

PILOT'S NOTES
FOR
MUSTANG III
PACKARD MERLIN V-1650-3 ENGINE



PROMULGATED BY ORDER OF THE AIR COUNCIL

REPRODUCED BY PERMISSION OF THE UNITED STATES GOVERNMENT

NOTES TO USERS

THIS publication is divided into five parts: Descriptive, Handling, Operating Data, Emergencies, and Illustrations. Part I gives only a brief description of the controls with which the pilot should be acquainted.

These Notes are complementary to A.P. 2095 Pilot's Notes General and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P. 2095 (*see* A.M.O. 493/43).

Words in capital letters indicate the actual markings on the controls concerned.

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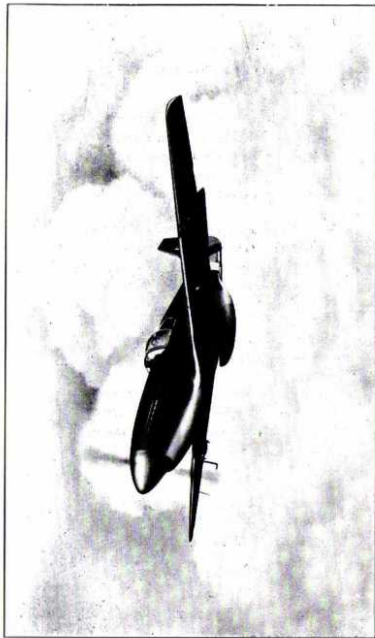
Comments and suggestions should be forwarded through the usual channels to the Air Ministry (D.T.F.).

MUSTANG III PILOT'S NOTES

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PART I

DESCRIPTIVE

INTRODUCTION

1. The Mustang III is a low-wing monoplane single-seat fighter of metal construction. It is powered by a Packard Merlin V-1650-3 engine fitted with a 4-blade Hamilton Hydromatic constant-speed propeller. Four 0.5 in. guns are fitted, two in each wing, and there is provision for carrying up to 2×500 lb. bombs, one under each wing.

FUEL AND OIL SYSTEMS

2. **Fuel tanks.**—Two $76\frac{1}{2}$ Imp. gallon (92 U.S. gallon) tanks are fitted, one in each wing, and provision is made for carrying either two $62\frac{1}{2}$ Imp. gallon (75 U.S. gallon) combat drop tanks or two 125 Imp. gallon (150 U.S. gallon) ferrying drop tanks, one under each wing. On later aircraft a 71 Imp. gallon (85 U.S. gallon) auxiliary tank can be carried in the fuselage. The vapour return line from the carburettor is connected to the port main tank. The drop tanks are automatically pressurized by air pressure from the exhaust side of the vacuum pump, over which the pilot has no control. For release of drop tanks, see para. 28.

Two direct-reading fuel gauges are provided for the main tanks, one on each side of the cockpit floor. Fuel gauges are not provided for the drop tanks. On later aircraft, a fuel gauge for the fuselage tank is behind the pilot's left shoulder.

3. **Fuel cock**

- (i) *On early aircraft with no auxiliary fuselage tank.*—One fuel selector cock is provided below the front switch-panel, marked MAIN TANKS, RIGHT DROP TANK, OFF, LEFT DROP TANK. When the selector is turned to MAIN TANKS, both tanks are connected to the engine through non-return valves. When the selector is

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turned to either of the drop tanks, the fuel will flow from that tank direct to the engine, and not into the main tanks.

- (ii) *On later aircraft with provision for auxiliary fuselage tank.*

—The fuel selector cock, which has no OFF position, is below the front switch panel, and the fuel shut-off valve is operated by a lever beside the selector. The selector cock has five positions—FUSELAGE TANK, MAIN TANK L.H., COMBAT DROP TANK R.H., COMBAT DROP TANK L.H., MAIN TANK R.H. When the selector is turned to either of the main tank positions, both main tanks are connected to the engine through non-return valves, but the booster pump will only be on in the tank selected, so that the engine will be fed largely from the selected main tank. When the selector is turned to either of the drop tanks, the fuel will flow from that tank direct to the engine, and not into the main tanks.

4. **Fuel booster pumps**

- (i) *On early aircraft with no auxiliary fuselage tank.*—Each main tank is fitted with an electric booster pump; the two switches are on the front switch panel and have three positions—NORMAL, OFF, EMERGENCY; the fuel selector must also be at the MAIN TANKS position for the booster pumps to function. The NORMAL position is used for starting the engine and in flight, and gives a fuel pressure of 12 lb./sq.in. without engine pump running. The EMERGENCY position is used for take-off, or if the fuel pressure falls off due to engine pump failure, and gives a pressure of $14\frac{1}{2}$ lb./sq.in. without engine pump running. In flight, the booster pumps can be used to control the relative emptying of the main tanks by switching off one of the pumps.

- (ii) *On later aircraft with provision for auxiliary fuselage tank.*—Both main tanks and the fuselage tank are provided with booster pumps; there is one master booster pump switch on the front switch panel with three positions—NORMAL, OFF, and EMERGENCY. The fuel selector cock switches on the booster pump in the tank selected, if the master switch is at either NORMAL or EMERGENCY.

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5. **Priming pump.**—The priming pump is on the bottom starboard side of the instrument panel. To operate, push in handle and twist counter-clockwise to unlock. Then withdraw handle and pump. After priming is complete, push handle home and turn clockwise to lock.
6. **Oil system**
 - (i) The oil tank has a capacity of 12.5 U.S. gallons (10.4 Imp. gallons) plus 3.1 U.S. gallons (2.6 Imp. gallons) airspace.
 - (ii) On early aircraft the oil cooler shutter is hydraulically operated, on later aircraft it is electrically operated. In both cases the shutter can either be controlled automatically by a thermostat or manually. See para. 25.
 - (iii) An oil dilution system is provided; the switch is on the front switch panel.

MAIN SERVICES

7. Hydraulic system

- (i) The brake system and the engine-pump-operated hydraulic system both draw fluid from the same hydraulic reservoir; otherwise, both have entirely separate pipe lines. A reserve supply for operation of the brakes is trapped in the reservoir.
- (ii) The engine-driven hydraulic pump operates:
 - Undercarriage and fairing doors
 - Flaps
 - Radiator shutter (on early aircraft)
 - Oil cooler shutter (on early aircraft)
- (iii) A hydraulic accumulator is fitted which provides a reserve of hydraulic pressure when the engine pump is not running. An unloading valve directs engine pump pressure back to the reservoir when the accumulator pressure reaches 1,000 lb./sq.in.
- (iv) A handpump is provided on the right of the seat for operating the flaps, and, on early aircraft, the radiator and oil cooler shutters, when the engine pump is not running; to operate handpump, pull out handle and twist anti-clockwise to lock. Then put selector lever to desired position and work handpump up and down.

