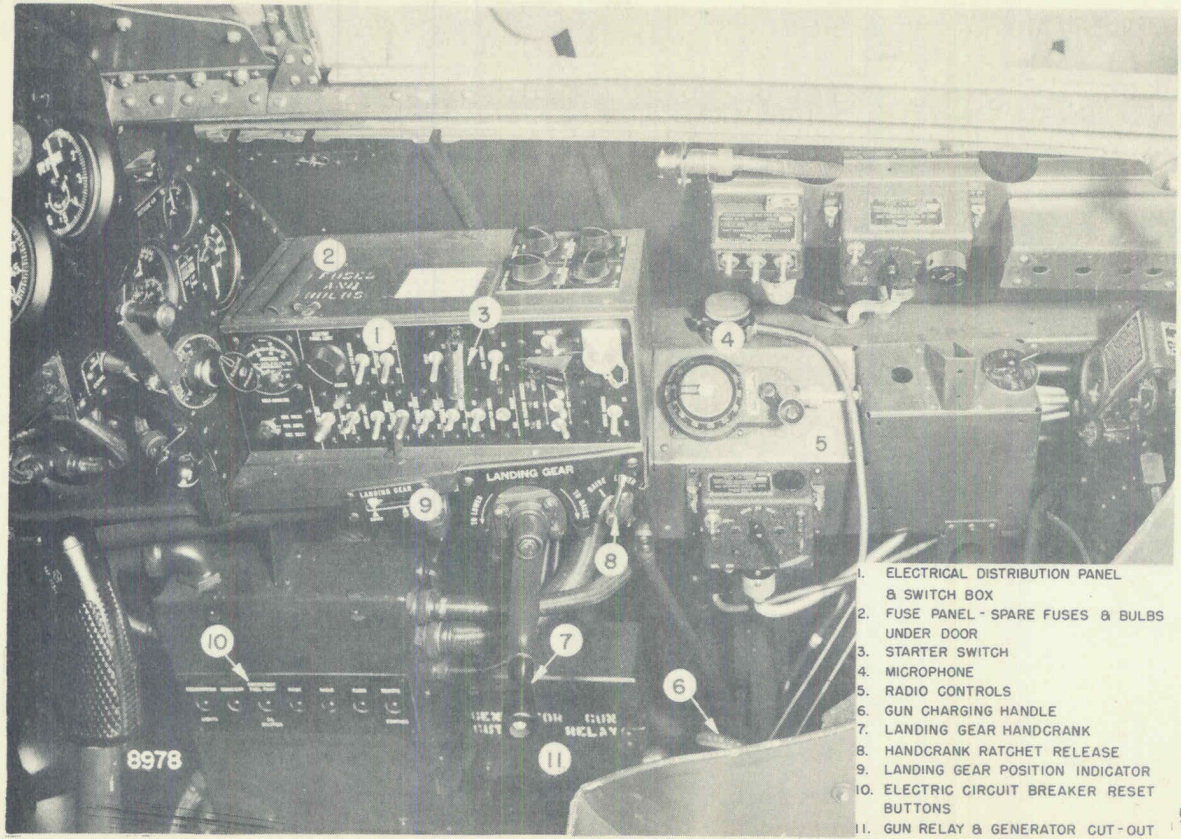


FIG. I INSTRUMENT PANEL



1. MAP CASE, PAD & PENCIL HOLDER
2. LANDING GEAR WARNING HORN
3. SUPERCHARGER CONTROL LEVER
4. FUEL TANK SELECTOR VALVE
5. WING FLAPS CONTROL
6. RUDDER TAB CONTROL
7. AILERON TAB CONTROL
8. THROTTLE CONTROL
9. MICROPHONE SWITCH BUTTON
10. MIXTURE CONTROL
11. ELECTRICAL WIRING DIAGRAM
12. ARRESTING HOOK CONTROL
13. TAIL WHEEL CASTER LOCK
14. BOMB CONTROL
15. FRICTION ADJUSTING KNOB
16. ELEVATOR TAB CONTROL
17. GUN SIGHT LIGHT RHEOSTAT

FIG. 2 COCKPIT - LEFT HAND



1. ELECTRICAL DISTRIBUTION PANEL & SWITCH BOX
2. FUSE PANEL - SPARE FUSES & BULBS UNDER DOOR
3. STARTER SWITCH
4. MICROPHONE
5. RADIO CONTROLS
6. GUN CHARGING HANDLE
7. LANDING GEAR HANDCRANK
8. HANDCRANK RATCHET RELEASE
9. LANDING GEAR POSITION INDICATOR
10. ELECTRIC CIRCUIT BREAKER RESET BUTTONS
11. GUN RELAY & GENERATOR CUT-OUT

FIG.3 COCKPIT - RIGHT HAND

II
OPERATION INSTRUCTIONS

1. FLYING CONTROLS

(a) Aileron Trimming Tab Control

The aileron trimming tab, located on the left aileron only, is adjustable in flight from 20° up to 20° down in relation to the chord line of the aileron.

Control is effected by turning the handwheel in the cockpit which operates a flexible shaft and drive assembly to the screw type actuator in the left aileron.

To depress the right wing rotate the handwheel clockwise.

To depress the left wing rotate counter-clockwise.

(b) Elevator Trimming Tab Control

The elevator trimming tabs are adjustable in flight from +5°54' to -10°51' in relation to the center line of the elevators (+5°54' is for max. down elevator.)

Control is effected by turning the handcrank in the cockpit which operates screw type tab actuators in each elevator through flexible shafts and torque shafts.

For "Nose Down" rotate the elevator tab control handcrank clockwise.

For "Nose Up" rotate counter-clockwise.

(c) Rudder Trimming Tab Control

The rudder trimming tab is adjustable in flight from 22°19 left to 16°26 right with respect to the center line of the rudder.

Control is effected by turning the handwheel in the cockpit which operates flexible shafts and torque tubes leading to the screw type tab actuator in the rudder.

For "right rudder" turn the handwheel clockwise.

For "left rudder" turn counter-clockwise.

(d) Rudder Pedal Adjustment

The rudder pedals are adjustable to four (4) positions.

Adjustment is accomplished as follows: With toes on adjustment levers push pedals all the way forward, then with toes under pedals bring them aft one notch at a time until the desired position is attained. Check to see that each pedal has ratcheted past the same number of notches.

(e) Landing and Altitude Flaps Control

The flaps are operated by two (2) actuating systems, a vacuum system, and a pressure system, interconnected to a single control lever on the left hand cockpit shelf, which has two (2) positions:

Handle Outboard - Flaps Down
Handle Aft - Flaps Up

The supply sources for the vacuum system are the engine vacuum pump and the intake manifold, from which lines are led to the vacuum storage tank and thence connected to the flap actuating cylinders through the control valve. The line to the intake manifold is equipped with a check valve to permit flow from the vacuum storage tank to the intake manifold but not vice versa.

The pressure system is supplied from the carburetor air elbow where pressure is increased when the auxiliary supercharger is in either Low or High blower.

When the control lever is in the "Up" position, the forces on either side of the pistons in the actuating cylinders are equalized and the flaps are held in the up position. (Auxiliary springs aid in holding the flaps up.) When the control lever is moved to "Down" the vacuum on the aft side of the pistons and pressure on the forward side move the pistons out and the flaps are moved down.

The vacuum tank has sufficient capacity to operate the flaps at least twice with the engine "cut". The engine will produce vacuum with the throttle closed unless completely stopped even though the switch is "Off".

The operating force on the flaps is sufficient to hold the flaps down when the engine is idled. When power is applied, the flaps will start to come up and as more power is applied and the speed picks up the flaps will gradually come up until, at about 130 knots, the angle of droop will be approximately 10°. If the power is then re-

moved, the flaps will return to the down position. This feature is very helpful when it is necessary, for any reason, to "go around again" after approaching for a landing. The flaps can be left down until ample speed and height are attained, and if the valve is turned to "Up" there will be no "sinking" effect.

When using the flaps for MANEUVERING AT ALTITUDE, they will come down partially at speeds up to 140 knots. At higher speeds the force of the airflow on the flaps will overcome the hold-down force.

2 LANDING GEAR CONTROLS

(a) Retracting Mechanism

The landing gear is retracted or extended by means of a handcrank unit located on the right hand side of the cockpit

Approximately 30 turns of the crank are required to raise or lower the landing gear. Rotate the crank clockwise to raise and counter-clockwise to lower.

The handcrank is automatically latched by a ratchet acting on the crank while the wheels are being raised or lowered. The ratchet is released by operating the small lever just aft of the handcrank. After releasing the ratchet lever, the crank remains locked until pressure is exerted on the crank opposite to the desired rotation

(b) Handcrank Brake

A landing gear handcrank brake is installed on the operating shaft just forward of the handcrank gear box. This unit ratchets when the landing gear is being raised, but when the gear is being lowered, a pawl engages the drum and the braking action retards the speed with which the wheels are lowered. The single adjusting nut which regulates the tension on the friction brake must be so regulated that the lowering speed of the wheels will not cause the handcrank to be pulled from the pilot's hand. When lowering the landing wheels, it is IMPORTANT that the handcrank be kept in check to prevent the wheels from running down free which may strip the gears. Proper adjustment of the handcrank will prevent this, but the pilot must retain a firm grip on the

crank as a precaution.

(c) Position of Wheels

The crank is rotated as far as it will go in the desired direction - either to raise or lower the wheels. The wheels should then be in the desired position. A mechanical position indicator is located forward of the handcrank.

(d) Wheel Lock

With the wheels cranked to the "full-down" position sufficient locking force is exerted by the large operating chains, supplemented by a spring counterbalance unit, to prevent all possibility of the wheels retracting during landing and take-off.

No adjustment is necessary on the counterbalance unit since it is so designed that it will always exert the proper force.

(e) Warning Indicators

Mechanical - Small arrow head pointer in slot on right hand shelf just forward of the handcrank.

Electrical - A landing gear warning horn is located on the side of the left hand cockpit shelf. It is connected in series with the Check-Off switch, throttle and landing gear handcrank unit. The horn will sound only when the engine is throttled below 1200 RPM with the wheels not fully down and the Check-Off switch - turned to "Landing".
If the Check-Off switch is turned to

"Take-Off", the electric circuit is broken and the horn is inoperative regardless of landing gear or throttle positions.

(f) Tail Wheel Caster Lock

The tail wheel drag link is provided with a "lock-pin" which locks the wheel caster in the trailing position.

