RESTRICTED

PILOT'S HANDBOOK

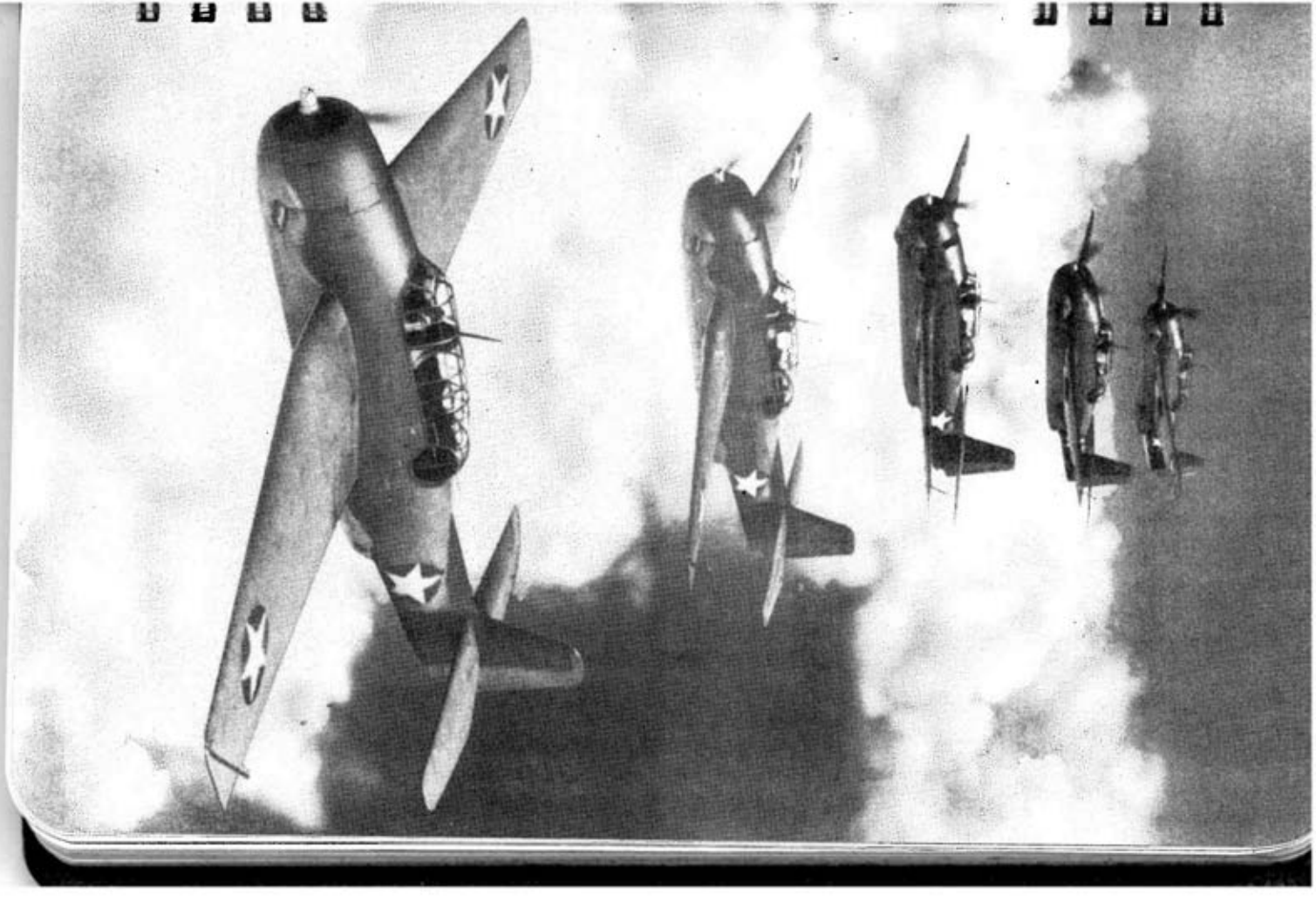
MODEL TBF-1 AIRPLANE
MODEL TBM-1 AIRPLANE

CONTRACT NO. LL-91367
CONTRACT NO. 98837
ENGINE NO. R-2600-8 OR R-2600-8A

AVENGER 1

RELEASED BY THE BUREAU OF AERONAUTICS NAVY DEPARTMENT

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
BETHPAGE, L. I., N. Y.
EASTERN AIRCRAFT–TRENTON DIVISION
GENERAL MOTORS CORPORATION, TRENTON, N. J.



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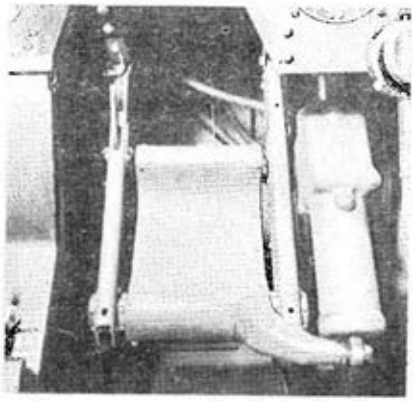
LIST OF ILLUSTRATIONS

SECTION I
COCKPIT ARRANGEMENT
AND
CONTROLS

The arrangement of the cockpits and compartments 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 name plates.



I. FLIGHT CONTROLS

Aileron & Elevator

Standard type stick.

Rudder

Standard underhung pedals.

Rudder Pedal Adjustment

Adjustable to three (3) positions by a toe lever on each inner pedal arm.

With toes on adjustment levers, push pedals all the way FORWARD, then with toes under 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. Adjustment of the rudder pedals automatically adjusts the brake pedal to the same position.

Brake Control

The hydraulic brakes are operated by pressing on the upper part of the rudder pedals. Cylinders outboard of pedals move in conjunction with pedals.

Aileron Trimming Tab

Handwheel on forward side of left hand shelf.

ROTATE OUTBOARD - LEFT WING DOWN
ROTATE INBOARD - RIGHT WING DOWN

Elevator Trimming Tab

Handwheel on inboard side of left hand shelf.

ROTATE CLOCKWISE - NOSE DOWN
ROTATE COUNTER-CLOCKWISE - NOSE UP

Rudder Trimming Tab

Handwheel on top of left hand shelf.

ROTATE CLOCKWISE - NOSE RIGHT
ROTATE COUNTER-CLOCKWISE - NOSE LEFT

Wing Flap Control

Round Knob Control Lever on Flap and Landing Gear Control Unit located on lower left hand side of the main instrument panel. See Page 52 for operating instructions. The flap position indicator is located adjacent to the control lever. Lowering the flap lever also lowers the landing gear if it has not been previously lowered.

LEVER UP - FLAPS UP
LEVER DOWN - FLAPS DOWN

It is important to note that the wing flaps are not equipped with locks for holding them in the DOWN position, therefore, they depend upon the hydraulic pressure remaining constant. In an emergency, when there are indications of loss of hydraulic pressure or leaks in the system, the flaps should always be lowered after the landing gear. If they are lowered first and leaks have developed in the system, the slipstream may force the flaps UP and there would not be enough fluid in the system to lower them again.

Surface Controls Locking Device

This device consists of a metal cap which fits over the control stick, two elastic cords which hook into the body structure and two cables which hook into the rudder pedals.

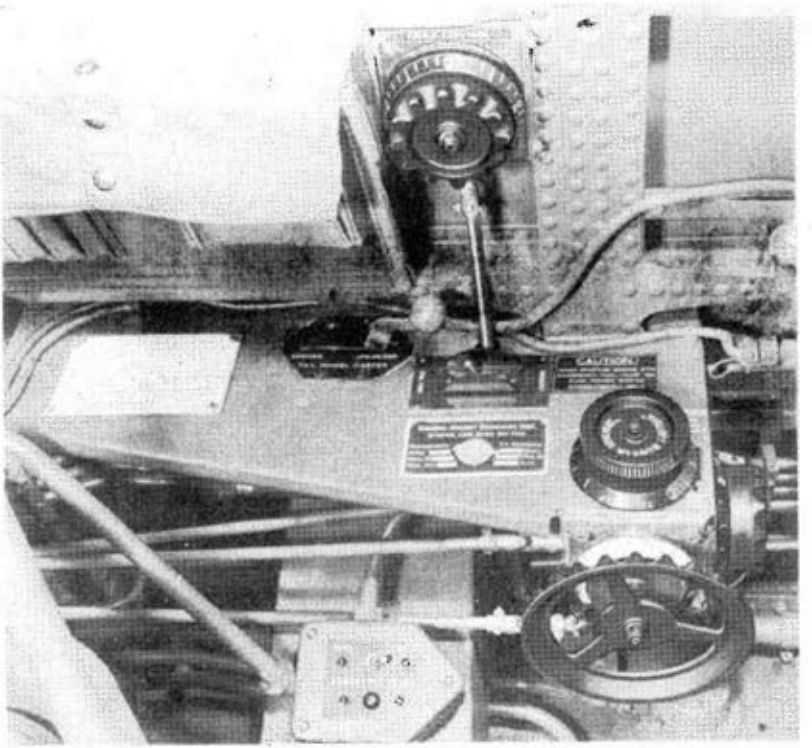
S.B.A.E. Unit

Refer to Section II, Article 2, for Operation.

Attitude control on left hand side of pilot's cockpit below cabin rail.

TURN CLOCKWISE - NOSE DOWN
TURN COUNTER-CLOCKWISE - NOSE UP

Servo and Precessing Switches and Tell-Tale Lights on pilot's electrical distribution panel.



2. LANDING GEAR CONTROLS

The airplane is equipped with hydraulically operated Main and Tail Wheels which are retracted or extended simultaneously by double acting hydraulic cylinders. The operating pressure is supplied normally by the engine driven hydraulic pump or by the hydraulic hand pump for auxiliary operation.

Normal Operation (See Page 9)

The Main and Tail Wheels are retracted or extended by manual operation of the two position Square Knob Control Lever on the Flap and Landing Gear Control Unit located on the lower left hand side of the main instrument panel.

LEVER UP - WHEELS RETRACTED
LEVER DOWN - WHEELS EXTENDED

Auxiliary Operation

In the event that the engine driven pump is not operating, the Main and Tail Wheels may be raised or lowered by operating the Hydraulic Hand Pump in conjunction with the Hand Pump Selector Valve.

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

Time Required to Raise - 75 Sec. Approx.
Time Required to Lower - 20 Sec. Approx.

Emergency Operation

In the event of complete hydraulic system failure, the Emergency Unloading Valve "T" Handle, located directly below the Square Knob Control Lever, should be pulled. Pull FULL AFT and LOCK by rotating 45° CLOCKWISE. This handle operates the emergency hydraulic pump valve and unlatches the retracted position locks; the force of gravity aided by the springs in the hydraulic cylinders lowers and locks the wheels in the full down position.

CAUTION: Reduce the indicated airspeed to approximately 95 Knots or less before lowering landing gear.

NOTE: If the gear does not come full down and lock, shake airplane from side to side.

The "T" Handle will operate regardless of the position of the Square Knob Control Lever.

No other part of the hydraulic system is affected by 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 the reason for hydraulic failure determined.

Wheel Locks

The mechanical interconnector, between the Square Knob Control Lever and the nut-cracker arm on the left hand shock strut, prevents landing gear retraction on the ground. The control lever cannot be moved to the UP position unless the shock struts are in the fully extended position, which occurs in flight only. (Operation completely automatic.)

On the ground, a mechanical lock prevents the side 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 cylinder.

A retracted position lock, operated by the landing gear actuating cylinder and located in the wing center section, locks the wheels in the UP position. The lock is connected to the Emergency Release "T" Handle by a cable in order to permit lowering the wheels in the event of failure of the hydraulic system.

Warning Indicators

Mechanical

Small arrow head pointers, in slot directly inboard of the control, indicate the position of each wheel.

Electrical

A landing gear warning horn is located on the bulkhead behind the pilot. It is connected in series with the Throttle, Landing Gear and Wing Folding Switches. The horn will sound when the engine is throttled below approximately 1200 RPM with the landing gear not fully extended and locked.

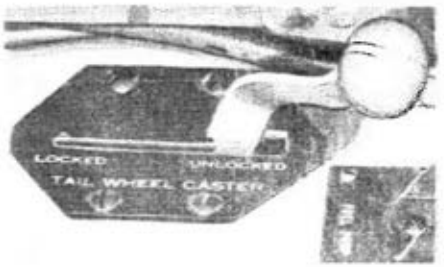
Operation Check

The pilot, before putting his landing gear down, should check his pump pressure gage. If the pressure is found to be below 1150 lbs., which is the minimum normal operating pressure, he should employ the following emergency measures: Set the landing gear control lever to DOWN, move the Hand Pump Selector Valve Handle to LANDING GEAR, and then proceed to build up 1750 lbs. system pressure. Such pressure would insure that both the main wheels and tail wheel were down and locked.

It is possible, due to hydraulic failure, that the Main Wheels might indicate full-down but the Tail Wheel is fully retracted; therefore, after lowering the Landing Gear preparatory to making a landing, check hydraulic pressure on inboard gage. If this gage shows no pressure, pull Emergency Landing Gear "T" Handle.

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 UNLOCKED
LEVER AFT - CASTER LOCKED

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.

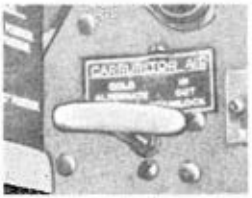
For carrier operation leave the tail wheel caster unlocked.

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

3. POWER PLANT CONTROLS

Carburetor Air Control

Push-pull "T" Handle located on the upper left hand side of the main instrument panel.



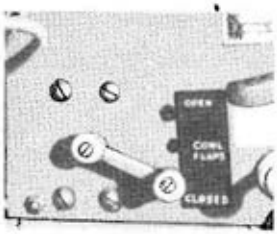
IN - DIRECT
OUT - ALTERNATE
PULL UP TO UNLOCK

Ram increases the maximum power available at any altitude above rated altitude and increases the altitude at which rated power is available. Operation on ALTERNATE (protected) carburetor air supply reduces the power available only at FULL throttle. To compensate for loss of ram at any altitude below rated altitude or during part throttle operation, open the throttle a little wider. The higher temperature of the ALTERNATE supply causes a further loss in power which may also be overcome during part throttle operation by opening the throttle a little more. Actual power available when operating on alternate air intake is not affected at any throttle opening other than full throttle. From the above it can be seen that nothing can be gained by using the ramming DIRECT air intake below full throttle power. Use the ALTERNATE air intake under any operating condition when there is even the slightest possibility of induction system icing.

Do not use an intermediate position of this control.

Cowl Flaps Control

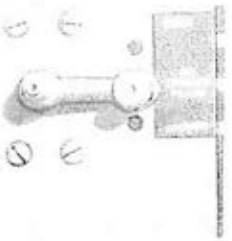
Three position hydraulic control lever located directly above the left rudder pedal. Flaps may be stopped in any intermediate position by returning the control lever to NEUTRAL.



LEVER UP - FLAPS OPEN
LEVER CENTER - NEUTRAL
LEVER DOWN - FLAPS CLOSED

Oil Cooler Flaps Control

Two position hydraulic control lever located on the left hand side of the main instrument panel.

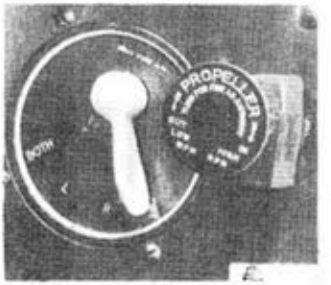


LEVER UP - FLAPS OPEN
LEVER DOWN - FLAPS CLOSED

The flaps can be operated by the Hydraulic Hand Pump in conjunction with the Hand Pump Selector Valve Control when the engine driven hydraulic pump is not operating. See Hydraulic System, herein.

Ignition Switch

Located on the left hand side of the instrument panel.



Primer - Electric

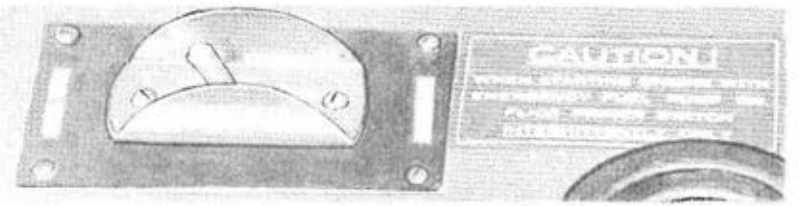
Located on the pilot's distribution panel.

Propeller Anti-Icer Control

The propeller anti-icing system consists of a five-gallon fluid supply tank, feed lines, an electrically driven pump and a slinger ring, located on the aft side of the propeller.

The rheostat control for the pump's motor is located on the lower right hand side of the main instrument panel. A circuit breaker reset button is located on the side of the electrical distribution panel.

Fuel Pump - Electric Emergency



Controlled by a toggle switch on the pilot's left hand shelf. Use pump to build up pressure for starting the engine, to maintain fuel pressure at altitude, for emergency use in case of fuel pump failure, and to maintain fuel pressure while changing tanks. When shifting to droppable tank, make sure that electric emergency fuel pump is left on for at least one minute after effecting shift, otherwise loss of fuel pressure and engine failure may result.

Fuel Strainer Drain - Main

Push-pull knob on control panel above left rudder pedal. Press center of knob to unlock, then pull AFT to drain strainer, hold out for approximately 5 seconds, then push FULL IN.

NOTE: Strainer should be drained at least every day just prior to flight.

CAUTION: Keep closed after draining.

Fuel Tank Selector

Five position dial with standard control handle located on the lower instrument panel.

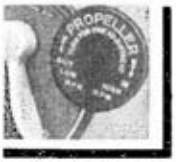
The dial has the following designations:

OFF
CENTER MAIN
LEFT MAIN
RIGHT MAIN
DROPPABLE

NOTE: Unless the fuel cock shaft rotates far enough so that proper positioning can be noted by feeling the shaft cam detent engage with the poppet valve acutating pin, there is a possibility that the poppet valve of the adjacent port is not fully closed. In this condition two ports are open with the consequent transfer of fuel from the high positioned tank to that of the lower and possible loss in fuel pressure and engine failure.

Electric Switches for Droppable Tanks

Later Avenger I's have three droppable tanks, right and left wing droppable tanks and center droppable tank. An electric "ON-OFF" switch for each of these tanks to be used in conjunction with the tank selector valve is located below the tank selector valve. See page 67



Propeller Control

Push-pull Governor Control Knob on left hand side of the main instrument panel.

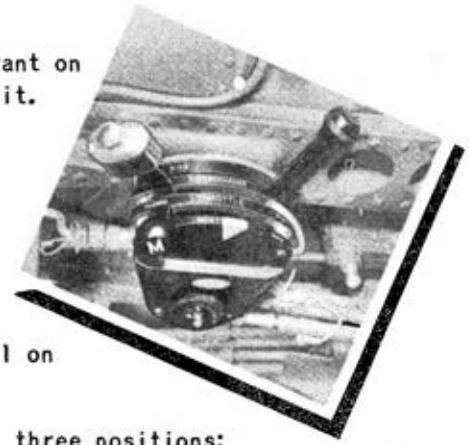
PUSH IN - INCREASE RPM (DECREASE PITCH)
PULL OUT - DECREASE RPM (INCREASE PITCH)

For vernier control, turn control knob clockwise to increase RPM and COUNTER-CLOCKWISE to decrease RPM.

Throttle Control

On engine control quadrant on left hand side of cockpit.

LEVER AFT - CLOSED
LEVER FORWARD - OPEN



Mixture Control

On engine control on left hand side of cockpit. See Mixture Control on page 63

The Mixture Control has three positions:

LEVER AFT	- IDLE CUT-OFF	(RED)
LEVER CENTER	- AUTOMATIC LEAN	(WHITE)
LEVER FORWARD	- AUTOMATIC RICH	

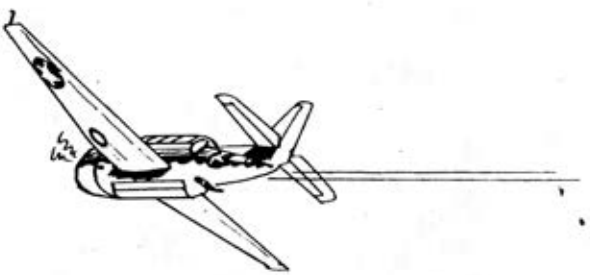
Supercharger Control

On engine control quadrant on left hand side of cockpit.

FULL FORWARD - LOW BLOWER
FULL AFT - HIGH BLOWER

Engine Control Quadrant - Friction Adjustment

The Friction Adjustment Knob is located on the inboard side of the Engine Control Quadrant. Rotate knob Clockwise to increase friction on levers.



4. AUXILIARY CONTROLS

Approach Light

Automatic Operation

Turns ON automatically when the arresting hook is extended.

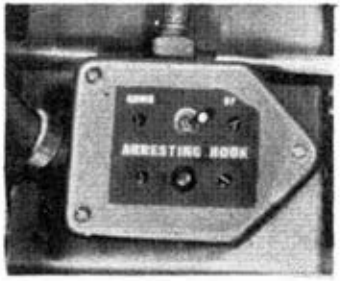
Electric Operation

The Approach Light Switch on the distribution panel is used when simulating carrier operation on land fields.

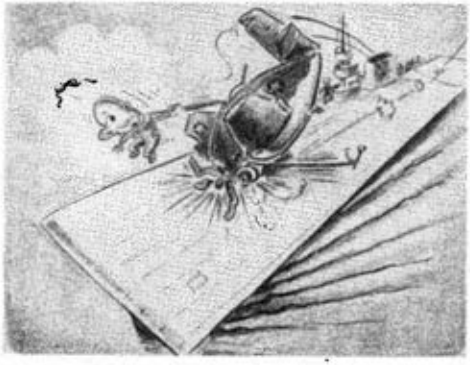
Arresting Hook

Electric Operation

The Arresting Hook Switch and Circuit Breaker Reset Button located below pilot's left hand shelf, operate electric motor to either EXTEND or RETRACT hook.

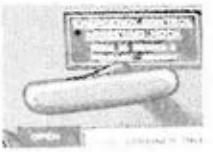


FORWARD - HOOK RETRACTED
AFT - HOOK EXTENDED



WARNING: Pilot shall insure that switch is in the hook out position and that the manual control cannot be pulled through a full stroke, prior to landing aboard a carrier.

Manual Operation



Emergency Control "T" Handle located on control panel directly above left rudder pedal. Pull ten inches and release to extend hook - repeat approximately 5 strokes. This control will not RETRACT the hook.

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

Cockpits Enclosure Controls

Pilot's Cockpit

The pilot's sliding enclosure is constructed in two sections, left and right. Either side of the enclosure may be latched in either the full open or closed or in any one of three fixed intermediate positions. Each side also may be locked or unlocked from the outside while in the closed position by pressing the knurled push button on the selected side panel.

For emergency exit, the Red Painted Release Lever on the LEFT HAND SIDE PANEL shall be pulled INBOARD then push side panel OUT.

Second Cockpit

Enclosure operating control lever on the right hand side just above the cockpit rail. The enclosure may be opened from the outside by access through the small door below the right hand cabin rail.

For emergency exit, pull the Red Painted Knob on the right hand side of the enclosure INBOARD, turn handle DOWN, and push enclosure UP.

Turret Operation

For emergency exit from the turret, push the handle on operator's right hand side AFT and shove circular hatch OUTBOARD. Since gunner does not have parachute attached this exit can not be used for emergency in flight.

Gunner uses bomber's compartment door in flight.

Bomber's Compartment

The door on the right hand side of the compartment can be jettisoned by pulling the Red Painted Lever, located just forward of the door, UP and pushing the door. This operation pulls out the door hinge pins.

Pilot's Seat Adjustment

Standard vertical adjustment lever located on the right hand side of the seat. Shoulder type harness adjustment lever on left hand side of seat.

Drift Sight

Plates for mounting a drift sight indicator are installed at Sta. #237 to the right and left of the tunnel gun.

The bombsight may be used to take drift readings by opening rear sub-doors of bomb bay doors and sighting on through. However, later model airplanes will not have bomb bay sub-doors. In later Avenger I's, a drift angle scale will be mounted concentric to the tunnel gun yoke for use with pointer attached to the gun yoke. Tunnel gun with ring and post sight will be used when sighting for drift angle determination.

