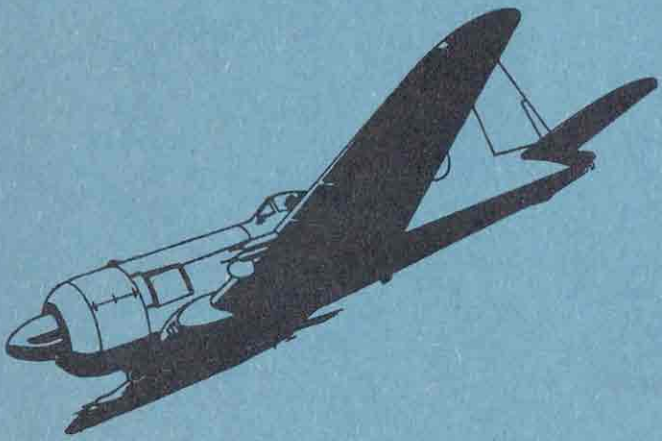
A.P. 2208 E—P.N.

PILOT'S NOTES

FOR

FIREBRAND T.F.V.



PREPARED BY DIRECTION OF THE MINISTER OF SUPPLY

A. C. Poulett.

PROMULGATED FOR INFORMATION AND GUIDANCE OF ALL CONCERNED BY COMMAND OF THEIR LORDSHIPS

J. G. Lang

AMENDMENTS

Amendment lists will be issued as necessary and will be gummed for affixing to the inside back cover of these notes.

Each amendment list will, where applicable, be accompanied by gummed slips for sticking in the appropriate places in the text.

Incorporation of an amendment list must be certified by inserting date of incorporation and initials below.

A.L. NO.	INITIALS	DATE	A.L. NO.	INITIALS	DATE
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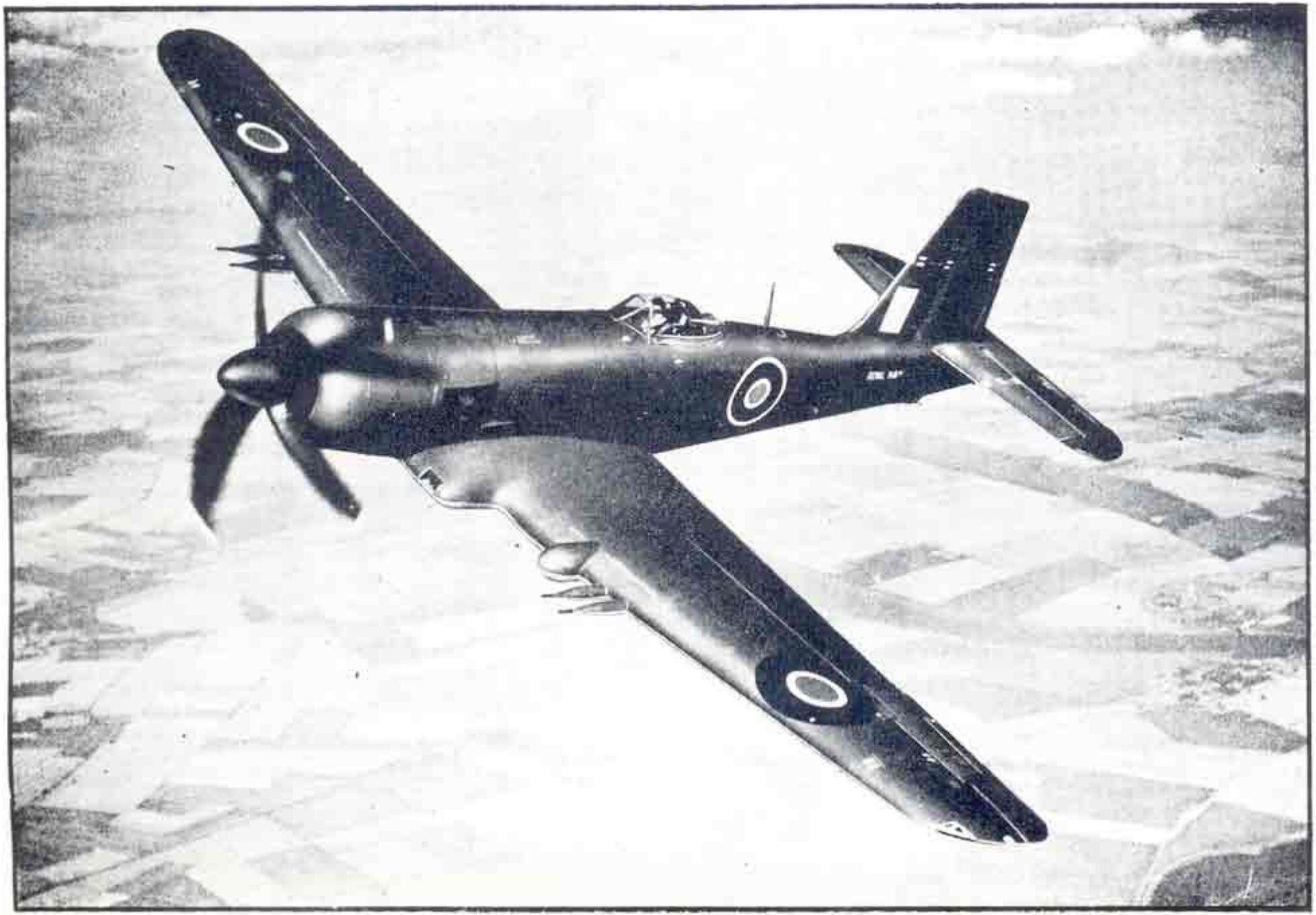


NOTES TO USERS

THIS publication is divided into five parts: Descriptive, Handling, Operating Data, Emergencies, and Illustrations.

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.F.O. 7432/45).

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

Additional copies may be obtained from S.N.S.O. Cricklewood by application on Royal Navy Forms S134D or D397. The number of this publication must be quoted in full—A.P. 2208E—P.N.

Comments and suggestions should be forwarded through the usual channels to the Admiralty (D.A.W.).

ADMIRALTY
May, 1948
(Reprinted December, 1950.)

FIREBRAND TF. MK. V

LIST OF CONTENTS

PART I—DESCRIPTIVE

APPENDIX I

FIREBRAND MK. 5A

I. INTRODUCTION

Power-assisted aileron controls are fitted to a few Mk. 5 aircraft and these aircraft are known as Firebrand Mk. 5A.

With this system of control, the aileron spring tabs are dispensed with, and the aileron operating lever is connected to the aileron by a rigid link instead of a spring link. Movement of the ailerons is brought about by a servodyne unit mechanically operated by the control column, power for the servodyne being derived from the main hydraulic system.

II. FLYING LIMITATIONS

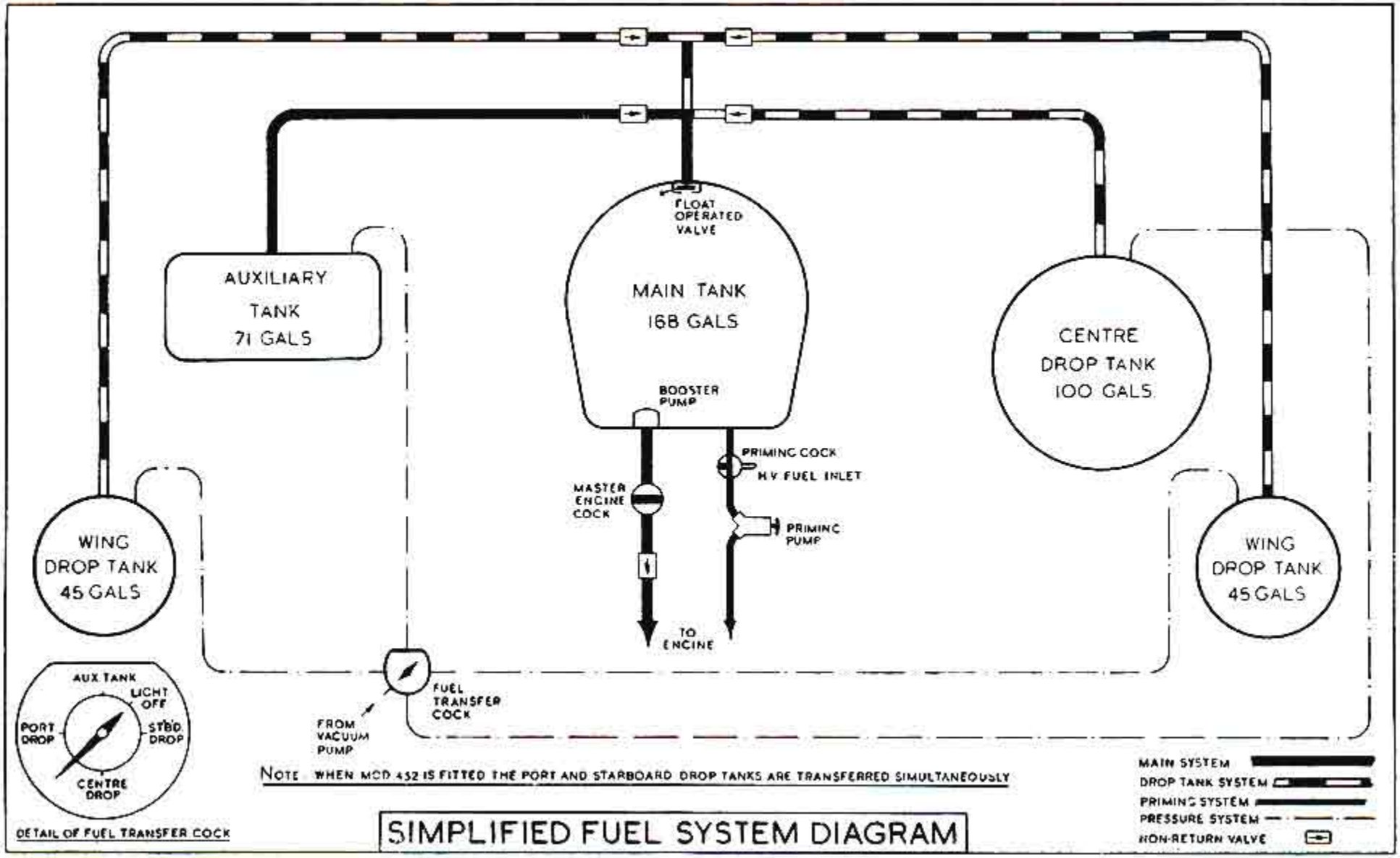
The aircraft may be operated from shore bases only, and the carriage of external stores or drop tanks is not permitted. Otherwise the flying limitations are the same as for Mk. 5 aircraft.

