RESTRICTED

PRELIMINARY

PILOT'S HANDBOOK

MODEL F6F-3 AIRPLANE

CONTRACT No. 90071

ENGINE No. R-2800-10

HELLCAT

RELEASED BY THE BUREAU OF AERONAUTICS NAVY DEPARTMENT

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

BETHPAGE, L. I., N. Y.

REVISED 7/28/43

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FOREWORD

The Pilot's 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.

The airplane is a Class VF single engine, single place, folding low wing fighter designed to take off from the deck of an aircraft carrier and land either in an arresting gear or on land. It is equipped for catapulting from a carrier deck.

The engine is a Pratt & Whitney Twin Row R-2800-10, geared 2:1, 18 cylinder, two stage radial; take-off rating, 2000 BHP at 2700 RPM at sea level.

The wings are folded and spread manually, and locked in the spread position by hydraulically operated locking pins controlled from the pilot's cockpit. The wing flaps, of the low drag type, are hydraulically operated.

The landing gear and tail wheel are extended and retracted hydraulically.

There are two main self-sealing fuel cells suspended in hammocks located in the wing center section; each has a maximum capacity of 87.5 gallons. The reserve self-sealing fuel cell,

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installed beneath the pilot's cockpit, has a maximum capacity of 75 gallons, and the droppable tank 150 gallons. The oil tank has a capacity of 19 gallons with a 3 gallon foaming space and ½ gallon sump.

Armor plate is installed forward of the oil tank, on the firewall and on the bulkhead immediately aft of the pilot's seat. There is an auxiliary bullet proof windshield.

Armament installation includes provision for six (6) .50 calibre machine guns, three (3) in each outer wing panel.

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SECTION I

COCKPIT ARRANGEMENT

AND

CONTROLS

The arrangement of the cockpit and the locations of the various controls and instruments are shown on the accompanying photographs.

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

1. FLYING CONTROLS

Ailerons & Elevators

Standard type stick.

Rudder

Standard underhung pedals.

Rudder Pedal Adjustment

Adjustable to four (4) positions by a toe lever on each outer pedal arm.

With toes on adjustment levers, push lower pedals all the way FORWARD, then with toes under lower pedals bring AFT one notch at a time until desired position is attained. Check that each pedal has ratcheted past the same number of notches.

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Brake Control

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

Tab Control Unit

Tab Controls for the Aileron, Elevators and Rudder are installed on the Tab Control Unit located on the left hand side of the cockpit.

Aileron Trimming Tab

The Aileron Trimming Tab is located on the Left wing only. Control is effected by the handwheel on the forward side of the Tab Control Unit.

ROTATE OUTBOARD - LEFT WING DOWN

Elevator Trimming Tabs

Control is effected by the handwheel on the inboard side of the Tab Control Unit.

ROTATE CLOCKWISE - NOSE DOWN

Rudder Trimming Tab

Control is effected by the handwheel on the top of the Tab Control Unit.

CLOCKWISE - NOSE RIGHT

2. WING FLAPS SYSTEM

The Wing Flaps, of the low drag type, are actuated by four hydraulic cylinders controlled from the pilot's cockpit. Two cylinders are installed in each wing, one inboard and one outboard.

The Flap Hydraulic Control Valve governing the cylinders is operated by an electric servo motor controlled by a Toggle Switch on the left hand shelf, to RAISE or LOWER the flaps during NORMAL OPERATION. If electric power fails, the Flaps are controlled by the Wing Flap Manual Control Lever located on the lower left hand side of the cockpit. If the normal hydraulic system fails, the Flaps are controlled by the auxiliary hydraulic system, i.e., the Hydraulic Hand Pump to the right of the pilot's seat and the Hydraulic Selector Valve on the right hand cockpit shelf.

Four spring units, one connected to each Flap, arranged to allow the flaps to "blow up" with increasing airspeed, automatically control the flap angle in flight when the flap linkage is all the way out, i.e., when the flaps are down. This feature is not controllable from the cockpit and is entirely independent of the hydraulic cylinders.

The range of flap angle is 48° at 93 knots airspeed down to 15° at 150 knots airspeed.

NOTE: The four flaps are not interconnected mechanically but are arranged to extend and retract together by means of restrictors in the hydraulic lines leading to each flap operating cylinder. It is possible that during the first few flights on a new or overhauled airplane dirt may lodge in any one of these restrictors.

and hence prevent one of the flaps from extending or retracting. It is, therefore, advisable to check the proper operation of all flaps before take-off and to lower them in the air at a safe speed and altitude.

Electric Switch

The Wing Flaps Electric Control Switch is located on the left hand shelf.

To Lower the Flaps, throw the Control Switch to the DOWN position (AFT). To Raise, throw the switch to the UP position (FORWARD).

If the Wing Flaps fail to operate electrically, push the circuit breaker reset button to restore power.

Automatic Unit

The flaps will not come down at speeds in excess of 170 Knots, even though the Electric Control Switch is in the FLAPS DOWN position. An Airspeed Switch, located in the engine compartment, is connected in parallel with the airspeed indicator. The Airspeed Switch will automatically retract the flaps when the airspeed exceeds 170 Knots. If the Flap Switch is left on the FLAPS DOWN position, this switch will extend the flaps again when the airspeed drops below 170 Knots.

Manual Controls - Hydraulic

Auxiliary

In the event of electric power failure, the Flaps are Raised or Lowered by the spring loaded lever located on the lower left hand side of the cockpit.

PUSH DOWN & FORWARD ——————— FLAPS UP
PUSH DOWN & AFT ——————— FLAPS DOWN
CENTER ——————— NEUTRAL

CAUTION: THIS CONTROL SHALL BE OPERATED ONLY IN CASE OF ELECTRIC POWER FAILURE. USE THE ELECTRIC SWITCH ON THE LEFT HAND SHELF WHEN THE ELECTRIC POWER IS RESTORED.

WARNING: IT IS IMPORTANT TO PRESS THE RED HANDLE DOWN TO DISCONNECT MOTOR THEN MOVE RED HANDLE FORWARD OR AFT. IF THIS RED HANDLE IS FORCED WITHOUT FIRST PRESSING IT DOWN, SERIOUS DAMAGE WILL RESULT TO THE ELECTRIC MOTOR SPLINED SHAFT AND THE RUBBER CLUTCH. AFTER OPERATING THE FLAP CONTROL MANUALLY AND ELECTRIC POWER IS RESTORED PUT RED HANDLE IN NEUTRAL POSITION.

NOTE: The above control applies to airplanes serial numbers 04789 and subsequent.

Emergency

In the event the engine driven hydraulic pump is not operating, the wing Flaps are raised or lowered by operating the Hydraulic Hand Pump in conjunction with the Hydraulic Hand Pump Selector Valve located on the right hand shelf. (See Hydraulic System, Pages 26 and 27.)

1. Flap Switch - DOWN or UP as required.

or

2. Lever on Auxiliary Hydraulic Control Valve, left hand side of cockpit - in UP or DOWN position as required, if electric power has also failed.

3. Lever on Hand Pump Selector Valve, right hand cockpit shelf - WING FLAPS.

4. Operate Hydraulic Hand Pump

   Approximately 35 double strokes required to extend.
   Approximately 25 double strokes required to retract.

NOTE: Keep Hand Pump Selector Valve Control on SYSTEM position when not being used.

Wing Flaps Position Indicator

The position of the Wing Flaps is shown on the combination Landing Gear and Flap Indicator on the left hand instrument panel.

3. LANDING GEAR CONTROLS

The airplane is equipped with hydraulically operated Main and Tail Wheels which are retracted or extended by double acting hydraulic cylinders. The operating pressure is normally supplied by the engine driven hydraulic pump or by the hydraulic hand pump for auxiliary operation. An air cylinder supplies pressure for emergency extension of the wheels.

Normal Operation

The Main and Tail Wheels are normally retracted or extended by manual operation of the two position Square Knob Control Lever located on the left hand instrument panel.

This Square Knob Lever is distinct in appearance from any other control, being designed to prevent inadvertent retraction or extension of the Landing Gear by the pilot in flight.

LEVER UP ——————————— WHEELS RETRACTED
LEVER DOWN ——————————— WHEELS EXTENDED

Make certain Landing Gear Control Lever is in fully lowered position before take-off and landing.

CAUTION: THE LANDING GEAR WILL NOT LOWER COMPLETELY AT SPEEDS ABOVE 110 KNOTS, INDICATED AIRSPEED.

Auxiliary Operation

In the event that the engine driven hydraulic pump is not operating, the Main and Tail Wheels may be retracted or extended by operating the

Hydraulic Hand Pump in conjunction with the Hand Pump Selector Valve on the right hand shelf.

Set the Square Knob Control Lever to the desired position, move the Hand Pump Selector Valve Lever to Landing Gear and operate Hand Pump.

Approximately 90 double strokes required to Raise.
Approximately 70 double strokes required to Lower.

NOTE: When lowering by hand pump, considerably less effort will be required if the air-speed is reduced to 100 Knots or less.

Emergency Operation

In the event of complete hydraulic system failure, the Main and Tail Wheels may be fully extended and locked by manual operation of the Landing Gear Emergency Release "T" Handle Control located on the lower center control panel.

The Emergency Landing Gear Extending system consists of the "T" Control Handle, an air bottle, valves and pipe lines.

To EXTEND Main and Tail Wheels, Pull "T" Handle FULL DOWN and LOCK.

When the "T" Handle is pulled, the Up Locks are released, the air system vent valve closes, the air bottle valve opens, and the On-Off (hydraulic dump valve) opens, all functioning simultaneously.

NOTE: To read the L. G. dump bottle air pressure turn valve to open position only long enough to read gage then close. Only a slight hand pressure is required when closing the valve. Bottle pressure 1850 p.s.i.

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THIS SYSTEM WILL OPERATE REGARDLESS OF THE POSITION OF THE SQUARE KNOB CONTROL LEVER.

No other part of the hydraulic system is affected by use of this control. Normal operation of the landing gear hydraulic system is restored when the "T" Handle is returned to its normal position. This should not be done until after landing and reason for hydraulic failure determined.

This operation permits the Main and Tail Wheels to extend and lock in the FULL DOWN position at any airspeed less than 85 Knots indicated.

Time required to Lower - 10 sec. approx.

CAUTION: THE WHEELS CANNOT BE LOWERED MORE THAN ONCE BY THIS CONTROL. THEREFORE, DO NOT OPERATE THIS CONTROL UNTIL SURE THAT HAND PUMP SYSTEM WILL NOT FUNCTION. IF THE EMERGENCY SYSTEM IS OPERATED AT HIGHER AIRSPEEDS THAN IT CAN OVERCOME, THE GEAR WILL COME DOWN PART WAY AND TRAIL. ANY SMALL LEAK IN THE SYSTEM MIGHT THEREFORE DISSIPATE ENOUGH OF THE LIMITED SUPPLY OF AIR WITH THE RESULT THAT THE GEAR WILL NOT EXTEND COMPLETELY. THEREFORE, FLY AS SLOWLY AS POSSIBLE BEFORE OPERATING THIS CONTROL AND HOLD THIS SLOW SPEED UNTIL THE GEAR IS DOWN AND LOCKED.

IF IT IS DESIRED TO MAKE A WHEELS UP LANDING AFTER THE LANDING GEAR HAS BEEN LOWERED BY THE EMERGENCY CONTROL, THE WHEELS MAY BE RETRACTED BY PLACING THE

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EMERGENCY "T" HANDLE CONTROL BACK TO ITS NORMAL POSITION, SQUARE KNOB CONTROL LEVER TO WHEELS UP POSITION, HAND PUMP SELECTOR VALVE TO LANDING GEAR AND OPERATING THE HAND PUMP.

Wheel Lock

The mechanical interconnector, between the Landing Gear Square Knob Control Lever and the nutcracker arm on the left hand shock strut, prevents landing gear retraction on the ground. The control lever cannot be moved into the Retracted position unless the left oleo is Fully Extended which occurs in flight only. (Operation completely automatic).

On the ground, a mechanical lock prevents the drag strut knuckle from breaking under any loading condition. In flight, as the wheels retract, this lock is released during the initial motion of the hydraulic cylinders. The position of this lock is indicated electrically by a microswitch operated by the lock itself connected to the position indicator in the cockpit.

Position of Wheels

The position of the Main and Tail Wheels are shown on the combination flap and landing gear indicator, located on the left hand instrument panel. This indicator, in addition to showing the approximate position of each wheel, also shows whether or not they are locked Up or Down.

Tail Wheel Caster Lock

The tail wheel drag link is equipped with a lock-pin which locks the caster in the trailing position. The lock-pin is controllable by cable from the lock lever located on the pilot's left hand shelf.

LEVER FORWARD - CASTER LOCKED
LEVER AFT - CASTER UNLOCKED

The primary purpose of the lock is to reduce the possibility of ground looping in landing.

Lock the tail wheel immediately after taxiing into position for take-off. The tail wheel will then remain locked during flight and during landing. Unlock after the landing run has been completed in order to facilitate taxiing.

For carrier operation leave the tail wheel caster unlocked.

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

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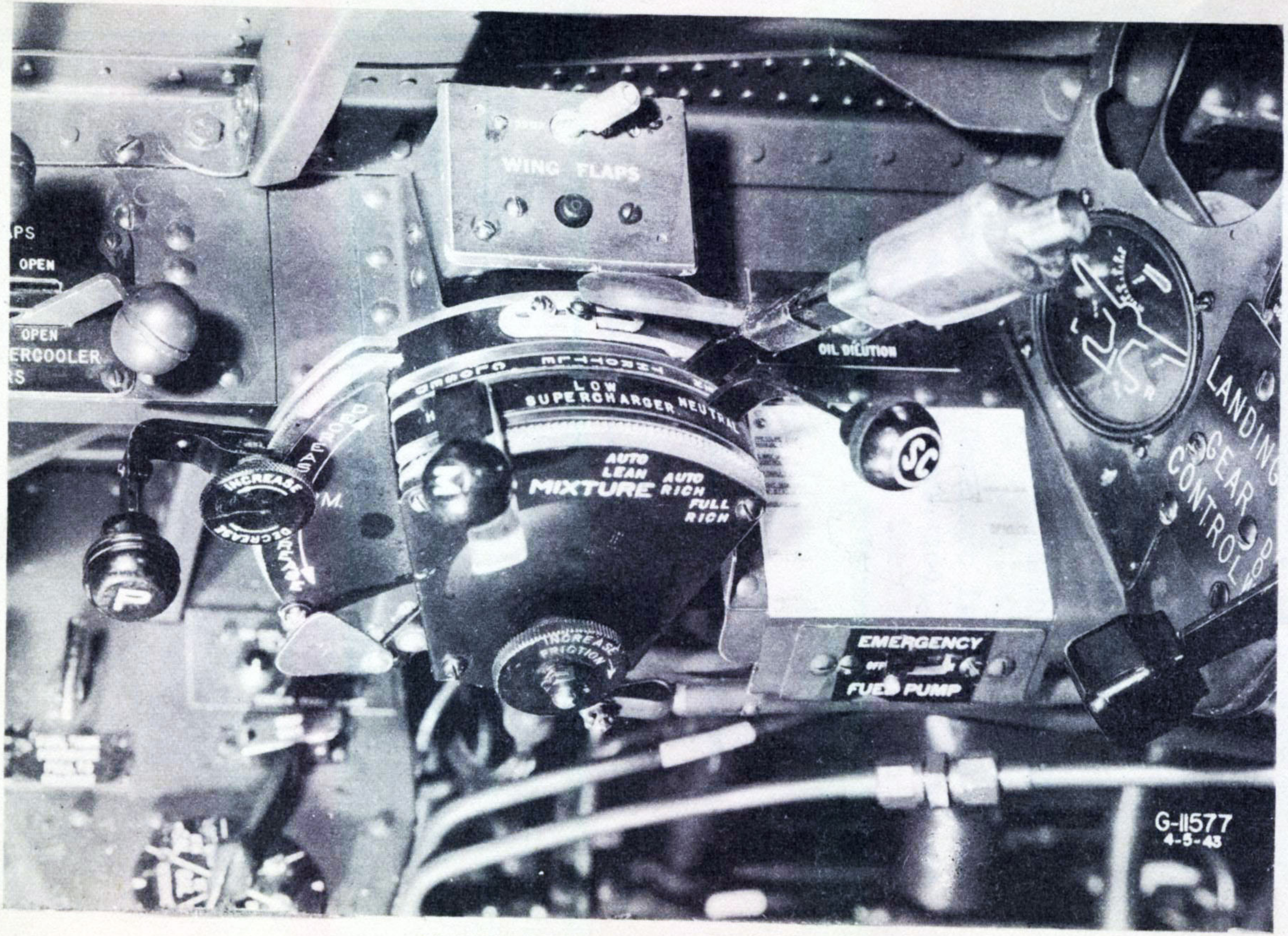

ENGINE CONTROL QUADRANT

4. POWER PLANT CONTROLS

Engine Control Quadrant

The Engine Control Quadrant is located on the left hand shelf, and contains the following controls:

SUPERCHARGER - AUXILIARY
THROTTLE, WITH MICROPHONE SWITCH
MIXTURE
PROPELLER GOVERNOR & VERNIER HANDWHEEL

The Engine Control Quadrant is equipped with a friction adjustment handwheel, located on the inboard side, to adjust the friction on the throttle and propeller governor control levers.