The lock-pin is controllable by cable from a small lever located on the pilot's left hand shelf. The "locked" and "unlocked" positions are plainly marked on the name plate provided at the lever. The primary purpose of the "lock" is to reduce the possibility of ground looping in landing.

It is desirable that pilots lock the tail wheel immediately after taxiing into position for take-off --- but before taking off. The tail wheel will then remain locked during flight and during landing. Check after take-off and before retracting wheels to see that lever is in the "locked" position. It may be unlocked by the pilot after the landing run has been completed, in order to facilitate taxiing.

The tail wheel is a 360° swivel type equipped with a spring centering device.

NOTE: The tail wheel shall be left unlocked for all carrier operation.

Tail wheels of the pneumatic type should be used for shore based operations where soft fields and/or cross wind landings might be encountered. Pneumatic tail wheel tires improve directional control in preventing ground looping.

Solid tired tail wheels are supplied as additional equipment for carrier operation.

3. POWER PLANT CONTROLS

(a) Engine

This airplane is powered with a Pratt & Whitney Model R-1830-86 geared 3 to 2, two stage supercharged, 14 cylinder radial, air cooled engine.

Ratings

1200 B.H.P. at 2700 R.P.M. for take-off
1100 B.H.P. at 2550 R.P.M. at 2500'
(Aux. Supercharger - Neutral)
1050 B.H.P. at 2550 R.P.M. at 12000'
(Aux. Supercharger - Low Speed)
1000 B.H.P. at 2550 R.P.M. at 19000'
(Aux. Supercharger - High Speed)
Designed to operate on 100 octane fuel, Spec. AN-VV-F-781
Oil Grade 1100, Spec. AN-9532

Maximum Diving Speed

Never exceed 3050 R.P.M. All diving must be done with the auxiliary stage supercharger in neutral.

(b) Auxiliary Supercharger

The main supercharger is in the same relative position as on all P & W engines; that is, between the carburetor and the cylinders. The auxiliary supercharger when in use boosts the pressure of the air before it enters the carburetor. Intercoolers between the auxiliary supercharger and the carburetor remove part of the heat of compression from the air as it leaves the auxiliary supercharger.

In order to assist in the description of this engine and its operation, a diagram is provided in the Erection & Maintenance Instructions Manual for this airplane.

The main supercharger is geared directly to the crankshaft and always turns with it at an 8.08:1 ratio. The auxiliary supercharger can be disengaged by a system of clutches from its geared connection to the crankshaft. This allows conventional single-stage operation for relatively low altitudes when the auxiliary supercharger does not turn.

When the auxiliary supercharger is to be engaged at the "Low Ratio" (6.43:1) or at the "High Ratio" (8.48:1) hydraulic accelerators automatically speed up the impeller to nearly the correct R.P.M. Friction clutches then engage and positively lock the impeller to whichever gear train is selected. The timing and synchronization of the accelerators and friction clutches are automatically and hydraulically controlled by a dash pot and oil valve system so that the pilot has no control over the time of engagement.

The air induction system is so arranged that when the auxiliary supercharger is not turning, air normally enters the engine through lightly loaded Main Stage inlet valves which are installed in the intercooler air duct system. However, if sufficiently high pressure cannot be maintained at the carburetor, the auxiliary supercharger stage gate valves ahead of the auxiliary supercharger will open to supply more air through the inactive auxiliary supercharger. This operation is controlled by an automatic servo mechanism powered by oil pressure.

When the auxiliary supercharger is turning,

the automatic regulation of the auxiliary stage gate valves controls the output of the auxiliary supercharger by accurately throttling its inlet to maintain a constant carburetor air pressure of 29" Hg. absolute.

Complete control of the manifold pressure must be maintained by operating the throttle manually in the conventional manner. However, when the auxiliary supercharger is engaged, the manifold pressure is limited to 46.5" Hg.

It is recommended that during the first preliminary engine run-up and after each overhaul three additional oil pressure gages (0 to 200 lbs.) be used to check the operation of the auxiliary supercharger accelerator and the low and high speed clutches. These gages will immediately indicate whether or not the controls are properly adjusted and if the auxiliary supercharger drive mechanism is functioning satisfactorily.

Since the carburetor is practically non-icing and is automatically compensated for air pressure and temperature, regulation of the carburetor air temperature is not necessary unless icing is suspected. The spring-loaded valve in the airscoop before the auxiliary supercharger is intended to suck open in the event that the airscoop becomes clogged with ice. Considerable carburetor air temperature rise is available by engaging the auxiliary supercharger either in low or high blower ratio due to the heat of the compressed air.

If there is the slightest indication of carburetor icing, immediately engage the auxiliary supercharger. The same procedure should be used in shifting as described on page 32. The power

out-put with the auxiliary stage engaged shall not exceed the rating for that combination of superchargers (1050 BHP)

To Change from Neutral to Low Auxiliary Stage, use the following procedure in the sequence given:

1. Mixture control in Automatic Rich
2. Partially close the throttle to avoid excessive pressure after the auxiliary supercharger is engaged. The amount of closing will be determined by experience and operating conditions.
3. Move blower control rapidly from the Neutral to the Low Position and lock.
4. Readjust throttle setting if manifold pressure is not at the desired value.
5. Readjust RPM setting as specified in the chart on page 41.
6. Set the mixture control to position indicated in the chart on page 41.
7. Attention is invited to the fact that serious overspeeding may result if this shift is made when operating at or near rated RPM. In this case, the engine speed should be reduced prior to shifting.

To Change from Low Auxiliary to High Auxiliary Stage, use the above Procedure.

To Change from Low Auxiliary to Neutral, use the following procedure in the sequence given:

1. Set mixture control in Automatic Rich
2. Move the blower control rapidly from the Low Auxiliary position to the Neutral position and lock.
3. Adjust throttle to obtain desired manifold pressure.
4. Readjust RPM setting as specified on the chart on page 41.
5. Readjust mixture control to position indicated in the chart on page 41.

To Change from High Auxiliary to Low Auxiliary use the same procedure as for changing from Low Auxiliary to Neutral.

(c) Mixture Control

The mixture selector control on the Stromberg Carburetor PD-12E-2 has four positions: "Full Rich", "Automatic Rich", "Automatic Lean" and "Idle Cut-Off". These four positions are plainly marked on the throttle and mixture control quadrant.

All ground and flight operations should be conducted with the "Automatic Rich" mixture setting except that "Automatic Lean" may be used for cruising in level flight in either blower ratio at or below 70% rated power.

"Full Rich" position is for emergency use only in the event of failure of the automatic features. See Engine Operating Chart on page 41 for positions to be used for various flight conditions

For Idle Fuel Cut-Off, place manual mixture lever in aft position (red sector)

(d) Propeller

This airplane is equipped with a Curtiss Electric Constant Speed 9'-9" diameter 3 bladed propeller equipped with shank cuffs.

The basic settings are 21.2° low pitch and 45° high pitch.

Automatic Control

To Increase R.P.M.

1.	Main Propeller Switch	On
2.	Automatic - Manual Switch	On Automatic
3.	Propeller Governor Control	Push In

To Decrease R.P.M.

1.	Main Propeller Switch	On
2.	Automatic - Manual Switch	On Automatic
3.	Propeller Governor Control	Pull Out

NOTE: Vernier Control by turning Control Handle. Turn Clockwise to increase engine revolutions

Manual Control

To Increase R.P.M.

1	Main Propeller Switch	On
2.	Automatic - Manual Switch	On "Inc."
3.	Automatic - Manual Switch	On Manual

To Decrease R.P.M.

1.	Main Switch On	On
2.	Automatic - Manual Switch	On "Dec"
3.	Automatic - Manual Switch	On Manual

NOTES: Hold Manual Switch "On" only momentarily, until desired R.P.M. is attained as indicated on tachometer.

Propeller Governor Control

When increasing power, set the desired R.P.M. first with the governor and then adjust the

throttle to obtain the desired manifold pressure.

When decreasing the power, set the desired manifold pressure first with the throttle control, then set the propeller control to the desired RPM. Reset the throttle if necessary.

When in the automatic position RPM's are governed entirely by the operation of the push-pull control knob on the instrument panel. Engine revolutions are increased by pushing the knob in and reduced by pulling it out. Once so selected, the RPM will remain constant under all conditions within the operating limits of the Governor.

If, however, the Selector Switch is moved out of the Automatic position and into the Manual position, the propeller will function at "fixed pitch", unaffected by movement of the control knob. For a given manifold pressure, revolutions can then be adjusted by holding the switch in either the "Increase RPM", or the "Decrease RPM" gate until the desired RPM is obtained. Immediately upon release, the switch will automatically return to the Manual position, and the propeller will again function at "fixed pitch".

If the Safety Switch is opened by an overload, the propeller will operate at "fixed pitch", and at the pitch-angle in effect at the moment the switch opened, - until the Switch is reset to full "ON".

CAUTION: Always move the push-pull control knob slowly, as a slight movement will cause a great change in engine RPM.

Cruising in fixed pitch is desirable as a drop in RPM will give immediate indication of any malfunctioning

of engine. However, always shift to "Automatic" before commencing any maneuver where any considerable power change may be required.

(e) Starter

The cartridge starter is a Breeze Type II unit. The cartridge breech is located on the right hand side of the engine mount structure and is accessible from outside the airplane thru the right hand landing gear wheel well. The electric firing toggle switch is located on the electrical distribution panel.

Under normal conditions use Type "C" cartridge for starting, however, Type "D" cartridge may be used in cold weather or under other conditions when type "C" is inadequate.

(f) Starting Engine

With the ignition switch "OFF" rotate the engine four or five revolutions by hand. If the engine has stood idle for one hour or more, it may be necessary to remove a spark plug from each of the lower cylinders so that accumulated oil may be expelled.

When cold, the engine should be primed with the separate hand priming pump. Do not over prime; a short stroke is sufficient for a warm engine; four strokes are usually sufficient for cold starts in warm weather, more being required in cold weather.

Before starting, the mixture control should be placed in the "Idle Cut-off" position. This will normally prevent flooding of the carburetor when the emergency fuel pump is switched on; but,

in order to insure against leakage of fuel past the cut-off valve, it is advisable to delay switching on the emergency pump until immediately before firing the starter cartridge.

However, it is permissible to operate the emergency fuel pump briefly prior to the priming operation until normal fuel pressure is registered. Shut off during actual priming operation.

