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BEAUFORT DESCRIPTIVE MANUAL

(Australian)

PRATT & WHITNEY TWIN WASP

S3C4G S1C3G

Compiled by Service Department
BEAUFORT DIVISION

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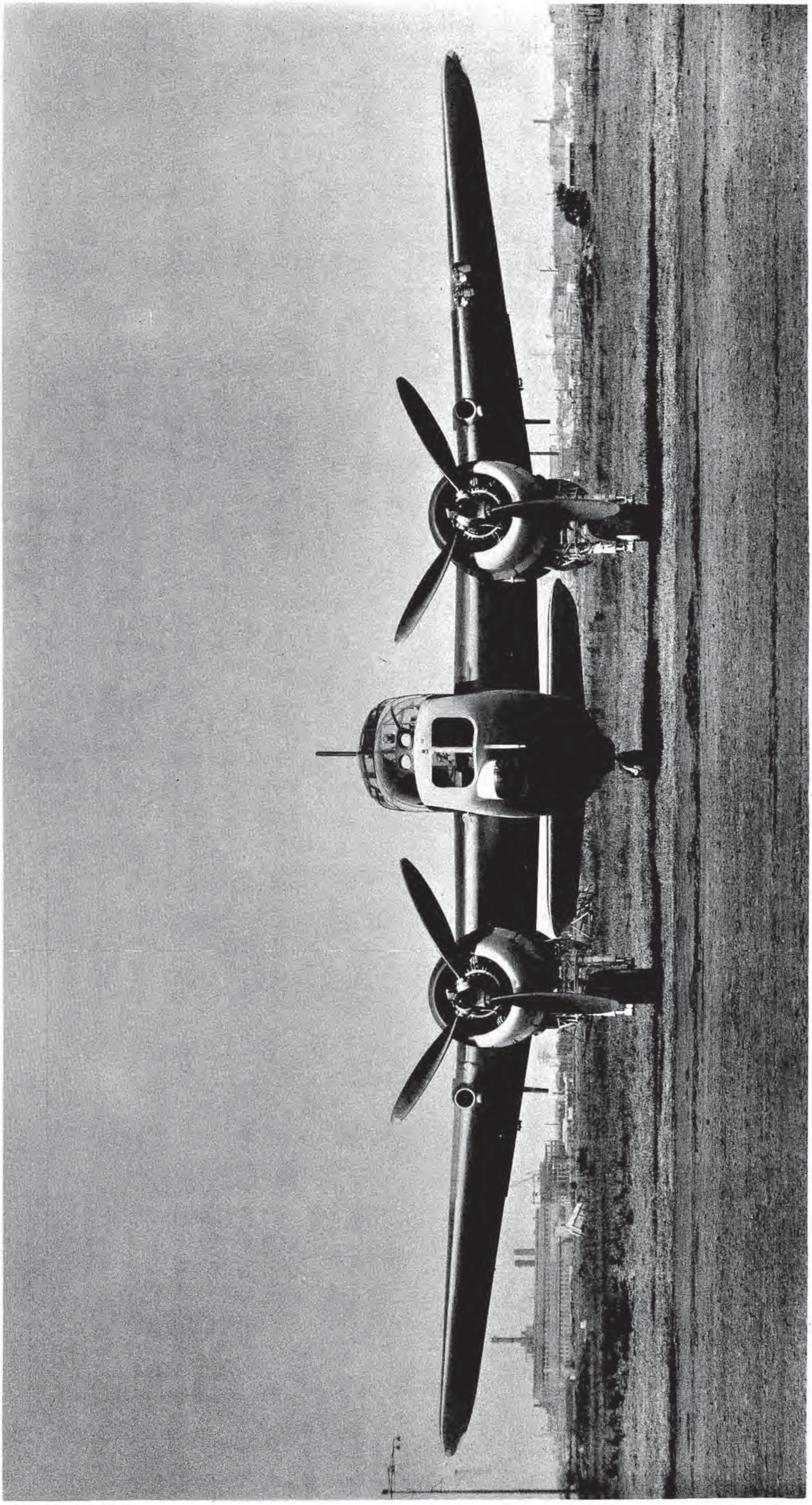

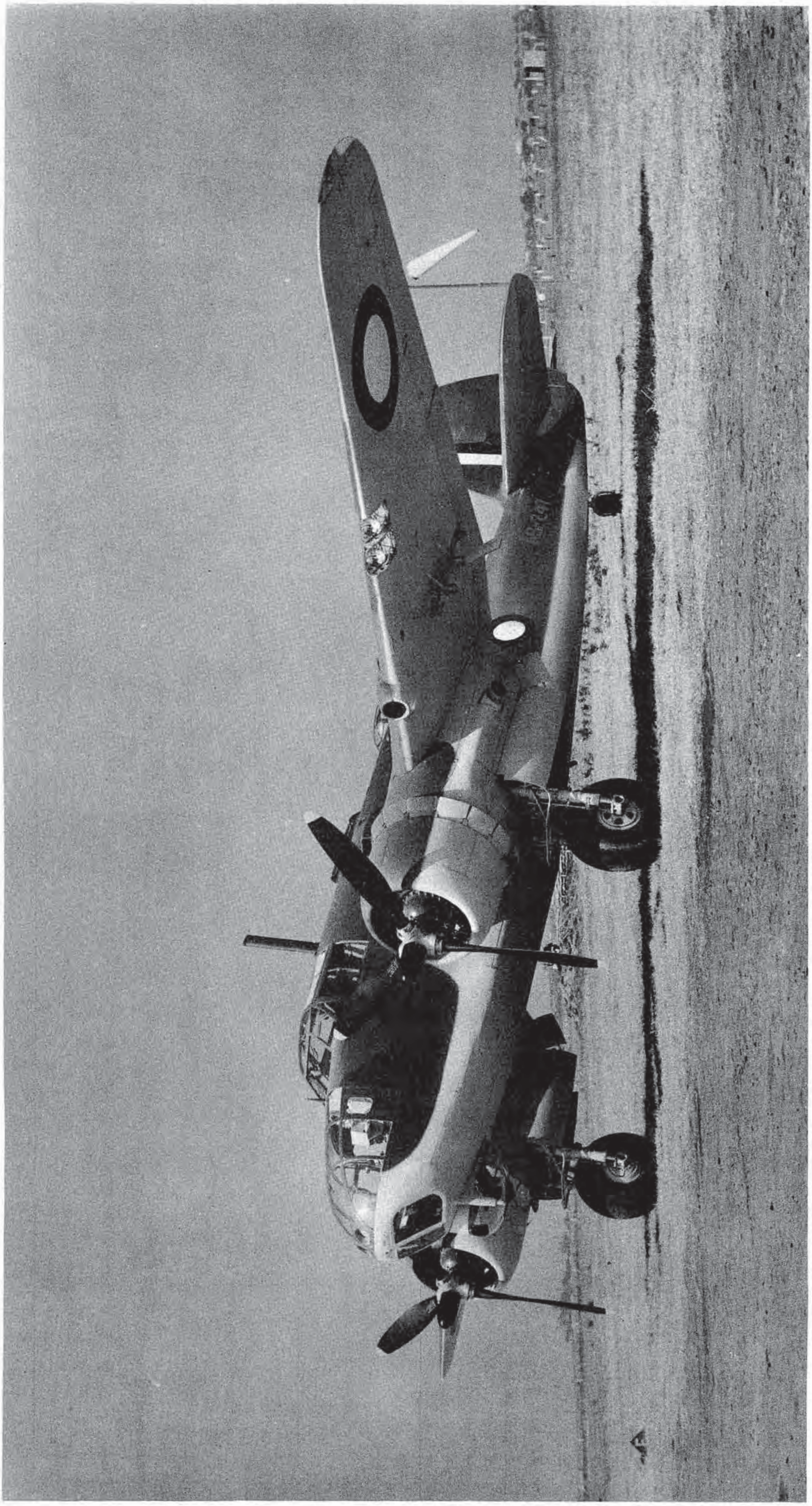

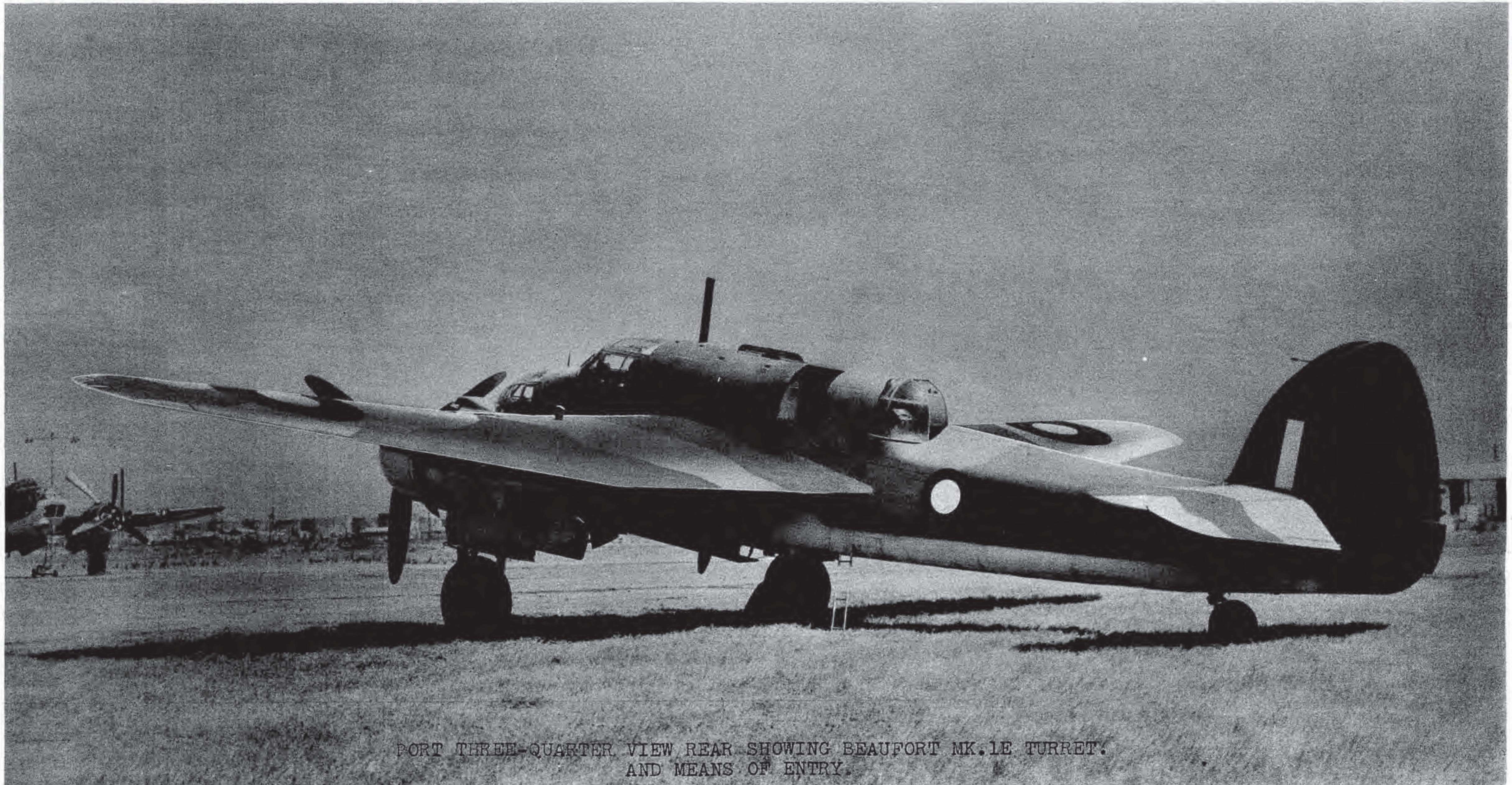

PORT THREE-QUARTER VIEW REAR SHOWING BEAUFORT MK.1E TURRET.
AND MEANS OF ENTRY.

AMENDMENT CERTIFICATE

Incorporation of an amendment list in this publication should be certified by inserting the amendment list number, initialling in the appropriate column, and inserting the date of incorporation.

Holders of the Pilot's Notes will receive only those amendment lists applicable to the preliminary matter, Introduction, and Sections 1 and 2.

Amendment List No.	1	2	3	4	5	6	7	8	9	10	11
Preliminary Matter											
Leading Particulars											
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Where an order or instruction contradicts any portion of this publication, an amendment list will generally be issued, but when this is not done the order or instruction must be taken as the over-riding authority.

VOLUME 1

LIST OF SECTIONS

(A detailed list of contents is given at the beginning of each Section)

AUSTRALIAN BEAUFORT

INTRODUCTION

1. The Beaufort 152 is an all-metal mid-wing Monoplane fitted with two Pratt & Whitney twin row S3C4G or S1C3G engines. It is equipped for torpedo-bombing, general reconnaissance and general purpose duties, and accommodation is provided for a crew of four, consisting of the pilot, the navigator or bomb aimer, wireless operator, and the rear gunner.

2. The fuselage, main plane, tail plane, and fin are covered with alclad sheet. Monocque construction is employed in the fuselage, with alclad lipped channel and Z-section formers and lipped extruded hiduminium angle-section stringers. The main plane is a two-spar stressed-skin cantilever structure tapered in chord and tnickness; it is constructed in three portions, the port and the starboard outer planes with detachable tips and the centre plane through the fuselage, and which is bolted to it. The fin and the tail plane are cantilever structures mainly of alclad, and the rudder, elevators, and ailerons have a duralumin tubular spar, alclad ribs, and fabric covering.

3. A retractable ladder and a hatch on the port side just forward of the gun turret provide the means of entry to the aeroplane, and inside the fuselage a walkaway on the starboard side leads through a curtained partition and over the centre plane spares to the extreme nose of the aeroplane. A table, and a seat that can be stowed out of the way under the table, are provided in the nose for the navigator or bomb aimer. The pilot with his equipment and controls is accommodated on the port side at a higher level than the walkaway, and there is an additional seat for the navigator or bomb aimer on the starboard side just aft of the pilot's seat. Emergency exits are provided in the floor of the navigator's compartment, and the roof of the pilot's cockpit. Aft of the pilot, the wireless equipment and the wireless operator's seat are located between the centre plane spars. A seat for the gunner is incorporated in the gun turret.

4. The alighting gear consists of two independent undercarriage units, fitted under the engine nacelles at the outer ends of the centre plane, and a tail wheel unit. The three units are retractable and are operated hydraulically. A separate cartridge-fired system for emergency lowering of the main and tail wheels is incorporated together with a hand operated pump for emergency lowering of the flaps and servicing operations. The undercarriage units swing backwards and upwards into the engine nacelles, and the tail wheel unit retracts forward and upwards into a recess in the fuselage tail. Electrical indicators and a buzzer in the pilot's cockpit indicate the position of the three units. Each under-

carriage unit has two Vickers oleo-pneumatic shock-absorber legs and the tail wheel unit has a single Lockheed automotive products oleo-pneumatic shock absorber leg. Dowty oleo pneumatic legs and tail wheel strut may be used as an alternative. Dunlop pneumatically-operated brakes are fitted to the undercarriage.

5. The flying controls are orthodox in operation; the pendulum-type rudder pedals are connected to the rudder, and the spectacle-type control column to the ailerons and elevators by chains and cables. For directional and longitudinal trimming, tabs controllable by the pilot are inset in the trailing edges of the rudder and elevators. For lateral trimming, pilot-operated tab is fitted on the starboard aileron, and another tab, adjustable on the ground only, is fitted to the port aileron. Automatic controls are not being fitted as yet. Dual control may be installed side-by-side with the main controls. Hydraulically-operated split-trailing-edge flaps extend from the fuselage sides to the ailerons.

6. The two Pratt & Whitney S3C4G or S1C3G engines, which are of the twin row radial air-cooled type, are installed in the nacelles near the outboard end of the centre plane and are fitted with Curtiss Electric Constant Speed Full Feathering Airscrews, or De-Havilland Constant Speed Airscrews. Lockheed type long-chord cowls with detachable panels are fitted over the engines and controllable cowl gills that govern the flow of cooling air are fitted around the trailing edge. Fuel is carried in four main tanks, one in the centre plane and one in the outer plane on each side of the fuselage, and an auxiliary fuel tank may be installed in the bomb cell under the fuselage. Each engine has a separate oil cooler, for which the cooling air is collected by a duct on the leading edge. The engines are fitted with electrical starters and hand-turning gear is provided for maintenance work.

7. The protective armament consists of a fixed Browning gun mounted in both port and starboard main planes, and fired pneumatically by means of a push-button valve on the pilot's control column. A Bristol Type Mk. 1E or Blenheim Mk. V power operated turret mounting twin Vickers or Browning, respectively, amidships. Two beam guns are fitted just forward of the power operated gun turret, one in the rear entrance hatch, port side, and one opposite on starboard side. An under-defence gun is mounted in the front escape hatch in the nose of the machine. The main bomb load is carried beneath the fuselage in a cell fitted with hydraulically-operated doors, but provision is also made for carrying a bomb externally under each main plane. When a torpedo or a 2000-lb. bomb is carried, the bomb cell doors are folded inwards, and the bottom of the cell is left open and the rear torpedo cell doors are removed.

8. The electrical installation is a 24-volt system, and provides for the usual lighting service, landing lamps in the leading edge of the port outer plane, engine starting, A.S.I. pressure head, camera motor, Graviner fire extinguishers, wireless motor generator, undercarriage position

indicators, and warning buzzer, bomb release, fusing and radio, etc. The wireless installation is mounted between the centre plane spars and comprises a transmitter and a receiver as well as A.S.V., I.F.F., and T.R.9.F. aerials are provided. Inter-communication between the members of the crew is provided by an independent amplifier.

9. Other equipment provided includes a dinghy in the port trailing edge of the centre plane, a signal pistol, flares, sea markers, and Elsan sanitary closet, an F.24 camera, oxygen apparatus, etc. Lorenz beam approach equipment, desert equipment, camera gun and target towing hook may also be fitted.

LEADING PARTICULARS

Type - -	Twin-engined mid-wing monoplane.
Duties - -	Torpedo-bombing, general reconnaissance and general purpose.

PRINCIPAL DIMENSIONS

(Aeroplane in rigging position, unless otherwise stated)

Span	57 ft. 10 in.
Overall length	44 ft. 2 in.
Height, maximum, to top of rudder	15 ft. 10 in.
Height, maximum, tail wheel to ground	12 ft. 2 in.
Height to top of wireless mast, tail wheel on ground	14 ft. 5 in.

MAIN PLANES

Aerofoil section	R.A.F. 28 (basic)
Chord, at root (1 ft. 4 in. from centre-line)	11 ft. 6 in.
Chord, at tip (26 ft. 8 in. from centre-line)	5 ft. 5 in.
Incidence	$2\frac{1}{2}°$-0°-15′
Dihedral, outer plane (on top of front spar)	$5\frac{1}{4}°$-0°-15′
Dihedral, outer plane (to datum)	$6\frac{1}{2}°$-0°-15′
Aileron span	7 ft. 11 in.
Aileron chord (maximum)	2 ft. $1\frac{1}{4}$ in.

TAIL UNIT

Elevators, total span (including balance)	18 ft. 0 in.
Tail plane incidence	$0° \pm 0°$-15′
Tail plane span	18 ft. 4 in.
Tail plane chord, at root (including elevator)	5 ft. 9 in.
(Tail plane only)	3 ft. 3 in.

ENGINES

Name . . .	Pratt & Whitney S.3.C.4.G. or S.1.C.3.G.
Type . . .	14-cylinder, air-cooled, double-row radial blower ratio (upper 8.47-1 — S.3.C.4.G. only); (lower 7.15-1 — S.3.C.4.G. and S.1.C.3.G.).
Number . .	Two.
Fuel used .	Specification DTD 95 octane.
Oil used . .	Specification DTD 109 in 3 grades.

AIRSCREWS

Type . . .	Curtiss Electric, constant speed and full feathering.
Pitch settings	Low angle, range 21-5°. High angle, range 46-5°.
Type . . .	De Havilland constant speed.
Pitch settings	Low angle 21°. High angle 42°.

AREAS

Main planes, including ailerons (gross)	503 sq. ft.
Main planes, including ailerons (nett)	451 sq. ft.
Ailerons total, including trimming tabs	26.6 sq. ft.
Trimming tabs, total	0.58 sq. ft.
Fin	9.7 sq. ft.
Elevators, total, including trimming tabs	32.5 sq. ft.
Trimming tabs, total	1.5 sq. ft.
Rudder, including trimming tabs	52.8 sq. ft.
Trimming tab	0.8 sq. ft.
Flaps, total	57.1 sq. ft.
Tail plane	52.8 sq. ft.

TANK CAPACITIES

Centre section fuel tanks (two)	194 gallons each
Outer plane fuel tanks (two)	91 gallons each
Total fuel (without auxiliary tank)	570 gallons
Auxiliary fuel tank	138 gallons
Total fuel (with auxiliary tank)	708 gallons
Oil tanks (two) ... Oil	19 gallons each
Air space	2½ gallons each
Total oil	38 gallons

RANGES OF MOVEMENT OF CONTROL SURFACES

(Linear dimensions measured on chord of arc of tailing edge)

Ailerons	Up 28° - 0° +3°. Down 14° - 2°.
Aileron trimming tab (stbd.)	Up 20°. Down 20° (approx.).
Aileron trimming tab (port)	Fixed before delivery.
Elevators	Up 34° 15'. Down 24° 45' ± 0° 30'.
Elevators, trimming tabs	Up 1-11/16th ins. Down 1⅜" ± 1/16".
Rudder	Port 30°. Starboard 30° ± 1°.
Rudder trimming tab	Port 1⅜". Starboard 1⅛" ± 1/16".
Flaps	Up 0°. Down 58° - 2°.

ALIGHTING GEAR

Undercarriage—

Type	Two retractable single wheel units, with two oleo legs.
Track	18' 0".
Compression legs . .	Vickers oleo-pneumatic.
Air pressure	375-400 lbs./sq. ins., with legs fully extended and wheel clear of ground.
Wheels	Dunlop I.W. 11, 14.00 x 14.
Tubes	Dunlop I.W. 2, 14.00 x 14.
Tyre pressure	45 lbs./sq. in. (all loadings).
Brakes	Dunlop pneumatic.

TAIL WHEEL UNIT

Type	Retractable castering type with manually operated locking device.
Compression leg . .	Lockheed oleo-pneumatic.
Air pressure	105 lbs./sq. ins. Strut fully extended and wheel clear of ground.
Wheel	Dunlop A.H. 2038.
Tyre	Dunlop W.N. 11, 9.00 x $5\frac{1}{4}$ heavy.
Tube	Dunlop W.N. 2, 9.00 x $5\frac{1}{4}$.
Tyre pressure	40 lbs./sq. ins.

SECTION 1

PILOT'S CONTROLS AND EQUIPMENT, GENERAL EMERGENCY EQUIPMENT AND EXITS

SECTION 1

PILOT'S CONTROLS AND EQUIPMENT, GENERAL EMERGENCY EQUIPMENT AND EXITS

ILLUSTRATIONS

1. INTRODUCTION.

This aeroplane was designed for operation by a single pilot, and for dual instruction the necessary extra controls can be installed as a separate dual control unit. The notes to follow will give a detailed description of the pilot's controls and equipment at his station:—

2. FUEL AND OIL.

The fuel and oil to be used with the S1C3G and S3C4G Pratt & Whitney Twin Row Wasp Engines are as follows:—

Fuel— S1C3G Engine:
Normal fuel 90 octane (95 or 100 may be used).
S3C4G Engine:
Normal fuel 95 octane (100 octane may be used).

Oil— Designation: D.T.D. 109.
R.A.A.F. Stores Ref. No. K2/139.

3. FLYING CONTROLS.

Reference Construction Sect. 7, Chapter 5.

Operation and Adjustment Ref. Sect. 4A, Chapter 2.

(a) A control column is provided for operating the elevators. (Fig. 1.) Conventional fore and aft movement of the control column provides longitudinal control of the aeroplane. Spectacles for operating the ailerons are mounted on the control column. Conventional movement of the spectacles provides lateral control of the aeroplane.

These controls can be locked when the aeroplane is parked. (Refer Section 4, Para. 3.)

(b) Pedals are provided for operating the rudder, and are situated under the instrument panel on the port side of the pilot's cockpit. They are of the pendulum type and have an adjusting control situated at the bottom of the instrument panel. Conventional operation of the pedals provides directional control of the aeroplane.

(c) The elevator trimming tabs are controlled by a handwheel at the top of the hydraulic control panel (Fig. 1). The spindle of the handwheel is mounted transversely with a portion of the wheel protruding beyond the panel, and when the handwheel is rotated upwards towards the position marked "NOSE DOWN," the action of the tab tends to depress the nose of the aeroplane and relieve the pilot from the prolonged effort of countering any "tail heavy" tendency. This operation causes the tabs to be raised and the load on the tabs then forces the elevators down slightly. When the handwheel is rotated downwards towards the position marked "NOSE UP," the effect is reversed. An indicator showing the position of the tabs is incorporated in the handwheel (Fig. 1).

The rubber trimming tab is controlled by a handle mounted on the hydraulic control panel below the undercarriage and flap control levers (Fig. 1). When the handle is turned clockwise in the direction marked turn "right," the action of the tab tends to turn the aeroplane to starboard, and relieve the pilot from the prolonged effort of countering any slight tendency of the aeroplane to turn to port. This operation causes the tab to be moved to port and the air load on the tab then forces the rudder slightly to starboard. When the handle is turned counter-clockwise in the direction marked "left," the effect is reversed. An indicator (Fig. 1) showing the position of the tab is incorporated on the handle. The aileron trimming tab on the starboard aileron is controlled from a handwheel, mounted forward of, and below the engine controls (Fig. 1). To counteract any tendency of the aeroplane to fly with the port wing high, the wheel should be rotated to port in the direction marked "PORT WING DOWN," and vice-versa. To depress the port wing, the tab is raised and the air load on the tab then forces the starboard aileron down slightly. An indicator showing the position of the tab is fitted on the hydraulic control panel beside the rudder trimming handle (Fig. 1). The tab on the port aileron can be adjusted on the ground only.

(d) The wing flaps are actuated by hydraulic pressure, the control lever is located on the hydraulic panel (Fig. 1), between the elevator and rudder trim handwheels. To lower the wing flaps, move the control lever in the down position (i.e., with hydraulic selector in the "out" position); when the flaps have moved to the down position as shown by the position indicator on the hydraulic panel (Fig. 1), return the control to neutral. To raise the flaps, move the control to the "up" position; when flaps are in the up position return control to neutral position. When the aeroplane is standing idle, always have the flaps in the "up" position with the control lever in neutral.

4. POWER PLANT CONTROLS (Refer Fig. 4).

(a) The carburettor air temperature controls are situated at the rear of the pilot's seat (on the starboard side and above the fuel tank cock levers), and control either hot or cold air to the carburettors. The lever for the port engine air intake has a red knob and the starboard is green. Down position cold air, up position hot air (Fig. 4).

(b) The supercharger ratio controls are situated in front of the engine throttle controls, and above the aileron trim handwheel (Fig. 4). When controls are back towards engine throttle, they are in "low" position. When controls are fully forward it is in the "high" position. When changing from one blower ratio to the other, the engine should be partly throttled back and the supercharger control moved without pausing to avoid rough operation during the clutch engagement.

(c) Two throttle controls are mounted on a quadrant at the forward end of the engine control structure on the right hand side of the pilot's seat (Fig. 4). The throttle lever slots are fitted with a gate to prevent the engines being over-boosted during take-off, the gate being adjusted so that the maximum boost obtained is 47" H.G. They are also marked "shut" and "open." A shielded bomb firing switch is fitted on the starboard throttle lever control.

(d) The mixture controls are mounted as above (para. (c)), and they have four positions which are:—

(1) Right back—Full rich.

(2) First position forward—Automatic rich.

NOTE.—This position is used for all normal operations.

(3) Second position forward—Automatic lean.

(4) Right forward—Idle cut-off position.

An adjuster for the stiffness of the above controls is provided at the side of the quadrant.

(e) The Curtiss airscrew controls are situated aft of the Hobson control box in the following order:—

(1) Electric airscrew control box (Fig. 4).

(2) Airscrew governor control (Fig. 4).

The manual airscrew control levers are of the same design for both type airscrews, and are situated at the pilot's right hand on the engine control structure. In the case of the Curtiss electric, the electric control box containing the micro and feathering switches are fitted in front of the aforementioned manual levers.

(f) There are two types of cowl gills used, namely, Lockheed electric and C.A.C. manually operated. The switch which operates the Lockheed electric is on the port side of the fuselage (Fig. 3). The manually operated are controlled by two hand wheels situated on the port side of the fuselage by the pilot's seat (Fig. 3). The gills are controlled by a cable running from the hand wheels to the actuating arms which operate the gills.

(g) The oil cooler flap is situated at the top and rear of the oil cooler fairing, both port and starboard, and may be adjusted on the ground only.

5. FUEL SYSTEM CONTROLS.

(a) The auxiliary and balance controls are situated on the starboard side of the fuselage aft of the emergency and priming cock (Fig. 4). There are four positions marked on the indicator, the positions being as follows:—

(i) Auxiliary with balance on (handle pointing upwards).

(ii) Auxiliary to stbd. engine (handle pointing forward).

(iii) Auxiliary to port engine (handle pointing aft).

(iv) Auxiliary off with balance on (handle pointing downwards).

NOTE.—

(b) The fuel tanks selector controls are situated aft of the airscrew controls on the engine structure, near the pilot's right hand. The back position being "off" and the forward position "on." Each control has an indicator fitted to the control box. The coloured knobs on the levers indicated as follows:—

Auxiliary tank: "BLACK."

Stbd. main and wing tanks: "GREEN."

Port main and wing tank: "RED."

(c) The emergency and priming controls are situated on the starboard side of the fuselage aft of the fuel contents gauges. There are four positions marked on the indicator. They are as follows:—

"OFF": Handle pointing upward.

Port engine "ON": Handle pointing forward.

Stbd. engine "ON": Handle pointing aft.

Port and stbd. engine "ON": Handle pointing down.

(d) The wobble pump is situated in the engine control structure and below the engine control levers (Fig. 1).

(e) The priming pump is situated at the bottom of the hydraulic control panel. There are two types used, namely, Ki-gass and Parker. The Ki-gass being a separate pump for each engine, and the Parker being a dual pump. The operation of the Parker being, push handle in and turn "left" to prime "port" motor, and turn "right" to prime "stbd." motor (Fig. 1).

(f) The fuel jettison valve is attached to the fuselage on the port side near the pilot's seat. The object being to jettison the fuel in the wing tanks in an emergency. The "OFF" position being aft of the control box and "ON" forward of control box (Fig. 3).

6. LANDING GEAR CONTROLS.

(a) The hydraulic undercarriage control lever is situated on the hydraulic panel (Fig. 1). It has a black round knob, which controls the raising and lowering of the two undercarriage units and tail wheel unit. (Tail wheel unit is now locked "DOWN.") The movement of the lever is in the same sense as the movement of the units, i.e., "up" to raise the units and "down" to lower them.

For operation, the by-pass and turret selector valve must be pulled out. (Ref. Section (1), Part (7), Para. (e).)

(b) There are two emergency systems, being the emergency hand pump and the emergency cartridges firing. The emergency hand pump is fitted behind the hydraulic control panel, with an attachment for the pump handle protruding through the panel. The pump handle has a red handle grip and is stowed in the clips at the bottom of the hydraulic panel. When this pump is used, fluid is delivered to the two undercarriage jacks, via the main control valve. The operation is as follows:—

(i) Pull out by-pass and turret selector valve.

(ii) Place the undercarriage lever in the "DOWN" position.

(iii) Then use the emergency hand pump.

NOTE.—This is recommended if there is sufficient time to lower the undercarriage by hand (time 7 to 15 minutes). If time does not allow, the emergency cartridge firing system should be used.

The emergency cartridge firing system has a valve which is incorporated in the gravity line to the emergency cartridge firing system lines, and it is manually operated and is situated on the port side of the fuselage near the pilot's compass (Fig. 3).

The valve is used because the circuit is an open one, and thus the circuit should be closed before use, as resulting pressure on the operation of cartridge system would be lost through the oil reservoir. It is of the rotary type, and is situated below the push button, with its own operating lever, and is so positioned that the latter, when it is "off," prevents the shield over the push button being lifted. To operate the system, the lever must be pulled back from the vertical position to the horizontal position marked "Emergency." The lever and shield are painted red.

NOTE.—It is imperative that once emergency by-pass valve lever is put in the emergency position it should not be moved, for the following reasons:—

(i) As stated above.

(ii) To facilitate the cleaning and servicing of the hydraulic system.

(c) The undercarriage indicating and warning devices include three electrical indicators situated on top of the hydraulic panel, one for each unit, and an electrical buzzer which is controlled by a switch actuated by either engine throttle lever which operates it at 15" to 16" H.G. manifold pressure. The operations of the indicators are as follows:—

(i) "RED" is "UP."

(ii) "GREEN" is "DOWN."

The electrical buzzer is situated on the rudder control structure fore of the rudder pedals.

(d) The undercarriage safety lock control is situated on the hydraulic panel, and left of the undercarriage control lever. At the rear of the hydraulic panel is located a spring loaded plunger. This when moved in the upwards or downwards direction actuates, per medium of a cam, a bolt which moves across the undercarriage lever in the "down" position.

In order to prevent inadvertent retraction of the alighting gear when the aeroplane is on the ground, the control lever is automatically locked in the "down" position by the safety lock. When the weight of the aeroplane is on the undercarriage and the oleo frame is compressed, the cable is slack and the pin is forced by the spring into a position where it obstructs the movement of the control lever in the "up" position. When the aeroplane is in flight and the weight is removed from the undercarriage, the lock can be moved out of the way by hand, pulling out the knurled knob at the centre of the pin and removing the pin to the left.

(e) The undercarriage safety locking pins are fitted in the radius rods and have a warning flag attached to prevent the pilot from taking off with pins in position.

(f) **Tail Wheel Locking Control:** The tail wheel locking control is attached to the starboard side of the hydraulic control panel. Its operation is as follows:—

(i) "DOWN": Tail wheel "FREE."

(ii) "UP": Tail wheel "LOCKED."

(g) **Landing Lamp Controls:** The landing lamp controls are attached to the side of the engine control structure, directly below the airscrew controls. Its operation is as follows:—

(i) Forward: Lights "DOWN."

(ii) Back: Lights "UP."

7. HYDRAULIC CONTROLS (Refer Fig. 1).

(a) **Undercarriage Controls:** Refer Section 1, Chap. 6, Para. (a).

(b) **Emergency Hydraulic Hand Pump Control:** Refer Section 1, Chap. 6, Para. (b).

(c) **Flap Control:** Refer Section 1, Chap. 3, Para. (d).

(d) **Bomb Door Controls:** The bomb door control lever is situated on the left of the hydraulic panel, and has a red knob. It controls the opening of the hydraulically operated doors of the bomb cell under the fuselage; to the "up" position of the lever the doors are closed, and in the "down" position the doors are open. Refer Sec. 1, Part 8, Para. (iv).

(e) The turret and by-pass control operates a valve that directs the fluid either for the operation of the undercarriage, flaps and bomb doors, or to the gun turret and fluid by-pass. For undercarriage, flaps and bomb doors operation, the control should be pulled "out," but unless these services are being used it should be pushed "in." It is situated on the left of the hydraulic panel, and an indicator attached to the side of the control indicates which alternative is in use.

(f) **Undercarriage Emergency Cartridge Firing Controls:** Refer Section 1, Part 6, Para. (b).

(g) **Emergency Flap Controls**: In case of failure of the main hydraulic system, it is necessary to make an emergencv lowering of the flaps; the following operations are carried out:—

(i) Pull out the emergency selector (situated below the flaps controls).

(ii) Place the flap lever in the down position.

(iii) Then use the emergency hand pump.

NOTE.—TO PREVENT DAMAGE TO FLAP PULLEY BRACKET DUE TO JAMMING OF FLAP JACK MECHANISM, THE FOLLOWING INSTRUCTIONS MUST BE RIGIDLY ADHERED TO:—

UNDER NO CIRCUMSTANCES MUST MAIN HYDRAULIC SYSTEM BE OPERATED TO RAISE OR LOWER FLAPS WHILE EMERGENCY HAND PUMP CONTROL VALVE IS IN AN "OPEN" POSITION.

8. BOMB CONTROLS.

(a) **Bomb Door Controls:** Refer Section 1, Part 7, Para. (d).

(b) **Throttle Release Switch:** This switch is attached to the starboard engine throttle lever, and it enables the pilot, after the selection has been made by the bomb aimer, to release the bombs. It also allows him to drop his torpedo when carried (Fig. 4).

(c) The bomb jettison is attached to the fuselage on the port side, aft of the instrument panel attachments. It consists of a globe in a container with a shield covering the globe, which is also the indicator, which reads: To jettison bombs, lift flap and press bulb (Fig. 3).

(d) The small bomb container jettison switch is situated aft of the bomb jettison switch, and attached to the fuselage on the port side. There is an indicator which reads: "To jettison bombs, lift flap and press" (Fig. 3).