Supercharger Control

Lever located on engine control quadrant

FORWARD ——————— NEUTRAL
CENTER ——————— LOW RATIO
AFT ——————— HIGH RATIO

Throttle

Lever located on engine control quadrant.

LEVER FORWARD - THROTTLE OPEN
LEVER AFT - THROTTLE CLOSED

Propeller Controls

Governor Control

Lever located on engine control quadrant.

LEVER UP - DECREASE RPM (INCREASE PITCH)
LEVER DOWN - INCREASE RPM (DECREASE PITCH)

Vernier Control

Handwheel located on the inboard side of the Governor Control. Rotate for close adjustment.

ROTATE CLOCKWISE - DECREASE RPM (INCREASE PITCH)
ROTATE COUNTER-CLOCKWISE - INCREASE RPM (DECREASE PITCH)

Mixture Control

The four position Mixture Control Lever is located on the engine control quadrant.

FULL FORWARD ——————— FULL RICH
CENTER, FORWARD ——————— AUTOMATIC RICH
CENTER, AFT ——————— AUTOMATIC LEAN
FULL AFT - RED SECTOR — IDLE FUEL CUT-OFF

Fuel Control Panel

The Fuel Control Panel is located on the left hand side of the cockpit and contains the following controls:

PRESSURIZED FUEL SYSTEM MANUAL CUT-OFF
FUEL TANK SELECTOR VALVE
RESERVE TANK WARNING LIGHT & DIMMER
DROPPABLE TANK SWITCH

Pressurized Fuel System Manual Cut-Off

The fuel tanks are equipped with the Stromberg Fuel Pressurizing System. The Manual Shut-Off Valve for this system is controlled by a Push-Pull "T" Handle located on the Fuel Control Panel.

PULL TO RELEASE PRESSURE
PUSH TO RESTORE PRESSURE

NOTE: See Navy T.O. #5-40, Operation of Pressurized Fuel Systems.

See Navy T.O. #55-41, Fuel Tank Protection against gun fire.

Fuel Tank Selector Valve

The five (5) position Selector Dial has the following designations:

OFF
RIGHT MAIN
LEFT MAIN
RESERVE
DROPPABLE

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Reserve Tank Warning Light

The Reserve Fuel Tank integral Warning Light and Dimmer are located on the Fuel Control Panel. When the Reserve Tank contains 50 gallons or less, the light will glow. The Fuel Quantity Gage shall be closely watched and the pilot shall fly at the most economical speed, if possible.

LEAVE LIGHT ON BRIGHT - ROTATE LAMP TO DIM

Droppable Tank Switch

The spring loaded switch is located on the left hand side of the cockpit at Sta. #29-1/8.

TO RELEASE DROPPABLE TANK - FLICK SWITCH ON

If the switch fails to function, push the circuit breaker reset button on the electrical distribution panel to restore power.

Auxiliary Electric Fuel Pump

Control switch on forward side of left hand shelf.

SWITCH AFT - OFF
SWITCH FORWARD - ON

Use this pump to build up initial fuel pressure for starting the engine, to maintain fuel pressure at altitude, during critical periods of fuel system operation such as take-off, landing and when changing tanks, for emergency in the event of failure of the engine driven fuel pump.

NOTE: Auxiliary electric fuel pump MUST be ON during ALL flight operations.

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Starter and Primer Switches

The Starter and Primer Switches are located on the top of the Electrical Distribution Panel. Both switches may be operated by one hand. They are momentary spring loaded switches, and need only be released to turn OFF.

Ignition Switch

The Ignition Switch is located on the left hand instrument panel.

Cowl Flaps Control

The spring loaded three position Cowl Flap Hydraulic Control Lever is located on the left hand shelf.

LEVER FORWARD - FLAPS OPEN
LEVER CENTER - NEUTRAL
LEVER AFT - FLAPS CLOSED

Intercooler & Oil Cooler Shutters Control

Two position Hydraulic Valve Control Knob located on the left hand shelf.

LEVER AFT - SHUTTERS CLOSED
LEVER FORWARD - SHUTTERS OPEN

Auxiliary Operation

Cowl Flaps
Intercooler & Oil Cooler Shutters

These units can be operated by the Hydraulic Hand Pump in conjunction with the Hand Pump Selector Valve when the engine driven hydraulic pump is not operating. (See Hydraulic Sysyem, Pages 26-27.)

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Oil Dilution Valve Control

The Oil Dilution Switch is a spring loaded switch located on the left hand shelf, forward of the engine control quadrant.

FOR OIL DILUTION - Hold switch ON

NOTE: See Page 79 for Operating Instructions for Oil Dilution System.

Protected Air Control (Auxiliary Stage)

Two position "T" Handle control is located on the left hand instrument panel.

FULL FORWARD - DIRECT (NORMAL)
FULL AFT - PROTECT AIR (AUXILIARY STAGE)

CAUTION: NEVER USE AN INTERMEDIATE POSITION FOR THIS CONTROL.

NOTE: When sand or dust conditions are encountered, for PROTECTED AIR pull control FULL AFT. For operation of this control under icing conditions, see Section II, Protected Air Control.

Revised 7/28/43

5. HYDRAULIC SYSTEM

This airplane is equipped with a Hydraulic System for the operation of the following units:

Wing Flaps - Auxiliary Operation
Landing Gear - Main and Tail Wheels
Cowl Flaps
Intercoolers and Oil Cooler Shutters
Wing Locking Pins
Gun Charging

Normal Operation

The Hydraulic System is normally operated by the engine driven hydraulic pump, and its various functions are governed by hydraulic selector control valves.

The normal hydraulic system operating pressure is 1500 p.s.i., and the normal pump pressure is zero except when operating some circuit (1500 p.s.i.). The system pressure gage is located on the right hand shelf.

Auxiliary Operation

The Hydraulic Hand Pump is located on the cockpit floor to the right of the pilot's seat. Use this pump to operate the system if the engine driven pump is not functioning.

Hand Pump Selector Valve

When the Hydraulic Hand Pump is used, the Hydraulic Hand Pump Selector Valve Control must first be turned to the desired position marked on the adjacent nameplates. This control is located on the right hand

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cockpit shelf. When this selector valve is moved, the system pressure gage indicates the pressure in the particular hydraulic circuit selected. Thus, if the valve is kept on SYSTEM, the system gage will indicate malfunctioning of the engine pump if pressure falls below 1200 p.s.i. Also a malfunctioning of any circuit may be found by watching this gage while moving the selector from point to point. The positions of the lever for the operation of the various controls are as follows:

SYSTEM
WING FLAPS ONLY
LANDING GEAR ONLY
GUN CHARGING, WING LOCK, ENGINE FLAPS

When this control lever is not being used to operate one of the above hydraulic units, keep it on the SYSTEM position.

NOTE: In the event of Hydraulic System failure, due to an opening in a line or unit, each individual system can be checked with the Hydraulic Hand pump. Approximately three strokes are sufficient to determine whether or not pressure can be built up in that system. When the leak is located, the pilot shall then refrain from using the damaged system in order to retain the hydraulic fluid for operation of the other units.

The Hydraulic reservoir capacity is 1.6 gals.

Use fluid, Navy Specification M-339 (red color)

Revised 1/12/43

6. ELECTRICAL SYSTEM

The Electrical System includes Generator, Battery, Switches, Rheostats, Circuit Breakers and Lights controlled mainly from the electrical distribution panel and switch box.

The following units operate electrically:

WING FLAPS VALVE
ARRESTING HOOK
PRIMER
AUXILIARY ELECTRIC FUEL PUMP
LIGHTS
COCKPIT HEATER
PITOT TUBE HEATER
GUN SELECTOR & SAFETY SWITCHES
GUN TRIGGER SWITCH
GUN CAMERA
GUN SIGHT
GUN HEATING (AUTOMATIC)

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Revised 1/28/43

Generator & Battery

The Generator normally supplies the current for the Electrical System, and is the sole source of power for normal operation of the electrical units, after the Engine has started.

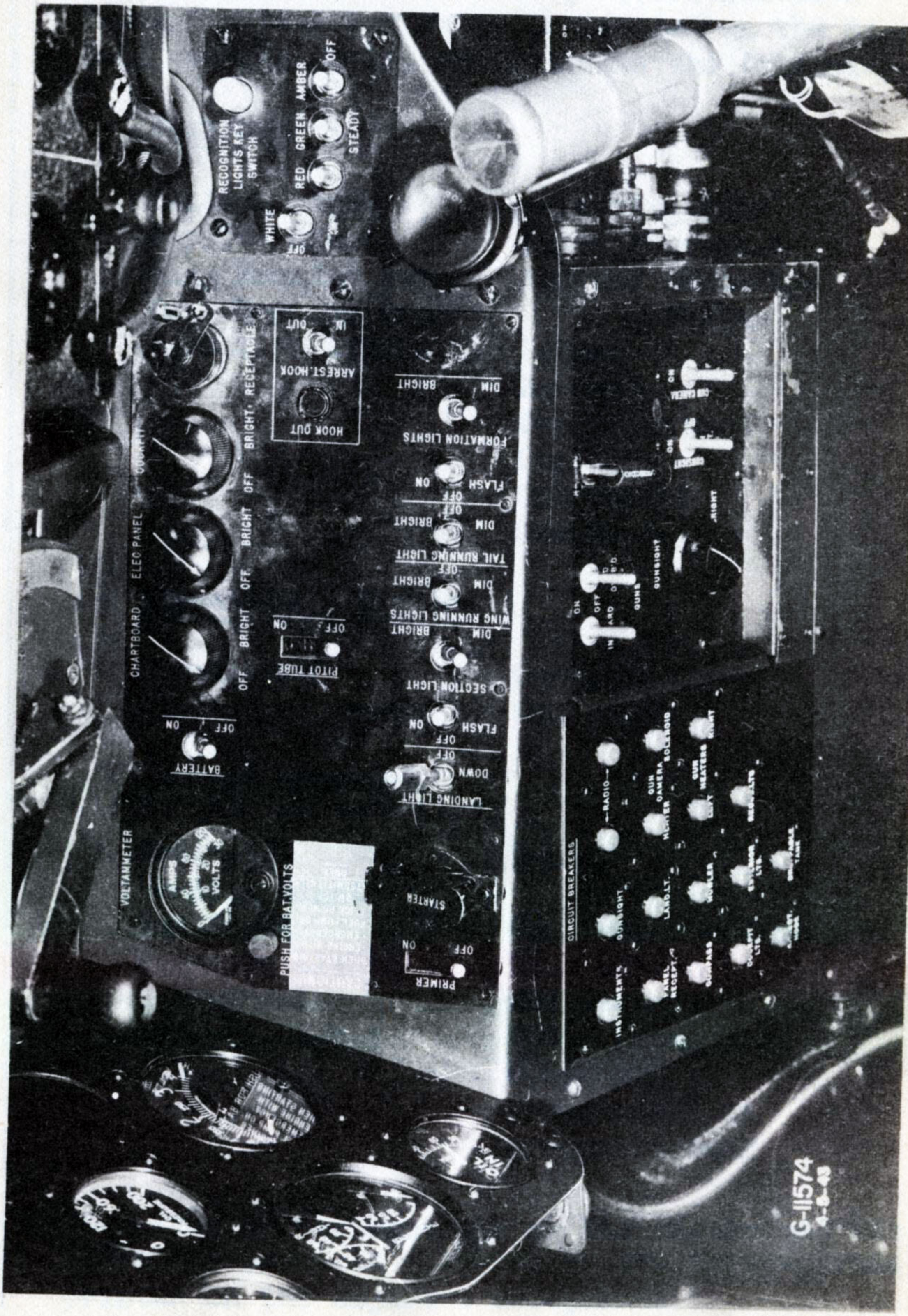
There is no Generator Switch in the Airplane; the Generator being connected directly to the load buss through the automatically operated generator cut-out relay.

The Battery switch, located on the Electrical Distribution panel, has two positions; ON and OFF.

The Battery switch must be ON to prime and start the engine.

NOTE: The following devices are not affected by this switch. They are energized regardless of Battery switch position when their respective control switches are turned on:

1. Recognition Light
2. Pilot's Radio Control Switches



ELECTRICAL DISTRIBUTION PANEL

Electrical Distribution Panel & Switch Box

The Electrical System of the airplane is controlled mainly by switches, rheostats and circuit breakers on the Electrical Distribution Panel & Switch Box which is located on the Right Hand cockpit shelf, and contains the following:

Switches

Landing Light
Section Light
Wing Running Light
Tail Running Light
Formation Lights (2)
Arresting Hook
Pitot Tube Heat
Starter Cartridge Firing
Primer
Battery
Gun Selectors
Gun Sight
Gun Camera
Gun Master

Rheostats - Lights

Chartboard
Electrical Panel
Cockpit
Gun Sight

Circuit Breakers

Radio (2)
Landing Light
Gun Sight
Exterior Lights
Instruments
Cockpit Lights
Heater
Gun Camera Solenoid
Recognition Lights
Gun Heaters (2)
Panel Receptacle
Compass
Arresting Hook
Droppable Tank

Operation of the controls on the electrical distribution panel is directed by the instructions printed on the adjacent nameplates.

Revised 12/10/42
Revised 1/28/43

Volt-Ammeter

The Volt-Ammeter is located on the electrical distribution panel. It normally shows generator amperes. Battery volts may be read by pushing the button on the face of the meter when the engine is not running over the generator cut in speed. System volts is read when the Generator is operating at engine speeds above 1300 RPM.

FOR ADDITIONAL OPERATION INSTRUCTIONS ON ELECTRICAL CONTROLS, SEE:

AUXILIARY CONTROLS
USEFUL LOAD CONTROLS
WING FLAPS

Revised 4/20/43

Cockpit Lights

The cockpit lights are controlled by the cockpit lights rheostat located on the Electrical Distribution Panel.

The intensity of the chartboard light and the electrical panel light is regulated by the rheostat for each one, marked on the adjacent nameplates. Turning any of these rheostats to the OFF position will shut off the lights they control.

Fluorescent Lights

The fluorescent lights are controlled by rheostats located on the lower center instrument panel. To start the lights, turn the rheostats from the OFF to the START position, and hold there for a few seconds until the lights turn ON. Then, turn the rheostat to Dim or Bright position. In order to obtain ordinary or Bright lights, turn the head of the light 90°, to whichever is desired. If the lights fail to operate push the fluorescent lights circuit breaker reset button.

Exterior Lights

The exterior lights, controlled from the Electrical Distribution Panel, are as follows:

Landing	Wing Running
Section	Tail Running
	Formation

Operation of the above lights is directed on adjacent nameplates.

The landing Light, which is installed in the left wing, is retractable. If it fails to operate, push the Landing Light Circuit breaker on the Electrical Distribution Panel.

NOTE: Do not lower the landing light at speeds above 120 knots. Check position of light during engine warm-up.

Recognition Lights

The Recognition Lights and Keying Switch are located on the right hand shelf. A switch is provided to select each light as desired. Throwing any switch to the opposite position will NOT cause the light to glow until the Recognition Lights Keying Switch is Closed. If any light fails to operate, the Recognition Lights circuit breaker on the Distribution Panel shall be pushed.

Lights - White, Red, Green, Amber

Revised 1/28/43

7. AUXILIARY CONTROLS

Arresting Hook

Electric Operation

The Arresting Hook Switch and Circuit Breakers are located on the Electrical Distribution Panel. To EXTEND the hook, throw the control switch to the OUT position (right).

When the hook is Fully Extended, the light adjacent to the switch will glow. The running OUT of the hook will also turn on the Approach Light in the wing. If the hook fails to operate, push the circuit breaker reset button.

CAUTION: THE PILOT SHALL INSURE THAT THE SWITCH IS IN THE HOOK OUT POSITION PRIOR TO LANDING ABOARD A CARRIER.

Manual Operation

The "T" Handle Arresting Hook Emergency Control is located on the bulkhead aft of the pilot's seat on the lower left hand side. This control will not Retract the hook.

To Extend hook, pull "T" Handle and release - Repeat approximately 5 strokes.

If the Arresting Hook is fully extended, the pilot will be unable to pull the manual control through a full stroke.

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Cockpit Fresh Air Control

The flow of fresh air into the cockpit is governed by a manual lever on the lower center control panel. To operate, push lever to desired position, marked on the adjacent nameplate. - OPEN, INTERMEDIATE, OR CLOSED.

Cockpit Heater

The Cockpit Heater Switch is located on the Lower Center Control Panel. If the heater fails to operate, push the circuit breaker on the Electrical Distribution Panel.

CAUTION: DO NOT OPERATE COCKPIT HEATER DURING TAKE-OFF, LANDING, FULL POWER OPERATION OR WHEN ENGAGED IN ACTUAL COMBAT.

Windshield Defroster

A lever, located on the lower center control panel, directs the flow of hot air to the windshield. With the lever at the Top position, the air is directed to Defroster Only; in the Center position, Defroster & Feet, and in the Bottom position, Feet Only.

Pitot Tube Heater

The Pitot Tube Heater Switch is located on the Distribution Panel. The Pitot Tube shall be turned ON when icing conditions are encountered If apparently incorrect airspeed is indicated during icing conditions, check the position of the Switch to be sure it is in the ON position.

Revised 4/20/43

Panel Receptacle

The Panel Receptacle is located on the Electrical Distribution Panel. Portable lights, flying suit, or similar equipment can be plugged into this Receptacle.

Cockpit Enclosure Control

The Handcrank operating the Cockpit Enclosure is located on the right hand side of the cockpit.