When the engine fires on the priming charge, the mixture control should be moved immediately, but not rapidly, into the "Auto-Rich" position. In cold weather it may be necessary to keep the engine running for a short time with the primer before shifting the mixture control.

If the engine fails to pick up on the carburetor, the mixture control should be returned to the "Idle Cut-Off" position and the emergency fuel pump switched "OFF" until the next starting attempt is made.

Starting Check-Off

1.	Ignition Switch	Off
2.	Mixture Control	Idle Cut-Off (Full Aft)
3.	Rotate Engine	Over 4 or 5 Revs.
4.	Throttle	Set 1/10 Open
5.	Auxiliary Blower	Neutral
6.	Cowl Flaps	Open
7.	Propeller Master Switch	On
8.	Propeller Selector Switch	Automatic
9.	Propeller Control	Automatic 2700 RPM
10	Prime (If necessary)	4 strokes approx
11.	Battery ~~& Generator~~ Switch~~es~~	On
12	Ignition Switch	On - Both
13	Emergency Electric Fuel Pump Switch	On
14.	Starter Switch	On to Fire Cartridge
15.	Mixture Control	Advance to "Auto-Rich" as Engine Fires. If engine fails to continue running, return to "Idle Cut-Off" and switch off Emergency Fuel Pump.
16	Idle	At 800 RPM or less for 30 secs. until oil pressure registers.
17.	Warm-Up	1000 RPM until oil inlet temperature reaches 60°C Desired. 25°C Min. for Normal Take-Off. 15°C Minimum for Emergency Take-Off.

If the oil pressure gage does not indicate pressure within 1/2 min., the engine should be stopped and an investigation made.

NOTE: In cold weather, if excessive oil pressures are obtained when the speed is increased to 1000 RPM, the engine should be operated at 800 RPM until the oil pressure drops below 100 p.s.i.

To prevent damage to the oil pressure gage, avoid high oil pressure when engine is still cold, by holding down RPM.

Refer to Tech. Order No. 21-39 and Tech. Note No. 8-39 for general operating instructions regarding the cartridge starter installation.

(g) Engine Ground Test

In warming up, the engine shall be run at 1000 to 1200 RPM and there shall be a positive indication on the gage that oil pressure is being maintained in the engine. The oil inlet temperature shall be brought up to at least 40°C before take-off. This temperature will be reached fairly rapidly, due to the action of the automatic oil temperature control located at the bottom of the oil tank.

Oil pressure will vary with RPM and need cause no alarm by falling as low as 25 p.s.i. with the engine idling.

Ground Test Check-Off

1.	Cowl Flaps	Open
2.	Propeller Control	Automatic 2700 RPM
3.	Auxiliary Blower	Neutral
4.	Mixture Control	Automatic Rich
5.	Manifold Pressure	30" Hg. Max.
6.	Maximum Head Temp	205°C.
7.	Oil Inlet Temp	54°C. - 95°C Desired 25°C Min. for take-off
8.	Oil Pressure	85 to 105 p.s.i. at 2000 RPM at 60°C. oil inlet
9.	Fuel Pressure	14 to 16 p.s.i.

ENGINE OPERATING TABLE

ENGINE MODEL: R-1830-76 & -86 CARBURETOR: PD-12E-2 PROPELLER: Curtiss Electric

Operating Conditions	Altitude Feet	Max. Permissible	Max. Abs. Man. Press. In. Hg.	Prop. Set.	Carb. Set.	Auxiliary Blower Setting	Max. Cyl. Head Temp. °C/(°F.)	Oil in Temp. Desired °C/(°F.)
Starting	S. L.	1200*	- -	Auto. Low Pitch	Idle Cut-Off	Neutral	- -	- -
Take-Off****	S. L.	2700	46.5	Auto.	Auto. Rich	Neutral	260 (500)	Min. 25/(80)
Climb-Normal Rated Power	SL-2500 4700-12000 13900-19000	2550 2550 2550	43.6-43.4 (FT) 45.0-45.0 (FT) 45.4-45.4 (FT)	Auto.	Auto. Rich	Neutral Low High	232*** (450)	54/(130) to 95/(203)
Cruising Power Climb, 70% Rated Power	SL-9600 11200-16900 18100-23700	2270* 2270 2270	34.6-31.6 (FT) 34.0-33.4 (FT) 33.0-32.8 (FT)	Auto.	Auto. Rich	Neutral Low High	232 (450)	54/(130) to 95/(203)
Cruising 70% Rated Power	SL-9600 11200-16900 18100-23700	2270*	34.6-31.6 (FT) 34.0-33.4 (FT) 33.0-32.8 (FT)	Auto.or Manual	Auto. Lean	Neutral Low High	232 (450)	54/(130) to 95/(203)
Normal Rated Power Level Flight	SL-2500 4700-12000 13900-19000	2550 2550 2550	43.6-43.4 (FT) 45.0-45.0 (FT) 45.4-45.4 (FT)	Auto.	Auto. Rich	Neutral Low High	232*** (450)	54/(130) to 95/(203)
Landing	- -	2550**	- -	Auto. **	Auto. Rich	Neutral	232 (450)	54/(130) to 95/203)
Stopping	- -	1000	- -	Low Pitch	Idle Cut-Off	Neutral	140 (284)	54/(130) to 95/(203)

* Maximum Recommended RPM

** See T.O. Nos. 9-40 & 16-41

*** 260 C. (500 F.) is permissible for one-hour operation.

**** See (g) Take-Off Note

Oil Pressure: 85-105 lbs/sq. in. for all operating conditions but idling when 25 lbs/sq. in. is the minimum.

Fuel Pressure: 14-16 lbs/sq. in. at carburetor entrance relative to the scoop pressure.

(h) Take-Off

Mixture control in the "Automatic Rich" position.

Auxiliary Supercharger - Neutral

Propeller governor controls in "Take-Off" or "Automatic" 2700 RPM position.

During take-off the manifold pressure must be controlled manually with the throttle, 46.5" Hg. should not be exceeded. At 2700 RPM this corresponds to 1200 BHP at sea level.

NOTE: EMERGENCY TAKE-OFF

In order to improve the take-off performance, emergency take-off may be made utilizing 2900 RPM and 48" Hg. (abs.) manifold pressure. These limits are maximum permissible and shall be used only as long as is necessary for take off but in no event in excess of one (1) minute for any one take-off.

The take-off run in a 25 knot wind will be about twenty (20) feet shorter than with the standard take-off limits

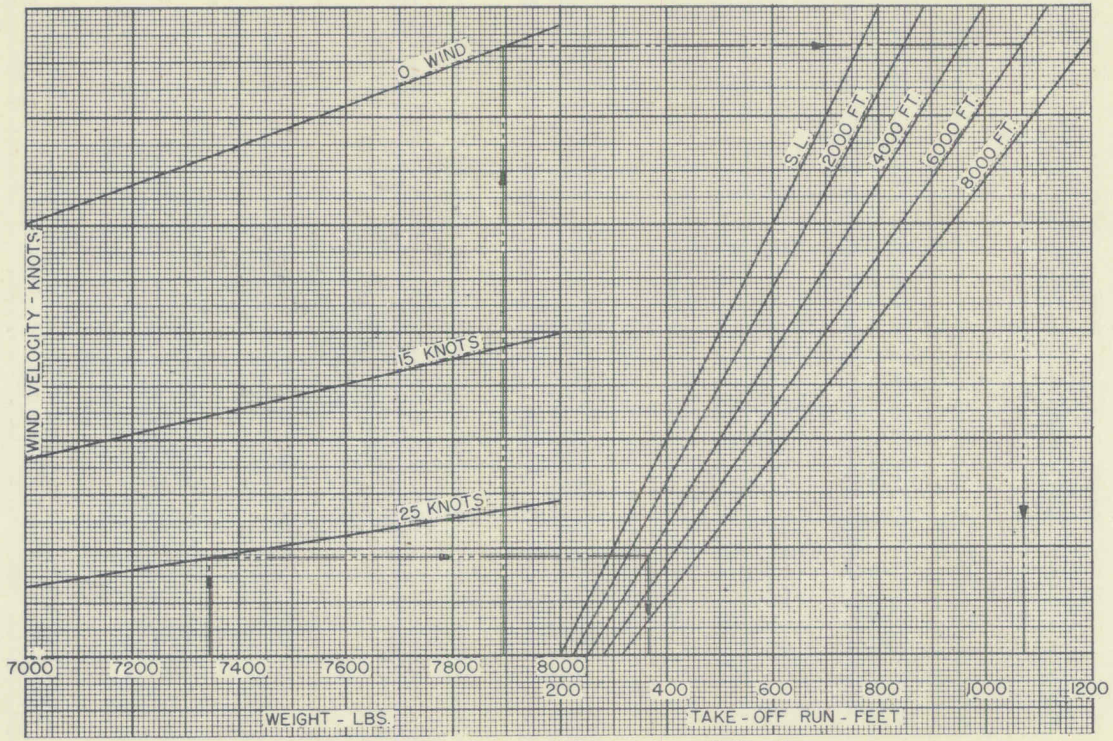
Propeller Operation Check

With the electrically controlled propeller, the electric power supply for "Automatic" control of the pitch of the propeller by the governor is essential to safe take-off. Pilots should form the habit of glancing at the ammeter while checking the cockpit controls before taking off. The ammeter indicates the amount of electrical power being supplied to the system by the generator. If it does not indicate flow of current, the following action must be taken:

1. Manually change propeller pitch to best universal position for flight and landing. Do not throw propeller switch to "Automatic".

2. If the ammeter does not indicate a flow of current during the time the propeller pitch is being changed, the generator is dead, and all electric power switches controlling devices not essential to safety must be turned off. The reserve power in the battery is all that is available for use.

3. Try to get the generator in action by manually working the generator cut-out. If this fails to make the ammeter indicate a positive flow of current: (a) Use radio sparingly. (b) Turn battery switch "Off" as much as possible consistant with safe operation; but turn "On" at intervals to take readings, use radio, adjust propeller pitch and etc. Turn battery "On" before landing so all devices on the airplane will function normally.



TAKE-OFF S.L. - 8000 FT. - F4F-4

FIG. 5

(i) Normal Rated Power Climb & High Speed Level Flight

Maximum continuous engine RPM is 2550.