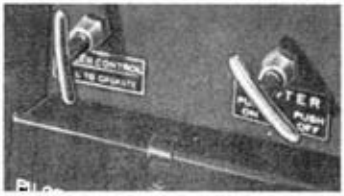
Heating and Ventilating

Sliding door on turret gunner's right side may be latched open approximately 90°. This door when fully open allows the gunner to reach around and clean the outside surface of the turret enclosure in front of the sight.

Warm Air By-Pass Valve

Control "T" Handle on pilot's lower instrument panel. When in OFF position warm air is by-passed outboard.

"T" HANDLE OUT - ON
"T" HANDLE IN - OFF



Warm Air Distributing Valves

Below the pilot's electrical distribution panel on the floor.

On right hand side of turret compartment.

In bomber's compartment at bomb sight windows and above tunnel gun.

Cold Air Distributing Valves

Located below and to the right of the pilot' seat. Located in the bomber's compartment on the right hand side.

De-Icer Control - Wing & Tail Surfaces

"T" Handle control located on the pilot's lower center instrument panel. Circuit breaker on the side of the distribution panel.

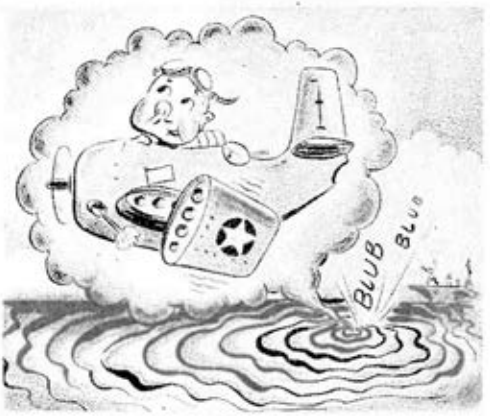
"T" HANDLE OUT - ON
"T" HANDLE IN - OFF

Wing Folding and Spreading

The outer wing panels are folded and spread and the hinge pins operated in the proper sequence by a single movement of the Wing Folding Hydraulic Control Lever located on the control panel above the right rudder pedal.

The hinge pins are positively locked in the safe position by the mechanical Wing Lock Safety Pin Control "T" Handle located adjacent to the Wing Folding Control Lever.

The wings will not fold or spread with the flaps DOWN, due to the action of the timing valve located in the trailing edge of the wing. A by-pass part in the locking cylinder prevents flow to the folding cylinders until the lock pin is withdrawn. When spreading, a second timing valve on the center section rib bulkhead prevents flow to the locking cylinder until the locking pin eyes are lined up and the pin can be moved into position.



'Blub! Blub! I should of looked at the flag.

CAUTION: The Red Metal Flags, at the wing leading edge adjacent to the folding axis, disappear into the wing skin only after the outer panels are fully spread, the hinge pins full home and safety lock pins engaged.

Warning Horn

The warning horn (Howler) sounds as the safety pins are withdrawn from the wing hinge pins and the outer panels are rotated through approximately the first 40° of the folding operation. During spreading, the horn starts sounding as the outer panels reach the last 40° of spreading and continues to sound until the panels are fully spread, hinge pins home and safety lock pins engaged.

To Spread Outer Panels

1. Disconnect Wing Tip Tieback Cables at Stabilizers.
2. Wing Flap Control Lever UP.
3. Wing Folding Control Lever SPREAD.
4. Wing Lock Safety Pin "T" Handle PUSH FULL IN and ROTATE CLOCKWISE.
5. Operate hydraulic hand pump if engine is not running. Hand pump selector on General System.

To Fold Outer Panels

1. Wing Flap Control Lever UP.
2. Wing Lock Safety Pin "T" Handle ROTATE COUNTER-CLOCKWISE then PULL FULL AFT.
3. Wing Folding Control Lever FOLD.
4. Secure Wing Tip Tieback Cables to Stabilizers.

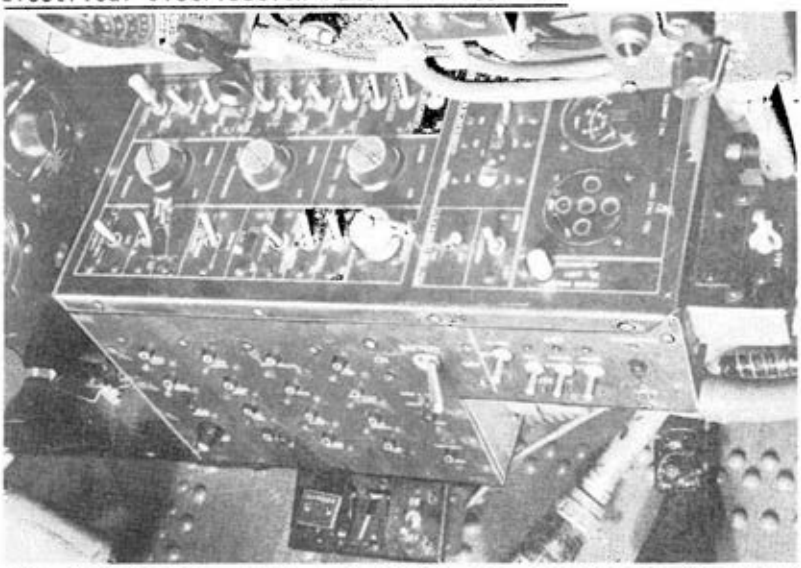
If difficulty is experienced in locking the Safety Pin "T" Handle, operate the hand pump several strokes until additional pressure is placed on the wing spreading hydraulic system and the "T" handle goes completely in without undue force.

In the event of hydraulic failure, the outer panels can be folded manually by first unlocking the mechanical safety pin with the cockpit control then actuating the locking pin by a hand lever and moving the panel aft by hand. The extension handle for this purpose is clipped on the outboard wing stub bulkhead.

CAUTION: Do not reverse wing folding lever until operation is complete.

CAUTION: Do not push or pull wings to accelerate the spreading or folding operation.

Electrical Distribution Panel & Switch Box



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

Switches

Landing Light	Armament Master
Section Light	Torpedo, Smoke Tank & Bombs
Approach Light	Engine Primer
Wing & Tail Running Lights	Engine Starter
Formation Lights	Remote Compass
Pitot Tube Heater	Panel Receptacle
Cockpit Lights	Recognition Lights
Fluorescent Lights	Recognition Lights Key
Gun Camera	Battery
Gun Selector	Volt-Ammeter
ABA Keying Switch	Oil Dilution Switch

Tell-Tale Lights, Pilot's Director Indicator Switch, and S.B.A.E. Switches.

On later Avenger I's the Armament Master Switch, Cockpit Light Switch, Panel Receptacle Switch, and Remote Compass Switch are removed. The Armament Master Switch is changed to Bomb-Torpedo Master Switch. The cockpit lights are turned ON and OFF by the rheostat. The Panel Receptacle and Remote Compass

are turned ON & OFF with the Battery Switch. The Section and Formation Lights are turned ON & OFF by one ON-OFF-FLASH switch.

Rheostats

Compass Light Electric Panel Light Chartboard Light

Instructions for the operation of the above items are on adjacent name plates.

Circuit breaker reset buttons are located on the side of the distribution panel.

The battery voltage may be read on the volt-ammeter by setting of the selector switch with the battery switch ON.

NOTE: The battery switch must be ON to operate any of the electrical units with the exception of the recognition lights and inertia switch circuit which are connected direct to the battery.

Spare Bulbs & Fuses

A container for carrying spare bulbs and fuses is provided in the pilot's cockpit on the lower center instrument panel and in the bomber's compartment on the right hand side at Sta. #216.

CAUTION: Do not lower landing light at airspeeds above 120 knots.

In opening and closing any switch, especially the battery switch, use a fast positive action to minimize arcing and burning of contact points.

Before turning the battery switch either on or off, check to make sure that all transmitter switches and the turret power switch are in the OFF position.

5. USEFUL LOAD CONTROLS

Armament

(a) Fixed Fuselage Gun - .30 Calibre

The fixed gun is mounted in the right hand side of the fuselage forward of the instrument panel.

The handle locking-drawer type ammunition box, 500 round capacity, is installed through a door on the left hand side of the fuselage forward of the windshield.

The charging handle is located on the right hand side of the instrument panel; selector and armament master switches on pilot's distribution panel and electric trigger switch on the control stick.

To fire gun, close Gun Selector and Armament Master Switches then press Trigger on control stick.

(b) Wing Guns - .50 Calibre

Later model Avenger I's have two .50 calibre guns, one installed in each of the outer wing panels.

An ammunition box for each gun, containing 310 rounds, is installed outboard of the gun compartments.

The guns are hydraulically charged, controlled by a handle located on the right hand instrument panel.

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.

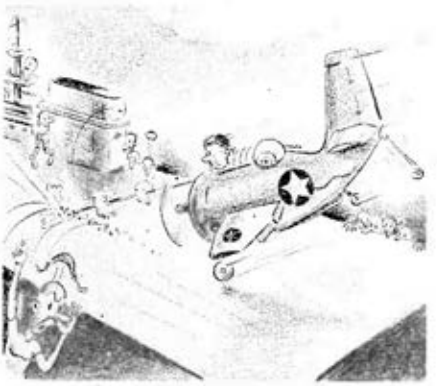
Auxiliary Operation

If the engine driven hydraulic pump is not functioning, use the hydraulic hand pump in conjunction with the hand pump selector valve as follows: Set on GENERAL, to build up sufficient pressure to charge guns. (800 p.s.i.)

To Fire Guns

1. Charging handle FULL IN at CHARGE.
2. Gun selector switch - ON.
3. Press trigger switch.

A Mark 30 illuminated torpedo director and gun sight is mounted abaft the windshield, in later models of Avenger I's. A special container, located on the floor to the left of the pilot's seat, is for stowage when the sight is not in use. An auxiliary ring and bead sight is provided to the right of the illuminated sight.



WARNING: Before landing, the Gun Selector Switch should be turned off to prevent accidental firing of unused ammunition.

(c) Flexible Tunnel Gun - .30 Calibre

The flexible gun, equipped with a ring and bead sight, is mounted in the tunnel position and clamps in a trailing position when not in use.

Five 100 round magazine containers are carried; one clipped to the gun and the four spares stowed in a rack on the right hand wall of the compartment. In later models of Avenger I's

a 500 round continuous feed installation will be provided. A latched door in the fuselage skin directly below the gun is provided for disposal of ejected links and cases.

CAUTION: This latched door must not remain open when not in use to avoid entrance of CARBON MONOXIDE.

(d) Cameras

A Type N-4 gun camera is mounted at each gun position. The forward gun camera is mounted inboard and above the .30 cal. fixed gun. The installation in the turret is inboard and on approximately the same level as the .50 cal. gun. In the tunnel gun position, the camera is mounted rigidly to the muzzle of the gun. The torpedo camera VT1015 is mounted under the left hand wing panel.

To Operate Forward Gun Camera

1. Pilot's camera switch on distribution panel to GUN position.
2. Press trigger switch on control stick.

To Operate Torpedo Camera

1. Pilot's camera switch on distribution panel to TORPEDO position.
2. Press torpedo release button on control stick.

To Operate Turret Gun Camera

1. Press trigger switch on main control grip.

To Operate Rear Gun Camera

1. Gun camera switch, L.H. side fuselage, to ON position.
2. Press trigger switch on GUN.

(e) Electric Power Turret

The turret is equipped with a .50 calibre machine gun, Mark 9 illuminated gun sight, 200 rounds of ammunition and a Type N-4 gun camera.

See Turret Controls Diagram for the name and location of the controls.

Main Control Unit

The Control Unit, operated by both hands, completely controls all motion of the turret and also the firing of the gun. At the top left of the unit is the Dead Man's Handle in which is incorporated the Master Power Switch and the Dead Man's Switch. When the Master Power Switch is pointed toward the operator, the switch is ON thus energizing the complete turret electrical system. The Dead Man's Switch must be held closed in order to have the turret controls in operation. When the Dead Man's Switch is released, the turret automatically returns to neutral with the gun muzzle trailing aft; and the power to the motors is cut off. In this position the turret is ready for instant action. The turret returns in train to neutral by the shortest path then the elevation returns to neutral. These functions do not occur simultaneously but in the sequence given.

The control Unit Grip controls the position of the turret both in elevation and train. Depression of the firing grip from the neutral position causes the gun to go up; elevation of the grip causes the gun to depress. Movement of the control grip to the left from the neutral position as viewed by the operator causes the turret to turn clockwise; counterclockwise rotation is obtained by moving the grip to the right. Simultaneous train and elevation or depression movement is obtained by moving the firing grip diagonally. The speed of both train and elevation movement is proportional to the distance of the control grip from its neutral position.

Turret Operating Speed.

The speed of both train and elevation movement is proportional to the distance of the Control Grip from its neutral position. Normal elevation speed is 15° per second and normal train speed is 20° per second. The High Speed Switch on the Control Unit gives an increased range of speed, namely 30° and 45° per second for elevation and train operation respectively.

NOTE: The High Speed Switch is for slewing only.

Both the train and elevation drive units are equipped with automatic switches to short out the Dead Man's Release so that in case of failure in one motion (either train or elevation) the remaining motion may be controlled electrically.

Emergency Switch

This switch with a circuit breaker reset button, is located on the left hand side of the bomber's compartment. The Emergency Switch is NORMALLY CLOSED and the junction box cover must be removed to cut off power to the turret.

'That's me all over'

CAUTION: Turret gunners should keep hands and feet clear of moving parts of the turret.

Manual Operation

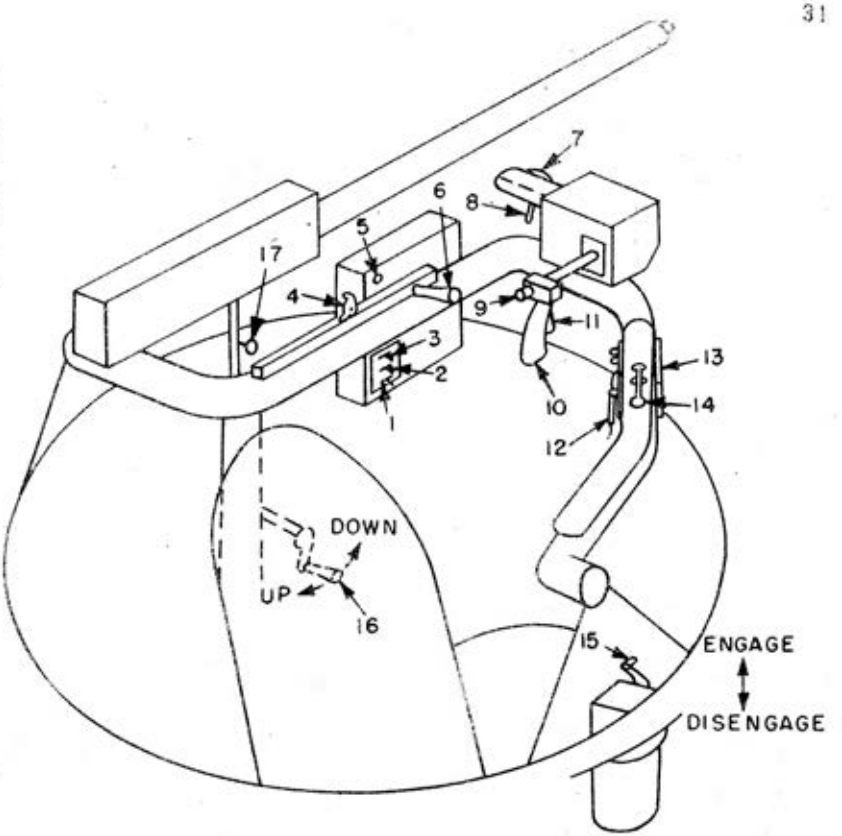
A clutch lever embodied in the train motor, located on the operator's right hand side, permits turret to be rotated freely.

CLUTCH LEVER UP - ENGAGED
CLUTCH LEVER DOWN - DISENGAGED

The manual elevation crank with integral clutch is located to the left of the operator.

ROTATE CLOCKWISE	TURRET ELEVATES
ROTATE COUNTER CLOCKWISE	TURRET DEPRESSES

CAUTION: Carefully unfold handle part way out and rotate until clutch dogs engage, then completely unfold handle and operate as desired.



1. Turret Light Switch
2. Elevation Power Switch
3. Train (Azimuth) Power Switch
4. Safety Catch - Charging Handle
5. Firing Solenoid Overload Reset
6. Gun Charging Handle
7. Dead Man's Switch
8. Master Power Switch
9. High Speed Switch
10. Main Control Grip
11. Trigger Switch
12. Microphone
13. Interphone Control Box
14. Radio Key
15. Clutch Lever - Train, (Azimuth)
16. Manual Crank - Elevation
17. Amm. Container Release

TURRET CONTROLS DIAGRAM

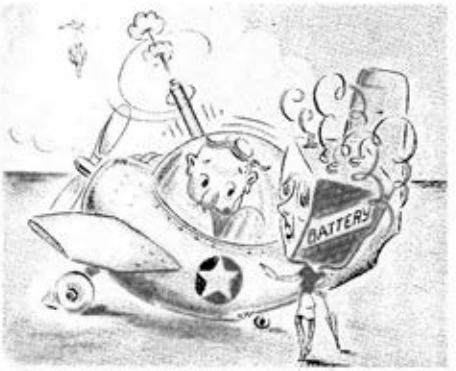
FIG. 1

To Operate Turret

1.	Battery Switch	ON
2.	Hinged Armor Plate	Locked in UP position
3.	Elevation Power Switch	ON - Away from Operator
4.	Train Power Switch	ON - Away from Operator
5.	Main Power Switch	ON - Toward Operator
6.	Dead Man's Switch	DEPRESSED
7.	Charge Gun	Pull Charging Handle Toward Operator and Release
8.	Main Control Grip	The Main Control Grip is Used like a Pistol; i.e., aim the grip in the direction desired and the gun will follow.
9.	Trigger Switch	Press to Fire Gun
10.	High Speed Switch	Press to Operate - For Slewing Only.

Before landing, move the gun charging handle behind the safety catch to prevent accidental firing of unused ammunition. TURN OFF the Main Power Switch before leaving the turret.

NOTE: When firing the gun horizontally or depressed, raise the gun momentarily after firing approximately the first 135 rounds to shake down the ejected links.



'You've gotta stop running me down'

CAUTION: Do not operate turret or radio on airplane's batteries alone. These units should not be turned on unless either the engine is running fast enough to cut the generator in or a good source of external power is connected to the airplane.

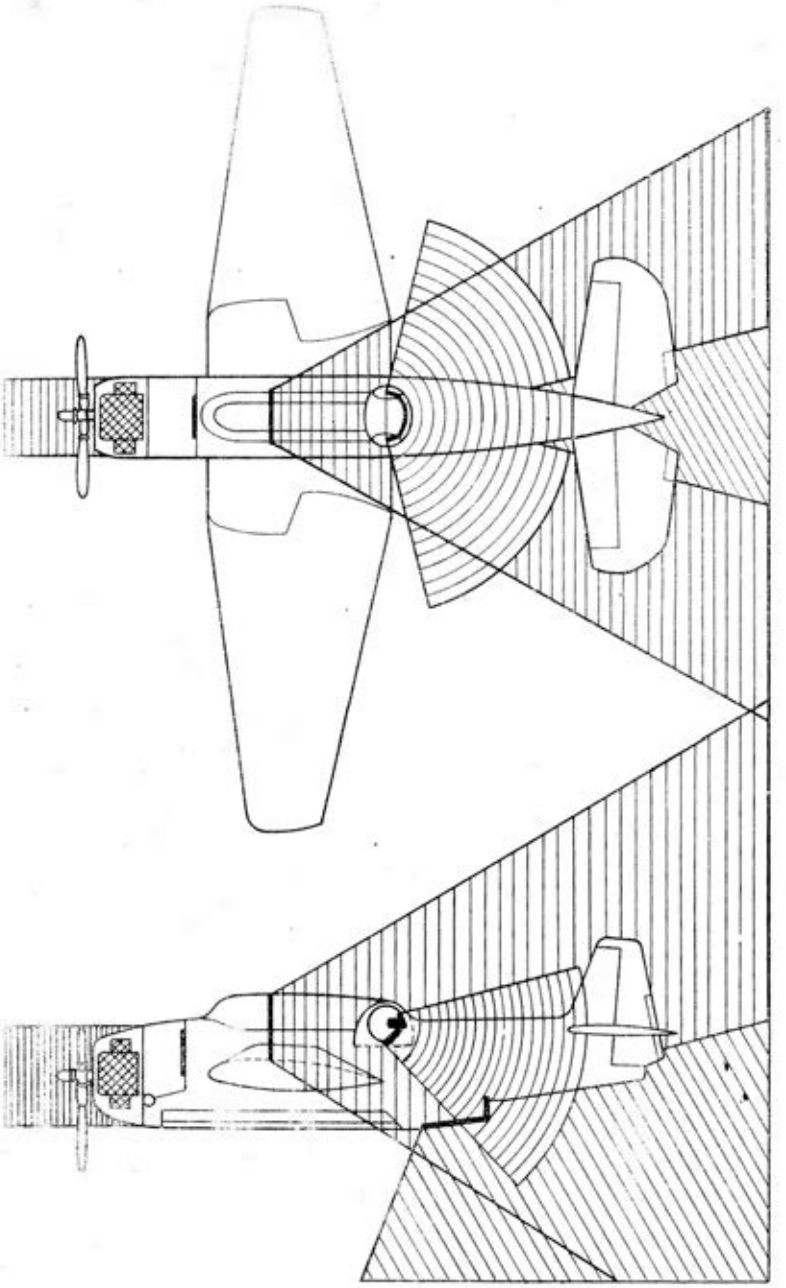
The drop in voltage that accompanies the inrush of current to start up the rotating equipment in the turret and/or the large radio transmitter dynamotor when the power is limited (without generator producing current or without external power source connected to airplane electrical system) will cause the power relay in these circuits to open. This in turn allows the voltage to be re-established and close the relay to start the cycle again. In a relatively short time, the relay contacts will become badly burned and may weld together thus preventing the unit from being turned off.

If the amplidyne motor-generators stop because of overload and the power switches on the junction box kick out, a wait of 30 seconds is required before the switches are reclosed. At the end of that time the switches should be pushed all the way to the OFF position and then returned to ON. Power may again be applied to the amplidyne motor-generators by closing the master switch and the dead-man switch.

The control grip should not be held down continuously so that the gun is kept up against the limit switch, for this will result in repeated attempts of the drive to return the gun to normal range.

An overload reset is provided for the firing-solenoid circuit breaker. If the circuit breaker should trip, 20 seconds should elapse before the overload-reset button is pressed.

When operated manually in train, the gun must be elevated sufficiently to clear the contour follower.



AREAS OF ARMOR PLATE PROTECTION

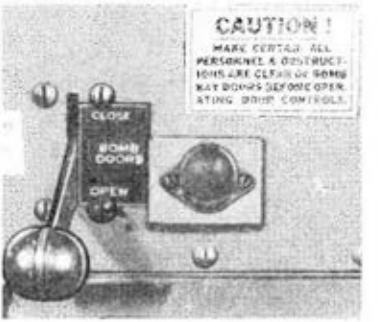
FIG. 2

(f) Bomb Bay Door Operation

The hydraulically operated bomb bay doors may be opened and closed by either the pilot or the bomber. The red jewel warning light, on the left hand side of the pilot's instrument panel, illuminates when the doors are OPEN.

Pilot's Control Lever located on the control panel above the rudder pedals.

LEVER UP - DOORS CLOSED
LEVER DOWN - DOORS OPEN



If the engine is not operating set the Bomb Door Control Lever to phase desired, move Hand Pump Selector Valve to Bomb Doors and operate Hand Pump.

Bomber's Red Painted "T" Handle Control located on bulkhead at Sta. #146.

"T" HANDLE FORWARD - DOORS CLOSED
"T" HANDLE AFT - DOORS OPEN

NOTE: Both electrical and manual bomb, torpedo, and smoke tank controls and manual droppable fuel tank controls will not operate unless the bomb bay doors are fully open.

(g) Bomb Controls

Arm-Safe Control

To operate the Arm-Safe Lever in the bomber's compartment, depress Knob on top of control lever and move lever to position desired - SAFE, ARMED TAIL or ARMED NOSE & TAIL.

Manual Bomb Release

"T" Handle located on pilot's left hand instrument panel.

PULL TO RELEASE

Firing Keys

Pilot's release button on top of control stick.

Bomber's firing key clipped to bulkhead Sta. #145.

Fuzing Units

Provisions are made to install British Fuzing Units to ARM and SAFETY the bombs in later model Avenger I's.