III. HANDLING

Aileron control is improved by the use of power assistance ; the lateral stick forces are appreciably lower and the rate of roll is higher when compared with Mk. 5 aircraft.

IV. EMERGENCY HANDLING

A control lever marked POWER CONTROLS EMERGENCY TWIST AND PULL is mounted on the port side of the cockpit immediately underneath the torpedo director unit. The control is normally left in the IN position, but if, in an emergency or a simulated emergency during flight, manual control of the ailerons is necessary, the power assister can be selected OUT by operating the lever in the manner indicated. When under manual control the ailerons are exceptionally heavy. Once the emergency lever has been selected OUT it must not be re-selected IN during flight owing to the possibility of causing severe overstressing in the aileron circuit. Simulated emergencies should, therefore, be practised only in smooth air conditions when a landing can be made into wind.



DETAIL OF FUEL TRANSFER COCK

NOTE WHEN MOD 432 IS FITTED THE PORT AND STARBOARD DROP TANKS ARE TRANSFERRED SIMULTANEOUSLY

SIMPLIFIED FUEL SYSTEM DIAGRAM

PART I

DESCRIPTIVE

NOTE.—The numbers quoted in brackets after items in the text refer to the illustrations in Part V.

INTRODUCTION

The Firebrand T.F. Mk. V is designed as a single-seat torpedo-carrying fighter for use in the Royal Navy. A variety of external stores can be carried (see para. 63). The aircraft is powered by a Centaurus IX engine driving a Rotol four-bladed hydraulic propeller. It is equipped for operating either from land or an aircraft carrier, provision being made for both catapult and rocket-assisted take-offs and for arrested landings. The main planes can be folded by hand.

FUEL AND OIL SYSTEMS

1. **Fuel tanks and pumps**

(i) Fuel is carried in two self-sealing fuselage tanks—main and auxiliary—and is delivered to the engine-driven pump from the main tank by an electric booster pump ; the supply in the auxiliary tank is transferred to the main tank by air pressure from the exhaust side of the vacuum pump. A float valve at the top of the main tank prevents it being overfilled. In the event of failure of the main tank pump a suction by-pass valve enables the engine-driven pump to draw fuel direct from the sump of the tank. The main tank is behind the fireproof bulkhead and the auxiliary tank is below the cockpit floor.

(ii) A drop tank of 45 gallons capacity may be carried under each wing and a 100-gallon drop tank may be carried on the torpedo carrier, the fuel from these tanks being transferred to the main tank in the same way that the auxiliary tank fuel is transferred. When necessary the drop tanks can be jettisoned (see para. 69).

(iii) The capacities are as follows :—

Main tank	168 gallons
Auxiliary tank	71 gallons
Central drop tank	100 gallons
Wing drop tanks	90 gallons
Total	429 gallons

2. **Fuel cocks and pump switch**

(i) The control lever (40) for the engine master cock is mounted in the controls box on the left-hand side of the cockpit. It has two positions, ON and OFF (forward and back respectively).

(ii) The switch (35) for the main tank booster pump is below the ignition switches.

(iii) The fuel transfer selector cock (65) on the right-hand side of the instrument panel can be set to admit air pressure to any of the auxiliary or drop tanks when carried :

(a) On aircraft in which Mod. 452 is not embodied the selector cock can be set to admit pressure to the AUXILIARY TANK, PORT DROP TANK, CENTRE DROP TANK or STARBOARD DROP TANK. An indicator light (54) on the right-hand side of the cockpit comes on when the tank contents being transferred to the main tank are exhausted. A fresh tank can then be selected, or alternatively the cock can be set to the LIGHT OFF position when the indicator light will cease to be illuminated.

NOTE.—Owing to the design of the cock, when it is set to LIGHT OFF, air pressure will be admitted to both the auxiliary tank and the starboard drop tank. The LIGHT OFF position is not, however, intended as one of the pressurising positions and should only be used to extinguish the light when all fuel has been transferred to the main tank.

(b) On aircraft in which Mod. 452 is embodied the selector cock can be set to admit pressure to the AUXILIARY TANK, CENTRE DROP TANK, PORT AND STARBOARD DROP TANKS (simultaneously) or OFF. The indicator light functions the same as in (a) above and when the cock is set to the OFF position the light will cease to be illuminated, and the air pressure is exhausted to atmosphere.

3. **Priming system**

The priming pump (45) and cock are mounted on the left-hand side of the pilot's seat. The cock has three positions marked OFF, MAIN TANK and HIGH VOLATILITY. The last position allows high volatile fuel

from an external supply (the pipeline is in the port wheel-well) to be used for starting in very cold weather. When in the MAIN TANK position, priming fuel is drawn from the main tank. The cock should always be kept in the OFF position except when priming the cylinders prior to starting the engine.

4. **Fuel contents gauge**

The electric fuel contents gauge (62) on the right-hand side of the instrument panel indicates the contents of the main tank and the auxiliary tank. The "tail down" figures are in red. There are no contents gauges fitted for the drop tanks.

5. **Fuel pressure warning light**

The fuel pressure warning light (57) on the right-hand side of the instrument panel comes on if the pressure falls appreciably below normal.

6. **Oil system**

(i) Oil is supplied from a self-sealing tank fitted between the fireproof bulkhead and the main fuel tank. The capacity of the tank is 24½ gallons of oil and 3½ gallons air space. An oil cooler flap is fitted ; prior to Mod. 230 it is "fixed" but when Mod. 230 is incorporated it is automatically controlled according to the oil temperature. Oil temperature (59) and pressure (61) gauges are mounted on the right-hand side of the instrument panel.

(ii) An oil dilution system may be fitted. The pushbutton (36) for operating the solenoid valve is beside the engine starter pushbutton on the instrument panel.

MAIN SERVICES

7 **Hydraulic system**

The hydraulic system operates the :—
Air intake filter
Dive brakes
Engine cooling shutters
Flaps
Oil cooler flap (if Mod. 230 is embodied)
Tailwheel centralising mechanism
Undercarriage and tailwheel (and torpedo carrier)

A handpump (80) on the right-hand side of the pilot's seat is provided for use in the event of failure of the engine-driven pump ; it will only operate the undercarriage, torpedo carrier and flaps.

8. **Electrical system**

A 24-volt engine-driven generator charges two accumulators for operation of the :—
Bomb and torpedo release
Cameras
Coffman starter
Drop tank release
Electric fuel pump
Engine instruments
Fuel contents gauge
Gun firing and R.P. release
Oil dilution
Pressure head heater
Radio and radio altimeter
R.I. compass (or ATM compass if Mod. 293 is embodied)
Undercarriage and trimming tab indicators
All usual lighting
A ground/flight switch (78) is fitted on the right-hand cockpit wall. When set to GROUND this switch isolates the generator and the accumulators from all the electrical services. A POWER FAILURE WARNING light (68) on the electrical panel on the right-hand cockpit wall comes on when the generator is not working.