(e) The bomb door positional indicator is directly aft of the small bomb container jettison switch; is attached to the fuselage. Its operation is as follows:—

(i) Bomb doors open: Red light is shown.

(ii) Bomb doors closed: No light is shown.

9. FIXED GUN CONTROLS (Fig. 1).

(a) The firing button is situated on the top left-hand corner of the spectacles. The front of the button is in the form of a knurled knob marked "Fire and Safe." The valve within the button can only be operated when this knob is turned to the "Fire" position. The press cap may then be depressed, which opens the inlet and closes the exhaust valve.

10. ELECTRICAL CONTROLS (Refer Fig. 2).

(a) **Ignition Switches:**

(i) Master chassis or ignition switch.

(ii) Magneto individual engine switches.

These switches are situated on the bottom of the instrument panel on the port side. The master or chassis switch works on the sliding principle; the operation is that this switch slides across the individual magneto switches and prevents them from being switched on. It also switches on the undercarriage indicator, and the oil temp. gauges, and the cylinder head temp. gauge. The individual switches are connected to the magnetos on the engines. The operations of these switches are as follows:

(i) "UP" is "ON."

(ii) "DOWN" is "OFF."

NOTE.—The magneto individual switches cannot be operated unless the master chassis switch is on.

(b) **Undercarriage Warning Horn and Release Switch:** Refer Section 1, Part 10, Para. C.

(c) **Undercarriage Indicator Lights (Dazzle)** (Fig. 1): Refer Section 1, Part 10, Para. B.

(d) **Starter Button Switches: Port and Starboard** (Fig. 1): These starter switches are situated on the left-hand top corner of the instrument panel (port side). These switches have a "safety" flap attached, which reads as follows: "Lift flap and press." There are two buttons under each flap, one being the starter button and the other booster coil. The port is at the top of the panel and the starboard directly underneath.

(e) **Fire Extinguisher Button Switch** (Fig. 2): The two shielded push buttons (painted red) are situated on the instrument panel (port side) of the blind flying panel, and when pressed release the contents of the two fire extinguishers, one in each engine nacelle.

(f) **Emergency Cartridge Firing Button** (Fig. 3): Refer Section 1, Part 7, Para. F.

(g) **Landing Lamp Switch and Recognition Lights** (Fig. 4): The landing lamp switch is situated on the starboard side directly below the fuel contents gauges. The operation is as follows:—

(i) Switch centre: "OFF" position.

(ii) Switch up: "INNER" lights "ON."

(iii) Switch down: "OUTER" lights "ON."

The recognition light signalling switchbox is situated on the port side of the cockpit, and fore of the identification lamp switches. It provides for independent or simultaneous use of the upward and downward identification lamps through the morse key, or alternatively a steady illumination from the lamps. The desired downwards lamps (red, green, or clear), should be selected on the 3-unit switchbox. (Refer Section 1, Part 10, Para. (g).)

(h) **Navigation and Formation Keeping Lights** (Refer Figs. 1 and 4): The navigation light switch is situated on the instrument panel (below the magneto individual switches—Refer Sec. 1, Part 10, Para. A). The navigation lamps are controlled by this switch. Its operation is: "UP" is "OFF" and "DOWN" is "ON." The formation keeping lights switchbox is situated on the starboard side fore of the emergency and priming control (Refer Sec. 1, Part 5, Para. C). It provides for morsing or steady illumination from the formation keeping lamps.

NOTE.—On the downward switch is wired.

(i) **Identification Lamps and Emergency Signalling—Abandon Aircraft System** (Fig. 3): The identification lamps are situated on the underside of the rear fuselage aft of the parachute flare doors, and are in this order: Clear, green, red. The control switchbox is situated on the fuselage (port side) aft of the recognition switchbox. The switchbox contains three independent switches, namely, one for each light. The operation is as follows: "UP" is "OFF," "DOWN" is "ON."

The emergency signalling abandon aircraft system is situated on the fuselage (port side) below the bomb jettison switches (Refer Sec. 1, Part 8, Paras. c and d). It consists of two panels, one with a switch and globe, and the other three globes, namely: Navigator, W.T. Operator. Rear Turret. For operation refer Sec. 3, Part 10, Para. o.

(j) **Fuel Contents Switch** (Refer Fig. 4): The fuel contents switch is situated on top of the housing of the fuel contents gauges on the starboard side. Its operation is fore "OFF," aft "ON."

(k) **Cockpit Lighting** (Refer Fig. 3): The pilot's cockpit has two lights, one on the port side just above ground identification light switches, and the other at the top of the junction of the pilot's and co-pilot's windows. These lights are of the directional type and are rheostat controlled.

(l) **Cowl Gill Switches:** Refer Section 1, Part 4, Para. f.

(m) **Pressure Head Switch** (Refer Fig. 2): The pressure head switch is situated on the bottom of the instrument panel next to the navigation light switch. Its operation being to electrically heat the pressure head when operating in icing conditions.

(i) Up position heat "OFF."

(ii) Down position heat "ON."

(n) **Airscrew Switches** (Refer Fig. 4):

(i) Thermal overload switch.

(ii) Increase, decrease, and automatic position switch (4 way). Refer Section 1, Part 4, Para. e.

(o) **Abandon Aircraft Signalling Switches and Indicators** (Refer Fig. 3): Refer Section 1. Part 10, Para. (i).

(p) **Torpedo Sight:** This sight is mounted on the port side of the pilot's cockpit and composes the following sections:—

(i) Parabolic mirror mounted forward and above pilot's head.

(ii) Parabolic row of lights (festoon) set at required angles mounted behind and above pilot's head.

(iii) Control box mounted on a folding and swinging table on starboard side of pilot's cockpit just forward and below fuel contents gauges. (Refer Section 1, Para. 10J.)

When both the parabolic mirror and parabolic row of lights are set up in a definite relation to one another, also with fuselage datum, this arrangement then enables the pilot when dropping a torpedo to make his run at the required angle of interception.

11. EMERGENCY EXITS.

(a) At each side of the cockpit a special window with a fixed pane and a sliding pane is provided; each window can be jettisoned by operating a lever at the bottom, and used as an emergency exit. The lever is operated by releasing the safety catch at the end, raising the lever clear of the fulcrum point near its middle, and removing the lever from the support bracket at the forward. The window can then be jettisoned by pushing it outwards.

(b) There is also an exit hatch in the roof of the cockpit on the starboard side, consisting of two hinged doors opening inwards. The doors are held shut by two bolts in stops at the forward and after ends, and may be opened by pulling down the handle at the centre. The inboard door, when open, is held against the roof by an elastic cord at the rear end. The head should be kept clear of the inboard door when opening the hatch, as the elastic cord causes it to open violently.

(c) Another emergency exit is provided in the floor of the navigator's compartment (being the under defence gun). It is released by raising the handle (painted red) in the recess on the port side of the hatch.

(d) The entrance hatch is the emergency exit used by the wireless transmitter operator and gunner.

12. PNEUMATIC SYSTEM CONTROLS.

(a) **Brake Lever** (Refer Fig. 1): The brake lever is attached to the top of the pilot's control column, and has a locking pin attached to lock the brakes in the "ON" position. The positions are as follows:—

(i) Lever pressed forward: "BRAKES ON."

(ii) Lever released: "BRAKES OFF."

(b) **Gun Firing Button** (Refer Fig. 1): Refer Section 1, Part 9, Para. A.

(c) **Camera Gun Control** (Refer Fig. 1): The camera gun is situated on the outboard of the front fuselage on the starboard side, and is controlled by the gun firing button—Refer Section (1), Part 9, Para. A.

(d) **Triple Pressure Gauge** (Refer Fig. 2): The triple pressure gauge is situated on the port side of the fuselage. The gauge has three pointers showing the air pressures—one for the air container bottle—and also the individual pressure on each wheel.

13. RADIO CONTROLS.

(a) **R3003 Receiver Master Switch** (Refer Fig. 4): The R3003 receiver master switch is situated on the starboard side of the fuselage directly below the fuel contents gauges. Its operation is as follows:—

Lift flap and press.

(b) **Intercommunication Jack or Socket:** The pilot's intercommunication jack is attached to the front, underneath side of the pilot's seat.

14. PILOT'S SEAT (Refer Fig. 4).

(a) The pilot's seat is constructed to take a seat type parachute, and is fitted with hinged arm rests. The seat is adjustable by means of a lever on the left-hand side; the lock for securing the seat at the desired height can be released by turning the twist grip at the end of the lever.

(b) **Safety Harness Release Control:** The Sutton harness safety release control is situated at the front of the pilot's seat, starboard side.

15. OPERATIONAL EQUIPMENT (Refer Fig. 2).

(a) **Blind Flying Panel:** The blind flying panel is situated in the centre of the pilot's instrument panel, and is attached to the instrument panel by shock absorber attachment legs. The blind flying panel consists of the following instruments:—

(i) Air speed indicator.

(ii) Artificial horizon.

(iii) Climb and descent.

(iv) Altimeter.

(v) Direction gyro.

(vi) Bank and turn.

(b) **Emergency Control Vac. Pump Change Over Cock** (Refer Fig. 4): The control is situated at the top tubular structure at the aft end of the engine control structure above the air intake levers (Section 1, Part 4, Para. a). The suction gauge is situated on top of the instrument panel (port side).

(c) **Pitot and Static Head:** The pitot and static head is situated fore and underneath the nose of the fuselage. A switch operated by the pilot controls the electrical circuit for heating purposes.

(d) **Fuel Contents Gauges (Refer Fig. 2):** The fuel contents gauges are situated on the starboard side of the fuselage, being a panel with the following gauges installed, take fore and aft.

(i) Port outer.

(ii) Port inner.

(iii) Starboard outer.

(iv) Starboard inner.

(v) Auxiliary.

(e) **Pilot's Gun Sight** (Refer Fig. 1): The pilot's gun sight for the fixed guns consists of a ring suspended close to the inside of the pilot's windscreen, and a bead on the faired post forward of the windscreen vertical adjustment is provided for the ring and lateral adjustment for the bead.

(f) **Parachute Flare Control:** The parachute flare control is situated on the port side of the fuselage, in line with the back of the pilot's seat and below the fuel jettison lever. Its operation is as follows:—When the lever is pulled through the first gate, the first flare is released, and when pulled through the second gate the second flare is released. After use, the lever should be returned to its normal position.

(g) **Verey Signal Pistol:** The Verey pistol has two positions, one being on the port side near the triple gauge (Refer Section 1, Part 12 Para. d), and the other upwards and behind the pilot's head.

(h) **Landing Lamp Controls:** Refer Section 1, Part 6, Para. g.

(i) **Oxygen Equipment:** A standard oxygen regulator is fitted on the port side of the instrument panel and a Mk. IIIA bayonet union is fitted on the port side of the fuselage in line with the back of the pilot's seat.

(j) **Camera Gun Control:** Refer Section 1, Part 9, Para. a.

(k) **Compass** (Refer Fig. 1): The pilot's compass is attached to a bracket which is attached to the fuselage, port side.

16. MISCELLANEOUS EQUIPMENT.

(a) **Hand Fire Extinguisher:** The hand fire extinguisher is attached to the engine control structure on the starboard side, aft of the wobble pump.

(b) **Fireman's Axe** (Refer Fig. 1): An axe, for cutting a way out of the fuselage in an emergency is stowed at the side of the vertical part of the engine control structure.

(c) **Sun Blind:** A sun blind is provided above the pilot's head; it is fitted with a tab and hook to enable it to be pulled forward and secured in an eye at the forward end of the wire rails on which it slides.

(d) **Ration Stowage:** Rations are stowed below the sextant and range finder aft of the pilot's head (Refer Section 1, Part 1, Para. k).

(e) **Direct Vision Windows or "Storm Window"** (Refer Fig. 1): In the rear corner of the pilot's windscreen, both port and starboard, is a direct vision windows for use of the pilot when his main windscreen is obscured. The windows open inwards on hinges at the inboard sides, and are retained in the open position by trip catches at the bottom of the windscreen. When the windows are opened, a small wind deflector plate at the hinge is rotated outwards. A small bar for opening the windows if they become frozen to the draught excluder round their edges is stowed along the sill tube behind the starboard direct vision window; to force the window the bar should be used as a lever in the fork below the securing catch.

(f) **Knock Out Panels** (Refer Fig. 1): Immediately aft of each direct vision window is a triangular panel that is secured on the outside only by the draught-excluder round the edges, and therefore may be easily knocked out if necessary in extreme conditions of bad visibility.

ILLUSTRATION 1

1. Control Column.
2. Rudder Pedals.

3 & 4. Trim Tab Controls.

5 & 6. Flap Controls.

7. Wobble Pump.
8. Undercarriage Controls.
9. Emergency Hydraulic Hand Pump.
10. Hydraulic Selector.
11. Bomb Door Lever.
12. Undercarriage Indicator (Dazzle).
13. Emergency Flap Control.
14. Firing Button (Wing Guns).
15. Starter Button, Port and Stbd.
16. Cockpit Lighting (Fore).
17. Brake Lever.
18. Blind Flying Panel.
19. Pilot's Gun Sight.
20. Landing Lamp Control.
21. Compass.
22. Fireman's Axe.
23. Aileron Indicator.
24. Undercarriage Safety Lock.
25. Storm Window.
26. Knock-out Panel.
27. Priming Pump.

ILLUSTRATION 2

1. R.P.M.
2. Boost Gauges.
3. Suction Gauges.
4. Air Speed.
5. Gyro Horizon.
6. Rate of Climb.
7. Altimeter.
8. Direction Indicator.
9. Bank and Turn Indicator.
10. Cylinder Head Temp.
11. Oil Temperature.
12. Fuel Pressure.
13. Oil Pressure.
14. 8 Day Clock.
15. Pilot's Steering Indicator.
16. Triple Indicator Gauge.
17. Oxygen Regulator.
18. Fire Extinguisher.
19. Chassis Master Switch.
20. Ignition Switches.
21. Navigation, Formation and Pitot Head Switches.
22. Rudder Pedal Adjustment.
23. Tail Wheel Locking Control.

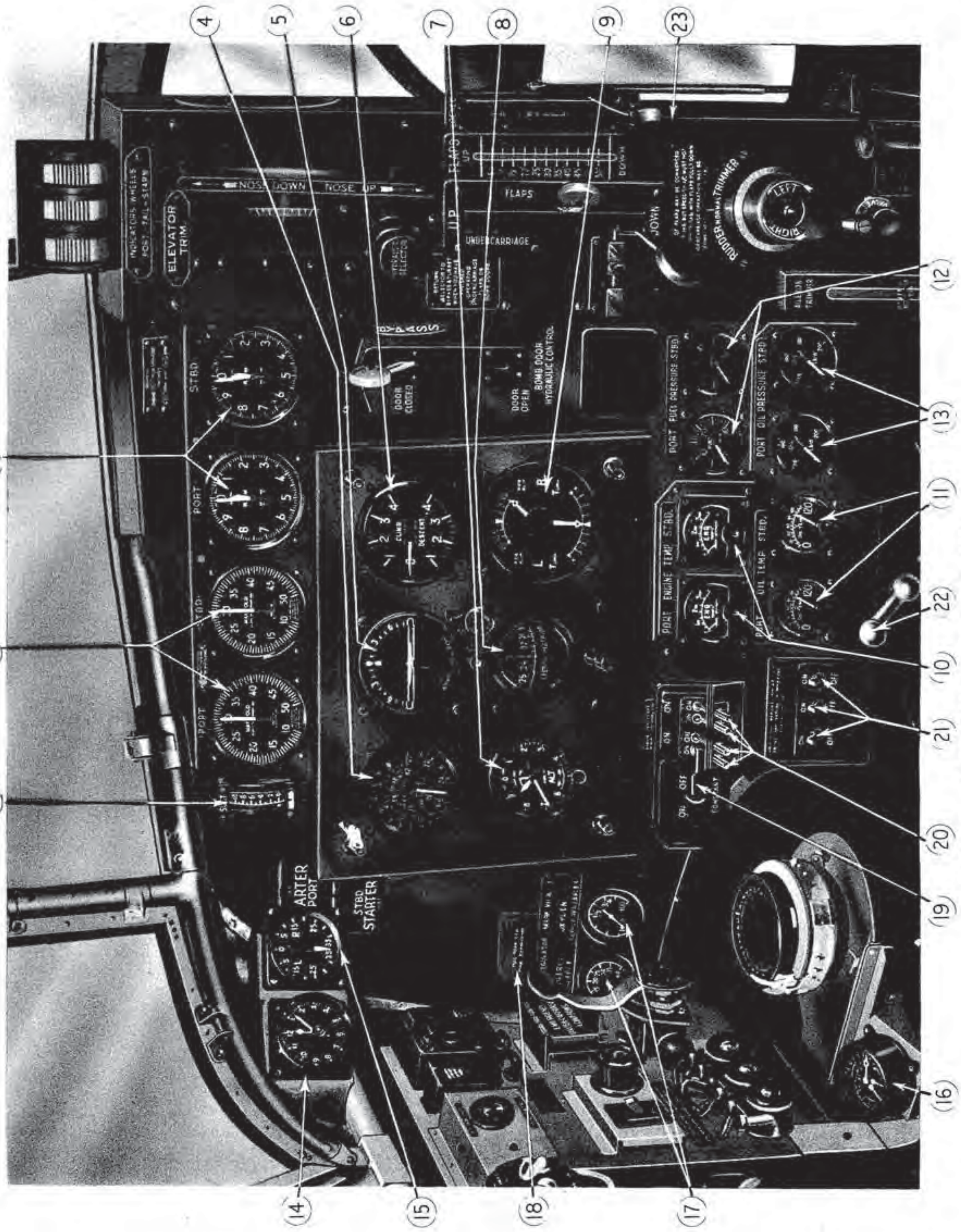

FIG. 2.—INSTRUMENT PANEL.

ILLUSTRATION 3

1. Cowl Gill Control (Manual).
2. Pilot's Seat.
3. Ground Identification Lights.
4. Cockpit Lighting.
5. Jettison Switches (Bombs and Containers).
6. Bomb Door (Positional) Indicator Lamp.
7. Emergency Signalling (Abandon Aircraft).
8. Knock-out Panel.
9. Pilot's Escape Window (Port Side).
10. Headlight Signalling.
11. Emergency Lowering By-pass Valve.
12. Emergency Cartridge Firing Button.
13. Sutton Safety Harness.
14. Cowl Gill Switches (Effective 1-50).
15. Fuel Jettison Valve.

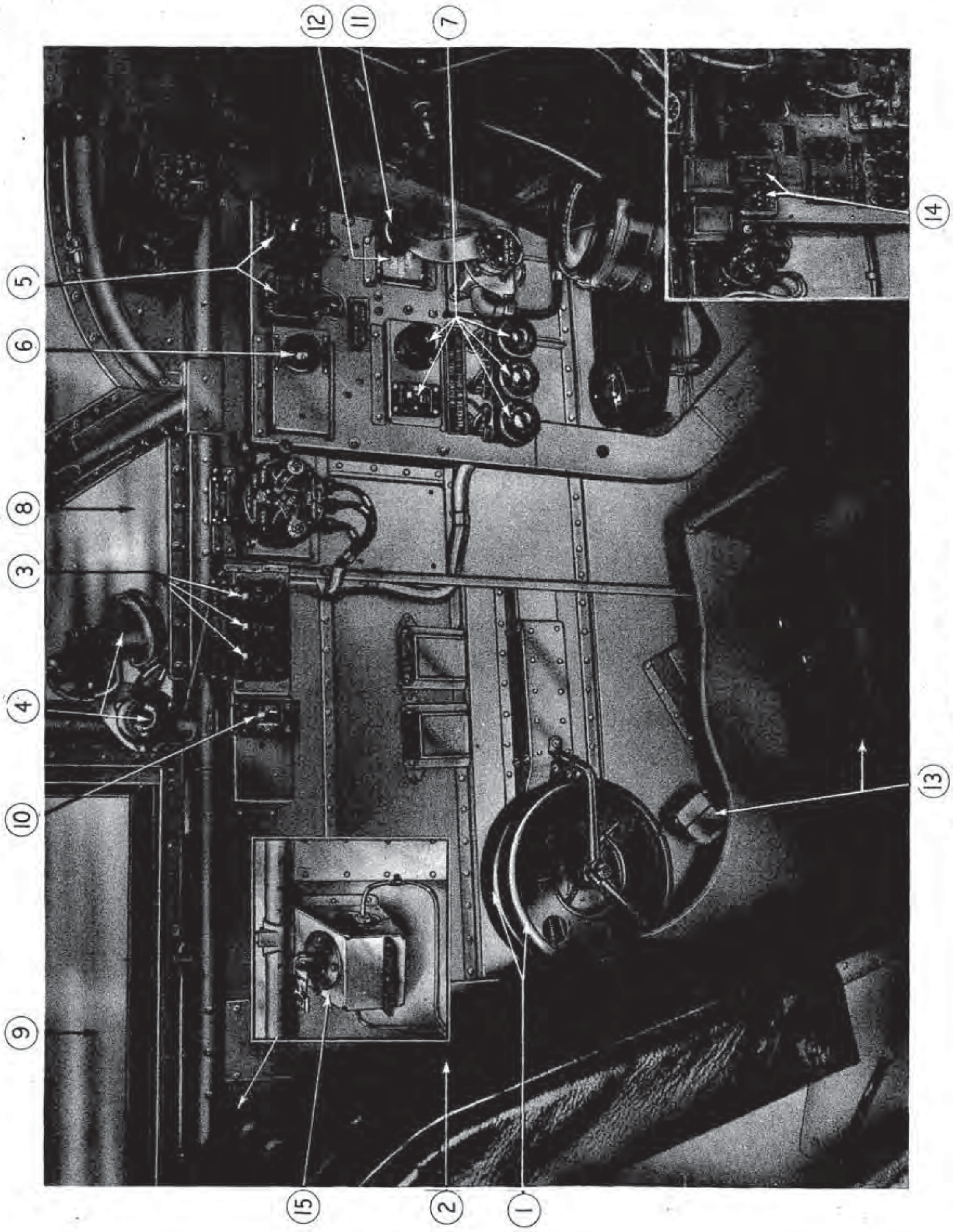

FIG. 3.—PILOT'S COCKPIT (PORT).

ILLUSTRATION 4

1. Emergency Escape Window (Stbd. Side).
2. Air Temp.
3. Fuel Contents Gauges.
4. Formation Keeping Switch Box.
5. Emergency and Priming Control.
6. Auxiliary and Balance Selector.
7. R. 3003 Master Switch.
8. Vacuum Pump Change Over Control.
9. Carburettor Air Scoop Controls.
10. Landing Lamp Switch.
11. Mixture Controls.
12. Supercharger Ratio Controls.
13. Throttle Controls.
14. Air Screw Governor Control.
15. Aileron Trim Control.
16. Throttle Bomb Release Switch.
17. Chart Case.
18. Air Screw Control Box Switches.
19. Fuel Contents Gauge Switch.
20. Pratt & Whitney Instruction Plate.
21. Air Screw Instruction Plate.

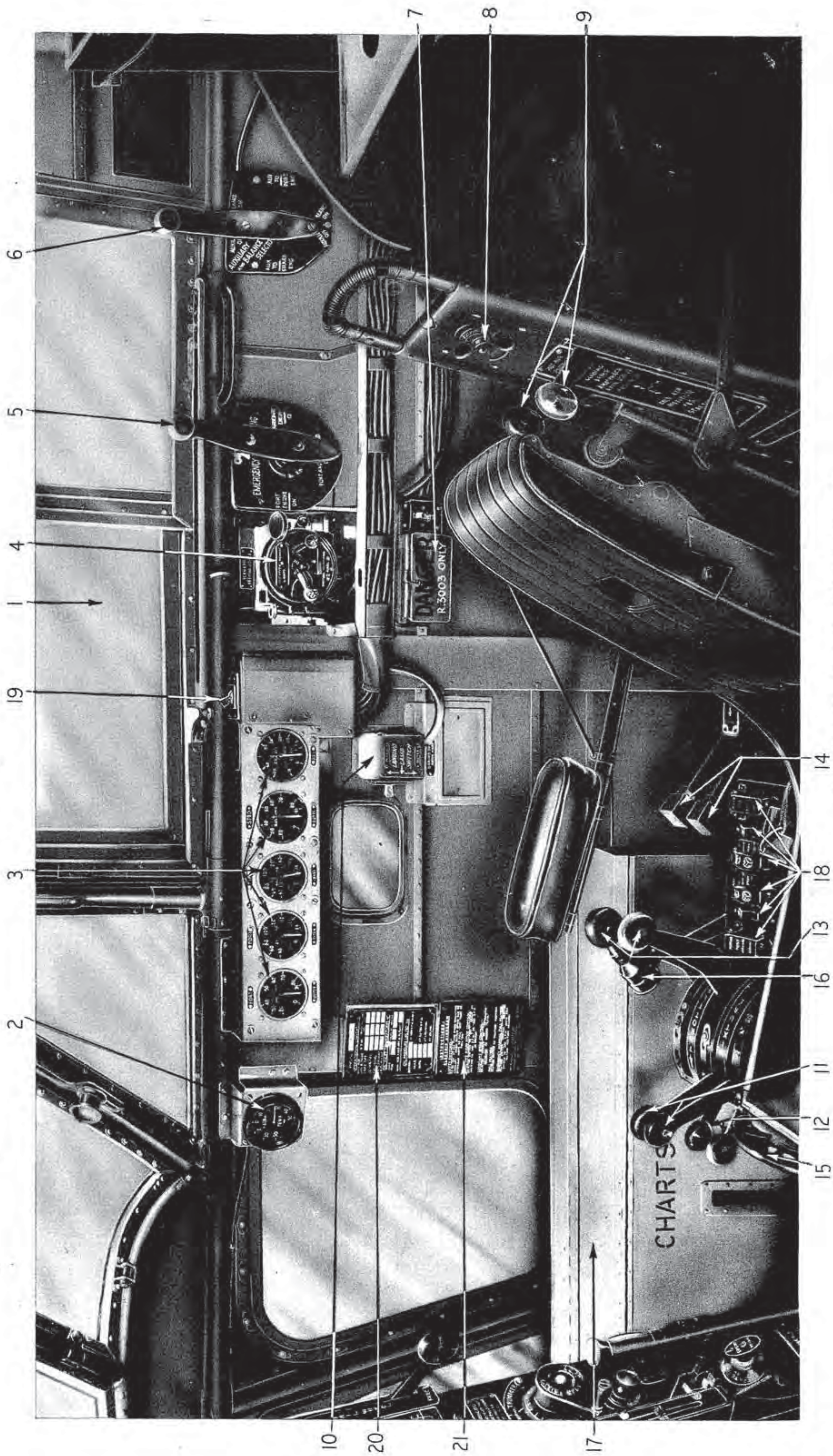

FIG. 4.—PILOT'S COCKPIT (STBD. SIDE).

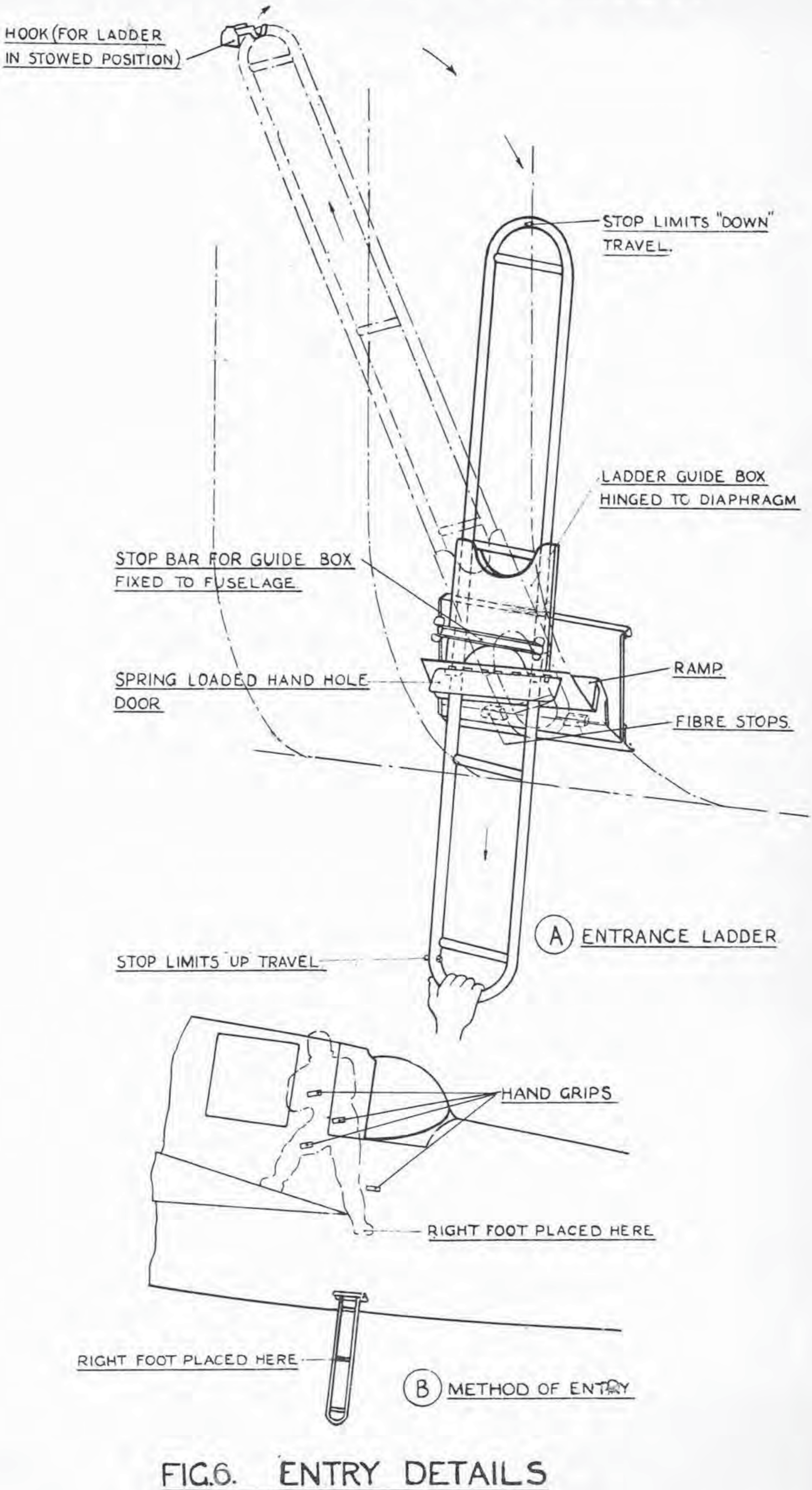

FIG.6. ENTRY DETAILS

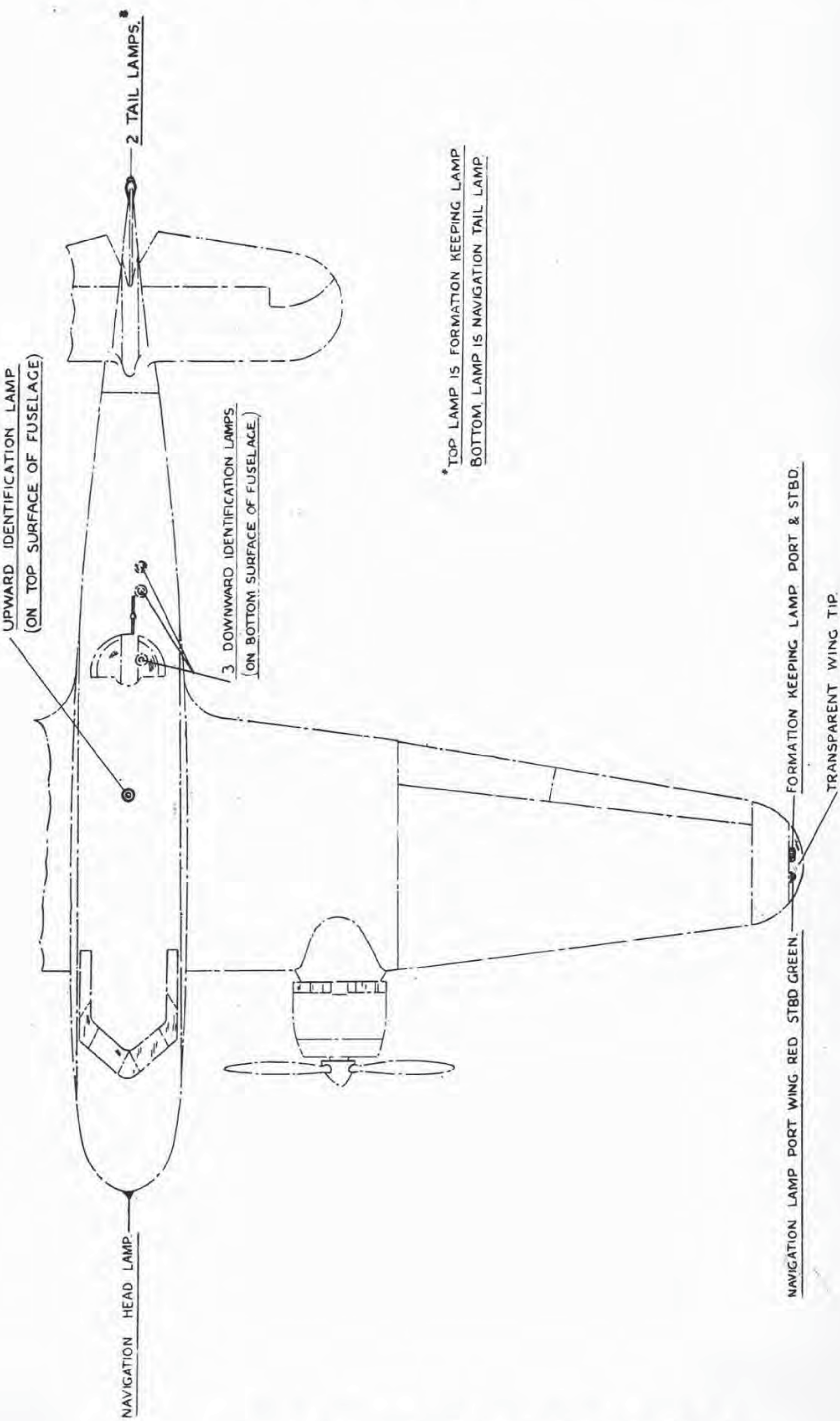

FIG.7 NAVIGATION & FORMATION LAMPS.

SECTION 2

HANDLING AND FLYING NOTES FOR PILOTS

SECTION 2 WILL BE INSERTED IN THE BOOK

AT A LATER DATE.

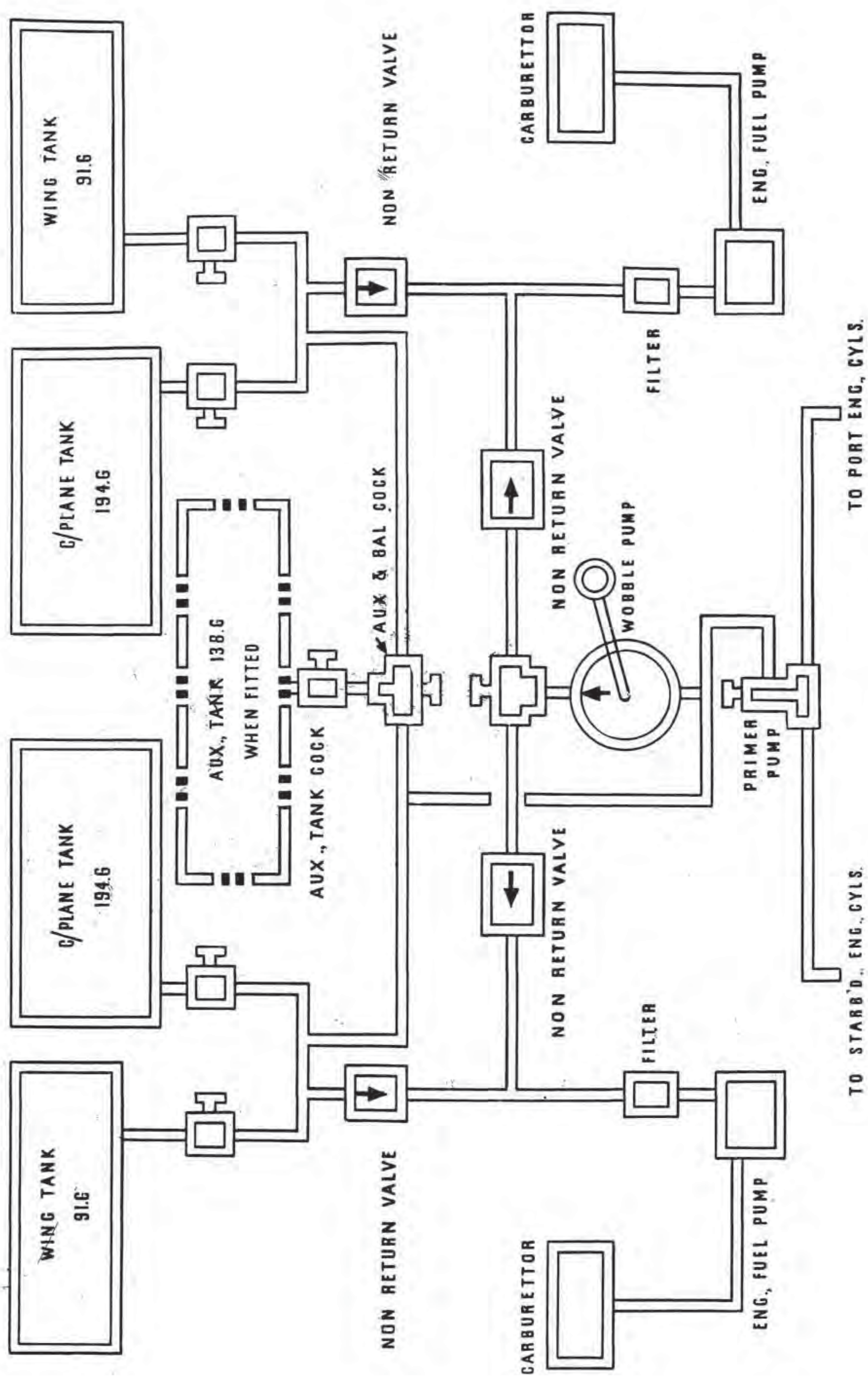

FIGURE 1. FUEL SYSTEM.