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8. **Pneumatic system.**—An engine-driven vacuum pump operates the gyro instruments, and the pressure side of the vacuum pump is used for pressurising the drop tanks, if fitted. The suction gauge should normally indicate $3\frac{1}{2}$ – $4\frac{1}{4}$ inches of mercury.
9. **Electrical system.**—An engine-driven generator and battery supply current at 24 volts for operating:
 - Electrically operated instruments
 - Cockpit lighting
 - Fluorescent lighting for instruments
 - Landing lamps
 - Navigation lights
 - Undercarriage warning lights
 - Gunfiring and heating
 - Gunsight
 - Camera
 - Radio
 - Pressure-head heater
 - Control for supercharger gear change electro-pneumatic ram
 - Oil dilution solenoid
 - Engine electric starter and booster-coil
 - Fuel booster pumps
 - Bomb release gear, if fitted
 - Thermostatic switches for radiator and oil cooler shutters and on later aircraft, operation of shutters

Master switches for the generator and the battery are provided on the starboard switch panel; the generator switch should always be on. When the master battery switch is on, the other circuits will be on when their respective switches are closed. A ground-battery socket is provided on the starboard side of the fuselage. The aircraft battery should be switched off when using a ground starter battery.

A row of circuit breakers is provided on the starboard switch panel; these will spring out if their respective circuits are overloaded, and can be reset by pushing them in again.

AIRCRAFT CONTROLS

10. **Rudder pedals.**—The rudder pedals are adjustable for leg reach in flight. Push the adjusting lever on the inside of the pedal towards the centre of the aircraft to disengage the locking plunger, then push pedal to desired position and release lever. There are five possible positions; make sure that both pedals are in the same position.
11. **Flying control locking gear.**—The locking gear for the flying controls is on the floor in front of the control column. To lock the controls, pull back the locking gear, pull out the plunger and engage it in one of the two holes in the lug on the bottom of the control column. When the locking gear is engaged in the lower hole, the flying controls and the tailwheel are locked. When the locking gear is engaged in the upper hole, the flying controls are locked but the tailwheel can swivel 360°; this position is used when the aircraft is to be towed on the ground.
12. **Trimming tab controls.**—Control handwheels and indicators for elevator, aileron and rudder trimming tabs are mounted on the port side of the cockpit. The movements are :

Elevator :	Clockwise	Nose down
Aileron :	Clockwise	Right wing down
Rudder :	Clockwise	Nose right
13. **Tailwheel lock.**—The tailwheel can either be locked to the rudder controls and steered over a range of 6° either side, or released to allow it to castor normally. The tailwheel is locked in the steerable position when the control column is held back past the neutral position. To unlock tailwheel, put control column fully forward; it will be felt to unlock as the column passes through the neutral position.
14. **Undercarriage selector lever.**—This lever is on the port side of the cockpit near the floor. When the full weight of the aircraft is on the wheels, the undercarriage selector cannot be moved to UP and the undercarriage cannot be raised. Before selecting DOWN or UP, the selector lever must be moved to starboard to release the catch which

engages in slots at the UP and DOWN positions. If DOWN has been selected and the fairing doors have started to open, the selector cannot be set to UP until the operation has been completed.

DOWN can be selected before the undercarriage has been fully retracted.

In the event of failure of the undercarriage hydraulic system, the undercarriage fairing doors may be released by pulling out the red knob marked EMERGENCY PULL TO OPEN LANDING GEAR FAIRING DOORS; when this is operated the main hydraulic system is bypassed allowing the fairing doors and the undercarriage to fall under their own weight.

For emergency operation of undercarriage, see para. 58.

15. **Undercarriage warning lights**

- (i) On all aircraft a red warning light and test button are fitted below the windscreen. With the wheels locked up the light comes on when the throttle is less than one-third open.

With the wheels between locks the red light comes on at any throttle opening, and when the wheels are locked down the light goes out.

This warning light does not indicate the position of the wheel doors.

- (ii) On some aircraft, additional undercarriage warning lights are on the port side of the instrument panel. The centre light indicates the tailwheel position and the outer lights the main wheels. Indications are:

Locked down	..	..	..	Green
Locked up or between locks	..	..	..	Red

The lights may be dimmed for night use by turning the central knob anti-clockwise and they may be tested by pressing the knob in.

16. **Flaps.**—The flaps selector is on the aft face of the control shelf on the port side of the cockpit. The flap selector quadrant is notched at the UP, 10°, 20°, 30°, 40°, and 50° positions, and to obtain any of these flap settings the selector is moved to the appropriate notch and left there. A bar is provided across the quadrant

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at the 20° (TAKE-OFF) position. It can be rotated parallel to the quadrant to permit greater flap angles to be obtained; when carrying the large ferrying drop tanks the flaps must not be lowered more than 20° and the bar should be kept set across the quadrant to prevent further lowering. A flaps position indicator is painted on the leading edge of the port flap, and can be seen from the cockpit window.

17. Brakes

- (i) The brakes are operated by toe extensions on the rudder pedals and may be used differentially.
 - (ii) The PARK BRAKE handle is on the bottom centre of the instrument panel. To park, pull the handle out lightly, depress and then release pedals, then release handle. To release the parking brake, depress pedals.
18. **R.I. compass.**—An R.I. compass is fitted which, on most aircraft, operates when the battery switch is on. On some aircraft there is also a switch on the front switch panel which must be on for operation of the R.I. compass.

ENGINE CONTROLS

19. **Throttle.**—The throttle quadrant has a stop at the take-off boost position; if the spring catch is lifted and the throttle lever is moved fully forward, 67 inches boost can be obtained for combat. The throttle lever friction control is the smaller of the two knobs on the quadrant. A boost control override is fitted on most aircraft on the left-hand side of the instrument panel, but this control has been rendered inoperative.
20. **Mixture control.**—A Bendix-Stromberg injection carburettor is fitted. The IDLE CUT-OFF position is used in starting and for stopping the engine. The lever must be moved down to AUTO LEAN, or RUN position after the engine has been started. Although on some aircraft the quadrant also has marked on it AUTO RICH and FULL RICH, these positions have been rendered inoperative and it is not possible to move the lever beyond AUTO LEAN. The mixture strength is automatically

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controlled by boost and r.p.m., and above 46 inches and 2,700 r.p.m. the mixture gradually richens. The friction control for the mixture and propeller lever is the larger of the two knobs on the quadrant.