ROTATE COUNTER-CLOCKWISE - TO CLOSE
ROTATE CLOCKWISE - TO OPEN

Handcrank pin holes are provided for locking the Enclosure in any number of Open positions or in the Fully Closed position. When the pin is in one of the holes, the enclosure is locked in the corresponding position. Pulling the control handle inboard unlocks the enclosure and permits the handcrank to be turned in the desired direction to open or close hood.

From fully open to fully closed, or vice versa, the handcrank rotates approximately 4-1/2 revolutions.

On the ground, the Enclosure can be opened and closed, and locked or unlocked from outside the cockpit. The push button is located on the right hand cockpit exterior. To Operate - Push Control Knob INBOARD and slide hood to desired position.

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Emergency Release

To jettison the Enclosure in flight, enabling quick exit from the cockpit, two lock pin handle grips are provided at the lower forward left and right hand corners of the Enclosure.

Turn Grips Inboard and Pull Aft
Push Hood Up Into Slipstream.

For emergency exit on the GROUND or WATER, the left and right hand panels of the enclosure can be opened from inside the cockpit by operating the manual release levers located on the center strip of the left and right hand panels.

Full lever Inboard then Pull UP
Push panel Outboard

Wing Folding & Spreading

The Wings are spread and folded manually from the ground and are automatically locked in the folded position. The Wings are Locked in the spread position, and Unlocked before folding, by hydraulically operated Locking Pins controlled from the cockpit. The two position Hydraulic Lever Valve Control operating the locking pins, is located on the right hand shelf.

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The Wing Safety Lock Pins are operated by a "T" Handle Control located on the lower center control panel. This control is used to safety the main locking pins after the outer panels are moved to the SPREAD position and the main locking pins are FULLY HOME. These safety lock pins, when engaged, prevent the main locking pins from dis-engaging, regardless of hydraulic pressure.

As the safety lock pins are withdrawn during the folding operation, red warning cylinders appear through the upper surface of the wing center section, one on the left and the other on the right hand side. Before take-off, check the cylinders which will be flush with the wing surface if the wings are spread and locked properly.

To Fold Wings

1. Wing Flaps - UP
2. Disengage Safety Lock Pins - To Unlock, push "T" Handle LEFT & FULL UP.
3. Push lever on Wing Folding Hydraulic Valve Control operating the main locking pins to FOLD position - FORWARD.
4. Operate hydraulic hand pump if engine is not running. Hand pump selector on SYSTEM or WING LOCK position.
5. Push wing panel back until folded lock engages.

CAUTION: THE CLEARANCE BETWEEN PART OF THE WING AND COCKPIT ENCLOSURE DURING FOLDING IS SMALL; THEREFORE, DO NOT FOLD WINGS WITH ANYONE STANDING ON WALKWAY, OR WITH ARMS OR ANY PART OF THE BODY PROJECTING OUTSIDE OF COCKPIT.

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Revised 1/28/43

To Spread Wings

1. Wing Flaps - UP

CAUTION: LIFT WING TIPS WHEN RELEASING JURY LOCK PIN WHEN SPREADING OUTER PANELS

2. Push lever on Wing Folding Hydraulic Valve Control operating the main locking pins to SPREAD position - AFT.
3. Release jury lock pin lock Control Handle located in the wheel well.
4. If engine is not running, place hand pump selector valve on SYSTEM and pump until system gage reads about 1500 p.s.i., BEFORE pushing wings UP to SPREAD position. This operation will charge the hydraulic accumulator which has sufficient capacity to engage the main locking pins the instant the wing reaches the SPREAD position. After pins are engaged, pump a few extra strokes to make sure pins are FULLY HOME.
5. Engage Safety Lock - to LOCK, pull "T" handle FULL DOWN and RIGHT.
6. Check Red Warning Flag to make sure of its retraction flush with top surface of wing.

WARNING: DO NOT ALLOW THE WINGS TO FALL FREE WHEN SPREADING AS DAMAGE MAY RESULT TO THE WING FOLDING AXIS.

Revised 7/28/43

8. USEFUL LOAD CONTROLS

Armament

Machine Guns

Provison is made for the installation of 6 .50 calibre machine guns, 3 mounted in each outer wing panel.

The gun selector and armament master switches are on the electrical distribution panel and the electric trigger and button switches on the control stick. The button switch controls the inboard guns and the trigger switch the mid and outboard guns.

Gun Camera

A AN-M-4 gun camera is installed in the leading edge of the left wing. The selector switch and circuit breaker are located on the electrical distribution panel.

Gun Sights

A Mark 8 electric gun sight is installed. The electric sight rheostat, switch and circuit breaker are on the electrical distribution panel. The switch has three positions: On - Off - On Alternate.

To use the sight, set the switch to ON and turn ON the rheostat. If the bulb does not illuminate, set the switch to ON ALTERNATE to use spare filament. The bulb can be replaced readily. A spare bulb is mounted in a clip located on the R.H. side of the gun sight mount.

Gun Charging - Hydraulic

The two gun charger handles, controlling the gun charging hydraulic cylinders, are located on the lower center control panel. One handle controls the right wing guns and the other the left wing guns. Each handle is equipped with a safety lock.

To Charge Guns

1. Handle on CHARGE position.
2. Push handle FULL IN.
3. Handle will automatically release, returning to the OUT position when guns are charged.
4. Turn COUNTER-CLOCKWISE to SAFETY position.

To Safety Guns

1. With handle on SAFETY position, push FULL IN.
2. Handle will automatically remain in this position.

To Charge from Safety Position

1. Turn handle CLOCKWISE from SAFETY position to CHARGE position.
2. The handle will then automatically release.
3. Push handle FULL IN.
4. Handle will automatically release when guns are charged, as above.

Auxiliary Operation

If the engine driven hydraulic pump is not functioning, use the hydraulic hand pump in conjunction with the hand pump selector valve as follows:

1. Turn hand pump selector valve to MACHINE GUNS or SYSTEM position.
2. Operate hand pump approx. 5 strokes.
3. Charging Handle on CHARGE position.
4. Push handle FULL IN.
5. Operate hand pump until sufficient pressure is built up to charge guns, and charging handle is automatically released. (approx. 800 p.s.i.)

To Safety

1. Charging handle on SAFETY position.
2. Push FULL IN.
3. Operate hand pump until approximately 800 p.s.i. registers on the pressure gage.

Gun Heaters - Electric

The gun compartments are heated electrically and are operated automatically.

The electric gun heater circuit is connected directly with the airplane generator through manually reset circuit breakers located on the distribution panel. When the heaters are plugged into their respective receptacles they will be energized automatically whenever the generator is running. They cannot be energized by the battery. Their plugs must be pulled to prevent them from being heated when the engine is running.

Radio Controls

Type ARA/ATA and ZB radio equipment is installed and provision is made for the alternate installation of ABA or ABK radio.

The radio controls are located on the right hand shelf.

Microphone & Headphones

The microphone holder is located on the right side above the right hand shelf. The microphone jack is located on the under face of the ATA radio control box on the RIGHT hand shelf, and the microphone switch is located on top of the throttle arm.

The headphones should be plugged into either one of the two "A" TEL jacks and all three switches on top of the control unit should be in the "A" position.

Operation of Radio Controls

Transmitter

Two frequencies are available, selected by the switch in the upper right hand corner of the transmitter control box, which is adjacent to, and FORWARD of, the receiver control box. This switch has four positions only two of which (Nos. 1 and 2) are to be used by the pilot.

CAUTION: IF THIS SWITCH IS PUT IN POSITIONS NO. 3 or 4 DAMAGE TO EQUIPMENT MAY RESULT

Choice of tone, CW or voice emission is available by using the switch on the upper left hand corner of the transmitter control box. After selecting the frequency and type of emission desired, the transmitter is turned ON by the toggle switch in the center of the control box, marked TRANS.POWER.

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After allowing 15 sec. to warm up, the transmitter tubes, the transmitter is operated either by pressing the microphone button, the throttle switch or the key located on top of the control box, depending on whether the hand microphone, throat microphone or key is used.

NOTE: The TRANS. POWER toggle switch should be left ON throughout the flight in order to avoid repetition of the 15 sec. warm-up period. Side tone will be heard when transmitting with the headphones plugged into the receiver.

Receiving

There are three receivers, all operated from a common receiver control box AFT of the transmitter control box, which has three sets of controls. Frequency ranges are indicated directly on the dials, which are calibrated either in KC or MC.

Receiver covering desired frequency range is placed in operation by turning the switch, above and to the RIGHT of the dial, to the CW or MCW position, and depending on whether telegraph or telephone signals are to be received. OFF position of the switch is center, CW to LEFT and MCW to RIGHT. Tuning is accomplished by turning the crank below and to the RIGHT of the dial. Volume

level is adjusted by turning the knob marked INC. OUTPUT, below and to the LEFT of the dial.

NOTE: The three switches, each one above and to the LEFT of each tuning dial in the center of the control box panel, should be left in the "A" position and the headphones should be plugged in either jack marked "K" TEL located on the receiver control box.

ZB Controls

The ZB control box, located on the right hand shelf adjacent to and aft of the receiver control box, is operated in conjunction with the ARA receiver unit, covering a 500 to 1500 KC range. To operate the equipment, turn the ON-OFF switch on the ZB pilot's control unit to the ON position, and turn the HOMING-COMM. switch to HOMING position. The switch above and to the RIGHT of the 500 to 1500 KC dial should be turned to the CW position. Details of operation are available only to Navy Personnel.

ABK or Alternate ABA Controls

Provision is made for the ABA or alternate ABK control box in the bulkhead immediately aft of the pilot's seat on the right hand side above the right hand shelf. The pilot's control switches are located on the right side above the right hand shelf.

CAUTION: POWER IS SUPPLIED TO THE PILOT'S CONTROL SWITCHES AT ALL TIMES REGARDLESS OF THE POSITION OF THE BATTERY SWITCH.

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Oxygen System

The shatterproof oxygen cylinder of 514 cubic in. capacity is located on the aft side of the crash bulkhead. The cylinder should be charged to 1800 lbs. per sq. in.

The shut-off valve handwheel extension is located to the left of the pilot's seat.

Rotate handwheel counter-clockwise to open valve.

The demand type regulator with breathing tube and facepiece is located on the bulkhead to the left of the pilot's seat.

Check the manual emergency by-pass valve lever to insure that it is securely in the off position.

After opening the cylinder valve and ascertaining that the pressure in the cylinder is approximately 1800 pounds per sq. in., close the valve and watch the pressure gauge needle. If a drop in pressure of no more than 100 lbs. per sq. inch occurs during a five minute period, the regulator and connections may be considered sufficiently tight for use. If the drop in pressure is more than 100 lbs. per sq. in. in five minutes have the connections checked for tightness prior to use.

With the breathing tube and facepiece attached so that a satisfactory seal to the face is produced breathe for several seconds to determine that automatic parts of the regulator are working satisfactorily. Next turn on the manually operated emergency by-pass lever to insure that it will permit the flow of oxygen if needed. Turn this lever to the off position since it is to be used only if the automatic part of the regulator is defective.

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CAUTION: OXYGEN EQUIPMENT MUST BE KEPT FREE OF OIL AND GREASE AND EASILY OXYDIZED MATERIALS.

Seat

The control lever for vertical adjustment is located on the right hand side of the seat; maximum adjustment is 6". The control lever for adjustment of the shoulder type harness is located on the left hand side of the seat.

Armrest

A folding armrest is located on the left hand side of the cockpit aft of the control quadrant. The armrest must be in the UP position to operate the cowl flaps control lever.

Chartboard

A standard Mark 2A chartboard is located under the main instrument panel. The chartboard should be locked in the stowed position when the airplane is catapulted.

Tow Target

Provision is made for installing a "T" handle Tow Target release control on the bulkhead aft of the seat, lower right hand side.

PULL OUT - TO RELEASE

Pyrotechnics

A type AN M-8 Very's Pistol is provided. The cartridge container is mounted on the lower center control panel containing six cartridges.

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9. MISCELLANEOUS EQUIPMENT

Map Case

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

Relief Tube

Receptacle NAF 1077 is located on the left hand side of the pilot's seat.

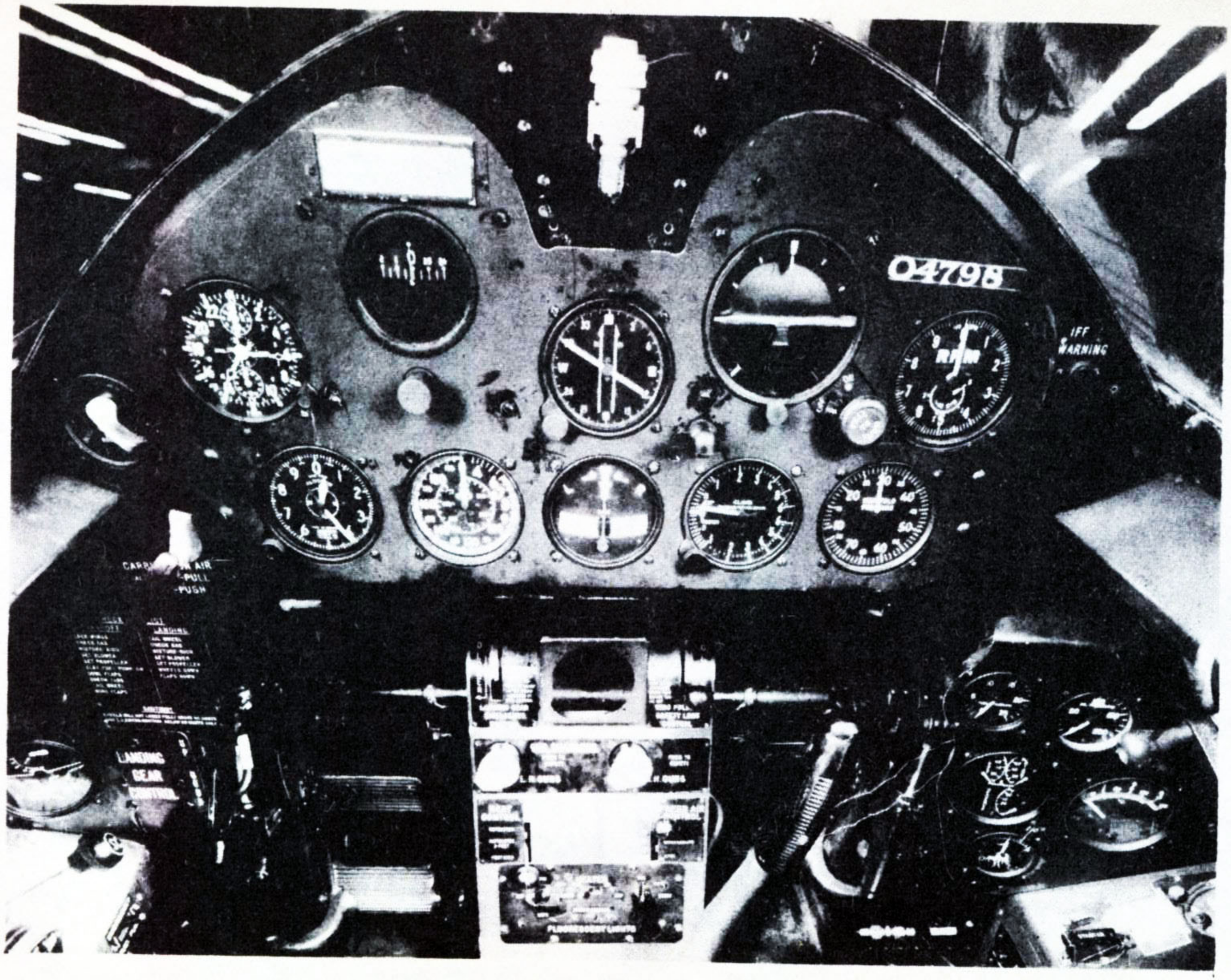

FIG. I INSTRUMENT PANEL

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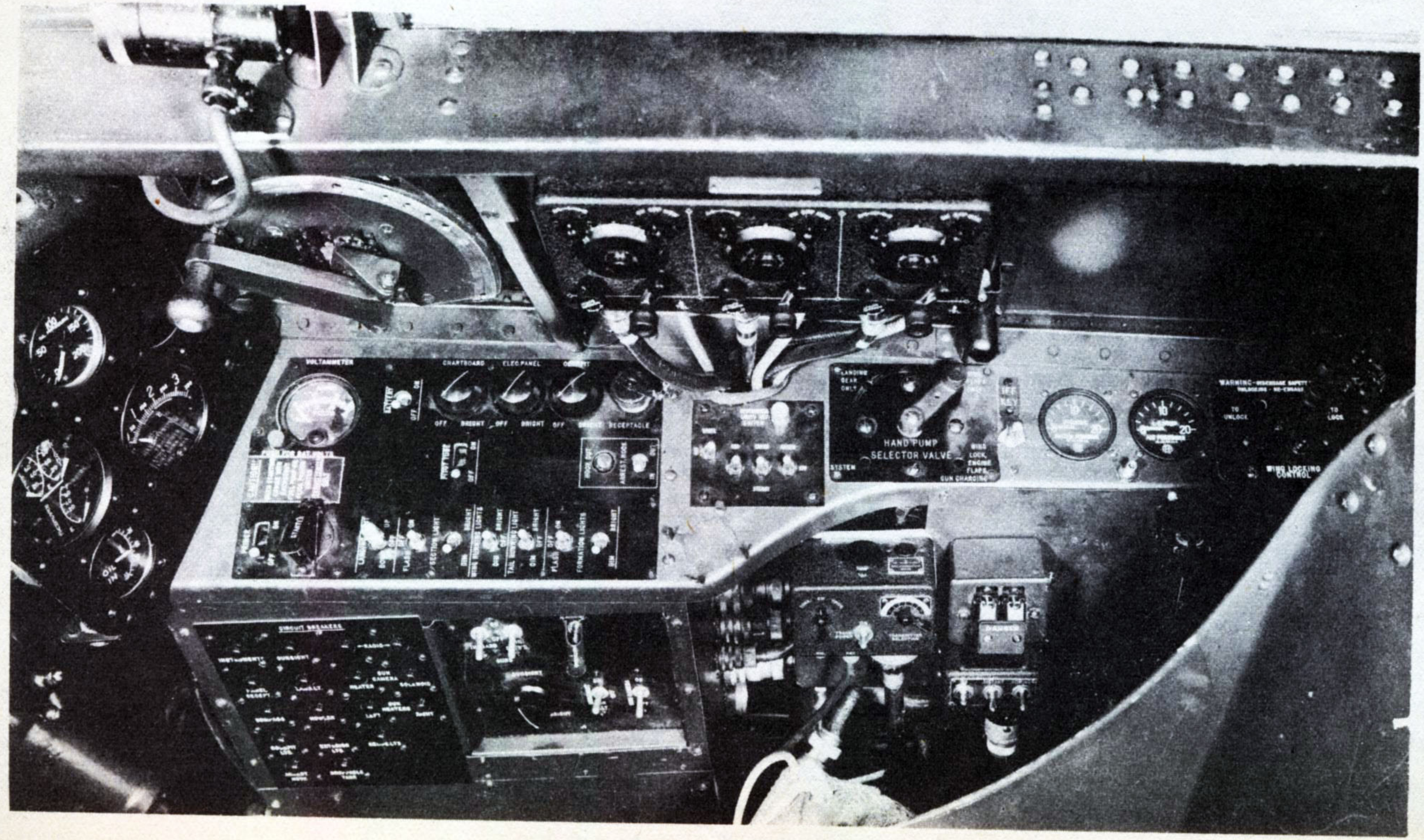