Two ARM - SAFE switches for NOSE & TAIL arming of bombs located on Bomber's Switch Panel. These are used instead of ARM - SAFE lever when Fuzing Units are installed.

NOTE: ARM-SAFE Lever must be in ARM position in order to release electrically.

(h) Torpedo

Electrical Release

1. Open Bomb Doors.
2. Close the Bomb - Torpedo Switch in TORPEDO position.
3. Unlock bomb shackles - Bomber throw Arm-Safe lever to ARM position.
4. Close Pilot's Armament Master Switch.
5. Press and release Pilot's Release Button on control stick.
6. Close Bomb Doors.

Manual Release

1. Open Bomb Doors.
2. Pull Emergency Bomb Release "T" Handle to RELEASE. (Approx. 6").
3. Close Bomb Doors.

NOTE: Torpedo cannot be released by bomber. A torpedo depth setting tool and access door are provided in the passageway at Sta. #107.

(i) Droppable Fuel Tank - Bomb Bay

Manual Release

1. Turn Fuel Tank Selector to Best Tank.
2. Open bomb doors.
3. Pull Emergency Bomb Release "T" Handle to RELEASE.
4. Close bomb doors.

NOTE: The droppable fuel tank cannot be released electrically or by the bomber.

(j) Tow Target

Two "T" Handle Controls located on the left hand side of the main instrument panel. On later Avenger I's the tow target release handle is located on the floor of the bomber's compartment at Sta. #170 just aft of the bombsight.

Stream Target

1. Open bomb doors.
2. Pull in Tow "T" Handle to release towing cable and target sleeve from container for towing.
3. Close bomb doors.

Drop Target

1. Pull Release "T" Handle to drop towing cable and target sleeve.

CAUTION: When towing sleeve, care shall be taken that the allowable cylinder head temperatures are not exceeded.

(k) Smoke Tank

The Smoke Tank Controls are on the left hand side of the bomber's compartment.

Lay Smoke Screen

1. Unwind exhaust pipe control reel to LOWER pipe.
2. Pull "T" Handle control to OPEN tank gate valve, then rotate to LOCK.

3. Regulate control valve on CO_2 cylinder, located below turret, for desired quality of smoke screen.

Smoke Tank Release - Electrical

1. Shut off CO_2 cylinder control valve.
2. Open bomb doors.
3. Close Bomb-Torpedo switch in TORPEDO position.
4. Unlock bomb shackles - Bomber throw Arm-Safe Lever to ARM position.
5. Close pilot's Armament Master Switch.
6. Close and release Pilot's Release Button.
7. Close bomb doors.

Smoke Tank Release - Manual

1. Open bomb doors.
2. Pull Emergency Bomb Release "T" Handle to RELEASE (Approx. 6").
3. Close bomb doors.

NOTE: Smoke tank cannot be released by bomber.

(1) Bomb Operation

After closing Bomb Signal Flash Light Switch to ON, the light will operate simultaneously with release of first bomb dropped.

Bomber's control panel is energized by the pilot's Master Switch when pilot's Bomb-Torpedo Switch is in BOMB position. The Armament Power Indicator Light will glow to indicate to the bomber that this connection exists.

With Bomb Sight - Bomber

1. Open bomb doors.
2. Manual-Automatic Switch to AUTOMATIC.
3. Select-Train Switch to SELECT for one (1), bomb; to TRAIN for bombs in Train.
4. Select-Train Switch on Intervalometer to SELECT for one bomb, to TRAIN for bombs in Train.
5. Bomber's Armament Master Switch to ON.
6. Unlock bomb shackles - Move Arm-Safe Lever to ARMED TAIL or ARMED NOSE & TAIL position as required.
8. Set Station Distributor to position:
   No. 1 for 100# bombs.
   No. 9 for 500# bombs.
   No. 8 for 1000# or 1600# bombs.
9. Upon completion of operation, move Arm-Safe Lever to SAFE.
10. Close bomb doors.

With Firing Key - Bomber

1. Open bomb doors.
2. Attach Firing Key Cable to receptacle under Bomber's Switch Panel.
3. Manual-Automatic switch to MANUAL.
4. Select-Train switch to SELECT to drop one (1) bomb; to TRAIN to drop bombs in Train.
5. Select-Train switch on Intervalometer to SELECT for one (1) bomb; to TRAIN for bombs in Train.
6. Bomber's Armament Master Switch to ON.
7. Unlock bomb shackles - Move Arm-Safe Lever to ARMED TAIL or ARMED NOSE & TAIL position as required.
8. Set Station Distributor to position:
   No. 1 for 100# bombs.
   No. 9 for 500# bombs.
   No. 8 for 1000# or 1600# bombs.
9. To control number of bombs to be released and interval of release, adjust intervalometer accordingly.
10. Press and release Bomber's Firing Key.
11. Upon completion of operation move Arm-Safe Lever to SAFE.
12. Close bomb doors.

With Firing Key - Pilot

1. Open bomb doors.
2. Bomber's Select-Train switch to SELECT or TRAIN as directed by the pilot.
3. Pilot's Bomb-Torpedo switch to BOMB.
4. Select-Train switch on Intervalometer to SELECT for one (1) bomb; to TRAIN for bombs in Train.
5. Unlock bomb shackles - Bomber move Arm-Safe Lever to ARMED TAIL or ARMED NOSE & TAIL position as required.
6. Close pilot's Armament Master Switch.
7. Set Station Distributor to position:
   No. 1 for 100# bombs.
   No. 9 for 500# bombs.
   No. 8 for 1000# or 1600# bombs.
8. To control number of bombs to be released and interval of release, bomber adjusts intervalometer accordingly.
9. Press and release Pilot's Release Button on control stick.
10. Upon completion of operation, move Arm-Safe Lever to SAFE.
11. Close bomb doors.

With Emergency Release - Pilot

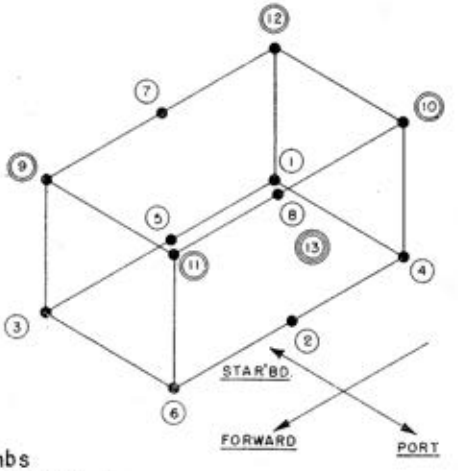
1. Open bomb doors.
2. Unlock bomb shackles - Bomber move Arm-Safe Lever to ARMED TAIL or ARMED NOSE & TAIL position as required.
3. Pull Emergency Bomb Release "T" Handle to RELEASE bombs (6" approx.).
4. Close bomb doors.

SD-1 Station Distributor

Mounted on the left hand side of the bomber's compartment. This unit, connected into the electrical bomb circuit, releases the bombs in the proper sequence. After firing the first bomb selected on the distributor dial, it resets the circuit for firing the next bomb in line.

Set the station distributor at the lowest station number at which a bomb is carried.

100# set at #1
500# set at #9
1000# set at #8
1600# set at #8



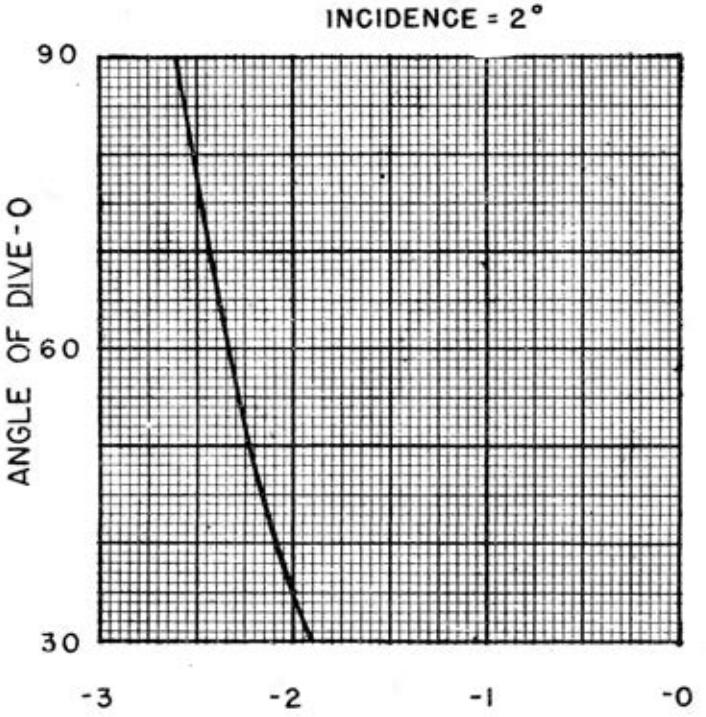
◯ 100# Bombs
◎ 100# or 500# Bombs

(13) Torpedo or Smoke Tank is suspended between shackles at positions Nos. 7 and 8. Shackle in position No. 8 is connected to receptacle (13) Shackle in position No. 7 does not operate, thus retaining slings. Droppable Fuel Tank is suspended between shackles at positions No. 9, 10, 11 and 12 and is released manually only.

(8) The 1000# or 1600# bomb is suspended between shackles at positions Nos. 7 and 8. Shackle in position 8 is connected to receptacle No. 8. Shackle in position No. 7 does not operate thus retaining slings.

BOMB RELEASE SEQUENCE DIAGRAM

FIG. 3



GLIDE BOMBING CURVE

FIG. 4

Life Raft & Emergency Rations

Stowed in Life Raft Compartment in fuselage abaft second cockpit; athwartship. Compartment door, on either side of fuselage is held in place by quick turn fasteners. Emergency rations, first aid kit, smoke grenades, a sea marker, paddles and water containers are stowed in an emergency equipment container. A service water container is stowed in the second cockpit.

Oxygen Equipment

One 514 cu. in. capacity cylinder is installed on the side of the passageway in the second cockpit. Rebreather units with face pieces and canisters are located on the left hand side of the pilot's compartment and in the turret position on the left hand side directly below the turret. A third rebreather is located on the left hand side of the tunnel compartment at radio operator's station. An additional check valve outlet is installed on the right side of the second cockpit in such a position as to serve the tunnel gunner when necessary to check equipment in the second cockpit. Two spare canisters are conveniently located adjacent to each of the three positions.

Check-Off List, Oxygen Rebreather Control Supply Type.

1. Attach rebreather apparatus to central oxygen supply line
2. Depress facepiece valve and put knob clamp in place.
3. Open central oxygen supply valve and allow breathing bag to become filled. Close supply valve and notice if bag deflates indicating leak in:
   (a) Hose connections.
   (b) Facepiece shut-off valve.
   (c) Canister holder sealing valves.
4. Install canister after removing metal caps from each end. Open oxygen supply valve.
5. Retest for tightness to check canister seal.
6. Put on facepiece. Release knob clamp, closing facepiece valve to the outside air. Check facepiece fit.
7. Flush out apparatus employing the following FLUSHING PROCEDURE.

(a) Inhale deeply with facepiece valve released.
CAUTION: Do not inhale when facepiece valve is depressed.
(b) Depress facepiece valve and exhale fully.
(c) Repeat (a) and (b) twice.

8. Repeat 7 (a, b and c) at end of first 5, 10, and 15 minutes of operation and every half hour thereafter.
9. Replace canister when it causes excessive resistance to exhalation (resistance due to overfilling of the breathing bag may be eliminated by employing (a) and (b) of 7. If this procedure does not eliminate the resistance, change canister). Normal canister life is approximately two hours.
10. Immediately after replacing canister, perform 7 (a), (b) and (c), repeating every ½ hour thereafter.
11. For stowage in aircraft, release facepiece valve and clamp when finished using the rebreathing apparatus.

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

Turret Gunner's Parachute Hook

Attached to fuselage stringer above exit door on right hand side of bomber's compartment.

Chartboard

Located below pilot's main instrument panel and equipped with a catch to hold it in the stowed position.

First Aid Kit

Stowed in life raft compartment with life raft.

Map Case, Pad & Pencil Holder

At left hand side of pilot's seat.

Weighted Container for Classified Matter

The chartboard shall be used as the weighted container for classified matter.

Parachute Flare Release

Two "T" Handles, left and right, located to the right of the

pilot's seat. The two flares, each in a separate release container, are located at the aft end of the bomber's compartment at Sta. #232.

Aldis Signal Lamp

A receptacle and switch is provided on the bomber's electrical panel for plugging in a British Aldis Signal Lamp.

Signal Discharge Pistol, M-8

Mounted in a flange fitting on the fuselage skin to the right of the pilot's seat; may be fired by the pilot without removal from the fitting. Twelve rounds of ammunition are carried in a container above the gun.

Float Lights

Eight (8) Mark 4 float lights are carried in racks above the parachute flare containers in the bomber's compartment.

Radio Controls

The following Radio, Radar and Transponder equipment is carried:

RU-12, RU-19 or ARB Receiver
GP-6, GP-7 or ATC Transmitter
ZB Homing Equipment
IFF, Model ABD, ABE, or ABK or ABA
AYD or AN/ARN-1 Equipment
ASB Equipment
RL-5 Intercommunication Controls
(Installed on later Avenger I's.)

Pilot Controls

Transmitter control box with volume controls, ON-OFF switch and selector switch for inter-communication system or radio transmitting used in conjunction with Microphone or Transmitting Key also receiver remote tuner on right hand side of pilot's cockpit.

ZB Homing Controls

Control Box on right hand side of pilot's cockpit.

AYD or AN/ARN-1 Controls

The AYD low range altimeter and indicator lights (red, amber and blue) are on the right hand side of the main instrument panel. To regulate the intensity of these lights, rotate their lense caps. The ON-OFF Switch Knob is located on the low range altimeter.

The amber light illuminates when the airplane is flying at the altitude set on the low range altimeter. When flying above the set altitude, the blue light illuminates - below, the red light illuminates.

NOTE: This altimeter can be used at low altitudes only.

ABA or ABD/ABE or ABK Controls

A key switch, located on the aft end of the distribution panel and a Red Warning light on the main instrument panel are used only in conjunction with the ABA equipment. The pilot's control switch box on the side of the electrical distribution panel contains the "D" switches provided with a Red guard. This switch box also contains an emergency switch and power ON-OFF switch to be used with ABD/ABE or ABK equipment.

CAUTION: The inertia switch and "D" switches are connected directly to the battery and are operative at all times.

Second Cockpit

Inertia switch and power feed circuit breaker reset buttons located on the junction box on the right hand side of the second cockpit. Radio circuit tester switch box, located on the right hand side of the second cockpit, is used to test "D" switch and inertia switch circuits.

Turret Controls

Transmitter control box with volume controls, ON-OFF switch and selector switch for inter-communication system or radio transmitting used in conjunction with Microphone or Transmitting Key.

Bomber's Controls

Transmitter control box with volume controls, ON-OFF switch and selector switch for inter-communication system or radio transmitting used in conjunction with Microphone or Transmitting Key, Receiver Controls and Trailing Antenna Reel.

ASB Controls

Antenna controls on the right hand side of the bomber's compartment. They operate hydraulically, 1° movement moves the antenna 1°.

Control box on right hand side of the fuselage abaft Sta. #146. Indicator below turret to right of turret collector ring on the floor.

CAUTION: Do not operate radio unless either the engine is running fast enough to cut the generator in or external power is connected.

ABA or ABD/ABF or ABK Controls

Control unit mounted on the right hand side of the bomber's compartment. For operation of all radio equipment, see Navy instruction book for the particular equipment.

Three receiver spare coil boxes are mounted on the left hand side of the bomber's compartment. A transmitter spare coil is located overhead abaft the turret.

NOTE: When operating the radio transmitter on the ground before take-off, it should be turned on as follows:

1. Start engine and run up to approximately 1400 RPM or until generator cuts in.
2. Turn radio transmitter on.
3. The transmitter may remain on during taxiing, idling, etc., unless engine is to be idled for an excessive period which might run the battery down.

It is the proportionately high current required to start the transmitter dynamotor that causes the relay trouble. Therefore, if this unit is started with the generator cut in and then operated from the airplane batteries alone, the relay will function satisfactorily but the batteries will discharge quite rapidly.

CAUTION: All transmitter switches except the pilot's switch should be wired in the off position to prevent inadvertent burning of the relay when the battery is turned off.

RL-5 Intercommunication Controls

The RL-5 Interphone Apparatus can only be turned on from the pilot's control box. The system can be converted from a two-way radio to a one-way intercommunication system at any control box location, providing this control box has its ICS-RADIO switch turned to ICS.

If a two-way intercommunication system is desired, it entails the turning of the ICS-RADIO switches to ICS position at every control box location wishing to intercommunicate.

If any of the control box operators turn the ICS-RADIO switch to RADIO while the system is being used as an intercommunication system, he can only talk over the transmitter and cannot hear any radio side tone while the intercommunication system is in use.

TURNING OFF POWER SWITCH (RED ICS-VOL KNOB ON PILOT'S CONTROL BOX), SECURES ALL APPARATUS FOR A SHUT-DOWN.

6. HYDRAULIC SYSTEM

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

Bomb Bay Door
Cowl Flaps
Oil Cooler Flaps
Landing Gear - Main & Tail Wheels
Wing Folding & Spreading
Wing Flaps

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 system operating pressure is 1250 p.s.i. and the normal pump pressure is almost zero except when operating a circuit then the pressure rises to 1500 p.s.i. Two gages for recording these readings are located on the Hydraulic Control Panel just to the right of the pilot's seat.

Auxiliary Operation

The Hydraulic hand pump is located on the cockpit floor to the right of the seat. Use this pump to operate the system if the engine driven pump is not functioning.

When the hand pump is used, the Hydraulic Hand Pump Selector Valve Control must first be turned to the desired position marked on the adjacent name plate. This control is located on the Hydraulic Control Panel. The positions of the lever for operation of the various controls are as follows:

LANDING GEAR
BOMB DOORS
WING FLAPS

GENERAL

Cowl Flaps
Oil Cooler Flaps
Wing Folding

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

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

The fluid capacity of the hydraulic system is 5½ to 6 gals. The hydraulic reservoir, 1.6 gals. capacity, is located behind the bulkhead at Sta. #107. Use fluid, Spec. M-339 (Mineral Oil - Red Color).

7. LANDING GEAR & WING FLAP CONTROL UNIT

In the basic design of this unit several features were incorporated in addition to the normal functions. These are intended to:

(1) Prevent Inadvertent Wheels Up Landings

It is believed that while anyone is very liable to forget to lower wheels, practically no one will forget flaps when approaching a landing. Therefore, the two levers have been interconnected so that wheel lever will be MOVED to the DOWN position when flaps are lowered.

(2) Prevent Inadvertent Retraction of Wheels While on the Ground.

Two safeguards against accidental retraction of the wheels are provided. One is a positive lock operated by partial compression of the left hand shock strut which prevents moving the Landing Gear Control from the DOWN position as long as the weight of the airplane is resting on the wheels.

An additional Landing Gear Lever Lock is provided which prevents moving the Landing Gear Lever when the flaps are down as it is common practice to raise the flaps before the end of the landing roll and sometimes even before touching the ground. This lock prevents accidental retraction of the gear if the Landing Gear Lever is mistaken for the Flap Lever, especially before the "on ground" lock can become effective.

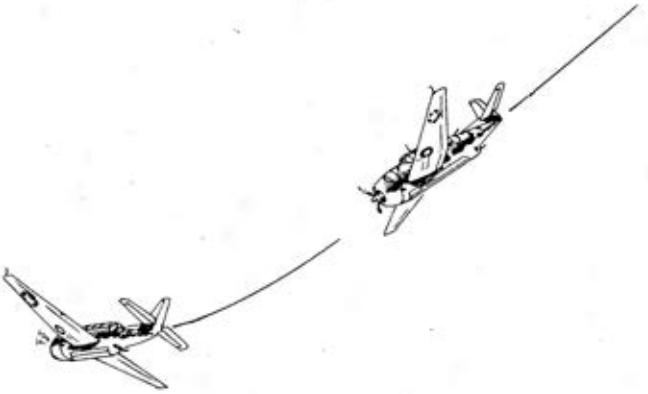
In order to allow complete flexibility for use in abnormal conditions, means have been provided for disconnecting the interlocking features:

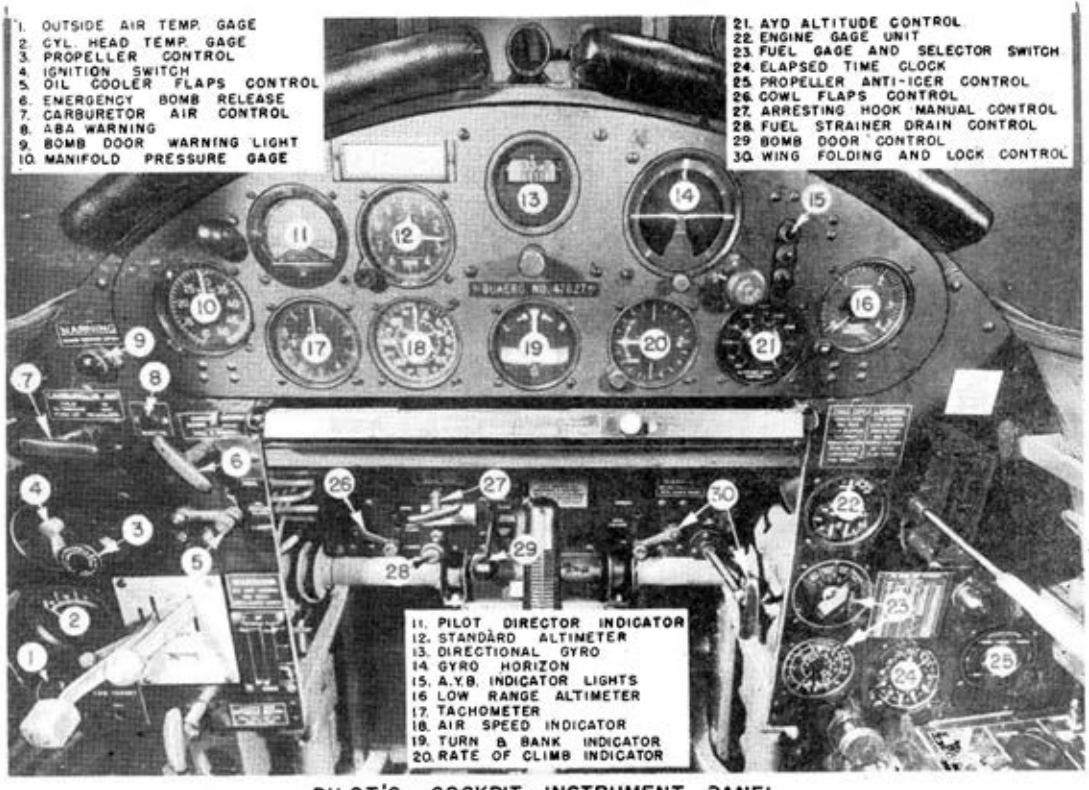
(a) If it is desired to make a wheels up landing either at sea or on soft ground, the flaps may be lowered independently of the wheels by first pressing the small button at the side of the flap control handle, holding the button in while moving flap control to down position. The same procedure may be followed if it is desired to use flaps for maneuvering purposes.

(b) Wheels may be retracted when flaps are down without disturbing flaps by first raising the small auxiliary Lock Lever located just to the left of the main Landing Gear Lever. Care must be taken to keep the Flap Lever full down when performing this operation as the Landing Gear Lever will carry the Flap Lever up also if the Flap Lever is a short distance from full down.

It is understood that some operating units prefer to use partial rather than full flap setting for take-offs. While this procedure is permissible, a longer take-off will result and caution must be exercised in retracting the landing gear. Under these conditions, first move the Flap Lever to the full flap DOWN position, then raise the Landing Gear Lever as described in (b) above. After Landing Gear Lever is up, the flaps may be re-adjusted as desired. The same procedure should be used if a water landing is necessary when wheels are down and flaps are partially down.

Unless the above instructions are followed, the Flap Lever will be moved up by the Landing Gear Lever, resulting in retraction of flaps, which may be dangerous at low altitude and low speed.