SECTION 3

SECTION 3

CONTROLS AND EQUIPMENT AT CREW STATIONS

SECTION 3

CONTROLS AND EQUIPMENT AT CREW STATIONS

ILLUSTRATIONS

SECTION 3

CONTROLS AND EQUIPMENT AT CREW STATIONS

1. NAVIGATOR OR BOMB AIMER'S STATION.

(a) GENERAL.

The fuselage is divided into three sections, namely, the station for the navigator, who also performs bomb aiming duties, the wireless compartment and the gunner's station. The navigator or bomb aimer's station extends from the nose to the pilot's instrument panel, and along the side of the pilot's cockpit to the main plane front spar; the wireless compartment and gunner's station are taken to be the compartment forward and aft, respectively, of the partition bulkhead at the main entrance hatch.

(b) BOMBING CONTROLS.

The bombing controls are situated in a panel attached to the armour plate at the rear of the navigator's table.

(c) BOMB SIGHT MOUNTING (Refer Fig. 1).

The bomb sight mounting is hinged on the support tube from the navigator's table, and is situated underneath the forward end of the navigator's table. To move it from its stowed position under the table, it is necessary to release the grooved locking ring above the hinge, then lift unit and turn to the required position and screw down locking ring.

(d) BOMBING CONTROL PANEL.

The bombing control panel consists of the following:—

Bomb Distribution.

(i) The bomb distributor is situated in the top left corner of the bomb panel looking aft. There are two types used, namely, C.A.C. and Air Ministry. For operation refer to "Maker's Instructions."

Container Distributor Switch.

(ii) The container distributor switch is situated in the centre of the control panel, and has two positions, namely:—

- (i) "Up" for container.
- (ii) "Down" for distributor.

Individual Bomb Selector Switch Panel.

(iii) The individual bomb selector switch panel is situated directly below the bomb distributor. There are seven switches on this panel, one to each bomb rack. The navigator or bomb aimer selects these as required; they are then controlled by the bomb distributor. The operation of the switches is as follows:—

(i) Forward position is "Off."

(ii) Up position is "Select."

(iii) Down position is "Distributor."

Nose and Tail Fusing Switches.

(iv) The nose and tail fusing switches are situated directly below the individual bomb selector switches. There are two switches, one for nose fusing and one for tail fusing. The operation of the switches is as follows:—

(i) Up position is "Off."

(ii) Down position is "On."

Bomb Door Indicator Light.

(v) The bomb door indicator light is situated to the left of the individual bomb selector switches. Its operation is as follows:—

(i) Light on: Bomb doors "Open."

(ii) Light off: Bomb doors "Closed."

(e) **NAVIGATOR'S SPECIAL WINDOWS** (Refer Fig. 1).

The navigator's special windows at the bomb aimer's seat position are situated port and starboard. The port window is hinged at the bottom, and the stbd. at the top. Both windows open inwards and are secured by catches.

(f) **NAVIGATOR'S SEATS** (Refer Fig. 1).

There are two navigator's seats, one a pan type and is attached to the central tubular structure forward of the pilot's instrument panel; when not in use the seat can be swung out of the way under the navigator's table. A spring-loaded pawl at the hinged end of the arm engages in a notched quadrant on the tubular support and enables the seat to be locked in any one of the three positions. Two pins are provided on the pawl for withdrawing it from the notches. A safety belt is fitted to attachments on the floor members. Another seat is provided on the starboard side just aft of the pilot's seat, and has a padded seat and back, and also a foot rest attached. In order to provide a foot rest up to the wireless compartment, the back is arranged to fold down on to the top of the seat. A safety belt is fitted and is connected by cable to two lugs on the top boom of the main plane front spar. To take in the dual control seat, the safety belt can be lengthened by removing two quick release pins.

(g) **ANTI-ICING BOMB AIMER'S WINDOW** (Refer Fig. 2).

To prevent the bomb aimer's window on the starboard side from being obscured in icing conditions, either alchol or glycol (or both, as required), can be supplied to a spray at the top of the window. The supply is delivered by compressed air taken from the pneumatic system, and is controlled by two push buttons on the starboard side below the camera supply socket. Each time a button is depressed, a measured supply of fluid is delivered to the spray. The anti-icing fluids are carried in containers under the navigator's seat in the pilot's cockpit.

(h) **0.2 COMPASS** (Refer Fig. 2).

Three alternative positions are provided for the 0.2 compass—one on the port side above the navigator's table and another on the starboard side opposite the hydraulic control panel. A socket for the electrical supply to the filament, when the compass is in position, is fitted near the compass. When the compass is in position, the socket for the inspection lamp may be used. The third is situated at the forward end of the navigator's table.

(i) **TAIL DRIFT SIGHT** (Refer Fig. 1).

The tail drift sight is mounted on a bracket on top of the navigator's table, port side. There is also a hole with a shield attached in the window panel, directly above, which is used in conjunction with tail drift sight. When the tail drift sight is not in use, it is stowed below the footrest of the navigator's seat.

(j) **MAP CASE.**

The map case is fitted on the starboard side of the pilot's cockpit. It is large enough to take maps without folding them, and has a slit in the side to facilitate their removal.

(k) **SEXTANT AND RANGE FINDER STOWAGE.**

The sextant and range finder is stowed behind the pilot's head in stowage box, marked: Stowage for Sextant Range Finder.

(l) **RECONNAISSANCE FLARE RELEASE CONTROL** (Refer Fig. 2).

The reconnaissance flare release control lever is situated on the stbd. side of the nose fuselage. It controls the release of reconnaissance flares. The operation is as follows:—To release a flare, the lever should be pulled upwards, and after release of the flare returned to its normal position.

(m) **NAVIGATOR OR BOMB AIMER'S INSTRUMENT PANEL** (Refer Fig. 2).

The navigator or bomb aimer's instrument panel is situated in the nose, attached to the fuselage on the stbd. side.

(n) **ALDIS SIGNALLING LAMP.**

The Aldis signalling lamp and extension lead are stowed on the port side of the fuselage, underneath the navigator's table; the supply socket for the lamp is fitted on the side of the pilot's hydraulic control panel.

(o) **CAMERA SIGHT** (Refer Fig. 2).

The camera oblique sight is situated on the starboard side of the nose fuselage fore of the navigator's special window (Ref. Section 3, Part 2, Para. (c)), and consists of a ring and bead mounted on a hinged arm. For use, the arm should be swung down against the stop and the position of the bead adjusted according to the angle at which the camera has been set.

(p) **NAVIGATOR SUN BLIND.**

The navigator's sun blind is stowed in a recess above the bomb aimer's panel.

(q) **INTER-COMMUNICATION JACK OR SOCKET.**

The inter-communication jack or socket is situated on the centre line of the aeroplane at the rear end of the navigator's table.

(r) **ABANDON SHIP SIGNALLING PANEL** (Refer Fig. 1).

The abandon ship signalling panel for the navigator is situated on top (at the forward end) of the navigator's table, and consists of one switch, a globe, and a fuse box. The operation is as follows:—

(i) Up position is "Off."

(ii) Down position is "On."

(s) **INSPECTION LAMP.**

The inspection lamp is stowed on the side of the hydraulic control panel door, and the electric supply is fitted directly below it.

(t) **COMPARTMENT LIGHTING** (Refer Fig. 1).

The compartment light is attached to a flexible arm on the port side above the navigator's table. This light is of the directional type and is rheostat controlled.

(u) **UNDER DEFENCE GUN** (Refer Fig. 1).

The under defence gun is attached to the underside of the nose by two clips. Its operation is for backward firing underneath the aircraft.

(v) **FIRE EXTINGUISHER** (Refer Fig. 1).

The fire extinguisher is of the hand type, and is situated underneath the pan type seat fore of the hydraulic panel.

(w) **AMMUNITION CONTAINER** (Refer Fig. 1).

The ammunition container for the under-defence gun is situated underneath the navigator's table.

(x) **FRONT TRAVERSING GUNS** (Refer Fig. 1).

The front traversing guns are situated in the nose of the aircraft.

(y) **AMMUNITION DRUM CONTAINER BRACKETS** (Refer Fig. 1).

Front Traversing Guns.

There are four drum container brackets for the front traversing guns. Their positions are as follows:—

(i) One directly underneath the nose guns, attached to the floor.

(ii) One directly above the reconnaissance flare release control on the starboard side.

(iii) Two attached to the hydraulic control panel door.

(z) **PARACHUTE STOWAGE.**

The navigator's parachute is stowed behind the pilot's seat.

2. WIRELESS COMPARTMENT.

(a) **GENERAL.**

The wireless compartment, which is taken to be that part of the fuselage from the main plane front spar to the partition bulkhead aft of the rear spar, is illustrated in Fig. 3. The wireless equipment is mounted on the port side with the wireless operator's seat aft of it. The speaking tube in Fig. 3 beside the wireless equipment is provided for communication between the compartment and the bomb cell when loading bombs. On the starboard side, opposite the seat, is the electrical control panel. The partition bulkhead at the aft end of the compartment is armour-plated to afford protection to the wireless operator, and has a curtain that can be drawn across the door opening on the stbd. side, and secured in clips on the port side.

(b) **WIRELESS OPERATOR'S SEAT** (Refer Fig. 3).

The wireless operator's seat is fitted on the port side forward of the main plane rear spar and faces the wireless equipment. It is hinged at the front, and is clipped to the structure at the back; by raising a handle at the back, the seat can be tilted forwards to give access to the wireless spare accumulators and changing sockets, which are fitted below it. A type D (lap type) safety belt is attached to a tubular member under the seat.

(c) **VENTILATOR.**

A small ventilator, consisting of a hinged door, is fitted just aft of the wireless operator's instrument panel. The degree of opening can be varied by means of a screwed adjusting nut.

(d) **WIRELESS EQUIPMENT** (Refer Fig. 3).

The wireless equipment is mounted as described below on a main frame aft of the main plane front spar.

(e) **TRANSMITTER** (Refer Fig. 3).

(i) The type A.T.5 transmitter is mounted on a sliding frame on the top right hand side of the main frame. The mounting is secured in position by a spring catch.

(f) **RECEIVER** (Refer Fig. 3).

(ii) The type A.R.8 receiver is mounted on a sliding frame on the bottom left-hand side of the main frame; it is secured in position by a spring catch.

(g) **AERIAL COUPLING UNIT.**

(iii) The aerial coupling unit is mounted on a sliding frame next the receiver on the bottom right-hand side of the main frame immediately below the transmitter, and is secured in position by a spring catch.

(h) **POWER UNIT.**

(iv) The power unit, located behind the receiver and aerial coupling unit, is mounted on slides and comprises the H.T. generators for transmitter and receiver, filter and starting equipment. The unit is secured in position by a spring catch.

(i) **JUNCTION BOX.**

(v) The junction box is bolted on a special bracket attached to the underside of the main frame below the power unit. Should it be necessary to remove the junction box, it is important when replacing to have the cables tagged "F" and "K" from the junction box facing forward, i.e., towards the main spar.

(j) **MORSE KEY** (Refer Fig. 3).

(vi) The morse key is mounted on a bracket secured to the table by two wing nuts.

(k) **INTER-COMMUNICATION FACILITIES.**

(vii) Facilities for continuous inter-communication between all members of the crew are provided by means of the audio amplifier stage of the receiver. Combined microphone-telephone sockets are provided at each crew station.

(l) INTER-COMMUNICATION CONNECTIONS.

(viii) Connection from the junction box to the aircraft inter-communication, wiring is made via cables "F" and "K," which are supplied terminated in a six pin plug and four pin plug type, respectively. A bracket carrying a six pin socket type and a four pin socket type is mounted on the port side forward of the aerial winch beneath the wireless frame. Connections to the aircraft wiring are made to these sockets.

(m) AERIAL CHANGE-OVER PLUGS.

(ix) Both fixed and trailing aerials are provided, and provision for using either as required is made possible by changing plugs on the aerial coupling unit.

(n) INTER-CONNECTING CABLES.

All units of the equipment are inter-connected by cables tagged with identification letters as follows:—

Cable A—Transmitter power socket to power unit.

Cable B—Receiver power socket to power unit.

Cable C—Junction box to receiver junction box socket.

Cable D—Junction box to transmitter junction box socket.

Cable E—Junction box to aerial coupling unit.

Cable F—Junction box to six pin operator's socket.

Cable G—Receiver "aerial" to receiver "socket" on aerial coupling unit.

Cable H—100 ohm line from transmitter to aerial coupling unit.

Cable J—L.T. (24-v.) power input to power unit.

Cable K—Junction box to four pin socket I/C. connection to crew stations.

Cable L—Not supplied.

Cable M—Not supplied.

(o) DIRECTION-FINDING LOOP (Refer Fig. 3).

A retractable direction-finding loop is fitted behind the wireless operator. The two upper tubes of the loop, which is a pin-jointed square frame, are attached to a spindle supported on a bracket on the roof of the fuselage. The spindle extends downwards inside the fuselage, and has a lifting handle that fits inside a slot, open at the top, in a support tube fixed to the main plane rear spar. In the collapsed or retracted position, the four tubes of the loop lie together in a fore-and-aft direction; wood fairing pieces are fitted at each end. When the lifting handle is raised until it is above the support tube, thus leaving the spindle and loop free to be rotated, the four loop tubes form a square frame aerial. A hand-wheel and indicator is fitted near the roof and, by means of a catch, can be locked to the spindle in either the retracted or extended position of the loop. Aft of the handwheel, a handle is provided for operating a brake that enables the loop to be locked at any point of its rotation. The lead from the loop to the wireless receiver is taken from a socket at the support bracket to the fuselage roof.

(p) **ELECTRICAL CONTROL PANEL** (Refer Fig. 3).

The electrical control panel is mounted on the stbd. side of the fuselage in line with the wireless operator's seat, and comprises a charge regulating switch, a generator voltmeter, ammeters for the general services and engine starting accumulator charging circuits, and two links switches, a rheostat and an ammeter for the wireless accumulator charging circuit. The main electrical fuses are mounted in three banks below the panel.

(q) **TORPEDO DEPTH CONTROL.**

For access to the torpedo depth-setting control, according to the type of torpedo carried, two doors are provided on the fuselage floor—one underneath the wireless operator's seat, and another aft of the main plane rear spar. A key, attached by lanyard to the carrier, is provided for adjusting the control, and a lamp fitted with a push switch and mounted on the roof of the bomb cell near each door illuminates the control.

(r) **FIRE EXTINGUISHER** (Refer Fig. 5).

The wireless operator's fire extinguisher is situated on the diaphragm attached to the starboard side.

3. GUNNER'S STATION.

(a) **GENERAL.**

The gunner's compartment is taken to be the gun turret, and that part of the fuselage forward to the partition bulkhead (see illustration).

(b) **GUN TURRET** (Refer Figs. 5 and 6).

There are two types of gun turrets fitted, namely:—

(i) Mk. IE: Beaufort to aircraft A9-190.

(ii) Mk. V: Blenheim from aircraft A9-191 on.

Operation of Mark IE and Mark V Turrets.

These two turrets are operated on the same principle as the motor cycle, and are as follows:—

(i) Hold master valve control on left end of handle bar "down."

(ii) Turn handle bars to left and turn in that direction and vice-versa.

(iii) Turn handle bars towards gunner's seat to elevate, and vice-versa to depress.

NOTE.—In case of Mk. V turret, two foot controls are provided on forward end of footboards which, on operation, overrides the orthodox controls and allows extra movement to left or right, depending on foot control operated.

(c) **AMMUNITION DRUM CONTAINER** (Refer Fig. 6).

The ammunition drum container is situated aft of the gun turret on the port side (i.e., this not installed when the Mk. V turret is installed). It accommodates three rows of six (18 in all) ammunition drums. Each row of six drums may be made available in turn, and each drum after use in the guns is replaced in its original position; an indicator is provided and works automatically as each drum is withdrawn, so that the full and empty drums are clearly distinguished.

The ammunition containers for the Mk. V turret are attached to the structural members of the turret.

The ammunition drums for the beam guns are stowed on brackets attached to the fuselage, port and stbd.

(d) **GUNNER'S INSTRUMENT PANEL.**

The gunner's instrument panel is mounted behind an armour-plated hinge panel on the stbd. side aft of the turret, and carries a panel lamp, dimmer switch, and switches for the reflector and free-type camera gun.

(e) **ARMAMENT.**

The armament for the gunner's compartment consists of the following:—

(i) Two turret guns.

(ii) Two beam guns.

The two beam guns are situated, one on the port side attached to the entrance rail, and the other directly opposite.

(f) **CAMERA G.22.**

Provision is made opposite the main entrance hatch for the installation of a G.22 camera. The camera can be adjusted vertically by releasing the spring loaded bolts that secure the cross-members of the mounting structure in the holes in the vertical members, and engaging them in a different set of holes; lateral adjustment can be obtained by sliding the type 25 mounting along and across members. Openings covered by doors secured in clips, are provided for both vertical and oblique photography. The installation permits the use of cones up to 14 in. focal length for both vertical and oblique photography. Aft of the camera, the camera motor is mounted on a bracket attached to the fuselage skin. The electric remote control and supply socket are mounted in the nose of the fuselage on the starboard side.

(g) RECONNAISSANCE FLARES AND CHUTE (Refer Fig. 4).

The reconnaissance flares are stowed on the stbd. side of the fuselage opposite the entrance hatch. The flare chute is situated directly aft of the camera. When a flare has been released from the chute, the doors on the bottom of the fuselage must be closed by pulling up the door return handle before another flare is loaded.

(h) FLAME FLOATS AND SEA MARKERS (Refer Fig. 4).

The flame floats, H.T.V. sea markers, and aluminium sea markers, are stowed on the starboard side of the fuselage directly above the flare chute and camera.

(i) TARGET RELEASE LEVER.

The target release lever is situated on the starboard side of the rear fuselage in line with the turret. It operates the release mechanism for the towing target hook.

(j) TURRET MULTIPLE CONTROL VALVE (Refer Figs. 5 and 6).

The turret cut-out control valve is a group of three plug valves, namely:—

(i) Master valve.

(ii) Gun elevation.

(iii) Turret rotation.

The master valve is a "power on and off" valve, and is designed to permit a certain amount of regulation. The multiple control valve is operated by a "T" shaped control handle.

(k) FIRST AID KITS (Refer Fig. 5).

There are two first aid kits in this compartment, one on the port side below and aft of the entrance hatch, the other being attached to the roof of the fuselage on the port side.

(l) UNDERCARRIAGE LOCKING PINS STOWAGE (Refer Fig. 5).

There are two positions for the undercarriage locking pins, one as used on A/C. up to A9-190, being on the diaphragm, stbd. side, fore of the gun turret, and the other is attached to the fuselage aft of the entrance hatch, i.e., this installation from A/C. A9-191 upwards.

(m) STARTING HANDLE STOWAGE.

There are two positions for the starting handle, one being held by three clips under the entrance hatch, and the other by three clips on the bulkhead.

(n) **BOMB WINCH HANDLE** (Refer Fig. 5).

The bomb winch handle is stowed on the stbd. side of the diaphragm fore of the turret.

(o) **GUNNER'S FIRE EXTINGUISHER** (Refer Fig. 5).

The gunner's fire extinguisher is attached on the port side of the diaphragm fore of the gun turret.

(p) **INTER-COMMUNICATION JACKS OR SOCKETS** (Refer Fig. 4).

There are two inter-communication jacks or sockets for the gunner attached on the stbd. side of the diaphragm fore of the gun turret.

(q) **ELSON CLOSET STOWAGE.**

The Elson closet is attached to the floor on the port side, and is used as a step to enter aircraft.

(r) **PARACHUTE STOWAGE.**

The parachute stowage box is attached to the floor on the port side aft of the Elson closet.

(s) **TURRET ISOLATION VALVE** (Refer Figs. 3 and 4).

The turret isolation valve is situated on the fuselage directly in line with the gunner's seat. Once this valve has been placed in the "on" position, the control valve at the forward end of the circuit, which is situated in the W/T. operator's compartment, must be operated.

(t) **ENTRANCE LADDER STOWAGE.**

The entrance ladder is stowed on the port side of the fuselage aft of the entrance hatch.

(u) **EMERGENCY SIGNALLING PANEL.**

The gunner's emergency panel is situated on the port side directly in line with the gunner's seat, and contains a switch and globe. The operation of the switch is as follows:—

(i) Up position "off."

(ii) Down position "on."

(v) **WRITING PAD CONTAINER** (Refer Fig. 4).

The writing pad container is attached to the stbd. side of the fuselage directly in line with the gunner's seat.

(w) **MAP CONTAINER** (Refer Fig. 5).

The map container is attached to the fuselage on the stbd. side fore of the writing pad container.

ILLUSTRATION 1

1. Navigator's Seat.
2. Fire Extinguisher.
3. Under Defence Gun.
4. Optically True Panel.
5. Bomb Sight Mounting.
6. Ammunition Container.
7. Nose Guns Mounting Gimbel.
8. Emergency Signalling (Abandon Aircraft).
9. Cockpit Lighting (Flexible Stand).
10. Drift Recorder Mounting.
11. Bomb Distributor.
12. Navigator's Table.
13. 0.3 Compass Mounting.
14. Pencil Box.
15. Bomb Door Indicator Light.
16. Under Defence Gun Jettison Handle.
17. Bomb Aimer's Safety Belt.

ILLUSTRATION 2

1. Bomb Aimer's Steering Indicator Switches.
2. Air Speed Indicator.
3. Altitude Meter.
4. Navigator's Instrument Panel Lighting.
5. Oxygen Regulator.
6. Stop Watch Holder.
7. Nose Guns Steady Arm.
8. Reconnaissance Flare Control.
9. Camera Sight.
10. Navigator Special Window.
11. 0.2 Compass Mounting Bracket.
12. Anti-Icing Buttons.
13. Ammunition Drum Peg.

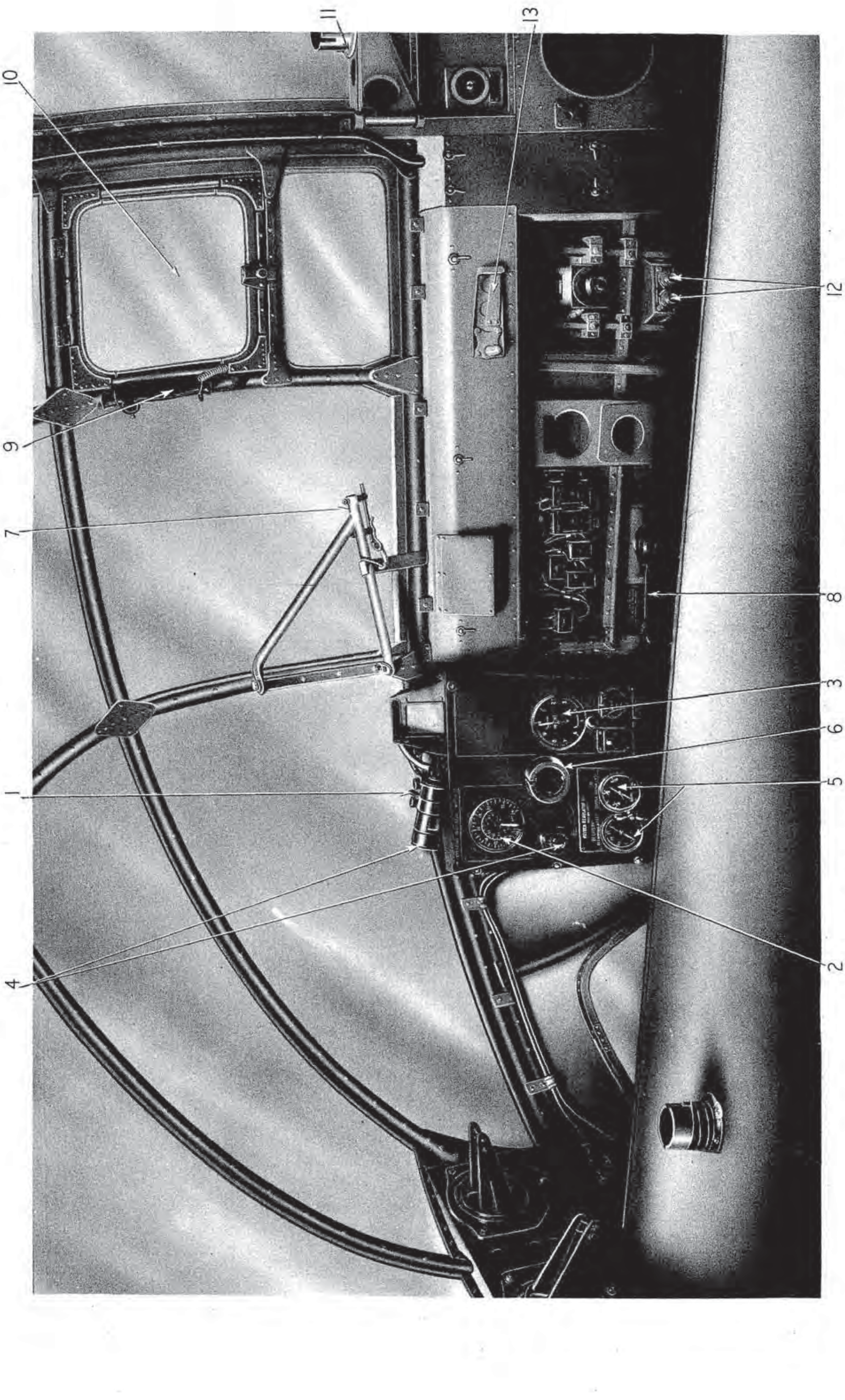

FIG. 2.—NAVIGATOR'S OR BOMB AIMER'S COMPT. (STBD. SIDE.)

ILLUSTRATION 3

1. Wireless Equipment.
2. D.F. Loop.
3. Port, Port Hole.
4. Morse Key.
5. Stowage Box (Bomb Loading).
6. Wireless Operator's Safety Belt.
7. Wireless Operator's Seat.
8. Battery Stowage.
9. Fuse Panel.
10. Master Switch.
11. Turret Isolation Valve.
12. Compartment Lighting.
13. Oxygen Regulators.
14. Emergency Escape Hatch (Pilot's).

ILLUSTRATION 4

1. Beam Gun Port Hole.
2. Beam Gun Mounting.
3. Inter. Com. Jack or Socket.
4. 800 lb. By-Pass Valve (Turret).
5. Reconnaissance Flare Chute.
6. Diagram Case.
7. Sea Marker Stowage.
8. Camera Port Hole (Oblique).
9. Reconnaissance Stowages.
10. Ammunition Gun Stowage.

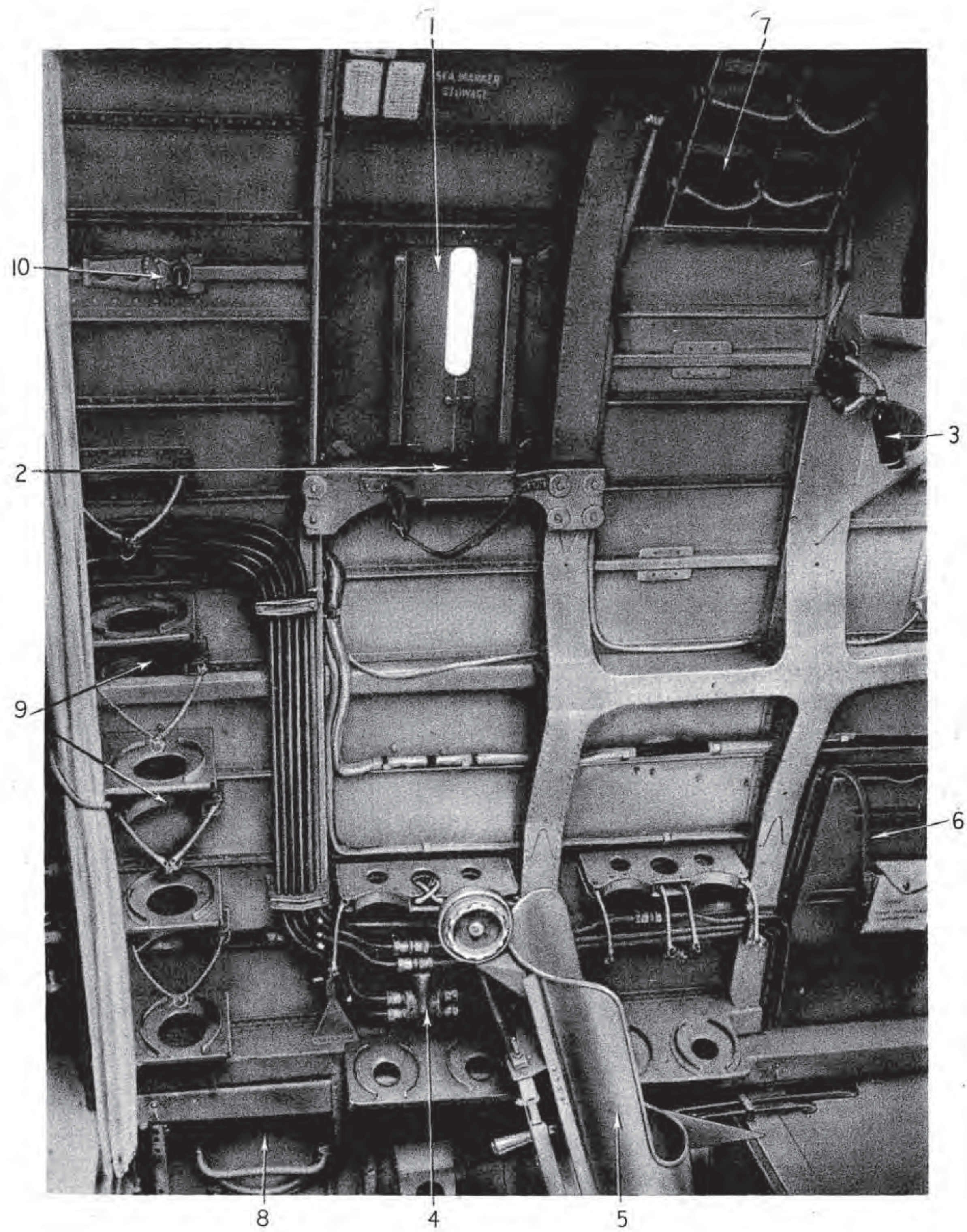

FIG. 4.—GUNNER'S COMPARTMENT (STBD. SIDE).

ILLUSTRATION 5

1. First Aid Box.
2. Fire Extinguisher.
3. Bomb Winch Handle.
4. Undercarriage Radius Rod Locking Pin Stowage.
5. Isolating Control Valve Lever.
6. Turret Elevation and Depression Control.
7. Master Hydraulic Control Valve (Turret).
8. Thermos Flask Container.
9. Gunner's Safety Belt.
10. Ammunition Belt Containers.
11. Retractable Ladder.
12. Ammunition Drum Pegs.

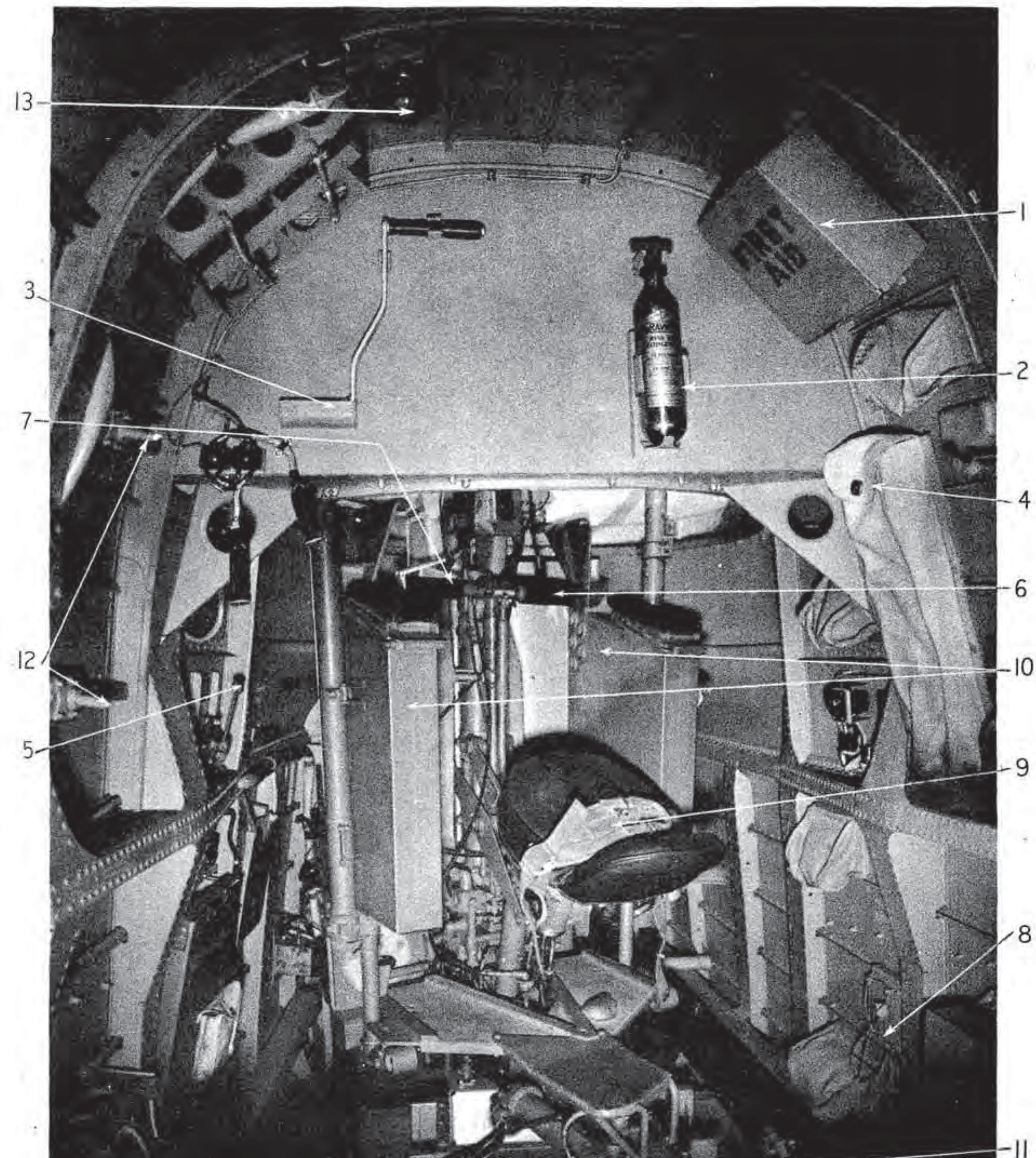

FIG. 5.—GUNNER'S COMPT., SHOWING MK. V TURRET.

ILLUSTRATION 6

1. Armour Plate.
2. Diaphragm Rear of Turret.
3. Main Control Handles.
4. Master Valve Control Lever.
5. Armour Plate.
6. Main Control Handles.
7. Ammunition Gun Container.