FIG. 2 COCKPIT R.H. SIDE

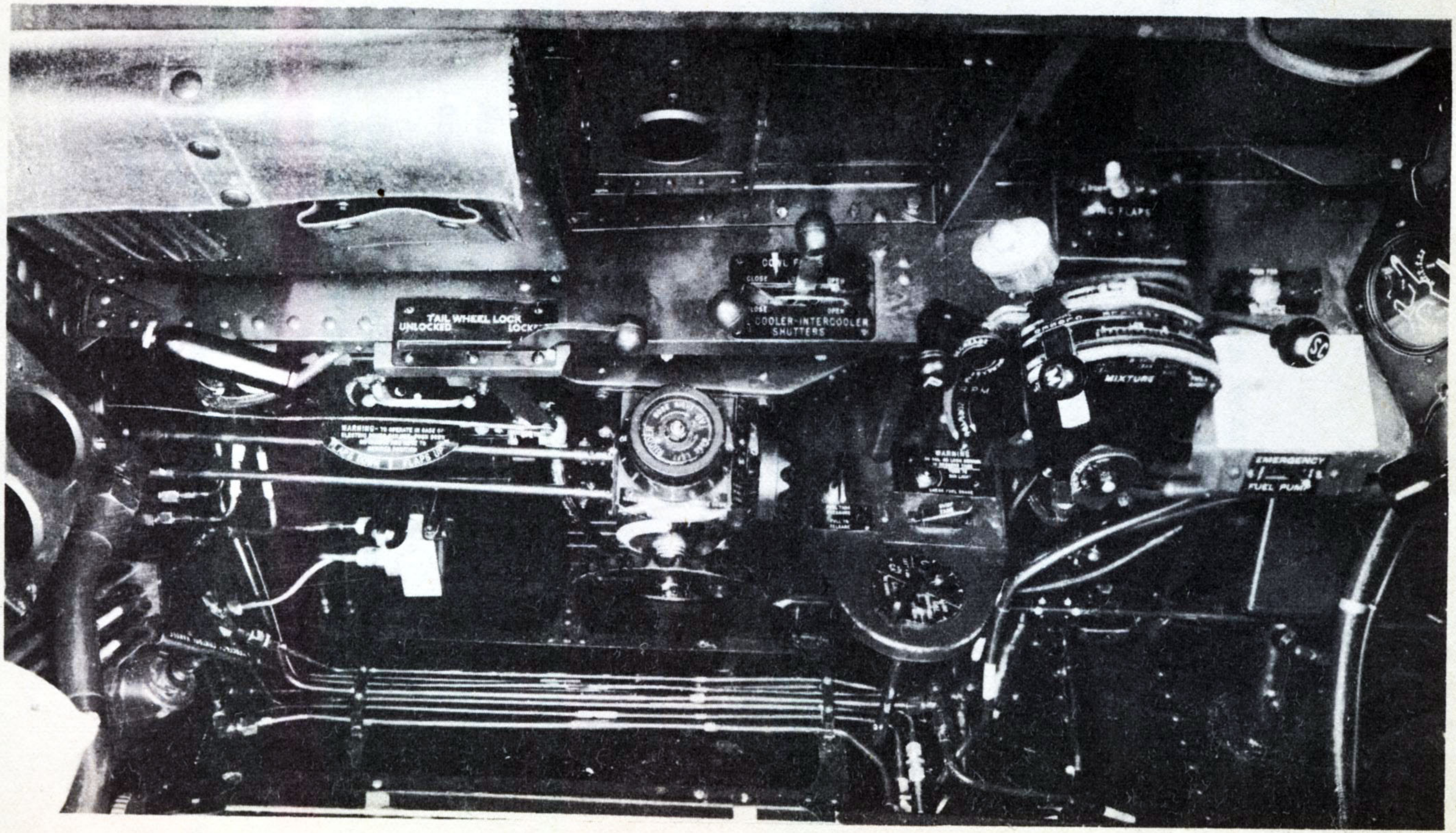

FIG. 3 COCKPIT L.H. SIDE

10. POWER PLANT

(a) Engine

Pratt & Whitney Double Wasp R-2800-10, geared 2:1 two-stage, two speed, 18 cylinder radial, air cooled engine.

Rating

	BHP	RPM	BLOWER	ALTITUDE
Take-off (5 Min.)	2000	2700	NEUTRAL	S.L.
Normal	1675	2550	NEUTRAL	S.L.-5500
	1625	2550	LOW	16400
	1550	2550	HIGH	21500
Military (5 Min.)	2000	2700	NEUTRAL	S.L.-1700
	1800	2700	LOW	15500
	1650	2700	HIGH	20800

NOTE: Horsepower ratings obtained from Aeronautical Engine Laboratory calibration and apply under the following conditions of operation:

Manufacturer's guaranteed specific fuel consumption.

Neutral - Standard altitude temperature and pressure at entrance to carburetor and standard altitude pressure at exhaust.

Auxiliary Stage - Standard altitude temperature and pressure at entrance to auxiliary stage supercharger and standard altitude

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pressure at exhaust. Constant carburetor air temperature of 32° C. (90° F.) and 0 pressure drop through intercoolers and ducts.

Fuel Spec.

100 octane, AN-F-28 or AN-VV-F-781, Amend. 5.

Oil Spec.

AN-VV-O-446

Maximum Diving Speed - (30 Sec.) - 3060

All diving should be done with the Auxiliary Supercharger in NEUTRAL.

(b) Propeller

Hamilton Standard Hydromatic, 3 blade, 13'-1" diameter, constant speed controllable pitch equipped with a spinner.

The basic settings are 26° Low Pitch and 65° High Pitch.

(c) Propeller Governor Control

The Low Pitch, High RPM or Take-off position of the lever full down; and the High Pitch, Low RPM position is full up.

Engine RPM should be set by the propeller governor and manifold pressure set by the throttle. Engine speed is governed entirely by the operation of the governor control located on the engine control quadrant. Engine speed is increased by pushing the lever down and is decreased by pulling it

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up. Once so selected, the RPM will remain constant under all conditions within the constant speed range of the governor.

NOTE: The handwheel located on the inboard side of the governor control is the vernier control.

Rotate clockwise - Decrease RPM (Increase Pitch)

Rotate Counterclockwise - Increase RPM (Decrease Pitch).

Always move the handwheel slowly since a slight movement will cause a considerable change in RPM.

(d) Starter & Primer

The cartridge starter is an Eclipse Type III unit. The cartridge breech is located on the starboard side of the engine mount structure and is accessible from outside the airplane through a hinge door locked by a quick turn fastener. The firing switch is located on the electrical panel.

Use Type "D" cartridge for starting under normal conditions. However, Type "E" may be used in cold weather or under other conditions where Type "D" is inadequate.

The primer switch is located on top of the electrical panel adjacent to the starter switch. The battery switch must be ON to prime and start the engine.

(e) Carburetor Protected Air Control (Auxiliary Stage).

The two position Carburetor Protected Auxiliary Air Control "T" Handle is located on the left hand side of the instrument panel.

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"T" Handle Full Forward - Direct (Cold)
"T" Handle Full Aft - Protected Air (Hot)

This control regulates the Auxiliary Stage Air only and does not affect main stage air which is taken from the accessory compartment when operating in Neutral Blower. The primary function of the control is to actuate a door to prevent direct ramming air from entering the Auxiliary Stage when carburetor air filters are being used to filter main stage air while operating in Neutral Blower.

However, when operating in Auxiliary Stage, when the control is actuated, hot air is drawn into the auxiliary stage from behind the engine cylinders.

The combination of the Stromberg Injection Carburetor and the Pratt & Whitney blower throat fuel discharge nozzle and spinner, with the absence of distribution vanes in the blower throat, makes the Double Wasp two stage engine unusually free from icing tendencies. However, ice can form in the induction system when the outside air temperature is below 0° C. (32° F.) and free moisture is present. Under icing conditions mentioned above, or at the first sign of a decrease in manifold pressure not occasioned by a change in airplane altitude, throttle position or engine RPM, the air control should be shifted to "Protected Air" and the carburetor air temperature should be maintained above 0° C. (32° F.) by the use of the auxiliary stage supercharger. 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. The standard shifting procedure should be used as noted under F.

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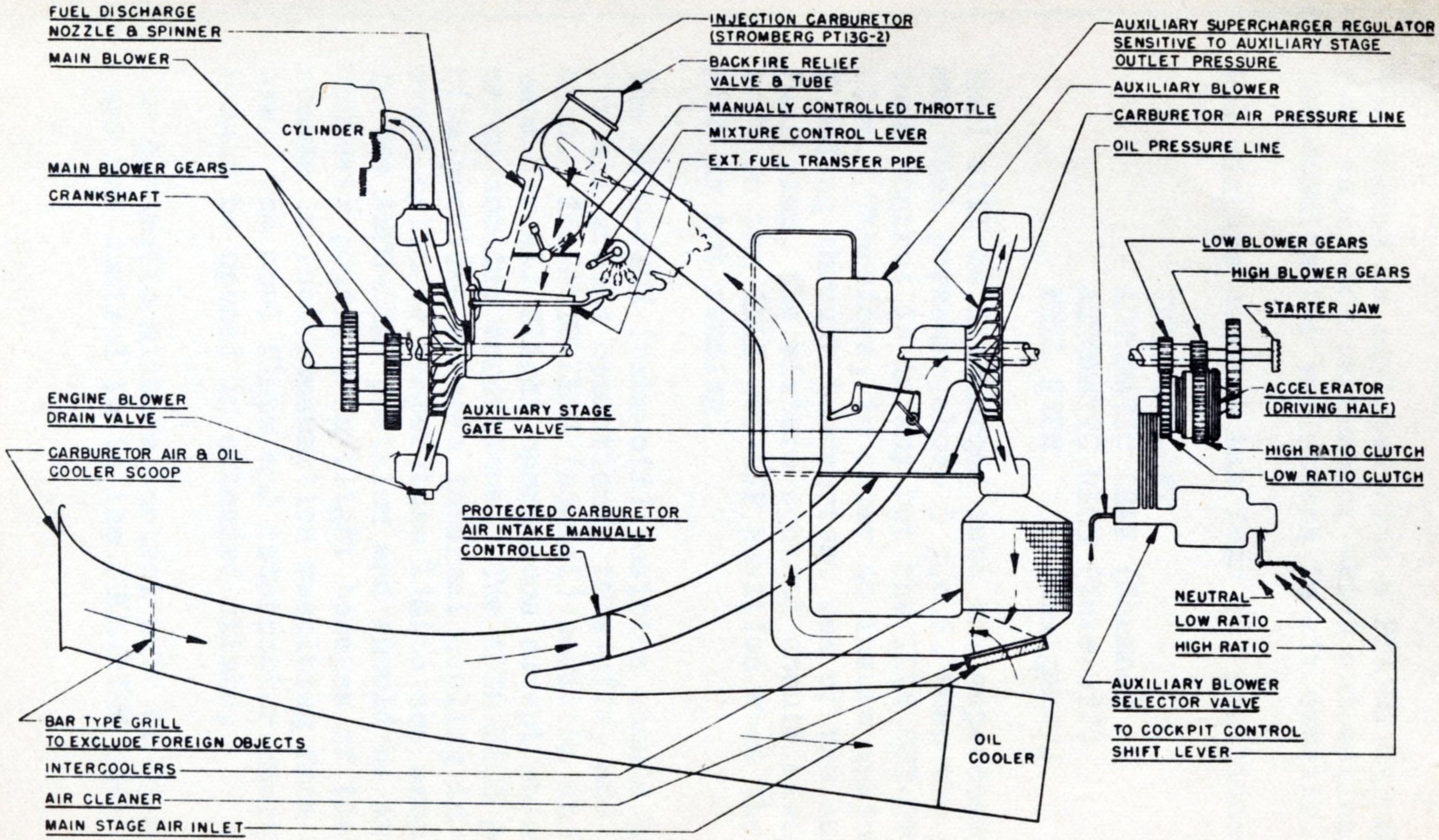
The power output with the auxiliary stage engaged shall not exceed the rating for that combination of superchargers given on Page

The flow of cooling air through the intercoolers may be controlled by the Intercooler shutters. They may be left fully open during all normal operation, unless carburetor icing conditions require warmer carburetor air.



CARBURETOR INDUCTION SYSTEM

FIG. 4

(f) Mixture Control

The engine is equipped with a PT13G2 Stromberg fuel injection carburetor which automatically compensates for variations in air density.

The mixture control has four (4) positions:

IDLE CUT-OFF
AUTOMATIC LEAN (Normal)
AUTOMATIC RICH (Take-off)
FULL RICH (Emergency)

Fuel will be discharged into the supercharger at any fuel pressure above 5 p.s.i. when the mixture control is in any but the IDLE CUT-OFF position. Therefore, in order to insure against flooding through inadvertent use of the auxiliary fuel pump, the mixture control should always be left in the IDLE CUT-OFF position when the engine is not running.

The AUTO-RICH (take-off) position should be used for all ground operations, take-offs, and landings. The AUTO-LEAN (normal) position should be used for all flight operations except under adverse cooling conditions. The AUTO-RICH position provides reserve internal cooling in the event cylinder temperature limits are exceeded in the AUTO-LEAN position and should be avoided whenever possible in flight because of the increase in fuel consumption resulting from its use. The cowl flaps and intercooler shutters should be opened in extended climbs.

The Automatic mixture control unit is by-passed when the control is in the FULL-RICH position.

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This position provides an additional reserve of internal (fuel) cooling and may be used in the event cylinder temperatures are excessive in the AUTO-RICH position. The mixture control is fully manual in this position, i.e., the mixture is not compensated for altitude. If it is necessary to resort to this position at altitude, excessively rich mixtures may be encountered. In this event, the control should be eased toward the AUTO-RICH position until smooth engine operation is restored.

g. Supercharger Control

Do not shift the supercharger control more often than at five minute intervals, except in an emergency, to allow the dissipation of heat from the clutches.

The control must be at the extremity of its travel in either ratio to prevent clutch slippage and to insure the availability of rated power at all times.

If practicable, at the end of each five hour period of operation in HIGH or LOW ratio, shift to NEUTRAL for a period of five minutes to eliminate sludge accumulation in the clutches.

To change from NEUTRAL to LOW ratio or from LOW ratio to HIGH ratio, the following procedure shall be used:

1. Mixture control in AUTO-RICH.
2. Close throttle as necessary to avoid exceeding desired manifold pressure after shift.
3. Reduce RPM if practicable.
4. Shift rapidly.
5. Mixture control to AUTO-LEAN; Readjust RPM, throttle setting as necessary to obtain desired power.

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To shift from HIGH ratio to LOW ratio or from LOW ratio to NEUTRAL, the following procedure shall be used:

1. Mixture control in AUTO-RICH.
2. Shift rapidly.
3. Mixture control to AUTO-LEAN; Readjust RPM, throttle setting to obtain desired power.

The engine should be operated in the blower ratios specified in the Engine Operation Chart, page 82. In cruising, the lowest degree of supercharging which will provide the desired cruising power at a specified altitude should be utilized since a higher degree will result in inferior fuel consumption and a greater tendency toward detonation.

