

2nd Edition

M. MANDALAY SQUADRON, A.P. 20475—P.N.

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MASTER

PILOT'S NOTES *copy*

FOR

LINCOLN B.2.



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PREPARED BY DIRECTION OF THE MINISTER OF SUPPLY

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PROMULGATED BY ORDER OF THE AIR COUNCIL

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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
1	R.B.D	6-4-60	7		
2			8		
3			9		
4			10		
5			11		
6			12		

NOTES TO USERS

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. A718/48).

Additional copies may be obtained by the station publications officer by application on R.A.F. Form 294A, in duplicate, to Command Headquarters for onward transmission to A.P.F.S. (see A.P. 113). The number of this publication must be quoted in full—A.P. 2847B—P.N.

Comments and suggestions should be forwarded through the usual channels to the Air Ministry (T.F.2).

LINCOLN B.2.

This edition supersedes all previous issues.

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PILOT'S CHECK LIST

(Excluding Checks of Operational Equipment.)

ITEM	CHECK	ITEM	CHECK
External checks.			
N.B.—Start at the entrance door and work clockwise around the aircraft.			
1. Dinghy external release.	Secure.	13. Port fin.	Condition. Leading edge.
2. Tail oleo.	Extension.	14. Port tailplane.	Condition. Leading edge.
3. Tail wheel.	Tyre for cuts and creep. Valve for freedom.	15. Static vent.	Plug removed.
4. Starboard tailplane.	Condition. Leading edge.	16. Port mainplane.	Condition of upper surfaces. Tank cover secure.
5. Starboard fin.	Condition. Leading edge.	17. Port flaps.	Position.
6. Starboard rudder.	Condition. Trimmer. External control lock removed.	18. Port aileron.	Condition. Trimmer. External control lock removed.
7. Starboard elevator.	Condition. Trimmer. External control lock removed.	19. Port identification lights.	Condition.
8. Rear turret.	Locked fore and aft.	20. Port navigation light.	Condition.
9. Rear lights.	Condition.	21. Port mainplane.	Condition of leading edge. Condition of undersurfaces. Landing lamp retracted.
10. External aerials.	Condition.	22. No. 1 engine.	Security of oil tank cover and coolant cap cover. Security of cowings. Condition of propeller and spinner. Oil and coolant leaks.
11. Port elevator.	Condition. Trimmer. External control lock removed.		
12. Port rudder.	Condition. Trimmer. External control lock removed.		

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ITEM	CHECK	ITEM	CHECK
23. No. 2 engine.	Security of oil tank cover and coolant cap cover. Security of cowings. Condition of propeller and spinner. Oil and coolant leaks.	32. Starboard undercarriage.	Fuel servicing cock plates in position. External lock removed. Micro-switches clean and free. Extension of oleo legs. Brake leads secure. Towing shackle secure. Locking ring for creep and wedges in position. Valve free. Tyre for cuts and creep. Chock in position.
24. Port undercarriage.	Distributor tanks drain cock off. Fuel servicing cock plates in position. External lock removed. Micro-switches clean and free. Extension of oleo legs. Brake leads secure. Towing shackles secure. Locking ring for creep and wedges in position. Valve free. Tyre for cuts and creep. Chock in position.	33. No. 3 engine.	Security of oil tank cover and coolant cap cover. Security of cowings. Condition of propeller and spinner. Oil and coolant leaks.
25. Port fuel jettison pipe cover plate.	Pin secure.	34. No. 4 engine.	Security of oil tank cover and coolant cap cover. Security of cowings. Condition of propeller and spinner. Oil and coolant leaks.
26. Hinged leading edge.	Security.	35. Starboard mainplane.	Condition of leading edge. Condition of under-surfaces.
27. Bomb doors.	Condition.	36. Starboard navigation light.	Condition.
28. Pressure head.	Cover removed.	37. Starboard resin lights.	Condition.
29. External fire-extinguishers.	In position.		
30. Starboard fuel jettison pipe cover plate.	Pin secure.		
31. Hinged leading edge.	Security.		

ITEM	CHECK	ITEM	CHECK
38. Starboard aileron.	Condition. Trimmer. External control lock removed.	55. Central escape hatch.	Freedom. Security.
39. Starboard flaps.	Position.	56. Main oxygen supply.	On.
40. Starboard mainplane.	Condition of upper surfaces. Tank covers secure. Ditchy cover secure.	57. Nitrogen system.	On if required.
41. Static vent.	Plug removed.	58. Auxiliary tank cocks.	Off.
42. Dispersal area.	All clear around aircraft.	59. Hydraulic accumulator.	Pressure 220 lb./sq. in.
Internal checks.			
N.B.—Start at the rear of the aircraft and work forward.			
43. Rear turret doors.	Closed.	60. Emergency air supply.	Pressure 1,200 lb./sq. in.
44. Crash axe.	In position.	61. Hydraulic pump selector.	Starboard pump to reservoir.
45. Fire-extinguisher.	In position.	62. Batteries.	Leads secure.
46. Elsan.	Secure.	63. Cross-feed cock.	Freedom. Turn off.
47. First-aid kit.	In position.	64. Cabin heater isolation cock.	Freedom of movement.
48. Dipsticks.	In position.	65. Fire-extinguisher.	In position.
49. Flying control rods.	Free from obstructions.	66. Crash axe.	In position.
50. Trimmer cables.	Free from obstructions.	67. Ground flight switch.	Flight.
51. D.R.C. master unit.	Clear of magnetic interferences.	68. Intercommunication.	On.
52. Loose equipment.	All secured.	69. Electrical panel.	Battery state. Generator failure warning lights.
53. Fire-extinguisher.	In position.	70. Circuit breaker switches.	All pushbuttons in.
54. Turret heating master control.	As required.		

ITEM	CHECK	ITEM	CHECK
71. Fuel gauges.	Contents.	87. Bomb door lever.	Up.
72. Overload tank booster pumps.	Off.	88. Fuel jettison control.	Normal.
73. Navigator's fire-extinguisher.	In position.	89. Fire-extinguisher.	In position.
74. U/c warning horn and light.	Test by push-button.	90. Pilot's call light.	Operation.
75. U/c control lever.	Down. Safety bolt engaged.	91. Auto pilot control cock.	Spin.
76. Radiator shutters.	Automatic.	92. Auto pilot control clutch.	In. Engage controls.
77. Fuel flow-meters.	Set to zero.	93. Windscreen de-icing pump.	Operation.
78. Pressure-head heater.	Test.	94. Magnetic compass.	Serviceability.
79. Booster pumps.	Test.	95. Downward identification light switch.	As required.
80. Main parachute escape hatch.	Operation. Security.	96. External lights master switch.	As required.
81. Fire-extinguisher.	In position.	97. U/c position indicator.	Operation.
82. Portable oxygen bottle.	In position. Full.	98. Altimeter.	Set.
83. Internal control locks.	Remove and stow.	99. Direction indicator.	Cage.
84. Pilot's escape hatch.	Freedom. Security.	100. Pneumatic pressure.	Available pressure. Delivery to each wheel brake.
85. Flying controls.	Full and correct movement.	101. Navigation lights switch.	As required.
Cockpit checks.			
N.B.—Work from left to right and then down centre.			
86. Port D.V. Panel.	Security.	102. Landing lamp.	Operation. Retracted.
		103. Boost cut-out control.	As required.

ITEM	CHECK
104. Nos. 1 and 2 engines master cocks.	Off.
105. Auto pilot control switch.	Off.
106. Ignition switches.	Off.
107. Boost gauges.	Check static reading.
108. Flap indicator.	Check reading against position of flaps.
109. Super-charger switch.	"M" gear.
110. Nos. 3 and 4 engines master cocks.	Off.
111. Air-intake heat control switch.	Cold.
112. Air cleaner control switch.	Air cleaner in.
113. Fuel cut off switches.	Engine on.
114. Identification light switches.	As required.
115. Starboard D.V. panel.	Security.
116. Throttle controls friction adjuster.	Function.
117. R.p.m. control friction adjuster.	Function.
118. Elevator trimmer.	Full and correct movement.
119. Aileron trimmer.	Full and correct movement.
120. Rudder trimmer.	Full and correct movement.
121. Emergency lights switch.	Test.

ITEM	CHECK
122. Pilot's harness.	Adjust. Check lock.
123. Intercommunication.	Adjust headset. Check with crew.
124. Oxygen.	Delivery.
125. Ground/flight switch.	Ground.
126. Entrance ladder.	Stowed.
127. Entrance door.	Locked.
Start and warm up the engine (see para. 54).	
128. Flaps.	Operation.
129. D.R. compass.	On and setting. Synchronise repeaters.
130. Suction.	Test normal and emergency supply.
131. Radio.	Test V.H.F. and other radio aids. Check altimeter setting with control.
132. Direction indicator.	Set with magnetic compass. Check with D.R. compass. Uncage.
133. Radiator shutters.	Open.
Run up the engines (see para. 55).	
134. Generators.	Charging.
135. Fuel flowmeters.	Operation.
136. Pneumatic pressure.	Supply increasing to maximum.
137. Bomb doors.	Closed.
138. Chocks.	Clear.
139. Pressure-head heater.	On if required.

ITEM	CHECK
140. Taxiing.	As soon as possible test brakes. Direction indicator for accuracy. Artificial horizon for accuracy. Check temperatures. Check brake pressure.
Checks before take-off.	
141. Trim—Elevator.	Neutral to 2 divs. nose heavy.
Rudder.	Neutral.
Aileron.	Neutral.
142. Throttle and r.p.m. controls friction adjusters.	Tighten.
143. Air-intake filter control.	Air cleaner in.
144. Air-intake heat control.	Cold air on.
145. Boost control cut-out.	As required.
146. Superchargers.	Low gear.
147. R.p.m. control levers.	Max. r.p.m. position.
148. Fuel.	Contents. Engine master cocks on. Booster pumps on.
149. Flaps.	↓ down.
150. Auto-pilot.	Clutches in. Control cock "Spin."
151. Direction indicator.	Set with magnetic compass. Uncage. Automatic.
152. Radiator shutters.	Automatic.
153. Harness.	Adjusted and locked.
Checks during flight as required.	
154. Auto pilot.	Control cock "Spin."
155. Superchargers.	Low gear.
156. Air-intake filter control.	Air cleaner in.
157. Air-intake heat control.	As required.
158. Fuel.	Contents. Booster pumps on.
Then reduce speed to 140 knots and check:—	
159. Flaps.	↓ down.
160. Undercarriage.	Down and locked.
161. Pneumatic supply.	Pressure sufficient. Delivery to each wheel brake.
162. R.p.m. control levers.	Set as required, 2,850 r.p.m. on final approach.
163. Flaps.	As required on final approach.
164. Harness.	Locked.
After landing—clear runway.	
165. Pneumatic pressure.	Supply.
166. Flaps.	Up. Selector neutral.
167. Radiator shutters.	Open.
168. R.p.m. control levers.	Maximum r.p.m. position.
169. Booster pumps.	Off.

ITEM	CHECK	
170. Pressure-head heater.	Off.	
On reaching dispersal. Run down the engines (see para. 66) and when they have stopped:		
171. Ignition switches.	Off.	
172. Engine master fuel cocks.	Off.	
173. Flaps.	Select down.	
174. Electrical services.	All off.	
175. Chocks.	In position.	
176. Brakes.	Off.	
177. Direction indicator.	Caged.	

ITEM	CHECK	
178. Intercommunication.	Off.	
179. Flying controls.	Locked.	
180. Radiator shutters.	Auto.	
181. Ground/flight switch.	Ground.	
182. Main oxygen supply.	Off.	
183. Nitrogen system.	Off if necessary.	
184. Static vents.	Plugs in.	
185. Pressure-head.	Cover on.	