9. **Pneumatic system**

An engine-driven compressor charges an air bottle for the operation of the brakes. A connection is fitted for charging the bottle from an external source and there is a triple pressure gauge (11) on the top right-hand side of the instrument panel.

AIRCRAFT CONTROLS

10. **Flying controls**

The control column is of the spade-grip pattern and incorporates the brakes control lever (15) and parking catch. The rudder bar is adjustable for reach by operating the central, foot-operated, starwheel.

11. **Flying controls locking gear**

This folds downwards and is stowed on the cockpit floor when not in use. It is provided with interference horns which extend across the cockpit when the locking gear is in position.

12. **Trimming tabs**

A crank handle (48) on the side, and a handwheel (51) at the rear of the controls box operate the elevator and rudder trimming tabs respectively. Both operate in the natural sense and the settings of the tabs in the sense of aircraft trim are shown on an electrical indicator (30), on the lower left-hand side of the instrument panel.

13. **Undercarriage control**

(i) The undercarriage main wheels and tail wheel are retractable. The selector lever (44) in the controls box moves in a gated quadrant marked UP and DOWN, and incorporates an electrically-operated locking device which prevents the undercarriage being retracted, while the weight of the aircraft is on the wheels. Should it not be possible to move the selector to the UP position after take-off the fabric patch (42) on the side of the control box should be torn off and the spindle thereby revealed should be pressed in.

(ii) On aircraft on which Mod. 457 has not been embodied the air-intake filter control (31) is interconnected with the undercarriage selector lever so that when the undercarriage is lowered the filter is automatically brought into operation. When Mod. 457 is incorporated the interconnection is deleted.

(iii) The operation of the torpedo carrier is automatic with the operation of the undercarriage, i.e., when the undercarriage is raised or lowered, the torpedo carrier is lowered or raised respectively.

14. **Tail wheel centralising lock**

A tail wheel centralising lock is fitted ; it is brought into operation hydraulically by moving a lever (49) at the rear of the engine controls box. If the tailwheel is not centralised it will not retract fully.

15. **Undercarriage indicators**

(i) The electrical visual indicator (33) on the lower left-hand side of the instrument panel operates as follows :—

All lights green ... ... Undercarriage locked DOWN
All lights red ... ... Undercarriage between locks
No lights ... ... Undercarriage locked UP

A spare set of lights is brought into operation by pulling out the knob in the centre of the indicator ; rotation of the knob operates the dimmer screen for night flying.

(ii) Red painted mechanically operated rods protrude through the wing roots when the main wheels are down. These rods lie flush with the top surface of the wing-skin when the main wheels are locked UP.

(iii) An external lamp is mounted on the starboard side of the centre plane leading edge and illuminates the starboard oleo strut when the arrester hook is down and the main undercarriage wheels and tailwheel are locked down.

16. **Undercarriage warning light**

A red warning light (34) mounted close beside the undercarriage visual indicator comes on when the throttle is less than $\frac{1}{3}$ open and the main wheels and tailwheel are not locked DOWN.

17. **Flaps control**

The flaps are controlled by the selector lever (38) at the forward end of the controls box. Intermediate flap settings may be obtained by returning the selector to the neutral (mid) position when the desired setting is reached. The neutral position is not marked and must be located by feel. The setting of the flaps is determined by reference to the " knots " scale marked on the port flap.

18. **Dive brakes control**

The brakes are extended by twisting clockwise the handle (6) to the left below the instrument flying panel, pulling it, and then allowing it to twist anti-clockwise to lock it. The brakes are closed by twisting the handle clockwise, pushing it in, and allowing it to twist anti-clockwise.

19. **Arrester hook control and indicator**

(i) The hooked lever (18) at the rear end of the controls box is moved down to lower the arrester hook. The hook can only be raised manually. When the hook is lowered three attitude lights are automatically switched on.

(ii) A green light (50) forward of the rudder trimming tab control indicates when the hook is lowered (see also para. 15 (iii)).

20. **R.A.T.O.G controls**

Provision is made for rocket-assisted take-offs and the following controls are fitted in the cockpit.

(a) *Master switch* (24). This is on the panel on the left-hand side of the cockpit, and is fitted with a locking slide and nut.

(b) *Firing pushbutton.* This is incorporated in the top of the throttle lever.

(c) *Jettison lever.* This is fitted on the left-hand side of the pilot's seat, and must be pulled up fully to jettison the rocket carriers.

21. **Wing folding controls**

The wings are folded and spread manually, the locking pins being operated by two crank handles, one in each wheel well. Before folding or spreading the wings the brakes should be locked " on," the flaps should be fully up and the dive brakes closed. A mechanical indicator near each crank handle shows when the latch pins are fully engaged or withdrawn ; transparent inspection panels are fitted in the skin over the latch pins.

NOTE.—Before folding the wings, the wing drop tanks, if carried, should be empty and wing bombs or stores should be removed.

22. **Deck-landing airspeed indicator**

A special airspeed indicator is fitted externally on the left-hand side of the windscreen for the pilot's use when deck-landing.

ENGINE CONTROLS

23. Throttle control

The throttle control lever (47) in the controls box moves in a gated quadrant marked SHUT, E.C.B. (cruising), R.B. (rated) and TAKE-OFF. A friction damper (46) is provided.

24. Mixture control

A Bendix-Stromberg pressure-injection carburettor is fitted. Mixture control is fully automatic and is governed by the setting of the throttle control lever. An economical mixture strength is obtained only with the throttle at or behind the E.C.B. gate.

25. R.p.m. control lever

(i) The r.p.m. control lever (43) is to the right of the throttle lever in the controls box. The lever moves in a gated quadrant marked MAX. R.P.M. and AUTO; with the lever at AUTO, r.p.m. are controlled automatically by the setting of the throttle lever, but with it at MAX. R.P.M. the interconnection device is overridden and r.p.m. are then governed at 2,700. With the lever at AUTO the corresponding r.p.m. for a given throttle setting are :—

Boost (lb./sq. in.)	R.p.m.
−2 to 0	1,580-1,620
+2 (E.C.B. gate)	2,100-2,220
+6 (Rated gate)	2,380-2,460
+8½	2,680-2,720

The lever can, however, be used in the same way as the conventional r.p.m. control lever to enable the pilot to select higher r.p.m. than those given by "interconnection." Automatic control of r.p.m. is effected only when the lever is at AUTO and indiscriminate use of it in any other position may increase fuel consumption considerably.

(ii) The friction damper for the throttle lever also controls the damping of the r.p.m. control lever.

26. **Supercharger control and warning light**

The supercharger control lever (39) mounted at the forward end of the controls box has two positions, S (forward) and M (back). When changing gear the control lever must always be moved smartly and without pause. A red warning light (32) on the instrument panel comes on if S (high) gear is engaged below full throttle height for combat power in M (low) gear.

27. **Carburettor air-intake heat control**

The carburettor air intake heat control (26) moves in a quadrant to the left of the controls box. The quadrant is marked COLD (forward) and WARM (back). The shutter is set to the warm position automatically if the air intake becomes iced up. The control should not be moved into the WARM position manually unless filtered air has been previously selected.

28. **Carburettor air intake filter control**

The carburettor air intake filter control (31) mounted at the forward end of the controls box has two positions, BY-PASSED (forward) and IN CIRCUIT (back).
Prior to Mod. 457 the air filter is automatically brought into operation when the undercarriage is lowered (see para. 13 (ii)).

29. **Engine cooling shutters control**

The engine cooling shutters control lever (41) (marked GILLS) moves in a two position quadrant in the controls box. The quadrant is marked OPEN (forward) and CLOSE (back). No position indicator is fitted, but the shutters, when open, can just be seen from the cockpit.

30. **Fuel cut-off control**

The fuel cut-off control lever (29) is mounted at the forward end of the controls box. The control lever has two positions, RUN (forward) and IDLE CUT-OFF (back).

NOTE.—A "cold start cam" is fitted, and enables the pilot to set the throttle to the correct position for starting without moving the fuel cut-off control to RUN.

31. **Starting controls**

(i) The shielded pushbutton (37) at the bottom of the instrument panel fires the starter cartridge and also operates the booster coil. The ignition switches (17) are above and to the left of the pushbutton.

(ii) The re-indexing control (53) for the Coffman starter is at the bottom right-hand side of the instrument panel and should be pulled out and then returned slowly to index the next cartridge in the breech. A total of five cartridges is contained in the magazine.

COCKPIT EQUIPMENT

32. **Sliding hood**

The sliding hood is opened and closed by means of the crank handle (69) mounted on the right-hand cockpit wall and is automatically locked at each quarter revolution when the crank handle is released. The hood may be released externally by a lever on the port side of the fuselage, marked PRESS & PULL TO RELEASE HOOD, above the foot step.

33. **Cockpit lighting**

(i) Two red floodlights, one on each side of the cockpit, provide illumination for the instrument panel. Both lamps are controlled by a dimmer and switch on the electrical panel.