(h) Changing Power Conditions

In order to prevent excessive pressures within the cylinders, the following procedures shall always be used when changing power:

Increasing Engine Power

1. Adjust the mixture control for the power condition desired as specified in the Engine Operation Chart.

2. Adjust the propeller control to obtain the desired RPM.

3. Adjust the throttle to obtain the desired manifold pressure.

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Decreasing Engine Power

1. Adjust the throttle to obtain the desired manifold pressure.

2. Adjust the propeller control to obtain the desired RPM.

3. Adjust the mixture control for the power condition desired as specified in the Engine Operation Chart.

(i) Cowl Flap Control

The three position Cowl Flap Hydraulic Control Lever is located on the port shelf.

Lever Forward - Flaps Open.
Lever Center - Neutral
Lever Aft - Flaps Closed

Cylinder Temperatures

The maximum allowable cylinder temperatures are:

	HEADS *	
	°C.	°F.
Take-off Power	260	500
High Speed and Climb at Normal Rated Power	260	500
Continuous Operations at any Power Below 68% Normal Rated Power	232	450

* Measured at point embedded in gasket of rear spark plug.

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(1) Fuel System

The fuel system consists of two main self-sealing cells and a reserve cell, engine driven pump, auxiliary electric fuel pump, fuel tank pressurizer, quantity gage, mixture control, fuel selector valve, lines and fittings.

The main fuel cells are located in the wing center section, one left and one right, the reserve tank is located in the fuselage below the cockpit. Each cell is suspended in a hammock. Fuel lines are of self-sealing construction. Provision is made for the installation of a droppable fuel tank, under the fuselage.

NOTE: Refer to Navy T.O. #55-41, "Fuel Tanks Protection Against Gun Fire."

The fuel supply is as follows:

Cells	Max. Cap.
Main, Left Wing	87.5
Main, Right Wing	87.5
Reserve, Fuselage	75.0
Droppable Tank	150.0
TOTAL	400.0

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Electrical Fuel Quantity Gage

The fuel quantity gage on the RIGHT hand instrument panel indicates the fuel quantity of each main and reserve cell with an individual pointer. No gage is provided for the droppable fuel tank.

Fuel Spec.

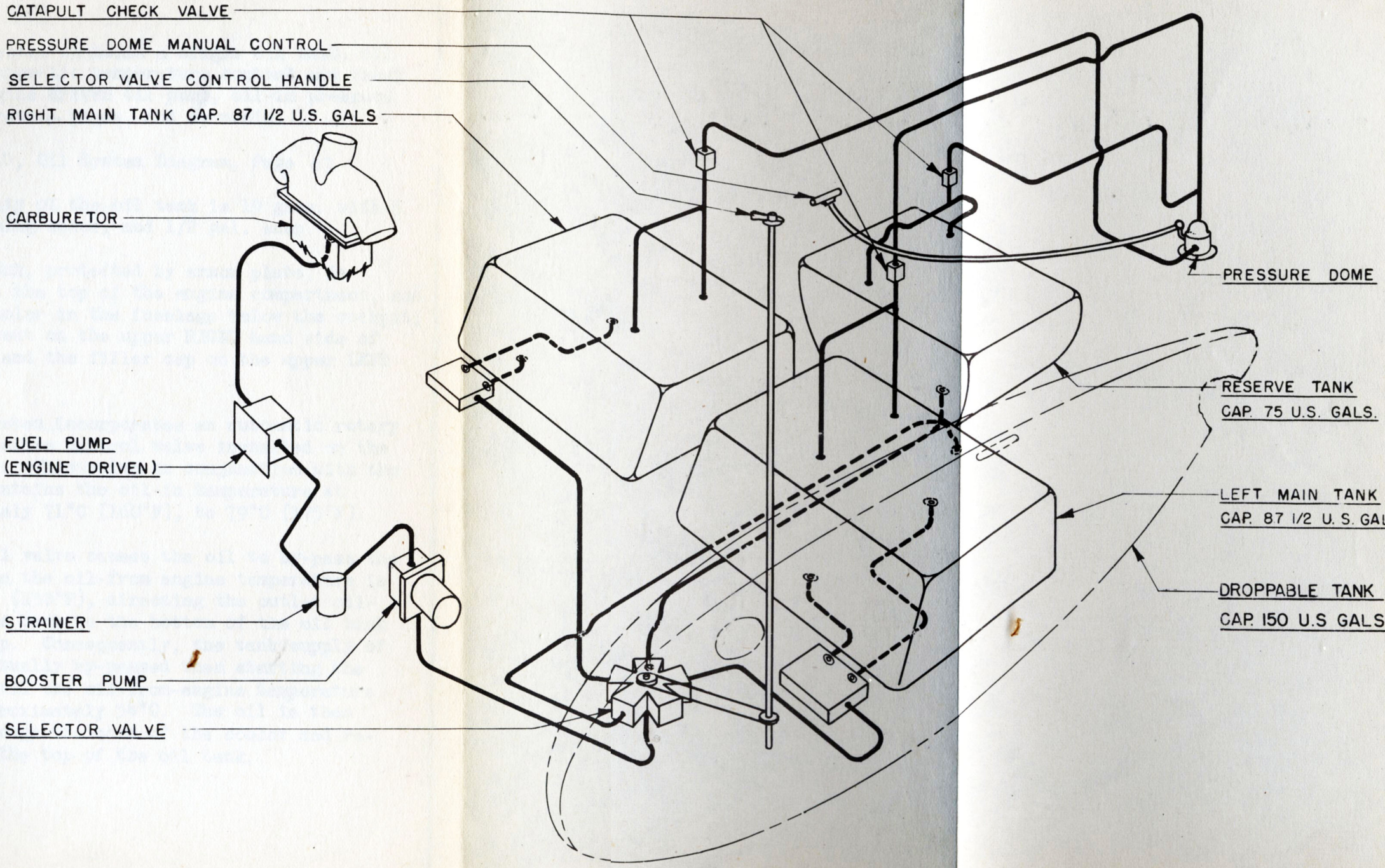
The fuel is grade 125 or 130, AN-F-28, or AN-VV-F-781.

Fuel Pressure

Desired - 16 p.s.i.
Allowable - 16-18 p.s.i.
Minimum Idling - 7 p.s.i.

Filler Caps

On LEFT hand side of fuselage for left main, on right hand side, for right main and reserve.



FUEL SYSTEM DIAGRAM

FIG. 5

(k) Oil System

The oil system includes a single oil tank, oil cooler, automatic temperature control and check valve, engine driven oil pump, oil-in pressure and temperature gages, and controls.

See Fig. 10, Oil System Diagram, Page 67.

The capacity of the oil tank is 19 gals. with 3 gals. foaming space, and 1/2 gal. sump.

The oil tank, protected by armor plate, is located at the top of the engine compartment, and the oil cooler in the fuselage below the cockpit; oil tank vent on the upper RIGHT hand side of the tank, and the filler cap on the upper LEFT hand side.

The oil system incorporates an automatic rotary oil temperature control valve installed on the oil cooler. This valve in conjunction with the cooler maintains the oil-in temperature at approximately 71°C (160°F), to 79°C (175°F).

The control valve causes the oil to by-pass the cooler when the oil-from engine temperature is below 54°C (130°F), directing the outlet oil-from-engine back to the bottom of the oil tank for warm-up. Consequently, the tank supply of oil is virtually by-passed when starting the engine, until the oil-from-engine temperature reaches approximately 54°C. The oil is then passed through the core of the cooler and returned to the top of the oil tank.

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When the engine is not operating, a check valve unit prevents oil flow from the tank to the engine and back through the oil-out line from the engine to the control valve.

Oil Spec.

Grade 1100 or 1120, Spec. AN9542 or AN-VV-O-446.

Oil Inlet Temperatures	°C	°F
Min. for take-off & flight	40	104
Desired	60-70	140-167
Maximum level flight	85	185
Maximum climb	100	212

Oil Pressures	p.s.i.
Desired, at 2000 RPM at 60°C	75-80
Min. at rated RPM at 100°C	75
Min. at 2100 at 85°C	60
Min. at 1200 at 85°C	50
Min. Idling	25

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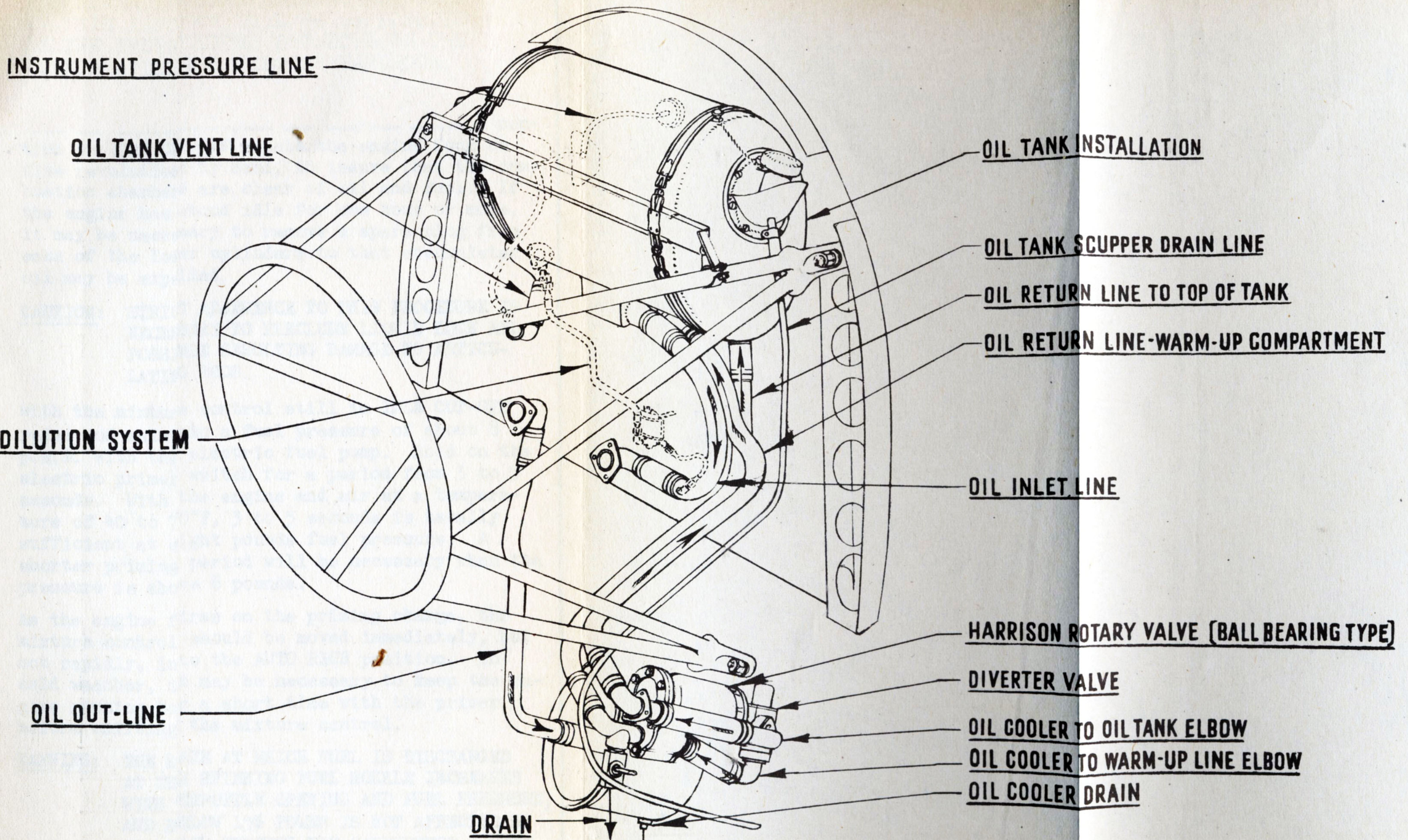

OIL SYSTEM DIAGRAM

FIG.6.

N O T E

THE OPERATING INSTRUCTIONS AS GIVEN IN THIS HANDBOOK WILL BE SUPERSEDED BY THE INSTRUCTIONS SET DOWN IN THE "INFORMATION FOR PILOTS" HANDBOOK.

...with the ignition switch off and the mixture control in IDLE CUT-OFF rotate the engine four or five revolutions by hand, to insure that the combustion chambers are clear of oil and fuel. 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 to that accumulated oil may be expelled.

CAUTION: STRICT ADJERENCE TO THIS PROCEDURE IS NECESSARY TO PRECLUDE LIQUID LOCK AND POSSIBLE RESULTING DAMAGE TO ARTICULATING RODS.

With the mixture control still in IDLE CUT-OFF raise and maintain a fuel pressure of about 8 p.s.i. with the electric fuel pump. Hold on the electric primer switch for a period from 3 to 5 seconds. With the engine and air at a temperature of 40 to 70°F, 3 to 5 seconds is usually sufficient at eight pounds fuel pressure. A shorter priming period will be necessary when the pressure is above 8 pounds.

As 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.

WARNING: THE RATE AT WHICH FUEL IS DISCHARGED AT THE SPINNING FUEL NOZZLE INCREASES WITH THROTTLE OPENING AND FUEL PRESSURE, AND BELOW 15% POWER IS NOT AFFECTED BY AIR FLOW THROUGH THE CARBURETOR. WITH THE ELECTRIC FUEL PUMP EXCESSIVE QUAN-

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TITIES OF FUEL WILL BE DISCHARGED AT THE SPINNING NOZZLE WITH 1/4 THROTTLE OPENING. THEREFORE, IT IS MOST IMPORTANT TO RETURN THE MIXTURE CONTROL TO IDLE CUT-OFF AND RETURN THE ELECTRIC FUEL PUMP SWITCH TO OFF IF A SUCCESSFUL START HAS NOT BEEN ACCOMPLISHED.

CAUTION: OVERPRIMING OR EXCESSIVE PRIMING PRIOR TO TURNING THE ENGINE OVER, MAY RESULT IN DRAINAGE OF SUFFICIENT GASOLINE INTO THE LOWER CYLINDERS TO CAUSE BENDING OR FAILURE OF AN ARTICULATING ROD. EXCESSIVE PRIMING HAS A TENDENCY TO WASH OIL OFF THE CYLINDER WALLS. SCORING OR SEIZING OF THE PISTONS AND CYLINDER BARRELS MAY BE CAUSED BY THIS CONDITION.

RUSTING OF THE PISTON RINGS AND CYLINDER WALLS WILL OCCUR IF THE ENGINE IS ALLOWED TO STAND FOR A DAY OR MORE AFTER UNSUCCESSFUL ATTEMPTS TO START, UNLESS SURFACES ARE PROTECTED BY A FRESH APPLICATION OF OIL.

Adjust the throttle to hold the engine to as low a speed as possible for the first 30 seconds after starting and watch for an indication of oil pressure on the gage. If the oil pressure does not register on the gage within 30 seconds stop and investigate.

Starting Check-Off

1.	Ignition Switch	OFF
2.	Mixture Control	IDLE CUT-OFF
3.	Rotate Engine by Hand	4 or 5 revolutions
4.	Supercharger Control	Neutral
5.	Throttle	1/10 OPEN (About 700 RPM)
6.	Propeller Control	LOW PITCH (TAKE-OFF RPM)
7.	Cowl Flaps	OPEN
8.	Oil Cooler & Inter-cooler Shutters	OPEN
9.	Carburetor Protected Air Control	DIRECT (Normal) (T.O. 44-40)
10.	Battery Switch	ON
11.	Auxiliary Electric Fuel Pump Switch	ON (for initial fuel pressure for priming)
12.	Fuel Pressure	8 p.s.i.
13.	Electric Primer	ON for 3 to 5 sec.
14.	Ignition Switch	ON-BOTH
15.	Starter Switch	ON TO FIRE CART-RIDGE
16.	Mixture Control	Advance to AUTO RICH as engine fires. If engine fails to continue running, return to IDLE CUT-OFF.
17.	Idle	At 1000 RPM until oil temperatures reads 40°C. (104°F.)

NOTE: If the oil pressure gage does not indicate pressure within 30 sec., the engine should be stopped and an investigation made.

When operating an engine in which the oil has been diluted, allow adequate warm-up before taking off except in cases of extreme emergency. Since the oil in the hydromatic propeller is not diluted, care must be taken to determine that the propeller pitch changing mechanism is operating prior to take-off.

In cold weather, if excessive oil pressures are obtained when the speed is INCRKASED hold to 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.

See Navy T.O. #52-42 for General operating instructions regarding the cartridge starter installation.

(b) Engine Ground Test (Warm-Up)

1.	Carburetor Protected Air Control	DIRECT (Normal)
2.	Cowl Flaps	Open
3.	Mixture Control	AUTO-RICH
4.	Propeller Control	Take-off RPM
5.	Throttle	Operate at 1200 RPM until oil temp. is at least 30°C.
6.	Check Magnetos	(a) Set throttle, 30° Hg. max. (b) Operate on single magneto for shortest possible time. (c) Return switch to BOTH between checks to allow engine to clear out.
7.	Check Supercharger	(a) Increase engine speed to 1200-1400 RPM with propeller control in LOW pitch (High RPM) (b) Shift rapidly from NEUTRAL to LOW (c) Slight drop in RPM will indicate proper operation. (d) Same procedure for check from LOW to HIGH ratio.

NOTE: Do not exceed 232°C (450°F) head temperature during ground operations.