Normal High Speed Check-Off

1. Cowl Flaps	As required
2. Prop. Control	2550 Automatic
3. Aux. Blower	Maintain 43" Hg. Manifold Pressure
4. Mixture Control	Automatic Rich
5. Manifold Pressure	See Operating Chart on page 41.
6. Max. Cylinder Head Temp.	232°C for con't. 260°C for 1 hour duration.

The auxiliary blower shall be controlled as follows:

Normal Climb & Normal High Speed

Auxiliary stage, "Neutral"	0 to 4700'
Auxiliary stage, "Low"	4700 to 13900'
Auxiliary stage, "High"	13900 & up

The maximum permissible manifold pressures for various altitudes are shown on the Maximum Permissible Operating Conditions Curve. The note on that curve sheet reads, "Carburetor ram will increase somewhat the altitudes at which limiting manifold pressures are obtained". In other words the shifts from Neutral to Low Auxiliary Stage and from Low Auxiliary Stage to High Auxiliary Stage should be made at slightly greater altitudes than those given on the curve sheet, the actual difference in altitudes will be determined by experience.

(j) Cruising

On the Altitude Manifold Pressure Percent Rated Power Curves is a line labeled "Maximum Recommended Cruising Limits." Cruising may be done at any engine power below Normal Rated Power, but this line represents approximately the minimum specific fuel consumption, and it is therefore desirable from the fuel consumption standpoint to conduct cruising as near this line as operations will permit. Attention is invited to the fact that while minimum specific fuel consumption is obtained while operating near this line, maximum range is not necessarily obtained there. The conditions giving maximum range must be determined by experience. For mixture control settings, blower-control positions, etc. see Operation Chart on page 41.

CRUISING POWER CHART

RPM, MANIFOLD PRESSURE, AND ALTITUDES FOR 60% & 70% NORMAL RATED POWER

	70% Power	60% Power
Neutral ..	770 BHP	660 BHP
Low	735 BHP	630 BHP
High	700 BHP	600 BHP

Altitude	RPM	M.P.	RPM	M.P.
S.L.	2270	34.5	2150	31.5
2000	2270	34.0	2150	31.0
4000	2270	33.5	2150	30.0
6000	2270	33.0	2150	29.5
8000	2270	32.0	2150	28.5
10000	2270	F.T.	2150	28.0
	Shift to Low Aux. at 11400 Ft.		Shift to Low Aux.	
12000	2270	34.0	at 13800'	27.0
14000	2270	34.0	2150	30.5
16000	2270	F.T.	2150	30.0
	Shift to High Aux. at 16300 ft.			
18000	2270	33.0	2150	30.0
			Shift to High Aux.	
20000	2270	33.0	at 19600'	29.5
22000	2270	33.0	2150	29.5
24000	2270	F.T.	2150	29.0
26000	2270		2150	F.T.

(k) Stopping Engine

In stopping, the engine shall be allowed to turn over at 800 to 1000 RPM for a few minutes, especially if after flying at full throttle, to allow the engine to cool down. Then the mixture lever shall be pulled back to Idle Cut-Off position. Afterwards shut off the fuel valve and turn off the ignition switch ~~and also the generator~~ and battery switch~~es~~.

Stopping Engine Check-Off

1. Cowl Flaps	Open
2. Prop. Control	2700 RPM Auto.
3. Auxiliary Blower	Neutral
4. Idle Short Time	1000 RPM Max.
5. Stop	Place mixture control in "Idle Cut-Off"
6. Ignition Switch	Off
7. ~~Generator~~ Battery Switch~~es~~	Off

NOTE: Refer to Technical Order No. 14-42 Operating Instructions for Oil Dilution Systems.

(l) Cylinder Head Temperatures

The maximum allowable head temperatures are:

Take-Off and Max. Climb 5 mins. duration	260°C. (500°F)
Max. for 1 hour duration	260°C. (500°F)
Normal Power continuous or below	232°C. (450°F)
Cruising	232°C. (450°F)
Ground Operation	205°C. (401°F)
Maximum Permissible Base Temperatures	168°C. (335°F)

(m) Normal Instrument Readings

Typical Cruising

The following instrument readings were taken on a cruising flight at 7000 ft. altitude:

	Maximum	Economical
Propeller	Gov.	Man.
R.P.M.	2550	2200
Manifold Pressure	44" Hg. (F T)	30" Hg.
Cyl. Head Temperature	185°C.	180°C.
Outside Air Temp.	-4°C.	-4°C.
Fuel Pressure	15 p.s.i.	15 p.s.i.
Mixture	Auto Rich	Auto Lean
Oil Pressure	95 p.s.i.	95 p.s.i.
Oil Temperature	67°C.	67°C.
Airspeed	224 Knots	192 Knots
Elevator Tab Setting	D-1	D-.8
Rudder Tab Setting	R-.75	R-1
Aileron Tab Setting	Rwd-3	Rwd-2
Blower	Low	Neutral

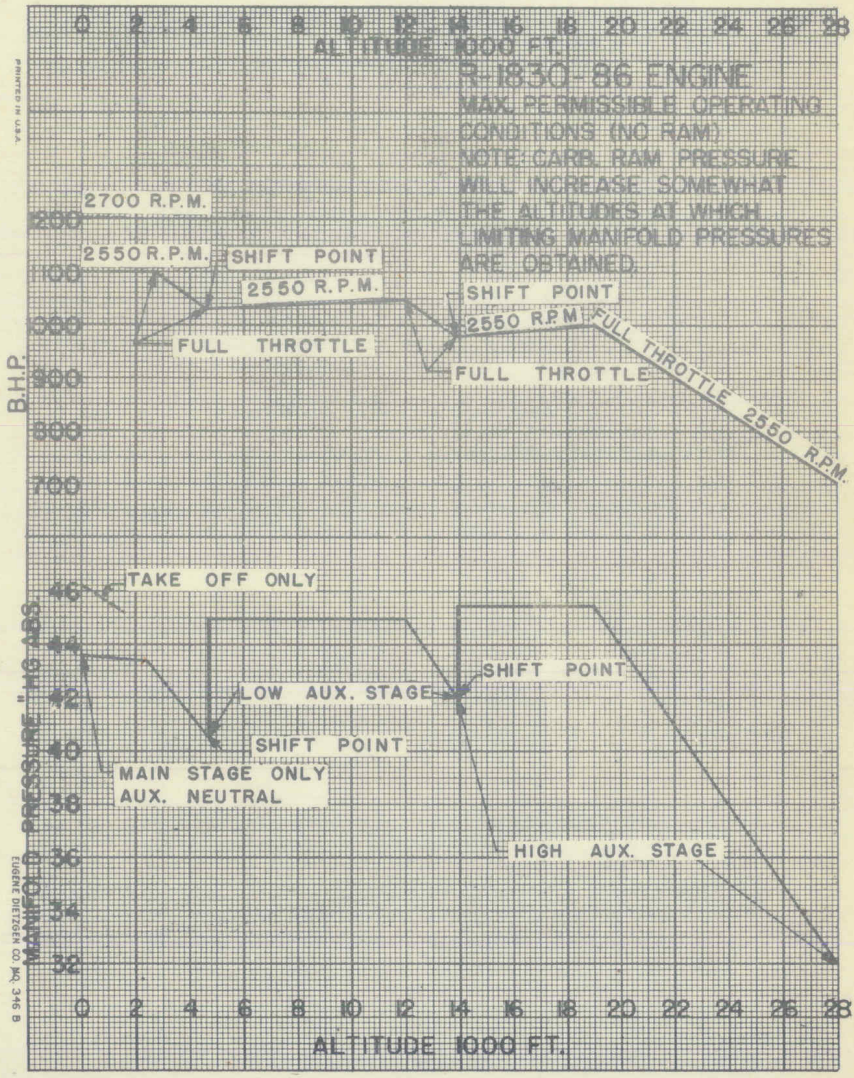

R-1830-86 ENGINE
MAX. PERMISSIBLE OPERATING CONDITIONS (NO RAM)
NOTE: CARB. RAM PRESSURE WILL INCREASE SOMEWHAT THE ALTITUDES AT WHICH LIMITING MANIFOLD PRESSURES ARE OBTAINED.
ALTITUDE 1000 FT.
B.H.P.
MANIFOLD PRESSURE "HG ABS.
2700 R.P.M.
2550 R.P.M.
SHIFT POINT
2550 R.P.M.
FULL THROTTLE
SHIFT POINT
2550 R.P.M.
FULL THROTTLE
FULL THROTTLE 2550 R.P.M.
TAKE OFF ONLY
LOW AUX. STAGE
SHIFT POINT
SHIFT POINT
MAIN STAGE ONLY
AUX. NEUTRAL
HIGH AUX. STAGE
EUGENE DIETZGEN CO. NO. 346 B
PRINTED IN U.S.A.