21. **Propeller control.**—The constant-speed lever for the 4-blade Hydromatic propeller moves forward to give high r.p.m., back to give low r.p.m., and governs between 3,000 and 1,800 r.p.m.
22. **Supercharger.**—The supercharger gear change is operated by an electro-pneumatic ram controlled by an aneroid which, when the cockpit supercharger switch is set at AUTO, changes the supercharger to HIGH gear at approximately 20,500 feet when the aircraft is climbing and back to LOW gear at approximately 19,500 feet when the aircraft is descending. For cruising in LOW gear above this altitude, the supercharger gear change switch can be set to LOW. On later aircraft the switch is spring loaded and can be held up to test HIGH gear on the ground. It will spring back to the LOW gear position when released. A HIGH gear warning light is provided on the right of the selector switch which should show when HIGH gear is engaged either on the ground or in the air.
23. **Carburettor air-intake.**—On most aircraft there are two air-intakes, one of which incorporates a filter. The control for the air-intake is on the left-hand shelf, and should be in the forward RAM AIR position at all times except for ground running, take-off and landing on sandy or dusty airfields or when flying through sandstorms, when the UNRAMMED FILTERED AIR position should be used. On a few early aircraft there is no air filter but there is an alternative warm intake. In this case the control is fully back for NORMAL and moves forward through a range of positions to ICING. The control should be kept at NORMAL unless icing occurs.
24. **Engine starting.**—A normal direct-cranking electric starter is fitted; a hand-crank and extension for starting are also provided in the starboard wheel well. The socket for the hand-crank extension is in the lower aft engine cowl on the starboard side.

25. **Coolant radiator and oil cooler shutters.**—The radiator and the oil cooler each have their own adjustable shutter. On early aircraft both shutters are hydraulically operated, on later aircraft electrically operated. They may either be manually controlled, or automatically controlled by their respective thermostatic switches. The radiator thermostat begins to open the shutter at 90° C. and at 110° C. the radiator shutter is fully open; the oil cooler thermostat begins to open the shutter at 60° C. and at 80° C. the oil cooler shutter is fully open. The controls for radiator and oil cooler shutters are two switches on the port cockpit wall, each being marked AUTOMATIC—OPEN—CLOSE. The switches for electrically controlled shutters have a safety catch to hold them in the AUTOMATIC position. On aircraft in which the shutters are hydraulically operated, under manual control they can only be fully open or fully closed; on aircraft in which the shutters are electrically controlled there is a neutral position midway between the OPEN and CLOSE positions so that intermediate settings of the shutters can be obtained by returning the switch to the neutral position when the desired setting is obtained; there is, however, no position indicator either for the radiator or for the oil cooler shutters. Using the manual control, the electrically operated coolant shutter takes 20–25 seconds, and the oil cooler shutter 10–15 seconds, to operate from fully closed to fully open, or vice versa.

OPERATIONAL CONTROLS

26. **Gun-firing.**—The master switch for the 0.5 inch guns and the camera gun is on the left-hand switch panel, and must be on for operation of guns or camera. If set up to the GUNS AND CAMERA position, the trigger on the front of the control column will fire camera and guns simultaneously; if set down to the CAMERA position, the trigger will fire the camera gun alone. **WARNING.** If a continuous burst of between 50 and 75 rounds is fired, very high barrel temperatures are reached and the guns may fire whether the master switch is on or off.

27. **Gun heating.**—The guns are heated electrically. The gun heater switch is beside the gun master switch. When the master switch is on, the camera gun heaters function automatically when the temperature drops.
28. **Bomb release gear.**—The bomb safety switch on the left-hand switch panel must be on before the bombs can be released by the electric release button on the control column. When Mod. 536 is incorporated, the safety switch is replaced by two switches for selecting either wing bomb. The bomb control handle on the left-hand switch panel has three positions—LOCK, SEL. (selective) and SALVO. Bombs cannot be released with the control handle at LOCK.
To release bombs normally:
(a) Put bomb control handle to SEL.
(b) Set fusing switches as desired
(c) Safety switch READY (or where Mod. 536 is incorporated selector switches as desired).
(d) Press release button on top of control column.
This will release both wing bombs simultaneously. If this fails to release bombs, they can be dropped mechanically (after fusing them as above) by lifting the guard on the bomb control handle and moving fully forward to SALVO. If the fusing switches are left off, moving the bomb control handle to SALVO will release bombs unfused.
NOTE.—When drop tanks are carried as an alternative to bombs, they may be released by either of the two methods described above.

OTHER EQUIPMENT

29. **Ventilation.**—The COLD AIR ventilating control is on the floor at the forward right-hand corner of the pilot's seat, and is adjustable in four positions. Move the lever to the right for more air. Care must be taken not to tread on this control as it is easily broken.
30. **Heating.**—Warm air from the coolant radiator is admitted to the cockpit by the HOT AIR control on the right-hand side of the pilot's seat, which rotates clockwise to let in more heated air.

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31. **Windscreen defrosting.**—Warm air from the coolant radiator is allowed to play on the windscreen when the DEFROSTER control, on the floor at the forward left-hand corner of the pilot's seat, is turned clockwise.
32. **Instrument lighting.**—Two fluorescent lights are provided, one on each side of the cockpit. The control for the left-hand light is on the centre switch panel, and for the right-hand light on the starboard switch panel. To switch on, turn the rheostat fully to the START position until light has warmed up; then turn back to give the desired amount of light. (The rheostat can be set at any position.)
33. **Oxygen.**—To obtain oxygen, it is only necessary to plug in the oxygen mask. As the working of the demand regulator depends upon the suction applied to it, it is essential that the oxygen mask should be a good snug fit. For normal operation, the red emergency knob on the demand regulator (at the forward starboard side of the cockpit) should be OFF and the AUTOMIX control should be ON; then when the oxygen mask has been plugged in, the regulator is set in operation and regulated by the user's breathing, a mixture of oxygen and air suitable for the altitude being delivered. If the AUTOMIX control is OFF, the air supply is cut out and pure oxygen will flow to the mask through the regulator; at any time when lack of oxygen is suspected AUTOMIX should be set OFF; this will reduce the oxygen endurance of the aircraft. The AUTOMIX control is to be turned OFF at heights above 30,000 feet, but if adequate oxygen supply is available, it should preferably be turned off at heights above 20,000 feet.
At the latter altitude the oxygen consumption will be about 25 per cent greater with the AUTOMIX control off than on, i.e. about 4 hours with AUTOMIX off above 20,000 feet; this percentage will gradually decrease and will be zero at 30,000 feet, when the endurance will be about $3\frac{1}{2}$ hours. The emergency control is provided to bypass the regulator mechanism, if this should become faulty; when the emergency knob is ON pure oxygen will

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flow at a high fixed rate irrespective of altitude; this high flow will quickly reduce the oxygen supply available, and therefore the emergency control should only be set on when absolutely necessary and for as short a time as possible. A blinker flow indicator on the instrument panel shows if the regulator is working properly; it is set in motion by the pilot's breathing.