(ii) An ultra-violet light is mounted beside each red floodlight and is controlled by a dimmer switch on the electrical panel.

(iii) An auxiliary light above the engine controls box is controlled by a dimmer switch (22).

(iv) The light above the compass is controlled by an on—off switch (52).

34. **External lighting**

The recognition, upper identification, navigation, formation and resin lamps are controlled by switches grouped together on the standard control panel (89) on the right-hand side of the cockpit.

35. **Cockpit and windscreen heating and ventilating**

Two finger plates (55) and (56) below the instrument flying panel, when pulled out, admit HOT AIR to the cockpit and windscreen. Before pushing in, the ratchet should be released by lifting the lower edge of the finger plate. An adjustable cold air louvre is fitted on the right-hand side of the cockpit.

36. **Windscreen de-icing**

A windscreen de-icing handpump (10) is fitted at the top right-hand side of the instrument panel for pumping de-icing fluid to a duct in the base of the windscreen frame. The fluid emerges from the duct on to the windscreen in a fine spray through a row of small holes in the top side of the duct. The pump is operated by pressing down the handle which is spring-loaded to return at a pre-set speed according to the setting of the needle valve beside the pump. A catch is provided on the pump body to retain the handle in the depressed position when not in use.

37. **Pilot's seat and headrest**

(i) Adjustment of the pilot's seat for height is effected by the lever (81) to the right of the seat. Further adjustment for individual requirements can be made when the aircraft is on the ground.

(ii) The pilot's headrest may be adjusted in a fore and aft direction and is locked by a draw-pin engaging one of a series of holes in the headrest support tube. The draw-pin is controlled by a lever beside the headrest.

38. **Plotting board**

When Mod. 309 is embodied a plotting board is stowed on the side of the map case (90) to which it is secured by a

spring catch. The board can be fitted on to brackets mounted on the gunsight support tube, and it is supported by two stays which lock over each side-rail of the cockpit.

OPERATIONAL CONTROLS

39. **Guns**

The four 20 mm. guns are fired electrically and the gun-firing control consists of a " wobble " switch (8) mounted on the control column spade grip, the same switch controlling the cine camera, bomb, torpedo or R.P. firing. To fire all four guns the cover plate must be set to FIRE and the top portion of the switch depressed.

40. **Bombs and R.P.**

The master selector switch (21) on the left-hand cockpit wall, above the engine controls box, has three positions : R.P., SAFE and BOMBS. The bomb fusing, distributor and release switches are mounted on a panel on the right-hand side of the cockpit, below the electrical panel.

Prior to Mod. 431 two R.P. distributor switches (66) are mounted together above the electrical panel ; embodiment of the mod. deletes these switches and two salvos of four rockets are released when the selector switch on the left-hand side of the cockpit is set at SALVO.

Bombs or R.P. are released or fired respectively by depressing the lower portion of the " wobble " switch.

41. **Torpedo**

The torpedo director control unit (27) is mounted on the left-hand side of the cockpit.

When carrying a torpedo the centre bomb release switch (85) is used as the master switch and the torpedo is released by depressing the lower portion of the " wobble " switch.

42. **Camera controls**

A G.45 cine camera and an F.46 torpedo camera are fitted. The camera master switch marked OFF and ON, and the camera selector switch marked TORPEDO CAMERA and CAMERA GUN, are mounted together on the electrical panel. When the master switch is ON the camera selected operates simultaneously with the guns or torpedo, but it can be operated independently by depressing the portion of the " wobble " switch (8) marked CAMERA on the safety flap.

Provision is made for fitting on the left-hand side of the cockpit an airspeed recording (Bantam) camera. This is used to photograph the essential flying instruments, and operates simultaneously with the F.46 camera.

PART II
HANDLING

43. **Management of the fuel system** (see paras. 2 and 3)

(i) The fuel transfer cock may be set to AUX. TANK at any time as the float valve prevents the main tank being overfilled.

(ii) If fitted, the drop tanks should be selected early in flight and before the auxiliary tank.

(iii) If Mod. 452 is incorporated the contents of both wing drop tanks are transferred simultaneously, the spare position of the fuel transfer cock then becoming the LIGHT OFF position.

(iv) If Mod. 452 is not incorporated the fuel transfer cock should not be turned to the LIGHT OFF position until all the fuel from the auxiliary and drop tanks has been used.

(v) The booster pump should be on for take-off, landing, when flying at high altitude and at any time should the fuel pressure warning light come on.

44. **Preliminaries**

(i) Before entering the cockpit carry out the usual external checks and ensure that the arrester hook is locked up. Check that the wings are correctly spread and locked by ensuring that the pointers in each wheel-well indicate LATCH PINS IN, and by checking visually through the inspection panels above the upper, and below the lower, latch pins. Check the cockpit hood jettison mechanism by ensuring that the two outer and the centre rail locking plungers are correctly engaged.

(ii) On entering the cockpit check :—

Gun firing button	SAFE
Bombs and R.P. master switch	SAFE
R.A.T.O.G. master switch	OFF
Ignition switches	OFF
Undercarriage selector lever	DOWN
Flaps selector lever	UP
Dive brakes lever	CLOSED
Fuel cut-off control	IDLE CUT-OFF
Main tank booster pump	OFF

NOTE.—The fuel cut-off control must never be set to RUN with the main tank pump ON, unless the engine is running; otherwise, fuel may be injected into the engine and there will be in consequence a serious risk of fire.

(iii) Switch the Ground/flight switch to FLIGHT and check :—
That all electrically-operated instruments register.
All warning lights appear.
Undercarriage green lights on.
Fuel contents.

(iv) Check the operation of the hydraulic handpump, first exhausting the accumulator by lowering and raising the flaps, and then lower and raise the flaps by using the handpump. Check the sliding hood mechanism by closing and opening the hood.

(v) Note the static boost reading (0 lb./sq. in. under "standard atmosphere conditions").

45. Starting the engine and warming up

(i) Set the controls as follows :—

Engine master cock	ON
Throttle	Open to the stop
R.p.m. control lever	Fully forward
Air intake heat control	COLD
Air intake filter control	IN CIRCUIT
Engine cooling shutters	OPEN
Supercharger control	M (low gear)

(ii) Check ignition switches OFF and have the propeller turned through two revolutions by hand to check for hydraulic locks.

(iii) With the fuel cut-off control at IDLE CUT-OFF switch ON the main tank booster pump for approx 30 secs. then switch it OFF again. Move the idle cut-off to the RUN position.

(iv) Turn the priming selector cock to MAIN TANK and operate the priming pump until fuel reaches the priming nozzles, this being indicated by a sudden increase in resistance. Prime with the following number of strokes ;

Air temperature °C.	+30	+20	+10	0	−10	−20
Normal fuel	1	1½	2	3		
High volatility fuel				1	3	6

NOTE.—The number of strokes given above apply when the engine is cold. Less priming will be required when it is warm and when it is hot it is unlikely that any priming will be needed. However, since individual engines differ, the pilot should always discuss the amount of priming required with the ground crew concerned.

Leave the priming plunger out ready for use.

(v) Index the Coffman starter breech. No. 4 Mk. I cartridges should be used. (For new engines use No. 7 Mk. I cartridges).

(vi) Switch ON the ignition and press the starter pushbutton, keeping it pressed as it also operates the booster coil. It may be necessary to continue priming gently until the engine picks up on the carburettor. Under no circumstances pump handle the throttle as this will induce backfires.

NOTE.—A visual all clear signal must be obtained from the ground crew before each cartridge is fired.

(vii) When the engine is running smoothly, screw down the priming pump and return the selector cock to OFF. Switch ON the main tank booster pump.

(viii) Ensure that the oil pressure has steadied, then warm up at approx. 1,200 r.p.m. Switch ON the R.I. compass.

46. **Testing the engine and services**

While warming up :

(i) Check all temperatures and pressures and test the operation of the hydraulic system by lowering and raising the flaps.

(ii) Test each magneto in turn as a precautionary check before increasing power further.

After warming up to 180°C. (cylinder) and 15°C. (oil).

(iii) Open up to the static boost reading observed before starting the engine (0 lb./sq. in. under "standard atmosphere" conditions) and check :—

(a) That the generator is functioning by noting that the power failure warning light is out.

(b) Exercise and check the operation of the constant-speed propeller by moving the control lever over its full range at least twice. Return it fully forward.

(c) That r.p.m. are within 50 of the reference r.p.m. quoted in the form 700, thus verifying that all cylinders are operating.

(d) The operation of the supercharger gear change by changing to high gear, noting the momentary drop in oil pressure and r.p.m. fluctuation.

(e) The correct engagement of the high gear clutches by noting that the static boost reading is maintained and that r.p.m. are 80-100 below those obtained on the power check. Change back to low gear, and ensure that the original conditions are restored.