FIG. 7

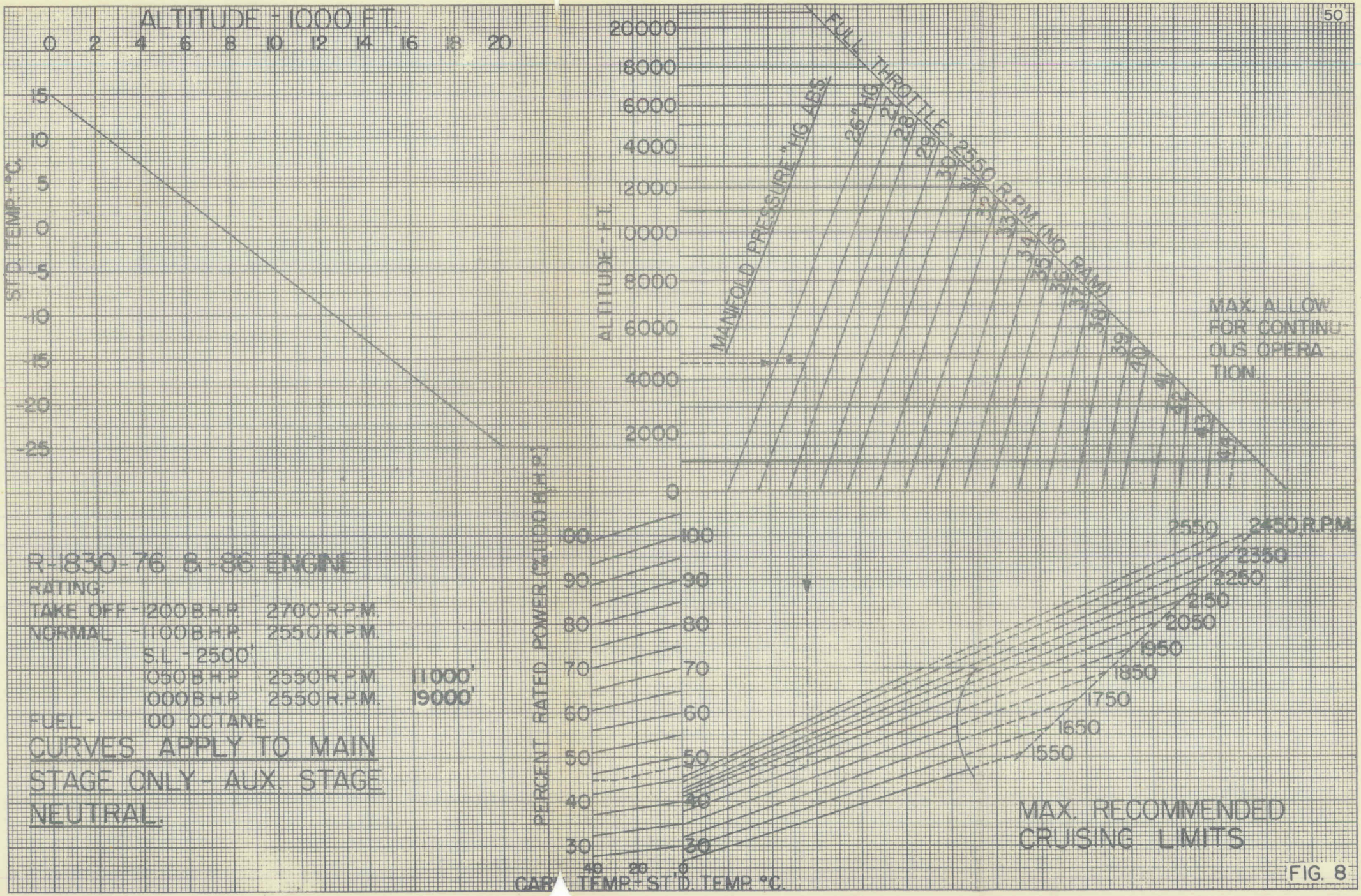

ALTITUDE - 1000 FT.
0 2 4 6 8 10 12 14 16 18 20
15 10 5 0 -5 -10 -15 -20 -25
ST'D. TEMP. - °C.
R-1830-76 & -86 ENGINE
RATING:
TAKE OFF - 1200 B.H.P. 2700 R.P.M.
NORMAL - 1100 B.H.P. 2550 R.P.M.
S.L. - 2500'
1050 B.H.P. 2550 R.P.M. 11000'
1000 B.H.P. 2550 R.P.M. 19000'
FUEL - 100 OCTANE
CURVES APPLY TO MAIN STAGE ONLY - AUX. STAGE NEUTRAL.
PERCENT RATED POWER (%1100 B.H.P.)
ALTITUDE - FT.
20000 18000 16000 14000 12000 10000 8000 6000 4000 2000 0
100 90 80 70 60 50 40 30
40 20 0
CARB. TEMP. - ST'D. TEMP. °C.
FULL THROTTLE
MANIFOLD PRESSURE - "HG. ABS.
25" 26" 27" 28" 29" 30" 31" 32" 33" 34" 35" 36" 37" 38" 39" 40" 41" 42" 43" 44" 45" 46" 47" 48"
2550 R.P.M. AND BELOW
MAX. ALLOW. FOR CONTINUOUS OPERATION.
2550 2450 R.P.M.
2350 2250 2150 2050 1950 1850 1750 1650 1550
MAX. RECOMMENDED CRUISING LIMITS

FIG. 8

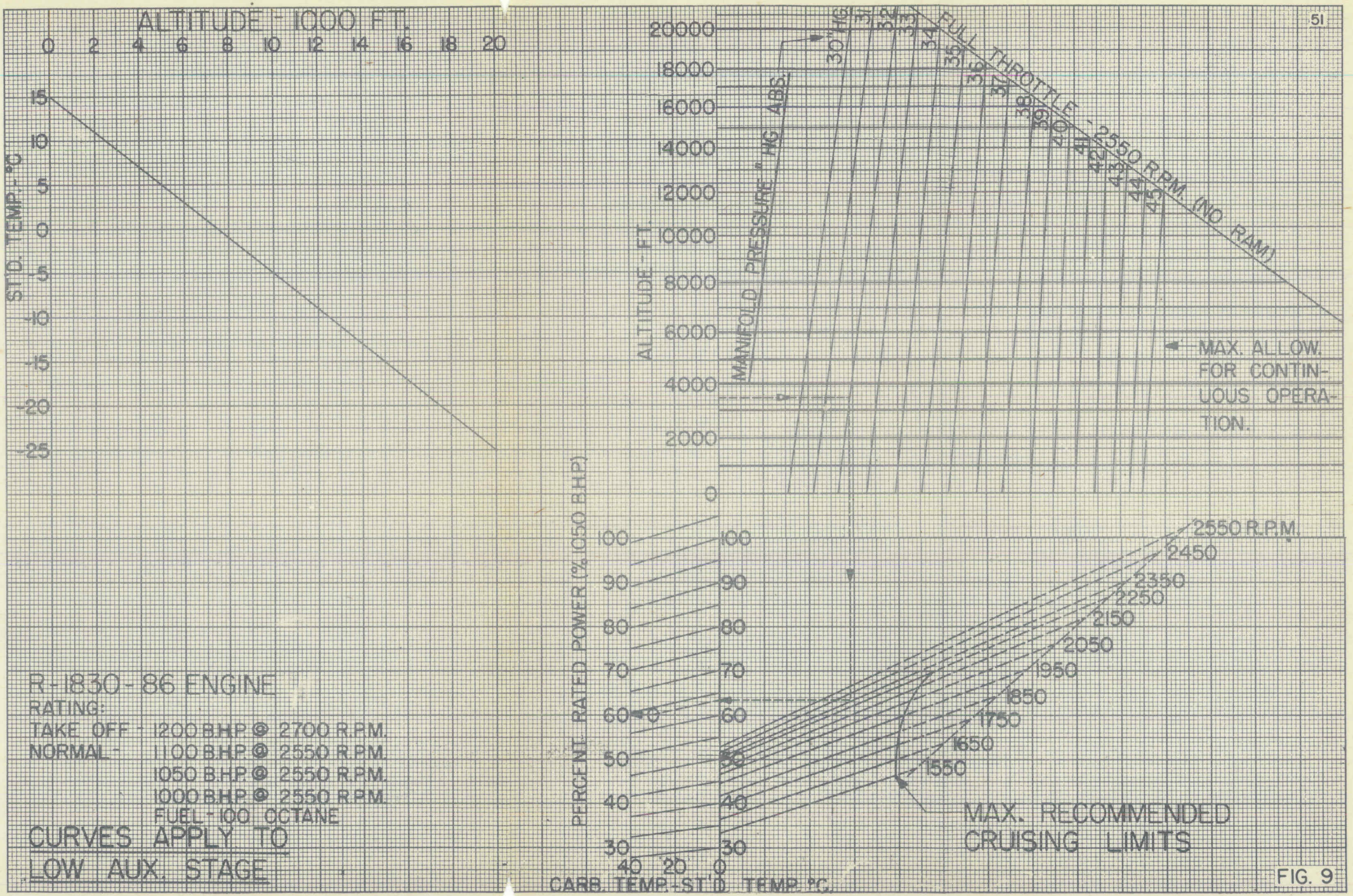

ALTITUDE - 1000 FT.
0 2 4 6 8 10 12 14 16 18 20
15 10 5 0 -5 -10 -15 -20 -25
STD. TEMP. - °C
20000 18000 16000 14000 12000 10000 8000 6000 4000 2000 0
ALTITUDE - FT.
MANIFOLD PRESSURE - INS. ABS.
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
FULL THROTTLE
2550 R.P.M. (NO RAM)
MAX. ALLOW. FOR CONTINUOUS OPERATION.
PERCENT. RATED POWER (% 1050 B.H.P.)
100 90 80 70 60 50 40 30
40 20 0
CARB. TEMP. - ST'D TEMP. °C.
2550 R.P.M.
2450
2350
2250
2150
2050
1950
1850
1750
1650
1550
MAX. RECOMMENDED CRUISING LIMITS
R-1830-86 ENGINE
RATING:
TAKE OFF - 1200 B.H.P. @ 2700 R.P.M.
NORMAL - 1100 B.H.P. @ 2550 R.P.M.
1050 B.H.P. @ 2550 R.P.M.
1000 B.H.P. @ 2550 R.P.M.
FUEL - 100 OCTANE
CURVES APPLY TO LOW AUX. STAGE