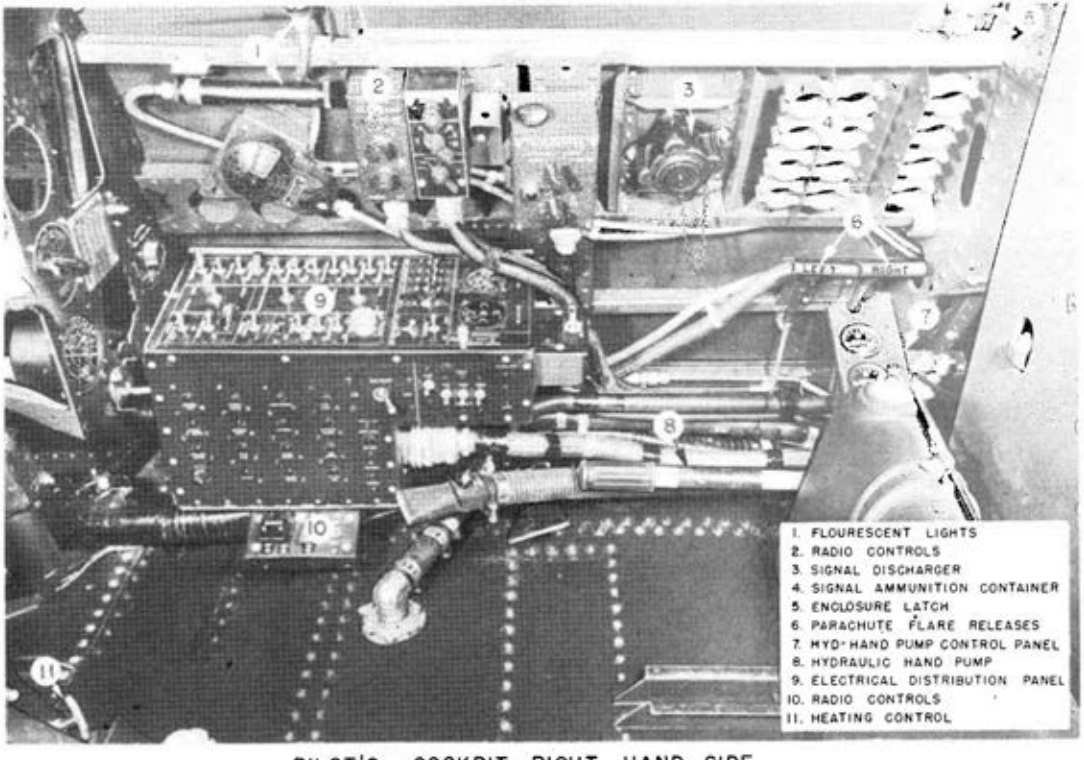
PILOT'S COCKPIT - INSTRUMENT PANEL

FIG. 6

1. EMERGENCY ENCLOSURE RELEASE
2. MAP CASE
3. FUEL SYSTEM DIAGRAM
4. TAIL WHEEL CASTER LOCK
5. S.B.A.E. ATTITUDE CONTROL
6. EMERGENCY ELEC. FUEL PUMP SWITCH
7. MIXTURE CONTROL
8. THROTTLE CONTROL
9. SUPERCHARGER CONTROL
10. CONTROL QUADRANT FRICTION ADJUSTMENT
11. RUDDER TAB CONTROL
12. AILERON TAB CONTROL
13. ELEVATOR TAB CONTROL
14. ARRESTING HOOK SWITCH
15. OXYGEN PLUG-IN
16. FLAP & LANDING GEAR CONTROL UNIT
17. LANDING GEAR EMERGENCY RELEASE
18. WING & TAIL SURFACE DE-ICING CONTROL

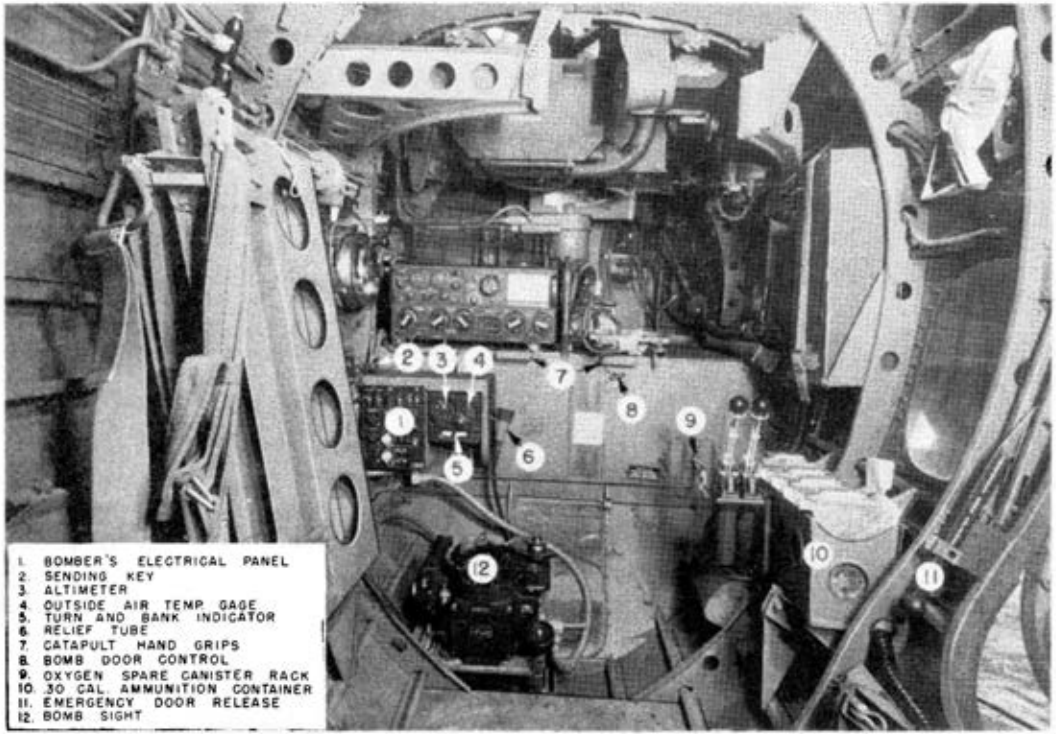
PILOT'S COCKPIT - LEFT HAND SIDE

FIG. 7



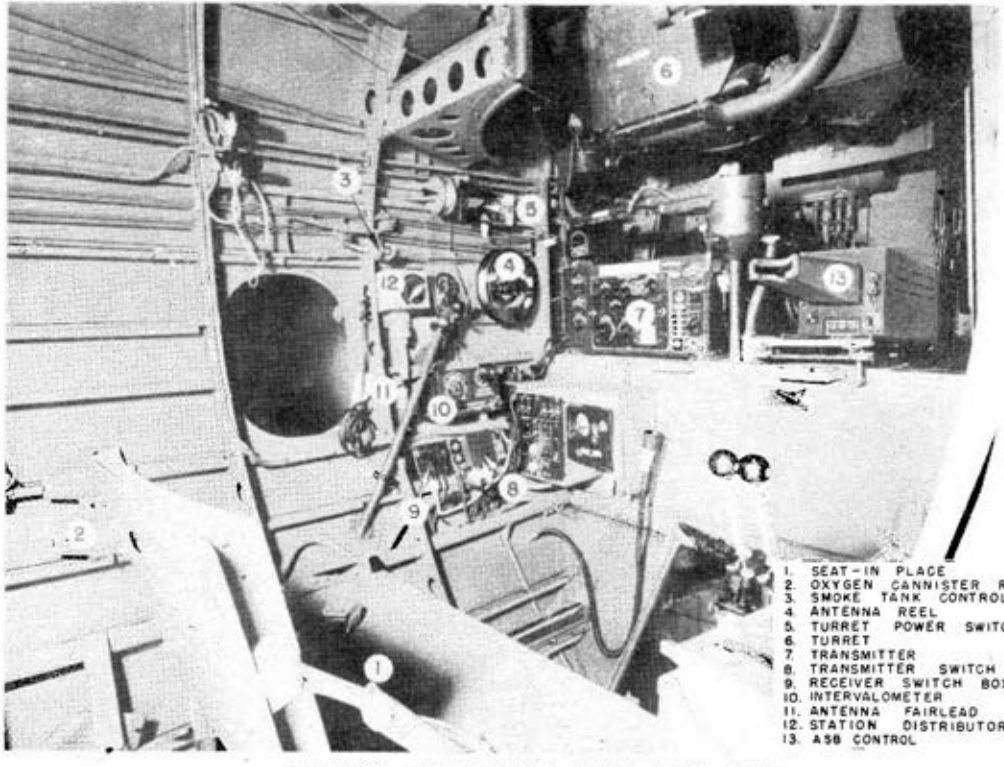
PILOT'S COCKPIT - RIGHT HAND SIDE

FIG.8



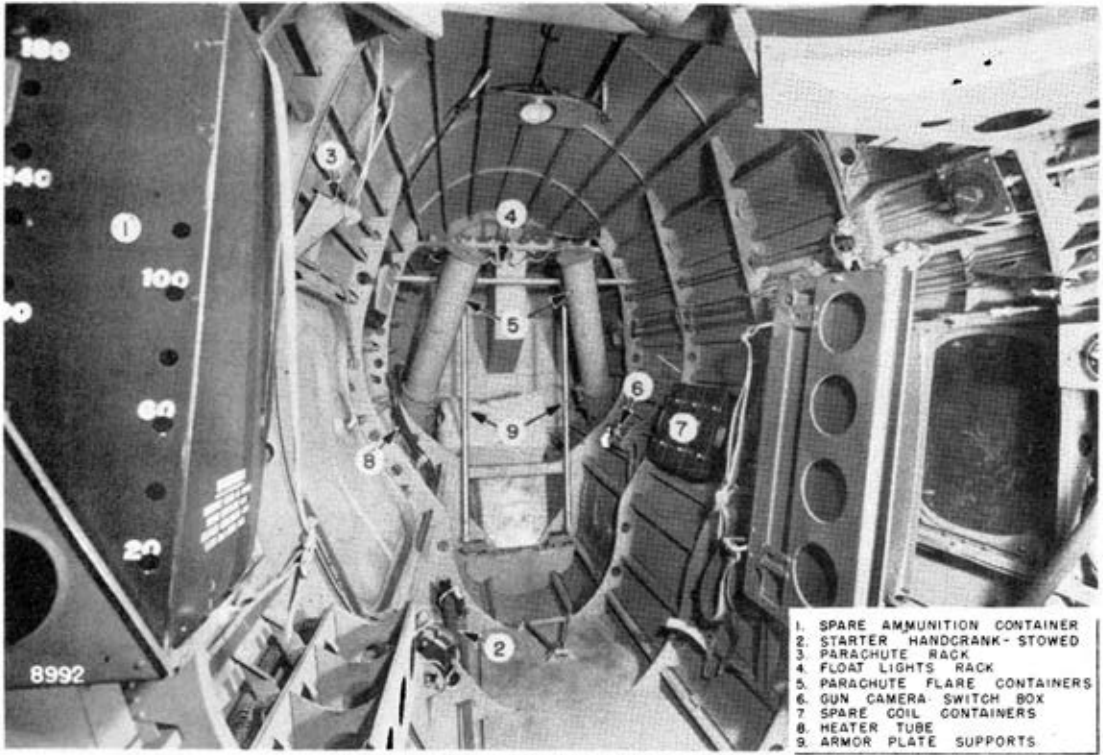
BOMBER COMPARTMENT - FORWARD

FIG. 9



BOMBERS COMPARTMENT LEFT HAND SIDE

FIG. 10



1. SPARE AMMUNITION CONTAINER
2. STARTER HANDCRANK - STOWED
3. PARACHUTE RACK
4. FLOAT LIGHTS RACK
5. PARACHUTE FLARE CONTAINERS
6. GUN CAMERA SWITCH BOX
7. SPARE COIL CONTAINERS
8. HEATER TUBE
9. ARMOR PLATE SUPPORTS

BOMBER'S COMPARTMENT. - REAR

FIG. 11

8. POWER PLANT

a. Engine - Wright, Model R-2600-8 (or 8A), 14 cylinder radial, geared 16 to 9, two-speed supercharged air-cooled engine.

RATING

	BHP			
Normal	1500	2400 Low	S. L.	- 5,900
	1350	2400 High	8,900	- 13,000
Military	1700	2600 Low	S. L.	- 3,000
(5 min. only)	1450	2600 High	8,000	- 12,000
Take-OFF	1700	2600 Low		
(5 min. only)				

Fuel - 100 Octane, AN Spec. AN-VV-F-781
Oil - Grade 1120, AN Spec. AN-VV-O-446
(See Page 70)

Maximum Diving RPM - 3100 (All diving should be done in Low blower ratio)

b. Propeller - Hamilton Standard, Hydromatic Three Bladed, 13'-0" diameter.

c. Propeller Governor

The high RPM (low pitch), or "Take-Off", position of the control knob is full IN and the low RPM position is full OUT.

The operating range of the constant speed governor unit is from 1200 RPM to 2700 RPM. Within this range, engine RPM should be regulated entirely by the propeller governor control, the throttle being used to regulate the manifold pressure.

Once so selected, the RPM will remain constant under all conditions, within the operating limits of the governor.

NOTE: Vernier control is obtained by turning the control knob. Turn clockwise to increase RPM.

Always move the push-pull control knob slowly. Slight movement makes a great change in RPM.

d. Starter

Designation - Jack and Heintz, Model JH-5C, electric-hand inertia starter, 24 volt DC.

Handcrank and Gear Box - This equipment not included in weight empty but may be carried in bomber's compartment if desired.

Electrical Operation - Toggle switch on pilot's distribution panel.

LEFT - ENERGIZE (not over 15 sec.)
RIGHT - ENGAGE

NOTE: An exterior battery receptacle is provided on the lower right hand side of the fuselage.

On later Avenger I's, an A.C. external power receptacle is located adjacent to the D.C. plug for ground checking special radio devices.

CAUTION: When using an external power source, for starting, check polarity of leads.

Manual Operation - Handcrank socket and engaging cable release are located on the lower right hand side of the engine compartment cowling.

- Start turning slowly and easily. ONE MAN ONLY.

NOTE: Shaft and mount are of light construction and may be damaged by excessive loads.

The booster coil is energized only when the starter switch is held in the ENGAGE position.

NOTE: Airplane #06199 and up (TBF-1) and #24547 and up (TBM-1) are equipped with a Jack and Heintz Model #JH-5F starter.

The following instructions apply to this type starter only.

Electrical Operation - Toggle switch located on pilot's distribution panel.

LEFT - ENERGIZE (not over 15 sec.)
RIGHT - ENGAGE

NOTE: If starter does not energize, flick switch to ENGAGE momentarily to insure that brushes which might have been lifted and locked for hand cranking are released and back on the commutator.

Manual Operation (Rotation counter-clockwise.) - Pull engaging cable "T" Handle control full out and allow to snap back, this lifts and locks brushes. Otherwise, three men would be required to turn crank.

Turn starter handcrank COUNTER-CLOCKWISE until sufficient speed is obtained.

Pull engaging cable "T" Handle once more to start engine.

e. Two-Speed Blower Control

The engine should be operating in the blower ratios specified in the Engine Operating Chart, Page 80. HIGH blower ratio may be used as indicated in the Engine Operating Chart to obtain maximum speeds and rates of climb. It should not be used for cruising at altitudes at which cruising power is available in LOW blower ratio, since fuel economy is inferior to that obtainable in lower blower ratio, and the tendency to detonate is greater.

Use LOW blower for all power conditions up to full throttle and 2400 RPM.

Do not shift the supercharger control more often that 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 (5) hour period of operation in HIGH ratio, shift to LOW ratio for a period of five (5) minutes to eliminate sludge accumulations in the clutches.

To change from LOW 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 in HIGH ratio.
3. Reduce RPM if practicable (not below 1700 RPM).
4. Shift rapidly from LOW to HIGH.
5. Readjust RPM, throttle setting and mixture control as necessary to obtain desired power.

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

1. Mixture control in AUTO RICH.
2. Move blower control rapidly from HIGH to LOW and lock.
3. Readjust the RPM, throttle setting and mixture control to obtain desired power (See Changing Power Conditions, page 64.

If a shift to HIGH ratio is attempted and the clutch does not engage or if for some reason the HIGH ratio clutch becomes disengaged, close the throttle to 800-1000 RPM or as low as possible, shift to LOW, speed engine up to at least 1700 RPM and shift to HIGH using the procedure described above.

f. Mixture Control

The carburetor provides automatic altitude compensation of the mixture in all positions of the mixture control except IDLE CUT-OFF (red sector of the quadrant).

The two normal operating positions are AUTOMATIC RICH (full forward-marked RICH), and AUTOMATIC LEAN (middle of the quadrant-marked with white sector). AUTOMATIC RICH should be used for maneuvers and all operations above 65% normal rated power-AUTOMATIC LEAN should be used for cruising at 65% normal

rated power, and below. There is a certain additional amount of manual control between the positions marked on the quadrant.

For maximum economy cruising it is permissible to operate with mixtures leaner than AUTOMATIC LEAN, the limit of such leaning being that for smooth engine operation. However, the use of any position but AUTOMATIC RICH is contingent upon not exceeding the allowable cylinder head temperatures.

An over-ride valve, incorporated as a safety feature in the carburetor, automatically returns the mixture to AUTOMATIC RICH at approximately 70% normal rated power, thereby rendering the manual control inoperative under these conditions. The over-ride zone is indicated by a shaded area on the Plotting Graph and Pilot's Operating Graph. As the cut-in point may vary, do not depend on the charted fuel consumption at points in the over-ride zone.

To insure release of the over-ride valve when operating with the mixture control in other than AUTOMATIC RICH, close the throttle momentarily after changing to AUTOMATIC LEAN.

g. Cowl Flap Control

Cowl flaps must be FULL OPEN for all ground operation to avoid local overheating. This applies to warm-ups in cold weather as well as warm weather. At normal temperatures, all level flight and cruising climbs can be done with closed cowl flaps. When leveling off for cruising, best results will be obtained by leaving the cowl flaps partly open until the head temperature drops to 190°C., and then closing the cowl flaps, after which a rise to 205°C. is permissible.

NOTE: Cowl flap drag when cowl flaps are OPEN is in excess of 20 knots at maximum velocity; run closed when temperatures permit.

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 Operating Chart, page 80.
2. Adjust propeller control to obtain the desired RPM.
3. Adjust throttle to obtain the desired manifold pressure.

Decreasing Engine Power

1. Adjust throttle to obtain the desired manifold pressure.
2. Adjust propeller control to obtain the desired RPM.
3. Adjust mixture control for the power conditions desired as specified in the Engine Operating Chart, page 80.
4. Close throttle momentarily to insure release of mixture control over-ride valve.
5. Readjust throttle to desired manifold pressure.

9. FUEL SYSTEM

Fuel

Use 100 Octane fuel, AN Spec. AN-VV-F-781.

Tanks

The fuel is carried in the wing center section in three tanks each equipped with a self-sealing liner. Droppable fuel tanks without self-sealing protection can be carried in the bomb bay, and/or under each wing.

Tank	Capacity with Liners
Center Main	147.3
Left Main	93.2
Right Main	95.0
Droppable Center (No liner)	275.0
Droppable Left Wing (No liner)	58.0
Droppable Right Wing (No liner)	58.0

Without the self-sealing liners in the main tanks, the left and right main will hold 110 gals. each and the center main 175 gals. These quantities do not allow for expansion space.

Refer to the Loading Schedule herein, for the fuel gallonage for the different loading conditions.

The tank filler caps are located as follows:

Right main - right walkway
Left main - left walkway
Center main - left side of fuselage
Droppable - right wing outboard of walkway

NOTE: Refer to T.N. #85-42, Fuel Tanks - Protection against Gunfire.

Wing Droppable Fuel Tanks

Later models of Avenger I's are equipped to carry two 58 gallon capacity droppable wing tanks in addition to the regular 275 gal. droppable tank. These tanks are suspended, one under

each wing, just inboard of the folding axis.

Fuel from each of the three droppable tanks is piped into a single junction, which runs to the inlet port of the fuel tank selector valve. Before the junction point of each of these lines, electrically operated valves are installed with "ON-OFF" switches for individual selection of left, center or right droppable tank.

To select any one of the three droppable tanks:

1. Switch the ON-OFF electrical switch on the pilot's lower center panel to tank desired.
2. Switch ON emergency fuel pump.
3. Turn fuel tank selector valve control to DROPPABLE tank position.

Each wing tank is dropped by pulling one of the two "T" Handle releases (painted chrome-yellow) located side by side below the chartboard, on the pilot's center control panel.

Tank Selector Valve

The fuel tanks selector valve has five positions:

CENTER MAIN
RIGHT MAIN
LEFT MAIN
DROPPABLE
OFF

CAUTION: Use the fuel tank selector to change tanks, not the fuel gage selector.

When a droppable tank is carried, use fuel from this tank first except for take-off and landing when droppable tank fuel should not be used.

CAUTION: To prevent loss of fuel pressure when changing tanks, operate the emergency electric fuel pump. (See page 68 Fuel Pump - Electric Emergency.)

Quantity Gage

The electric fuel quantity gage, located on the lower right hand side of the instrument panel, indicates the fuel quantity of the three main tanks and center droppable tank on the same dial face. The tank selector control is located directly above the gage.

Fuel Strainer Drain

Push-pull control knob with lock located above left rudder pedal. Push button on knob and pull knob AFT. Hold out for approximately five seconds then push FULL IN. Approximately $\frac{1}{2}$ pt. of fuel will drain out.

NOTE: Strainer should be drained at least every day just prior to flight.

Fuel Pump - Electric Emergency

Controlled by a switch on the pilot's left hand shelf. This pump is used to build up initial pressure for starting the engine, to maintain fuel pressure at altitude, for emergency use in case of fuel pump failure, and to maintain fuel pressure while changing tanks.

10. OIL SYSTEM

Oil

AN Spec. AN-VV-O-446

Grade	Operating Range °C
1080	47-85
1100	54-95
1120	60-102

Tank

The oil is carried in a tank just forward of the firewall. Armor plate is installed on the firewall abaft of the tank.

Max. Capacity	32 gallons
Filler Cap	Upper left hand side of engine compartment

The actual quantity of oil carried will depend upon the oil consumption of the engine and the type of operation or mission. As a general rule, a fuel/oil ratio of 15/1 will be satisfactory. The quantity of oil should be varied from this ratio to about 18/1 for long range cruising power operation; for operation involving especially severe scavenging and foaming conditions such as continued carrier landing practice, it is advisable to carry not less than 20 or more than 25 gallons of oil.

Temperature Control Valves

Two oil coolers are mounted in series, one on each side of the engine mount. A U-D-7000 thermostat valve is mounted on the left hand cooler and a U-D-7030 thermostat valve on the right hand cooler.

The oil from the engine enters the U-D-7000 valve in the left hand cooler and during warm-up the valve opens returning the oil to the bottom of the tank.

When the engine oil-in temperature reaches 54°C, the thermostat in the U-D-7000 valve closes. The oil then flows through

the core of the left hand cooler and over to the right hand cooler. If no additional cooling is required, the oil by-passes the right hand cooler and returns to the top of the tank. If on leaving the core of the left hand cooler there is need for additional cooling, the oil is forced through the right hand cooler core and then to the top of the tank. The thermostatic valves are set to regulate the engine oil-in temperature from 71°C to 79°C.

Temperature	Desired 60°C - 102°C.
Pressure	Desired 75 to 90 p.s.i. Idling 25 p.s.i.

Oil Dilution System

The oil dilution system consists of a flexible line from the fuel pressure connection at the carburetor to the engine disconnect block and from there a tube to the shut-off valve at the oil-to-engine outlet of the oil tank. See Page 78.

On later Avenger I's an electrically operated dilution valve is installed on the opposite end of the oil dilution line with an ON-OFF switch located at after end of the Electrical Distribution Panel.

SECTION II

OPERATING INSTRUCTIONS

1. ENGINE

a. Starting Engine

1.	Ignition Switch	OFF
2.	Mixture	IDLE CUT-OFF
3.	Rotate Engine by hand	3 to 4 Revolutions
4.	Throttle	Set for 800 RPM
5.	Blower Control	LOW RATIO
6.	Propeller Control	TAKE-OFF RPM
7.	Oil Cooler Flaps	OPEN
8.	Cowl Flaps	OPEN
9.	Carburetor Air	DIRECT (T.O. 44-40)
10.	Battery Switch	ON
11.	Emergency Fuel Pump Switches	ON
12.	Check Fuel Pressure	7 p.s.i.
13.	Starter Switch	ENERGIZE (15 sec.)
14.	Ignition Switch	ON - BOTH
15.	Electric Primer	ON (During last 3 to 5 seconds of starter energizing period.)
16.	Mixture	AUTO RICH
17.	Starter Switch	ENGAGE
18.	Electric Primer	ON - Intermittently as necessary until engine runs smoothly.
19.	Idle	1000 RPM for 30 sec. If oil pressure gage does not indicate pressure in 30 sec. stop engine and investigate.