PART I DESCRIPTIVE

NOTE.—Throughout this publication the following conventions apply:—

- Words in capital letters denote the actual markings on the controls concerned.
- The numbers quoted in brackets after items in the text refer to the illustrations in Part V.
- Unless otherwise stated all speeds quoted are indicated airspeeds.

INTRODUCTION

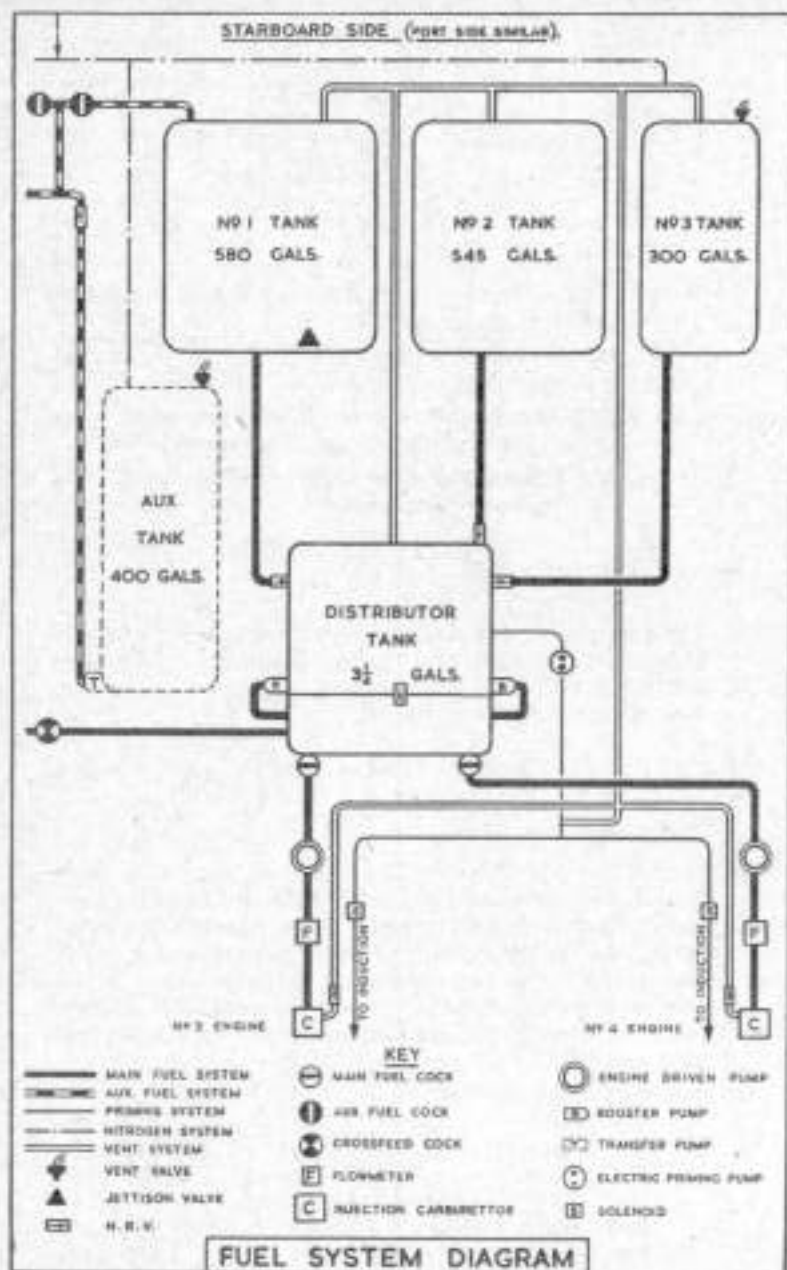
- The Lincoln B.2 is a heavy bomber powered by 4 Merlin 68A engines driving four-bladed, hydromatic propellers and fitted with Bendix Stromberg injection carburettors. The tailwheel is non-retractable.

FUEL, OIL AND COOLANT SYSTEMS

2. Fuel tanks

- Fuel is carried in six permanent self-sealing tanks, three in each wing numbered 1, 2 and 3 outboard from the fuselage. Fuel is fed by gravity to two small distributor tanks, one on the firewall of each inboard power plant, and thence to the two engines on the same side. Normally each group of tanks is used independently but the two distributor tanks are interconnected by a cross-feed pipe and cock.
- The tank capacities are:—

No. 1 tank	...	...	...	580 galls.
No. 2 tank	...	...	...	545 galls.
No. 3 tank	300 galls.
				—
Total (each wing)	1,425 galls.
Total (both wings)	2,850 galls.



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- (iii) Provision is made for the carriage of one or two 400-gallon auxiliary fuel tanks in the bomb bay. Fuel from these tanks may be transferred to either or both No. 1 tanks, the contents only of which are jettisonable.
- (iv) As fuel is used nitrogen can be fed into all tanks, to avoid the risk of an explosion should they be holed by enemy action.
- (v) Any ~~condensation~~ vapour in an injection carburettor is returned via a vapour vent connection to a vapour vent pipe common to the three fuel tanks on each side. This pipe does not vent directly to atmosphere but provision is made for an external vent by means of a separate pipe connected to No. 3 tank. This external vent pipe terminates in three branches each fitted with a nitrogen valve.

3. Fuel cocks

- (i) The four engine master cocks are operated by four levers (26) and (29) mounted two on either side of the control pedestal and controlled by the pilot. There are no tank selector cocks. The cross-feed-cock, which should normally be OFF, is on the cockpit floor just forward of the front spar, the handle being visible through the front spar cover.
- (ii) When auxiliary tanks are carried the two fuel transfer cocks are fitted behind the front spar in the centre of the fuselage.

4. Fuel booster pumps

Two electric fuel booster pumps, each controlled by a switch (77) on the flight engineer's panel, are fitted in each distributor tank. A test pushbutton (76) for each pump is fitted below the appropriate ON-OFF switch. The booster pumps should be used to maintain fuel pressure at altitude and for priming the carburettors before starting. They should also be switched ON during take-off and landing and as recommended in Part II.

5. Auxiliary fuel transfer pumps

An electrical transfer pump is provided in each auxiliary tank, when fitted, to transfer the fuel to the No. 1 tanks. The fuel transfer cocks must be ON before the transfer

PART I—DESCRIPTIVE

pump switches, situated on the fuel contents gauges panel, are switched ON. Test pushbuttons are provided immediately below the switches.

6. Fuel gauges

- (i) Electrical fuel contents gauges are fitted for all tanks except the distributor tanks. These gauges (70) are on the aft panel on the starboard side of the cockpit and indicate whenever the ground/flight switch is turned to FLIGHT and electrical power is available.
- (ii) "Gallons gone" flowmeters (75), which record the quantity of fuel used by each engine, are on the flight engineer's panel on the cockpit starboard wall. They should be set to zero by means of the milled knobs before starting the engines.

7. Fuel pressure warning lights

Four fuel pressure warning lights (59) on the engineer's panel indicate whenever the fuel pressure falls below normal.

8. Fuel jettison control

The control for the jettison valves in the No. 1 tanks is on the cockpit floor to port of the pilot's seat. It is painted red and should be pulled up and turned anti-clockwise to jettison fuel.

9. Nitrogen system

- (i) Nitrogen is carried in 17 bottles, 6 on the starboard side of the fuselage, 4 on the port wall forward of the rear spar and 7 on the forward face of the rear spar. The bottles are charged to a pressure of 1,600 to 2,000 lb./sq. in. via a charging point on the bomb bay starboard wall. The system is controlled by means of a cock on the fuselage starboard wall between the front and rear spars. A pressure gauge is fitted above the control cock.
- (ii) If required the cock should be turned fully on before starting the engines and turned off after landing. In flight pressure gauge readings should be taken at half-hourly intervals. A reading which differs by more than 100 lb./sq. in. from the previous reading indicates faulty

PART I—DESCRIPTIVE

operation of the system and should be reported on landing.

10. Priming pumps

An electric priming pump in each inboard engine nacelle serves both engines on that side. The pumps are controlled by a three-position master switch (65) and four priming pushbuttons (17) on the starboard side of the instrument panel. Two warning lights are mounted immediately above the master switch and when the switch is moved from the central OFF position to either port or starboard the appropriate light indicates that the selected priming pump has been brought into circuit.

11. Oil system

- (i) Each engine has an independent oil system provided by a separate tank in each nacelle. The capacity of each tank is 37½ gallons of oil with 4½ gallons air space. The filler necks of the outboard tanks project outboard and when the aircraft is in a tail down position the correct oil level corresponds with the bottom edge of the filler opening. The filler cap of the inboard tanks is on top of the tanks and a dipstick should always be used when filling to ensure that the airspace is not filled with oil. A drain cock is provided at the base of each tank.
- (ii) A reserve of 2-3 gallons is provided in each tank for feathering the propeller. The constant-speed unit is operated by normal high-pressure oil.
- (iii) Under cruising conditions the engine oil temperature should not exceed 60°C. but temperatures up to 90°C. may be used without damage to the engine. The oil consumption should normally be from 8 to 16 pints per hour.
- (iv) An oil dilution system may be fitted, the pushbutton controls for which are situated on the fuel contents gauges panel.

12. Coolant system

- (i) A mixture of water and glycol the proportions of which vary with climatic conditions is used as coolant. A separate supply for each engine is circulated through a

PART I—DESCRIPTIVE

header tank and radiator. Independent header tanks and radiators are also supplied for the supercharger intercoolers.

- (ii) Pressure in the systems is controlled by thermostatic relief valves in the header tanks and airflow through the radiators is regulated by thermostatically controlled shutters, and electro-pneumatic rams.
- (iii) If it is desired to override the thermostatic control, manual override switches (68) are provided to open the radiator shutter.
- (iv) The coolant systems of the inboard engines are of greater capacity than those of the outboard engines as they are used for the cockpit heating system (see para. 40).

MAIN SERVICES

13. Hydraulic system

- (i) A pump on the No. 2 engine operates the following services through a small accumulator:—
 - Bomb doors
 - Flaps
 - Fuel jettisoning
 - Undercarriage main wheels.A handpump for ground test purposes is fitted on the port side of the fuselage, but owing to its small capacity is unsuitable for use in flight.
- (ii) A second pump is fitted to the No. 3 engine, but should only be used in the event of failure or malfunctioning of the pump on the No. 2 engine. A two-position selector cock, marked STARBOARD PUMP TO RESERVOIR and STARBOARD PUMP DELIVERY is positioned on the forward face of the front spar. The cock should normally be at STARBOARD PUMP TO RESERVOIR but in an emergency when the port pump is not working it should be set to STARBOARD PUMP DELIVERY. The hydraulic accumulator will then be charged by the starboard pump.
NOTE.—The cock should *not* be left at STARBOARD PUMP DELIVERY when the port pump is functioning, otherwise the operation of the flaps will be much too fast and erratic.
- (iii) The hydraulic accumulator should be charged with air,

PART I—DESCRIPTIVE

via an air charging valve, to a pressure of 220 lb./sq. in. When the engines are not running and the hydraulic pressure is exhausted this air pressure will be indicated on a gauge on the aft port side of the front spar. When the engines are running pressure builds up to a gauge reading of 800-850 lb./sq. in. at which pressure an automatic cut-out operates and the hydraulic idling circuit is brought into use. When any circuit is selected the accumulator supplies the initial pressure to the pistons of the jacks. When the pressure drops to 500 lb./sq. in. the cut-out again operates and directs fluid from the hydraulic pump to the circuit then functioning. When the operation is completed the pump again builds up pressure in the accumulator to 800/850 lb./sq. in. when the idling circuit re-commences.