(f) Test each magneto in turn. If the single ignition drop exceeds 50 r.p.m. but there is no undue rough running the ignition should be checked at higher power, see below.

NOTE.—The following checks, should be carried out after repair, inspection other than daily, when the single ignition drop at the static boost reading exceeds 50 r.p.m. or at the discretion of the pilot. Normally, if the checks above are satisfactory, no useful purpose will be served by a full-power check. When a full power check is made the tail of the aircraft must be securely lashed down.

(g) Open the throttle fully and check take-off boost and r.p.m. This check should be as brief as possible.

(h) Throttle back until the r.p.m. fall just below the take-off figure and test each magneto in turn. If the single ignition drop exceeds 50 r.p.m. the aircraft must not be flown.

(iv) After completing the checks, either at the static boost reading, or at full power, steadily move the throttle to the fully-closed position, and check the minimum idling r.p.m., then open up to between 1,000 and 1,200 r.p.m.

47. **Taxying**

(i) Before taxying ensure that the pneumatic supply pressure is 450 lb./sq. in. If below this figure ensure that the pressure has built up during the ground running of the engine. Check brake pressure 100 lb./sq. in.

(ii) Normally the tail wheel should be UNLOCKED for taxying. Under conditions of high cross wind, however, the tail wheel may be LOCKED to assist the pilot in keeping a straight course. It must, of course, be UNLOCKED before turning.

(iii) Taxying with the wings folded is prohibited.

48. **Check list before take-off**

Trimming tabs	
Elevator	At all loads up to 17,500 lb. and all flap settings— NEUTRAL
Rudder	FULLY LEFT
R.p.m. control lever ...	Fully forward
Fuel	Check contents
Engine master cock ...	ON
Transfer cock	As required
Booster pump	ON
Flaps	UP (fully down for shortest run)
Engine cooling shutters ...	OPEN
Supercharger	M (low gear)
Air intake heat control ...	COLD
Air intake filter control ...	IN CIRCUIT (as required)
Tailwheel	LOCKED. (If this control is not locked before take-off the tail wheel may not retract fully).

49. **Take-off**

(i) The tendency to swing to starboard is easily controlled by the rudder and full power and full flap may be used.

(ii) When comfortably airborne brake the wheels and retract the undercarriage. There is a nose-up change of trim after selecting undercarriage up.

(iii) Move the r.p.m. control lever smoothly back to AUTO before reducing boost. When power has been reduced the engine cooling shutters may be closed.

(iv) The air intake filter control should be set to BY PASSED unless operating in sandy or dust laden conditions.

(v) For a carrier take-off use full flap and an elevator trim setting of neutral. If Mod. 457 is incorporated set the air intake filter control to BY PASSED. Use full power. Raise the flaps at a safe height.

(vi) For a catapult take-off use full flap and trim the elevators and rudder neutral. If Mod. 457 is incorporated set the air intake filter control to BY PASSED. The tail wheel must be LOCKED and the rudder bar held neutral until the aircraft leaves the catapult. A little left rudder is then needed to prevent crabbing. Raise the flaps at a safe height.

50. **R.A.T.O.G.**

(i) Determine the correct firing point from the chart and note the actual position on the take-off run at which the rockets should be fired. It is preferable to fire the rockets slightly late rather than early.

(ii) Check list as for normal take-off ;

Elevator trim tab	Neutral
Flaps	Fully down
Air intake filter control ...	BY PASSED (See para. 49 (v))
R.A.T.O.G. master switch	ON

(iii) The run should be started as for a normal take-off, extra care being taken to keep the aircraft straight.

(iv) When opposite the firing point depress the firing button. The rockets should fire simultaneously or within ½ second of pressing the button ; if they do not do so the take-off should be abandoned.

(v) When clear of the ship and having reached a safe height, raise the flaps to not lower than the 150 knot mark and jettison the rocket carriers at a speed not exceeding 150 knots I.A.S. Then switch OFF and lock the R.A.T.O.G. master switch.

WARNING.—If the take-off is cancelled, make sure that the R.A.T.O.G. master switch is OFF and locked before leaving the cockpit.

51. **Climbing**

(i) The speed for maximum rate of climb is 145 knots I.A.S. from sea level up to 12,000 ft. thereafter reducing speed by 5 knots per 2,000 ft. For ease of control, however, a climbing speed of 160 knots I.A.S. from sea level up to operating height is recommended.

(ii) When climbing at +6 lb./sq. in. boost change to high gear when the boost available in low gear has fallen to +3 lb./sq. in. When climbing at +8½ lb./sq. in. boost change to high gear when the boost available in low gear has fallen to +4½ lb./sq. in.

52. **General flying**

(i) *Stability*

At low cruising speeds and on the climb the aircraft is longitudinally unstable. At all other times stability is satisfactory. When a torpedo is carried longitudinal stability is much improved.

(ii) *Controls*

The ailerons are heavy, except at low speeds, when they are somewhat ineffective. The elevator is light and powerful and must be used with care to avoid inducing large accelerations in steep turns and when pulling out of dives. The rudder also is light and powerful and becomes more sensitive as speed is increased. Violent use of the rudder induces strong changes in lateral and longitudinal trim and care must be exercised in its control.

(iii) *Changes of trim*

Undercarriage up	Initially nose up, finally slightly nose down
Undercarriage down ...	Slightly nose up
Flaps up	Nose down
Flaps down	Strongly nose up
Dive brakes open	Slightly nose down
Dive brakes closed	Slightly nose up

There are marked changes of directional trim with changes of speed and power. These should be countered by accurate use of the rudder trimming tab control.

(iv) *Flying at reduced airspeed*

Set the r.p.m. control lever to give a minimum of 2,000 r.p.m. and lower the flaps to the 220 knot mark. Speed may then be reduced to 120 knots I.A.S. It is unwise to reduce airspeed any lower because aileron control deteriorates noticeably.

(v) *Supercharger gear-changing*

To avoid sludging of the clutch plates, exercising of the supercharger should be carried out if possible once every two hours during flight and in any case prior to landing (see para. 61 (iv)).

53. **Stalling**

(i) The stalling speeds, engine off, in knots I.A.S. are :—

	At normal fighter load 15,150 lb.	With torpedo Max. A.U.Wt. 17,500 lb.
Undercarriage and flaps up	95	100
Undercarriage and flaps down	77	85

(ii) There is little warning of the stall especially with the undercarriage and flaps down. At the stall the aircraft pitches gently and the nose and either wing fall through 10-15 degrees. The aircraft can be held level with the controls but the pitching continues and the aircraft loses height in a heavily stalled glide. Recovery is straightforward and easy. When carrying a torpedo the stall is characterised by a pronounced nose drop which condition is aggravated by any further backward movement of the control column.

(iii) Warning of the approach of a stall in a steep turn is given by a lightening in elevator control forces. Further backward movement of the control column will cause the aircraft to flick out of the turn.

54. **Diving**

(i) The aircraft should normally be trimmed into the dive ; this is important if the dive brakes are to be used. The ailerons become heavier as speed is increased, but the elevators and rudder remain light and effective. In particular, the rudder should be used with care as a sudden movement promotes violent yaw and skid. Care should be exercised in recovery as it is easy to induce large accelerations by misuse of the elevators. When diving with a torpedo and wing drop tanks fitted, there is a tendency for the port wing to drop, which tendency increases until at the limiting speed a considerable stick force is necessary to keep the aircraft laterally level.

(ii) Use of the dive brakes (see para. 63 (vi)).

(a) For maximum diving speeds permitted with the dive brakes extended see para. 63 (iii).

(b) The changes of trim on opening and closing the dive brakes are slight, being nose down and nose up respectively. Some buffeting may be experienced during recovery from a dive with the brakes extended and care should be exercised in using the elevator control. The dive brakes when extended increase the stalling speeds by some 15 knots.

55. **Spinning**

Intentional spinning is prohibited. Should an inadvertent spin occur normal recovery action should be initiated immediately. If the spin develops, the stick forces become excessive and the aircraft should be abandoned.

56. **Aerobatics**

Aerobatics are prohibited, but tactical manœuvres necessary to the torpedo and bombing roles of the aircraft are permitted at weights below 16,700 lb.

57. **Check list before landing**

(i) Reduce speed to below 220 knots I.A.S., lower the flaps to the 220 knot mark and check :—

Main tank booster pump	ON
Pneumatic pressure ...	450 lb./sq. in.
Brake pressure	100 lb./sq. in.
Engine cooling shutters ...	CLOSED
Supercharger	M (low gear)
Air intake heat control ...	COLD
Air intake filter control ...	IN CIRCUIT
Tailwheel	LOCKED

(ii) Reduce speed below 160 knots I.A.S., lower the undercarriage and set the r.p.m. control lever to give 2,400 r.p.m.