NOTE: Steps 14, 15 and 16 are accomplished during the 15 second starter energizing period.

NOTE: Do not prime if the engine is warm. In warm weather the tendency is to overprime.

When restarting a short time after stopping, leave the mixture control in IDLE CUT-OFF. This locks a charge of fuel in the carburetor accelerating pump chamber which is released by subsequent movement of the mixture control to AUTO RICH, thereby aiding the start.

Do not pump the throttle to keep the engine running. Use the primer intermittently as required until the pressure rises to 7 p.s.i.

If the engine has been flooded by excessive priming and fails to start, open the throttle wide and set the mixture control to IDLE CUT-OFF, and ignition switch to OFF, then rotate the engine several revolutions by hand. Replace the throttle and mixture controls in normal starting position, and attempt another start.

Operating at high RPM when the engine is cold may damage the oil pressure gage.

b. Engine Ground Test - Warm Up

1. Carburetor Air Control ——— DIRECT
2. Cowl Flaps ——— OPEN
3. Oil Cooler Flaps ——— OPEN
4. Mixture Control ——— AUTO RICH
5. Propeller Control ——— 2600 RPM
6. Operate at 1200 RPM until oil temp. is 30°C.
7. Check Magnetos
   (a) Set throttle, 30" Hg. Max.
   (b) Operate on single mag. for shortest possible time.
   (c) Return switch to BOTH between checks to allow engine to clear out.
8. Check Two-Speed Blower
   (a) Set propeller to take-off RPM.
   (b) Open throttle to 1700 RPM
   (c) Shift rapidly, LOW to HIGH
   (d) Open throttle to approx. 30" HG.
   (e) Observe man. press. when RPM is stabilized.

(f) Shift rapidly HIGH to LOW (do not move throttle.)
(g) Sudden decrease in man. press. indicates proper operation.
(h) Open throttle momentarily to 33" Hg. to check re-engagement of LOW blower clutch.

NOTE: Cooling is insufficient for prolonged high power ground operation. Airplane should be headed into wind to avoid local overheating of the engine. Do not exceed 205°C. Cylinder head temperature before take-off.

c. Take-Off

1. Mixture Control ———— AUTO RICH
2. Blower Control ———— LOW RATIO
3. Propeller Control ———— 2600 RPM
4. Carburetor Air Control —— DIRECT
5. Cowl Flaps ———— OPEN
6. Oil Cooler ———— OPEN
7. Throttle ———— Open slowly to 43.0" Hg.
8. Max. Cyl. Head Temp. ——— 248°C

NOTE: Apply brakes when retracting landing gear to prevent tire wear as wheels retract into the wheel wells.

d. Military Power Climb and Level Flight (5 min.)

Operate according to the Engine Operating Chart, page 80, and the Operating Limits Chart, page 81. Table I gives the throttle and blower control settings for this condition.

'Boy, am I hot'.

CAUTION: Do not exceed 248° C. Cyl. head temperature.

TABLE I

MILITARY POWER - 2600 RPM

PRESS. ALT.	MAN. PRESS. "HG.	BLOWER RATIO
S. L.	43.0	LOW
2000	42.5	LOW
3000	42.0	LOW
3000-8000	F.T.	LOW
8000	45.5	HIGH
10000	45.0	HIGH
12000	44.5	HIGH
Above 12000	F.T.	HIGH

e. Rated Power Climb and Level Flight

Operate according to the Engine Operating Chart, Page 80, and the Operating Limits Chart, Page 81. Table II gives the throttle and blower control settings for this condition.

CAUTION: Do not exceed 235°C. (one hour) or 218°C. (continuous operation) cylinder head temperature.

TABLE II

RATED POWER - 2400 RPM

PRESS. ALT.	MAN. PRESS. "HG.	BLOWER RATIO
S. L.	38.5	LOW
3000	38.0	LOW
5900	37.5	LOW
5900-8900	F.T.	LOW
8900	41.0	HIGH
13000	40.5	HIGH
Above 13000	F.T.	HIGH

f. Cruising

While cruising may be conducted at any engine power and RPM below rated power and RPM, if fuel economy is of importance and if it is tactfully feasible to do so, cruising operations should be conducted in a range not to exceed 65 per cent of

normal rated power.

The engine should be operated in Automatic Lean at 65% power and below, except when conditions are such that a cylinder head temperature of 205 C is exceeded. In such cases Automatic Rich should be used.

Manual leaning beyond Automatic Lean to the point of engine roughness is permissible at 65% power and below for minimum fuel consumption.

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

Propeller pitch limitations for this installation preclude the use of the low cruising RPM conditions on the Operating Limits Chart at altitudes appreciably above sea level.

For maximum range at design gross weight (14,500#), cruise at 126 IAS in still air; add $\frac{3}{4}$ knot for each knot of headwind. Do not exceed maximum Automatic Lean IAS for any headwind; for other weights consult table adjacent to the Pilot's Operating Graph.

g. Stopping Engine

1. Cowl Flaps ———— OPEN
2. Oil Cooler Flaps —— OPEN
3. Propeller Control —— LOW PITCH
4. Throttle ———— 800 RPM until cyl. head temp. is 149°C, or below.
5. Throttle ———— Open to 1000-1200 RPM for 30 Sec.
6. Mixture Control —— IDLE CUT-OFF
7. Fuel Selector Valve — OFF
8. Ignition Switch —— OFF
9. Battery Switch —— OFF

NOTE: After each flight it is highly desirable (while operating below 1000 RPM) to shift the supercharger control alternately from LOW to HIGH several times remaining in each position for 30 seconds to wash sludge accumulations from the supercharger clutches.

CAUTION: Before turning the battery switch off, all transmitter switches and the turret power switch must be turned off.

OIL DILUTION PROCEDURE

In the event that temperatures below 35°F are forecast for the period prior to the next start, the engine lubricating oil should be diluted as follows:

1. Open manual shut-off valve in dilution line.
2. Engine oil-in temperature not more than 30°C (86°F.)
3. Start engine (if previous stoppage was necessary to comply with Step 2 above.)
4. Engine speed constant - 1000 RPM.
5. Hold dilution switch closed for approximately two minutes. (See Note A below).
6. Stop engine by moving Mixture Control to IDLE CUT-OFF position then cut ignition. Dilution switch should be held closed until engine stops rotating.

NOTE: A - When the dilution valve is opened, there will be a sharp drop in indicated fuel pressure.

PRECAUTION:

1. *Do not overdilute.*
2. *Guard against fire.*
3. *Dilute only when justified by forecast of low temperatures, i.e., below 35°F.*
4. *Keep oil system free of sludge and water.*
5. *Close manual shut-off valve prior to take-off.*

h. Pilot's Operating Graphs

It is expected that cases may arise wherein the RPM-Airspeed relationships specified on the Pilot's Operating Graphs will not be obtainable without exceeding the limits specified in the Operating Limits Chart. This condition may be brought about by engine power deficiency (such as may be caused by high carburetor air temperatures) or by increased drag of the airplane. If this condition is encountered:

1. Slightly lower airspeed may be accepted, or
2. Increase the RPM (at limiting manifold pressure) to give desired airspeed.

Operating Limits Chart

The Operating Limits Chart presents only those power conditions which are recommended for safe operation of the R-2600-8 or 8A engine in this airplane.

The section to the left is for LOW blower operation; the section to the right is for HIGH blower operation.

The manifold pressure-RPM relationships shown to the right of the heavy oblique dashed lines in both the HIGH and LOW blower sections are full throttle conditions and do not portray operating limits - any manifold pressure-RPM relationship shown in the full throttle sections of the chart can be used for part throttle operation.

To Determine Horsepower - Any Power Condition

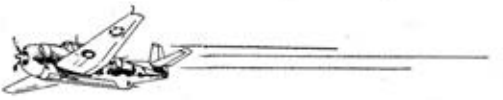
1. Spot the RPM-manifold pressure relationship in the full throttle portion of the chart for the desired blower ratio. (Ex. (A), 1700 RPM-22" Hg.)

2. Draw a line through the point determined parallel to the dash-double dot line (drawn for this example) to the desired pressure altitude and read HP (Ex. (B)-640 HP).

Pressure Altitude

1. Determine the amount the barometric pressure is above or below 29.92" Hg.

2. Add 100 feet to indicated altitude for each 0.1" Hg. below 29.92; subtract 100 feet for each 0.1" Hg. above 29.92.



ENGINE OPERATING CHART R-2600-8 (or -8A)

OPERATING CONDITION	PRESSURE ALTITUDE FT. (NO RAM)	CRANKSHAFT RPM OR PROP. GOV. SETTING	MAX. ABS. MANIFOLD PRESSURE	MIXTURE CONTROL	BLOWER RATIO	MAX. CYL. HEAD TEMP. °C	OIL IN* TEMP. °C MIN.	OIL IN* TEMP. °C MAX.	OIL PRESSURE LB./IN.^{2}
Starting	--	Full Low Pitch	800 RPM	Auto Rich	Low	--	--	--	(20 sec.) 25-90
Warm-Up	--	Full Low Pitch 1000-1200	30.0	Auto Rich	Low & High	205	--	--	25-90
Take-Off	S.L.	2600	43.0	Auto Rich	Low	248 (5 min.)	30 ***	102	75-90
Military Power (5 min.)	S.L. - 3,000 8,000-12,000	2600	43.0-42.0 45.5-44.5	Auto Rich	Low High	248 (5 min.)	60	102	75-90
Normal Rated Power	S.L. - 5,900 8,900-13,000	2400	38.5-37.5 41.0-40.5	Auto Rich	Low High	235 (1 Hr.) 218 (cont.)	60	102	75-90
65% Rated Power (Maximum allowable for Lean Mixture Operation)	S.L.-13,500 19,600-21,400	2080	29.5-26.5 27.5-27.0	Auto Lean**	Low High	205 (cont.)	60	102	75-90
Landing	--	2400	--	Auto Rich	Low	205	--	--	--
Stopping	--	Full Low Pitch 1000 RPM	--	Idle Cut-Off	Low	149	--	--	--

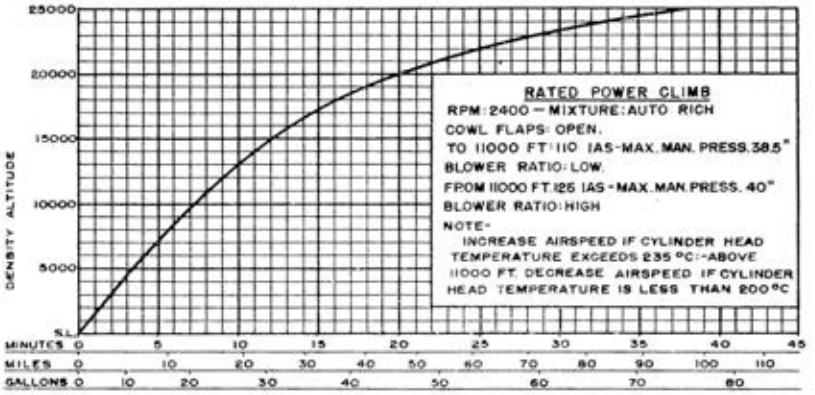
* See T.O. 24-41

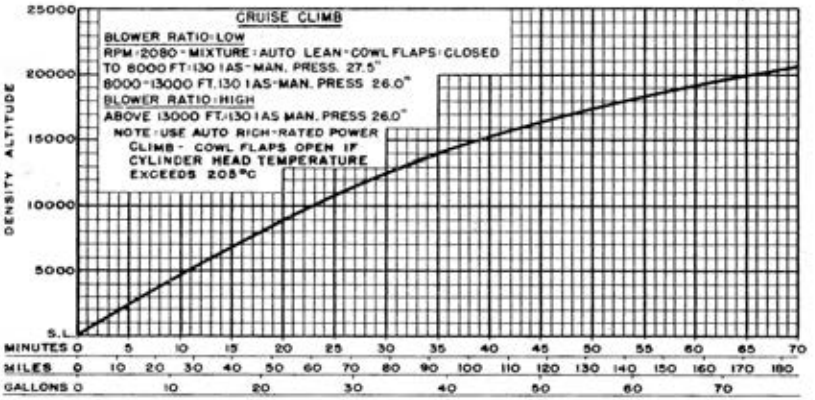
** Use Auto Rich if max. cyl. Head temp. is exceeded.

*** 20°C. emergency take-off.

FUEL PRESSURE - 6-7 LBS./SQ. IN.

FIG. 14





CLIMB DATA

FIG. 18

2. S. B. A. E. Unit

Before Leaving the Ground

1. SWITCH AT THE BOMBER'S STATION. Check for proper setting in accordance with directions on the bulkhead forward of the bomber's window to give pilot complete control of the SBAE.

2. PILOT'S POWER SWITCH on the starboard panel of the pilot's cockpit may be thrown ON prior to take-off if an initial warm-up is desired, BUT SHOULD BE OFF DURING TAKE-OFF AND CLIMB TO A SAFE ALTITUDE to avoid the possibility of inadvertent throwing of control switches.

During Flight

3. PILOT'S MASTER POWER SWITCH is thrown on when the plane is at a safe altitude.

4. WARM-UP of the equipment. Allow at least five minutes period to insure full erection of the flight gyro to the vertical. A longer period may be required under low temperature conditions.

5. TELL-TALE LIGHTS ON. Switch is on the pilot's starboard switch panel.

Engagement of Rudder

6. PILOT DIRECTOR INDICATOR (PDI) is on the pilot's instrument panel. Bring to zero by either of the following methods:

   a. Hold the plane on a steady course at normal cruising speed (170 knots indicated for TBF-TBM) and hold the switch marked PRECESSION, RIGHT AND LEFT in the direction the needle must move to be centered.

   b. Turn the plane in the direction that the PDI needle is pointing to bring the needle to center.

7. ENGAGE RUDDERS with the plane trimmed to fly Hands Off, and the PDI needle on or within one division of center. Throw the outboard switch marked RUDDER to ON, thereby transferring control of the rudder to the SBAE.

Engagement of Elevators

8. ELEVATOR TELL-TALE LIGHTS are located fore and aft on the tell-tale light unit, pilot's starboard switch panel. With the plane at the attitude desired, turn the attitude control (at the pilot's left elbow) CLOCKWISE to extinguish the forward light and COUNTER-CLOCKWISE to extinguish the after light. If neither light is ON, check their function by turning the attitude control in either direction to turn a light on, and then extinguish as above. If not possible to fly lights out, adjust the attitude control to obtain blinking of both lights.

9. ENGAGE ELEVATORS. With the lights out or blinking, throw the center switch marked ELEVATOR to ON, thereby transferring control of the elevators to the SBAE.

Engagement of Ailerons

10. AILERON TELL-TALE LIGHTS are located athwartship on the tell-tale light unit, pilot's starboard switch panel. A wing-low condition is indicated by the corresponding tell-tale light being on. If neither light is on, tip the wings to check functioning of the tell-tale lights--then level the wings to extinguish or obtain blinking of both lights.

11. ENGAGE AILERONS. Throw the inboard switch marked AILERONS to the ON position, thereby transferring control of the ailerons to the SBAE.

    The SBAE now has complete control of the plane, but the PILOT can immediately REGAIN CONTROL by throwing the SBAE power switch to the OFF position.

12. SWITCH OFF THE TELL-TALE LIGHTS. Chattering of controls sometimes results from leaving the tell-tale lights on during automatic flight. This is especially true if improper bulbs are used (the system is designed for the use of 35 milliamp, 28 volt bulbs only.)

Operational Adjustments

Attitude Adjustment

The plane's attitude may now be changed through rotation of the attitude knob. Move the top of the attitude knob FORWARD (clockwise rotation) to lower the nose. Move the top of the knob AFT (counter-clockwise rotation) to raise the nose. Remember that after the elevators are engaged the movement of the top of the attitude knob must be in the direction of control-stick movement to effect lowering or raising of the nose. The fore and aft tell-tale lights, if ON, indicate respectively that the nose is below or above the pre-set attitude. (Prior to engagement of the elevators, CLOCKWISE movement of the knob extinguished the forward tell-tale light, and COUNTER-CLOCKWISE movement of the knob extinguished the after light.

Disengaging the SBAE while in a Banked Turn

The pilot may safely disengage the SBAE by throwing the Master Switch to OFF and take over manual control of the plane at any time regardless of the attitude of the plane at the moment the switch is thrown. The following PRECAUTIONS MUST BE TAKEN before re-engaging the SBAE for automatic flight:

a. No attempt should be made to re-engage the SBAE while the plane is in a turn.

b. If steep turns (over 40 degrees) have been made after the SBAE has been dis-engaged, the flight gyro has probably been thrown off-balance by hitting the stops. Allow at least ten minutes for re-erection of the flight gyro. Use the Tell-Tale Lights to indicate return of the flight gyro to the vertical. Re-engage the RUDDER, ELEVATORS AND AILERONS individually as above.

c. If no steep turns have been made after the SBAE is engaged, the flight gyro will maintain the vertical during the following few minutes (at least five minutes, since it runs down slowly), hence the gyro system remains operative and upon return to level flight, the RUDDER, ELEVATORS, and AILERONS may be individually re-engaged

in the manner above described without a long waiting period.

BANKED TURNS. Proportionally banked turns can be made by use of the Precession Right and Left switch, which is spring loaded to return to OFF position when released.

BOMBING RUN TURNS. Since positive, accurate changes of course are necessary during bombing runs, turns must be entered abruptly, hence ball-high turns must be accepted.

PERFORMANCE OF SBAE. Optimum performance of SBAE is obtained at the indicated speed for which the original adjustments were made. For TBF-TBM planes, original adjustments are made for 170 knots indicated. The equipment can be re-adjusted for any desired speed, by a competent SBAE mechanic.

While on extended flights, the pilot should disengage the SBAE hourly, retrim and re-engage in accordance with the above instructions. Failure to retrim periodically may result in excessive control forces which must be carried by the SBAE. Upon disengaging the SBAE, the need for a retrim will be evidenced by the tendency of the plane to leave the desired attitude.

SECTION III

FLYING CHARACTERISTICS

I. LOADING SCHEDULE

This schedule has been prepared to permit a relatively simple and rapid check on balance by operating personnel for any combination of Useful Load and Special Equipment, or with Weight Empty Equipment removed for some particular mission.

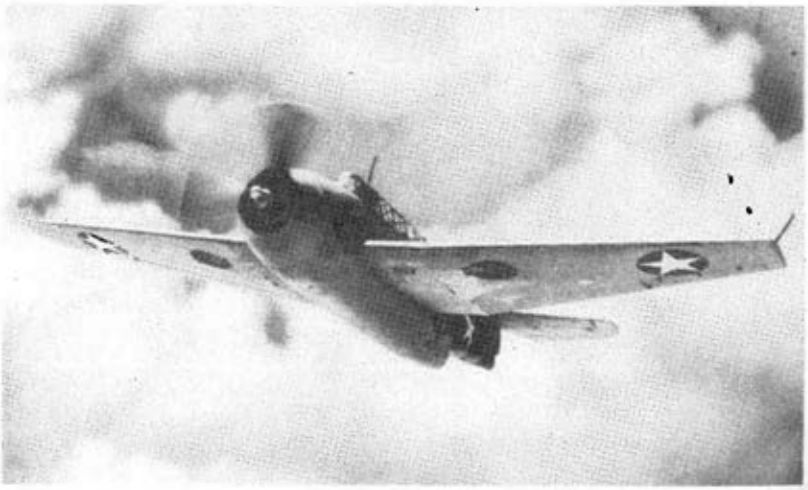
Definition of terms used in this schedule are listed below:

1. Combat Basic Weight is the Combat Weight Empty plus items of Useful Load usually carried at all times (see pg. 90)

2. Index Unit is the moment (Weight x Distance) of any item about the Horizontal Reference Line divided by 1000 to allow greater ease in handling. (See pg. 99).

3. Limiting Percent Lines (see Fig. 22, page 101.) The diagonal lines represent the recommended balance limits between which the Center of Gravity should be maintained. The lines are expressed in percentage of the mean aerodynamic chord.

4. Example showing use of Loading Schedule is on Page 92.



DERIVATION OF COMBAT BASIC WEIGHT & INDEX

ITEM	WEIGHT	TOTAL WEIGHT	INDEX	TOTAL INDEX
COMBAT WEIGHT EMPTY (WHEELS UP)		10151		1450.2
CREW				
Pilot & Chute	200		27.6	
Radio Operator & Chute in Bombardier's Seat	200		56.6	
Gunner in Turret	180		43.6	
Gunner's Detachable Chute	20		5.8	
		600		133.6
FUEL & OIL				
Trapped Fuel, 6 gals.	36		5.5	
Trapped Oil, 11 gals.	82.7		6.1	
		118.7		11.6
ARMAMENT				
Fwd. .30 Cal. Fixed Gun, M-2 incl. Trigger Motor, Trunnion, Charging Handle & Mtg. Post	23.3		2.5	
Impulse Generator & Cable	3.0		.2	
Trigger Switch	0.5		.1	
Gun Firing Solenoid	3.5		.2	
Telescope Sight	1.5		.2	
TOTAL FIXED GUN INSTAL. LESS AMM.		31.8		3.2
Turret .50 Cal. Gun, M-2, incl. Slide Group Assembly, Trigger Control & Ejected Link Chute	66.5		16.4	
Trigger Switch	1.0		.3	
Gun Mount Adapter	7.0		1.7	
Sight	1.5		.4	
TOTAL TURRET GUN INSTAL. LESS AMM.		76.0		18.8
Tunnel .30 Cal. Gun M-2 (Flex) Incl. Mag. Holder Gun Mt. Adapter & Latch & Ejected Link Chute	26.9		8.8	
Telescope Sight & Mount	4.5		1.4	
Gun Sight Armor	6.2		1.9	
TOTAL TUNNEL GUN INSTAL. LESS AMM.		37.6		12.1
Pilot Director Indicator		.7		.1
Firing Key, NAF 1174 (1)		.5		.1
SUB TOTAL (CONT'D. ON NEXT PAGE)		11016.3		1629.7

DERIVATION OF COMBAT BASIC WEIGHT & INDEX (CONT'D)

ITEM	WEIGHT	TOTAL WEIGHT	INDEX	TOTAL INDEX
SUB TOTAL (From preceding page)		11016.3		1629.7
EQUIPMENT				
Navigation				
Chartboard & Set of Charts	3.3		.4	
Drift Indicator (Stowed)	1.1		.3	
Drift Indicator Base Plates (2)	1.2		.4	
		5.6		1.1
Oxygen				
Bottle (1) Reg. & Shutoff Valves	28.3		5.4	
3 Complete Rebreather Assemblies	25.0		5.3	
Spare Canisters (6)	10.2		2.2	
Hose Assembly	3.4		.7	
		66.9		13.6
Pyrotechnics				
M-8 Signal Pistol & Adapter	3.4		.5	
Cartridges (12)	3.0		.5	
Aircraft Float Lights, Mk. 4 (4)	8.8		2.9	
		15.2		3.9
Container for Classified Matter		2.3		.6
Life Raft, Mk. 4, Type S		51.0		11.0
Emergency Kit		18.7		4.0
One qt. Container of Water		3.5		.9
Radio (GP-7, RU-19, ZB)		*199.5		46.5
Radar (ASB)		*164.6		31.8
Radio (AYB) or (AN/ARN-1)		* 29.3		4.6
Radio (ABK)		* 52.1		9.5
COMBAT BASIC WEIGHT (WHEELS UP)		*11625.		1757.2
Extend Wheels		0		- 6.2
Combat Basic Weight (Wheels Down)		11625		1751.0

NOTE: The Combat Basic Weight & Index 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 Combat Basic Weight are not carried, the weight and index for those items should be subtracted.

*For Detail Breakdown of Armor, Radar & Radio included in Combat Basic Weight see pages 102 and 103.