14. Pneumatic system

- (i) A compressor driven by No. 3 engine charges an air bottle to 450 lb./sq. in. for the operation of the:—
 - Wheel brakes
 - Radiator shutters electro-pneumatic rams
 - Fuel cut-off controls
 - Air-intake controls
 - Air-filter controls
- (ii) The pressure is controlled by a regulating valve which permits recharging when the pressure drops to 390-410 lb./sq. in. If the pressure in the air bottle falls below 160 lb./sq. in. a pressure maintaining valve closes, rendering the entire pneumatic system inoperative except for the wheel brakes. ~~Should this occur low gear will automatically be engaged and it will not be possible to operate the controls listed in (i) above until the pressure builds up.~~
- (iii) If it is impossible to stop the engines with the fuel cut-off controls, close the throttles and stop the engines by turning off the engine master cocks. This will drain the carburettors, which should be carefully primed to expel all air from the fuel chambers before restarting.
- (iv) A compressor driven by No. 2 engine operates the Mk. 8 Automatic Pilot. *and MK 14 Bomb sight, if fitted.*

15. Vacuum system

Three vacuum pumps are fitted, two connected to one pipeline, on No. 2 engine and one on No. 3 engine. When

PART I—DESCRIPTIVE

the vacuum changeover cock (19) is at NORMAL the No. 3 engine vacuum pump operates the flying instruments and the No. 2 engine pumps operate the Mk. 14 bombsight, the computer unit and other special equipment when carried. When the change-over cock is set to EMERGENCY the No. 2 engine pumps operate the flying instruments. The vacuum gauge (18) is connected to the pipeline feeding the instrument flying panel.

16. Electrical system

- (i) Two 6,000 watt generators, one driven by No. 2 engine and one by No. 3 engine charge 4, 12 volt 40 ampere hour aircraft batteries connected in series-parallel giving a capacity of 80 ampere hours at 24 volts, and supply the usual lighting and other services including:—

Automatic pilot
Bomb distributor heating
Bomb fusing and release
Bomb slip heating
Camera
Dinghy release
D.R. compass
Electro-pneumatic rams for the:—
Radiator shutters
Fuel cut-off controls
Air-intake heat controls
Air-intake filter controls
Engine priming and starting
Engine instruments
Fire-extinguishers
Flaps position indicator
Flare chute
Fuel booster and transfer pumps
Fuel contents and flowmeter gauges
Oil dilution
Propeller feathering
Radio and radar
Superchargers gear change
Turrets
Undercarriage position indicator

- (ii) The voltmeter on the main electrical control panel should normally read 28-29 volts in flight and over 24 volts on the ground with the engines stopped.
- (iii) A ground starter battery socket is mounted on the star-

PART I—DESCRIPTIVE

board side of the fuselage above the aft end of the bomb doors.

- (iv) The ground/flight switch is on a panel on the starboard side of the fuselage between the spars and connects all electrical services to the aircraft batteries when set to FLIGHT.
- (v) All electrical circuits are protected by circuit breakers. The generator field circuit breakers are mounted together with an emergency master switch, generator failure warning lights and a voltmeter on the panel on the starboard side of the fuselage forward of the front spar. The remaining circuit breakers, which are not labelled to show the circuit they protect, are mounted on a panel above the ground/flight switch. Fuses associated with these latter circuit breakers are mounted in three banks, one on the fuselage starboard side forward of the front spar, one on the fuselage port side between the entrance door and the mid upper turret and the third on the cockpit starboard wall. A wait of 30 seconds should be allowed before resetting any circuit breaker to enable the defective circuit to cool.
- (vi) Should a generator failure warning light indicate that the generator is not charging, check that the circuit breaker is in. If not it should be reset. In the event of it springing out again nothing further can be done in flight. If failure is indicated with the circuit breaker in, switch ON the emergency master switch and reset the pushbutton. Should the generator still not function, switch OFF the emergency master switch. When radar equipment is carried a further two 6 kilowatt generators driven by Nos. 1 and 4 engines also charge the batteries. The radar equipment is then supplied with current by two Type 4 motor generators, installed inside the aircraft, and driven by the main batteries.

AIRCRAFT CONTROLS

17. Flying controls

The flying controls are conventional. The rudder pedals may be adjusted for reach after releasing the spring locking catch at each side of the pedal. The pedals may then be raised and moved forward or aft over the spring-loaded ratchet mechanism.

18. Flying controls locking gear

- (i) External locking clamps are provided for all external control surfaces.
- (ii) Internal locking of the controls is provided for by means of:—
 - (a) A strut which fits to the top of the pilot's seat and to a bracket on the control column.
 - (b) A strut which fastens to the cockpit port rail and is secured by two screwed hooks to the handwheel to prevent its rotation.
 - (c) A T-tube, the transverse member of which fits into the hollow footrest of each rudder pedal and the other end to a bracket on the control column.

19. Trimming tab controls

The elevator (56), rudder (55) and aileron (54) trimming tab controls are mounted, together with their respective indicators, on the right of the pilot's seat. They all operate in the natural sense.

20. Wheel brakes

The brake-lever (4) is on the control column handwheel with a parking catch situated immediately above. Differential braking is provided by means of a relay valve connected to the rudder pedals. The available pressure in the main air supply 450 lb./sq. in. max. and at each wheel brake 125 lb./sq. in. max. is shown on the triple pressure gauge (43).

21. Undercarriage control

- (i) The undercarriage control lever (58) is locked in the DOWN position by means of a safety locking bolt (57) which must be pulled out in order to raise the lever. The bolt engages automatically when the lever is moved to DOWN.
- (ii) In emergency, the undercarriage may be lowered by the compressed air system.

WARNING :—No automatic lock, other than the safety bolt, is fitted to prevent inadvertent operation of the undercarriage when the aircraft is on the ground.

22. Undercarriage position indicator

The standard electrical visual indicator (41) on the lower port side of the instrument panel shows the position of the undercarriage at all times when the ground/flight switch is set to FLIGHT. It indicates as follows:—

Two green lights ...	Main wheels locked DOWN
Two red lights ...	Main wheels unlocked
No lights ...	Main wheels locked UP

23. Undercarriage warning horn and light

If either No. 2 or No. 3 engine throttle lever is less than $\frac{1}{2}$ open whenever the undercarriage is not locked DOWN a warning horn sounds. A test push switch and red light are provided on the cockpit port wall behind the pilot's seat to test the audible warning.

24. Flaps control

- (i) The flaps selector is a push-pull control (53) to starboard of the pilot's seat and has three positions UP, neutral and DOWN. When partial flap is required the control should be operated until the desired position is reached and then returned to the neutral position.
- (ii) In an emergency the flaps can be lowered by the compressed air system.

25. Flaps position indicator

The flaps position indicator (28) on the bottom centre of the instrument panel indicates whenever the ground/flight switch is at FLIGHT.

26. Automatic pilot

- (i) A Mk. 8 automatic pilot is fitted. The clutch lever (40) and control cock (39) are mounted above the P4 compass, the pitch control (1) is on the cockpit port wall and the control switch (10) is mounted above the D.R. compass repeater. Operation is normal, except that a stop is incorporated to prevent the control cock being moved from the SPIN to the OUT position; this is to avoid damaging the Mk. 14 bombsight.
- (ii) The Mk. 8 auto pilot and the Mk. 14 bombsight can be used simultaneously.

ENGINE CONTROLS

27. Throttle controls

The throttle levers are grouped on the central control pedestal. They are gated at the climbing boost position and should be pushed fully forward through the gate to obtain take-off and operational necessity conditions. Mixture control is entirely automatic, economical mixture strengths being obtained at power settings which give +7 lb./sq. in. boost 2,650 r.p.m. and below.

28. R.P.M. controls

- (i) The r.p.m. control levers (49) are below the throttle levers on the central control pedestal and move upwards from the DECREASE REVS. position to INCREASE REVS. Four feathering pushbuttons (60) are on the lower starboard side of the instrument panel.
- (ii) Before feathering action can be taken the r.p.m. control lever must be pushed down through the gate at the bottom of the quadrant.

29. Friction controls

Two friction controls are fitted on the starboard side of the control pedestal, the upper one being for the throttle levers and the lower one for the r.p.m. control levers.

30. Superchargers control switch

- (i) The superchargers control switch (13) is mounted on the instrument panel beside the ignition switches, together with four warning lights and a test pushbutton. The switch has two positions, AUTO when down and M.S. when up.

(ii) When set to M.S. the superchargers remain in low gear at all altitudes. When set to AUTO the gear change selection is controlled by an aneroid and high gear will automatically be engaged at approximately 11,000 ft. when climbing. This height is the correct supercharger gear change height only when using maximum power (operational necessity). When using lower power settings the selection of high gear should be carried out by switching to AUTO as recommended in para. 57. When descending in AUTO, low gear will be engaged at a slightly lower altitude than that quoted above. Failure of the electrical system will cause the superchargers to remain in, or return to, low gear. The warning lights indicate whenever high gear is engaged.

- (iii) If it is desired to cruise in low gear at heights above 11,000 ft. the switch should be set to M.S.

- (iv) The pushbutton, which overrides the superchargers altitude switch, should be depressed in order to test the gear change when the aircraft is on the ground.

31. Automatic boost control cut-out

With the automatic boost control cut-out, which is situated next to the No. 1 engine master cock, in the up position climbing boost is obtained with the throttles at the gate, and +18 lb./sq. in. boost with them fully forward. With this control in the down position, +21 lb./sq. in. boost is obtained with the throttles at the gate and also in the fully forward position.

32. Radiator shutters controls

- (i) The two position radiator shutters, are thermostatically controlled whenever the switches (68) on the flight engineer's panel on the cockpit starboard wall are in the up position. In this condition the shutters will open fully when the coolant temperature reaches 115°C and close again when the temperature falls to 109°C.
- (ii) When the switches are in the down position the thermostatic controls are overridden and the shutters are fully opened. This condition should be always be used for all ground running and taxiing.
- (iii) When the aircraft is parked, the shutters should be left in the AUTOMATIC position. If left in the OPEN position they will close when the electrical current is switched off, and open when it is switched on again with a consequent waste of pneumatic pressure.

33. Air-intake heat control

The hot and cold air-intake shutters are operated by electro-pneumatic rams and are controlled by a two position switch (24) as follows:—

Up —HOT AIR OFF, COLD AIR ON
Down—HOT AIR ON, COLD AIR OFF

On early aircraft these controls although fitted, are inoperative.

34. Air-intake filters control

- (i) The filters are electro-pneumatically controlled, and are connected to micro switches on the undercarriage.

PART I—DESCRIPTIVE

*When the two position control switch (25) is at AIR CLEANER OUT the filter position is automatically switched from IN to OUT on the retraction of the undercarriage. It is, therefore, recommended that take-offs be made with AIR CLEANER IN and manual selection to OUT be made at circuit height.

The switch operates as follows :—

Switch position	Undercarriage position	Filter position
AIR CLEANER IN	Down	IN
AIR CLEANER IN	Up	IN
AIR CLEANER OUT	Down	IN*
AIR CLEANER OUT	Up	OUT

- (ii) The filters are spring loaded to the IN position. In the event of electrical or pneumatic failure, or if the pneumatic pressure is less than 160 lb./sq. in. they will be held, at that position irrespective of the selection made.

35. Charge temperature thermometer

A charge temperature thermometer (22) is fitted above the feathering pushbuttons with an adjacent selector switch (20) enabling relevant engine selection. After checking the charge temperature the switch should be returned to OFF. If the charge temperature falls below 45°C. plug leading may result (see para. 61 (vii)).