FIG. 9

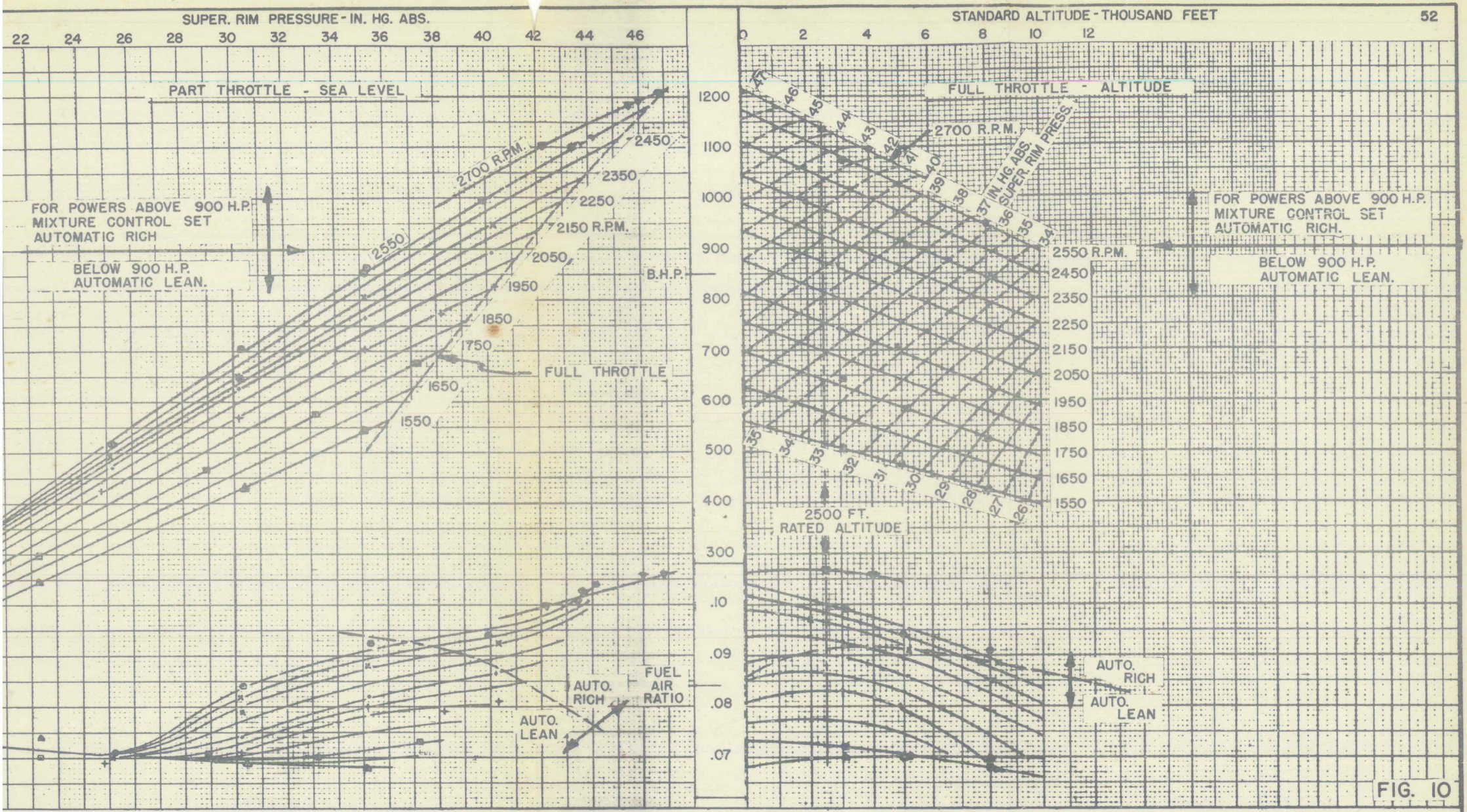


FIG. 10

ATIOS - COMP. - 6.7:1 IMPELLER - 8.08:1 MAIN PROP. - 3:2
ARB. - PD12E2
PARK - ADV. 25° BOTH PLUGS - AERO. LSIAC, BENDIX 656
IPELLER DIAM. - MAIN - 9 1/2 IN.
L - 1100
UEL - 100 OCTANE

	SEA LEVEL	ALTITUDE
TEST DATE	8-15, 16, 19-40	8-15, 16, 19-40
AV. ROOM BAR. - IN. HG.	29.9	29.9
AV. CARB. AIR TEMP. °F.	60	STD. ALT.
AV. OIL INLET TEMP. °F.	165	165
AV. COOL AIR TEMP. °F.	90	90

TEST EQUIPMENT - NO. 9 DYNA. + FLYWHEEL

NEUTRAL, AUX. STAGE
S.L. & ALTITUDE CHARACTERISTICS
P. & W. XR-1830-76 ENGINE (-86)
ENGINE - BU. NO. 4321 MFG. NO. 2115
AERONAUTICAL ENGINE LAB.
NAVAL AIRCRAFT FACTORY, PHILA., PA.
PROJ. 3498 ENG'R. G. L. SANWALD

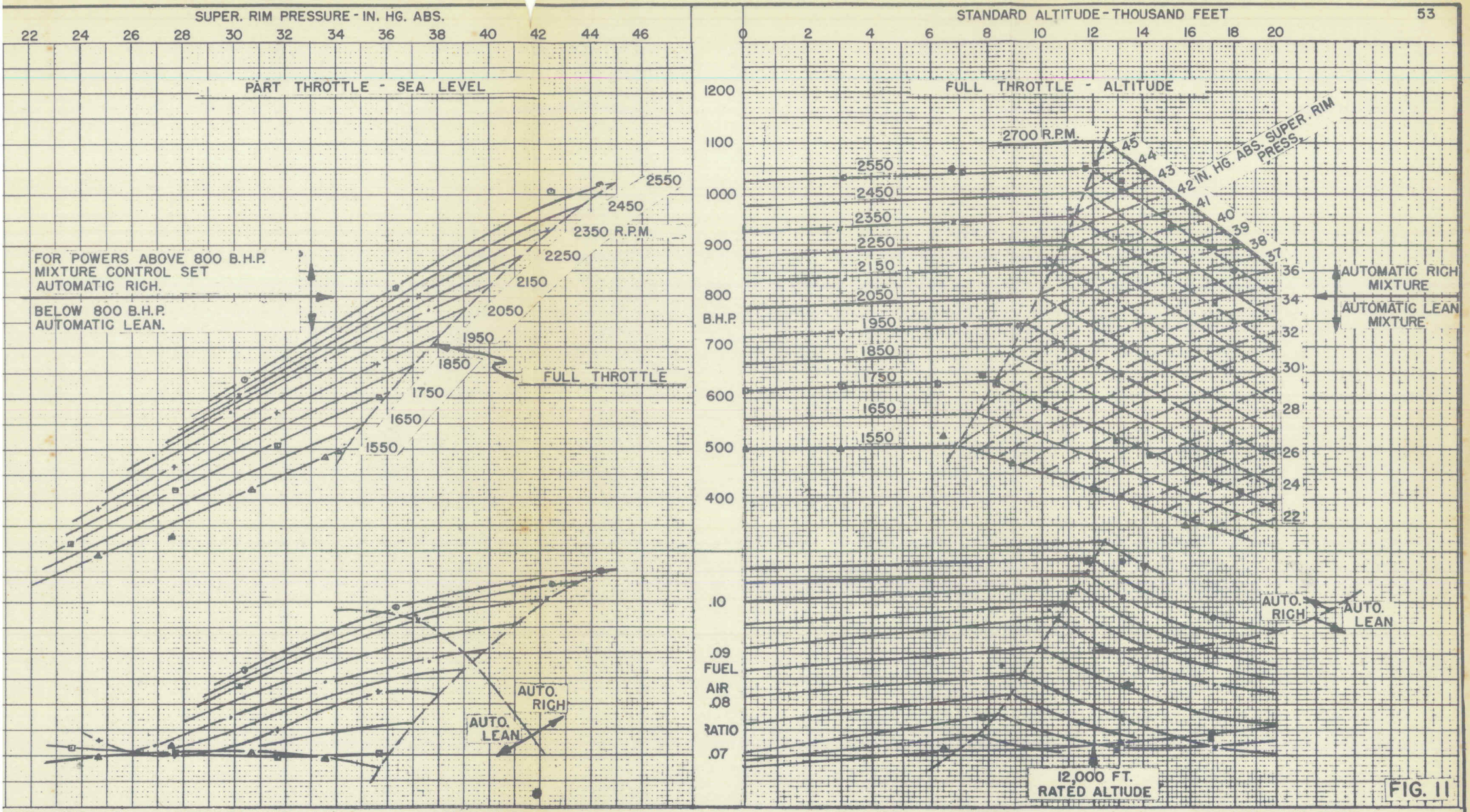


FIG. 11

TIOS - COMP. - 6.7:1 IMPELLER - 6.43:1 AUX. LO. PROP. - 3:2
RB. - PD12E2 - 8.08:1 MAIN OIL - 1100
ARK - ADV. 25° BOTH PLUGS - AERO. LSIAC, BENDIX 656 FUEL - 100 OCTANE
PELLER DIAM. - MAIN - 9.5 IN., AUX. - 11.0 IN.
RSEPOWER DATA OBTAINED 6-4,5-40 USING
12E2 CARBURETOR ALSO SHOWN.

	SEA LEVEL	ALTITUDE
TEST DATE	8-17,19-40	8-15-40
AV. ROOM BAR. - IN. HG.	29.8	30.02
AV. CARB. AIR TEMP. °F.	89	90
AV. OIL INLET TEMP. °F.	166	165
AV. COOL AIR TEMP. °F.	97	90

TEST EQUIPMENT - NO. 9 DYNA. + FLYWHEEL

LOW RATIO, AUX. STAGE
S.L. & ALTITUDE CHARACTERISTICS
P. & W. XR-1830-76 ENGINE (86)
ENGINE - BU. NO. 4321 MFG. NO. 2115
AERONAUTICAL ENGINE LAB.
NAVAL AIRCRAFT FACTORY, PHILA., PA.
PROJ. - 3498 ENG'R. - G. L. SANWALD