A warning light at the bottom right-hand corner of the instrument panel indicates when the oxygen pressure is dangerously low (100 lb./sq.in.). The normal pressure is 365 lb./sq.in. and a pressure gauge is provided to the left of the warning light.

PART II

HANDLING

34. Management of fuel system

(i) Early aircraft with no fuselage tank

(a) *Starting and warming up.*—Set fuel selector to MAIN TANKS and switch left booster pump to NORMAL, so that fuel is used first from the left main tank, to which is connected the carburettor vapour return.

(b) *Take-off* on MAIN TANKS with left booster pump switched to EMERGENCY to ensure that the fuel pressure is high.

(c) *In flight.*—Fly for 15 minutes on the MAIN TANKS with left booster pump switched to NORMAL and then, if carrying drop tanks, change over to RIGHT or LEFT DROP TANK. Use drop tanks alternately to maintain lateral trim. When both drop tanks are emptied, change back to MAIN TANKS and fly for at least 15 minutes with left booster pump NORMAL before using the right tank.

(ii) Later aircraft with fuselage tank fitted.

(a) *Starting and warming-up.* Fuel shut-off valve on. Set fuel selector cock to MAIN TANK L.H. and set booster pump master switch to NORMAL, so that fuel is used first from the left main tank, to which is connected the carburettor vapour return.

(b) *Take-off* on MAIN TANK L.H. with booster pump switched to EMERGENCY to ensure that the fuel pressure is high.

(c) *In flight.*—Switch booster pump to NORMAL and continue to fly on MAIN TANK L.H. for about 15 minutes. If not carrying drop tanks, change over and fly on FUSELAGE TANK until it is empty. If carrying drop tanks, fly on FUSELAGE TANK until at least 40

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Imperial gallons (48 U.S. gallons) have been used, to improve trim and stability, then change over to either drop tank. Use drop tanks alternately to maintain lateral trim until both are emptied.

Then change over and fly on FUSELAGE TANK with booster pump switch NORMAL. When it is empty fly on MAIN TANK L.H. for at least 15 minutes before changing to MAIN TANK R.H.

NOTE.—With either system the quantity of fuel in the left main tank should be checked periodically to ensure that it is not being overfilled through the vapour return line. A smell of petrol in the cockpit may be an indication that the left main tank is overfull.

(d) *Landing.*—Land on either main tank with booster pump at EMERGENCY.

(iii) *Dropping combat tanks.*—Drop tanks should be jettisoned only in straight and level flight.

35. Preliminaries

(i) Switch ON battery switch and check undercarriage indicator.

(ii) Test operation of flying controls.

(iii) Check flaps UP. If ferrying tanks are carried, check that bar is set across flap quadrant at the 20° position.

(iv) Check the following:

Generator	..	..	..	ON
Bomb control handle	..	..	..	LOCK
All bomb and gun switches	..	..	..	OFF
All circuit breakers	..	..	..	In

(v) Ensure that mixture control is in IDLE CUT-OFF and then check the operation of each booster pump thus:

(a) *With no fuselage tank fitted*

With fuel selector cock at MAIN TANKS, switch each booster pump in turn to NORMAL and EMERGENCY, and note fuel pressure.

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(b) With fuselage tank fitted

With fuel shut-off valve ON and master booster pump switch NORMAL, select MAIN TANK L.H., MAIN TANK R.H., and FUSELAGE TANK and note fuel pressure in each case. Repeat with master booster pump switch at EMERGENCY.

- (vi) Switch OFF battery and have ground starter battery plugged in.

36. Starting engine and warming up

NOTE.—The mixture control must be in the IDLE CUT-OFF position at all times when the booster pump is on and the engine is not running, to avoid risk of fire.

- (i) Set fuel selector cock to MAIN TANKS (or MAIN TANK L.H.), fuel shut-off valve (if fitted) ON.
- (ii) Set engine controls as follows:
- | | |
|-----------------------------|-----------------------------|
| Throttle | 1 inch open |
| Mixture | IDLE CUT-OFF |
| Propeller | Speed control fully forward |
| Coolant radiator shutter .. | AUTOMATIC |
| Oil cooler shutter .. | AUTOMATIC |
| Carburettor air-intake .. | RAM AIR (see para. 23) |
| Supercharger | AUTO |
| Ignition | OFF |

- (iii) Have the engine turned by hand for at least two revolutions of the propeller.
- (iv) Switch left or master booster pump to NORMAL—fuel pressure gauge should show 10–12 lb./sq.in.
- (v) Prime the engine 3–4 full strokes if the engine is cold, 1–2 strokes if the engine is hot, immediately before starting.
- (vi) Switch on ignition and press starter switch. Turning periods must not exceed 20 seconds with a 30 seconds wait between each. Additional priming should be given as soon as the engine fires and should be continued until it is running.

PART II—HANDLING

- (vii) When the engine is running regularly, move mixture control to running position and stop priming. If engine shows signs of being over-rich, return to IDLE CUT-OFF until it is running smoothly.
- (viii) If engine fails to start:
- Stop priming and move mixture control to IDLE CUT-OFF.
 - Wait till propeller stops rotating, then switch off ignition.
 - If the engine has been overprimed, open the throttle and have propeller turned several revolutions.
- (ix) When the engine is running satisfactorily, turn off priming pump (push and turn to lock).
- (x) Open throttle and warm up at 1,200 r.p.m.
- (xi) Switch on master battery switch and have ground battery disconnected.

37. Testing engine and installations

While warming up:

- (i) If drop tanks are carried, check operation of all tanks by turning fuel cock to each in turn.
- (ii) Check temperatures and pressures, and test operation of hydraulic system by raising and lowering the flaps. Hydraulic pressure should be 1,000 lb./sq.in.

After warming up to 15° C. (oil) and 60° C. (coolant).

NOTE.—The following checks should be carried out after repair, inspection other than daily, or at the pilot's discretion, and with the tail tied down. Normally they may be reduced in accordance with local instructions.