36. Fuel cut-off controls

- (i) The fuel cut-offs which are used for stopping the engines are operated by electro-pneumatic rams controlled by four two-positioned switches (14). The switches, which are spring loaded and protected by a guard rail, are on the starboard side of the instrument panel above the starter pushbuttons.
- (ii) The two positions are IDLE CUT-OFF and ENGINE ON and when the IDLE CUT-OFF position is required the switches must be held down.

WARNING.—The control switches must always be at IDLE CUT-OFF, or the engine master fuel cocks OFF, before switching on the fuel booster pumps when the engines are stationary.

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37. Engine starter and booster-coil pushbuttons

Four starter (15) and four booster-coil (16) pushbuttons are mounted below the fuel cut-off control switches on the starboard side of the instrument panel.

38. Ignition switches

Four pairs of ignition switches (12) are mounted on the top centre of the instrument panel.

COCKPIT EQUIPMENT

39. Pilots' seats

- (i) The first pilot's seat, on the port side of the cockpit, has an armour plated back and hinged armrests and is adjustable for height by means of a lever on the port side of the cockpit. To adjust the height the knob at the top of the lever should be depressed and the lever then works in the natural sense. The safety harness release (36) is situated on the starboard armrest.
- (ii) The second pilot's seat is on the starboard side of the cockpit. It is collapsible and when not in use may be folded back against the starboard wall. The footrest is tubular and when not in use it may be slid under the pilot's floor. On aircraft not equipped with dual control the backrest is a canvas webbing strap attached at one end to the cockpit starboard wall and by an attachment at the other end to the first pilot's seat. When dual control is fitted the canvas strap is replaced by a rigid backrest supported by a telescopic stay; when not in use the backrest assembly may be folded back to the cockpit starboard wall.

40. Cockpit heating

- (i) Hot air from a radiator connected to the No. 3 engine coolant system heats the nose and cockpit of the aircraft, the quantity of heat being controlled by a knob behind a sliding panel just forward of the front spar on the starboard side. The knob should be turned anti-clockwise to admit hot air. To assist circulation an adjustable extrac-

tor louvre is provided on the port side of the fuselage nose.

- (ii) A similar system connected to No. 2 engine coolant system heats the dorsal and tail turret positions. The controls are in the following positions:

- (a) Main control—Starboard side of fuselage on heater matrix.
- (b) Mid upper turret—Starboard side of H2S scanner unit.
- (c) Rear turret—Outside turret doors.

41. Oxygen system

The pilot's flexible oxygen pipe (35) is secured by spring clips to the cockpit port rail. A regulator (63) which controls the supply throughout the aircraft is on the starboard side of the instrument panel. A portable oxygen bottle is fitted in a stowage (33) at the rear of the pilot's seat, and at each crew station. A high-pressure, cut-off valve is provided at the front of the crate of cylinders in the fuselage centre section.

42. Windscreen de-icing

Two de-icing sprays for the windscreen are operated by a handpump (51) on the floor forward and to port of the pilot's seat. The fluid is carried in a 4-gallon reservoir fitted below the step at the rear of the nose, and is also used for the bomb-aimer's de-icing spray. Clear vision panels are fitted, one on each side of the windscreen. They open inwards.

43. Pressure-head heater switch

The switch (61) and a test pushbutton (62) interconnected with an ammeter (67) are on the port side of the flight engineer's panel.

44. Cockpit lighting

(i) Ultra violet and red lamps

The Dual system of red and ultra violet lamps is installed, the lamps being mounted in pairs and controlled by on/off dimmer switches on the cockpit roof panel.

(ii) Emergency lamp

The single emergency lamp is controlled by an on/off switch (31) on a bracket attached to the control column. The power is supplied by a separate battery.

(iii) P.4. compass lamp

The lamp over the P.4 compass is controlled by an on/off dimmer switch immediately above the compass.

(iv) D.R. compass repeater lamp

The lamp above the D.R. compass repeater is controlled by an on/off dimmer switch adjacent to the repeater.

on the cockpit roof panel.

45. Call lights

Call light boxes, incorporating an indicating light and pushbutton, are fitted at all crew stations. That (2) for the pilot is mounted on the cockpit port wall.

46. External lighting

All external lights are under the control of one master switch (32) fitted at the bottom of the pilot's instrument panel. A warning light adjacent to the switch indicates when the master switch is ON. The following external lighting services are fitted:—

(i) Navigation lights

The navigation lights are controlled by a 3-position OFF—DIM—BRIGHT switch (44), at the bottom of the instrument flying panel.

(ii) Resin lights

The wing resin lights are controlled by an on/off switch to the left of the navigation lights switch. The colour selection switch is on a panel on the starboard side forward of the front spar.

(iii) Identification lights

The identification lights are controlled by a combined switchbox and signalling key. The colour selection is made through a three position switch (3) above the external lights master switch.

(iv) Headlight

A headlight situated in the underside of the fuselage nose

PART I—DESCRIPTIVE

is controlled by a switch on the electrical panel on the starboard side. The switch has three positions OFF—STEADY and MORSE. When set to MORSE signalling may be carried out by means of the identification lights signalling key.

(v) *Glider tug lights*

The twin lights in the tail of the aircraft are controllable by an on/off switch (30) to the right of the landing lamp switch on the instrument panel.

(vi) *Landing lamp*

The angle of the landing lamp in the port wing is controlled by a three-position selector switch, to the left of the glider tug lights switch. It has three positions OFF, LOW and HIGH. The lamp is switched on automatically during its downward and off during its upward travel.

NAVIGATION AND OPERATIONAL EQUIPMENT

47. **Compasses**

(i) *D.R. compass*

The D.R. compass master unit is situated on the starboard side of the fuselage forward of the main entrance door. A repeater (11) is situated above the pilot's instrument panel.

(ii) *P.4. compass*

The P.4 compass is situated near the bottom left-hand corner of the instrument panel.

48. **Radio and radar controls**

(i) *TR. 1143A*

The control unit for the V.H.F. equipment is mounted on the cockpit port wall alongside the pilot's seat. A press-to-transmit pushbutton (5) is on the control column hand-wheel.

(ii) *Intercommunication*

An intercommunication system, powered by a separate battery, under the control of the radio operator, provides

FINAL CHECKS FOR TAKE-OFF

TRIM ... ELEVATOR: NEUTRAL
TO 2 DIV. NOSE HEAVY
RUDDER: NEUTRAL
AILERON: NEUTRAL

SUPER-
CHARGERS ... LOW GEAR

AIR INTAKE
HEAT ... COLD AIR ON

AIR INTAKE
FILTER ... FILTER IN

PROPS ... MAX. R.P.M.

FUEL ... CONTENTS
MASTER COCKS: ON
BOOSTER PUMPS: ON

FLAPS ... $\frac{1}{3}$ DOWN

AUTO PILOT ... CLUTCH: IN
CONTROL COCK: SPIN

FINAL CHECKS FOR LANDING

FUEL ... CONTENTS
BOOSTER PUMPS: ON

FLAPS ... $\frac{1}{3}$ DOWN
AS REQUIRED ON FINAL

PROPS ... AS REQUIRED
2,850 R.P.M. ON FINAL

WHEELS ... DOWN AND LOCKED

BRAKES ... OFF
CHECK PRESSURES

PART I—DESCRIPTIVE

intercommunication facilities between all crew members. Mic/tel. sockets are installed at all crew stations.

(iii) *A.R.I. 5025 or 5131*

The I.F.F. control unit is at the radio operator's station but a distress switch (37) under the pilot's control is mounted on the cockpit port wall.

49. Bomb doors control

- (i) The control lever (34) to port of the pilot's seat has two positions only, CLOSED in the up position and OPEN in the down position. When the doors are closed the bomb release system is inoperative but it is rendered operative soon after the doors begin to open and before they are fully open. It is, therefore, necessary to check the position of the bomb doors visually before releasing bombs.
- (ii) If necessary the bomb doors should be opened before stopping the engines, as otherwise considerable effort will be necessary to operate the doors by means of the handpump.

50. Bomb release and jettison controls

- (i) The pilot's bomb release pushbutton is mounted in the top of the left-hand side of the control column hand-wheel.
- (ii) The containers jettison pushbutton (66) and bomb jettison handle (64) are mounted together on the upper starboard corner of the instrument panel.
- (iii) A bomb aiming warning light (7) above the instrument flying panel indicates when the aircraft is not steady on its bombing run. It is connected to the Mk.2A bomb-sight sighting head.

51. Camera warning light

A warning light (6) also mounted above the instrument flying panel indicates in a manner similar to the bomb aiming warning light when photographic work is being carried out.

52. **Glider release**

The control handle (52), when fitted, just forward of the flaps selector control should be pulled up to cast off the glider at the desired point.

PART II HANDLING

53. **Management of the fuel system**(i) *Testing the electrical fuel booster and fuel transfer pumps*

Before starting the engines each booster pump should be tested as follows:—

- (a) The master engine cocks must be kept OFF. (Alternatively the fuel cut-off switches must be held in the IDLE CUT-OFF position, and the pneumatic pressure must be above 160 lb./sq. in.)
- (b) The pump switch should be OFF
- (c) Press the test pushbutton for each pump in turn and check the ammeter reading. This should be steady at between 4 and 7 amps.

(ii) *Use of the booster pumps*

All four booster pumps must be switched on for take-off and for landing, but they may be switched off during flight. They should, however, be switched on at any sign of fuel starvation.

WARNING:—The booster pumps must never be switched on when the engines are not running unless all master cocks are OFF (or the fuel cut-off switches are held in the IDLE CUT-OFF position, and the pneumatic pressure is above 160 lb./sq. in.).

(iii) *Use of the tanks*

The three tanks in each wing feed by gravity into the fuel distributor tank on that side. Because of their positions in the wing No. 3 tank will empty before No. 2 tank, and No. 2 tank will empty before No. 1 tank. When the auxiliary fuel tanks are carried in the bomb bay, their contents may be transferred into either or both No. 1 wing tanks when there is space available, by switching

on their transfer pumps, and turning on the auxiliary tank cocks. It is advisable to transfer fuel from the auxiliary tanks 100 gallons at a time as space becomes available in the No. 1 tanks rather than wait until there is sufficient space in the No. 1 tanks to transfer all the auxiliary tank fuel. Care must be taken, however, to ensure that the No. 1 tanks are never overfilled.

(iv) *Use of the cross-feed line and cock*

The cross-feed cock should normally be kept closed, unless it becomes necessary in an emergency to feed fuel from the tanks in one wing to the engines in the other wing. In these circumstances the booster pumps in the distributor tank being used should be switched on.

54. Starting the engines and warming up

- (i) After carrying out the external, internal and cockpit checks laid down in the pilot's check list, ensure:—

Booster pumps	...	...	OFF
Engine master cocks	...	...	ON
Fuel cut-off switches	...	...	ENGINE ON
Throttles	...	...	1 in. open
R.P.M. control levers	...	...	Max. r.p.m. position
Superchargers	...	...	Low gear
Air intake control	...	...	COLD AIR ON
Radiator shutters	...	...	AUTO

- (ii) If the engines are to be started from an external source, set the ground/flight switch to GROUND and have a starter battery plugged in.
- (iii) Prime the carburettors of both engines on the same side by holding down the fuel cut-off switches in the "engine off" position and switching on the booster pump on that side for 10 seconds. Then switch off the booster pumps and release the fuel cut-off switches.
- (iv) Turn the priming pump master switch to the appropriate position and then for each engine in turn:—

Press the priming pushbutton for two seconds if the engine is cold. Switch on the ignition, then press the starter pushbutton and after a short pause the booster-coil pushbutton. As the engine fires keep the booster-coil pushbutton depressed and give short burst of priming until the engine is running smoothly.