(c) Take-Off

1.	Wings	SPREAD & LOCKED
2.	Wing Flaps	AS REQUIRED
3.	Cowl Flaps	OPEN
4.	Oil Cooler & Inter-cooler Shutters	OPEN
5.	Propeller Control	LOW PITCH, 2700 RPM
6.	Mixture Control	AUTO RICH
7.	Supercharger Control	NEUTRAL
8.	Carburetor Protected Air Control	DIRECT (Normal)
9.	Fuel Selector Valve	RIGHT MAIN
10.	Fuel Pressure	16-18 p.s.i.
11.	Auxiliary Elec. Fuel Pump	ON
12.	Manifold Pressure	54" Hg.
13.	Aileron Tab	
14.	Elevator Tab	
15.	Rudder Tab	
16.	Tail Wheel Caster	LOCKED
17.	Cockpit Enclosure	LOCKED OPEN

NOTE: Before take-off be sure oil temperature is at least 40°C. (104°F) preferably 60°C. (140°F).

Do not exceed 232° C. cylinder head temperature before take-off.

(d) Rated Power Climb and Level Flight

Operate according to the Engine Operation Chart and the Operating Limits Chart. Table I lists the throttle and supercharger control settings for the condition.

TABLE I

Altitude (No Ram)	Manifold Press. ("Hg.)	Supercharger Ratio
S.L.-5500	45-44 (F.T.)	NEUTRAL
5500-6200	F.T.	NEUTRAL
6200-16400	51-50 (F.T.)	LOW
16400-17600	F.T.	LOW
17600-21500	50.5-50 (F.T.)	HIGH
21500 Up.	F.T.	HIGH

NOTE: The altitudes at which these manifold pressures can be obtained will vary considerably with carburetor entrance conditions; the above values are for standard air and no ram.

(e) Climb

Climbs are normally made with less than Normal Rated Power. However, Military Power may be used for 5 minutes, but head temperature shall not exceed 260°C. When operating in auxiliary stage, it is recommended that carburetor air temperature be maintained within 32°C. (90°F) by use of intercooler flaps. In no case shall carburetor air temperature be permitted to exceed 43°C (110°F) with intercooler flaps open, reducing power if necessary to maintain temperature within this limit. Adjust the cowl flaps to maintain cylinder temperatures below 260°C. A

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material reduction in cylinder and oil temperatures can be obtained by climbing at an indicated air speed 10 to 20 MPH higher than the speed for best climb, without much loss in rate of climb. A tendency for the oil to overheat can be checked more quickly by reducing the engine speed than by throttling alone.

The auxiliary stage supercharger regulator will be set to permit 30" Hg. absolute pressure at the carburetor inlet up to the critical altitude in either auxiliary gear ratio. This setting is sufficiently high to permit military power at full throttle in low gear and more than military power at full throttle in high gear. Consequently, it will be necessary to close the throttle partially at high gear military rated RPM and in both low and high gear normal rated RPM to prevent exceeding the respective rated powers.

Immediately before the Auxiliary Supercharger is shifted from NEUTRAL to LOW or from LOW to HIGH (See ( ) Supercharger) the throttle should be partially closed to reduce manifold pressure 3" to 4" Hg. This will prevent excessive manifold pressure before the automatic pressure regulator has adjusted itself for the change in the supercharger speed. A few trials should acquaint the pilot with the throttle movement necessary to prevent excessive manifold pressure after the shifting of the Auxiliary Supercharger.

(f) Military Power Climb and Level Flight

Operate according to the Engine Operation Chart and the Operating Limits Chart. Table II lists the throttle and supercharger control settings for the condition.

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TABLE II

Altitude (No Ram)	Manifold Press. ("Hg.)	Supercharger Ratio
S.L.-1700	54-52.5 (F.T.)	NEUTRAL
1700-4700	F.T.	NEUTRAL
4700-15400	56-54 (F.T.)	LOW
15400-17700	F.T.	LOW
17700-20800	54-52.5 (F.T.)	HIGH
20800 UP	F.T.	HIGH

NOTE: The altitudes at which these manifold pressures can be obtained will vary considerably with carburetor entrance conditions; the above values are for standard air and no ram.

(g) Cruising

While cruising operation may be conducted at any engine power below normal rated power, if minimum fuel consumption is of importance and if it is tactically feasible to do so, cruising operations should be conducted in a range not exceeding 68% of normal rated power.

The engine should be operated in AUTO-LEAN for cruising power operation as shown in the Operation Limits Chart. If a cylinder head temperature of 232° C. is exceeded, (with cowl flaps full OPEN) the mixture should be enriched.

The cruising manifold pressure-RPM relationships specified in the Operating Limits Chart should not be exceeded.

1. Cruising-Maximum

Cruising-Maximum on the Engine Operating Chart represents the highest power and RPM permissible with an economical mixture. This rating takes advantage of the highest permissible cruising RPM, in order to maintain the maximum permissible cruising brake horsepower to the highest altitude possible. Average cruising requirements normally call for reductions of 15% to 30% from maximum cruising power, and still further reductions where long range or endurance is a requisite and where maximum fuel economy is desired.

2. Cruising - Recommended Power

Under most conditions of cruising operation, use of the maximum cruising power available from the engine is neither necessary nor desirable. In such instances, minimum fuel consumption and, as a rule, maximum propeller efficiency are obtained by operating with power reduced by lowered engine speed rather than by reduced manifold pressure at high engine speeds. Benefits in cooling and engine life are realized from this plan of operation, which is particularly applicable to long range flying. For long range cruising this method of operating may be achieved by selecting manifold pressure and RPM values from the Operating Curve - Cruising B.M.E.P.

The following procedure may be used in adjusting power in order to avoid excessive pressures and to afford a comparatively smooth transition:

Lower the manifold pressure about 2" Hg. under that for normal rated power then bring the RPM down below that for normal rated power. If further reduction in power is desired, reduce the manifold pressure 2 to 4" Hg. then the RPM approx. 200 in successive alternate steps until the desired engine speed is attained for climb or cruising conditions and finally, adjust the manifold pressure to the desired value.

(h) Dives

1. Propeller control ——— 1900-2200 RPM
2. Max. Diving RPM ——— 3060 RPM (30 sec.)
3. Cowl Flaps ——— CLOSED
4. Supercharger Control ——— NEUTRAL
5. Intercooler - Oil Cooler Shutters - Closed

NOTE: This airplane is equipped with a propeller accumulator (See T.O. 49-42.)

(i) Landing

1. Wheels ——— DOWN
2. Tail Wheel Caster ——— LOCKED (Land)
   UNLOCKED (Carrier)
3. Cabin Hood ——— Locked (OPEN)
4. Propeller ——— See T.O. 16-41*
5. Auxiliary Blower ——— NEUTRAL
6. Mixture ——— AUTO-RICH
7. Fuel Selector Valve ——— Best Tank
8. Cowl Flaps ——— OPEN
9. Oil Cooler and Inter-
   cooler Shutters ——— OPEN
10. Wing Flaps ——— DOWN
11. Armament Master Switch — OFF

* While the airplane speed is being reduced, the

propeller governor should be set for maximum cruising RPM or less to prevent high speed "windmilling" of the engine. The throttle should be closed as desired. Taxi with cowl flaps fully open.

(j) Stopping Engine

The following desludging procedure is highly desirable after each flight when operations permit:

1.	Propeller control	Take-off RPM
2.	Throttle	1000 RPM
3.	Supercharger Control	Make several shifts remaining in each position for about 30 sec.
4.	Throttle	1000-1200 RPM (30 sec.)
5.	Mixture Control	IDLE CUT-OFF
6.	Ignition Switch	OFF (when engine stops)

(k) Oil Dilution Procedure

In the event that temperatures below -5° C. (+23°F) are forecast oil dilution should be effected as outlined below:

1. Engine Oil-In temperature not more than 50°C (122°F). This is necessary only on airplanes equipped with Pratt & Whitney Oil Temperature Regulator).

2. Start engine (If previous stoppage was necessary to cool oil under Step (1) above.

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3. Engine speed constant, 1000 RPM.

4. Open dilution valve (close dilution valve switch). See note below.

5. Hold dilution valve open (switch closed) for approximately two minutes. Stop engine by moving mixture control to Idle Cut-Off Position, then cut ignition. Hold dilution valve open until engine stops turning.

6. When a cold engine is subsequently started and, after running a short while, the oil pressure starts to fluctuate or drop, the dilution valve shall be opened intermittently for intervals of a few seconds over a period of about fifteen seconds. If the oil pressure still does not steady out, stop the engine and let rest for approximately five minutes before attempting another start.

NOTE: When the dilution valve is opened, there will be a sharp drop in indicated fuel pressure. Fuel pressure should return to normal immediately upon closing the valve. If it does not, stop the engine immediately and check the valve for leakage.

(1) Operating Limits Charts

Figures 83, 84, 85, are NEUTRAL, LOW and HIGH blower operation respectively.

High Power (Part Throttle)

1. Operate along one of the designated constant manifold pressure RPM lines (or some intermediate interpolation) when high power climb is desired. (44" Hg. - 2550 RPM gives rated power at 5500 ft. - NEUTRAL Blower).

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2. Select level flight condition from a point on one of the designated lines or some intermediate interpolation.

Cruising Power (Part Throttle)

1. For power conditions below the 2250 RPM line, the recommended manifold pressures are independent of RPM.

2. Recommended manifold pressure for maximum cruising at specified altitude shown on Operating Limits Charts.

To Determine Horsepower - Any Condition.

1. Approximate - knowing RPM and manifold pressure, read horsepower - any altitude.

2. More exact - draw a line through the point determined parallel to the constant manifold pressure-RPM lines shown and read horsepower at intersection of this line with the altitude line.

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Carburetor: Stromberg PT-13G2

ENGINE OPERATION CHART

Engine Model: R-2800-10

Operating Conditions	Pressure Altitude (feet)	Max. Permissible R.P.M.	Max. Permissible Manifold Press. "Hg.	Mixture Control	Blower Ratio	Max. Cyl. Head Temperature (°C)	Permissible Oil in Temp. Gauge (°C)	Oil Pressure Lbs. per Sq. Inch
Starting		700		Idle Cut-off then Auto-Rich	Neutral			
Warm-Up		1000		Auto-Rich	Neutral low,high	205		
Take-Off*	S.L.	2700	54	Auto-Rich	Neutral	260	40-85	75-100
Normal Rated Power	S.L.-5500	2550	46-44 (FT)	Auto-Lean	Neutral	260	60-85	75-95
Normal Rated Power	5500-6200	2550	F.T.	Auto-Lean	Neutral	260	60-85	75-95
Normal Rated Power	6200-16400	2550	51-50 (FT)	Auto-Lean	Low	260	60-85	75-95
Normal Rated Power	16400-17600	2550	F.T.	Auto-Lean	Low	260	60-85	75-95
Normal Rated Power	17600-21500	2550	50.5-50 (FT)	Auto-Lean	High	260	60-85	75-95
Normal Rated Power	21500 up	2550	F.T.	Auto-Lean	High	260	60-85	75-95
Max. Cruising Power	S.L.-10800	2250	36-33	Auto-Lean	Neutral	232	60-75	60-90
Max. Cruising Power	10800-21000	2250	36-35	Auto-Lean	Low	232	60-75	60-90
Max. Cruising Power	21000-26000	2250	36-35.5	Auto-Lean	High	232	60-75	60-90
Max. Cruising Power	26000 Up	2250	F.T.	Auto-Lean	High	232	60-75	60-90
Military Power *	S.L.-1700	2700	54-52.5 (FT)	Auto-Lean	Neutral	260	40-100	75-100
Military Power *	1700-4700	2700	F.T.	Auto-Lean	Neutral	260	40-100	75-100
Military Power *	4700-15400	2700	56-54 (FT)	Auto-Lean	Low	260	40-100	75-100
Military Power *	15400-17700	2700	F.T.	Auto-Lean	Low	260	40-100	75-100
Military Power *	17700-20800	2700	54-52.5 (FT)	Auto-Lean	High	260	40-100	75-100
Military Power *	20800 Up	2700	F.T.	Auto-Lean	High	260	40-100	75-100
Dive		3060	15-20	Auto-Lean	Neutral	232	60-75	
Landing		2250		Auto-Rich	Neutral	232	60-75	
Stopping		High R.P.M.		Auto-Rich (Idle) Idle Cut-off (Stop)	Neutral			

* 5 Min. Rating

Fuel Pressure: Desired - 16 p.s.i.
Allowable - 16-18 p.s.i.
Min. Idling- 7 p.s.i.

ALTITUDE CHARACTERISTICS
NEUTRAL GEAR - AUTO LEAN
PT-13D4 - NAF JETTING
P. & W. R-2800-8 ENGINE

3911 SANDWALD
6.65:1 2:1
7.8:1, 11" DIA. MAIN

This curve is identical for the P & W R2800-10 engine equipped with the PT13G2 carburetor.

CURVES ESTIMATED FROM DYN. AND FLIGHT DATA.
CARB. AIR TEMP. = STD. ALT.

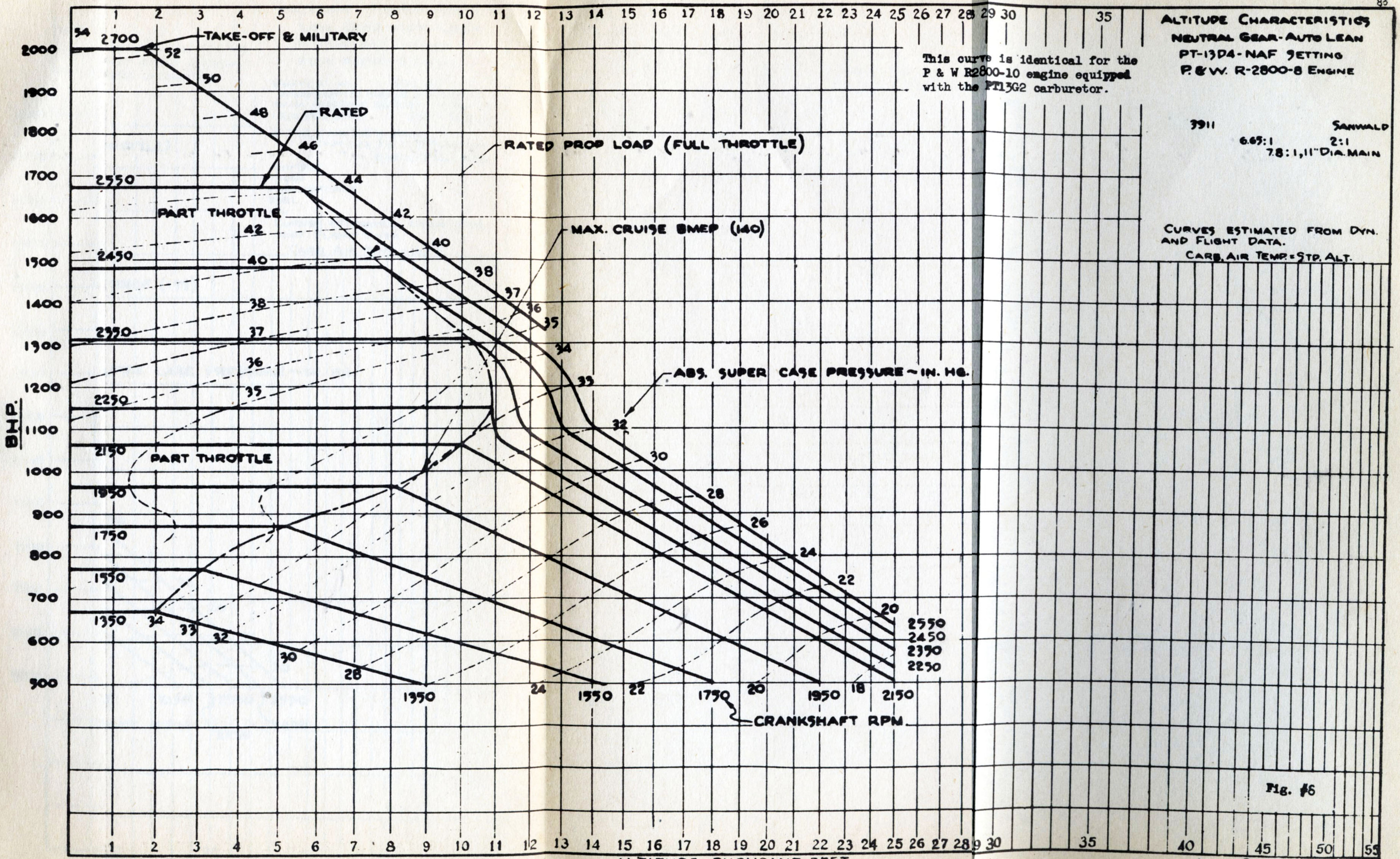

Fig. #6

SERIAL NO AEL

ALTITUDE CHARACTERISTICS
LOW GEAR - AUTO LEAN
PT-13D4 - NAF SETTING
P&W R-2800-8 ENGINE

ENGINE BU NO MFD NO
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY PHILA PA
PROJ 3911 DATE ENG'R SANWALD

RATIOS COMP 6.69:1 PROP 2:1
IMPELLER 7.8:1, 11" DIA. MAIN.
" 6.46:1, 13" DIA. AUX.

IGNITION
PLUGS
FUEL METERING
FUEL
OIL

CURVES ESTIMATED FROM DYN. AND FLIGHT DATA.

CARB. AIR TEMP. = 90°F.