- (iii) Test each magneto as a precautionary check.
- (iv) Open up to 2,300 r.p.m. and check operation of constant speed propeller. R.p.m. should drop to 1,800 with control fully back. Return speed control lever fully forward.
- (v) Open up to the take-off stop and check take-off boost (61 inches) and r.p.m. (3,000). (Tail tied down).
- (vi) Throttle back to 2,300 r.p.m. and check each magneto in turn; the drop should not exceed 100 r.p.m.
- (vii) Check that generator is charging.

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38. Taxiing

- (i) Check operation of brakes when starting to taxi.
- (ii) When making short radius turns, the control column must be held forward of the neutral position to allow the tail-wheel to swivel.

39. Check list for take-off

Sliding hood, if fitted	..	Open
T—Trimming Tabs	..	Elevator. With no flap (a) without filled fuselage tank, 5° back (b) with filled fuselage tank zero If 20° of flap are used, trim should be 3° more tail heavy than the above settings for zero flap. Rudder 5° right Aileron neutral
P—Propeller	.. ..	Speed control fully forward
F—Fuel	.. ..	Check contents of tanks Fuel cock MAIN TANKS or MAIN TANK L.H. Left, or master, booster pump Switch EMERGENCY
F—Flaps	.. ..	Up, or 20° down for shortest run. When fuselage tank is filled, 20° flap is recommended for take-off from grass airfield.
Supercharger	.. ..	AUTO (High gear warning light out)
Carburettor air intake	..	RAM AIR (see para. 23)
Radiator shutter	..	AUTOMATIC
Oil cooler shutter	..	AUTOMATIC
R.I. compass switch (if fitted)	..	ON

PART II—HANDLING

40. Take-off

- (i) Taxi forward a few yards with the stick back to ensure that the tailwheel is locked before opening up. Hold stick back to keep tailwheel locked, and do not attempt to raise the tail during the early part of the run. This will help to eliminate any tendency to swing.
- (ii) Open the throttle slowly to the take-off position, if 61 inches boost is required; 46 inches boost is sufficient for a normal take-off.
- (iii) The aircraft is very blind forward during the early part of the take-off run.
- (iv) The aircraft will take-off best in a tail-down attitude.
- (v) There is a tendency to swing to the left which can be easily held on the rudder.
- (vi) When carrying full fuselage tank, there is some pitching as the aircraft leaves the ground owing to reversal of stick loads.
- (vii) Do not start to climb until a speed of 150 m.p.h. I.A.S. has been attained.
- (vi.i) When the large ferrying drop tanks are carried the airflow may cause the undercarriage downlocks to bind and prevent the undercarriage from being retracted; to release downlocks, yaw the aircraft from side to side.
- (ix) If used, raise flaps at 500 feet. Raising the flaps causes a nose-up change of trim.
- (x) Switch left or master booster pump to NORMAL

41. **Climb.**—The speed for maximum rate of climb is approximately 160 m.p.h. I.A.S. up to 30,000 feet.

42. General flying

- (i) **Stability.**—Except when carrying full fuselage tank, the aircraft is stable longitudinally, laterally, and directionally. When the fuselage tank is full, the aircraft is longitudinally unstable in all conditions of flight, and tends to tighten up in turns; until at least 40 Imp. gallons (48 U.S. gallons) have been consumed from the fuselage tank, no manoeuvres other than very gentle turns should be attempted.

The carriage of wing bombs or drop tanks with full fuselage tank reduces this instability; hence should it be necessary to jettison wing loads while still carrying fuel in the fuselage tank, the pilot should expect a sudden change of trim and increase of instability.

(ii) *Change of trim*

Undercarriage down	..	..	Nose down
Flaps down	..	..	Nose down
Radiator shutter open	..	..	Nose down

The directional trim changes as speed and power are varied.

(iii) The elevator and rudder trimming tab controls are sensitive and must be used with care.

(iv) *Flying at low altitude in rain or bad visibility.*—Lower flaps to 20°, reduce speed to 150 m.p.h. I.A.S., and increase r.p.m. to 2,700. Check radiator and oil temperatures frequently.

43. **Stalling**

(i) The stalling speeds, engine off, are:

Flaps and undercarriage up	..	90	m.p.h. I.A.S.
Flaps 20° down, undercarriage down	..	85	" "
Flaps fully down, undercarriage down	..	75	" "

(ii) When no fuel is carried in the fuselage tank, slight tail buffeting occurs about 3 to 4 m.p.h. above the stall at which the right wing drops gently. With fuselage tank full or half full, there is no buffeting to give warning of the approaching stall, but a series of stick reversals occurs just above stalling speed, at the stall the right wing drops sharply, and unless immediate recovery action is taken, a spin may develop. The control column must be pushed firmly forward for recovery.

(iii) The aircraft sinks rapidly as stalling speed is approached.

(iv) If the control column is held back at the stall, a wing will drop very rapidly and the aircraft will become inverted.

(v) *High speed stall.*—If the aircraft is stalled in a steep turn either wing will drop very rapidly. The stall is preceded by pronounced juddering. Recovery is immediate if the pressure on the control column is relaxed.

44. **Spinning**

(i) Spinning is *not* permitted when drop tanks or fuel in the fuselage tank are carried.

(ii) Practice spins are not to be started below 12,000 feet, and the engine is to be throttled back before starting the spin. Recovery action is to be taken after not more than two turns.

(iii) The nose falls steeply as the spin is entered. The spin tends to be extremely uneven (especially spins to the right), slowing down almost to a stop with the nose on or above the horizon, and speeding up as the nose falls in each turn. Unless full rudder is applied in the direction of the spin when the spin is developing, the aircraft tends to recover unassisted by the pilot. If normal recovery action is taken after two turns have been completed, the aircraft recovers immediately. If recovery action is delayed until four turns have been completed, the rate of rotation at first increases for about 1-1½ turns, and the aircraft then recovers.

(iv) Fast flat spins to the left have been produced by spinning with engine on; the engine should be throttled back at once, when the spin should revert to the normal type. If, however, the spin should remain flat on throttling back and taking normal recovery action, the aircraft should be slowly rocked fore and aft by full movement of the control column, opening up the engine as the stick is pushed forward and throttling back as it is pulled back.

(v) A speed of at least 180 m.p.h. I.A.S. should be attained before easing out of the ensuing dive.

(vi) The average loss of height in two turns (to left or right) and in recovery, is about 3,000-3,500 feet.