- (v) When the engine is warm, little or no priming should be required, but individual engines may differ in this respect.
- (vi) When the engine is running satisfactorily, release the booster-coil pushbutton. When all engines are running satisfactorily, switch off the priming pump master switch.
- (vii) Ensure that the ground/flight switch is turned to FLIGHT and have the external battery removed if used.
- (viii) Open up each engine slowly to 1,200 r.p.m. and warm up at this speed.
- (ix) While warming up carry out the checks detailed in the Pilot's Check List, items 128 to 133.

55. Exercising and testing

- (i) After warming up until the oil temperature is +15°C, and the coolant temperature is +40°C, switch the radiator shutters to OPEN and test each magneto as a precautionary check before increasing power further. The fuel booster pumps should be kept off in order to check the operation of the engine-driven pumps. Then for each engine:—
- (ii) Open up to the static boost reading (0 lb./sq. in. under standard atmosphere sea level conditions) and check the operation of the superchargers, by pressing and holding the test pushbutton. As high gear is engaged, r.p.m. should fall and boost should rise slightly, and the appropriate warning light should come on, and remain on until the pushbutton is released.
- (iii) At the same boost exercise and check the operation of the constant-speed unit by moving the r.p.m. control lever slowly over its full governing range.
- (iv) At the same boost test each magneto in turn. If the single ignition drop exceeds 200 r.p.m. but there is no undue vibration, the ignition should be checked at higher power (see (vi)); if there is marked vibration the engine should be shut down and the cause investigated.
- (v) The full power check should be carried out after repair, inspection other than daily, when the single-ignition drop at the static boost reading exceeds 200 r.p.m., or at the discretion of the pilot. Except in these circumstances, if the checks above are satisfactory no useful purpose will be served by a full power check.

PART II—HANDLING

- (vi) The full power check should be carried out as follows:—
Set the boost cut-out control to the down position. Open the throttle to the gate and check take-off boost (+21 lb./sq. in.) and r.p.m. (3,000). Move the throttle fully forward and then set the cut-out to the up position. Check that the boost falls to +18 lb./sq. in.
- (vii) Throttle back until a fall in r.p.m. indicates that the propeller is not constant speeding and then test each magneto in turn. If the single-ignition drop exceeds 200 r.p.m. the aircraft should not be flown.
- (viii) 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.
- (ix) Before taxiing, carry out the checks detailed in the Pilot's Check List, items 134 to 140.

56. Take-off

- (i) After carrying out the checks laid down in the Pilot's Check List, items 141 to 153, align the aircraft carefully on the runway making certain that the tailwheel is straight.
- (ii) Clear the engines by opening up to the static boost reading if the run-up has not immediately preceded the take-off.
- (iii) If full power is likely to be required, the boost cut-out should be set to the down position before the take-off is commenced. In this event the throttles should be moved through the gate even though the boost will be the same as that obtained at the gate.
- (iv) Release the brakes gently and open the throttles slowly to the take-off boost required. Keep straight by use of the rudders and by differential throttle movement.
- (v) As speed is gained and the rudders become effective ease the control column forward to raise the tail.
- (vi) Ease the aircraft off the ground at the following speeds:—

All up weight	Knots
65,000 lb.	100—105
75,000 lb.	105—110
82,000 lb.	110—115

- (vii) When comfortably airborne, brake the wheels and retract the undercarriage.

PART II—HANDLING

- (viii) With the flaps $\frac{1}{2}$ down, the safety speeds are:—

All-up weight	Power	Knots
75,000 lb.	+21 lb./sq. in. boost, 3,000 r.p.m.	135
	+18 lb./sq. in. boost, 3,000 r.p.m.	125
	+12 lb./sq. in. boost, 3,000 r.p.m.	110
82,000 lb.	+21 lb./sq. in. boost, 3,000 r.p.m.	140
	+18 lb./sq. in. boost, 3,000 r.p.m.	130
	+12 lb./sq. in. boost, 3,000 r.p.m.	115

- (ix) When it is necessary to use full take-off power, it is recommended that this power be maintained only until the safety speed at +12 lb./sq. in. boost and 3,000 r.p.m. is attained; power should then be reduced to the maximum climbing setting. If full take-off boost (+21 lb./sq. in.) has been used, the boost cut-out should be returned to the up position with the throttles fully open. The boost will then fall to +18 lb./sq. in., and the throttles may then be set as required.
- (x) Raise the flaps in stages at a safe height. Then return the selector to neutral.

57. Climbing

(i) Maximum rate of climb

Use intermediate power (+12 lb./sq. in. boost and 2,850 r.p.m.) and climb at 145 knots. When the boost in low gear has fallen to +9 lb./sq. in. change to high gear by setting the switch to AUTO. Above 20,000 ft. the air-speed should be decreased by 2 knots per 1,000 ft.

NOTE.—In emergency, if combat power is to be used, the gear change switch should be set to AUTO, and high gear will be selected at the correct height for best performance.

(ii) Climbing for range

Climb may be made using weak mixture power (+7 lb./sq. in. and 2,650 r.p.m.), but the overall range will not be materially increased over that obtained when using the maximum rate of climb as given in (i) above. In addition, at the higher weights the aircraft requires careful handling to maintain the required rate of climb when using weak mixture power.

58. Cruising

(i) Range

- The recommended speed for maximum range varies considerably with all-up-weight. At 82,000 lb. it is approximately 160 knots while at 55,000 lb. it is 145 knots.
- Fly in low gear at the maximum obtainable boost not exceeding +7 lb./sq. in. and obtain the recommended speed by adjusting r.p.m., which may be as low as 1,800.
- At high altitudes set the supercharger gear change switch to AUTO, if, with the throttles at the gate, r.p.m. more than 2,500 are required.
- In high gear, the maximum permissible r.p.m. for cruising are increased to 2,850.
- Maximum A.N.M.P.G. decrease progressively above approximately 10,000 ft.; above approximately 20,000 ft. at the higher all-up weight it will not be possible to obtain the recommended range speed.
- If the air-intake control is set to HOT AIR ON, A.N.M.P.G. may be reduced. Hot air should, therefore, be used only to prevent carburettor icing.

(ii) Endurance

The recommended speed for endurance varies from 120 to 140 knots between 55,000 lb. and 75,000 lb. A.U.W.

59. Flight Planning Charts

The charts in Part V apply to aircraft cruising at heights of 10,000 ft. in low gear and 20,000 ft. and 25,000 ft. in high gear, at all-up-weights from 55,000 lb. to 82,000 lb.

60. Position error corrections

- Large errors and fluctuations of the airspeed indicator may be experienced when the aircraft is yawed, particularly at low speeds.
- When the aircraft is fitted with the small H2S Mk. 2 blister the position error correction is -1 knot at all speeds up to 313 knots.

- When the aircraft is fitted with the large H2S Mk. 4 "Camel" blister the position error corrections are as follows:—

From ...	120	160	210	knots
To ...	160	210	310	knots
Subtract ...	1	2	3	knots

61. General flying

(i) Controls

The elevator is relatively light and effective but tends to become heavy in turns. The ailerons are moderately light but spongy at cruising speeds. They become increasingly heavy at speeds above approximately 250 knots and lose some effectiveness at high altitude. The rudders are effective but become very heavy at speeds above approximately 250 knots.

(ii) Changes of trim

Undercarriage up	Slightly nose up
Undercarriage down	Slightly nose down
Flaps up	Nose down (the change of trim over the last $\frac{1}{3}$ of flap movement is large)
Flaps down	Nose up (the change of trim over the first $\frac{1}{3}$ of flap movement is large)
Bomb doors open	Slightly nose down
Bomb doors closed	Slightly nose up
Radiator shutters open or closed	No change

(iii) Flap creep

As there is a possibility of flap creep, periodic checks should be made in flight to ensure that the flaps are fully up. The flap selector lever should not, however, be left in the up position.

(iv) Effect of rotation of tail turret

Rotation of the tail turret causes the aircraft to yaw in the direction of rotation and causes a slight pitch.

PART II—HANDLING

(v) *Flying at reduced airspeed*

Reduce speed to 140 knots and lower the flaps $\frac{1}{2}$. Set the r.p.m. control lever to give 2,650 r.p.m. Speed may then be reduced to 120 knots.

(vi) *Speeds in turbulent conditions*

In turbulent conditions the aim should be to maintain a speed of approximately 160 knots.

(vii) *Engine handling*

Merlin 68A engines have automatic charge temperature control incorporated to maintain the charge temperature in the induction manifold of each engine above 45°C., since fouling of the sparking plugs by lead deposit may occur if the charge temperature falls below 40°C. It is recommended that, when cruising at r.p.m. below 2,250 or if the charge temperature falls below 40°C., engine power should be increased to +12 lb./sq. in. (when obtainable) and 2,850 r.p.m. for a period of one minute every hour.

(viii) *Use of carburettor air-intake heat control*

In icing conditions ice accretion on the gapped ice guards may cause a reduction in boost of 1 to 2 lb./sq. in. at full throttle cruising conditions. Should there be a further reduction in boost, or any other symptoms (such as rough running) denoting ice accretion in the carburettor, move the air-intake heat control switch to the HOT AIR ON, COLD AIR OFF position.

62. Stalling

(i) Warning of the approach of a stall is given by tail buffeting, which can be felt some 5-6 knots before the stall itself. With the undercarriage and flaps down the buffeting continues after recovery until speed has increased to 95-105 knots. In both cases the stall is gentle and recovery is straightforward.

(ii) *High-speed stall*

Warning of the approach of a stall in a steep turn is given by elevator buffeting. Continued backward pressure on the control column will then cause the nose and inner wing to drop slightly, but recovery is immediate if the pressure on the control column is relaxed.

PART II—HANDLING

(iii) The approximate stalling speeds, engines "off", in knots are as follows:—

	Undercarriage and Flaps	
	UP	DOWN
at 82,000 lb.	115	—
at 75,000 lb.	100	—
at 65,000 lb.	95	80
at 56,000 lb.	85	70
Power on, under typical approach conditions ...	—	65

63. Approach and landing

(i) Carry out the checks laid down in the Pilot's Check List, items 154 to 164.

(ii) The recommended final approach speeds in knots are as follows:—

	At maximum landing weight (65,000 lb.)	At light load (56,000 lb.)
	Engine assisted	95	90
Glide	105	100

(iii) The initial straight approach should be made at a speed some 10-15 knots above these figures.

(iv) To prevent any possibility of the flaps creeping up when they are fully lowered for landing the control should be left in the DOWN position until landing is complete.

64. Instrument approach

The following speeds, together with the appropriate flap and approximate power settings, are recommended for use during instrument approaches with the undercarriage lowered:—

	Boost	R.p.m.	Flaps	Airspeed
Pattern	+3	2,400	$\frac{1}{2}$	130-135
Final	+3	2,850	$\frac{1}{2}$	110-115
Glide path	-2	2,850	$\frac{1}{2}$	110

Large variations from normal in wind strength or aircraft loading may be compensated by ± 1 lb./sq. in. boost.

65. **Mislanding and going round again**

The aircraft will climb away satisfactorily at the maximum landing weight using intermediate power, with the undercarriage and flaps down.

- (a) Increase power progressively to +12 lb./sq. in. and 2,850 r.p.m.
- (b) Raise the flaps to $\frac{1}{2}$.
- (c) Raise the undercarriage.
- (d) Increase speed to 125 knots.
- (e) At a safe height raise the remainder of the flap.

NOTE.—It is essential to raise the flap to $\frac{1}{2}$ before the undercarriage is selected up; otherwise, an uncontrollable nose up change of trim may be experienced at loadings near the aft C.G. limit; this is aggravated by the use of full power.