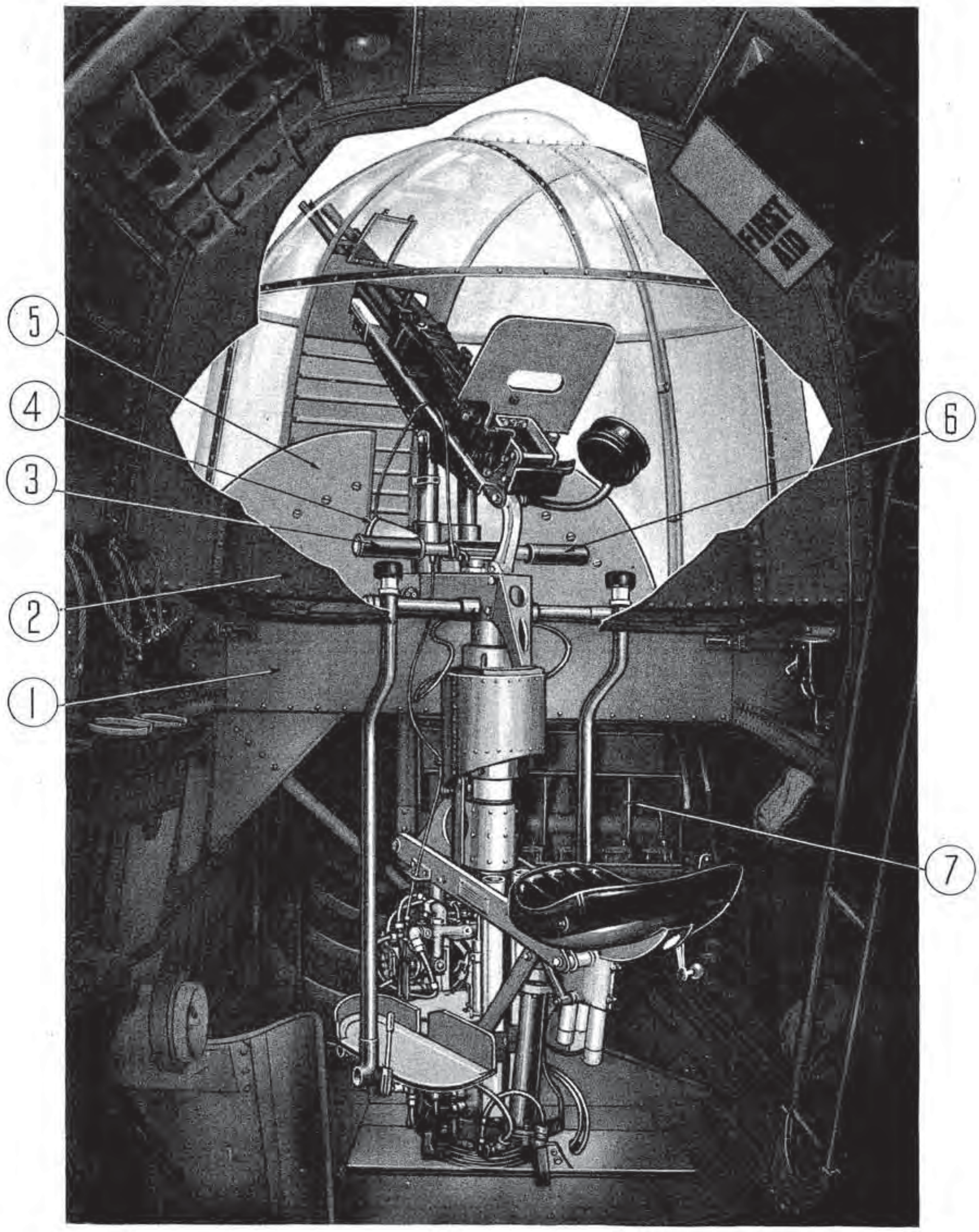

FIG. 6.—GUNNER'S COMPT., SHOWING MK. IE TURRET INSTLN.

ILLUSTRATION 3

1. Wireless Equipment.
2. D.F. Loop.
3. Port, Port Hole.
4. Morse Key.
5. Stowage Box (Bomb Loading).
6. Wireless Operator's Safety Belt.
7. Wireless Operator's Seat.
8. Battery Stowage.
9. Fuse Panel.
10. Master Switch.
11. Turret Isolation Valve.
12. Compartment Lighting.
13. Oxygen Regulators.
14. Emergency Escape Hatch (Pilot's).

SECTION 4

SECTION 4

INSTRUCTIONS AND NOTES FOR GROUND PERSONNEL

CHAPTER 1

HANDLING AND GENERAL PREPARATION

SECTION 4

HANDLING AND GENERAL PREPARATION

CHAPTER 1

ILLUSTRATIONS

HANDLING AND GENERAL PREPARATION

CHAPTER 1

1. JACKING (Refer Fig. 6).

Locations for jacking of aircraft for maintenance, rigging, dismantling and assembly operation are marked with "Trestle Here" on the underneath side of main plane and fuselage.

2. TOWING.

(a) **FORWARD.**

(i) Attach the towing cables to each towing eye on the inboard leg of the undercarriage.

(ii) Place the hooked ends of the steering arm into the eyes at end of yoke each side of tail wheel.

(iii) Unlock the tail wheel lock (Refer Sec. 1, Part 1, Para. d).

(iv) Ground personnel to take up the following positions:—

(a) One man to control the brake control in ship.

(b) One man at the tail wheel steering area handle.

(c) A lookout at each wing tip.

(d) One man only in charge of operations.

(e) If tractor is being used, do not travel too fast.

(b) **BACKWARD.**

This is not advisable under present arrangements.

3. PRIMARY FLYING CONTROLS (Refer Fig. 2).

(a) **LOCKING.**

(i) Hold the control column in the central position.

(ii) Insert the eyebolt on the locking gear through the hollow bolt at the bottom of the control column, and secure with pin on end of eye bolt.

(iii) Insert aft end of locking gear through the hole in the back of the pilot's seat, and attach it by the quick-release pin to the structure behind the seat.

(iv) Fix the clip on the aileron handwheel.

(v) Fix the clips on the rudder pedals.

4. PICKETING.

A mooring eye is incorporated in the lower bolt of the centre and outer plane spar joints. The eye is accessible through a sliding panel in the underneath skin just near aft edge of front spar. A strap is supplied for holding down the tail of the aeroplane, and is passed over the stern frame just forward of the fin. Two picketing hooks are provided, one port and one starboard, just above and aft of tail wheel. Primary flying controls should be locked. (Refer Sec. 4, Chap. 1, Part 3, Para. A.)

5. WEATHER PROTECTING COVERS.

Ground covers (see Fig. 1) of mercerised cotton fabric are provided for the nose, turret, airscrew hubs, engines, pilot's and navigator's compartments.

6. FILLING TANKS (Refer Fig. 3).

(a) FUEL.

(i) The main plane has two tanks, one each side of the engine nacelle, port and starboard. The two inboard tanks each hold approximately 194 Imperial gallons, while the capacity of the two outboard (wing) tanks is approximately 94 Imperial gallons each.

The filler necks for the inboard tanks are located on the upper surface of the centre section (main plane) just inboard of the fuselage aft of the front spar. The filler necks for the outboard tanks are located on the upper surface of the wing just aft of the front spar and towards the outer end of the wing.

NOTE.—When filling the tanks, ascertain the octane rating by reading notice on inboard face of tank doors in surface of main plane. Before refuelling, release any static electricity in the refuelling nozzle by grounding it on the aeroplane, a safe distance from the filler neck. After inserting the nozzle of the filler neck, ground it to the aeroplane structure by a wire or similar means.

(ii) When the auxiliary fuel tanks are fitted in the bomb bay filling is done from the main tanks with the main fuel tank cocks in the open position. Then move the balance and selector cock control to "Auxiliary and Balance On" position; also move auxiliary tank cock to the "ON" position. The auxiliary tank will then be filled from the main tanks automatically.

For positions of controls refer Sec. 1, Part 5, Paras. a and b.

(b) OIL.

An oil tank for each engine is located in the first bay outboard of the undercarriage wheel well, port and starboard. Each tank has a capacity of approximately 21½ Imperial gallons, of which 2½ is air space. To check oil level with aircraft in tail down position, measure 5 in. from the top of filler neck, which is just aft of the front spar.

NOTE.—When filling oil tanks, use oil which conforms to Specification DTD. 109.

(c) **HYDRAULIC.**

The fluid reservoir is installed and mounted behind the pilot's head. Its filler neck is accessible from inside the cockpit. When filling, always do so with aeroplane in tail-down position. With lines full the reservoir holds approximately 1 gallon of oil and one gallon of air space.

(d) **ANTI-ICER.**

These two bottles are located underneath the observer's seat, and are filled with alchol and one with glycol. The capacity of each is ½ gallon of alchol and glycol respectively; the rest is air space.

7. BOMB LOADING

(a) **GENERAL.**

Details of the bomb and torpedo installations are shown in Figs. 5, 7 and 8. Provision is made for carrying the following bombs loads (See Fig. 4) :—

(i) Two 500 lb. G.P., S.A.P., or A.S. bombs.

(ii) Four 250 lb. Type B special bombs (two in body and two under main planes).

(iii) Four 250 lb. G.P., S.A.P., A.S., L.C. bombs, or four 250 lb. small bomb containers.

(iv) One 2000 lb. A.P. bomb or one torpedo Mk. XIIA, XIVX or VIIIX.

(v) Six practice bombs.

b) The main bomb load is carried under the fuselage in a cell provided with hydraulically-operated doors. The 500 lb. and 250 lb. bomb loads are carried on racks (see Fig. 4) attached directly to supports provided in the bomb cell. Two of the 250 lb. type B special bombs are carried on racks attached to the underside of the main planes. The 2000 lb. bomb or the torpedo is carried in a special carrier frame (see Fig. 5) attached directly to supports provided in the bomb cell. Practice bombs are carried on universal carriers on an attachment (No. 3) on the main bomb carrier.

(c) **BOMB LOADING WINCHES** (Refer Fig. 7).

The bomb loading winch for 500 lb. and 250 lb. bombs under the fuselage is shown in Fig. 4. It is mounted in the front fuselage and is hand operated from the outside of the fuselage; the handle is stowed on the starboard side of the fuselage forward of the gun turret. The loading cable passes from the winch over pulleys inside the fuselage, over a movable pulley bracket at the required loading point, and then through the fuselage floor. A release lever operating a clutch in the winch is provided in the fuselage near the loading points to enable the hoisting cable to be quickly run out. The clutch cannot be operated whilst the bomb load is on the cable.

(d) The 2000 lb. bomb and the torpedo loading gear is shown in Fig. 5, and consists of two self-contained winches mounted in the main carrier beam, port and starboard. They are self-locking and hand operated from outside the fuselage, the handles, together with the slings, being stowed in a box attaching to the carrier. A release lever that operates a dog clutch is provided to enable the hoisting cable to be run out. The clutch cannot be operated while the bomb or torpedo load is on the cables.

(e) **OPENING CELL DOORS FOR LOADING OF TORPEDO OR 2000 lb. BOMB** (Refer Fig. 5).

The torpedo is housed in the main, forward and rear cells, and the 2000 lb. bomb is housed in the main cell and part of the rear cell only (see Fig. 2). To open all the doors, proceed as follows:—

(i) Move the control lever on the pilot's instrument panel to the OPEN position, and lower the main cell doors by means of the hydraulic hand pump.

(ii) Remove the operating mechanism lever extension with link which controls the door flaps by removing the two bolts (a) and (b) in Fig. 3; bolt the lever extension to the stowage brackets provided on the flaps and clip the flaps back to the main doors.

(iii) Open front cell doors by removing diaphragm, break the radius arms, and push doors upwards and latch in place.

Remove rear cell doors by pulling spring locks back until the rear ends of the doors are released. These locks are operated through finger holes immediately aft of the cell doors. Also break radius arms and push up and latch in place; then remove countersunk screws from hinges on modified aircraft, or piano wire from hinges on unmodified aircraft.

(iv) To hold the doors open, push upwards and engage the spring-loaded hooks on the roof of the cell by hand.

(v) Just before the load is in the final position, it opens further the front (or rear doors only in the case of the bomb load being carried), thus automatically releasing the retaining hooks so as to allow the doors to fall closed after the load is released.

8. INSPECTION BEFORE LOADING.

(a) Before loading any bombs or torpedo, check the operation of the release units as follows:—

(i) Provide electrical circuit for the release circuit either by plugging in an outside power supply at the ground battery connection, port side, underneath aft end of navigator's compartment, or by using the aeroplane batteries. In the case of the latter, the main battery switch must be turned on before any electrically controlled units can be operated.

(ii) Open the bomb doors and check to see that the door indicator lights on the pilot's and bomb aimer's bomb control panel are on. The release circuit is not operative unless the doors are fully open.

(iii) Lock all the electro-magnetic units.

(iv) Move each selector switch in turn to the "individual release" position, operating the pilot's bomb release button for each switch movement. Each rack position should release in the order selected.

(v) Re-cock all positions and operate the pilot's jettison switch, checking to see that all rack positions release simultaneously.

(vi) Repeat operation (iv) above, operating the bomb-aimer's release button rather than the pilot's release.

9. LOADING OF TORPEDO AND BOMBS.

(a) LOADING 500-lb., 250-lb. BOMBS AND SMALL BOMB CONTAINERS.

A spanner, Part No. 88319, for the bomb gear adjusting screw, and a movable pulley cradle, are stowed in a box in the wireless compartment aft of the front spar. To load these bombs or containers, proceed as follows:—

(i) Open the main cell doors by means of the hydraulic pump.

(ii) Open the door in the floor aft of the front spar, unscrew the bomb-carrier hooks, and detach the bomb carriers from the aeroplane by hand.

(iii) Fit the carrier to the bomb adjusting crutches, setting the fuse units and links.

(iv) Place the movable pulley bracket at the required loading position (SEE Fig. 7).

(v) Pull the clutch lever, draw out the cable and pass it over the pulley bracket and down through the hole in the floor.

(vi) Slip the T-head on the end of the cable into the pocket of the loading link attached to the carrier.

(vii) Hoist the bomb and carrier into position.

(viii) Engage the bomb carrier hook with the slot in the loading link and tighten the screw, which is automatically locked. (The above eight operations are repeated for each bomb to be loaded.)

(ix) Remove and stow the cable and also the movable pulley bracket.

(x) Plug in the electrical connections.

(xi) Close the door in the floor and also the bomb cell doors.

(b) LOADING 250-lb. TYPE B BOMB UNDER MAIN PLANE.

To load a 250 lb. type B bomb under the main planes, it should be hoisted into position with a standard bomb loading winch, type A, the crutch adjusted, the fuse links set, and the electrical lead plugged in.

(c) **LOADING TORPEDO OR 2000-lb. BOMB.**

To load a 2000 lb. bomb or a torpedo, proceed as follows:—

(i) Open the bomb cell doors (see Para. e).

(ii) Place the load under the cell in a convenient position on a trolley.

(iii) Attach a guy rope at each end to guide the load.

(iv) Attach the hoisting sling to the load at the correct point (see Fig. 8), so that the centre of the spreader tube coincides with the centre of the locating lug on the load (THIS IS IMPORTANT!).

(v) Release the winch drum by means of the dog-clutch actuating lever, release the hoisting cable ends, pull out the hoisting cables and attach them to the hoisting slings with quick release pins.

(vi) Insert the winch handles into the sockets provided outside the fuselage and start winding, raising the load until it is brought up into position almost against the front and rear central crutch steady pads. During this procedure the two guy ropes are brought into play.

(vii) Roll the load by means of the winches until the locating lug on the load coincides laterally with the locating socket, and longitudinally with the lug, and then wind up with the winches until the load touches both the front and rear central crutch steady pads.

(viii) Pass the slip cable round under the load and hook the free end into the slip gear. Tighten up the slip cable by means of the strainer.

(ix) Adjust the front and rear side crutch pads down on to the load and lock them, and also lock the socket adjusting screws.

(x) Slacken off the hoisting cables and release them from the hoisting sling. Then re-anchor the cable ends.

(xi) Remove the hoisting sling by removing the quick-release pins, and re-assemble the sling when clear of the load. Then stow the sling.

(xii) Attach the fusing link.

(xiii) Insert the safety shorting plug attached to the front crutch in the shorting socket.

(xiv) Remove the loading trolley.

10. BALLAST WEIGHTS.

Under certain loading conditions, ballast weights up to 18 in number have to be carried. Standard ballast weights (part No. A.G.S. 670), of $17\frac{1}{2}$ lb. each, are used. Provision is made for carrying the weights adjacent to the ammunition drum container slightly aft of the turret. Two sets of fittings are provided, each capable of carrying up to 9 weights. The weights are threaded on a tubular member, which incorporates an adjustable quick-release clip.

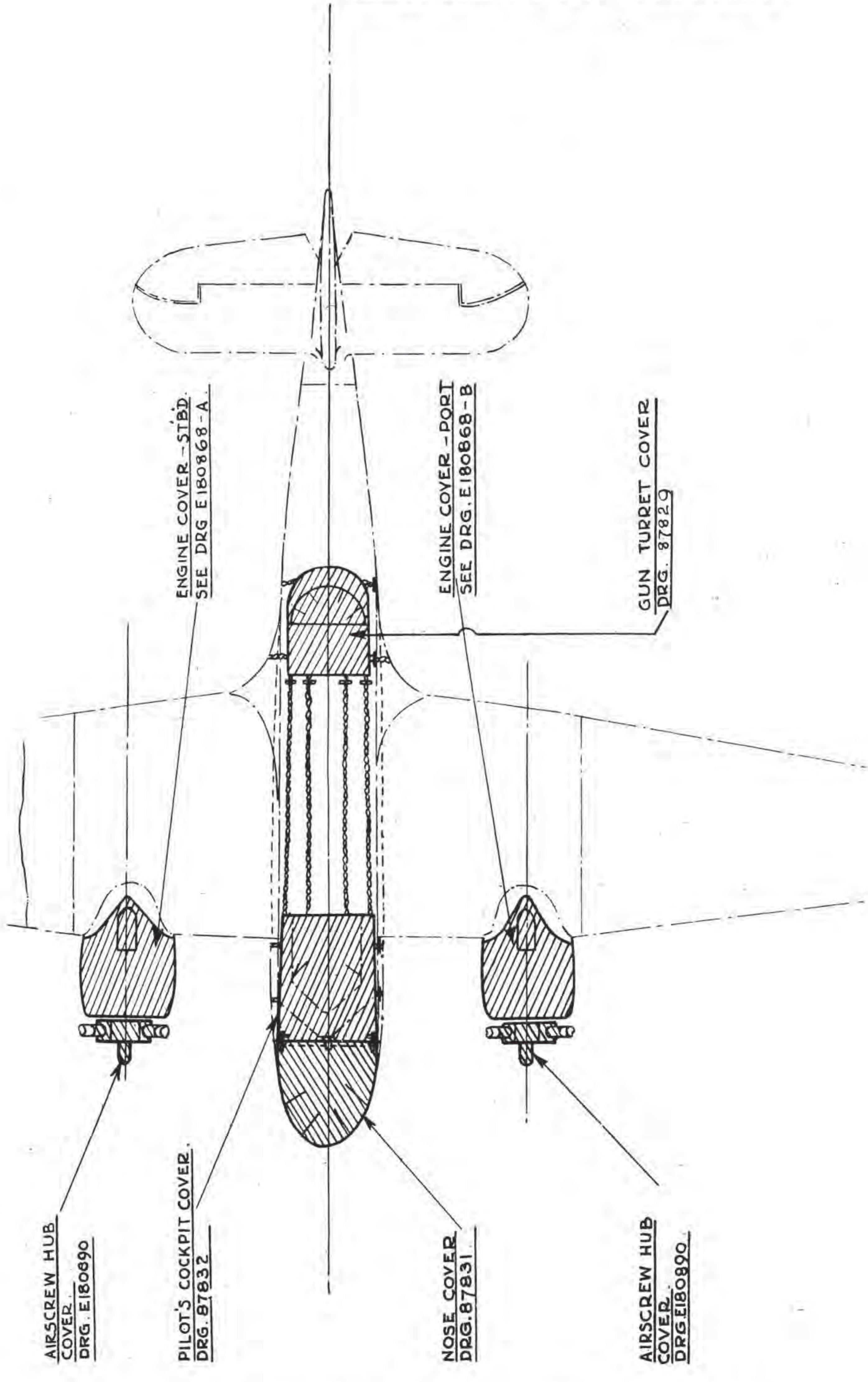

FIG. I. WEATHER PROTECTION COVERS.

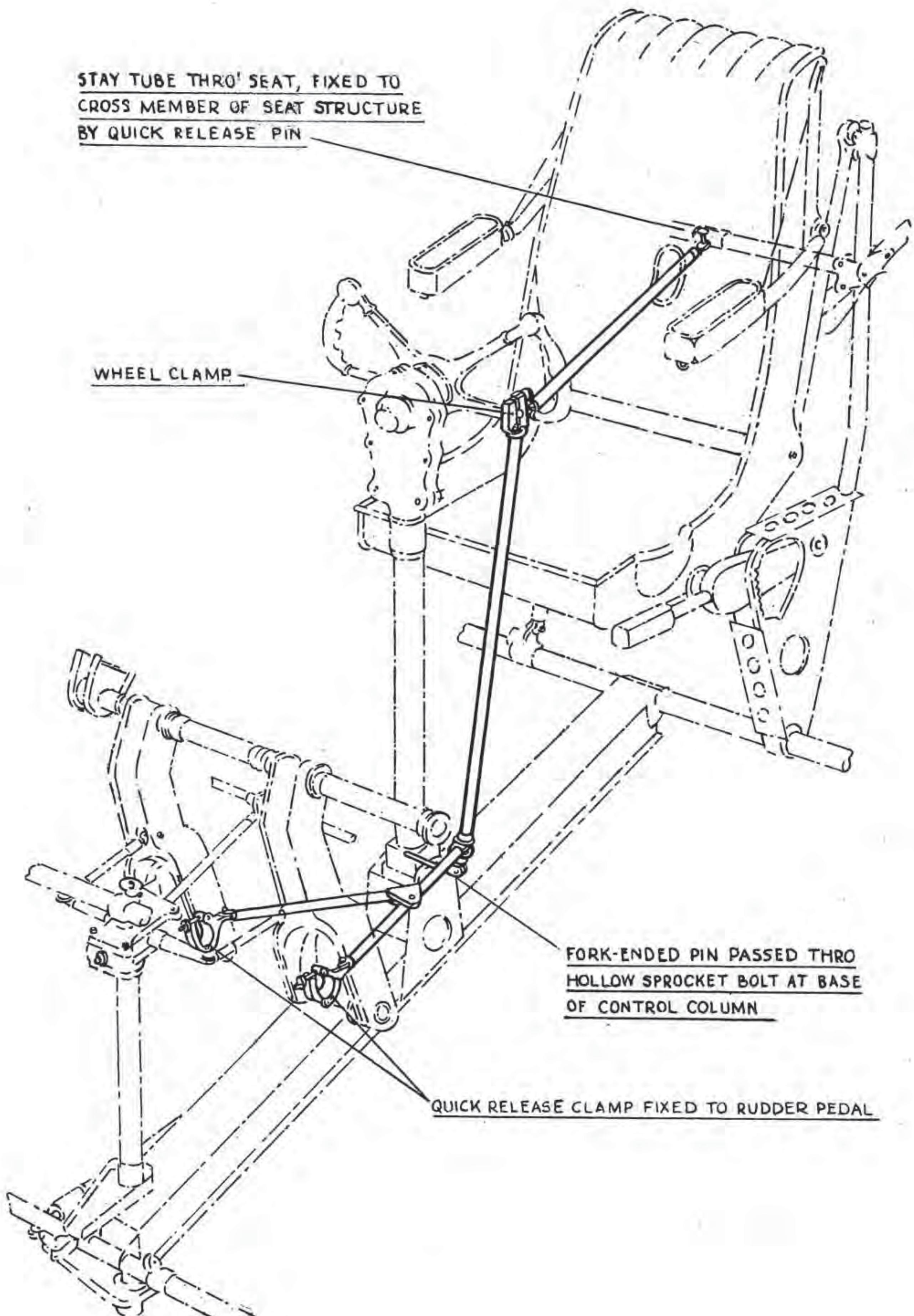

FIG. 2 FLYING CONTROLS LOCKING GEAR

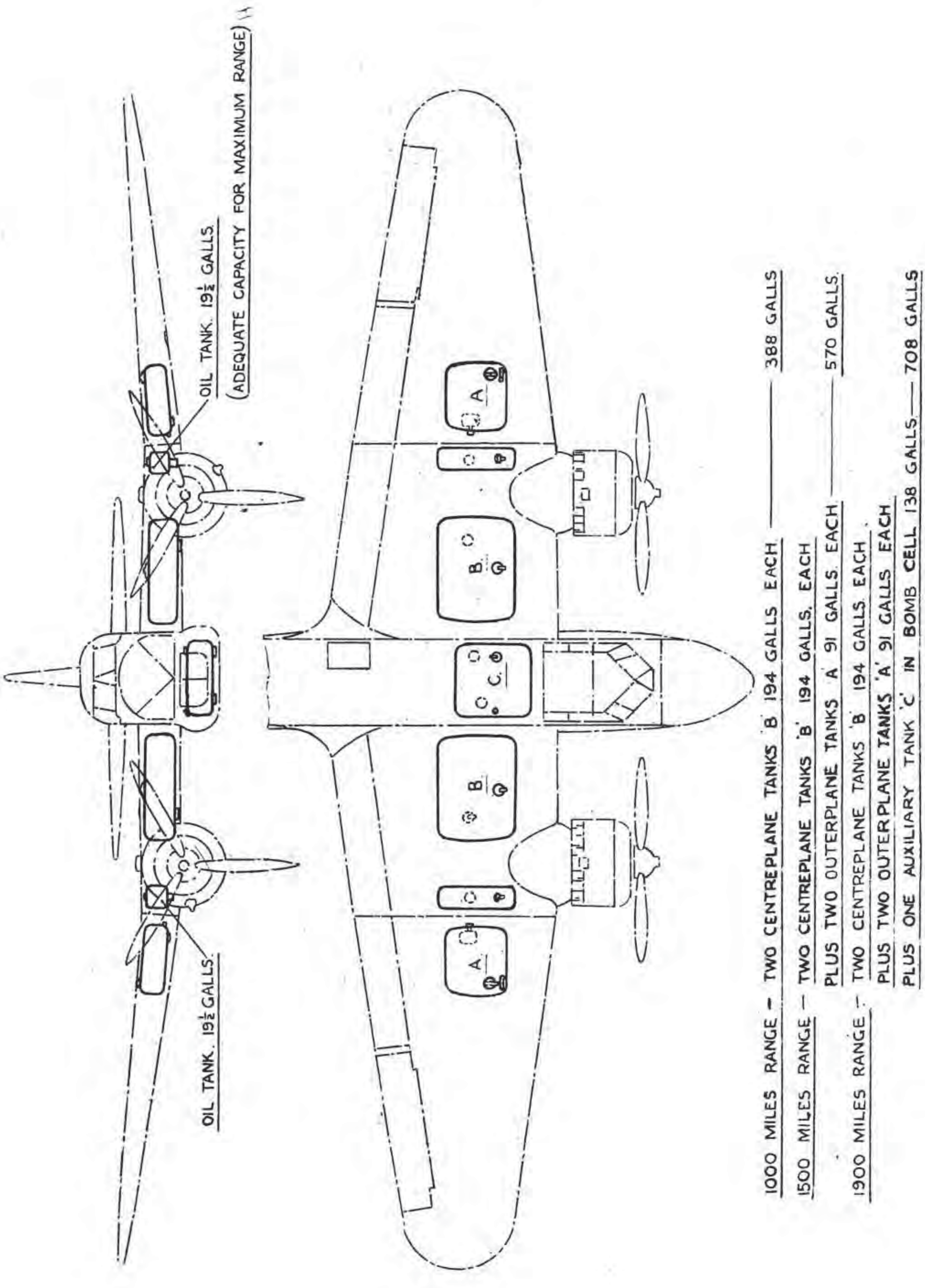

FIG.3 FUEL & OIL TANK RANGES.

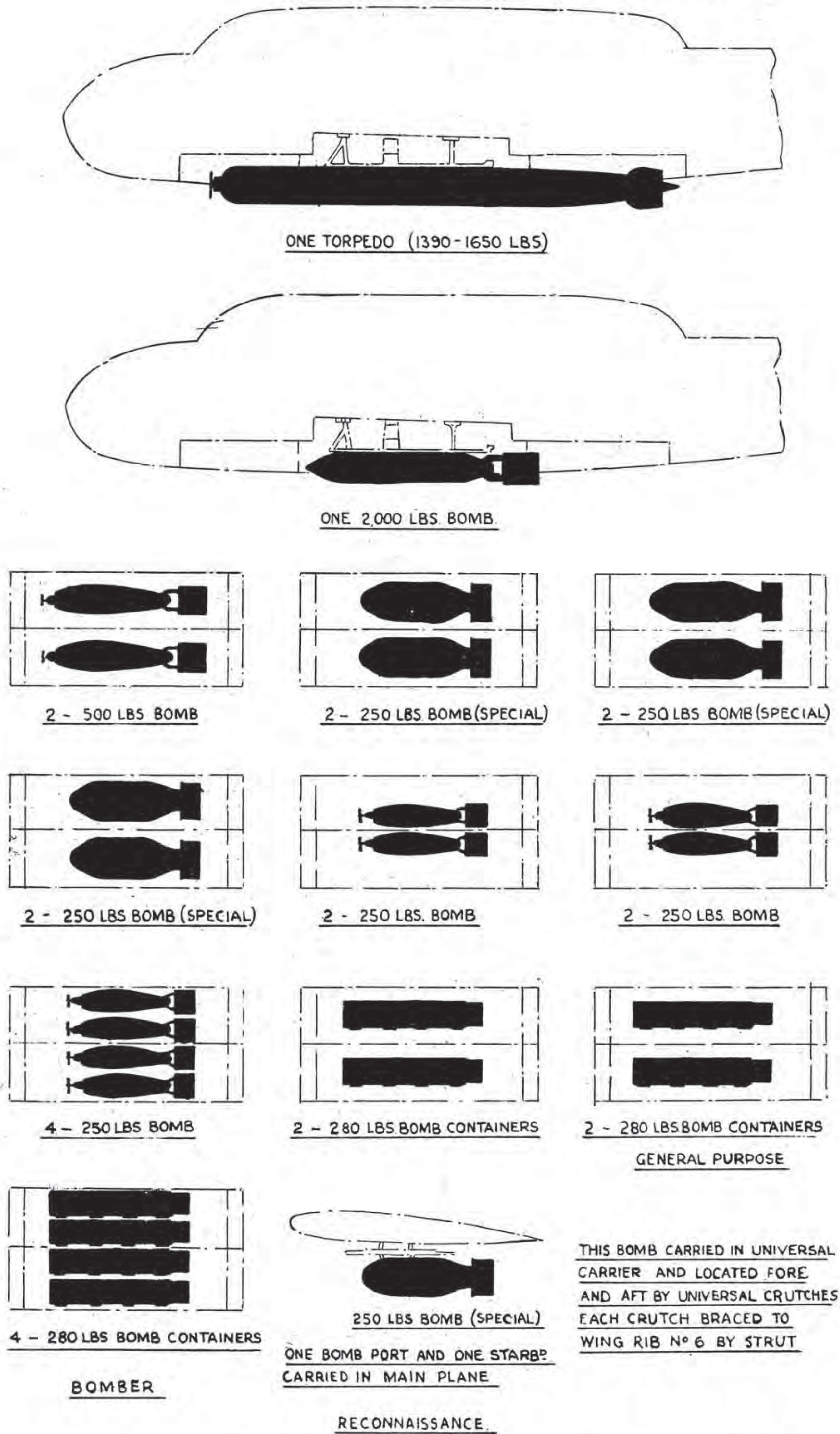

FIG. 4 ALTERNATIVE BOMB LOADS.

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SECTION 4A

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CHAPTER 1

MAINTENANCE INSTRUCTIONS

1. GENERAL.

This chapter describes the procedure for certain maintenance operations, and is intended to be a guide in the repair and maintenance of Beaufort Australian Aircraft.

(a) LIST OF REFERENCES.

The procedure for maintenance operations on certain of the components fitted to the aeroplane will be found in the following handbooks, as and when they are issued:—

Airscrew, Curtiss Electric—Maker's Handbook.

Engines, Pratt & Whitney S3C4G—Maker's Handbook.

Engine-driven Generator (Type QH and Type E)—A.P. 1095, Vol. 1.

Air Compressor—A.P. 1519, Vol. 1.

Turret (Type No. 4)—A.P. 1659B, Vols. 1 and 2.

Guns (Vickers)—A.P. 1641B, Vol. 2.

Gun Firing Controls—A.P. 1641E, Vol. 1.

Bomb Gear—A.P. 1664, Vol. 2.

Automatic Controls—A.P. 1469A, Vol. 1.

Pneumatic Brake System—A.P. 1464B, Vol. 1.

Graviner Fire-Extinguisher System—A.P. 1464B, Vol. 1.

Dinghy (Type H)—A.P. 1464B, Vol. 1.

Instruments—A.P. 1275, Vol. 1.

Tail Wheel Strut with Positive Locking—R.A.A.F. Pub. 280.

2. JACKING PADS (Refer Fig. 13, Sec. 4A, Chap. 3).

A bracket is provided on each oleo frame for the attachment of a jacking pad (see Fig. 13). The attachment pin for the pad is inserted at the bottom, and is anchored with a split-pin at the top end. An additional provision is made for jacking on the front spar of the centre plane immediately in board of the engine nacelle.

For jacking up the tail of the aeroplane, a standard 8-ton screw jack with a special jacking cap. Further details of jacking and trestling are illustrated in Fig. 4.

3. MAINTENANCE LADDER.

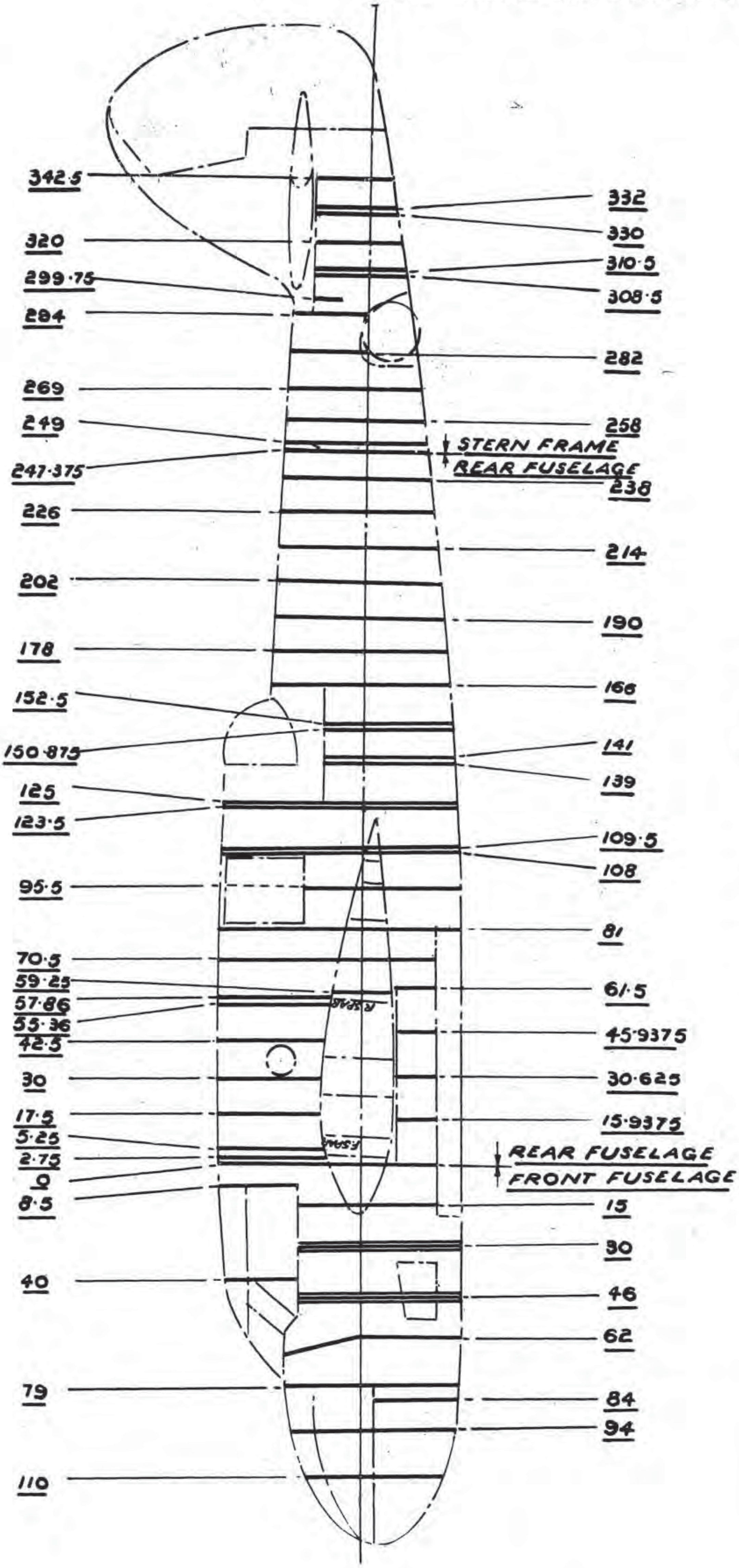
A maintenance ladder, which can be used either as an ordinary ladder or as a step ladder, is provided for giving access to the engines, etc., for servicing. When used as an ordinary ladder, a securing pin connects the two portions of the ladder together. When used as a step ladder, the securing pin is removed and the top portion is swung over the top of the lower portion and a tie cable is fitted between the two legs.

4. FORMER STATIONS AND INSPECTION PANELS.

The location of the fuselage formers and of inspection panels and doors are illustrated in Figs. 1 and 2.

5. LUBRICATION.

A lubrication diagram is given in Fig. 3. An oilite bearing is fitted on the handwheel spindle on the control column, and requires no lubrication. All ball and roller bearings are packed with anti-freezing grease before assembly, and should be regreased after 180 hours' service. See R.A.A.F. Maintenance Schedule, Section 11, flying controls. Some of the bearings have felt washers fitted to retain the grease, and these should be inspected periodically, and replaced if necessary.