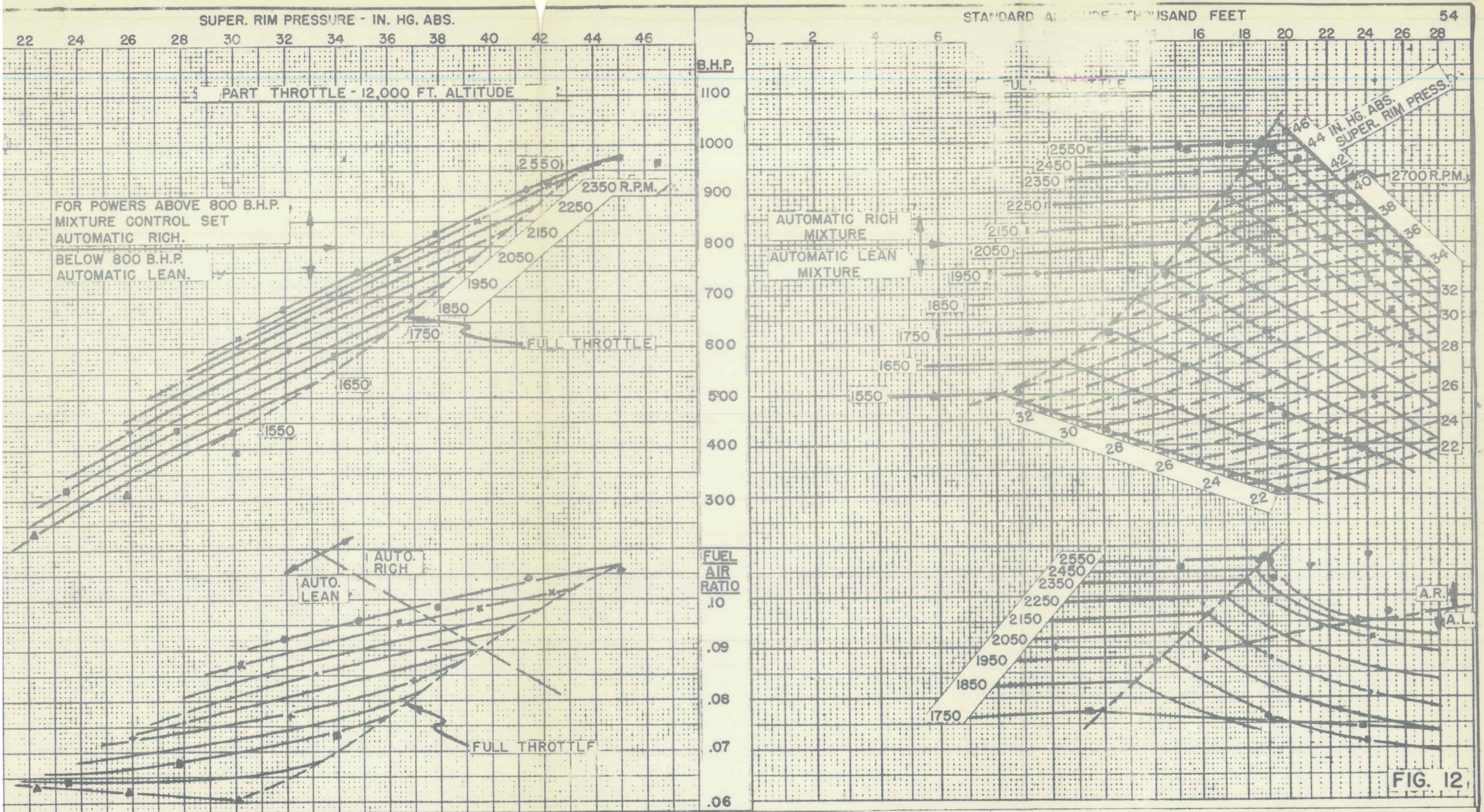


FIG. 12

ATIOS - COMP. - 6.7:1 IMPELLER - 8.48:1 AUX. HI. PROP. - 3:2
ARB. - PD12E2 - 8.08:1 MAIN OIL - 1100
PARK - ADV. 25° BOTH PLUGS - AERO. LSIAC, BENDIX 656 FUEL - 100 OCTANE
MPELLER DIAM. - MAIN - 9.5 IN., AUX. - 11.0 IN.

IORSEPOWER DATA OBTAINED 6-4,5,20-40
ISING PD12E2 CARBURETOR ALSO SHOWN.

	PART THROTTLE	FULL THROT.
TEST DATE	6-10,17-40	8-14,15-40
AV. ROOM BAR. - IN. HG.	29.98	29.84
AV. CARB. AIR TEMP. °F.	90	92
AV. OIL INLET TEMP. °F.	165	164
AV. COOL AIR TEMP. °F.	[illegible]	90
TEST EQUIPMENT - NO [illegible]		[illegible] + FLYWHEEL

HIGH RATIO, AUX. STAGE
ALTITUDE CHARACTERISTICS
P. & W. R-1830-76 ENGINE (-86)
ENGINE - BU. NO. 4321 MFG. NO. 2115
AERONAUTICAL ENGINE LAB.
NAVAL AIRCRAFT FACTORY, PHILA., PA.
PROJ. - 3498 ENG'R. - G. L. SANWALD

(n) Fuel System

The normal fuel load is carried in two (2) tanks, the main, located below the cockpit in the fuselage and the reserve, on the aft side of the pilot's bulkhead. Both tanks are equipped with internal self-sealing liners. Each wing stub is equipped with provision for the installation of a 50 gallon droppable tank.

Tank Capacity

Tank	Normal	Overload
Main	83 gals.	117 gals.
Emergency	27 gals.	27 gals.
Total	110 gals.	144 gals.

The fuel valve has five (5) positions: Main, Emergency, Left Droppable, Right Droppable and Off.

The electric fuel quantity gage indicates the fuel quantity in both main and emergency tanks.

The emergency electric fuel pump is used for building up initial fuel pressure for starting the engine and for insuring a proper fuel flow at high altitudes.

Pressurized Tank

This airplane is equipped with a Stromberg Fuel Tank Pressurizing device. The emergency shut-off valve for this device is controlled by a push-pull handle located on the floor just to the left of the pilot's seat.

Refer to Navy Technical Order #5-40, Operation of Pressurized Fuel Systems, and #55-41, Fuel Tanks Protection against gunfire.

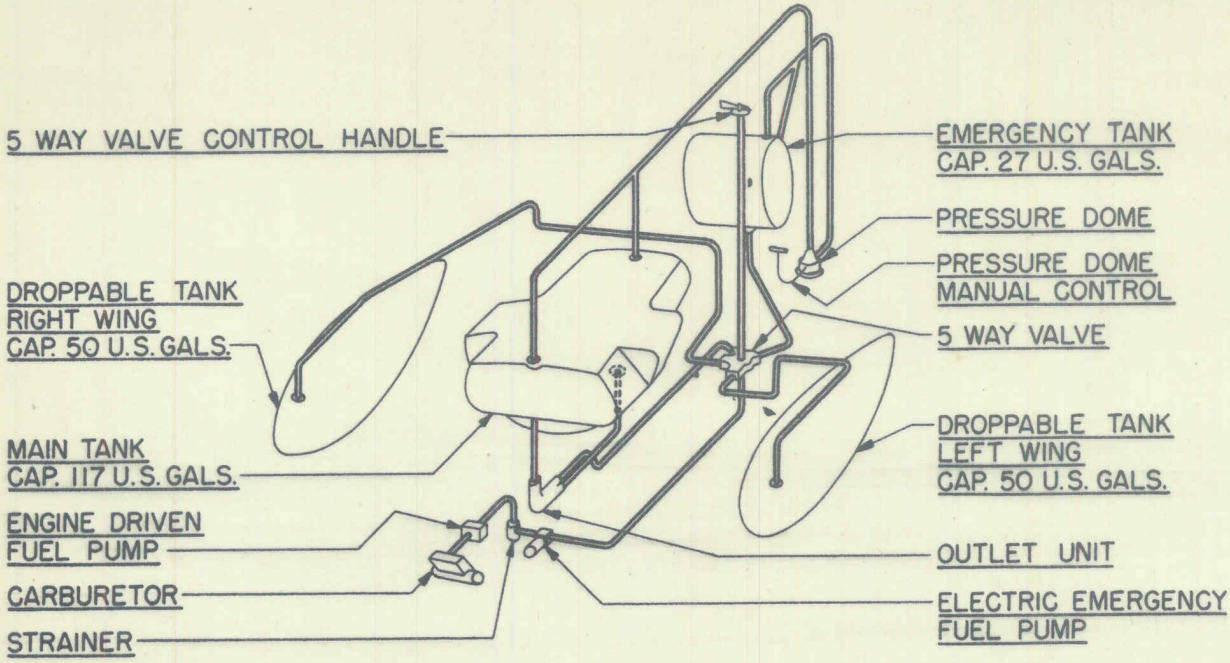
NOTE: The fuel gage is calibrated to indicate the amount of fuel in the tanks when the self-sealing liners are installed.

If the airplane is flown without the liners, the gage readings will be inaccurate. The following conversion tables show the true amounts of fuel in the tanks for this condition.

Emergency Tank (No liner)	
Gage Reading	True
5	6
10	11.5
15	16
20	21
25	27
Full	30

Main Tank (No liner)	
Gage Reading	True
5	6
10	9.5
20	19
44	40
60	55
80	73
100	94
110	107
Full	115

When the tank without liner is full, the pointer will go beyond the full mark on the dial.



FUEL SYSTEM DIAGRAM

FIG. 13

(o) Oil System

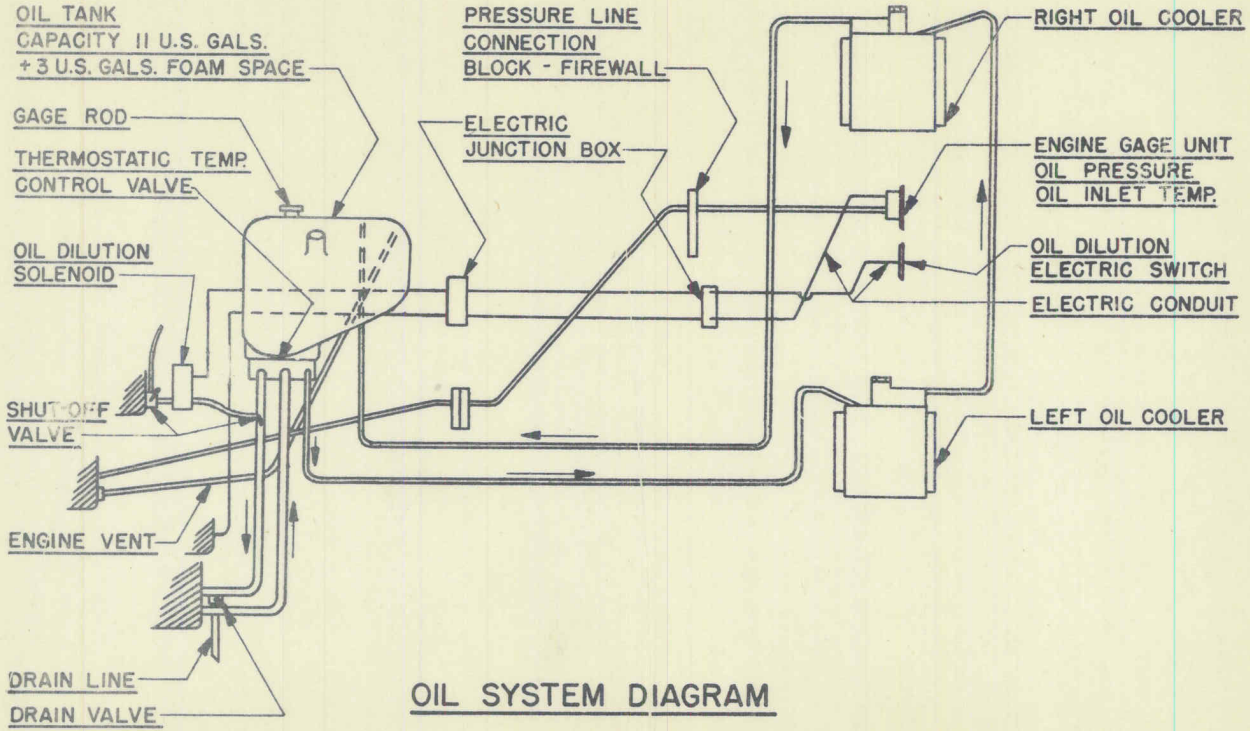
The oil is carried in a single tank. The capacity is 11 gallons of oil plus 3 gallons foaming space.