66. **After landing**

- (i) After landing, carry out the checks laid down in the Pilot's Check List, items 165 to 170.
- (ii) Before stopping the engines, open the bomb doors if required.
- (iii) *Stopping the engines*
 - (a) Check that the booster pumps are off and that the pneumatic pressure is at least 160 lb./sq. in. If not open up No. 3 engine to increase the pneumatic pressure.
 - (b) Idle the engines at 800-1,000 r.p.m. for a short period, and, if no other check of the ignition has been made, the magnetos should be tested for a "dead cut."
 - (c) Stop the engines by moving the fuel cut-off switches to the IDLE CUT-OFF position and holding them there until the engines have stopped. Then turn off the engine master cocks, and switch off the ignition. The fuel cut-off switch will be returned to ENGINE ON position as soon as it is released. The engines should not normally be stopped by turning off the engine master cocks.
- (iv) (a) If the serviceability of an engine is in doubt, such items of the run up given in para. 55 as may be necessary should be carried out.

- (b) The engine should then be idled and stopped as in (iii) above.
- (v) After stopping the engines, carry out the checks detailed in the Pilot's Check List, items 171 to 185.
- (vi) *Oil dilution*
 - (a) Adjust the oil level in each tank to 32 gallons.
 - (b) To ensure a satisfactory start without pre-heating at the following OAT's, dilute for the periods quoted:—

Between - 5°C. and - 15°C.	... 1 minute
Between - 15°C. and - 26°C.	... 2 minutes
 - (c) During the next start after a 1 minute dilution no special boiling off period is necessary. After a 2 minutes dilution the recommended boiling off period is 10 minutes.

PART III LIMITATIONS

67. Engine data—Merlin 68A

The principal maximum engine limitations are as follows :—

	Super-charger gear	R.p.m.	Boost lb./sq.in.	Temp. °C Coolant	Oil
TAKE-OFF					
5 MINS. LIMIT	Low	3,000	+21	135	105
INTERMEDIATE	Low } High }	2,850	+12	125	90
1 HR. LIMIT					
MAXIMUM CONTINUOUS WEAK	Low High	2,650 2,850	+7 +7	105 105	90 90
OPERATIONAL NECESSITY					
5 MINS. LIMIT	Low } High }	3,000	+18	135	105

+18 lb./sq. in. boost must not be exceeded below 2,850 r.p.m.

OIL PRESSURE :

Minimum in flight	30 lb./sq. in.*
Normal	60-70 lb./sq. in.

MINIMUM TEMPERATURES FOR TAKE-OFF :

OIL	+15°C.
COOLANT	+40°C.

* Any progressive and abnormally large drop in pressure should be regarded as indicating an engine defect even though the minimum pressure has not been reached. In this event feathering action should be taken immediately.

68. Flying limitations

(i) The aircraft is designed for manœuvres appropriate to a heavy bomber and care must be taken to avoid imposing excessive loads with the elevators during recovery from dives and in turns at high speeds. Intentional spinning and aerobatics are prohibited. Gentle manœuvres only are permitted at weights above 75,000 lb.

(ii) *Maximum speeds (in knots) :—*

Diving	315
Bomb doors open	315
Undercarriage down	175
Flaps down	150

NOTE.—If Mod. 1981 to H2S radome is not incorporated maximum speed is restricted to 200 knots.

PART III—LIMITATIONS

(iii) Maximum permissible all-up-weights :—

Take-off (runways only)	82,000 lb.*
Take-off and all forms of flying	75,000 lb.
Landing	65,000 lb.

* At this weight C.G. aft limit is restricted to 63" aft of datum.

PART IV EMERGENCIES

69. Feathering

- (i) Close the throttle immediately.
- (ii) Push the r.p.m. control lever down through the feathering gate.
- (iii) Press the feathering pushbutton and hold it in only long enough to ensure that it stays in by itself; then release it so that it can spring out when feathering is complete. If it does not do so, it must be pulled out by hand.

NOTE.—Pressing the button accelerates the feathering. The propeller will feather slowly at a decreasing rate, and not quite to the full, on the lever alone.

- (iv) Turn off the engine master cock immediately. This is most important if the booster pumps are still switched on.
- (v) Switch off the ignition when the propeller has stopped rotating.

70. Unfeathering

- (i) Put the ignition on, set the throttle fully closed and the r.p.m. control lever just forward of the feathering gate.
- (ii) Check that both booster pumps on the same side as the engine to be started are off, then set the engine master cock ON.
- (iii) Press the feathering pushbutton and when the r.p.m. rise to 800-1,000, pull it out. The pushbutton will not spring out automatically until r.p.m. rise to 1,750-1,800.

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- (iv) It is advisable not to unfeather at speeds higher than normal cruising in order to avoid the risk of overspeeding.
- (v) The propeller will not unfeather without the electrical assistance introduced by pressing the pushbutton.

71. Engine failure during take-off

- (i) With the flaps $\frac{1}{2}$ down safety speeds are :—

All up weight	Power	Knots
75,000 lb.	+ 21 lb./sq. in. boost 3,000 r.p.m.	135
	+ 18 lb./sq. in. boost 3,000 r.p.m.	125
	+ 12 lb./sq. in. boost 3,000 r.p.m.	110
82,000 lb.	+ 21 lb./sq. in. boost 3,000 r.p.m.	140
	+ 18 lb./sq. in. boost 3,000 r.p.m.	130
	+ 12 lb./sq. in. boost 3,000 r.p.m.	115

- (ii) If an outer engine fails before safety speed has been reached it may be necessary to throttle back the opposite outer engine, at least partially, to prevent control being lost. Once the propeller of the failed engine has been feathered and rudder trim applied it may be possible to reopen the throttle of the live outer engine gradually, increase speed and climb away.
- (iii) If the No. 2 engine fails during take-off it will be necessary for a member of the crew to set the hydraulic change-over cock to STARBOARD PUMP DELIVERY so that the undercarriage can be retracted.
- (iv) With the propeller of the failed engine feathered, the undercarriage up, flaps $\frac{1}{2}$ down and the rudder trim applied, the aircraft will climb away slowly at full load at 125 knots.
- (v) At a safe height, when the undercarriage is up, raise the flaps in stages retrimming as necessary, allow the speed to build up to 145 knots and continue the climb.

72. Handling on three engines

At 20,000 feet in high gear (in favourable conditions) and below 10,000 ft. in low gear the aircraft will maintain

height at 70,000 lb. on any three engines. Under these conditions the aircraft can be trimmed at a speed of about 130 knots.

73. Landing on three engines

Lowering of $\frac{1}{2}$ flap and of the undercarriage may be carried out as on a normal circuit, but the flaps should not be lowered further until it is certain that the runway is within easy reach. The initial straight approach should be made at 120 knots and the three live engines used to regulate the rate of descent. Power and speed should be gradually reduced and the airfield boundary crossed at the correct engine-assisted approach speed (see para. 63).

74. Going round again on three engines

The decision to go round again should be made before full flap is lowered. With the flaps $\frac{1}{2}$ down and the undercarriage down power should be increased to +12 lb./sq. in. boost and 2,850 r.p.m. The aircraft can be controlled comfortably at 125 knots. Select undercarriage up and while it is rising select flaps up in stages and retrim as necessary.

75. Flying on asymmetric power on two engines

(i) In flight

Below 10,000 ft. in low gear the aircraft will maintain height at 120-125 knots at 70,000 lb. If full rudder trim is applied to reduce the footload it is possible to induce mild rudder overbalance, and this is more likely when Nos. 1 and 2 engines are stopped. If not more than 10 divisions of rudder trim are applied rudder overbalance should not occur at this speed, but if encountered it can be easily corrected by winding off rudder trim. If the bomb load is jettisoned it will be possible to maintain height on two engines at a higher speed and the amount of rudder trim required will be much reduced.

(ii) Landing

A normal circuit can safely be made irrespective of which engines have failed. Speed should not be allowed to fall below 125 knots. Aim to have the undercarriage locked down at the end of the downwind leg; the flaps should not be lowered until the final straight approach is commenced and it is certain that the runway is within easy reach. The two live engines should be used within the limits of rudder control to regulate the rate of descent. The final approach should be commenced at 125 knots and power and speed gradually reduced, aiming to cross the airfield boundary at the normal engine-assisted approach speed.

76. Flapless landings

The initial approach should be made at 115 knots; little power is required to maintain this speed. The approach is flat with a nose-up attitude but control is satisfactory. Considerable nose up trim may be needed, and care must be exercised if it is necessary to go round again. Aim to cross the airfield boundary at 105-110 knots. Power should not be reduced suddenly as this results in a high rate of sink. The aircraft can be brought to rest within 2,000 yards, with moderate use of the brakes.

77. Undercarriage emergency operation

- (i) If the undercarriage or flaps will not lower by the normal means, it may be due to failure of the hydraulic pump on the No. 2 engine. The cock on the forward face of the front spar should be turned to STARBOARD PUMP DELIVERY so as to charge the accumulator from the pump on the No. 3 engine (see para. 13 (ii)).
- (ii) If the hydraulic system fails completely the undercarriage can be lowered by a compressed air system, irrespective of the position of the undercarriage selector lever.

NOTE.—The flap selector *must* be in the neutral position before using the undercarriage emergency air

PART IV—EMERGENCIES

system; otherwise, the flaps may lower inadvertently.

- (iii) The control (71) for the air system is just aft of the flight engineer's seat on the starboard side of the cockpit. The undercarriage cannot be raised again by this method. The control is spring loaded in the off position, and in order to ensure effective operation it should be held in the fully extended position until the operation of the undercarriage or flaps is completed.

NOTE.—Although the emergency air system will lower the undercarriage irrespective of the position of the undercarriage selector lever, this should, if possible, be set to DOWN for landing. If left in the UP position any leakage of air pressure might cause the undercarriage to collapse.

78. Flaps emergency operation

When the undercarriage has been lowered (see para. 77) the flaps may be lowered by selecting FLAPS DOWN and holding out the emergency air control until the lowering is complete. This admits air pressure to the flap jacks via the existing hydraulic lines. When the flaps have lowered, the flaps control *must* be retained at the DOWN position and the emergency control should be released. It is possible to raise the flaps again by the emergency method but there may be insufficient pressure left to lower them a second time. Furthermore, the pressure from the jacks when the flaps are raised will be transmitted to the hydraulic header tank and may be sufficient to cause it to burst. If it is absolutely necessary to raise the flaps by the emergency method extreme care should be taken to raise them slowly in stages.

79. Bomb jettisoning

- (i) Open the bomb doors, and check visually that both are fully open.

PART IV—EMERGENCIES

- (ii) Then jettison the containers first by the switch (66) on the starboard side of the instrument panel.
- (iii) Jettison the bombs by the handle (64) beside the container jettison switch.
- (iv) Close the bomb doors.

80. Fuel jettisoning

To jettison the contents of the No. 1 tanks :—

- (i) Reduce speed to 130 knots and lower flaps $\frac{1}{2}$.
- (ii) Lift and turn the jettison control on the left of the pilot's seat. Return the control after jettisoning.
- (iii) The jettison valve should be closed when about 100 gallons remain in each tank; if the jettison valve is open, all the fuel will be jettisoned less approximately 70 gallons, but the last 30 gallons of jettisonable fuel run out slowly and may possibly get splashed over the fuselage. The jettison valve may be closed at any time during jettisoning.
- (iv) The approximate weight of jettisonable fuel, leaving 100 gallons in each tank, is 6,900 lb.
- (v) The fuel jettison system must not be operated unless the pressure in the hydraulic accumulator is more than 650 lb./sq. in. When the flaps are lowered prior to jettisoning, the accumulator pressure should build up rapidly to 650-850 lb./sq. in. If, however, the gauge indicates a lower pressure, one of the main hydraulic systems should be operated momentarily, e.g., the bomb doors control should be moved to OPEN and then returned at once to CLOSED. This will cause the hydraulic cut-out valve to function and the pumps will then build up pressure in the system. To ensure the most efficient operation of the jettison system the control valve should be opened as the rising pressure passes 650 lb./sq. in., and a member of the crew should watch the gauge and signal the pilot at this moment.