45. **Diving.**—The aircraft is very steady in the dive. Unless carrying fuel in the fuselage tank, it becomes slightly tail heavy, and tends to yaw to the right. This tendency increases with increase in speed and should be counteracted by use of the rudder tab. This tab is powerful and sensitive and should be used with care.

When 1,000 lb. wing bombs are carried, they should, if possible, be dropped before pulling out from the dive; but if they must be dropped during the pullout, recovery should not be made abruptly.

PART II—HANDLING

With fuselage tank half full, the aircraft becomes increasingly nose heavy as the speed increases; care should be taken not to impose excessive loadings by too rapid recovery from the dive, which might overstress the aircraft.

46. Aerobatics

- (i) Flick manoeuvres are not permitted. When carrying bombs or drop tanks, or with fuel in fuselage tank, aerobatics are prohibited.
- (ii) Watch oil pressure carefully during aerobatics, and avoid more than a momentary drop.
- (iii) All the normal aerobatics are easy to perform, but a large amount of height may be lost during some manoeuvres and an ample margin must be allowed for recovery. Rolls should not be performed below 10,000 feet:

The following speeds, in m.p.h. I.A.S., are recommended:

Roll	220-250
Loop	300
Half roll off loop	350
Climbing roll	375
Upward roll	400

47. Check list for landing

Radiator shutter	AUTOMATIC
Oil cooler shutter	AUTOMATIC
Carburettor air-intake	RAM AIR (see para. 23)

Lower flaps 20° and reduce speed to 170 m.p.h. I.A.S.
Open sliding hood, if fitted.

U—Undercarriage	DOWN. Check indicator
P—Propeller	Speed control fully forward
F—Flaps	Fully down (unless carrying ferrying drop tanks, when only 20° may be used)

F—Fuel	MAIN TANKS
	Desired booster pump
	EMERGENCY

NOTE.—If carrying ferrying drop tanks it may be necessary to yaw the aircraft from side to side to engage the downlocks.

PART II—HANDLING

48. Landing

(i) Approach speeds in m.p.h. I.A.S.:

	Flaps fully down	Flaps up	Flaps 20° down with ferrying tanks on
Engine assisted	105	120	120
Glide	120	130	130

- (ii) With glide approach or flapless landing, considerable float will be experienced after flattening out. If landing with full combat drop tanks the above speeds should be increased by 10 m.p.h. I.A.S. If it should ever be necessary to land with one drop tank on, do not lower more than 20° flap, and land with the tail up.
- (iii) If it is necessary to land with full fuselage tank, the speed should not be allowed to drop below 140 m.p.h. I.A.S. on the turn in, which should be gentle. The normal approach speeds quoted above are satisfactory. During the hold-off, the control column must be pushed forward owing to reversal of stick load.

49. Mislanding

- (i) Open throttles to climbing boost position (with full fuselage tank, take-off boost position) and retrim as necessary.
- (ii) Raise undercarriage immediately.
- (iii) Climb at about 140 m.p.h. I.A.S. with flaps fully down. Watch oil and coolant temperatures.
- (iv) Raise the flaps to 20° at a safe height of about 300 feet and retrim nose height.

PART II—HANDLING

50. Beam approach

	Preliminary Approach	Inner Marker on Q.D.R.	Outer Marker on Q.D.M.	Inner Marker on Q.D.M.
Indicated height (feet)	1,500	1,000	600-700	150
Action	Flaps 20° down	Under-carriage down	Lower flaps fully	Throttle back slowly
Resultant change of trim	Nose down	Nose down	Nose down	—
I.A.S.	170 m.p.h.	150 m.p.h.	120 m.p.h.	105 m.p.h.
R.p.m.	2,400	2,700	2,700	2,700
Boost (level flight)	28"	29"	34"	30"
Boost (-500 ft./min.)	24"	25"	30"	—
Boost (overshoot)	—	—	—	46"
Remarks: Altitude error at take-off, minus 50 feet Altitude error at touch down, minus 80 feet. Flaps 20° minus 80 feet. Before preliminary approach adjust altimeter for Q.F.E. and touch down error as follows: Add 2.7 millibars to Q.F.E. to give zero reading at touch down.		OVERSHOOT Open throttle to 46" and retract u/c immediately. Climb at 140 m.p.h. I.A.S. Raise flaps to 20° at 300 feet and retrim.		

51. After Landing

- Raise flaps before taxiing. Turn OFF booster pumps.
- When making short radius turns hold control column fully forward to release tailwheel lock.
- Put flaps fully down after parking (unless carrying ferrying drop tanks) to prevent people walking on them.
- Stopping engine:
 - At 1,500 r.p.m. move mixture control to IDLE CUT-OFF and open throttle.
 - When engine stops, switch OFF ignition and turn OFF fuel.
 - Turn off all electrical switches.
- Leave brakes off if drums are at all hot.
- Oil dilution.—The oil dilution period is 2 minutes. See A.P. 2095.

PART III

OPERATING DATA

52. Engine data—Packard Merlin V-1650-3

- Fuel.—100 octane.
- Oil.—See A.P. 1464/C37.
- The principal engine limitations are as follows:

	R.p.m.	Boost ins. Hg.	Temperature °C.			
			Coolant		Oil	
			Max.	Desired	Max.	Desired
MAX. TAKE-OFF TO 1,000 FT. M	3,000	61				
MAX. CLIMBING & LEVEL CONTINUOUS M S	2,700	46	121	90-100	90	70-80
COMBAT 5 MINS. LIMIT M S	3,000	67*	121		90	

* 61 inches boost may be used for 15 minutes.

OIL PRESSURE:

MAXIMUM	..	..	..	..	90 lb./sq.in.
NORMAL	..	..	..	..	70/80 lb./sq.in.
MINIMUM FOR CRUISING	..	..	..	..	60 lb./sq.in.
MINIMUM FOR IDLING	..	..	..	..	15 lb./sq.in.

MINIMUM TEMPERATURE FOR TAKE-OFF:

OIL	..	..	..	..	15° C.
COOLANT	..	..	..	..	60° C.

- Fuel pressure: Normal 12/16 lb./sq.in.
Minm. for idling 9 lb./sq.in.

PART III—OPERATING DATA

53. Flying limitations

(i) Maximum speeds in m.p.h. I.A.S.