(iii) Reduce speed below 130 knots I.A.S., lower the flaps fully and set the r.p.m. control lever fully forward.

58. **Approach and landing**

(i) The recommended final approach speeds in knots I.A.S. for an airfield landing are :—

	At normal fighter load 15,150 lb.
Flaps down, engine on	90
Flaps down, engine off	100
Flaps up, engine on	100
Flaps up, engine off	105

The initial approach should be made at a speed some 10-15 knots higher than the above figures.

NOTE.—Should a landing at a weight in excess of 15,500 lb. be unavoidable in an emergency, the final approach should be made about 5 knots above the speeds quoted.

(ii) It is difficult to make a three-point landing from a glide approach and an engine-assisted approach is therefore recommended.

(iii) Care should be exercised when making flapless landings as :

(a) The view ahead is poor—a curved approach is essential.

(b) Aileron control deteriorates below 110 knots I.A.S. and speed should not be reduced to 100 knots I.A.S. until the airfield boundary has been crossed.

(c) A long landing run is needed.

(iv) For a deck landing lower the arrester hook in the circuit and check by the warning light. Set the air intake filter control to BY PASSED and ensure that the tailwheel is UNLOCKED. The final approach speed is 80 knots I.A.S. and an improved view of the deck is obtained if a curved approach is made. Aileron response is very sluggish below 110 knots I.A.S.

59. **Going round again and mislanding**

(i) The aircraft will climb away, flaps and undercarriage down, at climbing power.

(ii) Open the throttle smoothly to +6 lb./sq. in. boost and raise the undercarriage.

(iii) Climb away at 120 knots I.A.S. and at a safe height raise the flaps, retrimming as required.

60. **After landing**

(i) Before taxying, raise the flaps, switch OFF the fuel booster pump, open the engine cooling shutters and unlock the tailwheel.

On reaching dispersal :

(ii) Open up to 0 lb./sq. in. boost and exercise the supercharger by engaging high gear for 30 seconds and then changing back to low gear. This check is unnecessary if the supercharger has been exercised prior to landing (see para. 52 (v)).

(iii) After the last flight of the day check the ignition at zero boost. If the drop is excessive it should be noted in the Form 700.

(iv) Idle the engine at 1,000 r.p.m. for a short period, then close the throttle and move the cut off control to IDLE CUT OFF.

(v) When the engine has stopped turn OFF the engine master cock and switch OFF the ignition and all electrical services, including the Ground/Flight switch.

PART III

OPERATING DATA

61. **Engine data—Centaurus IX**

(i) Fuel—100/130 grade only.

(ii) Oil—See N.A.M.O. General/S.4.

(iii) Engine limitations :

		R.p.m.	Boost lb./sq. in.	Temp. °C. Cyl.	Oil
MAX. TAKE-OFF TO 1,000 FT.		2,700	+8½	—	—
MAX. CLIMBING I HR. LIMIT	M S	2,400	+6	300	90
MAX. RICH CONTINUOUS	M S	2,400	+6	300	80
MAX. WEAK CONTINUOUS	M S	2,400	+2	300	80
COMBAT 5 MINS LIMIT	M S	2,700	+8½	310	100

OIL PRESSURE (lb./sq. in.) NORMAL ... 100
EMERGENCY MINIMUM ... 80

MINIMUM OIL TEMP. (°C.) FOR TAKE-OFF :—
NORMAL 15
EMERGENCY 5

MAX. CYL. TEMP. (°C.) FOR STOPPING ENGINE 230

(iv) *Supercharger gear changes*

In flight, the supercharger gears must, whenever possible be changed at power not exceeding 0 lb./sq. in. boost and 2,400 r.p.m.

62. **Position error corrections**

From	110	120	140	knots
To	120	140	260	I.A.S.
Add	0	2	4	knots

63. Flying limitations

(i) The aircraft is designed for the duties of a single-seat torpedo bomber. Intentional spinning and aerobatics are prohibited but tactical manœuvres necessary to the torpedo and bombing roles of the aircraft are permitted at weights below 16,700 lb. Care must be taken to avoid inducing large accelerations in steep turns and in the recovery from dives.

(ii) The aircraft is cleared to carry the following stores :—

1—Mk. 15 or Mk. 17 torpedo.
1—2,000 lb. A.P. bomb.
1—1,000 lb. M.C. or G.P. bomb.
2—500 lb. G.P., A.S., L.C., S.A.P. or M.C. bombs.
2—250 lb. G.P., A.S., S.A.P. or M.C. bombs.
2—200 lb. No. 2 Mk. 2 smoke floats.
2—600 lb. clusters.
8—practice bombs.
8—4″ and 4½″ flares.
2—250 lb. Mk. 11 depth charges.
1—Mine A, Mks. 6, 7 or 9.
8—60 lb. head R.P.
12—25 lb. head R.P.
2—45 gallon wing drop tanks.
1—100 gallon fuselage drop tank.

(iii) *Maximum speeds* (*knots I.A.S.*)

(a) *Without external stores*

	Dive brakes	
	Retracted	Extended
From sea level to 8,000 ft.	380	320
From 8,000 ft. to 10,000 ft. ...	365	305
From 10,000 ft. to 15,000 ft	335	275
From 15,000 ft. to 20,000 ft	300	250
From 20,000 ft. to 25,000 ft.	270	225

NOTE.—These speeds are with flaps up. With the flaps partially lowered, speed must not exceed the figures marked on the port flap.

(b) *With external stores*

All R.P., smoke floats and bombs (except the 600 lb. clusters and the 500 lb. M.C. bombs) may be carried and released up to the maximum permissible speeds given in (a) above. The clusters may be carried and released up to a maximum permissible speed of 350 knots, and the 500 lb M.C. bombs may be carried up to the maximum permissible speeds given in (a) above, but must not be released at speeds greater than 230 knots.

The flares may be carried and released up to a speed of 250 knots.

The depth charges may be carried and released up to a speed of 275 knots.

The mines may be carried up to a speed of 230 knots, and released up to a speed of 217 knots.

The torpedo may be carried up to the maximum permissible speeds given in (a) above, except when fitted with a MAT 4 air tail, in which case it is restricted to 320 knots.

(c) *Maximum speed for jettisoning external fuel tanks (full or empty)*

100 gallon fuselage drop tank	...	250 knots I.A.S.
45 gallon wing drop tanks	...	* 300 knots I.A.S.

* Min. speed 145 knots I.A.S.

(d) *Other maximum speed limitations*

For lowering undercarriage	...	160 knots I.A.S.
For lowering flaps fully	...	130 knots I.A.S.
For flying with R.A.T.O.G. rocket-carriers attached	...	150 knots I.A.S.

(iv) The aircraft is cleared for catapult take-off, and for use of R.A.T.O.G. Arrested landings are permitted with or without any of the external stores fitted subject to the landing weight limitation, see sub. para. (vii) below.

(v) *Operational limitations*

(a) The maximum angle of dive permitted when releasing bombs is 70° ; 30° for the 250 lb. depth charges, and straight and level for flares and mines.

(b) Guns must not be fired when bombs are carried on the wing stations as the ejected links and cases damage the bomb fuzes.

(vi) *Use of dive brakes*

The use of dive brakes is restricted to tactical evaluation trials only, and they must not be used when wing tanks are carried.

(vii) *Maximum permissible all-up weights*

Take-off, R.A.T.O., catapulting and gentle manœuvres only	...	16,700 lb.
All permitted forms of flying	...	14,600 lb.
Landing, including arrested landings	...	15,500 lb.

(viii) *Approximate aircraft weights with different stores*

Typical service load (i.e., full internal fuel, ammunition and marine markers)	...	15,400 lb.
Typical service load + 1-100 gallon fuselage drop tank	...	16,400 lb.
Torpedo role (including 2 guns plus ammunition ; auxiliary tank empty)	...	16,700 lb.

64. **Maximum performance**

(i) *Climbing*

The speed for maximum rate of climb is 145 knots I.A.S. from sea level up to 12,000 ft. thereafter reducing speed by 5 knots per 2,000 ft. Change to high gear when the boost in low gear has fallen to +3 lb./sq. in.

(ii) *Combat*

Change to high gear when the boost available in low gear has fallen below +4½ lb./sq. in.

65. **Economical flying**

(i) *Climbing*

Set the throttle to the E.C.B. gate, the r.p.m. control lever to AUTO, and climb at 160 knots I.A.S. Change to high gear when the boost in low gear has fallen to 0 lb./sq. in.

(ii) *Cruising*

(a) The recommended speed for maximum range is 150 knots I.A.S.

(b) With the r.p.m. control lever at AUTO adjust the throttle to maintain the recommended speed, but do not advance it beyond the E.C.B. gate. Always use low gear if, in this gear, the recommended speed can be maintained with the throttle at or behind the E.C.B. gate and the r.p.m. control lever at AUTO.