FORMER STATIONS

ALL FIGURES QUOTED REPRESENT INCHES DISTANT FROM THE DATUM 'O' AT THE JUNCTION OF THE FRONT & REAR FUSELAGES

CHAPTER 2

RIGGING AND FLYING CONTROLS

1. RIGGING (Refer Fig. 2).

(a) GENERAL.

Since the main plane, fin and tail plane are fixed cantilever structures, no adjustment to them is possible. The only rigging operations are those concerned with checking diagonal measurements and the incidence and dihedral of the main and tail plane, and with the control settings and ranges of movement. A rigging diagram is given in Fig. 2, and all the main rigging dimensions and angles, with tolerances, are given in the leading particulars at the beginning of this publication. The sequence of rigging operations is as follows:—

(i) Trestle the aeroplane under the rear fuselage and centre plane as shown in Fig. 1, Sec. 4, and for location of jacking points refer Sec. 4, Para. 1.

(ii) Place a straight-edge transversely on the datum pegs on each side of former 95.5 in. at the entrance hatch; repeat this operation for the datum pegs fitted on former 190 in. aft of the gun turret. Retaining these two straight edges in position, place another straight-edge longitudinally on top of them. Adjust the trestles until a clinometer laid on the transverse and longitudinal straight-edges at fore end in gunner's compartment gives a zero reading in both directions. When a reading is taken, for example, transversely, turn clinometer around and take reading again in exact position.

(iii) Check the angle of incidence of the centre plane and outer planes by using incidence boards 87817 and 87822 respectively. Check the dihedral of the outer planes by means of a straight-edge and a clinometer. Locate incidence boards and straight edge in Fig. 3.

(iv) Check the incidence of the tail plane by using incidence boards 87818 and 87821 for port and starboard respectively in the position shown in Fig. 3, approximately No. 4 rib from centre line of tail plane, port and starboard. When the aeroplane is in the rigging position, the tail plane incidence is zero. Also check that the transverse level of the tail plane is horizontal.

(v) Check the symmetry between the main plane, fuselage, tail plane, undercarriages and engine by taking diagonal measurements as detailed in Fig. 2.

(b) CENTRE OF GRAVITY.

A datum plate, to which may be fitted a ¼ in. B.S F. bolt, is located 33 in. forward of former "0," to port side of front fuse. The C. of G. of aircraft is from 47-56 in. aft of this datum peg. (Refer A.M. Form 1336.)

2. FLYING CONTROLS (Refer Fig. 2).

(a) GENERAL.

The pendulum type rudder pedals and the spectacle type control column are connected to their respective control surfaces by chains and cables. A ground-adjusted trimming tab is fitted to the port aileron, and for directional, longitudinal, and lateral trimming, tabs controllable by the pilot are inset in the trailing edges of the rudder, elevators, and starboard aileron. The rudder tab, in addition to its trimming function, is arranged to give a servo action. All sprockets, pulleys, and levers for the chains and cables in the flying control system are carried on ball bearings. Locking gear is provided for the main flying controls, and dual controls may be installed side by side with the main controls. The split trailing edge flaps are hydraulically operated.

(b) CONTROL COLUMN.

The control column (see Fig. 3) is pivoted on a box bracket secured to the pilot's floor structure, and consists of a duralumin tube, to the top of which is bolted the control column head. The control column head is in two halves, and has an oilite bush for the spindle of the spectacle-type aileron control handwheel. At the centre of the handwheel, the undercarriage brake lever and parking lock are fitted, and at the top left-hand corner is the firing button for the fixed gun. A sprocket is fitted on the handwheel spindle, and from it a chain extends downwards inside the control column and over two sprockets mounted on ball bearings on a spindle fitted to the mounting bracket aft of the pivot point of the column. A socket bolted to the control column at the bottom is secured to spigots pivoted on ball bearings on the mounting; the inboard spigot has a lug that enables a torque tube to be fitted between it and a similar lugged spigot on the dual control column. The lever for the elevator control is riveted to the socket and spigots extend down below the mounting bracket. Adjustable stops, restricting the movement of the lever, are provided at the forward end and after ends of the bracket.

(c) RUDDER PEDALS.

The two rudder pedals (see Fig. 4) are pivoted at the top of a transverse support tube mounted between the port side of the fuselage and the central tube structure, and are of stirrup form with leather toe-straps. Each pedal lever, at approximately mid-length, is connected by a link tube to a lever that rotates a vertical counter-shaft. At the bottom of the countershaft there is a forward-pointing lever for the dual control connection, and an inboard-pointing lever for the normal control. Adjustable stops are mounted on the structure and restrict the movement of the dual control lever. To provide adjustment for leg reach the two levers at the top of the countershaft are rigidly fixed to a trunnion sliding within an adjusting box (see Fig. 15), pinned to a countershaft. The trunnion can be moved backwards or forwards to give a 3 inch adjustment to the pedals on either side of the normal position by means of a threaded rod that is connected by a universal joint and a tube to a crank handle below the instrument panel. To allow for the movement of the connecting tube when the rudder control is operated, the tube is supported at the handle end in a loose ring connected to the bottom support of the instrument panel.

(d) **ELEVATOR CONTROL** (Refer Fig. 3).

The run of the elevator control and details at various points are illustrated in Fig. 3. The lever at the bottom of the control column is joined by a connecting tube to a double relay post at former 30, that carries levers for the rudder and elevator normal and automatic controls. From the relay post, cables with turn-buckles at formers 129 and 166 extend along the port side of the fuselage over pulleys forward of formers 150 and 190, to a vertical double countershaft on the centre line of the aeroplane at former 249. The countershaft carrying the elevator levers is mounted on ball bearings outside the countershaft for the rudder control. From this countershaft, the elevator control movement is transmitted by an adjustable connecting tube to a horizontal countershaft at former 308.5, and thence to the elevators by a final connecting tube to which the operating levers for the port and starboard elevators are secured by a special bolt.

3. PREPARATION AND ATTACHMENT OF ELEVATORS.

(1) Fit bearing until high spots are removed and bearing revolves freely.

Check elevator trim jack. (NOTE.—This must be adjusted with an equal number of threads on jack, and with trim tab in the neutral position.)

When elevators are located in bracket, join port to starboard with distance tube and bolt.

(a) **GENERAL.**

Elevators must be so fitted that they will fall of their own weight. Grease at greasing points. Split pin as required.

(b) **ASSEMBLING OF ELEVATOR ROCK SHAFT.**

Assemble rock shaft (84280) to formers 308.5 and 310.5. (NOTE.—Packing plate and distance places as required.)

(c) INSTALLATION FOR ASSEMBLY OF LEVERS.

Insert ball races SKF.R.L.4 and BSS.BAL$\frac{1}{2}$ into housing 84293 pean over in six places ($\frac{1}{8}$ sq. punch). Install housing 84293 in mounting at former 250.

Part No. 84278 is then pushed in aperture of cross member with felt washer Part No. 50537 and distance collar 51007.

Part No. 84278 is then dropped into lower housing, after fitting 50537 felt washer and collar 51007 in lower bearing housing.

Top bearing pin 84262 is screwed down into top bearing to adjust end play, and locked with lock nut 51006. Part No. 84262 is finally locked with an AGS784-13 (split pin).

(d) INSTALLATION OF ELEVATOR CONNECTING TUBES (STERN FRAME).

Connect elevators to rock shaft, using connecting tube 84298 or E183847. This part attaches to the longest fulcrum on rock shaft. Attach to the short fulcrum connecting tube 84299.

(e) INSTALLATION OF ELEVATOR MAIN CONTROL CABLES.

Connect to King Post—

Cable.	Length.		Location.	Cable.	Length.		Location.
84360-3	9′ 0$\frac{3}{4}$″	to	Aft of former	84360-2	14′ 2$\frac{1}{4}$″	to	Relay post
84360-7	7′ 3$\frac{1}{4}$″		125 turn-buckles	84360-4	15′ 11$\frac{1}{4}$′		f/fuse

Main Adjustment.

Connect control column to relay post with connecting tube 84338.

Set the control column 1° forward, and with elevators in neutral adjust and tension at points indicated above. Adjust stops for full elevator ranges; stop located at base of column.

NOTE.—Compensation may be made on forward and aft connecting tubes. Check ranges and lock and pin where required. Bind cables with sisal.

4. RUDDER CONTROL (Refer Fig. 4).

The rudder control system and constructional details are illustrated in Fig. 5. From the lever at the bottom of the rudder pedals vertical countershaft, the movement is transmitted by a connecting tube to the rudder and elevator relay post, and thence by a cable run similar to the elevator control to the countershaft at former 249 (see Para. 4). From the top of this countershaft, cables with turn-buckles at the countershaft lever ends over pulleys at former 149 (see Para. 4). From the top of this countershaft cables with turn-buckles at the countershaft lever ends over pulleys at former 330 to the rudder operating lever.

(a) FITTING OF RUDDER AND BEARINGS.

Fit bearings until high spots are removed. When fitted, place bearings in their locations, check alignment (supporting sections may have to be eased).

Electric cables must be passed through into stern post prior to fitting rudder. Fit rudder in order to obtain free movement and within prescribed tolerances. Check for clearance on fairing block when rudder is in full range, port and starboard; bolt and split pin where required.

(b) INSTALLATION OF RUDDER MAIN CONTROL CABLES.

Connect from rudder to king post (upper location). Cables Nos. 84301 and 84302, length 8 ft. $4\frac{1}{2}$ in.

(c) FORWARD OF KING POST.

Cable.	Length.		Location.		Cable.	Length.		Location.
84360-7	9′ $0\frac{3}{4}$″	to	Aft of former 125	from	84360-6	14′ $3\frac{1}{4}$″	to	Relay post
84360-9	7′ $5\frac{3}{4}$″		turn-buckles		84360-8	15′$10\frac{1}{4}$″		f/fuselage

(d) MAIN ADJUSTMENT (FRONT FUSELAGE).

Connect rudder assembly to relay post by connecting tube 84339, and with rudder pedals and rudder set in neutral, adjust at points indicated above, and for port and starboard travel adjust stops located in cockpit.

5. AILERON CONTROL (Refer Fig. 5).

(a) GENERAL.

The run of the aileron control and details at various points are illustrated in Fig. 6. The aileron control chains at the foot of the control column are connected by cable to a double sprocket in the aileron relay post mounted on the main plane front spar. Four quadrants for the normal aileron control, and one for the automatic control, are connected at the double sprocket. From the relay post, chains and cables extend outboard over jockey sprockets on the front face of the front spar, port and starboard, to a point between ribs 11 and 12, where their direction is altered rearwards towards the aileron. Turn-buckles for adjusting the cables are fitted between the control column and the relay post, and also just outboard of the outer plane and centre plane joint. A telescopic conduit encloses the chains and cables from the front spar to the rear spar. The final chain passes over the sprocket mounted behind the rear spar, and then round a sprocket on the differential gear.

Two special tail ribs behind the rear spar at rib 12 support the aileron differential gear. The differential gear consists of a sprocket mounted on the inboard tail rib, and having an integral differential lever that is connected by a link to the aileron operating lever.

A lever on the outboard tail rib also supports the connecting link. The top point of the connecting link in the neutral position is mounted above the horizontal line through the centre of the sprocket, so that, for the same angle of rotation of the sprocket on either side of the neutral position, the amount of vertical movement of the pivot point, and therefore the angular movement of the aileron, is greater when the aileron is being raised than when it is being lowered.

(b) INTERCHANGEABILITY GAUGE No. TF 26647.

Prior to fitting, check bearings at attachment points for freedom of movement; also trim cables for correct attachment, the latter being fitted to starboard side only.

(c) AILERON ATTACHMENT.

The above has three points of attachment, and involves attachment, securing, and split pinning.

(d) AILERON RELAY POST.

Locate guard at three rear attachment points, then position relay post to former with post butted to spar attachment. The lower section holes to pick up attachment points to former section. Secure guard to floor on starboard side.

With top rib on relay posts parallel to spar, mark tooth nearest to end of guard (starboard side). Then, including connecting pin, count thirteen pins down on chain, attach chain between the twelfth and thirteenth position to marked tooth. Then connect to control column per medium of cables and chains. Point of adjustment between relay post and control column is situated at the base of the control column. (Turnbuckles.) Check turn-buckles for safety, then lock.

(e) ARRANGEMENT OF CHAINS AND CABLES, FRONT SPAR.

Arrangement of chains and cables from aileron relay post to turnbuckles, front spar (port and starboard).

(i) PORT SIDE:

	Chains.	Length.		Cables.	Length.	Location.
Connect	88837-2	11½"	to	88838-2	125.11"	Upper f. spar
	88837-4	30"		88838-1	116.11"	Lower f. spar

(ii) STARBOARD SIDE:

	Chains.	Length.		Cables.	Length.	Location.
Connect	88837-1	25"	to	88838-4	134.11"	Upper f. spar
	88837-3	44"		88838-3	115.86"	Lower f. spar

(f) **ARRANGEMENT OF AILERON CONTROL CABLES IN WINGS (PORT AND STARBOARD).**

Differential gear is meshed with chain No. 82637-1.

Chain.	Length.		Cable.	Length.		Chain.	Length.		Cable.	Length.
			Lower.			Lower.			Lower.	
Connect 82637-1	30″	to	82638-4	28.4″	to	82637-3	16½″	to	82638-2	92.125
			Upper.			Upper.			Upper.	
			82638-3	35.4″		82637-2	18″		82538-1	92.125

(g) **ADJUSTMENT OF AILERON CONTROLS, CABLES AND CHAINS.**

Op. 1.—Set "spectacle" on control column in neutral position.

NOTE.—This position may be fixed by the use of 2 wooden blocks 3-7/16 in. x 1 in. x ½ in.

Op. 2.—Clamp ailerons (port and starboard) in neutral, per medium of wooden clamps.

Op. 3.—Adjust turn-buckles (front spar), check tension with tensionometer, upper and lower cables (port and starboard).

NOTE.—It is desirable to have approx. 5 threads available for further adjustment as required.

Op. 4.—Check readings for limits. If the readings are not within limits it may involve either an increase or decrease of links on F/spar chains. Further adjustment is now provided on connecting link. (Location: Point of connection between aileron and differential gear.)

All movable parts should operate freely; check for safety. Lock, sisal cables.

6. TRIMMING TAB CONTROLS.

(a) **GENERAL.**

The trimming tabs inset in the trailing edges of the elevators, and of the rudder, are controlled from the hydraulic control panel on the starboard side of the pilot's instrument panel by means of cables and chains connected to Breeze actuating units at the stern frame. The aileron trimming tab on the port aileron can be adjusted only when the aeroplane is on the ground, but the tab on the starboard aileron is controllable by the pilot.

(b) **ELEVATOR TABS** (Refer Fig. 6).

The elevator tab control wheel and indicator is mounted at the top of the hydraulic control panel, and operates a drum from which cables extend along the starboard side to former 294 (see Fig. 7). At this former, the cables are connected by turn-buckles to chains that operate a drive unit mounted in the tail plane behind the rear spar. From the drive unit flexible drives are connected to a screw jack actuator mounted at the inboard end of each elevator, and coupled directly to the tab operating lever by an adjustable rod. When the control wheel is turned towards the NOSE DOWN position on the indicator, the trimming tabs are raised; the air load on the tab then forces the elevators down and relieves the pilot from the prolonged effort of countering any slight "tail heavy" tendency. When the control wheel is turned towards the "NOSE UP" position the effect is reversed.

(c) INSTALLATION OF ELEVATOR TRIM CONTROLS.

Op. 1.—Install unit to panel.

Op. 2.—Refer rudder trim (notes).

When elevator trim set at neutral, attach the following cables to breeze chain (Z8036) :–

Chain.	Length.		Cables.	Length.		Location.
Z8036	98″ $\frac{1}{4}$ pitch	to	84400-1 84400-1	38′ $1\frac{3}{4}$″ 38′ $1\frac{3}{4}$″	to	Breeze elevator control unit (cockpit)

Elevator trim cables pass through the remaining pulleys (refer rudder trim notes). Adjustments are similar to rudder trim.

(d) RUDDER TAB (Refer Fig. 7).

The rudder tab control and indicator are mounted on the hydraulic control panel below the undercarriage and flap controls, and is connected to a drive unit in the stern frame below the elevator tab drive unit by a run of cable and chain (see Fig. 8) similar to that for the elevator tab control. From the drive unit a flexible drive operates a screw jack or actuator mounted on the stern post. The tab operates similarly to the elevator tabs.

(e) INSTALLATION OF RUDDER TRIMMING CONTROLS.

(i) COCKPIT—

Op. 1.—Install unit to panel.

Op. 2.—Adjust unit to complete its travel to starboard direction so as to indicate the green four (4) and to indicate a red four (4) in port direction.

(ii) STERN FRAME—

With rudder trim set at neutral, attach the following cables to breeze chain (Z8035).

	Chain.	Length.		Cables.	Length.		Location.
Connect	Z8035	$\frac{1}{4}$ pitch 82″	to	84400-2	37′ $1\frac{3}{8}$″	to	Breeze rudder to control unit (cockpit).

From formers 249 to approximately 203 rudder trim cables are accommodated in the first and second pulleys nearest the centre line of aircraft and in a bank of four. (NOTE.—Pulleys are positioned in the horizontal.)

From former 202 pulleys are located in the vertical position (starboard) until at a point rear of hydraulic panel, where they assume the horizontal again. (Rudder cables are located on pulleys nearest the centre line of aircraft.)

Attachment of Cables to Drum.

1st Oper.—Wind drum back to green four (4), then take one complete turn of cable on drum and insert nipple into drum slot. Wind back to zero position on dial. Repeat this operation for attachment of other cable by turning to red four (4).

Check relationship of indicator to trim tab tension. Lock at turnbuckles and check for safety. Sisal cables.

(f) **AILERON TRIMMING TAB** (Refer Fig. 8).

The controllable tab on the starboard aileron is operated by a handwheel mounted forward of the engine throttle levers. Behind the handwheel is a control box which is connected by teleflex controls to another control box on the aft side of the rear spar (see Fig. 8). Cables and chains couple up this control box to the actuating unit mounted behind the aileron spar, and an adjustable tube connects the actuating unit to the tab operating lever. The trimming tab position indicator on the hydraulic control panel is operated by teleflex controls from a control box mounted below the handwheel and driven from it by a chain and sprockets.

(g) **AILERON TRIMMING TAB, CONTROLS, AND INDICATOR.**

(i) **COCKPIT.**

Pilot's control is located at the forward end of the engine control structure, and consists of a wrap box. There are three parts integral with spindle (1) wrap wheel, (2) sprocket, (3) operating hand wheel.

(ii) **CENTRE PLANE.**

Located on starboard side (rear spar) is a wrap box. There are two parts integral with spindle (1) wrap wheel, (2) sprocket.

(iii) **AILERON (STARBOARD).**

Located on trailing edge is the trim, movement of which is actuated by means of a jack; chain on jack should have equal length on either side of sprocket.

(h) **GENERAL NOTES (AILERON).**

Between points A and B motion is transmitted per medium of M.R.C. Bend radii must be on the highest limits permissible. Conduit must be free from kinks. Anti-freezing grease must be used within conduits, and in final adjusting of this run care should be taken not to over-tension, as this will produce a harshness, thus requiring an excess effort to effect the operation.

From points B to C guide pulleys must be free. Attach chain on wrap box at position B, with the tab on the "Up" position. Check that cables are not crossed on rear spar run.

Chain.	Length.		Cable.	Length.		Location.
			Upper.			
Connect 82579	57 links		89133-5	120.175"		Aileron trim
	465 m/m	to	Lower.		to	turn-buckles
			89133-6	146.5"		(rear spar)

(i) **SETTING OF CONTROLS.**

When hand wheel is turned clockwise, locking forward (that is, starboard wing down), box at centre plane should turn anti-clockwise, and tab should go down. Lock at turn-buckles, check for safety. Check connector pins. Sisal cables.

(j) **AILERON TRIM TAB INDICATOR.**

Location: Pilot's control panel.

Position of trim tab is indicated on the indicator by means of a positive drive (chain) from main wrap box to an accessory wrap box, then per medium of M.R.C. to indicator.

(k) **OPERATION.**

When main trim is moved in the anti-clockwise or clockwise position, the motion is indicated on the indicator. This run must be free in operation, as an incorrect indication would otherwise result.

7. **FLAP OPERATING GEAR** (Refer Fig. 9).

(a) **GENERAL.**

The two flaps on each side of the main plane are operated by a hydraulic jack pivoted on the rear face of the rear spar inboard of the centre and outer plane joint. The ram of the jack is coupled to the bottom of a quadrant pulley mounted on a support frame extending behind the rear spar, and two links pivoted at the top of the pulley are connected to the operating levers of the centre and outer plane flaps (see Fig. 10). A cable round the quadrant pulley is connected by a chain to a small sprocket on a relay shaft further inboard. From the large sprocket, on the relay shaft, chains and cables extend across the centre plane behind the rear spare to another relay shaft on the other side of the centre plane, and interconnect the flaps on each side so that they are raised and lowered simultaneously.

The handle for the flap control is mounted on the hydraulic control panel; instructions for operating the flaps are given in hydraulic system. An indicator beside the control handle shows the position of the flaps, and is connected by teleflex controls to a lever on the flap hinge at the starboard side of the fuselage (see Fig. 10).

(b) **INSTALLATION OF FLAP OPERATING MECHANISM.**

(1) Mount jack on frame.

(2) Locate mechanism. Check for alignment.

(NOTE.—Extreme outer edge of frame mechanism should be as near as possible in alignment with trailing edge of wing structure, although in many cases it will be noted that frame is up to ¼ in. below trailing edge.)

Drill, ream and bolt frame at upper and lower attachment points on spar.

Provision is made for shimming where hinge blocks (flap) are attached to frame. Shim as required, then drill, ream, and bolt.

Fit jack arrangement to attachment lug front spar, attach cable 891-33-1 to quadrant.

NOTE.—From centre line of cable fitting the lengths of cables are 42.0625 in. and 42.75 in. The long section passing through upper guide pulley (attachment bolt No. 89153) must be fitted with the nut on the inboard side (port and starboard).

(c) **FLAP DIFFERENTIAL ARRANGEMENT.**

Attach chains 89132-2, length 42½ in. (85 links) to large sprocket (rear spar), port and starboard. The relationship of these chains to sprockets is: Attach the above chains to sprocket with an approximate length of 3⅞ in., extending from centre line of sprocket.

	Chain Port.	Length.		Cables.	Length.		Chain.	Length. Stbd.
Connect	89132-2	42½"	to	89133-2 89133-3	174.8125" 174.8125"	to	89132-2	42½"

NOTE.—Cables cross at centre line of rear spar.

(d) **FINAL ATTACHMENT OF CABLES, CHAINS, AND ADJUSTMENT FLAP.**

With jack in position "UP" and differentials set as previously described, attach to chain No. 89132-1 (cable).

	Chain.	Length.		Cable.		Location.
Connect to	89132-1	16.5"	to	89133-1	to	Turn-buckle

NOTE.—Chain 89132-1 is attached to the smaller sprocket, with an approximate length of 2⅞ in. extending from centre line of sprocket (upper), port and starboard.

Connect toggle arms to flaps. Flaps must butt trailing edge evenly. Adjust outer flaps first, then inner.

Tension cables at turn-buckles lock and pin where required. Sisal cables and grease bearings.

8. DUAL CONTROLS (Refer Fig. 1).

If required, the dual controls may be installed on the starboard side of the cockpit, side by side with the first pilot's controls.

The dual control conversion set consists of a control column and rudder bar mounted on a cast floor structure, and a seat mounted on a separate tube structure. Instructions for installing the dual controls are given in Section 5.

The dual control floor structure is an aluminium alloy casting. It is attached to the fuselage structure at four points, and has a stay tube from the control column bracket to the aileron dual relay post forward of former 0.

The second pilot's control column, which is generally similar to that of the first pilot's (see Para. 2), except that it has no gun firing button or undercarriage brake lever, and no lever at the bottom for elevator control, is pivoted on a bracket at the rear of the floor structure. The chains from the aileron handwheel are connected to the relay sprocket shaft forward of former 0, from which a chain leads to the double sprocket on the aileron relay. For elevator control, the two control columns are inter-connected by a transverse torque tube between the two columns at the pivot points.

The rudder pedals are pivoted at the bottom of the tube for the rear support points, and are each coupled by a link tube to levers on an adjusting box, similar to the box on the first pilot's rudder control (see Para. 3), and pivoted at the front end of the floor structure. A lever pointing forward is fixed to the adjusting box, and from it a tube connects to the lever on the vertical countershaft for the first pilot's rudder control. The connecting tube and handle for the adjusting box are supported on a bracket between the pedals; the handle can be folded back and secured in a clip on the support bracket. The connecting tube from the handle is not directly connected to the adjusting box, but has a fork joint that engages with a pin on the adjusting box when the handle is pushed forward against the action of a spring at the handle end. To adjust the pedals, centralise the pedals in order to allow the fork joint to engage with the pin, push the handle forward and turn. As use of the adjusting handle locks the rudder controls, the pedals should be adjusted only when the aeroplane is on the ground, and after use the handle should be secured in the clip. The second pilot's seat is mounted on a tube structure that can be attached to the formers over the torpedo cell, and to formers 46 and 30 at the fuselage sides. The back of the seat is arranged to fold down.

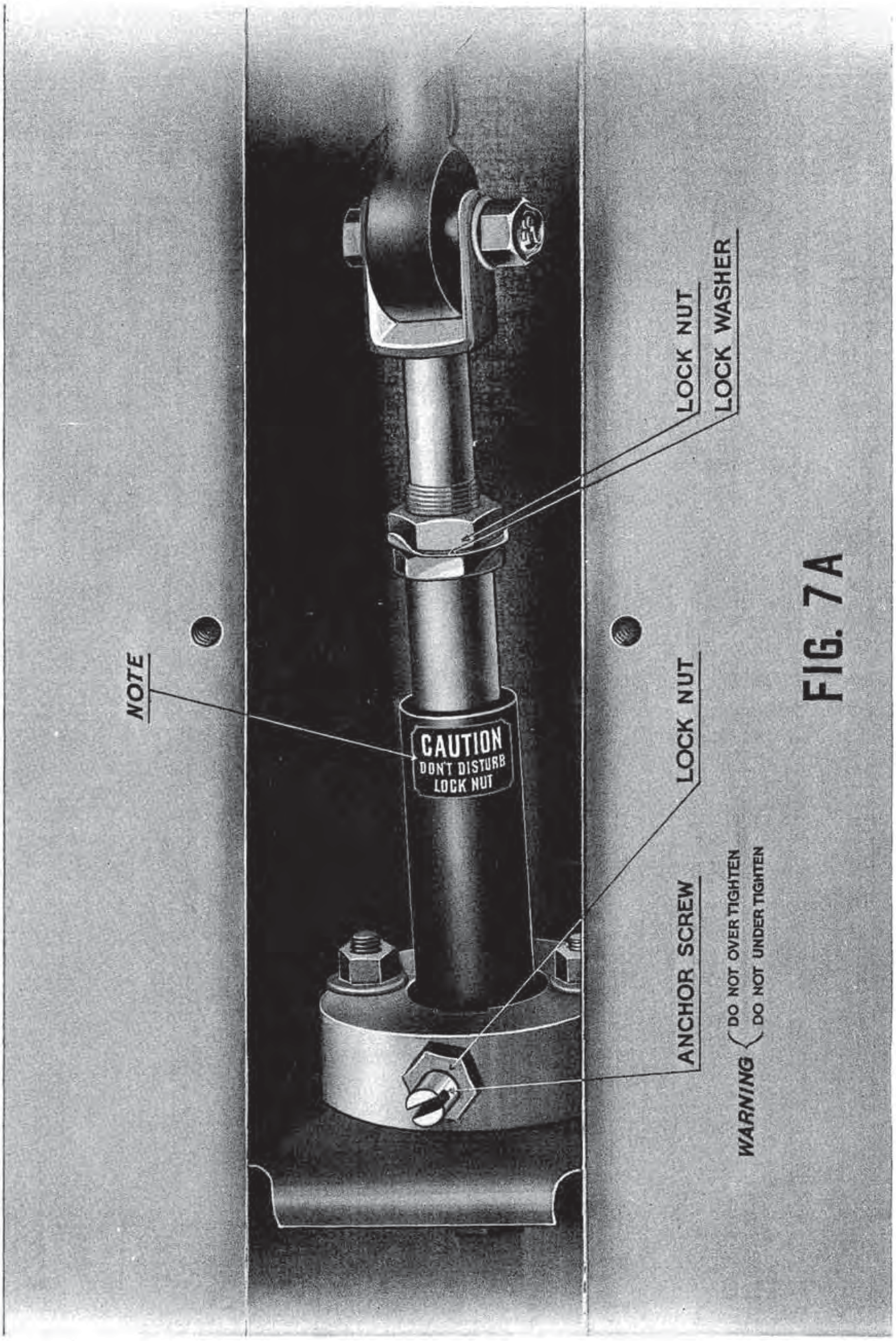

NOTE
CAUTION
DON'T DISTURB
LOCK NUT
LOCK NUT
LOCK WASHER
LOCK NUT
ANCHOR SCREW
WARNING
DO NOT OVER TIGHTEN
DO NOT UNDER TIGHTEN

FIG. 7A

CHAPTER 3

CHAPTER 3

1. ALIGHTING GEAR.

(a) GENERAL.

The alighting gear consists of two independent undercarriage units and a tail wheel unit. All three units are retractable, and are normally operated by hydraulic power. The undercarriage unit swinging backwards and upwards into a recess on the underside of the centre plane, and the tail wheel unit forward and upward into a recess on the underside of the stern frame.

The indicating and warning devices include three electrical position indicators, one for each unit, and an electrical buzzer which denotes the positions of the undercarriage units.

(b) UNDERCARRIAGE (Refer Fig. 1).

Each undercarriage unit has a single wheel carried on an axle between two oleo struts that are cross braced to form a rigid frame. The oleo frame is connected to the tube structure of the engine nacelle at pivot at the top of the oleo legs, and is braced in the "down" position by a pair of knee-jointed radius rods, the upper portion of which are fixed to a transverse torque shaft supported in bearings on the rear tube of the nacelle structure.

(c) OPERATION.

Pivoted above the transverse torque shaft are two levers with trunnion bearings, on which the cylinder of the hydraulic operating jack is mounted about midway along its length. At the middle of the torque shaft are twin levers which are linked to the jack trunnion lever. The end of the jack arm is connected by an adjustable fitting to a pin working in a pair of slots in a lifting bracket attached to the oleo frame at the junction of the cross bracing. A pair of knee-jointed radius rods brace the oleo frame in the "down" position; the lower portions of the rods are connected by adjustable eye-ends to brackets near the bottom of the oleo cylinders, and the top portions are rigidly fixed to the torque shaft.

2. LOCKING CATCHES (Refer Fig. 1).

(a) GENERAL.

Mechanical locking catches are provided for each undercarriage unit in both the lowered and the retracted positions. On each oleo leg a latch, toothed on the upper and lower sides, is pivoted on a bracket below the level of the lifting bracket, and is linked by a connecting rod and lever to the lifting pin in the slots in the lifting bracket; the latches, port and starboard, are inter-connected by a countershaft so that they both work together. The catch in which the lower tooth engages when the undercarriage is lowered is a spring-loaded lever catch fitted on the lower portion of the radius rod, and the catch in which the upper tooth of the latch engages when the undercarriage is retracted, is a spring-loaded plunger catch fitted on the rear tube of the nacelle structure forward of the torque shaft.

(b) OPERATION.

When the undercarriage is in the lowered position, and hydraulic pressure is admitted to the jack, the ram moves inwards and the lifting pin in the lifting bracket slides along the slots. This movement rotates the latch interconnecting shaft and raises both latches, disengaging them from the catches on the radius rods. Continued movement of the jack ram brings it against the end of the slots in the lifting bracket, thereby pulling directly on the oleo frame, and simultaneous movement of the jack cylinder on its trunnions and pivot levers rotates the torque shaft, thus breaking the knee-joints of the radius rods. Further inwards movement of the jack ram, and rotation of the jack on its trunnion, folds the radius rods and lifts the oleo frame until the upper tooth of each latch engages with the top catches on the nacelle structure. An adjustable stop for the oleo leg is fitted at the rear ends of the rear tube of the nacelle.

(c) ADJUSTING AND FUNCTIONING OF UNDERCARRIAGE (Refer Fig. 1).

Remove nacelle doors, then connect hand operated pump directly to U/C. jack.

After unlatching lower catches, disconnect jack from attachment point of connecting rod to undercarriage by removing lifting pin. Function jack for freedom of operation; any undue tightness will be revealed by increased pressure on pressure indicator mounted on test pump.

Remove radius rod pins at knuckle joint, check for excess wear. Refit; care should be taken to replace pins with the greasing nipple facing inboard.

Remove lower attachment pins, check for wear, then note that radius rods at the knuckle joint will, when raised, fall of their own weight (this is important).

Check cross tubular member for slackness at ferruling points, these being the anchorage for jack fulcrum arms, also radius rods; any movement at this point will seriously affect final adjustment.

Lower latches, i.e., inboard and outboard, are anchored to a common shaft; excess movement will directly affect the uniform latching of either the inboard or outboard latch.

The operator having satisfied himself that the above mentioned detail is O.K., assembly may be proceeded with in the following order:—

Refit lower end of radius rods to undercarriage structure (temporarily); special pins may be used.

Reconnect jack to point of attachment, then check for jack over-ride, permissible tolerance .080 ins. This operation is effected by operating hand pump with the control lever in the "down" position, at a pressure of 800 lbs. per sq. in. This is important, as either an increase or decrease of the above pressure will affect final adjustments. Should over-ride be either in excess or insufficient, adjustments can be effected by unlocking eye bolt, located at end of jack rod, and as required increase or decrease length of jack.

Verticality of oleo legs should be checked for limits; a compromise may have to be made at this point for the following reasons:—

Verticality range is effected by length of radius rods. Should it become necessary to shorten rods, it will also affect the length of jack rod; it can then be followed that a shortened jack rod may tend to over-retract, thus causing the undercarriage to foul main plane tank door. This is overcome by increasing the distance out of thrust on jack body.

(d) UNDERCARRIAGE RETRACTING MECHANISM ADJUSTMENTS (Refer Fig. 1).

(i) **GENERAL.**—The following is the sequence of operations for adjusting the various stops and locking catches:—

(ii) Prepare the aircraft by jacking with trestles to clear the main landing wheels from the ground, at the same time rigging the aeroplane datum in approximately flying position.

(e) UNDERCARRIAGE IN "DOWN" POSITION.

(i) Retract the undercarriage sufficiently to disengage the locking latch from the bottom catches.

(ii) Apply hydraulic pressure to the jack piston; set the undercarriage in a fully extended position with the lifting pin at the forward end of the slot in the lifting bracket.

(iii) By making use of shims made up from Alclad sheet, between locking latch brackets and their mounting face on sides of oleo legs, adjust the jaws between the locking latches and bottom catches with feelers to give a clearance of 0.015 in. to 0.025 in. The latch can then be set for correct mesh by adjusting the screwed fork end on the link, care being taken that the bottom catches are not depressed when the latch is in full engagement.

(iv) The adjustment should be so made that the working faces of the latches and the bottom latches are parallel to one another, and the clearances on both catches are equal.

(f) **UNDERCARRIAGE IN "UP" POSITION.**

(i) The undercarriage should then be fully retracted, and the top catch adjusted to mesh correctly with the top catches, this being done by unlocking the lock nut and screwing the barrel either clockwise or counter-clockwise, as required by turning the catch, care being taken to ensure that both catches are equally engaged, and then lock the locking nut. In the event of the top catches being at the incorrect height, rectify by means of the adjustment on the top catch struts.

(ii) If the height of the top catches is altered, then the top switch bracket must be readjusted to suit.

(iii) If the adjustment for the height be such that the end of the adjustment screw of the catch strut, which screws into the fork end comes below the inspection hole, then the oleo-pneumatic legs must be further retracted by adjusting the stop on the jack cylinder.

(g) **UNDERCARRIAGE JACK.**

(i) To adjust the extension piece on the jack cylinder, the lock nuts must be released and the extension piece, which screws into the stop nut, adjusted to suit the position at which the undercarriage is required to stop.

NOTE.—For final check of cylinder see Para. (g) (ii).

(h) **UNDERCARRIAGE AND JACK LIMITS.**

(i) After any undercarriage maintenance in which the jack and radius rods have been disconnected, the undermentioned limits should be observed.

(a) Check radius rod for measurement between knuckle joint and bottom hinge point of radius rod $= 20 \pm .004$ in.

(b) Check jack for measurement with piston fully retracted between centre of piston attachment eye bolt and centre of jack pivot point $= 15.285 \pm .125$ in.

(ii) With the jack piston rod extended and connected to the undercarriage bracket, with the lower catches locked, extra pressure within the following limits of movement of plus 0.030 in. and plus 0.080 in., should be allowed to prevent piston coming in contact with the end cap of jack. The adjustment is made with the end fitting and lock nut.