SAMPLE CALCULATION

Assume that the Airplane is to be flown in the following condition:

PAGE	ITEM	WEIGHT	INDEX
91	Combat Basic Weight (Wheels Up)	11625	1757.2
90	Less: Turret Gunner	-180	-43.6
90	Turret Gunner's Chute	- 20	- 5.8
102	Tunnel Vertical Sliding Armor	- 34	-11.3
96	Add: Droppable Tank Installation	+228.7	+35.8
98	Towing Eyes	+ 8.5	+ 1.0
	Starter Handcrank & Gear Box	+ 6.2	+ 1.9
100	Load: Fuel, 60 Gals. in each Outboard Tank & 100 Gals. in Center Tank	1320	182
	150 Gals. in Droppable Tank (Total Fuel 370 Gals.)	900	138
100	Oil 25 Gals.	187.5	15
99	Miscellaneous Equipment as follows:		
	60# Between Sta. #216½ & Sta. #232	60	19.2
	300# Between Sta. #185½ & Sta. #201	300	87.0
	Gross Weight at Beginning of Flight (Wheels Up)	14402	2176.4

If the Gross Weight is plotted against total index units on Fig. 22 Page 101, it is apparent that the center of gravity falls between the recommended limits and therefore is satisfactory for flight.

Gross Weight at Beginning of Flight (Wheels Up)	14402	2176.4
Fuel consumed from Outboard & Center Tanks (220 gals.)	-1320	-182
Fuel consumed from Droppable Tank (150 gals.)	- 900	-138
Extend Wheels	0	- 6.2
Gross Weight at end of Flight (Wheels Down)	12182	1850.2

If the Gross Weight is plotted against total index units on Fig. 22 Page 101, it is apparent that the center of gravity falls between the recommended limits and will be satisfactory at the end of the flight.

TABULAR SUMMARY OF

REPRESENTATIVE LOAD CONDITIONS

PAGE	ITEM	WEIGHT	INDEX
	TORPEDO NORMAL		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 199 Gals. in Center & Outboard Tanks	1194	165
100	Oil - 13 Gals.	97.5	8
96	Ammunition - Fixed Gun 500 Rds.	32.5	3.5
	- Turret Gun 200 Rds.	59.8	15
	- Tunnel Gun 500 Rds.	40.0	11.4
96	Torpedo Installation	1953.1	287.4
	Total Wheels Up	15002	2247.5
	Extend Wheels	0	- 6.2
	Total Wheels Down	15002	2241.3
	TORPEDO OVERLOAD		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 301 Gals. in Center & Outboard Tanks	1806	250
100	Oil - 17 Gals.	127.5	10
96	Ammunition - Fixed Gun - 500 Rds.	32.5	3.5
	- Turret Gun - 200 Rds.	59.8	15
	- Tunnel Gun - 500 Rds.	40.0	11.4
96	Torpedo Installation	1953.1	287.4
	Total Wheels Up	15644	2334.5
	Extend Wheels	0	- 6.2
	Total Wheels Down	15644	2328.3
	BOMBER - 1000# CLASS		
91	Combat Basic Weight (Wheels Up)	11525	1757.2
100	Fuel - 301 Gals. in Center & Outboard Tanks	1806	250
100	Oil - 17 Gals.	127.5	10
96	Ammunition - Fixed Gun - 500 Rds.	32.5	3.5
	- Turret Gun - 200 Rds.	59.8	15
	- Tunnel Gun - 500 Rds.	40.0	11.4
97	Bomb Installation (1) 1000# Demolition Bomb	1064.1	165.1
	Total Wheels Up	14755	2212.2
	Extend Wheels	0	- 6.2
	Total Wheels Down	14755	2206

TABULAR SUMMARY OF

REPRESENTATIVE LOAD CONDITIONS (CONT'D)

PAGE	ITEM	WEIGHT	INDEX
	BOMBER - 500# CLASS NORMAL		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 199 Gals. in Center & Outboard Tanks	1194	165
100	Oil - 13 Gals.	97.5	8
96	Ammunition - Fixed Gun - 500 Rds.	32.5	3.5
	- Turret Gun - 200 Rds.	59.8	15
97	- Tunnel Gun - 500 Rds.	40.0	11.4
97	Bomb Installation (4) 500# Demolition Bombs	2067.3	318.3
	Total Wheels Up	15116	2278.4
	Extend Wheels	0	- 6.2
	Total Wheels Down	15116	2272.2
	BOMBER - 100# CLASS		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 199 Gals. in Center & Outboard Tanks	1194	165
100	Oil - 13 Gals.	97.5	8
96	Ammunition - Fixed Gun - 500 Rds.	32.5	3.5
	- Turret Gun - 200 Rds.	59.8	15
	- Tunnel Gun - 500 Rds.	40.0	11.4
97	Bomb Installation (12) 100# Demolition Bombs	1319.3	204.5
	Total Wheels up	14368	2164.6
	Extend Wheels	0	- 6.2
	Total Wheels Down	14368	2158.4
	SCOUT NORMAL		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 301 Gals. in Center & Outboard Tank	1806	250
100	Oil - 17 Gals.	127.5	10
96	Ammunition - Fixed Gun - 500 Rds.	32.5	3.5
	- Turret Gun - 200 Rds.	59.8	15
	- Tunnel Gun - 500 Rds.	40.0	11.4
	Total Wheels Up	13691	2047.1
	Extend Wheels	0	- 6.2
	Total Wheels Down	13691	2040.9

TABULAR SUMMARY OF

REPRESENTATIVE LOAD CONDITIONS (CONT'D)

PAGE	ITEM	WEIGHT	INDEX
	SCOUT OVERLOAD		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 301 Gals. in Center & Outboard Tanks	1806	250
	- 270 Gals. in Droppable Tank	1620	249
100	Oil - 32 Gals.	240	19
96	Ammunition - Fixed Gun 500 Rds.	32.5	3.5
	- Turret Gun 200 Rds.	59.8	15.0
	- Tunnel Gun 500 Rds.	40.0	11.4
96	Droppable Tank Installation	228.7	35.8
	Total Wheels Up	15652	2340.9
	Extend Wheels	0	- 6.2
	Total Wheels Down	15652	2334.7
	BOMBER - 500# CLASS OVERLOAD		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 301 Gals. in Center & Outboard Tanks	1806	250
100	Oil - 17 Gals.	127.5	10
96	Ammunition - Fixed Gun 500 Rds.	32.5	3.5
	- Turret Gun 200 Rds.	59.8	15.0
	- Tunnel Gun 500 Rds.	40.0	11.4
97	Bomb Installation (4) 500# Demolition Bombs	2067.3	318.3
	Total Wheels Up	15758	2365.4
	Extend Wheels	0	- 6.2
	Total Wheels Down	15758	2359.2
	BOMBER - 1600# A.P. CLASS		
91	Combat Basic Weight (Wheels Up)	11625	1757.2
100	Fuel - 199 Gals. in Center & Outboard Tanks	1194	165
100	Oil - 13 Gals.	97.5	8
96	Ammunition - Fixed Gun 500 Rds.	32.5	3.5
	- Turret Gun 200 Rds.	59.8	15.0
	- Tunnel Gun 500 Rds.	40.0	11.4
97	Bomb Installation (1) 1600# A.P. Bomb	1664.1	245.8
	Total Wheels Up	14713	2205.9
	Extend Wheels	0	- 6.2
	Total Wheels Down	14713	2199.7

USEFUL LOAD ITEMS NOT INCLUDED IN COMBAT BASIC WEIGHT

ITEM		WEIGHT	INDEX
FUEL*	OUTBOARD TANKS (2)		
	Each 10 Gals.	60	8.3
	Capacity 188 Gals.	1128	156
	CENTER TANK		
	Each 10 Gals.	60	8.3
	Capacity 147 Gals.	882	122
	DROPPABLE TANK		
	Each 10 Gals.	60	9.2
	Capacity 275 Gals.	1650	254
OIL*	Each Gal.	7.5	0.6
	Capacity 32 Gals.	240	19
DROPPABLE TANK, INSTALLATION			
	Droppable Tank	145	22.8
	4 Bomb Shackles, P4F	26	4.0
	Feed & Filler Lines, Quick Disconnect	22.4	3.6
	Support Straps, Bracing	35.3	5.4
Total Droppable Tank Installation		228.7	35.8
AMMUNITION			
	Fixed .30 Cal. Gun per 100 Rds.	6.5	.7
	Capacity - 500 Rds.	32.5	3.5
	Turret .50 Cal. Gun per 100 Rds. in Turret	29.9	7.5
	Capacity - 200 Rds. in Turret	59.8	15.0
	Overload Amm. - 200 Rds. Stowed in Rear Comp't.	62.2	16.5
	Tunnel .30 Cal. Gun per 100 Rds. in Each Magazine (Stowed in Rear Comp't.)	8.0	2.2
	Capacity - 400 Rds. in 4 Magazines (Stowed in Rear Comp't.)	32.0	8.8
	Capacity - 100 Rds. in (1) Mag. on gun	8.0	2.6
TORPEDO INSTALLATIONS			
	MK 13-1 Torpedo with Stabilizer	1921	282.6
	Bomb Shackles, P4F (2)	13	2.0
	Torpedo Director MK 28-2 (Stowed)	3.5	.4
	Sway Braces & Drag Brace	11.7	1.8
	Cable Slings (2)	3.9	.6
Total MK 13-1 Torpedo Installations		1953.1	287.4
	MK 13-2 Torpedo with Stabilizer	2121	310.5
	Shackles, Torpedo Director, Bracing & Slings	32.1	4.8
Total MK 13-2 Torpedo Installation		2153.1	315.3

*Weight and Index for varying amounts of fuel and oil are given on Page 100

USEFUL LOAD ITEMS
NOT INCLUDED IN COMBAT BASIC WEIGHT (CONT'D)
& EFFECT OF CREW MOVEMENT

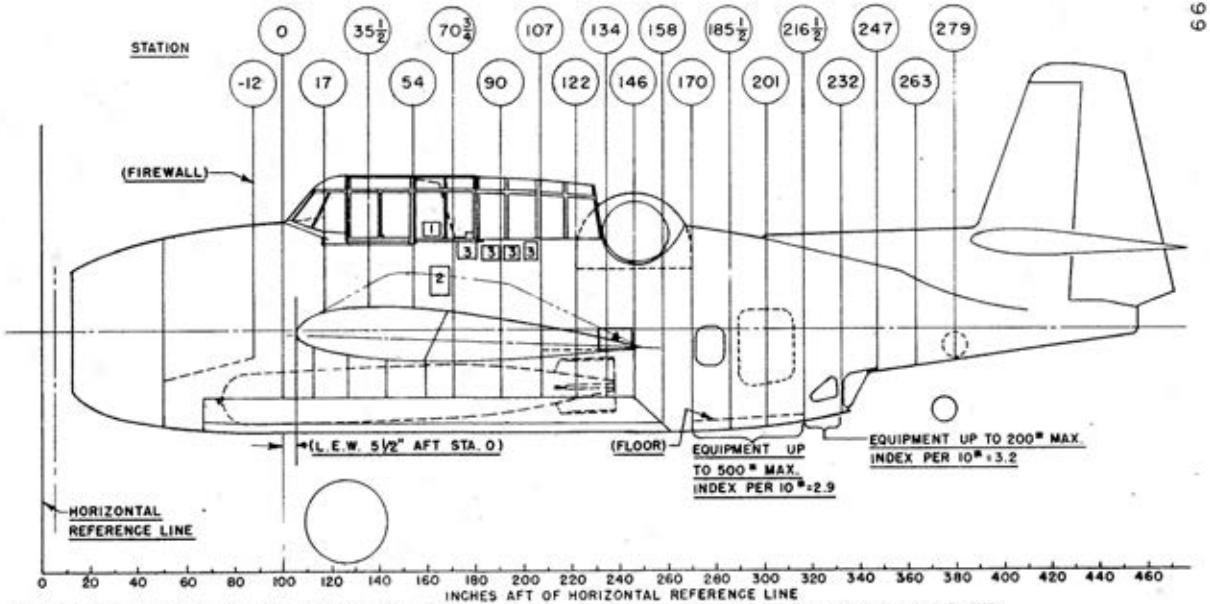
	WEIGHT	INDEX
BOMB INSTALLATION (1) 1000# DEMOLITION BOMB		
1000# Demolition Bomb	1000	151.7
2 Bomb Shackles, P4F	13	2.0
Bomb Sight, Mark 15-5	34.8	9.0
Cable Slings	3.7	.5
Sway Bracing	12.6	1.9
	1064.1	165.1
BOMB INSTALLATION (4) 500# DEMOLITION BOMBS		
2 Forward 500# Demolition Bombs	1000	104.6
2 Rear 500# Demolition Bombs	1000	199.1
2 Forward Bomb Shackles, P4F	13	1.4
2 Rear Bomb Shackles, P4F	13	2.5
Bomb Sight, Mark 15-5	34.8	9.0
Intervalometer	6.5	1.7
	2067.3	318.3
BOMB INSTALLATION (12) 100# DEMOLITION BOMBS		
4 Forward 100# Demolition Bombs	400	41.8
4 Center 100# Demolition Bombs	400	60.6
4 Rear 100# Demolition Bombs	400	79.6
4 Forward Bomb Shackles	25	2.7
4 Center Bomb Shackles	25	3.9
4 Rear Bomb Shackles	26	5.2
Bomb Sight, Mark 15-5	34.8	9.0
Intervalometer	6.5	1.7
	1319.3	204.5
BOMB INSTALLATION (1) 1600# A.P. BOMB		
1600# A.P. Bomb	1600	232.3
2 Bomb Shackles, P4F	13	2.0
Bomb Sight, Mark 15-5	34.8	9.0
Cable Slings	3.7	.6
Sway Bracing	12.6	1.9
	1664.1	245.8
MOVE RADIO OPERATOR TO TUNNEL GUN	- - - -	+ 4.4

SPECIAL EQUIPMENT

NOT INCLUDED IN COMBAT BASIC WEIGHT OR USEFUL LOAD

	WEIGHT	INDEX
Target Towing Equipment		
Container	18.2	3.1
Target, Sleeve, Swivel & Hoop (19' long 2.55' Dia.)	10	1.7
Line, 1000' 3/8" Manila	42	7.0
Bomb Rack	10.4	1.8
Bomb Rack Supports	1.9	.3
Controls & Release	4.2	.8
Total Target Towing Equipment	86.7	14.7
Engine Maintenance Platforms	233	No Stowage
Hoisting Sling	11.6	No Stowage
Cockpit Cover	17.3	No Stowage
Engine Cover	21.3	No Stowage
Propeller Hub Cover	1.5	No Stowage
De-Icing Boots & Attaching Strips (Wing Outer Panels, Stabilizers & Fin)	69	15.0
Propeller Anti-Icing Fluid, 5 Gallons	40.0	6.
Towing Eyes	8.5	1.0
Tricing Gear	11.0	No Stowage
Starter Handcrank & Gear Box	6.2	1.9
Parachute Flares (2)	40.0	13.3
Float Lights (4 Additional)*	8.8	2.9
Gun Camera, Fixed Forward	4.8	.4
Gun Camera, Turret	4.5	1.2
Gun Camera, Tunnel	4.7	1.3
Smoke Tank Installation		
Smoke Tank, Mark 5-3	989	149.3
(2) Bomb Shackles, P4F	13	2.0
(1) Cylinder CO_2, Mark 5-1	34	7.8
Sway Bracing	11.6	1.8
(2) Cable Slings	4.0	.5
Total Smoke Tank Installation	1051.6	161.5

*4 Float Lights included in Combat Basic Weight on Page 91.



TO DETERMINE THE INDEX FOR ANY ITEM OF EQUIPMENT

$$\text{INDEX} = \frac{W \times D}{1000}$$

W = WEIGHT IN POUNDS

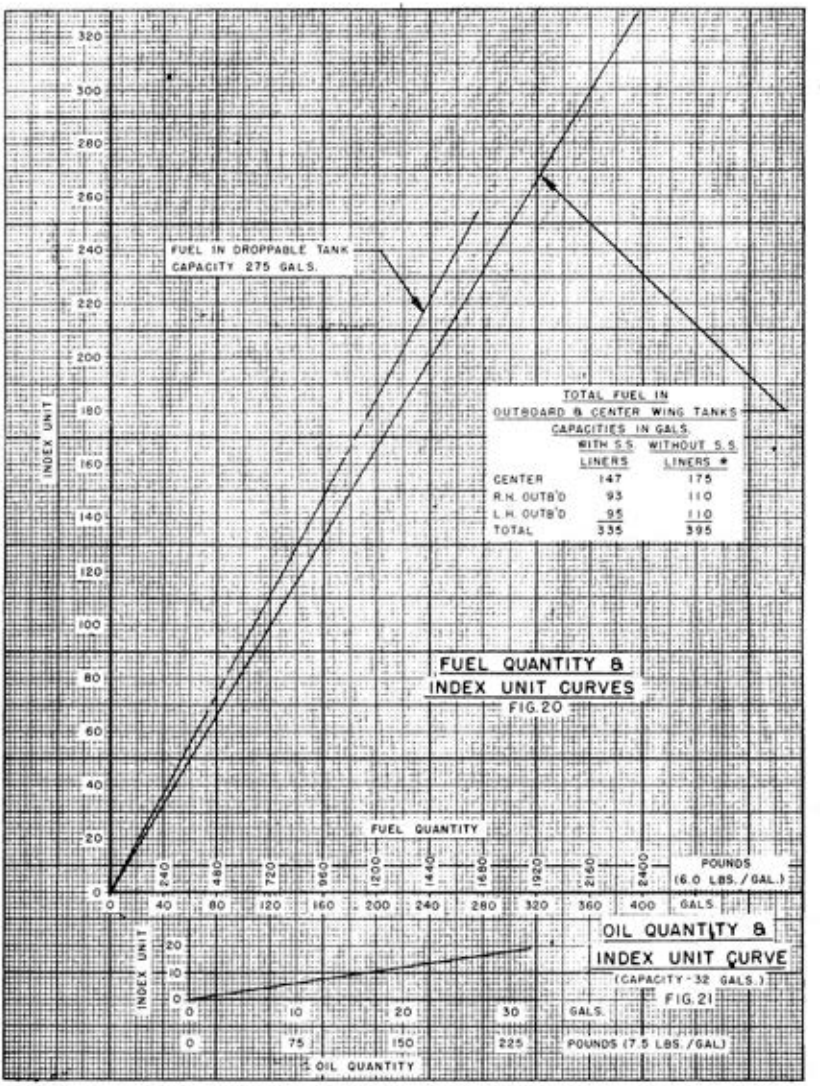
D = DISTANCE IN INCHES THAT THE WEIGHT IS LOCATED AFT OF THE HORIZONTAL REFERENCE LINE, OR, 100 PLUS THE DISTANCE IN INCHES THAT THE WEIGHT IS LOCATED AFT OF STA. 0

NOTE: NUMBERED UNITS INDICATE RADIO AND RADAR AS FOLLOWS:

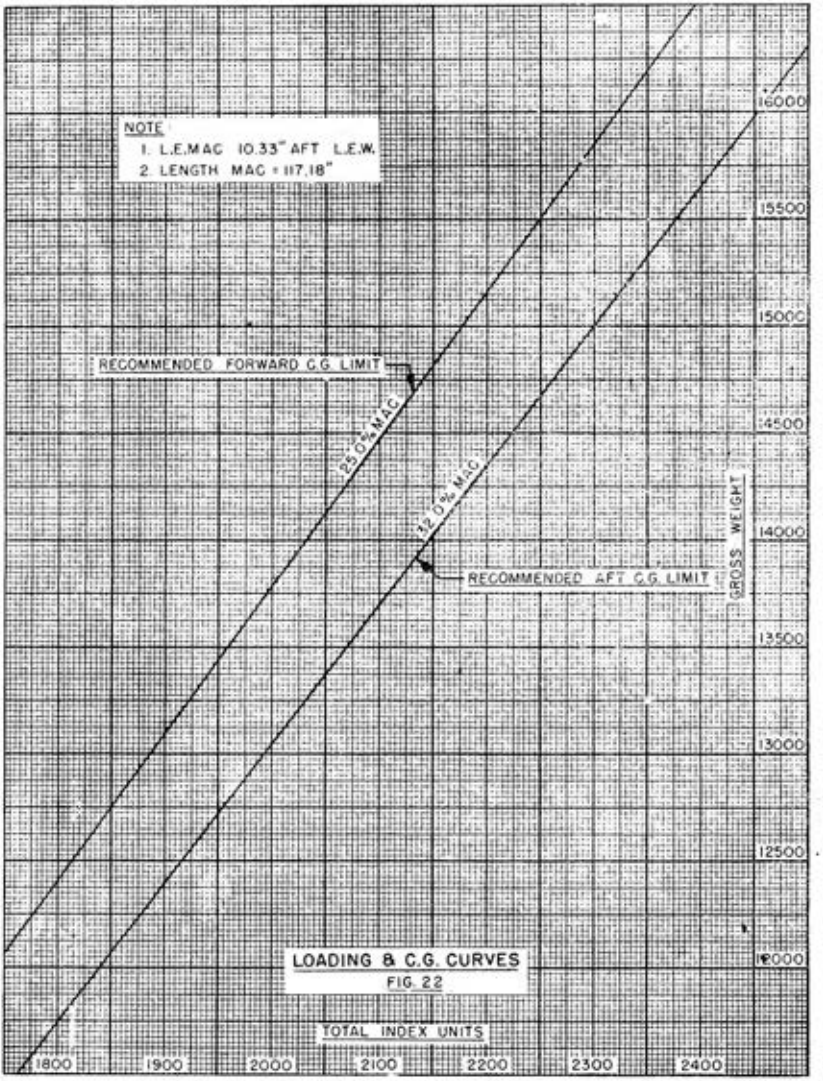
1. AYB UNIT
2. ABK-1 UNIT
3. ASB UNITS
4. GP-7, RU-19, ZB UNITS

LOADING DIAGRAM

FIG. 19



* SEE NOTE ON PAGE 102



LOADING & C.G. CURVES
FIG. 22

REMOVABLE ARMOR & SELF SEALING LINERS**

THESE ITEMS ARE INCLUDED IN THE COMBAT BASIC WEIGHT

(Note: Weights include necessary parts for installation.)

ITEM	WEIGHT	INDEX
Oil Tank Armor (on Sta. -12)		
Right Hand Side Piece	10.	.9
Center Piece	29.4	2.6
Left Hand Side Piece	16.	1.4
	55.4	4.9
Pilot's Armor (on Sta. 54)		
Upper Piece	34.	5.2
Lower Piece	68.2	10.5
	102.2	15.7
Turret Armor*		
Right Side Piece	7.	1.8
Center Spherical Piece	71.	19.0
Left Side Piece	9.	2.3
Lower Piece	14.	3.5
	101.	26.6
Tunnel Armor		
Forward Horizontal Floor Piece	33.	9.9
Aft Horizontal Exterior Piece (Incl. Door Piece)	15.	4.9
Lower Vertical Piece	8.	2.6
Vertical Sliding Piece (Including Tubes)	34.	11.3
(Note: For Gun Sight Piece, See Page 90)		
	90.	28.7
Self Sealing Liners, Wing Center Section Fuel Tanks**		
Right Outboard Tank	74.	10.2
Center Tank	112.	15.4
Left Outboard Tank	74.	10.2
	260	35.8

* Operation of Turret without Armor Plate is not Recommended.

**NOTE: Effective on the 1005th T8F-1 (Bu. Aer. #24046) and subsequent of Contract No. LL-91367 Center Section Wing Tanks will no longer be fuel tight without self-sealing liners.