66. **Fuel capacity and consumptions**

(i) *Fuel capacity*

Main tank	168	gallons
Auxiliary tank	71	gallons
Normal total	239	gallons
Centre drop tank	100	gallons
2 Wing drop tanks (45 gal. each) ...	90	gallons
Overload total	429	gallons

(ii) *Fuel consumptions*

With the r.p.m. control lever at AUTO the approximate fuel consumptions in the rich and weak mixture ranges are :—

	Boost lb./sq. in.	Gallons per hour
Rich	$+8\frac{1}{2}$	275
	+7	240
	+6	210
Weak	+2	82
	+1	66
	0	53
	−1	49
	−2	46

PART IV

EMERGENCIES

67. **Hydraulic system emergency operation**

In the event of failure of the engine-driven pump, the handpump may be used to operate the undercarriage, flaps and torpedo carrier only.

68. **Sliding hood jettisoning**

The sliding hood may be jettisoned in an emergency by pulling the yellow toggle handle mounted below the gunsight.

69. **Drop tank jettisoning**

The 100-gallon drop tank should be jettisoned at a speed not in excess of 250 knots I.A.S. and the 45-gallon wing drop tanks should be jettisoned at a speed not less than 145 knots I.A.S. and not greater than 300 knots I.A.S.

70. **Crash landing**

(i) The cockpit hood should be jettisoned, if possible, and the booster pump switched off.

(ii) Maintain a speed of at least 140 knots I.A.S. while manœuvring with flaps and undercarriage up.

(iii) Do not lower the flaps fully until it is certain that the landing ground or airfield can be reached comfortably.

(iv) Make the final approach in a straight glide at 100 knots I.A.S.

(v) If oil pressure is still available the glide can be lengthened considerably by setting the r.p.m. control lever fully back.

71. **Ditching** (see A.P. 2095)

(i) If ditching is unavoidable :—

(a) Jettison the cockpit hood.

(b) Keep the undercarriage retracted.

(c) Make certain the safety harness is tight and that the R/T plug is disconnected.

(d) Lower the flaps to the " 150 knots " mark to reduce speed as much as possible.

(e) Use the engine, if available, to ensure good control and a touch down in a tail down attitude at as low a forward speed as possible.

(ii) Ditching should be along the swell or into wind if the swell is not steep.

72. **Crash handgrip**

In cases of crash-landing or ditching, additional protection is afforded to the pilot by gripping firmly, with his left hand, the handgrip over his right shoulder.

PART V
ILLUSTRATIONS

KEY TO *Fig.* 1.

1. Altitude indicator.
2. Torpedo depth indicator.
3. Altitude warning lights.
4. Torpedo depth setting 3-way switch.
5. Gunsight skid indicator light.
6. Dive brakes control lever.
7. Hood jettison release handle.
8. Firing switch for guns, bombs. R.P., torpedo and cameras.
9. Gunsight skid indicator light.
10. Windscreen de-icing handpump and regulator.
11. Pneumatic supply and brakes pressure gauge.
12. A.S.V. warning light.
13. Oxygen regulator.
14. Radio " Press-to-talk " switch.
15. Wheel brakes lever.
16. R.I. compass indicator.
17. Ignition switches.

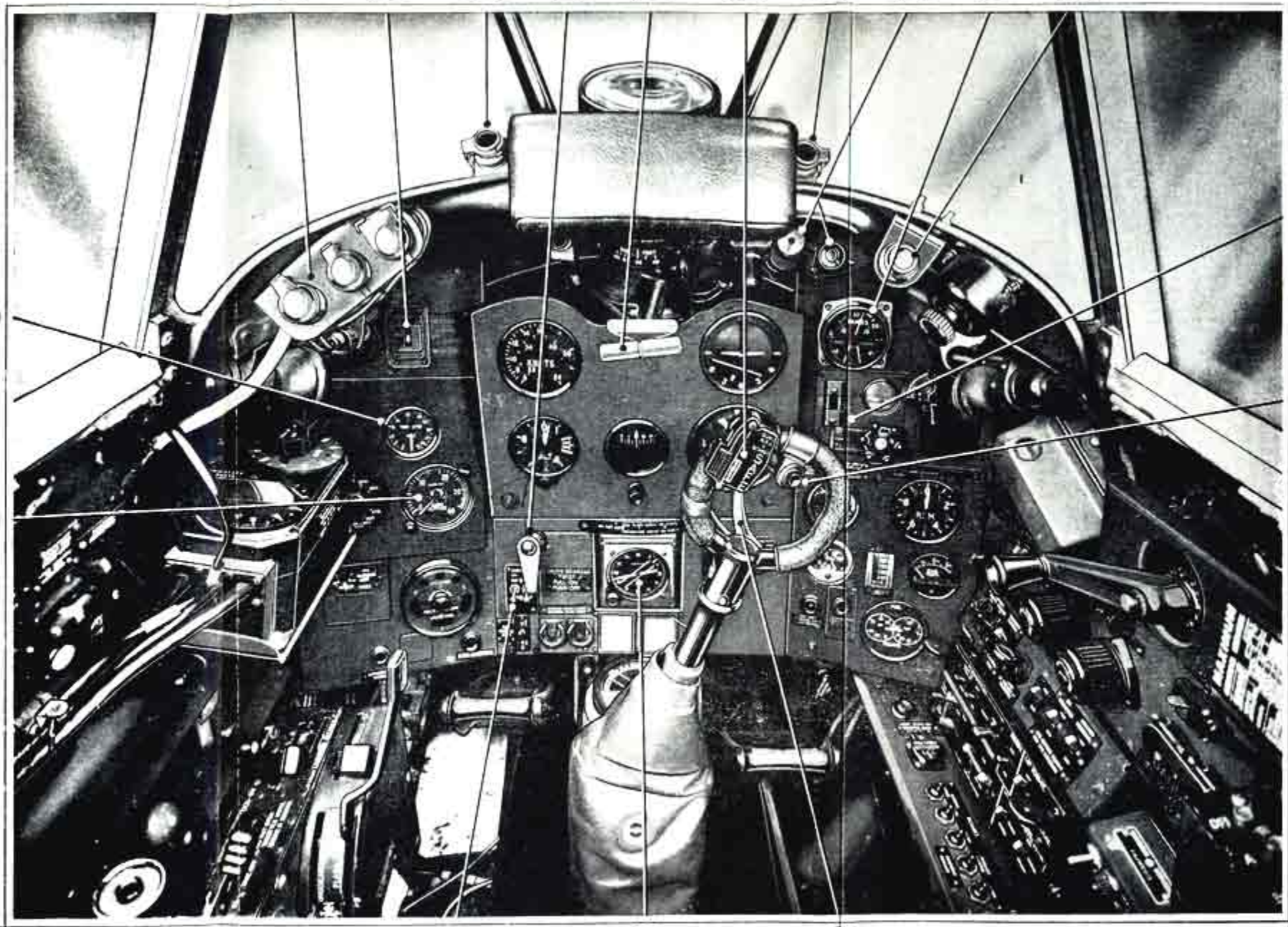


FIG 1

COCKPIT — FRONT VIEW

FIG 1

KEY TO *Fig.* 2.

18. Deck arrester hook control.
19. Stowage for safety harness.
20. ZBX control unit.
21. R.P. Bombs master selector 3-way switch.
22. Auxiliary light switch.
23. R.P. pairs/salvo switch.
24. R.A.T.O.G. master switch.
25. Torpedo director switch.
26. Air-intake heat control.
27. Torpedo director control unit.
28. Altitude limit switch.
29. Fuel cut-off control.
30. Rudder and elevator trimmers indicator.
31. Air-intake filter control.
32. Supercharger warning light.
33. Undercarriage position indicator.
34. Undercarriage warning light.
35. Fuel booster pump switch.
36. Oil dilution pushbutton.
37. Engine starter and booster-coil pushbutton.
38. Flaps control.
39. Supercharger control.
40. Master engine fuel cock.
41. Engine cooling shutters control.
42. Undercarriage safety lock access patch.
43. R.p.m. control lever.
44. Undercarriage control.
45. Engine priming pump.
46. Damper for throttle and r.p.m. control levers.
47. Throttle control.
48. Elevator trimmer control.
49. Tail strut centralising control.
50. Deck arrester hook indicator lamp.
51. Rudder trimmer control.