NOTE.—Refer to Para (g.).

(iii) When connecting the lower end of the radius rod to the hinge bracket on the shock absorber leg, the misalignment of the radius rod may be $\frac{1}{8}$ in. on either side.

NOTE.—Refer to Para. (d).

(iv) Remove the jack piston rod from its attachment and apply hydraulic pressure to ensure that the limits as per Para. (g) and Sub-

Para. (ii) are correct in both retracted and fully extended position of the undercarriage.

NOTE.—The lock nut must then be wired, locked to the stop nut, after final adjustments have been made.

(i) NACELLE STOPS.

When the undercarriage is in the fully retracted position, with "upper" catches engaged, adjust the stop bolt mounted on head and the oleo leg axle housing.

NOTE.—The following adjustments of nacelle fairing doors and bumper rails are carried out in conjunction with the above adjustments.

3. TOLERANCES.

(a) LOCKING CATCHES.

"Down" catches: 0.015 in. to 0.025 in.
"Up" catches: 0.025 in. to 0.040 in.

(b) UNDERCARRIAGE AND JACK LIMITS.

(i) Measurement between knuckle joint and bottom hinge point of radius rod = 20 in. ± .004 in.

(ii) Measurement with piston fully retracted between centre of piston attachment eye bolt and centre jack pivot point = 15.285 in. ± .125 in.

(iii) Alignment of radius rods may be $\frac{1}{8}$ in. on either side of centre line.

Adjustment of lower catches is effected by, as previously mentioned, application of pressure on the "down" position and per medium of shims adjust to the stated tolerances. On completion retract the undercarriage, and per medium of the turn-buckles adjust the upper catches with the pressure maintained at 800 lbs.

NOTE.—Final check of undercarriage in the retracted position must be carried out after the installation of nacelle fairing doors, and if stated clearances are not in evidence, bumper and slide rails only must be adjusted to give correct clearances previously obtained.

Finally, bolt and split pin. Bolts to be peaned as required. Glands and adjustments suitably locked, then system greased at required bearing points. Check safety holes for factor of safety.

4. OLEO LEGS (Refer Fig. 3).

(a) GENERAL.

Each undercarriage oleo leg consists essentially of two members, an upper cylinder contained air pressure, and a lower member or sustaining ram sliding within the upper cylinder and forming an oil chamber. Light loads are absorbed by air cushioning only, but heavier loads are absorbed by progressive hydraulic loading caused by forcing the oil through the annular holes that decrease in area as the ram moves upwards.

(b) CONSTRUCTION.

The top end of the upper cylinder has an integral attachment that provides one of the pivot points for the oleo frame, and is fitted with an air valve, an oil level plug and tube, and a hollow plunger; the plunger is tapered and has a small leak at the bottom end and holes for oil overflow into the plunger at the top end. At the lower end of the upper cylinder, a gland comprising U-section leather packing rings, a gland bearing sleeve, a retaining nut and a packing support ring is fitted. The retaining nut is locked in position by a screw, which is itself locked by a safety strap connected to the oil level plug; before the gland locking screw can be unscrewed the oil level plug must be removed. A lubrication nipple is provided for the gland, and an oil-retaining nut with L-section packing is screwed over the lower end of the gland nut.

The ram is a hollow tube attached at the bottom end of one side of the wheel axle. Near the top end of the ram is an integral partition that forms the base of the oil chamber and, at the top, a piston is constructed in two halves screwed on the ram. The inner diameter of the piston is sufficiently great to allow an annular clearance between it and the tapered out diameter of the plunger. An annular channel between the halves of the piston, and is fitted with a damper valve ring drilled with holes. On the outside of the ram a collar is screwed on, bearing against a buffer ring above the packing support ring, which acts as a stop for the downward movement of the ram.

5. SERVICING AND OVERHAUL INSTRUCTION.

(a) GENERAL.

The Vickers oleo strut consists essentially of an air cylinder and a piston, a working gland between the piston and the cylinder being oil sealed to prevent air leakage. The compressed air forms the spring medium, and there is an internal oil break and rebound damper which dissipates the energy of landing and damps out oscillations. The amount of fluid to be put into the unit is specified on the instruction plate strapped around the strut, namely, 4.62 pints of anti-freezing oil to specification DTD.44C. The oil lubricates all the working parts, and is used in the brake and damper. If there is reason to doubt the quantity of fluid in the strut, carry out an oil level test. If three jacks are available, the undercarriage can be lifted off the ground and the piston can be compressed into the body by means of the third jack, and on unscrewing of oil level plug a few turns, oil should start to flow, and when the oil flow ceases correct oil level has been reached. If third jack unavailable, fully extend piston with about 50 lbs. per sq. in. pressure, then unscrew oil level plug; if oil and air both start to flow, wait until oil stops flowing and air only emerges; this then is right oil level.

(b) **OPERATION** (Refer Fig. 4).

On the upward stroke of the shock absorbers, oil is forced up through the small apertures in the piston head. This compresses the air in the top end of the unit, and so provides a springing medium for taxying. On the recoil stroke a small clack valve is forced down on to the piston head, trapping the displaced oil above it. This oil can only escape through relatively small holes in the clack valve (piston head), and thus provides the required damping. At the upper end of the strut, a valve is provided for replenishing with oil and air (an inlet valve) for inflating the cylinder. The correct oil level is determined by an internal stack pipe extending downwards from the upper end of the strut.

(c) **MAINTENANCE OF STRUT IN SERVICE.**

Piston extension = $5\frac{1}{4}$ in. - $5\frac{3}{4}$ in. at 375 lbs. per sq. in.

The oleo struts are supplied with the correct quantity of oil, but without the compressed air. When installed in the aeroplane, and when the air pressure has been raised to the figure (375 lbs. per sq. in. approximately), with wheels off ground, as stated on the plate, the strut requires no further attention until 160 hourly inspection.

(d) **DIAGNOSING OF FAULTS.**

The following notes will enable the operator to diagnose any faults:—

(i) Air pressure is too low.

The strut is designed so that under normal load the piston will rest at 75 per cent. extension, and if the extension is only 50 per cent., and if on taxying there is evidence that the piston is moving into, say, 25 per cent., extension, then the air pressure is too low, and steps should be taken to increase it.

(ii) Air pressure is too high.

This state of affairs will be evident if the piston repeatedly stands at full extension under normal static load, and if, on taxying, the movement never exceeds 25 per cent. of the possible travel.

(iii) The air pressure is correct, but still the strut gives excessive piston travel, and the aeroplane rolls laterally on a turn.

In this case the compression ratio is too low, and indicates that there is a deficiency of oil; check oil level.

(iv) The air pressure is correct, but the strut is harsh and unyielding.

These conditions point to excess of oil and the level should be checked.

(v) When the main gland is in order, the oil seal is so perfect that only a trace of oil will be found on the piston.

If the piston is unduly wet, and if the strut is obviously losing oil, the packing rings (which are automatic in action) have perished, and although tightening the gland nut may be adopted as a temporary expedient, new rings should be fitted at the earliest opportunity.

(e) **ADJUSTING THE AIR PRESSURE** (Refer to Para. 5 (i)).

When it is necessary to adjust the air pressure, it is essential that the piston should be fully extended, and to ensure this the aeroplane must be jacked up with the wheel clear of the ground. Compressed air may be obtained from a commercial bottle of compressed air, provided the necessary precautions are taken, or any air pump capable of supplying compressed air up to, say, 800 lbs. per sq. in., may be used. Some pumps may inject an excessive quantity of oil with the air, and this must be guarded against. The action of the air filling valve and the oil-level valve is clearly shown.

(f) **HOW TO AVOID A FALSE READING.**

In making these check tests it is always advisable to pump pressure into the air line coupled to the air filling valve (before opening same), to a figure slightly in excess of the initial air pressure stated on instruction plate on strut. If this is not done, a false reading (low) of the pressure previously existing in the air chamber of the strut will be given by the gauge in the pipe line owing to the amount of air lost from the air chamber to the pipe line. This drop may be as much as 100 lbs. per sq. in. in the smaller struts.

(g) **TO CHECK OIL LEVEL.**

Oil level checks should not be carried out immediately after the strut has been in use, as the air and oil then exist in the form of an emulsion. To carry out the oil level check without dismantling the strut, the best method is to proceed as follows, after jacking undercarriage wheel clear of ground.

Open the oil valve from a quarter to a half turn, and allow the excess oil to blow out. During this time the air pressure in the cylinder should not be lower than, say, 50 lbs. per sq. in. The oil chamber in the strut does not readily permit the oil to find its level; therefore, the checking should not be hurried.

If on opening the oil level valve, air only escapes, this indicates that the oil level is too low. Oil should, therefore, be pumped into the strut through the air filling valve until it starts to blow out through the oil level valve, which is open from a quarter to a half turn.

NOTE.—As the oil is being pumped, air will also be included and the air pressure gauge must be watched, and the pressure be slackened off.

(h) **DISMANTLING THE STRUT.**

It will only be necessary to dismantle the strut if it is necessary to replace worn-out packing rings.

Proceed as follows:—Unscrew oil valve slowly. When the air has ceased escaping, the oil valve may be removed, and then the safety lock screw for locking the main gland unit is unscrewed and the gland nut is removed. During these operations care should be taken that the walls of the air cylinder or piston are not damaged. If any difficulty is experienced in withdrawing the piston, it is a good plan to force it out by pumping the oil in through the filling valve.

Having dismantled the strut, wash all parts in paraffin, and drain.

(i) **RE-ASSEMBLY** (Refer Fig. 3).

Place air cylinder (strut body) with valves shut, and inverted in vice. Pour in the measured quantity of oil. Insert piston, but do not displace oil. Slip rings over piston singly to prevent damage to feather edge of packing rings, and assemble with the feather edge inwards.

Tighten gland nut to bed rings into place, and then loosen half a turn. Refit safety lock. Now place oil seal ring with the feather edge downwards, and tighten retaining nut until the fine locking hole in it comes opposite the one in the gland nut, and then lock with circlip.

If it is intended that the strut is to be fitted to the aeroplane at once, inflate with compressed air to pressure stated on instruction plate (375 lbs. per sq. in.). This pressure changes from 375 lbs. to 400 lbs. per sq. in. at 18,000 lbs. training weight to all-up weight of 22,000 lbs., when pressure should be increased to 465 lbs. per sq. in. (with undercarriage wheels off the ground).

Struts are best stored vertically with the air cylinder uppermost, filled with the correct quantity of oil, but with no air. Inflation is best done immediately before the strut is put into use.

6. UNDERCARRIAGE POSITIONAL INDICATORS (DAZZLE LIGHTS AND WARNING HORN).

(a) **GENERAL** (Refer Fig. 2).

In the pilot's cockpit three electrical position indicators, for each unit, and a warning buzzer indicates the positions of the alighting gear units. The undercarriage indicator switches are operated by the locking catches (see Para. 6) on the undercarriage, the tail wheel indicator switch by the tail wheel retracting mechanism, and the buzzer switch by the engine levers.

(b) **OPERATION.**

The system introduces a warning buzzer switch, which is closed when the undercarriage is in the fully retracted position, and when the throttle levers are closed back to an approximate speed of 130 m.p.h. This serves to remind the pilot that his undercarriage is "UP." When undercarriage is fully extended and locked in the "DOWN" position, a micro-switch is operated which opens the buzzer circuit and closes the undercarriage and tail wheel "DOWN" circuits. On raising the undercarriage, the reverse operation takes place, and when the undercarriage is fully retracted the micro-switch changes the indicator to "UP" position.

(c) ADJUSTMENT.

The operator should aim to adjust leverage arms in order to obtain maximum of over-ride; if this is not carried out, warning horn circuit will be alternately open and close when aircraft is moving over rough surfaces. The warning horn to be adjusted to operate at 15 h.g. manifold pressure at 1000 feet, with airscrew in full fine position.

7. TAIL WHEEL UNIT (Refer Fig. 5).

(a) GENERAL.

The tail wheel oleo leg is mounted in a double frame attached to former 308.5-310-5, and to a special partial former 299.75 forward of former 308.5-310.5. The rear ends of the top and rear frame members provide bearings for a cross shaft to which the operating lever is connected and the oleo leg is pivoted centrally at the lower ends of the rear frame members. The cylinder head of the operating jack is pivoted to a fitting on a cross member at the forward end of the top frame members, and the jack piston rod is connected to the operating lever on the cross shaft.

When the piston rod moves inwards to retract the tail wheel unit, the cross shaft is rotated, and the retracting arms connected to the cross shaft move along a retracting slide fitted to the oleo leg, and bring the leg over the vertical position into the horizontal retracted position.

8. LOCKHEED TAIL WHEEL STRUT WITH LOCKING DEVICE.

(a) DESCRIPTION.

Generally speaking, this unit fulfills two functions:—

(i) Energy absorption on landing and taxying.

(ii) Maintenance of directional stability with the latch in the locked position.

The tail wheel buffer consists of a plunger tube which slides in a cylinder tube, the exposed portion of the former being fitted with a wheel fork retained in position by a pin. That portion of the wheel fork which is fixed inside the plunger tube and forms an air head and carries a rubber seat. A hole which passes through the air head communicates with a transverse hole in the fork, and is fitted with an air valve.

Inside the plunger tube is a floating separator fitted with two rubber glands, which isolates the air from the fluid. That end of the plunger tube which is inside the cylinder tube has a piston fitted with a rubber gland, and a flutter plate on its face which either blanks off or opens a series of holes that are drilled through the spline bearing portion of the piston. This is necessary to give effective damping on the return stroke.

Two sets of roller bearings are carried in suitable cages inside the lower end of the cylinder tube.

(b) MANUAL LOCKING DEVICE (TAIL WHEEL STRUT).

Manual locking device is fitted to the spline shaft, which passes through the oil head into the cylinder tube, and thence through the piston and into the plunger tube. As the shaft is splined to the piston, and the locking plate is fitted to the spline shaft, it will be seen that with the latch in position no movement is possible. Two lugs are provided on the bottom forging, and are drilled and bushed to locate a shaft which forms a fulcrum point when the strut is retracted. A lever with a roller on its lower end is fitted to a tubular member between the top sides of formers 308.5 and 310.5. This lever, which is operated by the pilot from the cockpit, is brought into operation by a relay of M.R.C. and cable. This draws the lever forward, and its lower end in turn pivoting backwards on the tubular cross members, strikes the lower end of the spring loaded latch, which moves out of locking plate and allows the strut to caster. On releasing of lever by pilot, who has a control lever in cockpit, the latch by pressure of spring under lower end face, engages with slot in locking plate, thus holding piston in central position, thereby reducing shimmying on take-off and landing.

(c) INSTRUCTIONS FOR SERVICING.

(i) Jack tail wheel clear of ground.

(ii) Deflate buffer by reversing air valve caps, and fully compress the plunger tube manually.

(iii) Charge the fluid A.I.R. 18280 gun, or other suitable gun, with hydraulic fluid Intava 685, taking care not to draw in any air.

(iv) Remove one of the filler plugs and screw the fluid gun extension piece into the orifice, and force the fluid into the buffer until the plunger tube is expanded approximately 5 ins. Unscrew fluid gun extension and replace the filler plug; remove trestle and place the weight of the aircraft on the strut. This will ensure that the air separator is forced to the bottom of the plunger tube.

(v) Loosen filler plug slightly to allow any air which may have accumulated in the top of the strut to escape, and allow the fluid to continue flowing until the plunger tube is extended approximately ½ in. Tighten the filler plug and lock with 20 gauge soft iron wire.

(vi) Replace aircraft on the trestle and remove air valve cap, and screw the hose connection to air valve and inflate to pressure of 105 pounds per sq. in.

(vii) Remove pump hose connection and check air valve for leaks, and replace cover cap.

NOTE.—It is absolutely essential for cleanliness to be maintained at all times, otherwise trouble will continue to result.

(d) **FAULTS.**

If the action of the leg is excessively harsh, and the plunger tube does not move, or only moves a small amount from the extended position when taxying, the air pressure is too high or the leg contains too much fluid.

If the action of the leg is spongy and slow in recovering, and the plunger tube does not extend to its normal position, the air pressure or the fluid level is too low.

When loss of air pressure occurs, the air valve should be checked for leaks by separating fluid all the joints. Leakage around the valve may be cured by tightening the valve body, but care must be taken not to strain the threads; leakage through the valve may be cured by fitting a new valve core.

9. **CONTROL SAFETY LOCK AND LOCKING PINS** (Refer Fig. 1).

The control safety lock and the locking pins for preventing inadvertent retraction of the undercarriage when the aeroplane is on the ground (reference should be made to M.R.C.).

10. **UNDERCARRIAGE LEVER LOCKING DEVICE** (Refer Fig. 1).

(a) **GENERAL.**

The object of the undercarriage jack is to safeguard the aircraft against the possibility of the collapse of the landing gear.

(b) **DETAILS OF ASSEMBLY ARE AS FOLLOWS:—**

FRONT FUSELAGE.—At the rear of the hydraulic panel is located a spring loaded plunger. This, when moved in the upwards or downwards direction, actuates per medium of a cam, a bolt which moves across the undercarriage gate, thus preventing the possibility of selecting the undercarriage "up" position.

DETAILS OF OLEO LEG ASSEMBLY.—On movable section of oleo leg is mounted a fixed bracket; on fixed section a guide is clamped. Attached to the movable section is an adjustable sliding rod. The sliding bolt in front fuse is actuated by movement of movable section of oleo leg, motion being transmitted per medium of M.R.C.

NOTE.—Cable is to be adjusted when legs are fully extended, i.e., when machine is supported other than on undercarriage, slack to be taken up in M.R.C., plus travel of indicator on operating lever, so that the lever can be pulled up to the "up" position without obstruction, when weight of machine is on undercarriage, indicator pin should spring back sufficient to prevent operating lever from being pulled to the "up" position.

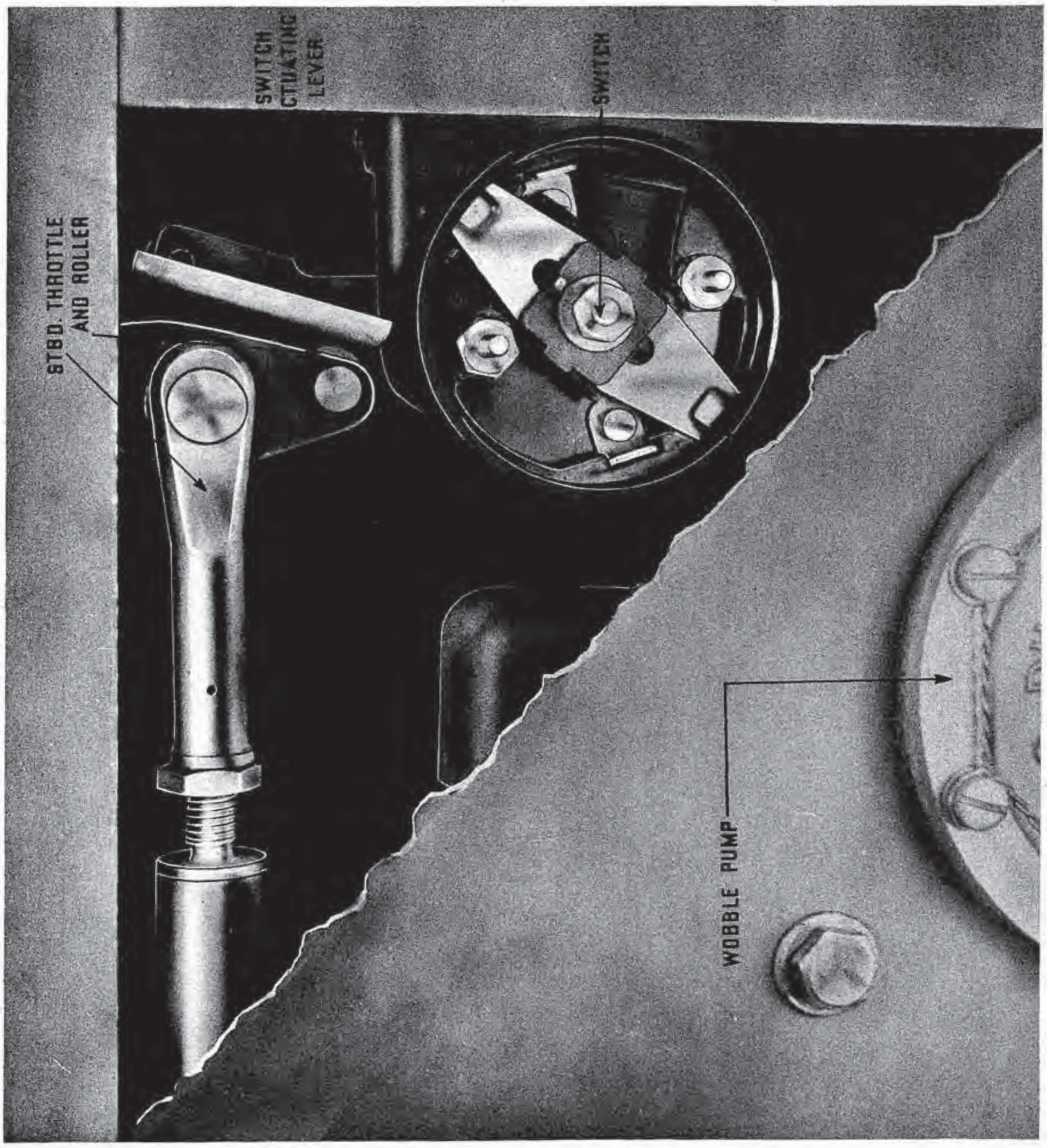


FIG. 6.—THROTTLE LEVER BUZZER SWITCH.

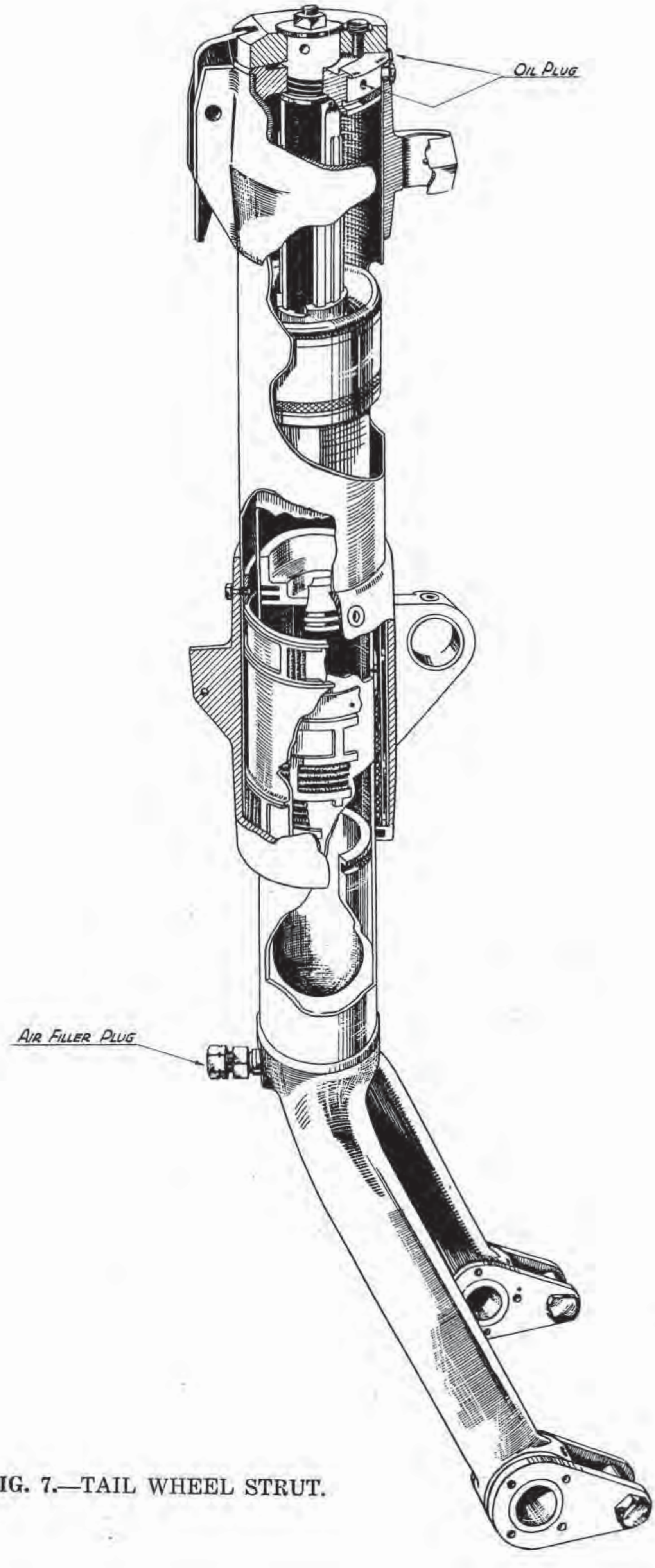


FIG. 7.—TAIL WHEEL STRUT.

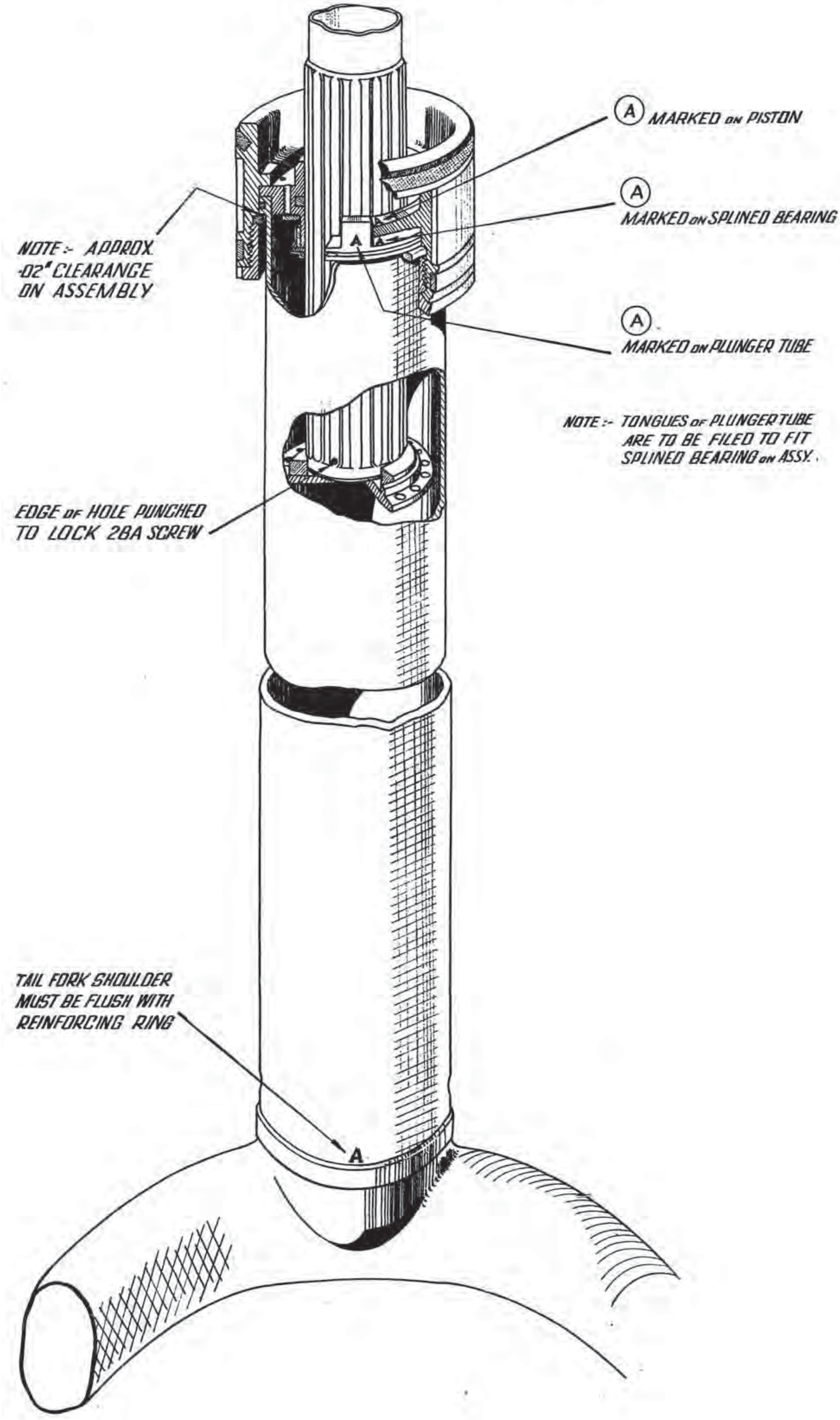


FIG. 8.—ALIGNMENT OF POSITIVE LOCKING.

CHAPTER
4

CHAPTER 4

BEAUFORT HYDRAULIC SYSTEM MK.II

PART I

1. GENERAL.

The hydraulic system fitted to all Australian Beauforts, type 152 in the Bristol Mk.II. It operates the undercarriage and tail wheel retracting gear, the lowering and raising of the flaps, opening and closing of bomb doors, and actuates the power operated gun mounting (turret). Power is supplied to the actuating jacks of the various units at a pressure of 1,200 lbs. per sq. in. except the turret which operates at 800 lbs. per sq. in. by an engine driven pump mounted on the outboard side of the accessory gear-box driven by the port engine. There is also a hand pump which operates the complete system for servicing operations and can be used also for emergency operation of the flaps, and undercarriage.

Included in the system is a fluid reservoir which acts as a header to the engine driven pump and which is gravity feed.

The following is a detailed description of the components and their function in the system:—

(a) FLUID RESERVOIR.

The fluid reservoir is installed and mounted behind the pilot's head and the filler spout is so positioned that the tank cannot be more than half filled, giving one gallon of air space and one gallon of fluid to specification DTD.44D which ensures that the pump has a supply of fluid during all conditions of operation and also compensates for leakage in the system generally.

There are two delivery pipe lines from the reservoir—(i) to the engine driven system with a stack pipe protruding up into the tank to prevent the drainage of all the oil if any of the system's pipe line is shot away or damaged; (ii) the other to the emergency system, this one not having a stack pipe and thus allowing complete drainage of the oil to this system. There is also an air vent in the top and a gauze filter in the filler spout.

(b) MAIN CONTROL VALVE.

The main control valve is situated behind the hydraulic control panel and consists of four rotary type valves in one block. There is one valve for each control:

1. Undercarriage and tail wheel.
2. Flaps.
3. Bomb cell doors.
4. By-pass through turret.

The latter (4) is closed when operation of any other circuit is required and opened again on completion of the operation.

OPERATION.

On the movement of the rotary valve to the "down" position, the oil is delivered to the top end of the jack and simultaneously oil from the opposite end is swept back out through the return line via the control valve to the filter. By rotating the rotary valve back to the "up" position, the direction of the flow of oil through the pipe lines is reversed.

(c) DOUBLE RELIEF AND NON-RETURN VALVE.

The double relief and non-return valve is situated behind the hydraulic control panel and immediately forward of the emergency hand pump. If the fluid pressure in the system rises above 1,200 lbs. per sq. in. the main relief valve in the delivery pipe line lifts and allows excess pressure to by-pass some of the fluid to the return pipe.

It consists of a spring loaded poppet main relief valve which is capable of by-passing the full delivery of the engine pump, also a non-return ball valve and a spring loaded valve. When the hand pump is in operation, the ball non-return valve prevents the passage of fluid into the engine driven pump line unless the pressure rises sufficiently to open the ball relief valve. This valve is set to open at 1,250 to 1,300 lbs. per sq. in.

(d) TRANSFER VALVES. Refer Figs. 3 and 4.

Five transfer valves are situated adjacent to the flap (2 valves, one at each jack), undercarriage (2, also one at each jack), and tail wheel (one only). They are automatic in action and come into use only when the emergency hand pump is being used and isolates the engine driven main circuit from the emergency hand pump circuit and vice versa.

OPERATION. Refer Figs. 5 and 6.

The engine driven circuit, being the normal supply, passes through unrestricted; on failure of this circuit and the emergency circuit being used, the resulting pressure through this delivery line forces the spring loaded transfer valve up and allows the emergency circuit to come into operation.

Incorporated in this transfer is a steel ball which closes off the emergency circuit on the return of the transfer valve to its original position. The valve is returned by the tension spring as well as the main circuit pressure.

(e) BY-PASS AND PRESSURE RELIEF VALVES. Refer Figs. 3 and 4.
(Refer to 3 and 6 for operation).

A by-pass valve is mounted near the outboard side of port undercarriage and is operated in conjunction with a push rod attached at one end to the oleo leg sustaining ram (piston). When the aircraft is on the ground the weight of the craft forces the sustaining ram into the oleo leg cylinder. The push rod thus travels upwards and makes contact with a lever which, in turn, forces the spring loaded by-pass valve up. The fluid then passes through to the pressure relief valve which operates at 600 lbs. per sq. in., thus relieving the load on the engine driven pump.

(f) BY-PASS VALVE. Refer Figs. 3 and 4.

This by-pass valve is situated close to the emergency hand pump and releases the pressure in the closed circuit on the delivery side of the emergency hand pump when it is not in use. Immediately the hand pump comes into operation, the by-pass valve closes.

NOTE: This valve is only incorporated where two header tanks are used, one being only for the emergency hand pump. This system was used on first English Beauforts.

(g) CHOKE VALVE. Refer Figs. 3 and 4.

This valve is situated in the return pipe line from the flap jacks and restricts the passage of the fluid thus slowing the upward movement of the flaps. It acts as a resistance against the wind pressure built up against the flap in the lowered position so that when the flaps are raised up, it retards any sudden upward movement of the flaps. This removes the danger of damage to the trailing edge of the main plane.

Its action is the same as a non-return valve in that it has a ball valve with a stop to prevent the closing off on the delivery side, thus allowing the oil to flow through the valve unrestricted. On the return, this ball valve closes off the other end of the passage and the oil by-passes around the valve through a smaller (diameter) pipe line to the return pipe line, thus restricting the passage of the fluid, so giving the flaps a steady upward movement.

(h) FILTER.

A gauze filter is fitted in the return circuit near the engine driven pump. It is mounted on the undercarriage nacelle structure behind the port bulkhead.

(i) HYDRAULIC LOCK (DOUBLE). Refer Figs. 3 and 4.

The hydraulic lock for the bomb doors is mounted on the forward face of the bomb cell in the pilot's cockpit on the starboard side. This lock enables the bomb doors to be locked and does not come into operation until the hydraulic jack has finished its movements. It is of the double acting type with two spring loaded poppet valves in the one body, each acting as a lock, one in each line from the jack to the hydraulic lock. It has four union points, two between the lock and the main control valve and two between the lock and the hydraulic jack.

NOTE: These lines change over from delivery to return and vice-versa, depending on the operation being carried out.

OPERATION. Refer Figs. 5 and 6.

On operation, fluid passes into the lock, the resulting pressure serves a dual purpose:—

(i) Forcing the spring loaded poppet valve up on the delivery side; and

(ii) Forcing up the other poppet valve by pressure on the lower face of its guide, thus allowing return oil to escape, and vice-versa, depending on whether bomb doors are being opened or closed.

NOTE: All lines are oscillating, being alternatively pressure or return.

On completion of operation the turret by-pass valve is opened, the resulting pressure is cut off and the oil between lock and jack on the delivery side is unable to escape, thus being trapped by poppet valve seating due to tension on head of valve.

(j) HYDRAULIC JACKS. Refer Figs. 3 and 4.

The jack consists of a hiduminium cylinder, a piston with two sealing rings; each sealing in turn (one for downward movement, and one for the retracting movement) thus sealing between the two bodies of fluid; and a steel tube piston rod which passes through a packing gland at the lower end of the jack. The gland cover at the lower end on all jacks is attached by closely pitched bolts and "Wills" high pressure joint rings. The top cover is attached by the same means except the flaps and tail wheel jack which are made in one piece. An adjustable eye bolt to pick up the operating mechanism is screwed into the piston rod with a lock nut for locking adjustments.

OPERATION. Refer Figs 5 and 6.

When fluid under pressure is applied to the jack through the top union connection, a pressure is built up between the cylinder head and the sealing ring fitted to the head of the piston, and by this means the piston rod is extended. During this operation fluid in the cylinder between the sealing ring on lower face of piston and gland cover is exhausted through the lower union connection back through the main control of the pump.

HYDRAULIC PUMPS

PART II

1. GENERAL.

Hydraulic pumps are used to provide power for the operation of the retractable undercarriage mechanism, wing flaps and other services.

Given below are the details of some of the various types of pumps which are used on the Australian Beaufort.

2. B.H. ENGINE DRIVEN PUMP. Refer Figs. 3 and 4.

This pump is of the gear type but it is unusual in that it has three stages in series. Thus each stage of the pump progressively generates one-third of the total pressure delivery (the first stage generating 400 lbs. per sq. in., then passing to the second stage, where it rises to 800 lb. per sq. in. from there to the final stage, where it reaches its maximum pressure of 1,200 lbs. per sq. in. so that a high efficiency is obtained.