(a) Diving—Without bombs or drop tanks	..	505
With 500 lb. bombs or combat tanks	..	450
With 1,000 lb. bombs	..	400
With ferrying tanks	..	210

(b) Flaps down 10°	..	..	..	..	400
Flaps down 20°	..	..	..	..	275
Flaps fully down	..	..	..	..	165

(c) Undercarriage down	170
------------------------	----	----	----	----	-----

(ii) Bomb clearance angles

Dive	..	..	..	..	..	90°
Climb	..	..	..	..	..	30°
Bank	..	..	..	..	..	5°

(iii) Maximum weights:

Take-off from prepared runways or good grass airfields, 11,250 lb.

All forms of flying, 9,300 lb.

This weight (9,300 lb.) includes full guns and ammunition and full permanent wing fuel tanks.

- (iv) Aerobatics and spinning are permitted, except when carrying wing bombs or tanks, or when carrying fuel in auxiliary fuselage tank. See paras. 44, 46.
Rolls of any sort should only be practised above 10,000 feet.

- (v) When carrying external bombs or tanks or auxiliary fuselage tank, spinning and aerobatics are not permitted. Fighter manoeuvres should be avoided as far as possible and care should be taken in pulling out of dives and in turns at high speeds to avoid imposing excessive loadings.

- (vi) When fuselage tank is filled, flying must be restricted to straight and level and no manoeuvres other than very gentle turns should be attempted until at least 40 Imp. gallons (48 U.S. gallons) have been consumed.

- (vii) When carrying 1,000 lb. bombs, these should on no account be dropped separately.

PART III—OPERATING DATA

54. Position error correction.

Corrections for position error are as follows:

From To	120 150	150 190	190 240	240 300	300 350	350 400	m.p.h. I.A.S.
Add	6	3	0	3	6	9	m.p.h.
Subtract							..

55. Maximum performance

(i) Speeds for maximum rate of climb:

160 m.p.h. I.A.S. from SL to 30,000 feet
155 m.p.h. I.A.S. from 30,000 to 35,000 feet
150 m.p.h. I.A.S. from 35,000 to 40,000 feet
145 m.p.h. I.A.S. above 40,000 feet

(ii) Combat

Set supercharger gear change to AUTO, r.p.m. to 3,000, and throttle lever fully forward.

56. Maximum range

(i) Estimated recommended speed 185 m.p.h. I.A.S.

- (ii) To obtain any desired I.A.S., fly at 1,800 r.p.m. with supercharger switch LOW and obtain the I.A.S. by adjusting boost, but do not exceed 46 inches. If the desired speed cannot be obtained at 46 inches or full throttle, increase r.p.m. as necessary up to 2,700. At high altitudes, if the I.A.S. cannot be obtained at 2,700 r.p.m., set supercharger switch to AUTO.

When flying at low r.p.m. it will probably be necessary to clear the engine every 15 minutes by increasing r.p.m. to 2,700 for two or three minutes.

57. Fuel consumption and capacity

(i) Consumptions in the rich mixture range:

Boost	R.p.m.	Gallons/hour Imperial	U.S.
67	3,000	137	165
61	3,000	112	135

PART III—OPERATING DATA

- (ii) Consumptions in the weak mixture range at low altitudes:

Boost inches Hg.	R.P.M.									
	2,700		2,400		2,200		2,000		1,800	
	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.
46	67	81	62	74	59	71	53	64	49	59
40	55	66	52	62	47	57	44	53	40	49
35	47	57	44	53	41	49	37	44	34	41
30	41	49	36	43	34	41	31	37	28	34
25	33	40	29	35	27	32	25	30	22	26
20	25	30	23	28	21	25	19	23	17	20

These figures apply at 2,000 feet. For every 2,000 feet above this (up to 10,000 feet) add $1\frac{1}{2}$ gallons/hour.

- (iii) Consumptions in the weak mixture range at medium altitudes:

Boost inches Hg.	R.P.M.									
	2,700		2,400		2,200		2,000		1,800	
	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.
40	62	75	57	68	53	64	48	58	—	—
35	53	64	49	59	46	55	42	50	39	47
30	45	54	42	50	39	47	36	43	33	40
25	38	45	35	42	32	38	30	36	28	34
20	30	36	28	34	26	31	24	29	23	28

These figures apply at altitudes between 10,000 and 20,000 feet.

- (iv) Consumptions in the weak mixture range at high altitudes:

Boost inches Hg.	R.P.M.									
	2,700		2,400		2,200		2,000		1,800	
	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.	Imp.	U.S.
40	63	76	57	68	—	—	—	—	—	—
35	54	65	50	60	47	56	—	—	—	—
30	46	55	43	52	41	49	38	46	—	—
25	40	48	37	44	35	42	33	40	30	36
20	34	41	31	37	29	35	27	32	25	30

These figures apply between 25,000 and 30,000 feet. Above 30,000 feet add about 1 gallon/hour for every 2,000 feet increase.

- (v) Fuel capacity:

	Imperial gallons	U.S. gallons
Two main tanks—each	76 $\frac{1}{2}$	92
Two combat drop tanks—each ..	62 $\frac{1}{2}$	75
Fuselage tank (if fitted)	71	85
Two ferrying drop tanks—each	125	150

PART III—OPERATING DATA

RESERVED FOR RANGE CURVES TO BE ISSUED
BY AMENDMENT

RESERVED FOR RANGE CURVES TO BE ISSUED
BY AMENDMENT

PART IV

EMERGENCIES

58. Hydraulic failure

(i) Undercarriage

If the wheels fail to lower:

(a) Select undercarriage DOWN, and pull out EMERGENCY handle. This bypasses the normal hydraulic system and allows fairing doors and wheels to fall under their own weight.

(b) Rock the aircraft from side to side to lock the wheels.

(c) The EMERGENCY handle must be pushed in before normal operation of hydraulic system can be resumed.

(ii) Flaps

Select desired flap angle. If engine pump is not effective, attempt to lower flaps by handpump. There is no other method of lowering flaps.

(iii) Radiator and oil cooler shutters (hydraulically operated types only)

Set switch to OPEN or CLOSE, as desired, and operate handpump. Return switch to neutral when the desired amount of opening is obtained; about 20 to 30 full strokes are required to open or shut the shutters completely.

59. Bomb or drop tank jettisoning.—To jettison bombs or drop tanks, lift guard and push bomb control handle fully forward to SALVO. This will release bombs unfused.

NOTE.—If it is necessary to jettison wing tanks or bombs while there is still fuel in the fuselage tank, the pilot should be prepared for a sudden change of trim and decrease in stability.

60. Parachute exit.—Pull red emergency handle on starboard window rail and push straight up on hood.

PART IV—EMERGENCIES

61. **First-aid kit.**—The first-aid kit is stowed above and behind the pilot's seat between the overturning pylon struts.