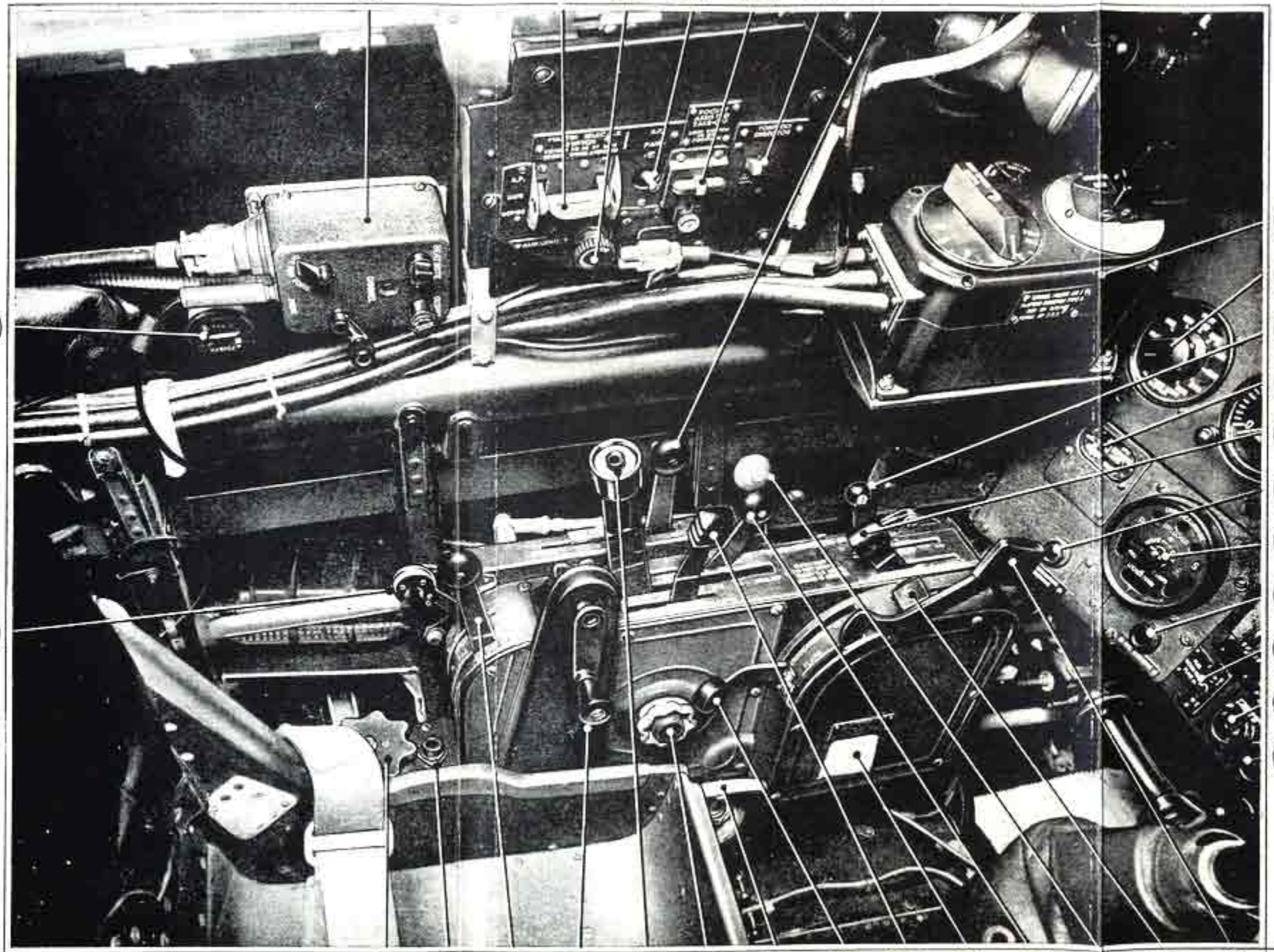


FIG 2

COCKPIT – LEFT HAND SIDE

FIG 2

KEY TO *Fig.* 3.

52. Compass light switch.
53. Cartridge starter re-indexing control.
54. Fuel transfer warning light.
55. Cockpit heating control.
56. Windscreen heating control.
57. Fuel pressure warning light.
58. Fire warning light.
59. Oil temperature gauge.
60. Boost gauge.
61. Oil pressure gauge.
62. Fuel contents gauge.
63. Engine temperature gauge.
64. R.p.m. indicator.
65. Fuel transfer cock.
66. R.P. salvo switches.
67. R.P. auto selector.
68. Power failure warning light.
69. Cockpit hood operating handle.
70. Emergency lighting master switch.
71. R.I. compass switch.
72. Pressure-head heater switch.
73. IFF demolition switches.
74. IFF auxiliary control unit.
75. Radio control unit.
76. IFF control unit.
77. IFF supply socket.
78. Ground/flight switch.
79. A.R.I.5748 D.C. and A.C. control switches.
80. Hydraulic handpump.
81. Seat-raising handle.
82. Bomb distributor switch.
83. Bomb (starboard) selector switch.
84. Signal pistol in stowage.
85. Bomb (centre or torpedo) selector switch.
86. Bomb (port) selector switch.
87. Bomb fuzing (tail) switch.
88. Bomb fuzing (nose) switch.
89. External lighting control panel.
90. Maps case.
91. Wing drop tanks/S.C.I. jettison switch.
92. Magnetic compass.

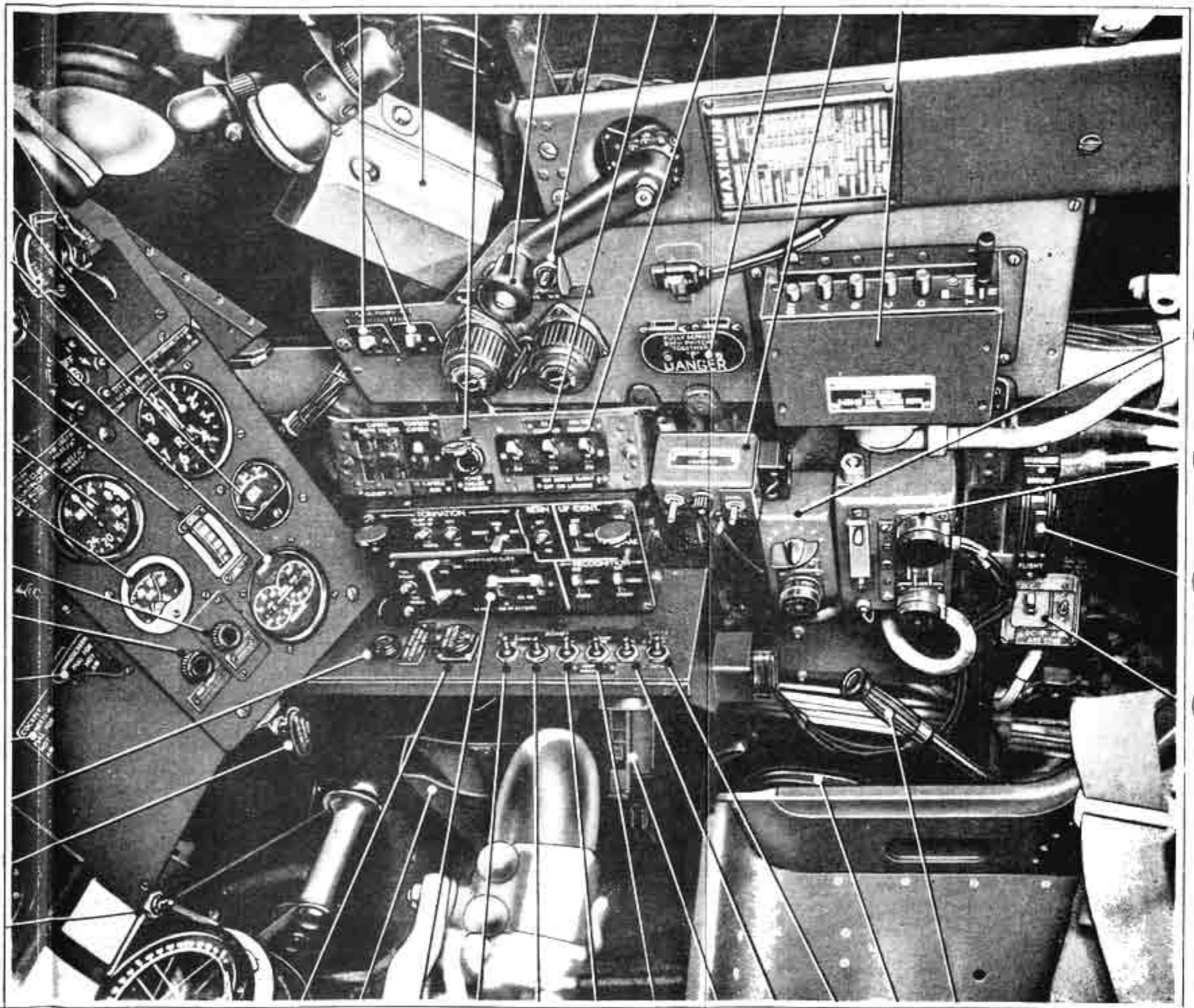


FIG 3

COCKPIT — RIGHT HAND SIDE

FIG 3