This curve is identical for the P & W R2800-10 engine equipped with the PT13G2 carburetor.

MILITARY
RATED
RATED PROP. LOAD (FULL THROTTLE)
PART THROTTLE
PART THROTTLE
MAX. CRUISE BMEP (135)
ABS. SUPER CASE PRESSURE — IN. HG.
CRANKSHAFT RPM

BHP

ALTITUDE THOUSAND FEET

Fig. #9

ALTITUDE CHARACTERISTICS
HIGH GEAR-AUTO LEAN
PT-13D4-NAF SETTING
P&W R-2800-8 ENGINE

ENGINE BU NO MFG NO
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY PHILA. PA.
PROJ 3911 DATE ENG'R SANWALD

RATIOS COMP 6.65:1 PRCP 2:1
IMPELLER 7.8:1, 11" DIA. MAIN
" 7.93:1, 13" DIA. AUX.

IGNITION
PLUGS
FUEL METERING
FUEL
OIL

RESULTS ESTIMATED FROM DYN. AND FLIGHT DATA.
CARB. AIR TEMP. = 90°F.

This curve is identical for the P & W R2800-10 engine equipped with the PT13G2 carburetor.

MILITARY
RATED
PART THROTTLE
PART THROTTLE

RATED PROP. LOAD (FULL THROTTLE)
MAX. CRUISE BMEP. (128)
ABS. SUPER CASE PRESSURE ~ IN. HG.
CRANKSHAFT RPM.

BHP.

ALTITUDE THOUSAND FEET

Fig. #10

(1) Normal Instrument Readings

Typical Cruising

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

Propeller

RPM

Manifold Pressure

Aux. Supercharger

Cyl. Head Temperature

Outside Air Temperature

Fuel Pressure

Mixture Control

Oil Pressure

Oil Temperature

Airspeed

Elevator Tab Setting

Rudder Tab Setting

Aileron Tab Setting

Fuel Consumption

SECTION III

FLYING CHARACTERISTICS

(a) Loading Schedule

This schedule has been prepared to enable service personnel to easily and quickly determine if the center of gravity for any loading condition is within the recommended forward and aft limits.

The definition of terms used throughout the schedule are listed below:

1. Basic Weight

   This weight represents the actual weight empty plus non expendable useful load items. (See page 88).

2. Index Unit:

   An Index Unit is the moment (weight x distance) of any item in the airplane about the horizontal reference line (see page 93 divided by 1000 to allow greater ease of handling.)

3. Limiting Percent Lines: (See Fig. 14, page 95).

   The diagonal lines represent the recommended balance limits between which the center of gravity should be maintained. The lines are expressed in percentage of mean aerodynamic chord.

4. A sample calculation showing how these data are used has been included on page 89.

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DERIVATION OF BASIC WEIGHT

	Weight	Index Unit
Actual Weight Empty	8886	885.6
Useful Load Items		
Pilot & Chute	200	29.0
Trapped Fuel & Oil	92.5	6.8
(2 inboard)	118.7	12.6
.50 Cal. Guns (2 mid)	118.7	13.4
(2 outboard)	118.7	14.4
6 Front Trunnions	6.6	0.7
6 Rear Post Assemblies	8.4	1.0
6 Electric Trigger Controls	13.2	1.6
Gun Switch	1.0	0.1
2 Hydraulic Gun Charging Valves	2.6	0.3
6 Hydraulic Gun Charging Cylinders	13.8	1.7
Gun Sights	5.6	0.7
Navigation Equipment	3.3	0.4
Oxygen Equipment	27.5	4.6
Molin Signal Discharger & Ammunition	11.8	2.3
Gun Camera	4.2	0.3
Life Raft (Seat Type)	14.0	2.0
Radio (ZB, IFF & ARA/ATA)	145.5*	31.6
Emergency Kit	8.7	1.3
Basic Weight (Wheels Up)	9801.0*	1010.4
Extend Wheels	0.0	-23.8
	9801.0	986.6

The Basic Weight and Index Unit represents the weight and center of gravity of items which are usually in the airplane under most operating conditions less fuel, oil and ammunition. In the event any of the items included in the basic weight are NOT carried, the weight and index unit for these items should be subtracted.

*See pages 96 & 97 for detail breakdown of Radio and Armor included in Basic Weight.

SAMPLE CALCULATION

Assume that the airplane is to be ferried and will carry 182 gals. of fuel and 13 gals. of oil; complete armament less ammunition; complete radio installation except that one receiver is not installed; all other useful load items which are included in the basic weight and 150 pounds of spare parts stowed at Station #112.

From	Item	Weight	Index Unit
Page 88	Basic Weight (Wheels Up)	9801	1010.4
Page 96	Omit One Radio Receiver	-10.7	-2.4
Page 94	Fuel (107 gals.) Main Tanks	642	72.5
Page 94	Fuel (75 gals.) Reserve Tank	450	64.9
Page 94	Oil (13 gals.)	97.5	8.8
Page 92	Box Spare Parts-Aft Baggage Rack Sta. 112 (2.2 units/10#)	150	33.0
	Gross Weight (Wheels Up) at beginning of flight	11129.8	1187.2

If the total weight is plotted against the total index units on Fig. 14, page 95, it is apparent that the C.G. falls between the recommended limits and therefore is satisfactory for flight.

Gross Weight at Beginning of Flight (Wheels Up)	11129.8	1187.2
Fuel Consumed from Main Tank (107 gals.)	-642	-72.5
Fuel Consumed from Reserve Tank (75 gals.)	-450	-64.9
Extend Wheels	0	-23.8
(Most Forward Condition) Gross Weight at End of Flight (Wheels Down)	10037.8	1026

If the total weight is plotted against the total index units on Fig. 14, page 95, it is apparent that the C.G. falls between the recommended limits and therefore will be satisfactory at the end of the flight.

REPRESENTATIVE LOADING CONDITIONS

FIGHTER NORMAL

Item	Weight	Index Unit
Basic Weight (Wheels Up)	9801	1010.4
Fuel - Main Tank (107 gals.)	642	72.5
Fuel - Reserve Tank (75 gals.) (Total Capacity)	450	64.9
Oil (13 gals.)	97.5	8.8
Ammunition		
400 Rds. Total Outboard Guns	119.6	14.1
400 Rds. Total Mid Guns	119.6	13.2
400 Rds. Total Inboard Guns	119.6	12.4
Normal Gross Weight (Wheels Up)	11349..	1196.3
Balance is 26.4% M.A.C. (Wheels Up)		
Subtract Units to Extend Wheels	--	-23.8
Normal Gross Weight (Wheels Down)	11349	1172.5
Balance is 24.2% M.A.C. (Wheels Down)		

FIGHTER OVERLOAD

Basic Weight (Wheels Up)	9801.	1010.4
Fuel - Main Tanks (175 Gals.)	1050	119.2
Fuel - Reserve Tank (75 gals.)	450	64.9
Oil (16 gals.)	120	10.8
Ammunition		
800 Rds. Total Outboard Guns	239.2	28.1
800 Rds. Total Mid Guns	239.2	26.5
800 Rds. Total Inboard Guns	239.2	24.8
Overload Gross Weight (Wheels Up)	12139.	1284.7
Balance is 26.8% M.A.C. (Wheels Up)		
Subtract Units to Extend Wheels	--	-23.8
Overload Gross Weight (Wheels Down)	12139	1260.9
Balance is 24.8% M.A.C. (Wheels Down)		

STRAWBRIDGE

FIGHTER WITH DROPPABLE TANK & MAXIMUM FUEL & OIL

Item	Weight	Index Unit
Basic Weight (Wheels Up)	9801.	1010.4
Fuel - Main Tanks (175 gals.)	1050	119.2
Fuel - Reserve Tank (75 Gals.)	450	64.9
Droppable Tank	111.4	12.0
Fuel - Droppable Tank (150 gals.)	900	92.6
Oil (19 gals)	142.5	12.8
Ammunition		
800 Rds. Total Outboard Guns	239.2	28.1
800 Rds. Total Mid Mid Guns	239.2	26.5
800 Rds. Total Inboard Guns	239.2	24.8
Gross Weight (Wheels Up)	13172.5	1391.3
Balance is at 26.6% M.A.C. (Wheels Up)		
Subtract Units to Extend Wheels	--	-23.8
Gross Weight (Wheels Down)	13172.5	1367.5
Balance is at 24.8% M.A.C. (Wheels Down)		

USEFUL LOAD ITEMS NOT INCLUDED IN BASIC WEIGHT

Item	Weight	Index Unit
Fuel - Main Tanks (each 10 gals.)	60.	6.8
Maximum Fuel Main Tanks (175 gals.)	1050.	119.2
Maximum Fuel Reserve Tank (75 gals.)	450.	64.9
Droppable Tank	111.4	12.0
Fuel Droppable Tank (Each 10 gals.)	60.	6.2
Maximum Fuel Droppable Tank (150 gals)	900.	92.6
Oil Per Gal.	7.5	0.7
Maximum Oil (19 gals.)	142.5	12.8
.50 Cal. Ammu. (for each 100 Rds. Each Outb'd Gun)	29.9	3.5
.50 Cal. Ammu. (for each 100 Rds. Each Mid Gun)	29.9	3.5
.50 Cal. Ammu. (for each 100 Rds. Each Inb'd Gun)	29.9	3.1
.50 Cal. Ammu. (Max. Cap. 400 Rds. Each Outb'd Gun)	119.6	14.1
.50 Cal. Ammu. (Max. Cap. 400 Rds. Each Mid Gun)	119.6	13.2
.50 Cal. Ammu. (Max. Cap. 400 Rds. Each Inb'd Gun)	119.6	12.4

SPECIAL EQUIPMENT AND BAGGAGE

Cockpit Cover	5.2	No Stowage
Engine Cover	18.0	No Stowage
Tow Target Provisions	2.0	.2
Prop. Cover	2.9	No Stowage
Wing Fold. Covers (2)	2.9	No Stowage
Carb. Air Filters	6.0	.4
Hoisting Sling	9.8	No Stowage
Tricing Sling (Forward and Rear)	6.2	No Stowage
Tool Kit	7.0	No Stowage
Baggage 10# at Sta. #112 (up to 180#)	10.0	2.2
Baggage 10# at Sta. #60 (up to 70#)	10.0	1.6

NOTE: The weight and index unit for any given amount of fuel or oil can be obtained from figures 12 and 13 on page 94.

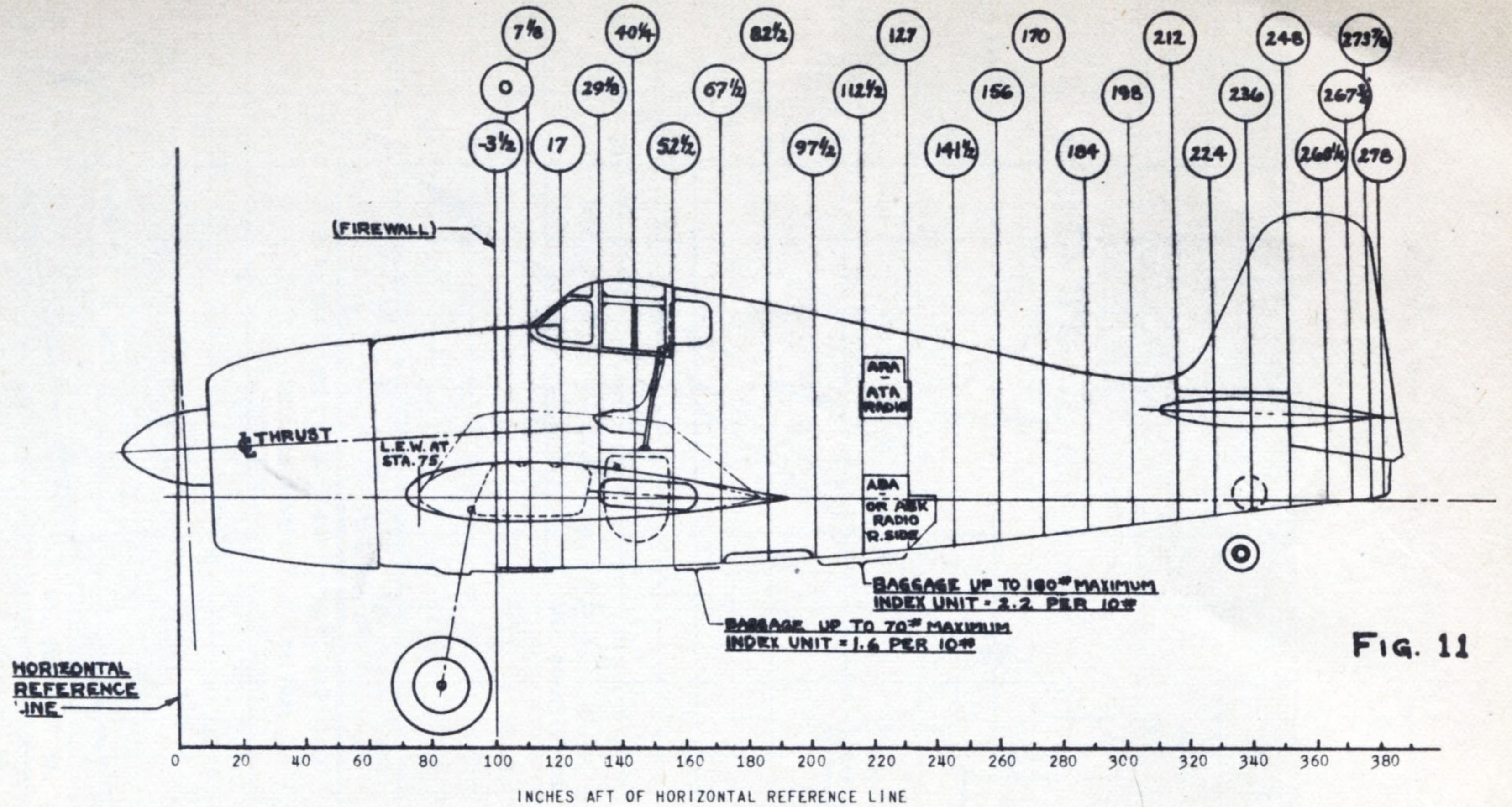
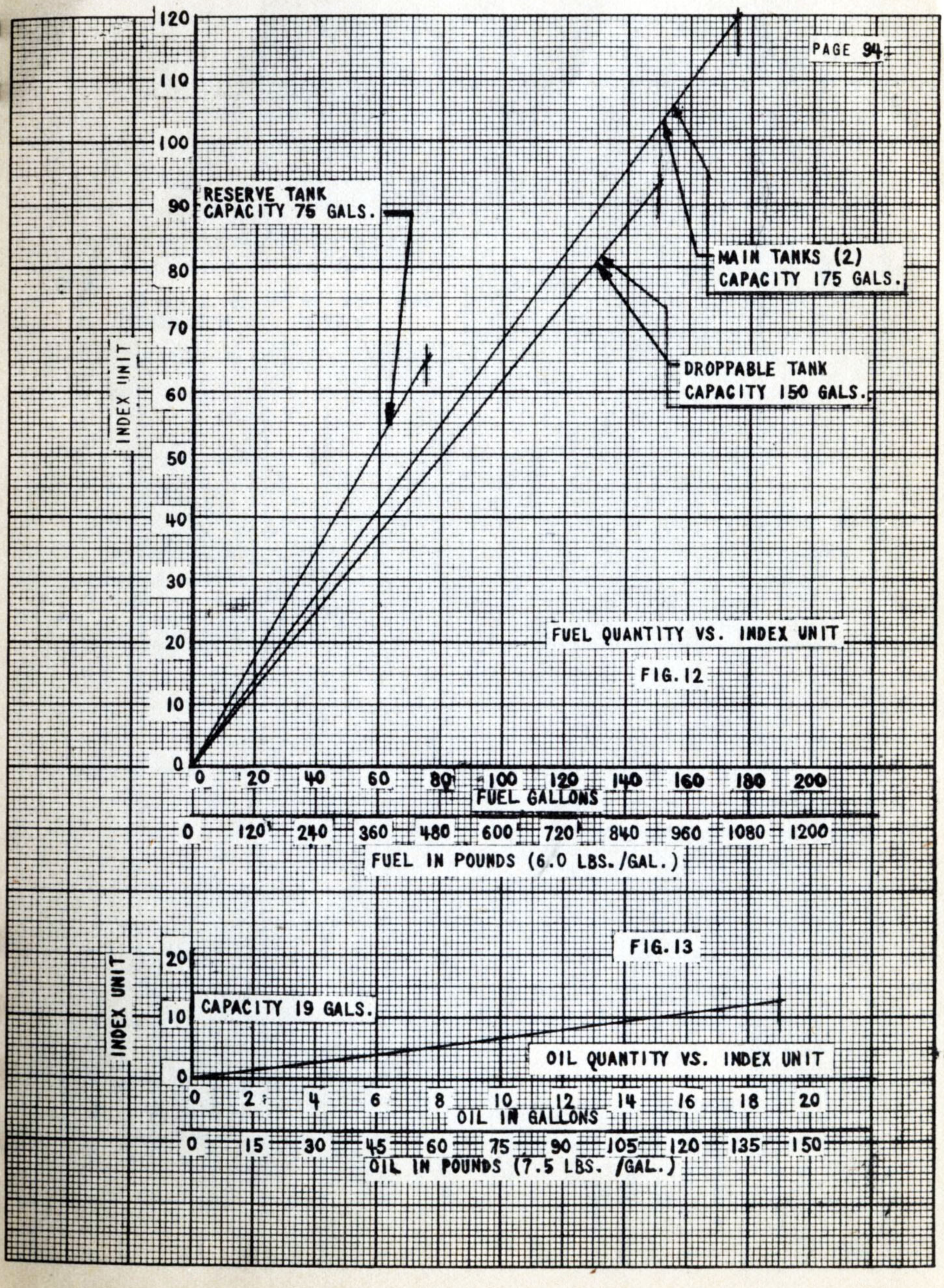


FIG. 11

To determine the index unit for any item of weight

$$\text{Index Unit} = \frac{W \times D}{1000}$$

W = weight in pounds
D = Distance in inches that the weight is located aft of the Horizontal Reference Line, or, 100 plus the distance in inches that the weight is located aft of Sta. -3½ (Firewall).