WEIGHT & INDEX OF RADIO & RADAR INSTALLATIONS INCLUDED IN COMBAT BASIC WEIGHT

	WEIGHT	INDEX
Radio (GP-7, RU-19, ZB)		
Transmitter & Tuning Unit	65.3	15.6
Microphones (3) & Keys (2)	3.4	0.8
Trailing Antenna Installation	10.9	2.8
Extra Tuning Unit & Container	18.0	4.0
Antenna Loading Coil	4.0	1.0
Receiver & Coil	14.6	3.5
Dynamotor	9.0	1.9
Extra Coils (2 Std., 1 High-Low)	7.9	2.4
Antenna	3.0	0.8
Homing Adapter	3.6	0.9
Switching Relay	1.4	0.3
Antenna	1.0	0.2
Control Boxes	5.6	1.2
Remote Radio Controls	5.3	0.9
Junction Box	6.7	1.5
Switch Box	1.0	0.3
Cables	13.8	2.9
Motor Generator & Control Box	25.0	5.5
	199.5	46.5
Radar (ASB)		
Transmitter	20.5	3.6
Receiver	9.0	1.8
Antenna Trees & Hyd. Cont. Rec.	22.5	3.4
Antenna Switch Unit	12.0	2.2
Hydraulic Exactor Control Unit	7.5	2.1
Hydraulic Fluid for Antenna Cont. (½ gal.)	3.8	0.8
Indicator Scope (Stowed Position)	16.3	4.1
Motor Generator & Control Box	25.0	4.0
Power Rectifier	12.5	2.5
Control Unit	3.5	1.0
Cables	32.0	6.3
	164.6	31.8
Radio (AYB) or (AN/ARN-1)		
Transmitter - Receiver Unit	17.5	2.8
Shock Mount	1.3	0.2
Altitude Indicator	1.6	0.2
Altitude Limit Indicator	0.7	0.1
Antenna (2)	1.3	0.2
Cables	6.9	1.1
	29.3	4.6
Radio (ABK)		
Receiver & Receiver Shock Mount	32.5	5.4
Inertia Switch	1.4	.2
Control Unit	1.9	.5
Pilot's Switch Box	0.6	.1
Horizontal Antenna	2.1	.7
Circuit Tester	0.6	.1
Cables	12.2	2.4
Vertical Antenna	0.8	.1
	52.1	9.5

2. MANEUVERS

In general the stability, control, and flying characteristics of this model airplane are normal with certain exceptions discussed below.

a. Stability

Longitudinal stability is normal with the center of gravity as far aft as 29.5% MAC. Elevator forces are comparatively heavy. As flaps are opened there is a tail heavy shift in trim with which pilots should carefully familiarize themselves prior to night and low visibility landings and take-offs. The flaps must not be used at speeds greater than 130 knots (150 MPH). Reference T.O. No. 42-42.

'Ripping

eh what'

Lateral stability is normal in the clean condition and neutral in the landing condition. Aileron control is comparatively heavy at small angles of deflection and somewhat less so at large angles. Full throw of the ailerons must be restricted to 130 knots (150 MPH). Reference T.O. No. 42-42.

Directional stability is normal in the clean condition, and weak in the landing condition, decreasing to zero at full yaw where under some conditions the rudder will reverse. Therefore, side slips at low altitude in the landing condition should not be carried beyond the points where there is a noticeable decrease in rudder force. At large angles of yaw a tail heavy shift in trim occurs also. These characteristics result in reduced control in side slips.

b. Stall

The stall warning is less pronounced than in the average airplane. Early in the indoctrination period pilots should investigate and familiarize themselves with the stall, associated control positions, and recovery characteristics. Recovery is greatly expedited by rapid and full control movements, but in general the airplane cannot be stalled at low altitude without considerable hazard.

c. Spins

Voluntary spins are not permitted in this airplane. If a spin is inadvertently entered, immediate recovery action should be taken. The airplane has not been demonstrated in spins, but spin tunnel model tests indicate that the airplane does not have peculiarities which would require a deviation from the standard spin recovery technique described in the current Bureau of Aeronautics Technical Order on the subject.

d. Carrier Operation

Investigation of carrier approaches and arrested landings on the landing platform at the Naval Aircraft Factory has indicated favorable characteristics for these functions. The following comments are added:

Variations in power or speed during the approach have less adverse effect than in other types.

A slow condition may be corrected by a large application of throttle without undue probability of excessive over-correction.

Response to application of increased power during the approach is normal. The power loading at gross weights up to and including 15,400 pounds, the maximum investigated, is not excessive.

Waveoffs are satisfactory. Application of full power may be made in response to a waveoff, but the throttle should not be opened so abruptly as to cause faulty engine acceleration.

Visibility during the approach is excellent, especially if the cowl flaps are not opened more than necessary.

For carrier approaches, the tabs should balance the airplane at the approach speed. If so balanced, control forces in a waveoff will not be unreasonable.

While five seconds are required to completely retract the arresting hook, the hook is raised clear of the wires in about 1½ seconds from the time of operating the switch.

It is necessary to raise the landing flaps before folding the wings. The airplane may be taxiied with the wings folded before they are secured.

e. Take-Off

The technique used by the Trial Board to obtain minimum take-off runs was as follows:

1. Flaps fully lowered.
2. Rated take-off power reached with airplane held by brakes before starting run.
3. Tail raised by moderate force on controls during first part of run.
4. When take-off speed was reached, tail pulled down to reach maximum angle of attack at moment of leaving the ground.
5. Wheels raised when clear of ground.
6. After reaching an airspeed of about 100 knots, flaps raised and airplane retrimmed longitudinally at the same time.

There is a considerable loss in lift when the flaps are raised, as well as a nose heavy shift in trim. It is recommended that pilots investigate this characteristic at an altitude above 500 feet during the initial familiarization period.

f. Water Landing

Information in model tests and actual water landings with other types indicates that this airplane should have good water landing characteristics under the following conditions:

1. Bomb Bay load dropped if possible.
2. Bomb Bay doors closed.
3. Wheels up.
4. Flaps down.
5. Fully stalled - power stall if power is available.

If altitude does not permit emptying the bomb bay and closing the doors, it may be preferable to land with the doors closed. It appears that the bomber's window would be broken and the bomber's compartment immediately filled if a landing is made with the bomb doors open. In addition, the high water drag of the bomb doors may tend to cause the airplane to dive.

g. Forced Landing

If forced to land on soft or very rough terrain where the wheels, if down, may cause a turnover, a wheels up landing is recommended.

'I gotta feeling

I'm wheeling'

h. Catapulting Instructions

This airplane may be catapulted as a scout, bomber or torpedo plane. Tests conducted at the Naval Aircraft Factory indicate that the following points should be observed for catapulting.

1. Flaps full down.
2. Elevator tab about $1\frac{1}{2}^{\circ}$ NOSE DOWN. (IMPORTANT)
3. Rudder tab about 3° NOSE RIGHT.
4. Aileron tab about 1° LEFT WING DOWN.
5. Stick about NEUTRAL.
6. Insure that throttle lever is not too loose.
7. Use headrest.
8. Use full take-off manifold pressure.

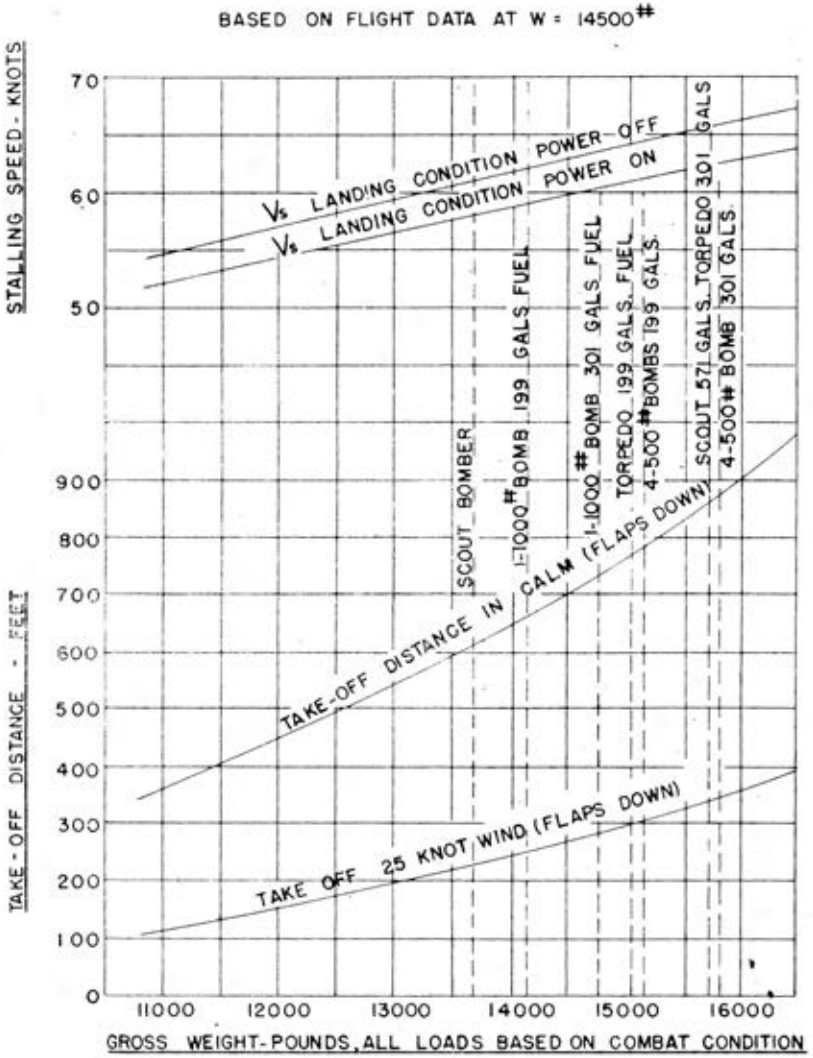
i. Permissible Accelerations, Speeds and Weights

The permissible accelerations and speeds at various gross weights when loaded either as scout, bomber or torpedo plane, including loadings with four 500 pound bombs, one 1000 pound bomb, one MK 13 torpedo or one MK 13-1 torpedo are tabulated below:

Gross Weight Pounds	Permissible Acceleration Positive	Permissible Acceleration Negative	Permissible Speed Knots (Indicated)
13,000 & Less	4.6g	2.0g	315
13,500	4.4g	2.0g	315
14,000	4.2g	2.0g	315
14,500	4.0g	2.0g	315
15,000	3.8g	2.0g	305
15,500	3.6g	2.0g	295
16,000	3.4g	2.0g	285

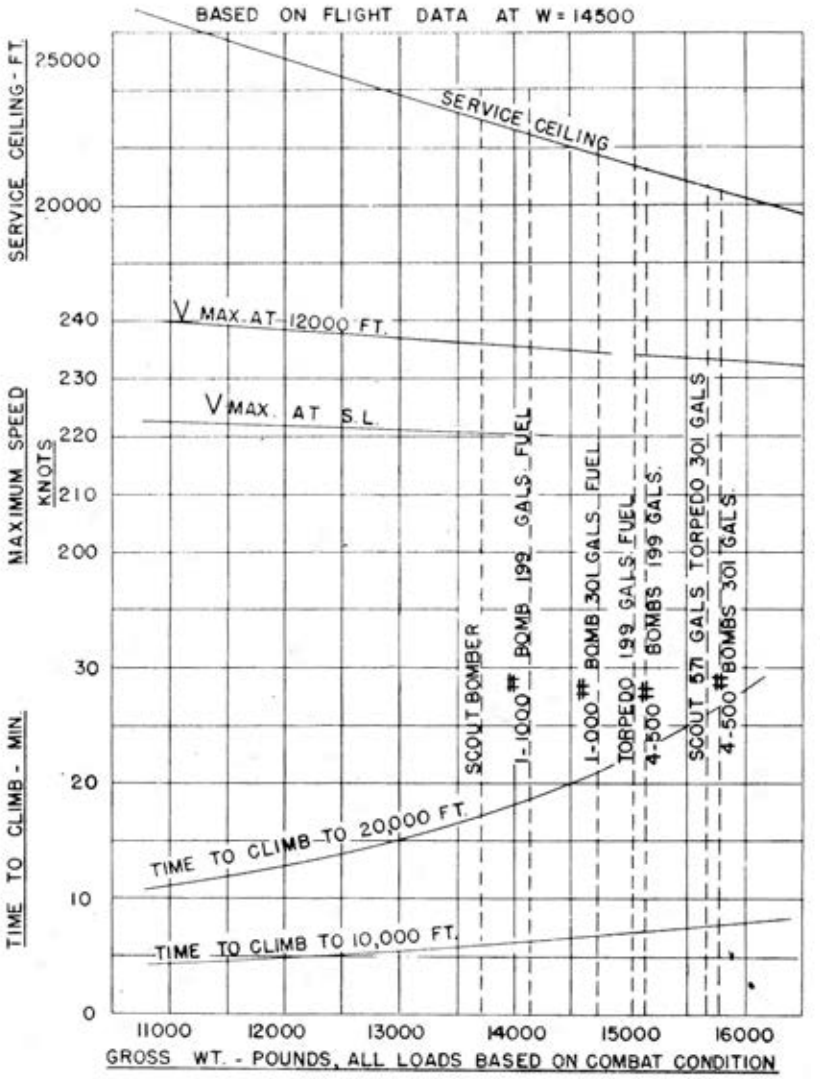
Maximum recommended values of gross weight for various types of operation are given below: these limitations apply to the airplane loaded as scout, bomber, or torpedo plane with bombs or torpedoes as stated above.

Take-off and landing, average fields	14,800
Landing, prepared runways	15,500
Take-off, prepared runways	16,000
Arrested landing, average conditions	14,800
Arrested landing, controlled conditions	15,500



TAKE-OFF RUN & STALLING SPEED CHART

FIG. 23



CLIMB, SPEED & CEILING CHART

FIG.24

3. CHECK-OFF LISTS

Take-Off

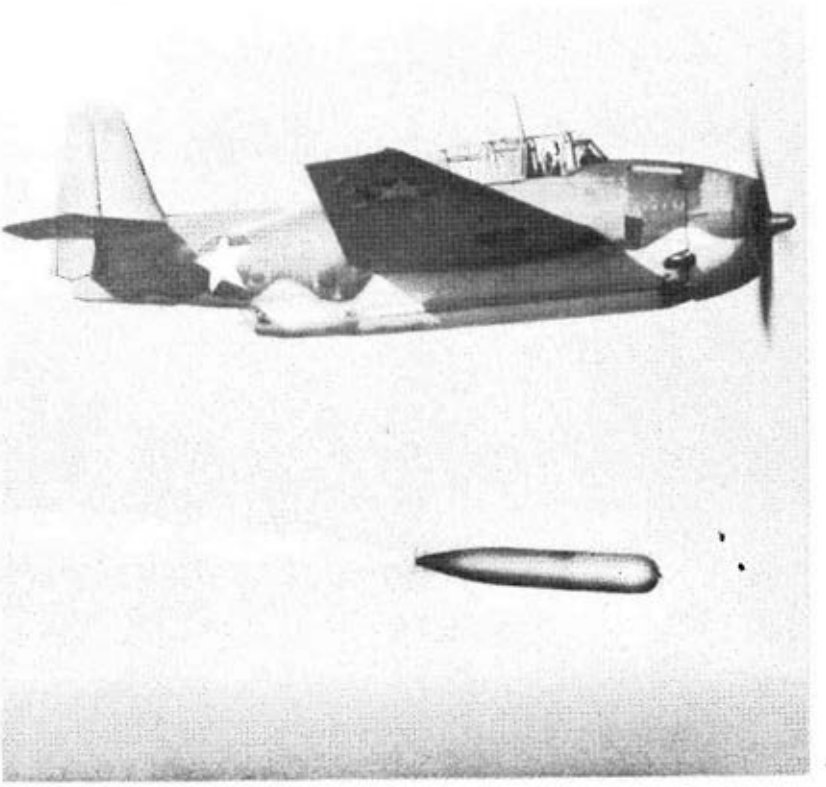
1. Wings — SPREAD & LOCKED
2. Bomb Doors — CLOSED
3. Mixture — AUTO RICH
4. Blower — LOW RATIO
5. Propeller — LOW PITCH 2600 RPM
6. Carburetor Air Control — DIRECT
7. Cowl Flaps — OPEN
8. Oil Cooler Flaps — OPEN
9. Fuel Tank Selector — BEST TANK
10. Elevator Tab — NEUTRAL
11. Rudder Tab — 1° NOSE RIGHT
12. Aileron Tab — NEUTRAL
13. Tail Wheel Castor — LOCKED
14. Cabin Hood — LOCKED OPEN
15. Manifold Pressure — OPEN SLOWLY TO 43.0" HG.

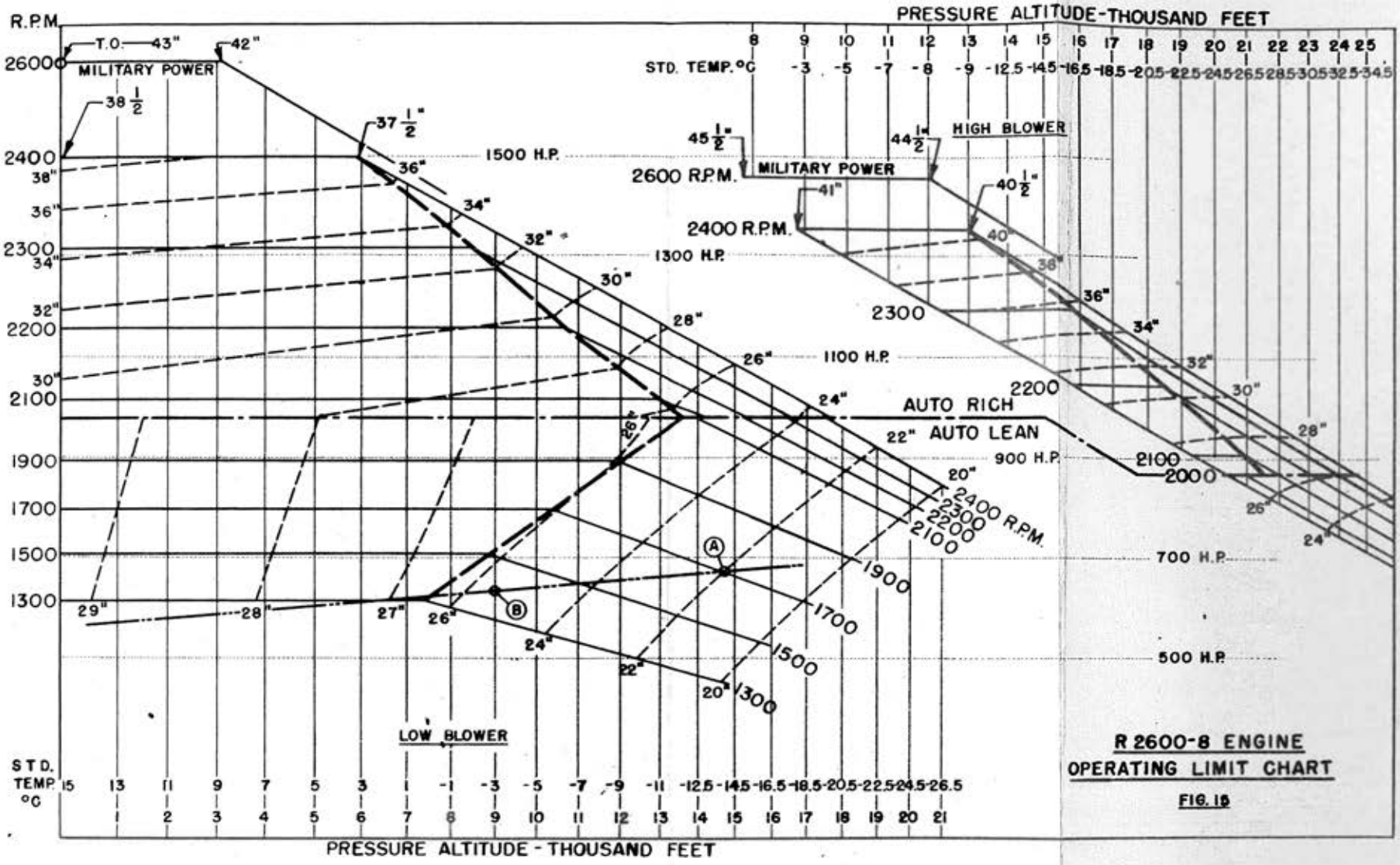
Flight - Cruising 65% Power

1. Wheels — UP
2. Cowl Flaps — AS REQUIRED
3. Oil Cooler Flaps — AS REQUIRED
4. Propeller — 2080 RPM
5. Blower 0 to 13500 ft. — LOW RATIO
   13500 and above — HIGH RATIO
6. Mixture — SEE PAGE 80
7. Manifold Pressure — SEE PAGE 80
8. Oil Pressure — 75-90 p.s.i.
9. Oil-In Temperature — See Navy T.O. 24-41
10. Cylinder Head Temperature — 205°C Continuous
11. Fuel Pressure — 6-7 p.s.i.

Landing

1.	Bomb Doors	CLOSED
2.	Wheels	DOWN
3.	Tail Wheel Caster	LOCKED (UNLOCK FOR CARRIER)
4.	Cabin Hood	LOCKED OPEN
5.	Carburetor Air Control	DIRECT
6.	Propeller	See T.O. #9-40
7.	Blower	LOW RATIO
8.	Mixture	AUTO RICH
9.	Fuel Tank Selector	BEST TANK
10.	Cowl Flaps	OPEN
11.	Oil Cooler Flaps	OPEN
12.	Wing Flaps	DOWN





R 2600-8 ENGINE
OPERATING LIMIT CHART

FIG. 15

NO WIND

NAUTICAL MILES PER GALLON

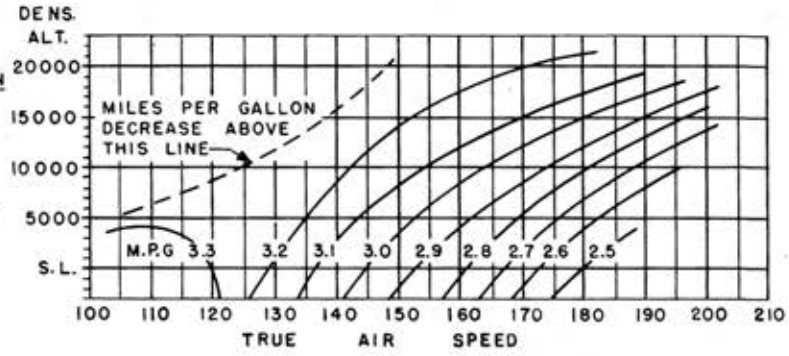
VS.

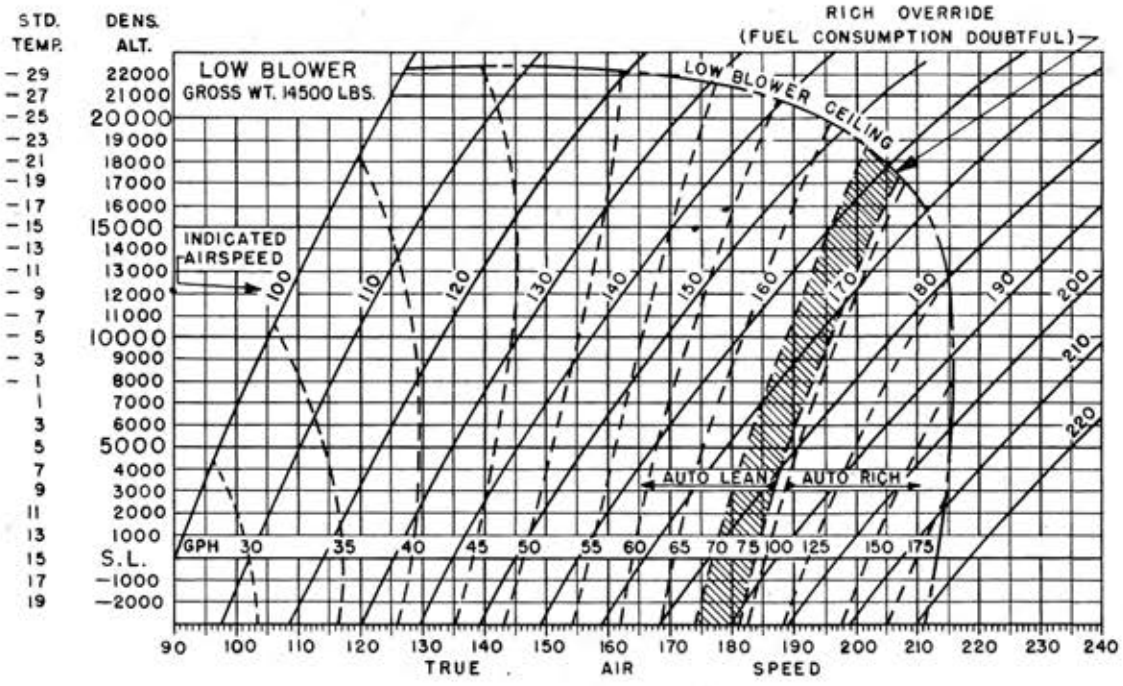
TRUE AIR SPEED

GROSS WEIGHT - 14,500 LBS.