The system incorporates an automatic oil temperature control and check valve attached to the bottom of the oil tank, which in conjunction with the oil coolers, maintains the oil-in temperature at approximately 65°C. (150°F.) to 75°C. (170°F.). The control valve causes the oil to by-pass the cooler when the oil-in temperature is below approximately 65°C. (150°F.), directing the outlet oil from the engine back to the bottom of the oil tank in close proximity to the suction outlet. Consequently, the tank supply of oil is virtually by-passed when starting the engine until the oil-in temperature reaches approximately 65°C. (150°F.). The check valve unit prevents flow of oil into the engine from the tank back through the oil-out line from the engine to the control valve when the engine is not in operation.

Temperatures	Desired	54 to 95°C. (130 to 203°F.)
Pressure	Desired	85 to 105 p.s.i.
	Cruising Min.	65 p.s.i.
	Idling Min.	25 p.s.i.

The system incorporates two 10 inch diameter oil coolers, one in each wing panel just outboard of the fuselage. They are piped in series.

There are by-pass valves in each of the oil coolers.



OIL SYSTEM DIAGRAM

FIG. 14

III
FLYING CHARACTERISTICS

(a) Balance

This airplane is designed to operate as a fighter or a light bomber and will balance satisfactorily in all conditions of useful load without the use of ballast.

The amount of elevator tab available will be found sufficient to maintain perfect trim in flight and to permit getting the tail down when landing in any of the loading conditions.

The center of gravity locations (wheels up) for the various conditions are as follows:

Combat Condition	Gross Weight	Rounds of Ammunition	Fuel	C.G. % M A C
Fighter Normal 4 guns	7345#	200/gun	110 (83+27)	28.37
Fighter Overload 6 guns	7896#	240/gun	144 (117+27)	29.51
Bomber Normal 2 guns 2 100# bombs	7338#	200/gun	110 (83+27)	27.86
Fighter Less Fuel & Ammun. 4 guns	6445#	- - -	- - -	25.30

Combat Condition	Gross Weight	Rounds of Ammunition	Fuel	C.G. % M.A.C.
Fighter Less Fuel & Ammun. 6 guns	6600#	- - -	- -	25.47
Bomber Less Fuel & Ammun. 2 guns	6438#	- - -	- -	24.57

For a complete weights breakdown refer to the Erection and Maintenance Instructions for this airplane.

(b) Maneuvers

The following maneuvers were performed with the airplane (normal fighter load):

Vertical Bank (R. & L.)
Loop
Aileron Roll (R. & L.)
Snap Roll (R. & L.)
Immelman Turn
Normal Stall (without power)

Correct Indicated Stalls

Power used for "Power On" conditions is minimum necessary to keep plane in level flight in prescribed condition.

Following are for clean wing no guns installed:

Power on, dirty	51 kts. indicated
Power off, dirty	58 kts indicated
Power on, clean	63 kts. indicated
Power off, clean	67.5 kts. indicated

Following are for four (4) guns installed ready to fire:

Power on, dirty	51 kts indicated
Power off, dirty	60 kts indicated
Power on, clean	63 kts. indicated
Power off, clean	69 kts indicated

(c) Diving

Diving with pull-outs at required velocities and accelerations has been successfully demonstrated by the manufacturer of this airplane.

The theoretical terminal velocity of the airplane is approximately 475 knots indicated air speed. It is not expected that this speed will be reached in service dives. Propeller at 45° pitch.

The maximum allowable engine speed in dives is 3050 RPM.

Before diving the airplane, the following items shall be checked.

1. Set Propeller	2100 RPM "Automatic"*
2. Blower	In Neutral
3. Cowl Flaps	Closed
4. Mixture	Automatic Rich
5. Elev. Tab	1-1/4 Nose Down
6. Lock Cabin	Full Open
7. After entering into Dive	Adjust throttle in accordance with Tech. Note #23-40

* Aut 14-206 (f) - Bureau of Aeronautics Manual directs that propeller be placed in positive high pitch prior to entering dives. However, if the procedure outlined above proves satisfactory in service (i.e., effectively prevents overspeeding) there is no objection to its use. Most severe propeller control problem occurs when propeller is in "Automatic" and push over is made with closed throttle. If "Automatic" is used considerable power should be used during dive entry after which throttle may be set according to TN-25-40

ANGLE OF DIVE VS ANGLE OF ATTACK

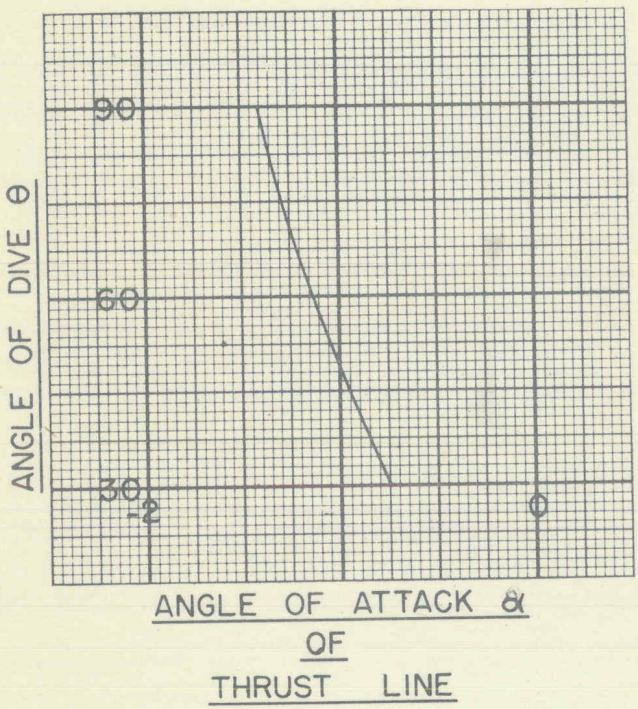


FIG. 15

(d) Spinning

Normal Spins

10 turns to left - Recovery 1/2 turns
10 turns to right - Recovery 1-7/8 turns

Ten turn spins both to right and to left were made, after a thorough preliminary investigation of the spinning characteristics of the airplane in spins of varying numbers of turns from 1-1/2 -2, up to 10. The following procedure was used by the pilot in the spin test:

1. Throttle was closed in all spins - no tendency for engine to quit. No power was applied at any time during spin or recovery.

2. Stick held full back and rudder full over during spins. Recovery was effected by abrupt reversal of rudder, followed by full forward movement of stick. It is estimated that a force of approximately 40-50# is required to obtain full forward stick position.

3. No aileron movement used either in spin or recovery.

4. Recovery - (1) from left hand spin recovery was almost immediate, (2) from right hand spin, recovery was slower but positive - the pilot reporting that the character of the spin started changing immediately upon application of recovery procedure - the nose dropping and speed of rotation increasing for about 1 turn before recovery.

5. The indicated airspeed was approximately 160 knots during the spins.

Inverted Spins

Inverted spins, both to the right and left, were made.

The following procedure was used by the pilot:

After stalling the airplane in the inverted position, the stick was held full forward and rudder hard over for the duration of the spin. Recovery was effected by abrupt reversal of rudder followed by a backward movement of the stick. No aileron movement was used in either right or left spins. Two turn spins were made with recovery in 1/4 to 1/2 turn after reversal of controls.

Spinning Tendencies

In accordance with Change No. 1 of SR-38B, the tendency of the plane to spin with landing gear and flaps extended was investigated. With landing gear and flaps extended, the airplane can be stalled by adjusting the elevator tab to the full tail heavy position and applying a rearward force of approx 10-15 pounds on the stick Stall is evidenced by a definite dropping of the nose and the left wing. The airplane recovers immediately upon release of the stick. The tendency of the airplane to spin is, therefore, immediately counteracted by a forward movement of the control stick.

(e) Take-Off with Full Flaps, 6 wing guns, Gross Weight 7921 lbs.

Take-Off Run in a 25 knot wind	297 ft.
Take-Off Run in no wind	686 ft.

A reduction of approximately 25% in length of run results from the application of full flap. This airplane is equipped with vacuum operated flaps which permit only one setting but are self regulating at higher air speeds. See pages 23 and 43.

(f) Glide & Landing

For the pilots not familiar with this model plane, it is recommended that a gliding speed of 90 mph be maintained. With practice the gliding speed will probably be reduced by each pilot. There is very little tendency to "overshoot" because the high drag from the flaps gives the ship a steep gliding angle and practically eliminates any tendency to "float". Attention is called to the fact that the top cowling slopes upward and forward about 4 degrees when in a 3-point landing attitude, hence during a normal glide with flaps down the airplane appears to be diving slightly. This attitude should be maintained until within a few feet of the ground, as speed is lost quickly when the nose is brought up.

(g) Check-Off Lists

TAKE-OFF

1. Cowl Flaps	Open
2. Propeller	2700 RPM
3. Aux. Blower, S.L. to 5000 ft.	Neutral
4. Mixture Control	Automatic Rich
5. Manifold Pressure	46.5" Hg.
6. Elevator Tab	Neutral
7. Rudder Tab	2-1/2°R
8. Tail Wheel Caster	Locked
9. Cockpit Hood	Locked Full Open

FLIGHT-CRUISING

1. Wheels	Retracted
2. Cowl Flaps	Closed
3. Propeller - "Automatic"	Pages 45 and 46
4. Aux. Blower	Page 41
5. Mixture Control	Automatic Rich
70% power or less	Automatic Lean
6. Manifold Pressure	Page 41
7. Cylinder Head Temp.(Cont)	232°C Max.
8. Oil Pressure	65 to 105 p.s.i.
9. Oil In Temperature	65 to 75°C
10. Fuel Pressure	15 p.s.i.

LANDING

1. Wheels	Down
2. Tail Wheel Caster	Locked
3. Cockpit Hood	Locked Full Open
4. Wing Flaps	Down
5. Cowl Flaps	Open
6. Propeller "Automatic"	2550 see T.O. #9-40
7. Auxiliary Blower	Neutral
8. Mixture Control	Automatic Rich