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- (vi) If the pressure in the accumulator cannot be built up to 650 lb./sq. in. due to failure of the supply system it may still be possible to operate the jettison system by means of the handpump.

81. Parachute exits

- (i) The hatch in the floor of the nose should be used by all members of the crew if time is available; the hatch is opened by a handle at the port side. It opens inwards and is secured by a clip which holds the hatch up on the starboard side. It can also be opened from outside the aircraft.
- (ii) The main entrance door should be used as a parachute exit only in extreme emergency.

82. Crash exits

Two push-out panels are fitted in the roof, one above the pilot, the other just forward of the rear spar.

83. Air-sea rescue equipment

- (i) The type Q dinghy stowed in the starboard wing may be released as follows:—
- (a) From inside by pulling the release cord running along the fuselage roof aft of the rear spar.
- (b) From outside by pulling the cable loop on the starboard side of the rear fuselage, forward of the tailplane leading edge.
- (c) Automatically by two immersion switches.

A dinghy radio, emergency pack type 4, and an AVRO type emergency pack are stowed with the dinghy.

PART IV—EMERGENCIES

- (ii) *K* type dinghies.

Seven stowages are provided adjacent to the parachute stowages.

84. Ditching

The flaps should be lowered $\frac{1}{2}$ for ditching, but if they will not lower by the hydraulic system, *do not attempt to lower them by the compressed air system, as this will also cause the undercarriage to lower.*

85. Fire-extinguishers

- (i) *Engine fire-extinguishers*

Each engine is provided with a fire-extinguisher system, and warning lights are mounted on the respective propeller pushbuttons; if a fire warning light comes on, pressing the feathering button also operates the fire-extinguisher system. The pilot should, however, press the fire-extinguisher pushbutton (23) as well. If the warning light is not on, pressing the feathering pushbutton will not operate the extinguisher. The engine fire-extinguishers are also operated automatically by a crash switch.

- (ii) *Hand fire-extinguishers*

Six hand fire-extinguishers are carried on the aircraft in the following positions:—

- (a) One on the starboard side of the nose.
- (b) One on the cockpit port rail.
- (c) One on the forward face of a panel at the forward end of the navigator's station.
- (d) One on the ^{port side} ~~starboard side~~ of the fuselage, forward of the front spar.

PART IV—EMERGENCIES

- (e) One on the starboard side ~~aft of the main door.~~
by the #2 S recon unit.
- (f) One on the port side forward of the rear turret. *on 1.*

86. First-aid

A first-aid kit is carried as a stowage on the starboard side of the fuselage aft of the main door.

87. Instructions for parachuting wounded men by static line

- (i) If possible fly the aircraft at 120 knots with flaps lowered $\frac{1}{2}$.
- (ii) Assist the casualty towards the bomb-aimer's compartment and place him on the floor at the flight engineer's station with his feet on the glycol tank.
- (iii) Check the wounded man's parachute harness, fit parachute pack and remove helmet.
- (iv) Remove the static line from stowage. Care should be taken that the threads keeping the static line folded are not broken.
- (v) Take the snap-hooks at the end of static line and attach to parachute as follows:—
- (a) Pass the safety becket on the static line through the double 8 cord safety loop, then pass the small snap-hook through the safety becket.
- (b) Snap the hook down on the rip-cord handle. Insert and close the safety pin to lock the shroud to the snap-hook.
- (c) Stow the slack of the static line between the becket and the snap-hook under the adjacent pack elastic to obviate all danger of this slack length fouling anything and thus pulling the rip-cord too soon.
- (vi) Open the front escape hatch.

PART IV—EMERGENCIES

- (vii) Slide the casualty through the exit feet first, facing aft. Care must be taken to keep his hands to his sides. Do not hold on to the static line by hand.

NOTE.—Crew members assisting the casualty must ensure that their parachutes are on, ready for immediate use.

PART V
ILLUSTRATIONS

	<i>Fig.</i>
Instrument panel	1
Cockpit—Port side	2
Cockpit—Starboard side	3
Flight Planning Charts	4

- KEY TO Fig. 1.**
1. Auto pilot pitching control.
 2. Pilot's call light.
 3. Downward identification light switch.
 4. Brakes control lever.
 5. "Press to transmit" pushbutton.
 6. Camera warning light.
 7. Bomb aiming warning light.
 8. Engine speed indicators (4).
 9. Boost gauges (4).
 0. Auto pilot control switch.
 1. D.R. compass repeater.
 2. Ignition switches (4 pairs).
 3. Supercharger controls.
 4. Slow-running cut-out switches (4).
 5. Engine starting pushbuttons (4).
 6. Engine booster-coil pushbuttons (4).
 7. Engine priming pushbuttons (4).
 8. Vacuum gauge.
 9. Vacuum change-over cock.
 0. Location of charge temperature thermometer engine selector switch.
 1. Identification lights switchbox.
 2. Location of charge temperature thermometer.
 3. Fire-extinguishers pushbuttons (4).
 4. Air-intake heat control switch.
 5. Air-intake filter control switch.
 6. Starboard engines fuel cocks (2).
 7. Oil pressure gauges (4).
 8. Flaps indicator.
 9. Port engines fuel cocks (2).
 0. Glider tug lights switch.
 1. Emergency light switch.
 2. External lights warning light and master switch.