FUEL QUANTITY VS. INDEX UNIT

FIG. 12

FIG. 13

OIL QUANTITY VS. INDEX UNIT

NOTE:
1. L.E.M.A.C. 79.70" AFT REF. LINE.
2. LENGTH OF M.A.C. IS 97.4".

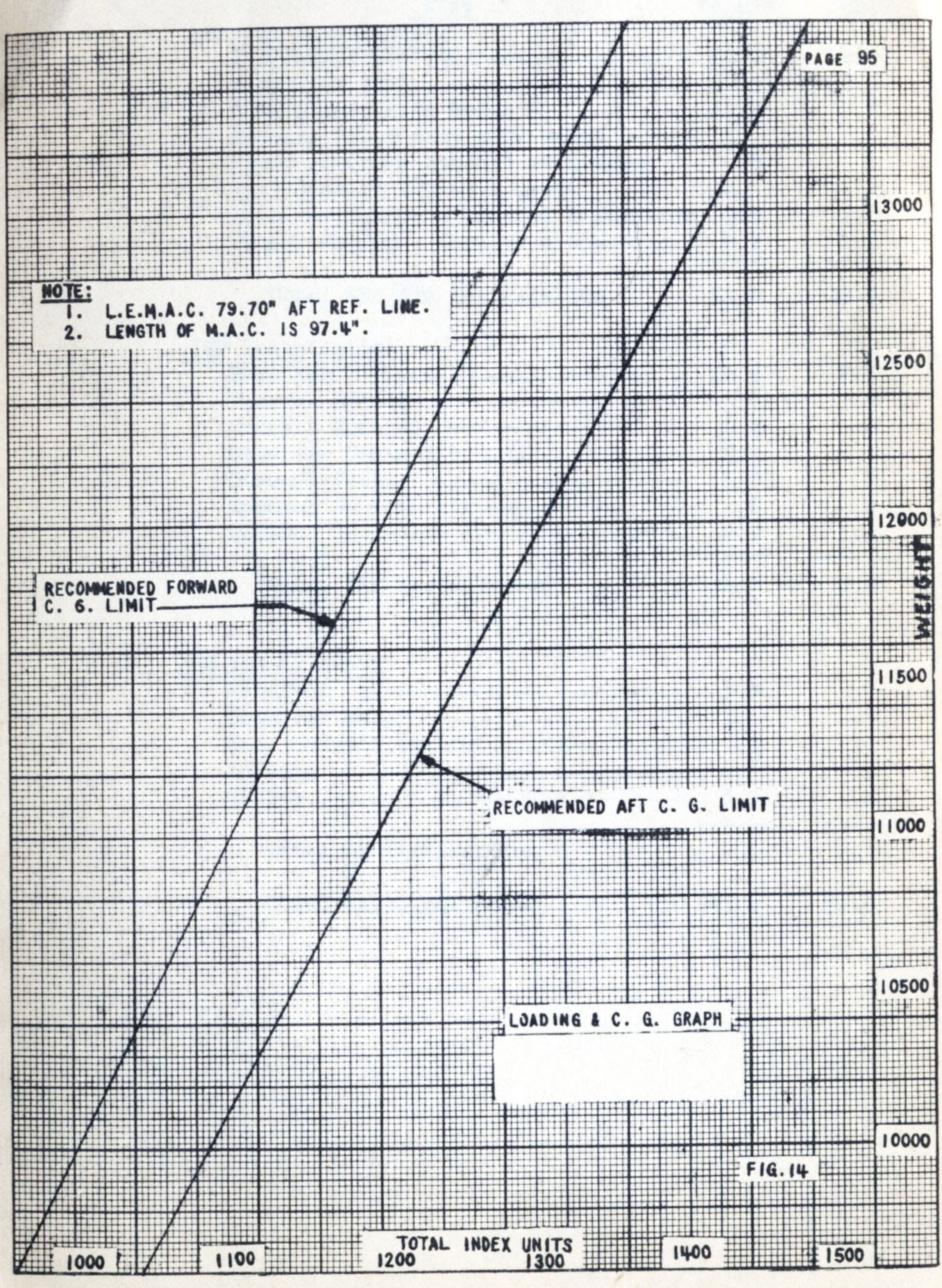


FIG. 14

RADIO EQUIPMENT
(Included in Basic Weight page 88)

Item	Weight	Unit
ARA/ATA Installation		
2 Transmitters with mount	20.4	4.6
Modulator 5325	18.0	4.2
3 Receivers with Mount	32.2	7.2
Antenna relay unit with mount	2.1	.4
Trans. Control Box CBY with mount	.8	.1
Rec. Control Box with mount	2.4	.4
Receiver Cables - Control & Electric	9.5	1.8
Trans. Cables - Control & Electric	5.7	1.2
Total ARA/ATA Installation	91.1	19.9
IFF Installation		
Receiver	32.6	7.4
Inertia Switch	1.4	.2
Cockpit Control	1.0	.1
Receiver Control	2.1	.3
Circuit Tester	1.0	.2
Antenna	.6	.2
Cables	6.0	1.2
Total IFF Installation	44.7	9.6
ZB Installation		
Receiver	3.5	.8
Receiver Relay	1.4	.3
Rec. Cockpit Control	.6	.1
Antenna	.8	.2
Cables	3.4	.7
Total ZB Installation	9.7	2.1
TOTAL RADIO EQUIPMENT	145.5	31.6

LIST OF REMOVABLE ARMOR
(Included in Basic Weight page 88)

Item	Weight	Unit
Station #-3½ - Firewall	20.1	2.0
Oil Tank	19.1	1.5
Ring Cowl	14.2	.3
Station #52½ Upper	26.7	4.2
Station #52½ Lower	81.3	12.9

(b) MANEUVERS

Restrictions (T.O. 7-43)

Pending satisfactory completion of demonstration of this model, the speed and acceleration restrictions are as follows:

Maximum permissible indicated speeds:

Altitudes up to 15,000 ft.	390 knots
Altitudes above 15,000 ft.	370 knots
For unlimited use of ailerons (at higher speeds, use of the ailerons should be restricted to the same control force required for full aileron operation at 200 knots.)	200 knots

Maximum permissible accelerations -

	Positive	Negative
Below 320 knots (indicated)	7.0	3.0
Above 320 knots (indicated)	5.5	2.5
For unlimited use of ailerons	5.0	2.0
For use of Maneuver Flaps	5.0	2.0

These maximum permissible accelerations are applicable to gross weights up to that of the overload fighter, approximately 12.200 lbs. Above the overload fighter gross weight, the maximum permissible accelerations should be reduced so as to maintain a constant product of gross weight and acceleration.

Revised 7/28/43

(c) SPINS

Spinning Tendencies

Normal Spins

Turns to Left ——————— Recovery —— Turns
Turns to Right ——————— Recovery —— Turns

Inverted Spins

(d) TAKE-OFF WITH FULL FLAPS - WING GUNS (6)

Gross Weight

Take-Off Run in no wind ——————————— Ft.
Take-Off Run in a 25 Knot wind ——————— Ft.

A reduction of approximately —— % in length of run results from the application of full flap.

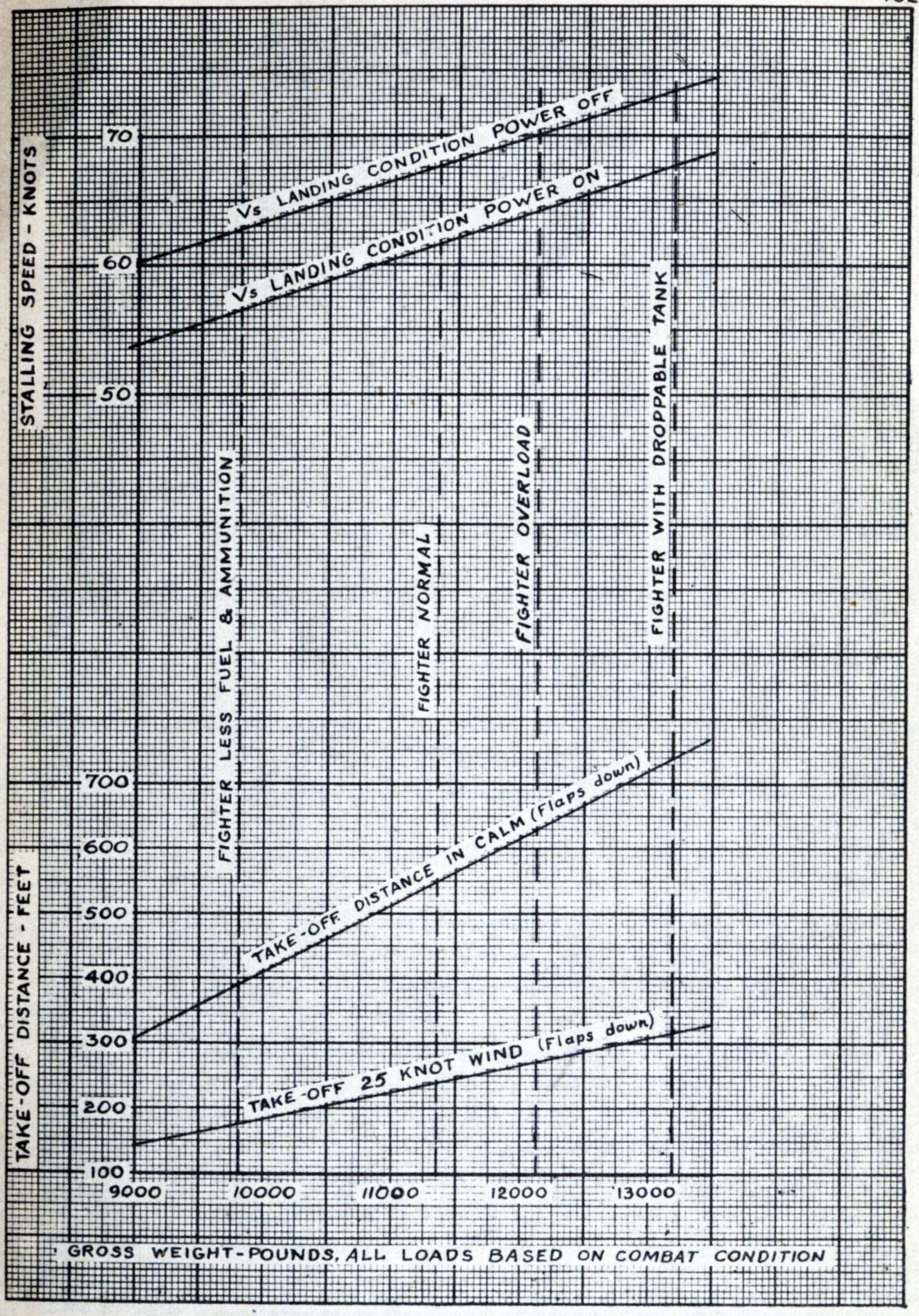


FIG. 15 - TAKE-OFF, RUN & STALLING SPEED CHART

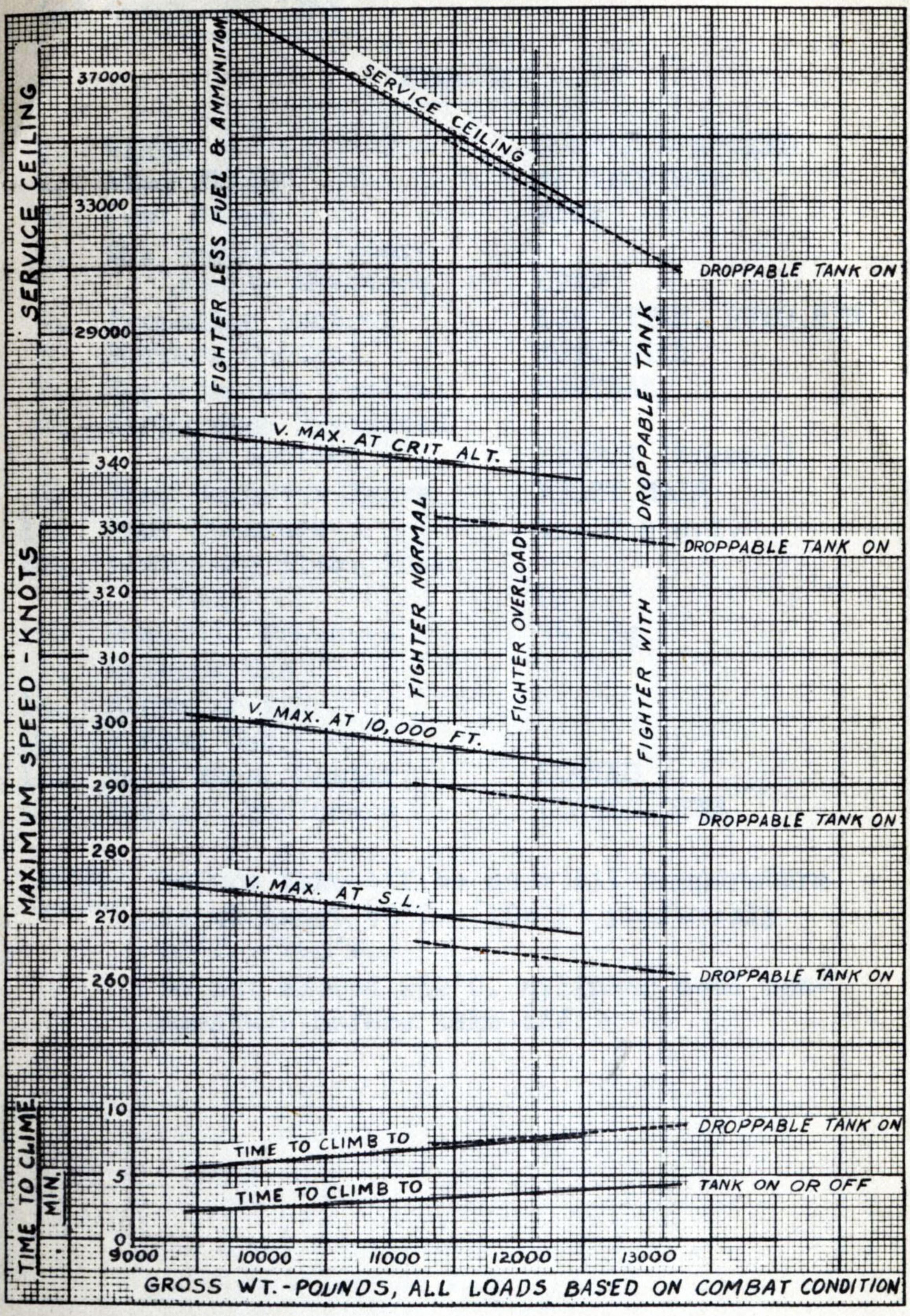


FIG. 16 - CLIMB - SPEED & CEILING CHART

(e) CHECK-OFF LIST

Take-Off

1.	Wings	SPREAD & LOCKED
2.	Wing Flaps	AS REQUIRED
3.	Cowl Flaps	OPEN
4.	Oil Cooler & Inter-cooler Shutters	OPEN
5.	Propeller Control	LOW PITCH, 2700 RPM
6.	Mixture Control	AUTO RICH
7.	Supercharger Control	NEUTRAL
8.	Carburetor Protected Air Control	DIRECT (Normal)
9.	Fuel Selector Valve	RIGHT MAIN
10.	Fuel Pressure	16-18 p.s.i.
11.	Auxiliary Elec. Fuel Pump	ON
12.	Manifold Pressure	54" Hg.
13.	Aileron Tab	
14.	Elevator Tab	
15.	Rudder Tab	
16.	Tail Wheel Caster	LOCKED
17.	Cockpit Enclosure	LOCKED OPEN

NOTE: Before take-off be sure oil temperature is at least 40°C. (104°F) preferably 60°C. (140°F.)
Do not exceed 232°C. cylinder head temperature before take-off.

Revised 4/20/43

Landing

1.	Wheels	DOWN
2.	Tail Wheel Caster	LOCKED (Land) UNLOCKED (Carrier)
3.	Cabin Hood	Locked (OPEN)
4.	Propeller	See T.O. 16-41*
5.	Auxiliary Blower	NEUTRAL
6.	Mixture	AUTO-RICH
7.	Fuel Selector Valve	Best Tank
8.	Cowl Flaps	OPEN
9.	Oil Cooler and Inter-cooler Shutters	OPEN
10.	Wing Flaps	DOWN
11.	Armament Master Switch	OFF

* While the airplane speed is being reduced, the propeller governor should be set for maximum cruising RPM or less to prevent high speed "windmilling" of the engine. The throttle should be closed as desired. Taxi with cowl flaps fully open.