This pump has been tested at speeds up to 3,500 r.p.m., while it will deliver at full pressure as low as 400 r.p.m. It has been subject to a very lengthy and comprehensive testing, with marked freedom from wear, which is shown by the way in which the output is maintained after long periods of running. This pump delivers 1¾ gallons of fluid per minute at the normal engine speed of 2,400 r.p.m.

3. PESCO HIGH PRESSURE PUMP. (ENGINE DRIVEN).

This pump of the spur-gear type and it incorporates several notable features, such as two spurs gears machined integrally with their shafts. These are supported in very sturdy bearings. In order to maintain close clearances on the end faces, the end cover is provided with a gasket, and thickness of which may be varied, thus enabling the efficiency of the pump to be kept up.

The drive shaft is separated from the driving gear with which it engages by means of a tongue and groove coupling so that, in the event of the pump seizing through any cause, with consequent failure of the shaft, replacement can be made with a minimum of cost.

Another important advantage lies in the added flexibility of design, as it is a simple matter to change the shaft for one having another type of coupling to suit any particular engine. The shaft bearings are provided with a specially developed metallic oil seal, which has been found to be extremely efficient in preventing leakage of the working fluid in the gear box. The mounting base is separate from the main casting so that the pump may be readily adapted to any desired type of mounting flange.

For a gear pump it is remarkably efficient, and this high performance has been obtained by holding manufacturing tolerances to very close limits and by adopting special alloys for the pump casing and liners so that clearances remain constant throughout the range of working temperatures. This pump may be driven in either direction.

4. HAND PUMP. Refer Figs. 3 and 4.

The hand pump is of the double acting type and consists of a body in which are two plungers. These are operated by a crank bracket with a con. rod attached either side of its fulcrum point, each connected to a plunger. Both of the plungers are actuated by the lever handle connected by relay to the crank bracket.

On operation of the lever handle, the crank bracket pivots on its fulcrum point and one plunger goes down and the other up, thus in one action we have both a suction and a compression stroke. Both of these plungers have two cup rings each. At the bottom of the body below the two cylinders both the inlet and outlet connections, also two non-return ball valves at the base of each cylinder, one being spring loaded and the other having a stop only. External moving parts are surrounded by a leather boot.

(a) OPERATION. Refer Figs. 5 and 6.

Fluid enters the pump at the inlet connection on movement of the handle, the upward pull of the plunger on the suction stroke drawing oil from the header tank through the valve chamber lifting the ball valve at the same time. As both cylinders have a common inlet, the other plunger on the compression stroke closes off its inlet passage by the pressure of the oil in the ball valve. On movement of the handle in the opposite direction the position is reversed in this first cylinder, the plunger on the suction stroke comes down on its compression stroke, thus compressing the oil, the non-return ball valve closing under pressure, the fluid unable to escape forces the spring loaded non-return valves down and the resulting fluid under pressure is delivered out through high pressure outlet to actuating jack.

NOTE: The action is the same for both pistons or plungers, one doing the suction stroke and the other delivering, and vice versa, so that the delivery is continuous.

BEAUFORT HYDRAULIC SYSTEM MK.II

PART III

PILOT'S HYDRAULIC CONTROLS

1. GENERAL.

The hydraulic controls for the operation of the various units are mounted on a panel on the port side of the main instrument panel. The following controls are fitted on this panel:—

(a) SELECTOR CONTROL.

The selector control operates a valve that directs the fluid either for the operation of the undercarriage, flaps, and bomb doors, or to gun turret and fluid by-pass. For undercarriage, flaps, and bomb doors operation, the control should be pulled out, but unless these services are being used it should be pushed in. The indicator at the side of the control shows which of the alternatives is in use.

(b) UNDERCARRIAGE CONTROL.

The undercarriage lever, which has a black round knob, controls the raising and lowering of the two undercarriage units and tail wheel unit. (Tail wheel unit is now locked down.) The movement of the lever is in the same sense as the movement of the units, i.e., "UP" to raise the units and "DOWN" to lower them.

(c) FLAPS CONTROL AND POSITION INDICATOR.

The flaps control lever, which has a white square knob, controls the lowering and raising of the split trailing edge flaps. Its movement is in the same sense as the movement of the flaps, i.e., down to lower and up to raise. To lower the flaps to a lesser degree than fully down, the lever should be placed in the down position until the indicator at the right hand side of the control shows that the flaps are lowered to the desired position, and the lever should then be returned to the gate (neutral) in the middle of the quadrant, thus shutting off the control valve.

(d) BOMB DOORS CONTROL.

The bomb doors lever, which has a red knob, controls the opening and closing of the hydraulically operated doors of the bomb cell under the fuselage. In the up position of the lever, the doors are closed and in the down position, the doors are open. Safety switches are fitted and operated by the door-operating mechanism which cut off the electrical circuit to the bomb release gear until the doors are fully open.

(e) EMERGENCY BY-PASS VALVE. (CARTRIDGE FIRING)

This valve is incorporated in the gravity feed line to the emergency cartridge firing system lines and is manually operated. The valve is used because the circuit is an open one and thus the circuit should be closed before use as resulting pressure on operation of cartridge system would be lost through the oil reservoir. It is of the rotary type and is situated below the push button, with its own operating lever, and is so positioned that the latter, when it is in the "off" position, prevents the shield over the push button being lifted. To operate the system, the lever must be pulled back from the vertical position to the horizontal position marked "emergency."

NOTE: For operation of rotary valve refer to Para. 2, Part 1.

(f) OPERATION AND FUNCTION OF SYSTEM. Refer Fig. 1.

The engine driven pump draws its supply of fluids from the return circuit and if its requirements are in excess of the amount of returning fluid, the supply is made up from the fluid reservoir. From the pump the fluid passes through the main relief valve incorporated in the double relief and non-return valve, which is set to operate at 1,200 lbs. per sq. in.

NOTE: Before reaching the main relief valve, the fluid must pass a by-pass valve; whilst the weight of the aircraft remains upon the main wheels, the fluid is allowed to pass through the by-pass valve to the relief valve. This valve is set to operate at 600 lbs. per sq. in., thereby taking the overload off the pump. After the main relief valve, the fluid passes through the non-return valve, also incorporated in the double relief and non-return, and thence to the main control valve, from where it is distributed to the various services as desired.

NOTE: The return fluid from the various services passes back through the main control valve to the pump.

In the flap return line is incorporated a choke valve. This valve is a ball controlled one-way choke, which, on the upward movement of the flaps, places a restriction of the line and so retards any sudden upward movement of the flaps.

The hand pump is supplied with the fluid via an entirely separate supply line, which is taken from the extreme bottom of the supply tank. This emergency supply line is also connected to the cartridge firing system in order that the cartridge firing system lines are always filled with fluid. On the delivery side of the hand pump is an emergency control valve. In normal use, this valve is so positioned that the fluid from the pump flows via one pair of ports to the line loading into the main pressure supply line running from the double relief and non-return valve to the main control valve.

When the hand pump is used, the non-return valve incorporated in the double relief and non-return valves seal off the engine pump delivery circuit. If, however, the pressure of the fluid from the hand pump exceeds 1,250-1,300 lbs. per sq. in. the secondary relief valve opens and allows some fluid to by-pass into the engine pump circuit.

To operate the flaps when the cartridge firing system has been used, it is necessary to close the by-pass valve and open the emergency control valve in order that the hand pump delivery is by-passed to the flap "down" line.

PART IV

EMERGENCY SYSTEM

1. GENERAL.

The Beaufort hydraulic system incorporates two emergency systems, the emergency hand pump and emergency cartridge firing; both can be used for lowering of the undercarriage and the lowering of the flaps by the emergency hand pump only. The following is a detailed description of these two systems:—

(a) EMERGENCY HAND PUMP SYSTEM. Refer Fig. 1.

A hydraulic hand pump for emergency lowering of the undercarriage and flaps is fitted behind the hydraulic control panel with an attachment for the pump handle protruding through the panel. The pump handle has a red handle grip and is stowed in the clips at the bottom of the hydraulic control panel. When this pump is used, fluid is delivered to all the jacks via the main control valve and to the flaps in emergency through pipe lines separate from the engine driven pump system. Automatic (transfer) valves isolate the two circuits from each other.

NOTE: In case of failure of the main hydraulic system, and if it is necessary to make an emergency lowering of the undercarriage and flaps, the following operations are carried out:—

(1) Pull out hydraulic selector.

(2) Place the undercarriage lever in "down" position.

(3) Then use emergency hand pump.

This is recommendeed if there is sufficient time to lower the undercarriage down by hand; the time required to do it is from 7 to 15 minutes. If time does not allow, the emergency cartridge firing system should be used and the hand pump used only for emergency lowering of the flaps.

2. FLAP ACTUATION, EMERGENCY SYSTEM. Refer Fig. 1.

To prevent damage to flap pulley bracket due to jamming of flap jack mechanism, the following instruction must be rigidly observed:—

Under no circumstances must main hydraulic system be operated to raise or lower flaps while emergency hand pump control valve is in "open" position.

3. EMERGENCY CARTRIDGE FIRING SYSTEM. Refer Fig. 1.

When the cartridge firing system for emergency lowering of the undercarriage and tail wheel is fitted, the cartridges are fired electrically by pressing a shielded button on the port side of the cockpit just above the pilot's compass and the shield is painted red. Before the button is pressed, the undercarriage control lever must be in the down position and, in addition, an emergency by-pass control lever below the push button must be pulled back from the vertical position to the horizontal position marked "emergency."

(a) OPERATION. Refer Fig. 1.

The emergency cartridge system lowers the undercarriage and tail wheel by high pressure gas generated by slow burning cartridges. There are four cartridges contained in firing chambers, two chambers being mounted in each needle. The cartridges are ignited by means of a shielded push button mounted below the pilot's bomb jettison switch. The push button releases four electro-magnetic firing units, one situated above each firing chamber.

The gas generated passes from the firing chambers through non-return valves to the sealing valves; these sealing valves burst under the gas pressure. From the sealing valves the gas passes into a common supply pipe, and tail wheel jacks through transfer valves, which automatically isolate the hydraulic system. Any hydraulic fluid displaced by the jacks during the gas operation is returned to the fluid reservoir through the normal return circuit.

NOTE: Before using the cartridge system the pilot must see that the hydraulic selector is at "undercarriage," the undercarriage and tail wheel control lever is in the down position, and the emergency by-pass control is in the emergency position. They must remain in these positions until the aircraft is trestled up and the gas is released.

(b) FIRING CHAMBERS.

These are mounted in pairs at the rear of each engine nacelle on forward face of rear spar and consist of a chamber, a cover with a spring loaded striking pin, a sheath which contains the cartridge, a trap to prevent passage of solid matter into the system and a bursting disc type safety valve which breaks down at 2,000 lbs. per sq. in.

(c) FIRING UNITS.

These are standard electro-magnetic bomb release units with a special striking hammer positioned one adjacent to each firing chamber and are released electrically by pressing a push button in the cockpit. The striking hammer connects with the striking pin in the cover of the firing chamber and detonates the cartridge.

(d) NON-RETURN (refer to Part I, Paras. 3 and 7).

These are mounted adjacent to each firing chamber and consist of a spring loaded ball. The valves prevent gas pressure from returning to a defective cartridge which may have failed to ignite, or broken down in any way.

(e) SEALING VALVES.

Sealing valves are mounted, one in each nacelle, to prevent any fluid leakage from the hydraulic system reaching the cartridges. The valve consists of a thin copper disc supported by a grid. The grid prevents the disc from breaking down under any fluid pressure but allows it to break down under gas pressure. The pressure required to break down the disc is approximately 200 lbs. per sq. in.

(f) PRESSURE RELEASE VALVE (refer to Part I, Para. 5)

A pressure release valve is situated on the outboard side of the port engine nacelle and consists of a spring loaded ball, the spring of which can be lifted manually. The normal function is that of a gas safety valve, but it is also used manually to release the gas when servicing the cartridge system after use. The valve relieves at a pressure of 1,800 lbs. per sq. in.

(g) SERVICE RELIEF VALVES.

A service relief valve is fitted between each transfer valve and jack operated by the emergency cartridge system, and is for releasing the gas when servicing the system after use.

(h) EMERGENCY BY-PASS VALVE.

This valve is situated below the push button, and its operating lever is so positioned that, when it is in the "OFF" position it prevents the shield over the push button from being lifted.

OPERATION. (Refer Para. 5, Part III.)

4. RELEASING GAS AFTER USE.

Before releasing the gas from the hydraulic system after use of the cartridge-fired system, precautions must be taken to prevent collapse of the undercarriage and tail wheel. The undercarriage may be locked by means of a locking pin for the radius rod knuckle joints and the tail trestled up, but preferably the whole aeroplane should be trestled. To release the gas from the system, proceed as follows:—

(i) Depress the hand lever of the pressure release valve situated on the outboard rib of the port engine nacelle. This releases the gas from the undercarriage and tail wheel jacks.

(ii) Unscrew the plug in the service relief valves situated adjacent to each jack until the gas from the valves just escapes. This releases the gas from the undercarriage and tail wheel jacks.

NOTE: When releasing the gas, stand clear of the outlets and take care not to inhale gas.

It is permissible in an emergency to use the hydraulic system immediately after using the cartridge system, but the gas must first be released as described above, and care must be taken to ensure that the pressure relief valve lever and the service relief valve plug are in their normal position. After use of the system in this way, the hydraulic system must be drained and re-filled as soon as possible.

5. CLEANING OF THE SYSTEM.

After releasing the gas, the system should be disconnected at the oil sealing valves and washed through with hydraulic fluid between the jacks and the oil sealing valves, particular care being taken with the transfer valves. The portion of the system between the oil sealing valves and the firing chambers should be cleaned with paraffin and finally flushed with petrol. The gauze of the main filter and of the filter in the reservoir should be examined for corrosion.

(a) RELOADING.

The procedure for cleaning and reloading the firing chambers is as follows:—

- (i) Remove the fuse from the fuse box.
- (ii) Recock the firing unit (see note below).
- (iii) Remove the eight nuts.
- (iv) Remove the cover complete with firing pins, cartridge sheath and used cartridges.
- (v) Examine the "Wills" packing ring for mechanical defects and replace if required.
- (vi) Remove the used cartridge and thoroughly clean the sheath.
- (vii) Clean the inside of the firing chambers and firing pins.
- (viii) Assemble the sheath, the new cartridge and the cover to the firing chamber. See that the chamber and sheath are thoroughly dry, and that the "Wills" packing ring is in place.
- (ix) Replace the nuts and securely tighten.

NOTE: Once the firing unit has been cocked, it can only be released electrically by the button in the cockpit. On no account should the units be released unless the covers of the firing chamber are in position, and care should also be taken that the firing arms are not forced or struck, as in both cases damage to the units (magnetic) firing will result.

Having cleaned and reloaded the system, the oil sealing valves should be assembled, replacing the broken copper disc with a new one (Part. No. 156214).

NOTE: Undercarriage control lever must be in down position before firing cartridges.

BEAUFORT HYDRAULIC SYSTEM MK.II

MAINTENANCE

PART V

1. GENERAL (MAINTENANCE) SECTION I.

In all maintenance operations on the hydraulic system, absolute cleanliness is essential. Clean fluid only should be used when filling or topping up, and the filter in the filler spout of the fluid reservoir should always be in place during this operation. The containers used for holding the fluid during the above operations or for reception of drained fluid should be perfectly clean, and it is preferable that after a container has been used, it should be flushed out with a small quantity of clean fluid, which should then be discarded.

The fluid is to specification DTF.44D, and it is important that the whole of the system is maintained full of clean fluid. The level of the main oil reservoir should be examined periodically and kept half filled, otherwise air may be drawn into the system. The efficient operation of the system depends to a large extent on the complete exclusion of air from the system.

The following notes will assist in the maintenance and inspection of this system:—

(a) DRAINING OF SYSTEM.

When necessary, the bulk of the fluid can be drained from the system by uncoupling unions or connections at the lowest points of individual pipe runs, depending on the position of the aeroplane. Draining is facilitated by operating the hand pump, control valve and the jacks. The turret should be drained as a separate unit. The fluid can be filtered and used again except at periodical replacement times. When pipe lines are disconnected, the unions and pipe ends should be blanked off to prevent the entry of dirt. Before connecting up the pipe lines, the various units should be examined for security, wear and cleanliness.

(b) REFILLING THE SYSTEM.

The system is refilled with fluid from the fluid reservoir, using an outside portable pump fitted with two flexible pipes, which connect to the stand pipes provided on the port bulkhead, lower outboard side.

Proceed as follows: Before using portable pump, fill the system from the fluid reservoir, the gauze filter being in position. If the portable pump is to be used, remove the blanking off caps from the ends of the stand pipes. Fill the two flexible pipes with fluid before connecting them to the appropriate stand pipe connections. This will assist in expelling air from the flexible pipes.

The portable pump, which is being used, can now be started. To prevent air going into the system, the level of fluid in the reservoir should be maintained until the required amount is in the system and reservoir. Whilst filling the reservoir and the system, all the hydraulic units and the hand pump should be operated several times to help expel the air. To operate the jacks to their full extent of travel without trestling up the aeroplane, disconnect the pin at the end of each undercarriage jack ram.

NOTE: Take care not to alter adjustment of jack travel in relation to locking catches.

When refilling the system, it is essential that the aeroplane is rigged in the tail down position, otherwise the required amount of fluid cannot be obtained in the reservoir. After using outside portable pump, replace blanking off caps on stand pipes at lower outboard side of port bulkhead.

NOTE: The longer the time taken to fill the system, the less amount of air will be found in the system, so do it slowly and allow oil to settle. Actuate hand pump and rotary valves and allow oil to travel through the system.

(c) OIL RESERVOIR FILTER.

After refilling or replenishing the system with fluid, the gauze filter under the filler cap should be examined and cleaned with filtered paraffin, if found necessary.

(d) SYSTEM FILTER.

The filter container should be periodically examined and cleaned if necessary. To remove the container, unscrew the wing bolt, holding the container, and pivot the strap to one side. The container can then be removed and cleaned with filtered paraffin. If found necessary to clean the gauze, unscrew the gauze to remove.

NOTE: In the event of metallic particles being found in the filter, their origin should be located and the worn parts renewed.

(e) OPERATING JACKS.

If the gland is leaking it can be overcome by finger tightening the gland adjusting nut, or if necessary, by renewing the gland packing. Should a replacement of the gland packing be necessary, the jack should be uncoupled by withdrawing the cross head bolt which passes through the piston rod end fittings. The jack can then be swung clear about its fulcrum end. A lock nut on the piston rod end fitting should next be released, allowing the fitting to be unscrewed from the piston rod. The gland adjusting nut should then be removed and the packing withdrawn.

When assembling the new packing, the moulded or soft packing is placed in first, then the rubber-fabric ring, and lastly the metal gland ring. Replace the gland adjusting nut, taking care not to exert too much pressure on the new packing. The nut should be finger tight only.

NOTE: After distributing the adjustable end fitting, the movement called for on the control it operates should be checked. Should it be necessary to remove the cover for renewal or examination of the "Wills" packing ring, care must be taken that the pressure is evenly applied to the joint when tightening the cover holding bolts.

(f) SWIVEL JOINTS:

This type of joint rarely gives trouble, but if a leak develops the methods of dealing with it are described in paragraph 9. If the leak persists, the packing should be renewed.

When fitting the new packing, the rings should be inserted in the following order:—

(i) Moulded or soft packing.

(ii) Rubber and fabric.

(iii) The metal gland ring.

The upper portion of the joint and gland nut should now be fitted, care being taken not to screw the nut too tightly and that the two half collars are flat on their seat above the metal gland ring.

(g) ALIGNMENT.

The alignment of the swivel joints should be maintained. The joints can only get out of line through accidental damage. The swivel joints in the pipe lines of the hydraulic rams (jacks) are so fitted that their working centres are directly in line with the fulcrum pin about which the ram swings. Slight misalignment should be corrected immediately by bending the pipes carefully back into position. If the pipes are badly bent, they should be renewed and any side load on the swivel joints must be avoided.

2. PIPING AND STANDARD PIPE UNIONS.

The pipe lines are mainly $\frac{3}{8}$ in. O/D tube, exception being $\frac{1}{2}$ in. pipes to the filter, and stand pipes from the input side of the pump to the bulkhead. The unions and similar fittings consist of a nut that embraces a loose collar with an internal conical face. The union fittings are of conical form and the pipe is flared over it and gripped between the collar and the conical end when the union nut is tightened.

The two stand pipes from the input and output ends of the pump are secured to the port bulkhead at lower outboard corner, and for testing purposes an external pump is connected to them. The stand pipes are blanked off under normal conditions. In all cases where the jack cylinders swing during operation, swivel joints are provided to accommodate this movement in the pipes.

When fitting a new length of piping it must be remembered that the union nut with the loose collar inside is slipped over the pipe before the pipe is expanded. Care is also to be taken that the contacting surfaces are clean and free from grit. Locking wire must be renewed and should be so fitted that a tendency for the nut to unlock is checked by the tension in the wire.

NOTE: When it is necessary to open a joint, the system need not be drained of fluid. A tray placed below the joint will catch the drainage.

(a) EXPANDING PIPE ENDS.

Pipe ends can be expanded by using the A.G.S. expanding tool equipment Nos. 772 Mk.I or 773 Mk.II according to the diameter of pipe, or by the method given below.

After the pipe has been bent or cut to template, leaving about $\frac{3}{8}$ in. additional length at each end, take off all rough edges. Heat the end of the pipe over a flame. Wrap two turns of paper round the pipe, keeping the paper $\frac{3}{8}$ in. in from end; this is to prevent the pipe from slipping. Place the pipe, with the paper round it, in a suitable block and grip the block in a bench vice. With a belling tool, which should have a 32° cone, lightly hammer the tool into the pipe end, rotating the tool occasionally. Oil should be used to lubricate the tool. Test the expanded end with either a suitable olive or a union over which the pipe end will be fitted.

(b) FLUID LEAKAGE.

The system must be regularly inspected for leakage and this may occur at pipe unions due to union nuts backing off at the glands of the jack or other units, or at the joints on the units themselves. Such leakages can usually be rectified by tightening up the nuts concerned, taking care to replace any locking wires and gaskets which have been disturbed. Excessive tightening must be avoided. If leakage still occurs after reasonable finger tightening of the jack gland adjusting nut, the gland packing should be renewed (refer para. 6).

3. EXPELLING AIR. (Refer to Para. 2.)

Air may be indicated in the hydraulic system by the flaps or any of the various units operating in a jerky manner, or by backlash. If a hand operated test rig is available, each of the jacks should be filled singly, thus helping to reduce the amount of air in the system; if not available, use the hand pump and operate the system as follows:—

(a) OPERATION.

The best method to expel air from the system on all occasions when changing fluid, or breaking pipe line connections, is to fill the fluid reservoir slowly, refer to (para. 2), and operate the hand pump or hand pump test rig, thus operating the units and filling the lines with fluid.

NOTE: Do not function except by hand pump after repairing, and renewing of fluid in system owing to danger of lines being crossed, retracting mechanism being out of adjustment and mis-alignment of swivel joints. Now disconnect the delivery piston till fluid flowing from this broken connection of the jack shows freeness from air bubbles. Now operate disconnected delivery lines (which in above operation would have been return line) until the fluid flowing from it shows freeness from air bubbles; now connect up and proceed in the same manner with the line at other end of jack and expel air to a minimum from other side of piston. All operating jacks can be cleared in the same manner.

Now that the jacks have been cleared as far as possible and system is full of oil, an engine driven test rig can be used, or port motor.

If ship is up on trestle and the engine driven test rig is connected to stand pipes, final check for exclusion of air from system can be carried out by operating each unit in turn, when undercarriage and flaps are being lowered, owing to weight of units they drop under own pressure to a certain degree, thus allowing a drop in pressure. If the emergency hand pump is operated at the same time, thus keeping up the pressure, the air will not be allowed to build up in the system and on raising of units will be swept out of jacks via the main control valve when the fluid returns to the reservoir. Do not use hand pump in this manner when retracting these units.

NOTE: This operation can be carried out also without trestles by disconnecting piston rod end fittings to the units; also take care that piston does not turn in jack.

Another means of excluding air while the ship is up on trestles is to operate the undercarriage and flap units by hand pump and just when the pressure is at its greatest, for example when the radius rods have just been locked give a few more pumps, close the turret and by-pass valve and allow the oil under this pressure to return via main control valve to reservoir.

The reservoir filler cap should be opened and if kept under observation, air will be heard bubbling to the surface; this last operation can be carried out just as undercarriage radius rods close or break.

4. REMOVAL OF COMPONENTS.

(a) BOMB DOOR JACK

(i) Disconnect the oil pipes at the swivel joints and blank off the swivels.

(ii) Remove the split pin and the pin from the jaw fitting at both ends of the jack.

(iii) After removing the jack, drain the fluid.

(b) UNDERCARRIAGE.

(i) Disconnect the pipes at the swivels and blank off.

(ii) Remove the four bolts, two either side securing the jack anchorage trunnion bearing assembly to the nacelle structure.

(iii) Remove the bolts from the top end of the two links connecting the trunnion bearing assembly to the levers on the torque shaft.

(iv) Remove the bolt through the lifting gear and at the end of the jack piston rod.

(v) Remove the jack and drain the fluid.

(c) FLAP JACK.

(i) Lower the flaps until the quadrant pins are in line with the holes in the frame.

(ii) Remove the pipes from the jack and swivels.

(iii) Straighten the tab washer and remove both quadrant pins.

(iv) Remove the split pin, nut and bolt securing the jack to the spar.

(v) Remove the jack by passing the body out through the cut-away in the frame and drain the fluid.

(d) TAIL WHEEL JACK.

Remove the tail wheel unit complete and the jack can then be removed by disconnecting the two bolts, one at each end of jack. Then drain the fluid.

5. OPERATING TIME FOR HYDRAULIC UNITS.

The operating times for hydraulic units on Beaufort Aircraft fitted with Bristol MK.IV pumps are to conform to the following figures:—

(a) UNDERCARRIAGE.

To retract	27 seconds maximum.
To lower	30 " "

(b) BOMB DOORS.

To open	5 seconds maximum.
To close	5 " "

(c) FLAPS.

To lower	6 seconds minimum.
	10 seconds maximum.
To raise	12 seconds minimum.
	20 seconds maximum.

(d) ALTERNATIVE HYDRAULIC PUMP.

Pesco 203 P.A. hydraulic pump has been fitted as an alternative pump to the Bristol MK.IV integral hydraulic pump.

This pump on type tests shows an approximate average reduction of speed of 20%, which also squares with the volumetric capacities of the pumps.

Delivery of pumps at 2046 r.p.m.

TYPE	RATE
Bristol MK.IV	3 gallons per minute.
Pesco 203 P.A.	2.4 gallons per minute.

NOTE: An increase in all times is necessary to allow a tolerance on all hydraulic units operated by the latter pumps.

PART VI — MARK IE—TURRET

1. DESCRIPTIVE ADJUSTMENT AND DISMANTLING NOTES.

(a) SYSTEM.

The hydraulic system of the MK.IE turret works on the open system principle, that is to say the fluid flows through the system until it meets resistance, when it immediately builds up pressure. This would happen until something burst or the pump reached its capacity, so a relief valve set at 800 lbs. sq. inch pressure is installed in the plane on the turret circuit to provide a safe working pressure.

(b) MULTIPLE VALVE.

The turret is provided with a multiple valve through which all movements of the turret are controlled. This multiple is split up into three rotary type valves. A master control valve which transfers the flow from the return line into the valve circuit and so builds up pressure. A rotation valve that transfers this pressure and flow to the rotation jack and an elevation valve that transfers the pressure and flow to the elevation jack. The elevation and rotation valves are designed with a small slot across the openings of the valve for several reasons. These slots are so positioned that they do not cut off the pressure, but centralise it. They also provide an opening for exhaust oil from the elevation jack when the hydraulic lock is opened.

(c) HYDRAULIC LOCK (25 lbs. per sq. in. Visual clearances 3½).

A hydraulic lock is placed in the elevating circuit for holding the turret in any desired position of elevation or depression. The lock is built up of five main parts of the body, plunger, valve and spring, and adjustable stop for manually operating the lock

There are three ports to allow for the passage of oil:—

(a) Port is connected by the pipe line to the top of the jack.

(b and c) Ports to the through line to the bottom of the jack from the valve.

When the gun is elevating, the jack is depressing, therefore the pressure is flowing to the top of the jack, and as the port (a) is connected to this pipe the pressure enters and moves the valve open and so allows the exhaust oil from the bottom of the jack to flow freely through.

(d) INTERRUPTER VALVE.

The turret is also equipped with an interrupter valve so that the guns will not foul the fairing. When the turret is swung around in line with the fairing a roller comes in contact with a cam shaped in proportions with the fairing, this roller being swung in such a way as to absorb the shock of striking the cam without bending and at the same time pull on a bowden cable connected to the interrupter valve arm. On rotation, this opens a valve which short circuits the flow between the feed and return pipes connected to the jack and the back pressure in both pipes causes the rotation jack to stop dead.

(e) OPERATING PLUNGER.

With the depressing of the gun on the fairing the interrupter is entirely different. The flow enters the interrupter valve straight from the feed pipe and is directed through a rotary valve to the bottom of an operating plunger, this plunger, having an end fitting with a long slot in it, and up and down this slot rides a pin connected to a spring control tube which in turn is connected through a pair of adjustable links to the elevation valve. When the roller comes in contact with the cam, it operates the interrupter valve and transfers the flow from the bottom of the operating plunger to the top, causing it to pull the elevation valve down to a central position and thereby stopping the guns from depressing any further. Now this plunger has stopped the guns from depressing but not elevating, as the valve has only been pulled down to central position and there is still a full slot left open, the valve to allow the guns to elevate and rise off the fairing. Now if this plunger does not centralise the elevation valve, the guns will pump creep down according to the setting of the valve.

(f) ADJUSTMENTS.

If the guns creep down after being interrupted it will either break the cable or pull the nipples off and thus cause the interrupter slider to break. Now the adjustment for this fault is in the adjustable link connected to the elevation valve arm. These should be lengthened. On the other hand, if the turret is pumping it will not cause any material damage, but as it is a fault it can be fixed by shortening the links to the valve arm or screwing the end fitting on the operating plunger higher.

(g) CREEPING.

The rotation valve is brought back to a central position by centralising links fitted to the handle and connected to the valve is an adjustable link, with the handles centralised this can be adjusted until there is only a slight creep in the turret, when the master valve is opened and when the finer adjustment can be taken up by the clamping screws of the lever on the control rod until the turret is stopped from creeping altogether.

(h) GUN FIRING SYSTEM.

In the gun firing system the accumulator is connected direct on the main feed pipe, but this is not fed until the master control valve is depressed and caused a non-return valve set at 250 lb. sq. inch to open and allow a pressure of 800 lbs. sq. in. to be built up in the accumulator and along a pipe connected to a non-return valve situated in the gun firing valve.

When the trigger is pulled it closes a switch which activates a solenoid, this draws a flat piece of metal with a pin attached to its centre towards it, this moves the main plunger along until it covers the return port of the valve. This plunger is attached to a lever with an adjusting screw on it, which lifts the non-return valve from the accumulator, allowing the pressure to operate ram units on the sears of the guns and start them firing. When the trigger is released it cuts off the flow of current to the solenoid which allows the main valve to return, opening the return port and allowing the non-return valve to seat there by cutting off the flow from the accumulator and allowing the built up pressure in the ram units to return to the supply tank.

(i) ADJUSTMENT AND SETTING OF FIRING INTERRUPTER.

(1) Firstly, be sure to adjust tracer bracket parallel to column by adjusting 6 BA screw in bottom of same.

(2) Check micro switch to see that it works O.K.

(3) Set micro switch by adjusting eccentric screw so that solenoid operates when tracer bracket is full forward.

(4) Depress gun until slider comes opposite tracer point, then bend micro switch mounting bracket until tracer point is 1/64 in. from slider.

(5) Operate turret carefully to see tracer point does not catch in image.

(6) Check on elevator to see if solenoid cuts off evenly on top and bottom, if not, move tracer point in the desired direction in vertical slot of tracer bracket.

(7) Check on rudder to see if solenoid cuts off evenly, if not, move micro switch bracket in the desired horizontal position after first slackening off the four holding screws in the top bearing.

A faulty micro switch can be checked by bridging terminals 1 and 3 in block on firing point.

A faulty press button switch in firing unit can be checked by bridging terminals 1 and 2 in block on firing unit.

(j) APPROXIMATE CONTROL LINKAGE SETTINGS.

Rotation control linkage

2-9/16 in. centre to centre.

Elevation control link

2-5/16 in. centre to centre.

Clip on spring control $1\frac{1}{8}$ in. from top of clip to top of spring control. End fitting on operating plunger 5/32 in. from top of locknut to bottom shoulder of end fitting.

(k) BOWDEN CABLE LENGTHS.

Master Cable	Outer	2 ft. $6\frac{1}{2}$ in.
	Inner	2 ft. 9 in.
Trigger Cable	Outer	2 ft. 4 in.
	Inner	2 ft. $7\frac{1}{4}$ in.
Interrupter Cable	Outer	1 ft. $10\frac{1}{2}$ in.
	Inner	2 ft. $2\frac{3}{8}$ in.

All outer cable lengths are given with ferrules fitted.

All inner cable lengths are given, including nipples.

2. DISMANTLING NOTES.

(a) STRIPPING SEQUENCE TO REMOVE CHASSIS.

(1) Disconnect chassis link (89688) from elevating tube (89625) by removing split pin (AGS784-10) that locks pivot pin (89690) to link. Remove pivot pin.

(2) Disconnect face shield support (159117) from jaw bolt on chassis by removing split pin and clevis pin (SP4D7). Remove jaw bolt and 3 2BA bolts holding chute (159038) and remove chute.

(3) Remove pipe E181470-20 and unscrew union nut connecting pipe (E181470-21) to swivel (156318). Remove split pin and unscrew castle nut on chassis pivot pin 159115.

(4) Remove 1/16 in. taper pin from R.H. chute bearing and unscrew bearing.

(5) Chassis swivel pins may be removed and chassis lifted off.

(b) STRIPPING SEQUENCE TO REMOVE TOP BEARING ASSEMBLY.

(1) Disconnect pipe (E181470-21), at top swivel (156318).

(2) Disconnect trigger cable at adjustable stop on firing unit at clip n interrupter guard and at clamp bolt on top support bracket.

(3) Disconnect master cable at master valve and unscrew adjustable stop.

(4) Remove 12 CS screws from interrupter guard, loosen 2 Simmonds nuts holding guard bracket to guard. Remove rear half of guard.

(5) Remove reflector sight and camera gun sockets and allow them to hang from cables.

(6) Remove 4 screws holding electric interrupter to top bearing and screw holding cable clip to top bearing assembly. Allow interrupter to hang on cable. Replace 4 screws in top bearing assembly.

(7) Remove 2 6BA studs from trigger side of centre cover of control handles. Remove 2BA nuts from bolt holding two halves of control handles together. Remove 2BA nut and bolt holding trigger side of control handles to centre bracket. Trigger side of control handles and rod through slipper block may now be removed. Remove link that connects control handle lever to rotation control tube lever.

(8) Knock out taper from elevation control rod (this pin located 5/16 in. above top of spring control). Elevation control rod may now be unscrewed from spring control.

(9) Disconnect rotation linkage and remove lever and bearing from bottom of rotation control tube.

(10) Remove two $\frac{1}{4}$ in. BSF bolts that clamp top support bracket to centre column.

(11) Remove 4 taper pins that fix top cross tube to top support bracket. Side struts and cross tubes may now be sprung from top support bracket.

(12) Remove complete assembly of top support bracket, chassis, face shield and controls.

(13) Top bearing, assembly may now be removed.

(c) STRIPPING SEQUENCE TO REMOVE FIRING UNIT.

(1) Disconnect electric cables from terminal blocks.

(2) Unscrew pipes (E181470-21), (E181470-22), (E181470-24) from unions on firing valve.

(3) Remove clips holding accumulator to firing unit.

(4) Disconnect trigger cable at adjustable stop.

(5) Remove 2 BA bolts and nuts fastening top of firing unit to interrupter gear guard fixing plate.

(6) Remove $\frac{3}{8}$ in. bolt, nut and spacer fastening bottom of unit to centre column.

(7) Remove $\frac{3}{8}$ in. bolt, nut and spacer fastening bottom of unit to centre column.

(8) Remove firing unit.

3. ASSEMBLY NOTES.

(a) GENERAL ASSEMBLY NOTES.

Always apply "Graphol" or other lubricant to dural threads to prevent seizing.

When removing pipes or valves always cover ends of pipes and unions to keep out dirt.

When fitting pipes be careful of dents of collapse of pipes on bends as this weakens the pipe and may cause trouble in operation of turret.

Make sure no pipes are touching, as vibration will cause pipes to wear.

Check bowden cable for sharp bends, as this will cause breakage or sticking of inner cables.

When assembling swivel packings make sure no hemp packing gets into hydraulic system.

When drilling or filing keep all movable parts covered.

Check locking nut on adjusting screw at bottom of electric interrupter. If this screw becomes loose it will allow tracer bracket to get caught on image and be damaged.

When fitting pipes make sure that flare on pipe seats squarely on union before tightening nut.