62. **Ditching**

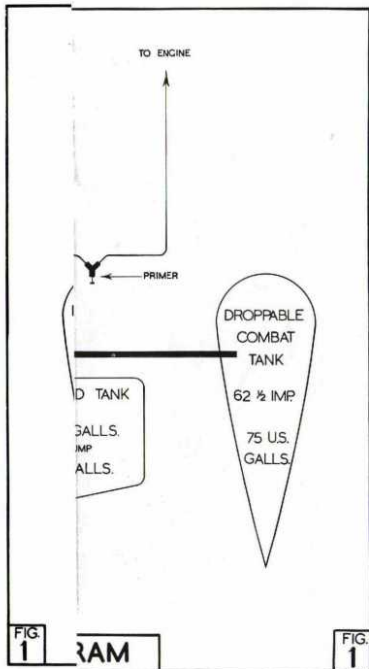
(i) It is strongly recommended that pilots should avoid ditching and should bale out whenever possible. Even when flying at low cruising speed at sea level, if the pilot takes immediate action, a height of about 800 feet can be quickly reached, thus allowing the pilot to bale out.

(ii) Should, however, ditching be unavoidable, wing drop tanks or bombs should be jettisoned; speed must be reduced as much as possible, and flaps should be lowered 30°. Ditch along the top of the swell, dipping the wing tip on the windward side in order that this should strike the water first.

This will result in a heavy swerve, but will reduce the tendency to dive. This manoeuvre calls for a very accurate judgment of height.

63. **Incendiary bombs.**—Stowage for two incendiary bombs is provided on the cockpit floor.

64. **IFF destruction.**—The destructor buttons and switch are on the starboard cockpit wall.



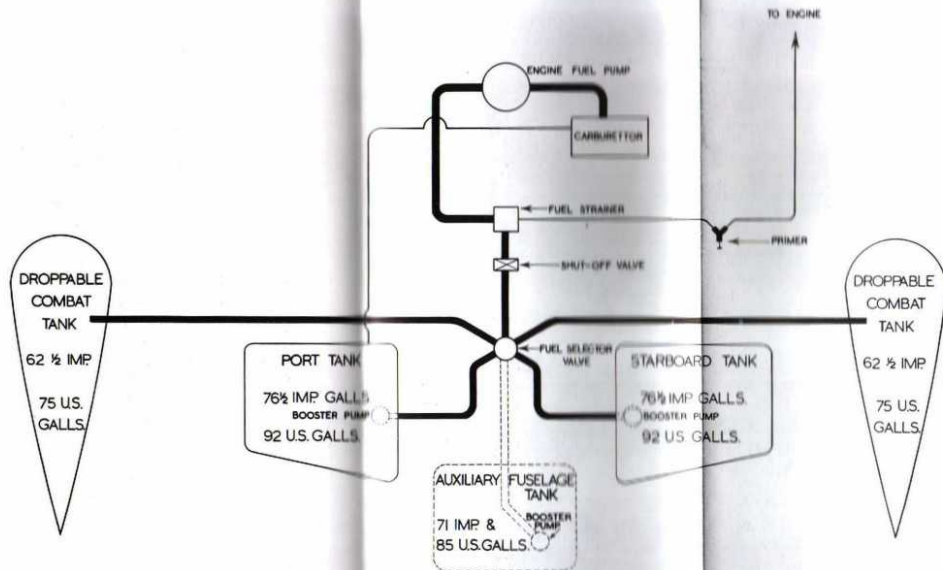
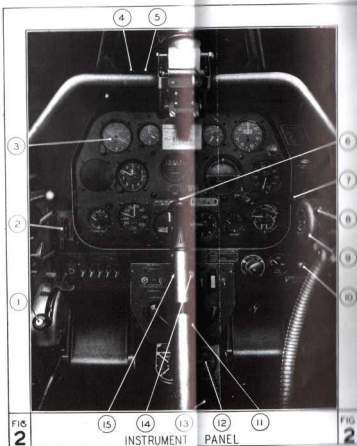


FIG.
1

SIMPLIFIED FUEL SYSTEM DIAGRAM

FIG.
1



KEY TO Figs. 2 and 3

1. Bomb control handle
2. Boost override (inoperative)
3. R.I. compass
4. Undercarriage warning light test button
5. Undercarriage warning light
6. Bomb release button
7. Oxygen EMERGENCY control
8. Oxygen AUTOMIX control
9. Oxygen demand regulator
10. Oxygen pressure warning light
11. Fluorescent lights rheostat
12. Hydraulic pressure gauge
13. Undercarriage emergency knob
14. Supercharger gear-change warning light
15. Supercharger gear-change switch
16. Carburettor air intake control
17. Coolant radiator manual switch
18. Oil cooler manual switch
19. Throttle lever
20. Press-to-transmit switch
21. Gunfiring button
22. Windscreen defroster control
23. Fuel contents gauge for left main tank

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FIG
3

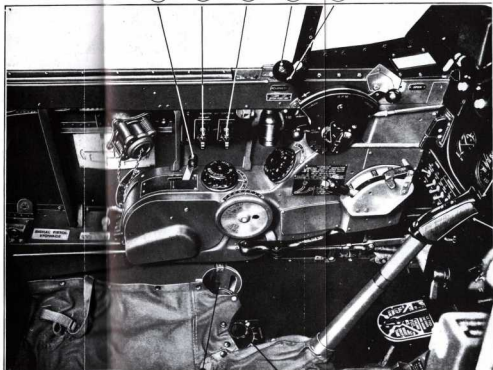


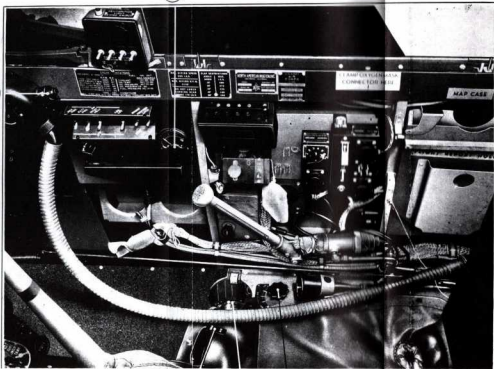
FIG
3

(23) (22)
COCKPIT—PORT SIDE

FIG
3

24

8



KEY TO *Fig. 4*

- 8. Oxygen AUTOMIX control
- 24. Ammeter
- 25. Cabin warm air control
- 26. Fuel contents gauge for right wing tank
- 27. Cabin cold air control

FIG
4

27 26 25
COCKPIT - STARBOARD SIDE

FIG
4