AUTO LEAN MIXTURE

LOW BLOWER





MANIFOLD PRESSURE LIMITS USE HIGHER RPM IF AIRSPEED IS NOT OBTAINED WITHIN THESE LIMITS					
HIGH BLOWER					
PRESSURE ALTITUDE	AUTO LEAN ALL ALTITUDES ALL RPM	AUTO RICH 2100 RPM	2200 RPM	2300 RPM	2400 RPM
25000	26.5	F.T.	F.T.	F.T.	F.T.
20000	26.5	28.0	F.T.	F.T.	F.T.
13000	26.5	*	*	36.0	40.5
11000	*	*	*	*	40.5
* POWER CAN BE MORE ADVANTAGEOUSLY OBTAINED IN LOW BLOWER.					
LOW BLOWER					
PRESSURE ALTITUDE	AUTO LEAN ALL R.P.M. TO 2080	AUTO RICH 2100 RPM	2200 RPM	2300 RPM	2400 RPM
15000 AND ABOVE	F.T.	F.T.	F.T.	F.T.	F.T.
10000	26.5	27.5	30.0	F.T.	F.T.
5000	28.0	28.5	31.0	33.5	37.5
SEA LEVEL	29.5	29.5	31.5	34.5	38.5

PLOTTING GRAPH

FIG. 16

This chart is based on the standard gross load of 14,500 lbs. If the airplane's weight varies materially from this, refer to the chart at the right and use the airspeed indicated for the weight. Fuel consumption per hour and RPM will be unchanged.

TO FIND DENSITY ALTITUDE

1. Set the barometric scale of the altimeter to 29.92", or add 10 feet for each .01" below 29.92", deduct 10 feet for each .01" above 29.91". This will give the pressure altitude.
2. On chart follow pressure altitude line to outside air temperature line. Read density altitude on the right.

a. Find PROPER OPERATION AND FUEL REQUIRED

Given:
- Desired indicated airspeed.....148 kts.
- Desired indicated altitude.....8,500 ft.
- Kollsman barometric setting.....29.32"
- Outside air temperature.....10°C
- Airplane weight.....14,500 lbs.

Solution: (Points A-B-C- on Pilot's Operating Graph, Fig. 17)

1. Find density altitude (above): Indicated altitude 8500 feet is corrected to 9100 feet pressure altitude. Find intersection of 9100 feet pressure altitude and 10°C outside air temperature. Proceed horizontally into chart at density altitude of 10530 feet.
2. At the intersection of 10,530 feet and 148 IAS read:
   RPM: 1750
   GPH: 56½ on Fig. 17
3. On Fig. 16 check the manifold pressure limit for 10,000 feet, and if the indicated airspeed cannot be attained in level flight within this limit, use higher RPM, allowing for a fuel consumption increase of 3% for each 100 RPM above that specified.

NOTE: If the weight in the above example had varied materially from the design gross weight of 14,500 lbs., on which all the graphs are based, proceed as follows:

Given: Conditions in example a., except that the airplane gross weight is 12,500 lbs.

Solution: Refer to weight correction table and find the IAS nearest the desired 148 on the 12,500 lbs. horizontal line, which is 150. Reading down vertically from this point we find that the comparative airspeed at 14,500 lbs. is 140: deducting the 2 knots we have 138 IAS as the IAS to use on the graphs to determine the proper RPM and resultant fuel consumption for 148 IAS at the lighter weight. Referring to Graph, the solution is 1629 RPM, 50 GPH.

b. Find FUEL REQUIRED FOR A BOMBING MISSION

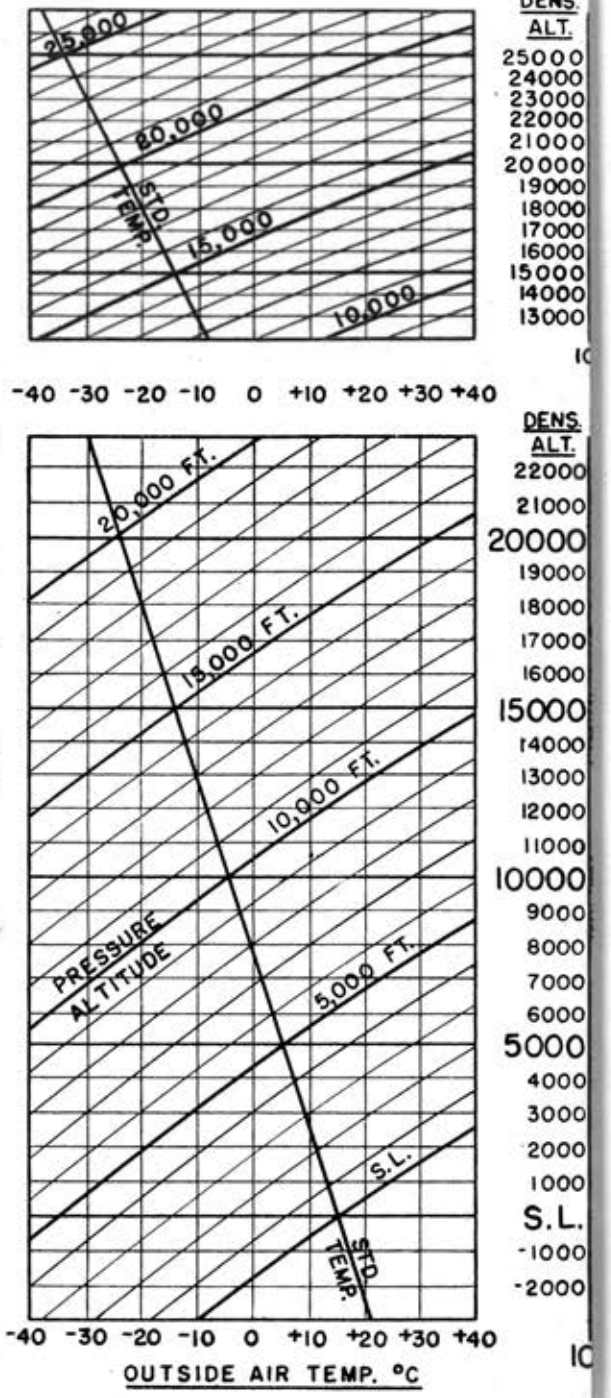
NOTE: The method given below is intended for use in making a quick approximation on the feasibility of an intended mission. An accurate plot, making proper compensations for wind and weight, should be prepared for an actual flight.

Given:
- Take-off weight.....15,500 lbs.
- Bombing altitude, reduced to density altitude.....18,000 ft.
- Distance from objective.....325 miles
- Reserve for maneuvers and unknown winds.....75 gals.

Solution:
1. Average weight for trip will be less than 14,500 lbs., therefore the graphs, which are based on this weight, will be used without compensation.
2. On Fig. 18, find the fuel required and distance covered for a cruising climb to 18,000 feet, 140 miles.....60 gals.
3. On Fig. 16, upper graph, find the best miles per gallon (3.2) and divide the remaining miles to be covered on the mission by this (510 ÷ 3.2).....160 gals.
4. Add the reserve for maneuvers and winds..... 75 gals.

Total fuel required for the mission.....295 gals.

* NOTE: This rule for aircraft in flight. Use 110 feet per degree for actual temperatures.



This chart is based on the standard gross load of 14,500 lbs. If the airplane's weight varies materially from this, refer to the chart at the right and use the airspeed indicated for the weight. Fuel consumption per hour and RPM will be unchanged.

TO FIND DENSITY ALTITUDE

1. Set the barometric scale of the altimeter to 29.92", or add 10 feet for each .01" below 29.92", deduct 10 feet for each .01" above 29.91". This will give the pressure altitude.
2. On chart follow pressure altitude line to outside air temperature line. Read density altitude on the right.

a. Find PROPER OPERATION AND FUEL REQUIRED

Given: Desired indicated airspeed.....148 kts.
Desired indicated altitude.....8,500 ft.
Kollsman barometric setting.....29.32"
Outside air temperature.....10°C
Airplane weight.....14,500 lbs.

Solution: (Points A-B-C- on Pilot's Operating Graph, Fig. 17)

1. Find density altitude (above): Indicated altitude 8500 feet is corrected to 9100 feet pressure altitude. Find intersection of 9100 feet pressure altitude and 10°C outside air temperature. Proceed horizontally into chart at density altitude of 10530 feet.
2. At the intersection of 10,530 feet and 148 IAS read:
   RPM: 1750) on Fig. 17
   GPH: 56½)
3. On Fig. 16 check the manifold pressure limit for 10,000 feet, and if the indicated airspeed cannot be attained in level flight within this limit, use higher RPM, allowing for a fuel consumption increase of 3% for each 100 RPM above that specified.

NOTE: If the weight in the above example had varied materially from the design gross weight of 14,500 lbs., on which all the graphs are based, proceed as follows:

Given: Conditions in example a., except that the airplane gross weight is 12,500 lbs.

Solution: Refer to weight correction table and find the IAS nearest the desired 148 on the 12,500 lbs. horizontal line, which is 150. Reading down vertically from this point we find that the comparative airspeed at 14,500 lbs. is 140; deducting the 2 knots we have 138 IAS as the IAS to use on the graphs to determine the proper RPM and resultant fuel consumption for 148 IAS at the lighter weight. Referring to Graph, the solution is 1629 RPM, 50 GPH.

b. Find FUEL REQUIRED FOR A BOMBING MISSION

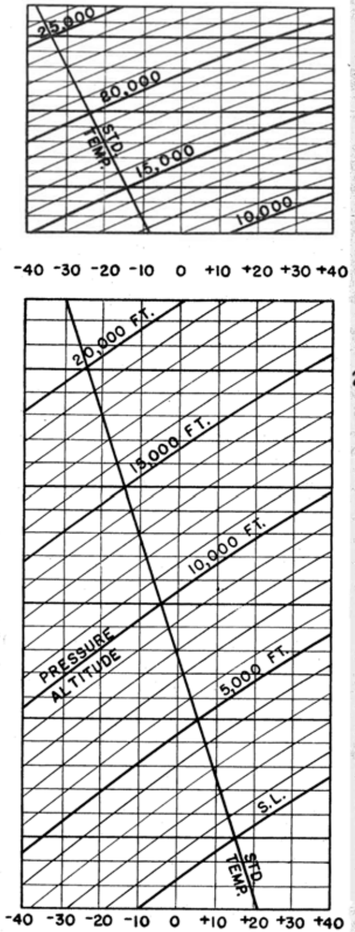
NOTE: The method given below is intended for use in making a quick approximation on the feasibility of an intended mission. An accurate plot, making proper compensations for wind and weight, should be prepared for an actual flight.

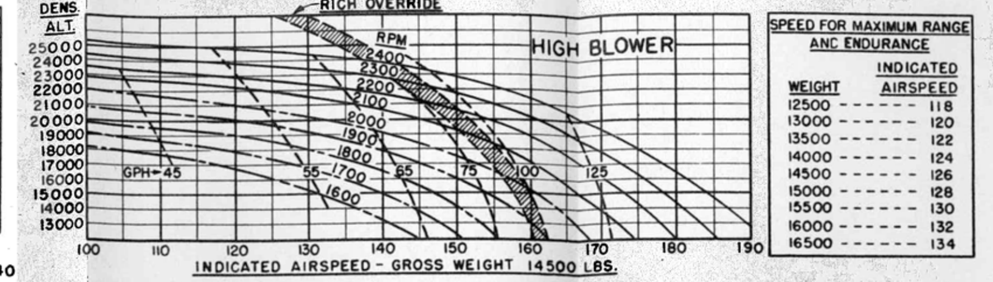
Given: Take-off weight.....15,500 lbs.
Bombing altitude, reduced to density altitude.....18,000 ft.
Distance from objective.....325 miles
Reserve for maneuvers and unknown winds.....75 gals.

Solution:
1. Average weight for trip will be less than 14,500 lbs., therefore the graphs, which are based on this weight, will be used without compensation.
2. On Fig. 18, find the fuel required and distance covered for a cruising climb to 18,000 feet, 140 miles.....60 gals.
3. On Fig. 16, upper graph, find the best miles per gallon (3.2) and divide the remaining miles to be covered on the mission by this (510 ÷ 3.2).....160 gals.
4. Add the reserve for maneuvers and winds.....75 gals.

Total fuel required for the mission.....295 gals.

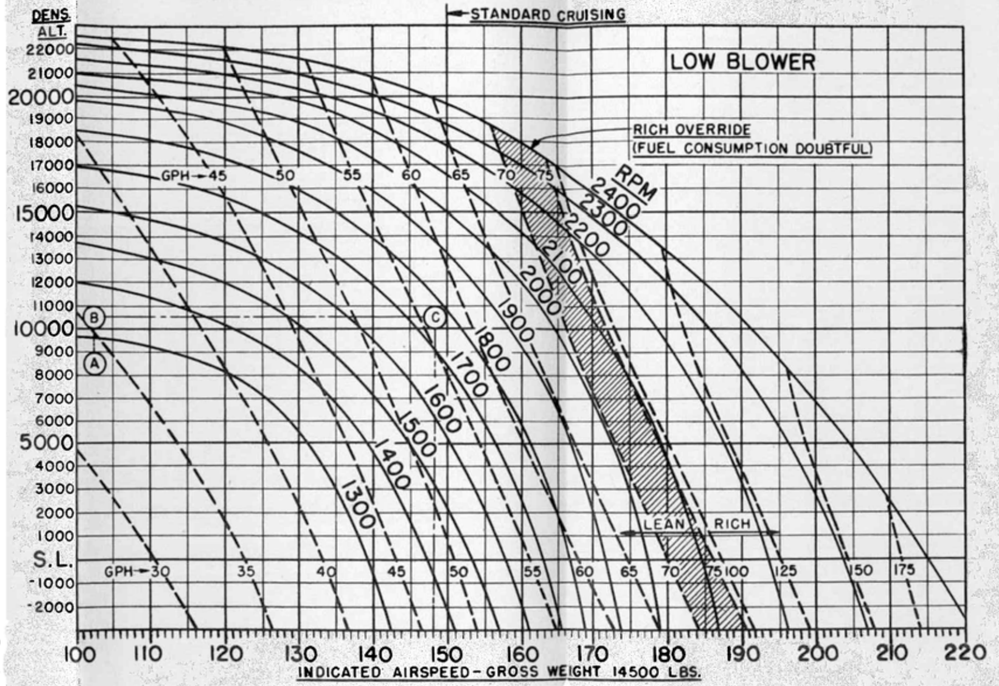
* NOTE: This rule for aircraft in flight. Use 110 feet per degree for actual temperatures.





SPEED FOR MAXIMUM RANGE ANC ENDURANCE

WEIGHT	INDICATED AIRSPEED
12500	118
13000	120
13500	122
14000	124
14500	126
15000	128
15500	130
16000	132
16500	134



WEIGHT CORRECTION TABLE

THIS TABLE SHOWS THE VARIATION OF AIRSPEED WITH WEIGHT AT A CONSTANT POWER AND ALTITUDE.

WEIGHT	INDICATED AIRSPEED												
12500	116	125	134	142	150	159	167	176	185	194	203	213	222
13000		121	131	139	148	157	165	175	184	193	202	212	221
13500		117	127	136	145	154	163	173	183	192	201	211	220
14000			123	133	142	152	161	171	181	191	201	210	220
14500	100	110	120	130	140	150	160	170	180	190	200	210	220
15000				127	138	148	159	169	179	190	200	210	220
15500				125	136	146	158	168	178	189	199	210	220
16000					134	145	156	167	177	188	199	209	219
16500					132	143	154	165	176	187	198	208	219

EXAMPLE OF USE:

INDICATING 150 KNOTS AT 5000 FEET DENSITY ALTITUDE WITH A GROSS WEIGHT OF 12500 LBS. WHAT RPM'S SHOULD BE USED, AND WHAT FUEL CONSUMPTION RESULTS?

1. FIND 150 KNOTS ON THE 12500 LB. LINE.
2. FOLLOW VERTICALLY DOWNWARD TO THE 14500 LB LINE, AND READ THE SPEED (140 KTS.)
3. ON THE GRAPH, AT THE INTERSECTION OF 5000 FEET AND 140 KNOTS, READ 1410 RPM AND 47.5 GPH, WHICH ARE THE PROPER RPM'S AND THE RESULTANT CONSUMPTION FOR 140 KNOTS WITH 14500 LBS. GROSS WEIGHT, OR FOR 150 KNOTS WITH 12500 LBS. GROSS WEIGHT.

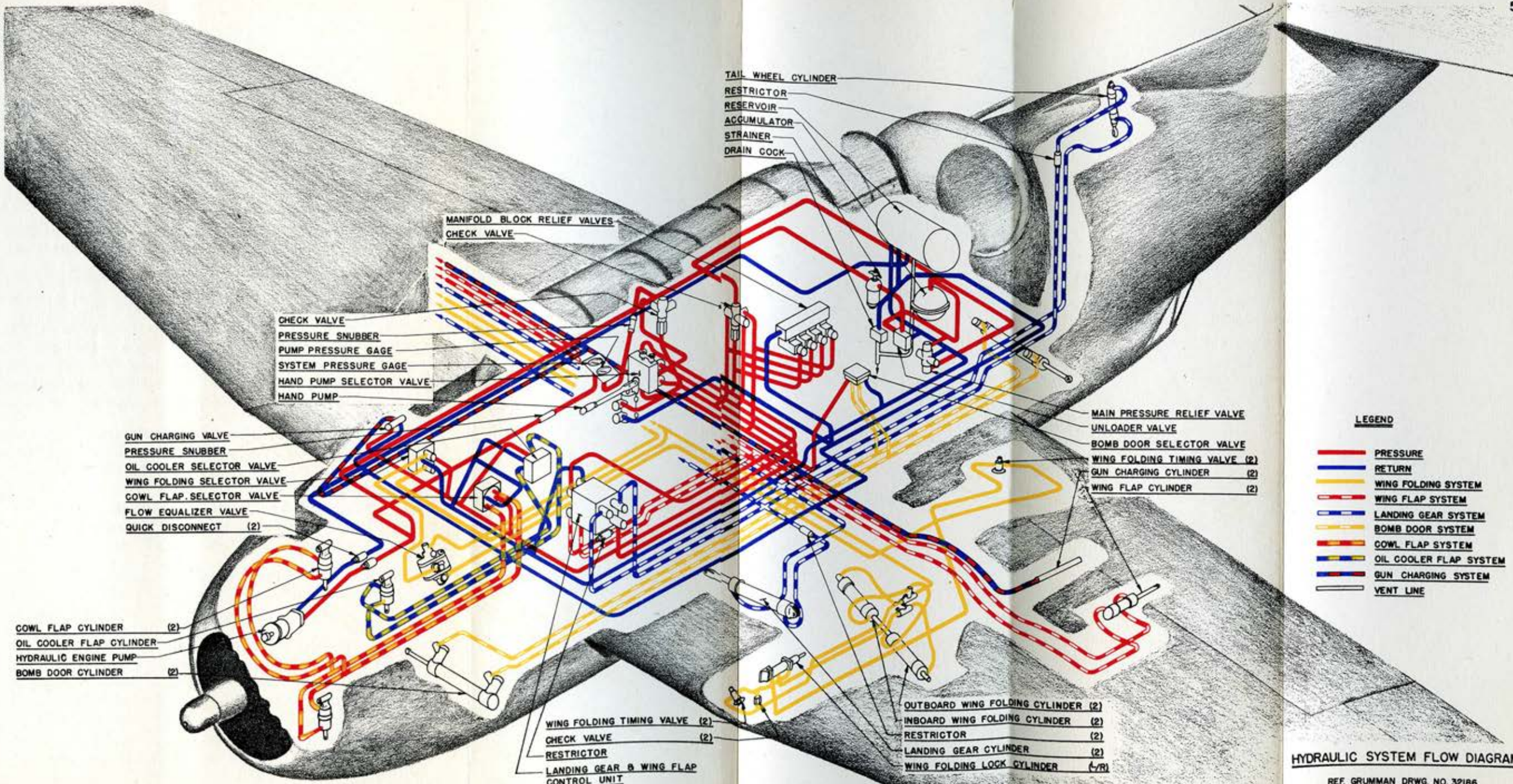
AIRSPEED ERROR

THE INDICATED AIRSPEEDS ON THIS GRAPH INCLUDE THE INHERENT AIRSPEED ERROR OF THE AIRSPEED METER INSTALLATION. THEY VARY FROM CORRECT INDICATED AIRSPEEDS AS FOLLOWS:

CORRECT	INDICATED	CALIBRATION FOR PLANE NO:_____
91	100	
102	110	
114	120	
125	130	
135	140	
146	150	
156	160	
167	170	
177	180	
187	190	
197	200	
208	210	
218	220	

PILOT'S OPERATING GRAPH

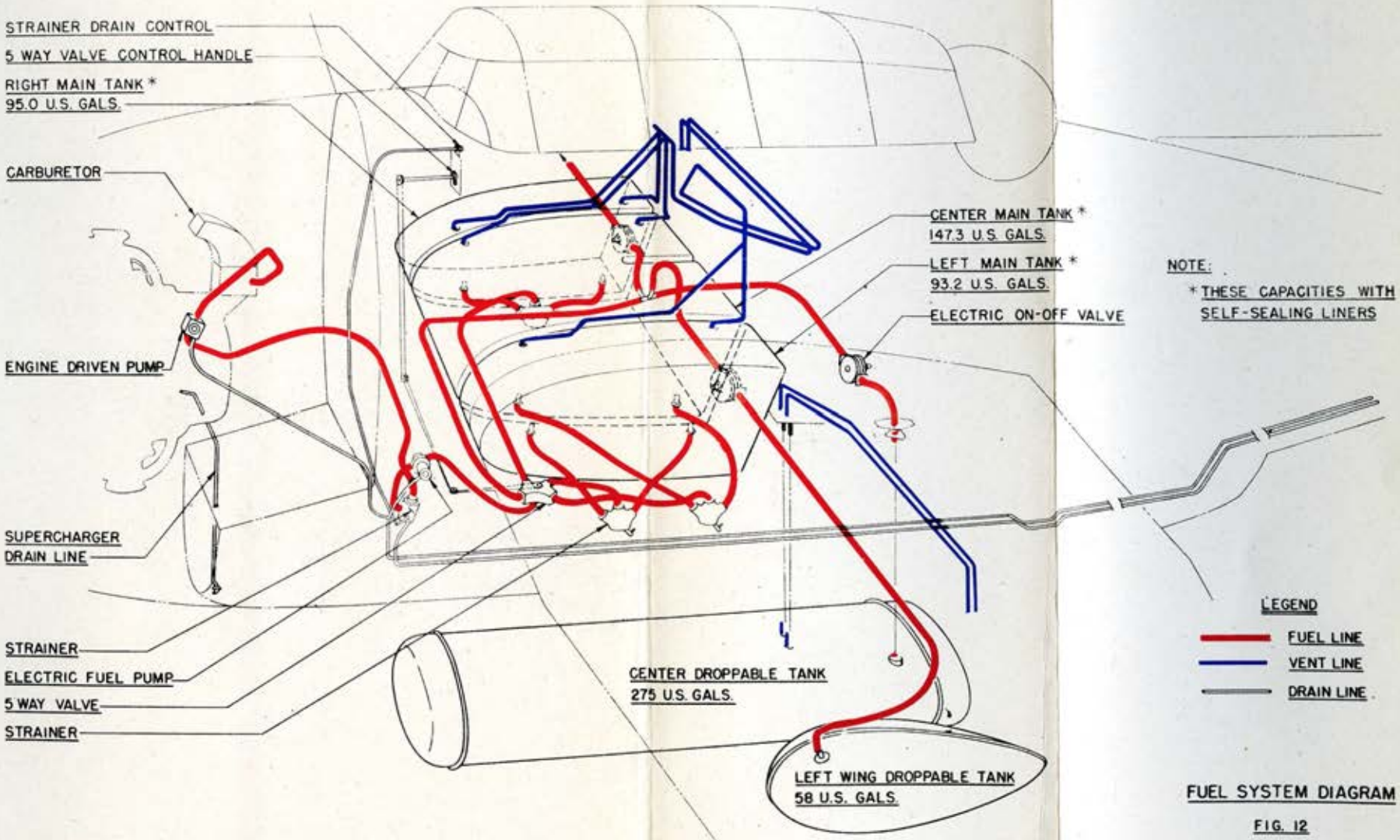
FIG. 17



HYDRAULIC SYSTEM FLOW DIAGRAM

REF. GRUMMAN DRWG. NO. 32186

FIG. 5



FUEL SYSTEM DIAGRAM

FIG. 12