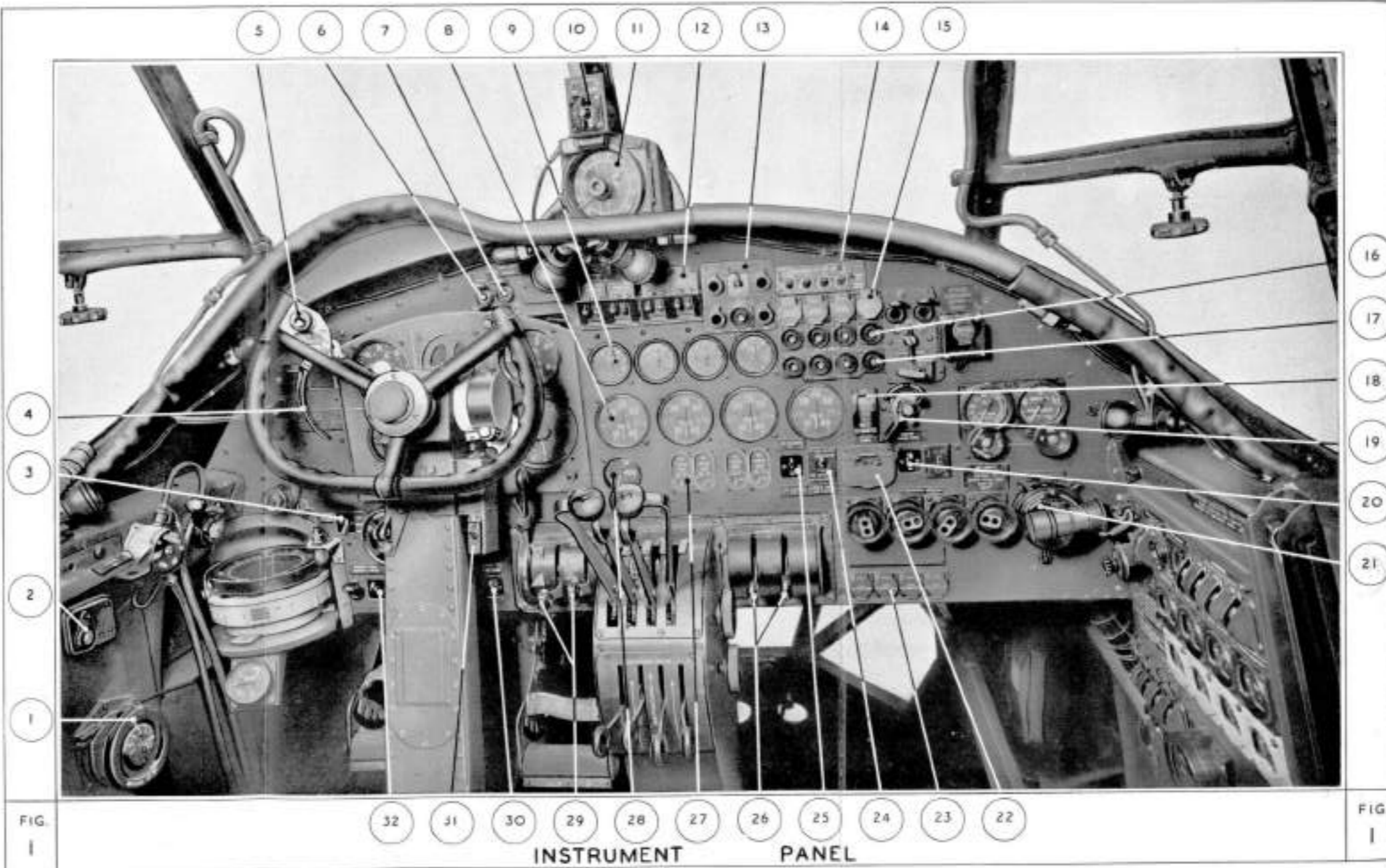


FIG. 1

INSTRUMENT PANEL

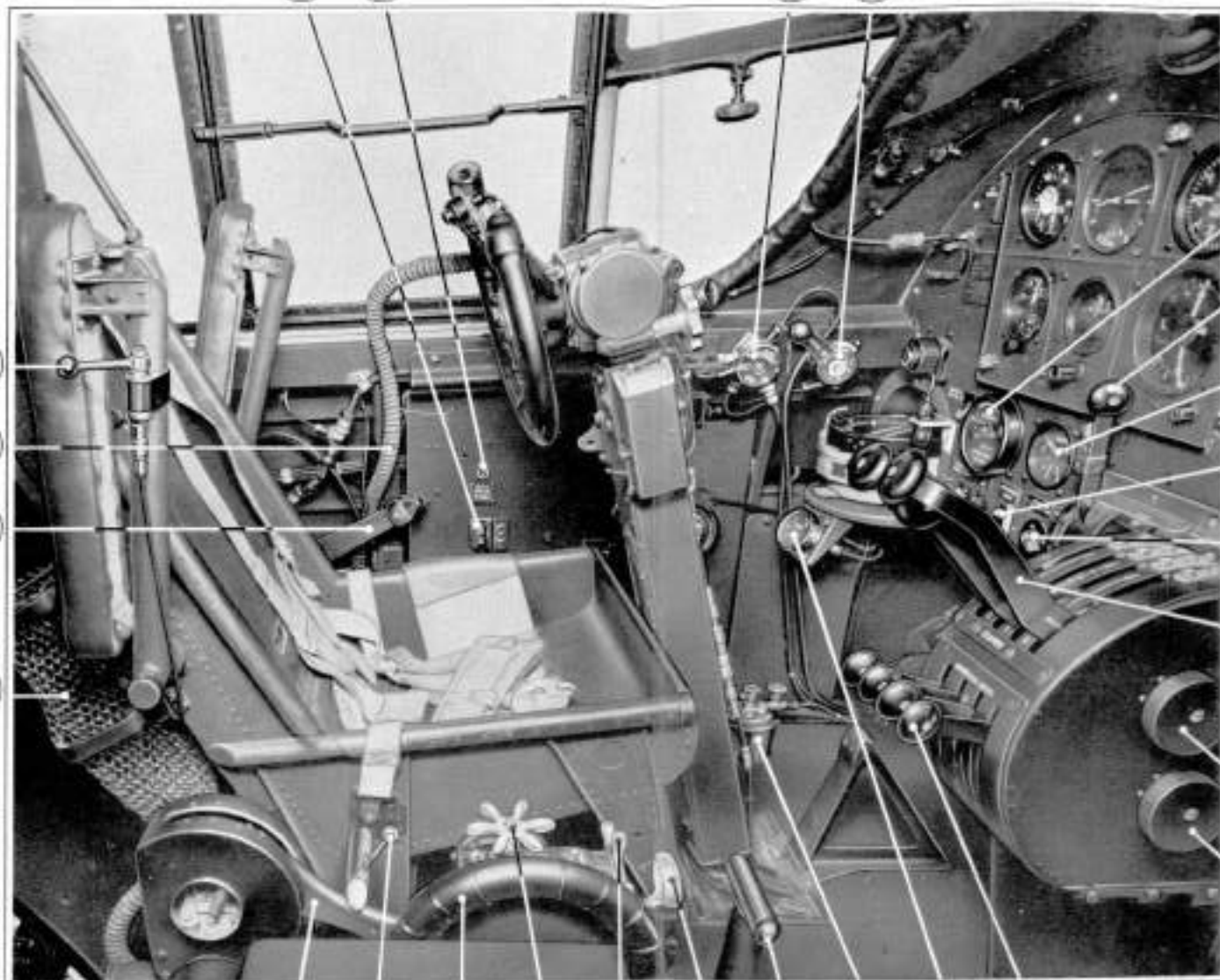
FIG. 1

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KEY TO Figs. 2 and 3.

- 33. Portable oxygen stowage.
- 34. Bomb doors control.
- 35. Pilot's oxygen connection.
- 36. Sutton harness release lever.
- 37. IFF distress switch.
- 38. Isolation switch for navigator's telephone.
- 39. Auto pilot controls cock.
- 40. Auto pilot clutch lever.
- 41. Undercarriage position indicator.
- 42. Boost cut-out control.
- 43. Air supply and brakes pressure gauge.
- 44. Navigation lights switch.
- 45. Landing lamp switch.
- 46. Throttle control levers (4).
- 47. Throttle lever friction control.
- 48. R.p.m. lever friction control.
- 49. R.p.m. control levers (4).
- 50. Auto pilot pressure gauge.
- 51. Windscreen de-icing pump.
- 52. Glider tow release.
- 53. Flaps selector control.
- 54. Aileron trimming tab control.
- 55. Rudder trimming tabs control.
- 56. Elevator trimming tabs control.
- 57. Undercarriage control safety bolt.
- 58. Undercarriage control lever.
- 59. Fuel pressure warning lights (4).
- 60. Feathering pushbuttons and fire warning lights (4).
- 61. Pressure head heater switch.
- 62. Pressure head heater test push-button.
- 63. Oxygen regulator.
- 64. Bomb jettison handle.
- 65. Engine priming master switch.
- 66. Bomb containers jettison switch.
- 67. Test ammeter.
- 68. Radiator shutter switches (4).
- 69. Flight engineer's oxygen connection.
- 70. Fuel contents gauges.
- 71. Undercarriage and flaps emergency control.
- 72. Flight engineer's seat.
- 73. Coolant temperature gauges (4).
- 74. Oil temperature gauges (4).
- 75. Gallons-gone fuel flowmeters (2).
- 76. Booster pump test pushbuttons (4).
- 77. Booster pump switches (4).

FIG
2

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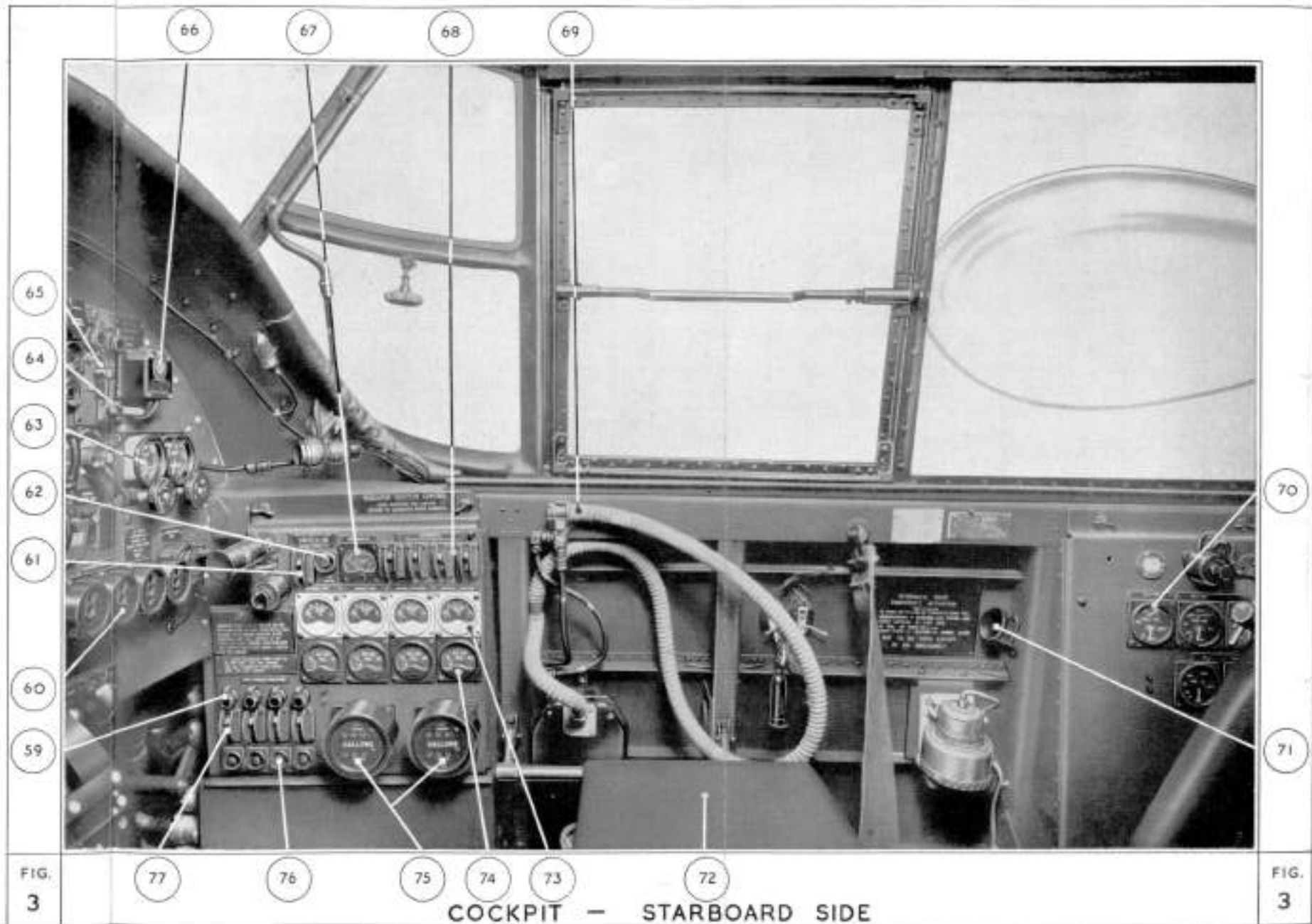
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COCKPIT - PORT SIDE

FIG
2



FLIGHT PLANNING CHARTS

CHART 1
10,000 FT. - LOW GEAR

CHART 2
20,000 FT. - HIGH GEAR

CHART 3
25,000 FT. - HIGH GEAR

INSTANTANEOUS WEIGHT CHART

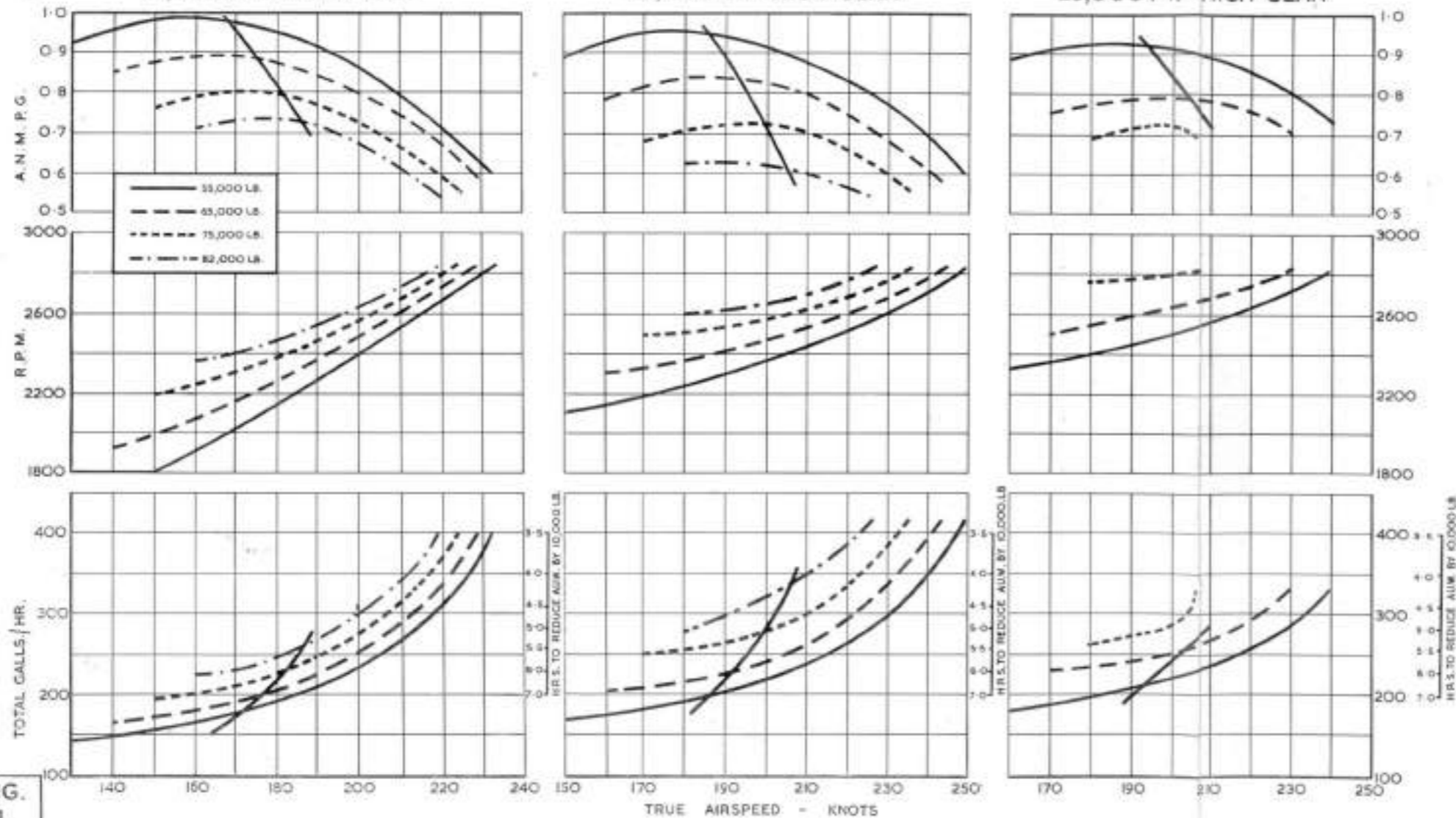


FIG. 4

FIG. 4