All locking wires should have at least half a turn on union nuts and be pulled up tight.

(b) ORDER OF ASSEMBLY OPERATIONS OF MK.IE TURRETS.

(1) Main frame.

(2) Bottom bearing drive cable and channel swivel feed valve.

(3) Interrupter slider and key.

(4) Seat assembly and elevating jack.

(5) Control rod and tube. Operating plunger and end fitting. Interrupter valve, multiple control valve.

(6) Interrupter cable. Interrupter guard and bracket gun firing unit.

(7) Hydraulic pipes.

(8) Control handles. Linkage and control cables.

(9) Electric wiring and electric interrupter.

(10) Gun chassis, face shield, flexible hose.

(11) General check.

(c) ORDER OF FITTING PIPES.

E181470-19 Right side of multiple valve to bottom left side of interrupter valve.

E181470-8 Bottom right side of swivel feed valve to bottom right side of interrupter valve.

E181470-9 Top right side of swivel feed valve to bottom front of interrupter valve.

E181470-3 Top left side of swivel feed valve to top front of interrupter valve.

E181470-14 Bottom left side of swivel feed valve to top left rear of interrupter valve.

E181470-6 Top centre of interrupter valve to right side of operating plunger.

E181470-13 Top right rear of interrupter valve to right side of multiple valve.

E181470-17 Bottom front left of interrupter valve to left of multiple valve.

E181470-16 Top centre front of interrupter valve to top left of multiple valve.

E181470-7 Top right back of interrupter valve to left bottom of operating plunger.

Assemble foot boards.

E181470-5 Hydraulic lock to left bottom of multiple valve.

E181470-4 Hydraulic lock to left top of multiple valve.

E181470-23 Left of firing valve to bottom left of accumulator.

E181470-22 Bottom right of accumulator to top of interrupter.

E181470-24 Front of firing valve to telescopic swivel.

E181470-1 Bottom of swivel to elevating jack to hydraulic lock.

E181470-2 Bottom of swivel of elevating jack to bottom union of elevating jack.

E181470-10 Bottom swivel of elevating jack to left side of multiple valve.

E181470-11 Bottom swivel of elevating jack to top of elevating jack.

E181470-21 Left jack of firing valve to top swivel on gun chassis pivot pin.

E181470-20 Top swivel to "Y" union on chassis.

These directions are given when looking from front of turret towards the rear.

ILLUSTRATION

FIGURE 7

BEAUFORT MK.IE TURRET

(1) Turret Rotating Drive.

(2) Hydraulic Lock Valve.

(3) Gun Elevating Jack.

(4) Hydraulic Lock Valve Lever.

(5) Interrupter Gear Plunger.

(6) Interrupter Gear Valve.

(7) Multiple Control Valve.

(8) Master Valve Lever.

(9) Chin Pad.

(10) Cheek Pad.

(11) Firing Trigger.

(12) Main Control Handles.

(13) Seat Elevating Handle.

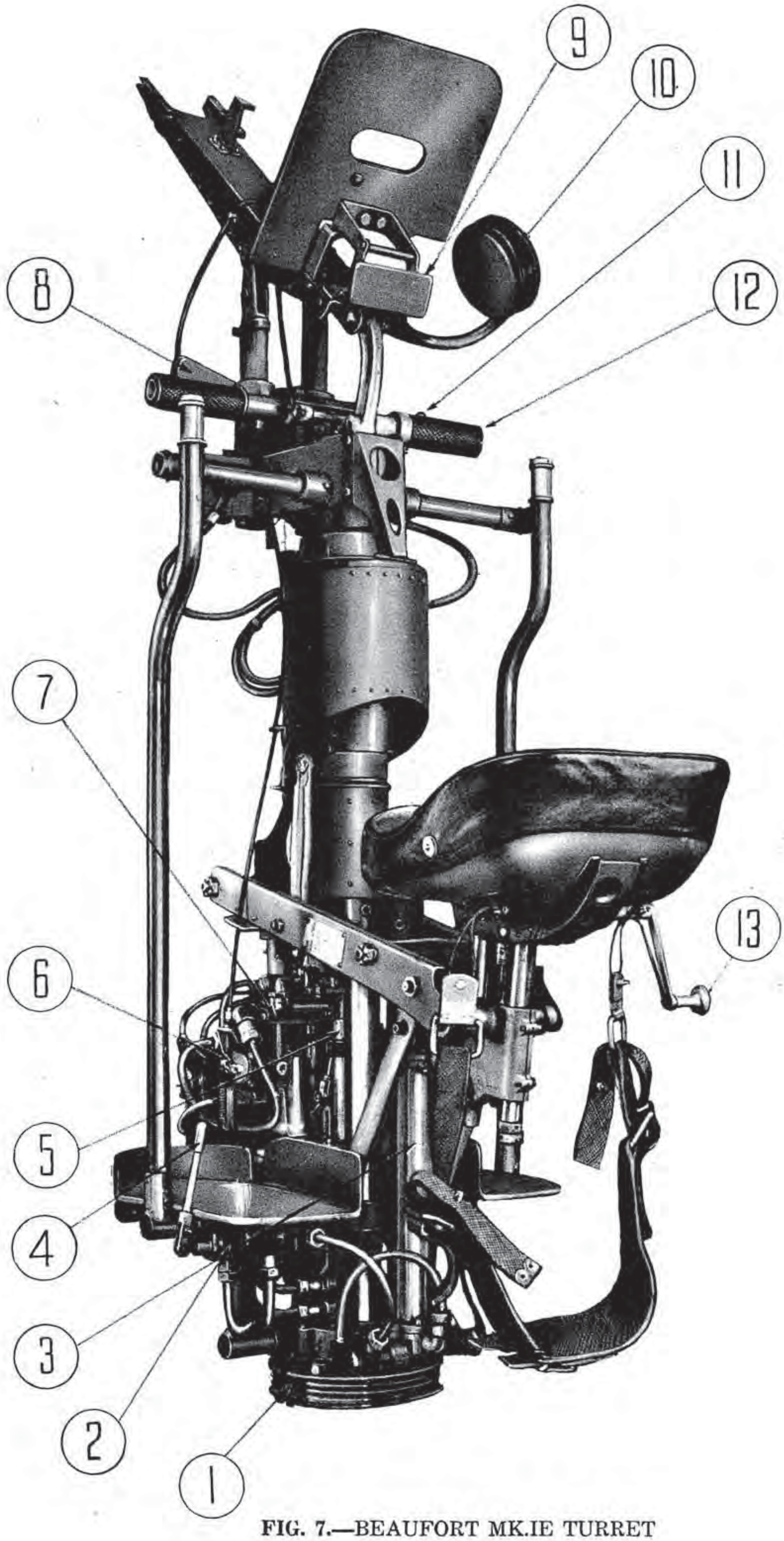


FIG. 7.—BEAUFORT MK.IE TURRET

ILLUSTRATION

FIGURE 8

BLENHEIM MARK V. TURRET

(1) Elevation Jack.

(2) Foot Override Controls.

(3) Gunner's Safety Harness.

(4) Ammunition Container.

(5) Master Control Valve.

(6) Cupola Doors Latched.

(7) Cupola

(8) Main Control Handles.

(9) Ammunition Container.

(10) Gunner's Seat.

(11) Seat Adjustment Controls.

(12) Rotating Jack.

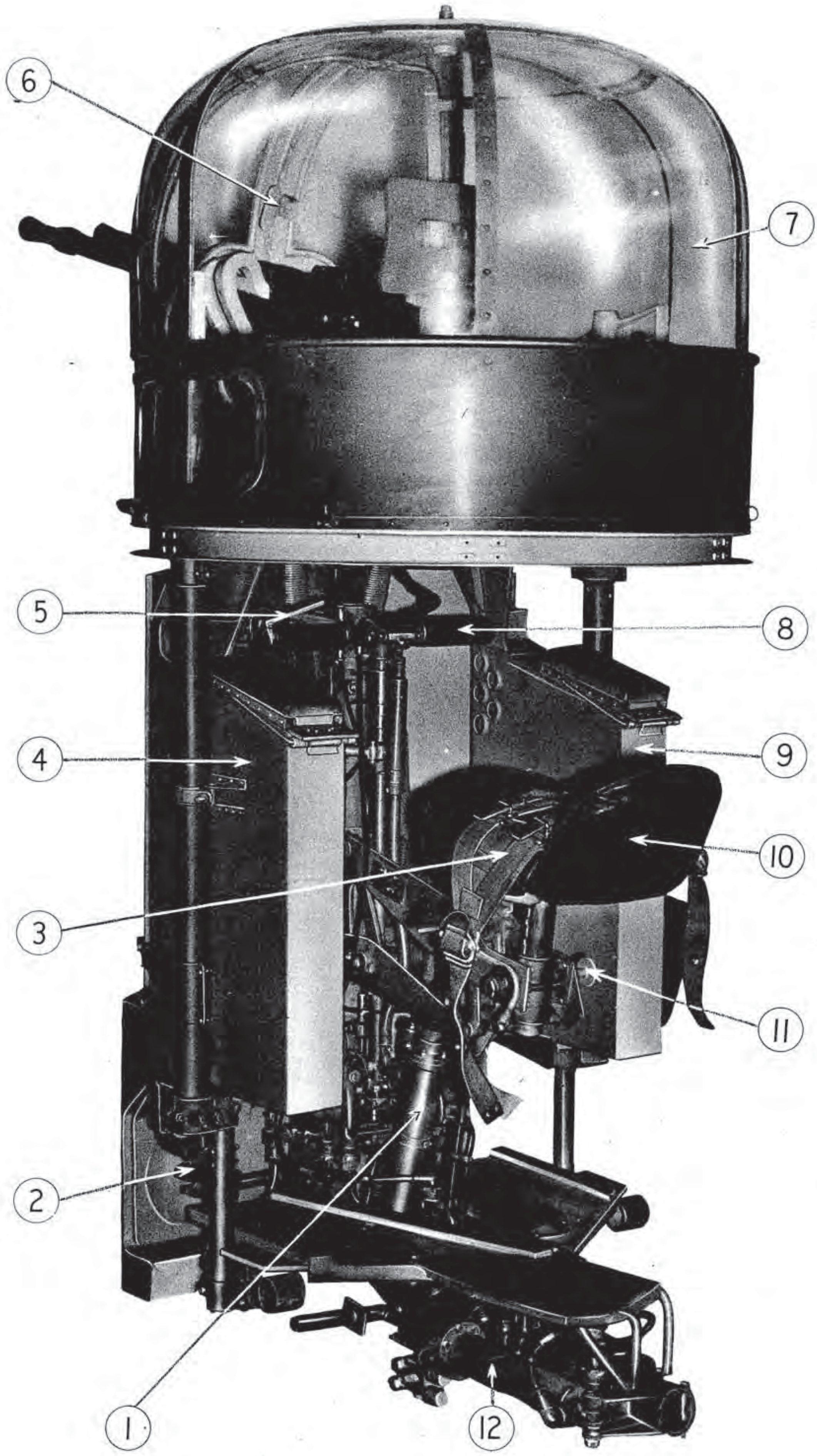


FIG. 8.—BLENHEIM MK.V. TURRET

CHAPTER 5

PNEUMATIC SYSTEM (DUNLOP)

1. B.T.H. LIGHTWEIGHT COMPRESSORS, TYPE A.V.

The A.V. type compressor has one cylinder and has a piston displacement of 0.368 cubic feet of free air per minute at a speed of 1,200 r.p.m. It is designed to charge an air bottle of 400 cubic ins. capacity to 200 lbs. per sq. in. from atmospheric pressure in ten minutes. At 200 lbs. per sq. in. discharge pressure it absorbs 0.175 horsepower and its weight is 4½ lbs.

(b) CONSTRUCTION AND OPERATION.

The compressor consists of a single piston driven by means of a crankshaft and integral cross head. On the upward stroke of the piston, air is drawn into the crankcase through the automatic inlet valve. As the piston descends, the air in the crankcase is compressed; at the lower end of its stroke, the piston uncovers a port in the cylinder wall and the air enters and fills the air cylinder. On the next upward stroke the air in the cylinders, after having been compressed still further, passes through the ball valve into the air bottle. When the air in the container attains the pressure for which the spring loaded relief valve is set, the back pressure from the air bottle, acting upon this valve, causes it to open, so that the air from the cylinder is by-passed directly through two passages back into the crankcase. In these circumstances no further pressure is generated and the air is simply circulated through the crankcase and cylinder. The very small size of the piston precludes the use of piston rings and a seal is obtained by maintaining in the crankcase a level of oil.

The sump holds approximately 20 c.c. of oil; it is necessary to check and to maintain the level by pouring in oil through the inlet valve after every ten hours running. The oil used is to specification DTD.72.

The compressor is air cooled and on installing it, every care must be taken to ensure that the temperature of the cylinder head does not exceed 70°C.

This is fitted on the forward face of the accessory gear-box driven by the starboard motor and is cooled through a duct from the accessory cooling air scoop protruding underneath the motor.

2. OIL RESERVOIR.

This is fitted in the system only when an engine-driven compressor is used as the source of supply. The capacity of the reservoir is 1½ pints and contains ½ pint of oil to specification DTD.72. The unit has two functions, the first being the most important.

(i) This function is important when the compressor is pumping, the air passes through the oil into the receiver. When the compressor cuts out, the back pressure from the air bottle forces the oil back along the delivery pipe to the compressor and seals the ball valve.

(ii) The oil retains any grit coming into the system and also keeps the area in the head of the compression around the outlet valve wet when the compressor is working. The action of the compressed air from the compressor forces the oil back into the reservoir, the oil then acting as a filter.

3. OIL TRAP.

An oil trap must be fitted in all installations where compressed air is supplied from an engine-driven compressor to prevent ingress of oil to the brake system from the oil reservoir. This type has a felt element to trap the oil, which should be taken out and cleaned periodically with petrol and dried off. There is a drain plug in the bottom for draining, and should be carried out periodically, the interval being determined by the amount of oil found in the system. Care should be taken that the drain plug is not leaking.

These are both mounted on the forward face of the front spar by a bracket fitted on the bottom boom, behind the starboard bulkhead.

4. COMPRESSED AIR BOTTLES.

This unit is constructed of sheet steel in the form of a hollow cylinder with hemispherical ends; the inner surface is varnished to prevent corrosion. Connections to the container are made to screwed flanges, one in each end, of which one is the main air line coupling, whilst the other end coupling is fitted to the engine-driven compressor. These containers are manufactured in varying capacities to suit the different size brake units. In all instances they are made to withstand the maximum working pressures, 200 lbs. per sq. in. in the case of bottles which are replenished with air by hand pump and 350 lbs. per sq. in. for those fitted with engine-driven compressors. It is essential that a stack pipe should be fitted inside the air bottle on the delivery side, from the bottle to the system, so that any moisture or foreign matter can accumulate and does not work its way through the system. When the pipe is installed, approximately 4 in. of tubing should be protruding inside the air bottle.

These are fitted in both port and starboard undercarriage nacelles on the aft face of the front spar in the inboard corner starboard, and outboard corner port.

5. AIR FILTER.

An efficient air filter is a practical necessity with all pneumatic systems. The type fitted to this system has a felt element for filtering, and has a drain plug in the bottom for the frequent draining of oil or water to prevent damage to the brake units. The felt element should be washed in petrol periodically and dried off. If oil is present, it is a sign that a surplus of oil is in the air bottles, in which case air bottles should be removed from the aeroplane and cleaned.

This is fitted behind the pilot's seat underneath the main stowage box forward of the wireless crates.

6. PRINCIPLE OF OPERATION OF THE BEAUFORT PNEUMATIC SYSTEM. (Refer Fig. 1.)

Compressed air is supplied to the air bottles from an engine-driven compressor through the oil reservoir and oil trap. They can also be replenished from air bottles or compressor unit on the ground through a Schrader valve fitted near the lower end of the starboard air bottle. The bottles have a balance line between each other. The compressed air, travelling on operation of any of the units or systems, passes through the air filter to the various units. The air passes from the air bottles to the different systems.

(i) Brakes.

(ii) Fuel jettison.

(iii) Anticing.

(iv) Gun firing and forward camera gun.

7. PNEUMATIC BRAKES (DUNLOP)

(a) GENERAL.

The following is a description of the main components, their operation, maintenance, and installation.

(a) THUMB BRAKE LEVER.

This type of control is for use where aileron control is by wheel or segment. It is mounted on the segment on top of the control column. The lever is connected to the differential relay column by bowden cable and should be as short and free from bends as possible. It is important, therefore, that the relay unit be mounted in the nearest position to the base of the control column, allowing for its linkage to the rudder control. The angular movement of the steering lever of the relay control unit should be 40° each side of the centre line, and the operating linkage to the rudder controls designed according to the angular movement of the rudder pedals.

(b) DIFFERENTIAL RELAY VALVE CONTROL.

The relay control valve is a novel and ingenious mechanism whereby differential operation of the brakes is obtained by connection to the rudder pedals. With the rudder control set in the "neutral" or dead ahead position, the braking effect is equal on each wheel, as the rudder is moved when the aeroplane is taxying, the retarding force is steadily increased on the inside and decreased on the outside wheel. Any degree of braking desired by the pilot can be obtained by the operation of the thumb brake lever fitted to the spectacle on top of the control column, which operates by bowden cable the relay valve.

This is mounted forward of the rudder controls on the port side at rear of instrument panel, just near aft end of navigator's table and joined by a linkage with the rudder pedals relay.

OPERATION.

Operation of the thumb brake lever causes the slides to move, pushing the links forward and compressing the springs. The loaded springs immediately distort the rubber diaphragm, causing the inlet valves to open. Compressed air flows from the air bottles to the chamber through which it flows to the respective wheel brakes. Immediately the pressure in the chamber equals the compression forces of the springs, the diaphragms return to their normal position and the inlet valves close. A partial release of the thumb lever causes a reduction in the compression of the springs. The pressure in the chamber now exceeds the compressive force of the springs and a negative deflection of the diaphragms takes place, opening the exhaust valves until the forces are in equilibrium.

Any degree of braking can thus be obtained by variation of the pressure on the thumb control. Movement of the rudder releases the pressure on one spring and increases it on the other, thus varying the pressure in the individual wheel brakes.

(c) PRESSURE GAUGE.

This gauge is of the triple indicator type and is mounted on the port side of the pilot's instrument panel. The dial of the gauge has three scales, graduated 0.130 lbs. per sq. in. on the two lower scales which indicate the individual pressures in the wheel brake units and an 0.220 lbs. per sq. in. on the upper scale (engine compressor type 0.350 lbs. per sq. in.) which registers the pressure in the air bottles. The connections at the back of the gauge are marked to assist in the connections of the pipes and so prevent damage to the mechanism of the gauge caused by errors in coupling.

(d) WHEEL BRAKE UNITS.

The wheel unit is of extremely efficient, yet simple design. It consists of a combined back plate and channel which houses an annular expansion chamber and the brake shoes. The expansion chamber has an elbow connection by which it is connected to the pipe line by means of a metal pipe with a flexible delivery tube, which allows for movement of the axle.

(e) OPERATION.

Upon inflation of the annular expansion chamber, the shoes are forced radially outwards against the brake drum of the wheel. Rotation of the brake shoes is prevented by the friction between the air bag and shoes and the clips which pass through slots in the channel. The brake shoes are positively returned to the "off" position by means of the spring upon release of the pressure in the annular expansion chamber (air bag).

No adjustment is required since the air bag automatically compensates for any wear of the brake shoes. All Dunlop brake shoes are moulded to correct brake drum diameter, and are carefully run in before issue, thus ensuring efficient braking. Actual tests have shown brake efficiency to be over 90 per cent.

(f) INSTALLATION AND MAINTENANCE.

It must be remembered that the efficiency of the brake system depends on the good condition of the brake units. Oil or grease which may have been on the shoes render these useless, even handling with clean hands slightly effects the surface and reduces the friction. The shoes should not be touched once they are correctly run in and, in the event of the shoes having become greased, they should be replaced. Extreme care should, and must be taken in the handling of the brake units, both in stores and during erection. The paper covering should not be removed from the friction face until the brake is in position and ready to receive the wheel. Before fitting the wheel, it is essential that any grease present should be removed from the brake drum.

8. DUNLOP PNEUMATIC BRAKE SYSTEM.

This system is hand operated by the pilot and gives automatic differential control of the braking of each wheel by movement of the rudder bar. The braking effect is progressive, smooth and easily controlled. The aircraft can be brought to rest at any position on the aerodrome by the pressure of the thumb on the control lever. It is leak proof and, in consequence, may be used for parking purposes when so desired.

9. FUEL JETTISON.

This system only operates on the port and starboard wing fuel tanks. It is operated by the pneumatic system, situated in the main feed lines to the jettison unit by a by-pass valve which only operates at a pressure greater than 80 lbs. per sq. in., thereby ensuring that sufficient pressure is in the system for the landing wheel brakes. This valve will only by-pass after pilot has removed jettison control lever in cockpit. The pilot's control is mounted on the port side of the fuselage just aft of pilot's seat.

10. ANTI-ICING. (Refer Fig. 2).

This system is operated also by the pneumatic system, but it is only used by the navigator or bomb-aimer on his optically true panel to prevent the formation of any ice on window. There are two bottles—one for anti-icing and one for cleaning fluid, both fitted under observer's seat beside pilot—and the fluids are glycol and alcohol respectively. The two control buttons are positioned on the starboard side of the navigator's instrument panel.

11. GUN FIRING AND FORWARD CAMERA GUN.

(a) GUN FIRING.

The port and starboard wing guns are actuated pneumatically. The only component fitted at the factory is the gun firing button and necessary lines to the gun bays.

(b) GUN FIRING BUTTON.

The gun firing button is mounted in a recess in the aileron control wheel, and forms an integral part of the wheel. The firing button is essentially a two-way valve operated by a press cap. It comprises a cylinderical body into which are led the air inlet and air delivery interposed, an inlet valve which, when opened, allows air to flow freely from the inlet to the delivery pipe. When the valve is closed no air flow is possible. So long as there is pressure in the air container the same pressure will exist in the inlet pipe, and will be retained only in the inlet valve.

The front of the button is in the form of a knurled knob marked "FIRE AND SAFE" and the valve within the button can only be operated when this knob is turned to the "FIRE" position. The press cap may then be depressed by opening the inlet, and closing and exhaust valve.

Immediately the press cap is released it is forced outwards by a return spring closing the inlet, and opening the exhaust valve, which is integral with the press cap; the air under pressure in the pipe line from the firing button to the gun units escapes to atmosphere through holes cut in the periphery of the press gap. The function of the exhaust valve is thus to release pressure from that of the inlet valve to supply pressure to the pipe line from the firing button to the gun firing units.

The connection to the control column rigid pipe line is made through a flexible rubber hose passing through the boss of the aileron wheel and attached to the inlet and delivery pipes of the button by means of a swaged ferrule, the rubber hose allowing for the angular movement of the wheel.

(c) G.22 CAMERA GUN OPERATING UNIT.

This unit provides pneumatic operation of the Williamson gun G.22 camera. The units consist essentially of a cylinder rigidly mounted on the base of the camera gun and provided with a length of flexible armoured hose and wing nut connection for coupling to the pipe lines of the system. Housed within the cylinder is a plunger and piston which is connected with an external slide, the slide being coupled to the shutter release mechanism of the camera.

When the gun firing button is depressed, compressed air flows through the pipe line into the cylinder of the unit, where it re-acts against, and causes the piston to operate, carrying with it the external slide which pulls on the trigger of the camera overcoming a return spring attached to the trigger, and opens the shutter of the camera. When the gun firing button is released the piston is returned to its original position by the return spring on the camera trigger.

(d) BULKHEAD CONNECTIONS.

Two types of bulkhead connections are used for coupling the gun firing units to the pipe line of the system.

(i) For machine gun only.

(ii) For camera gun only.

These units are essentially similar, but the bulkhead connection for the camera gun is only fitted with a jet to control the flow of air to the camera gun unit.

The bulkhead connection consists of a square flange provided with four holes for securing the connection to a suitable bulkhead or member of the aeroplane. Projecting from the back of the flange is a threaded connection for receiving the metal pipe line of the system. The front of the flange is formed with a threaded extension machined to receive the wing nut connection of the gun firing units.

PNEUMATIC SYSTEM (DUNLOP)

12. MAINTENANCE.

(a) GENERAL.

The maintenance of the system generally will be limited to inspection of the pipe line and connections for leaks. The essence of successful working of the system is that all parts be kept clean and free from oil. If any working part, e.g., the plunger of the gun unit, or the press cap of the firing button, should be sticking, it should not be lubricated, but should be cleaned. The following notes give maintenance instructions for each unit.

(b) OIL TRAP

The drain plug at the lower end of the unit should be unscrewed about one complete turn with air pressure in the system every ten flying hours, when any oil which has collected in the unit will be ejected through the drain hole. The drain plug must then be carefully screwed home and locked in position by the lock nut.

(c) AIR CONTAINER.

If the oil is ejected from the air filter when the filter is being drained, the container must be removed from the aircraft and drained free of oil. When the container is replaced it is essential that at least four inches of piping projects through the connections.

(d) AIR FILTER.

The drain plug at the lower end of the unit should be unscrewed about one complete turn with air pressure in the system every twenty flying hours, when any oil or moisture in the sump of the filter will be ejected through the drain hole. The drain plug must then be carefully screwed home and locked in position by the lock nut. If the oil is ejected during the draining operation it is an indication that oil is getting past the oil trap and stack pipes in the air container, which container must be removed from the aircraft and drained.

(e) RELAY VALVE CONTROL.

This unit requires no maintenance whatsoever. If this unit is found to be faulty it should be returned to the makers for examination and repair. Under no circumstances must this unit be dismantled.

(f) WHEEL BRAKE UNIT.

It must be remembered that the efficiency of the brake system depends on the good condition of the brake units. Oil or grease which may have been on the shoes renders these useless. Even handling with clean hands slightly affects the surface and reduces the friction. The shoes should not be touched once they are correctly run in. In the event of the shoes having been greasy they should be replaced.

(g) GUN FIRING BUTTON.

Any sticking of the press cap should be cured by its removal, and a thorough cleaning of the cap, and of the barrel over which it slides, by a rag dipped in petrol.

A moderate leak at the firing button when it is depressed, i.e., when the guns are being fired, is immaterial, and will probably be due to damage of the rubber washer in the base of the press cap or of the control seating through which the press cap pin slides. Leakage when the firing button is not depressed will probably be at the inlet valve. To verify this the front of the button must be removed. First remove the locking screw and spring washer from the back of the button; the knurled knob must then be unscrewed from the front of the handle and the press cap and return spring removed. If the knurled knob is tight it can easily be removed with a suitable lever, using a protective wrapping of rag around the knob to prevent damage of the knurling. The inside of the button is now exposed. To check for leakage of the inlet valve supply a small amount of soapy water to the conical seat of the barrel. If the valve is found to be leaking, the barrel should be unscrewed, using the special key provided, exposing the inlet valve. The valve should then be removed, using the valve key provided, and cleaned, but if there are any particles of metal embodied in the rubber seats of the valve, the whole valve should be replaced by a new one, which should be tested for leaks after re-assembly. Removal of the inlet valve will, of course, release all pressure from the air containers, which will need replenishment before any test for pressure tightness in the system, if possible.

Excessive leakage at the bottom when the press cap is depressed indicates that either the barrel is not screwed down properly and that its fibre ring joint is not air-tight, or particles of foreign matter are adhering to the rubber seat in the bottom of the press cap, in which case the remedy is to carefully clean the seat. In the case of a leaking fibre ring the barrel should be removed and the fibre ring renewed.

Care must be taken when replacing the locking screw after re-assembly of the button, to ensure the correct meshing of the half holes for receiving the screw

(h) G.22 CAMERA GUN UNIT. Refer Fig. 3.

The unit fitted to the camera should be dismantled every three months and the cup leather replaced if damaged. Before re-assembling, the washer should be soaked in the Dunlop G. oil. Care must be taken when re-assembling as the edge of the cup leather is sharp, and must not be damaged.

When re-assembling the unit, the nut in the end of the cylinder should be carefully adjusted so that when the button is held in "FIRE" position the end of the stroke is limited by this nut and not by any of the working parts of the camera. In other words, the operating levers on the camera should still have a little play after the shutter has been released.

CUP WASHER. Refer. No. AHO.3939.

(i) PIPE LINE AND CONNECTIONS.

A leakage of air in the system, when the button is depressed, is not very serious, as this leakage is only happening during actual firing. To check for leakage connections, soapy water should be applied to the joints whilst the gun button is depressed.

The gun firing Safe and Fire and Camera units are fitted with a length of reinforced armoured rubber hose to which is attached the hose connection and wing nut, by means of the ferrule. The ferrule is contracted on to the hose and connection by means of special tools, making a permanent joint which should not, in any circumstances, be interfered with.

The wing nut is fitted with a rubber sealing ring which makes a perfectly air-tight joint when the wing nut is tightened by hand only. Tools such as pliers or spanners should, on no account, be used for tightening the wing nut to the bulkhead connection.

After assembly the connection should be locked by means of a wire passing through one of the holes provided, to any suitable member adjacent to the connection.

The rubber sealing ring should be examined each time the connection is dismantled and should remain on the spigot of the connection. If damaged it must be replaced. The life of the sealing ring should not exceed six months and at the end of this period must be renewed irrespective of flying time. Ref. No. AHO 2053.

A special type of joint is used for connecting the metal piping to the various components of the system. The components of the joint compromise a waxed rubber seal and an outer sleeve. When making the joint, the metal pipe should be pushed home into the recess in the connection and be held firmly in this position until sufficient grip has been imparted to the rubber seal to prevent the tubing from slipping out of recess.

The front of the recess in the connection is tapered, and care must be exercised that the conical end of the rubber seal is assembled to mate this taper.

It is essential that the rubber seal should be moistened with water before assembly to assist the rubber to slip within the outer sleeve when being tightened.

Should this type of connection be dismantled at any time, a new rubber seal must be fitted when re-making the joint. Refer. No. AHO.1360/1 for $^3/_{16}$ in., AHO.1360/2 for $\frac{1}{4}$ in., AHO.1360/4 for $^7/_{32}$ in. pipe. After remaking any permanent joint, its air-tightness under pressure should be tested with soapy water.

(j) B.T.H. AIR COMPRESSORS.

Full instructions for the maintenance and repair of this equipment are contained in Air Publication 1519. However, it is considered necessary to stress in this publication the necessity of certain maintenance details as below.

(k) LUBRICATION.

These compressors should be replenished with oil every 10 hours of actual pumping time. The latest models bear an instruction plate to this effect. The oil should be to specification DTD. 72. The oil is introduced into the crankcase by way of the air inlet after removing the valve cover and depressing the valve stem. The plunger of the oil overflow valve on the rear end cover should be depressed during this operation and pouring done slowly to allow the oil to attain the same level in each half of the crankcase. Pouring should be stopped when oil commences to flow from the overflow hole.

(l) FAILURE TO BUILD UP PRESSURE.

Failure or delay in building up a pressure of 200 lb. per sq. in. points to a leak in the system, the smallest air leakage being sufficient to prevent the pressure from rising. Probable causes of leakage and the appropriate remedies are given below.

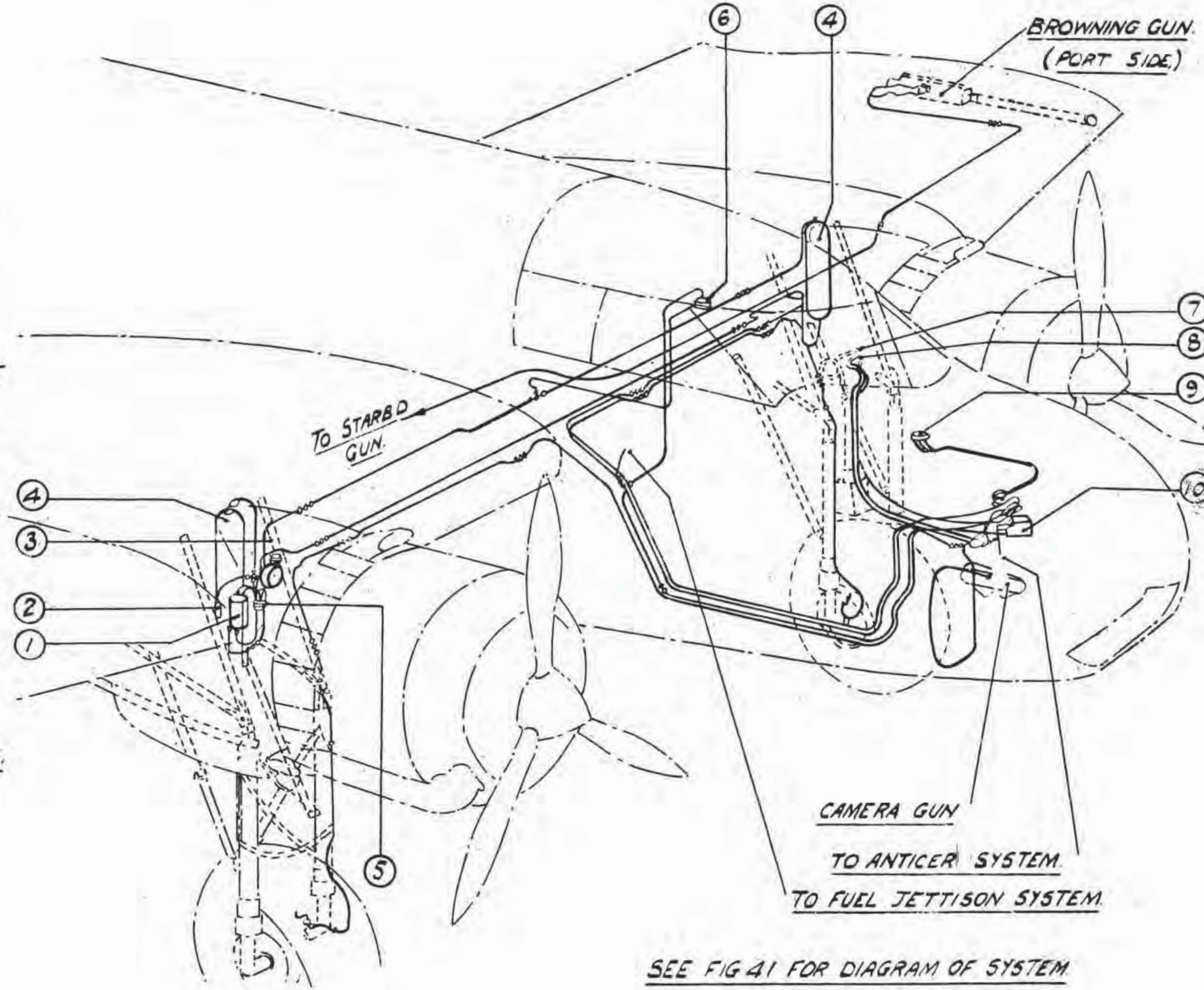
The oil coating between the piston and cylinder wall may have failed owing to insufficient oil being splashed on the piston. Check the level of oil in the compressor crankcase by depressing the plunger of the overflow valve, and make good any deficiency.

The oil seal of the non-return ball valve may have failed. Check the quantity of oil in the oil container or first air bottle, as described in A.P. 1519, Sect. A. Chapt. 2, paras. 5-7, and replenish if necessary.

Air may be leaking through defective joints in the compressor or outlet pipes. Brush all joints and connections with thin oil or soapy water and tighten any joint at which bubbling takes place.

Before carrying out this test release the air in the bottle, remove the hexagonal cap nut on the top of the compressor with spanner CX57097, and ensure that the tubular nut which secures the cylinder head is tight; a faulty joint between the tubular nut and the cylinder head would result in air leaking back to the crankcase, and such a leakage would not show up in the test. Use spanner CX5709 to tighten the tubular nut. Having replaced the cap nut on the compressor and closed the outlet valve of the air bottle, it will be necessary to operate the compressor until sufficient pressure is obtained to carry out the above test.

Carbon may be deposited on the piston, cylinder head and valves. Decarbonise the above parts, removing and replacing the valves in accordance with the instructions given in A.P. 1519, Sect. A, Chapt. 2, paras. 9-15.



1. OIL RESERVOIR MOUNTED FORW'D OF FRONT SPAR STB'D NACELLE.
2. RE-CHARGING CONNECTION ON REAR WEB OF FRONT SPAR STB'D NACELLE.
3. AIR COMPRESSOR REAR OF ENGINE
4. AIR BOTTLE MOUNTED REAR OF FRONT SPAR PORT & STB'D NACELLES.
5. OIL FILTER FORW'D OF FRONT SPAR STARB'D NACELLE.
6. AIR FILTER MOUNTED TO REAR OF PILOT'S SEAT STRUCTURE.
7. GUN FIRING PUSH-BUTTON IN WHEEL OF CONTROL COLUMN.
8. BRAKE OPERATING LEVER CONTROL COLUMN.
9. TRIPLE INDICATOR PRESSURE GAUGE MOUNTED ON COMPASS BRACKET
10. DUAL RELAY VALVE ON CROSS-MEMBER FORW'D OF RUDDER STIRRUPS.

SHEET 2 FIG. 1
PNEUMATIC SYSTEM INSTALLATION.

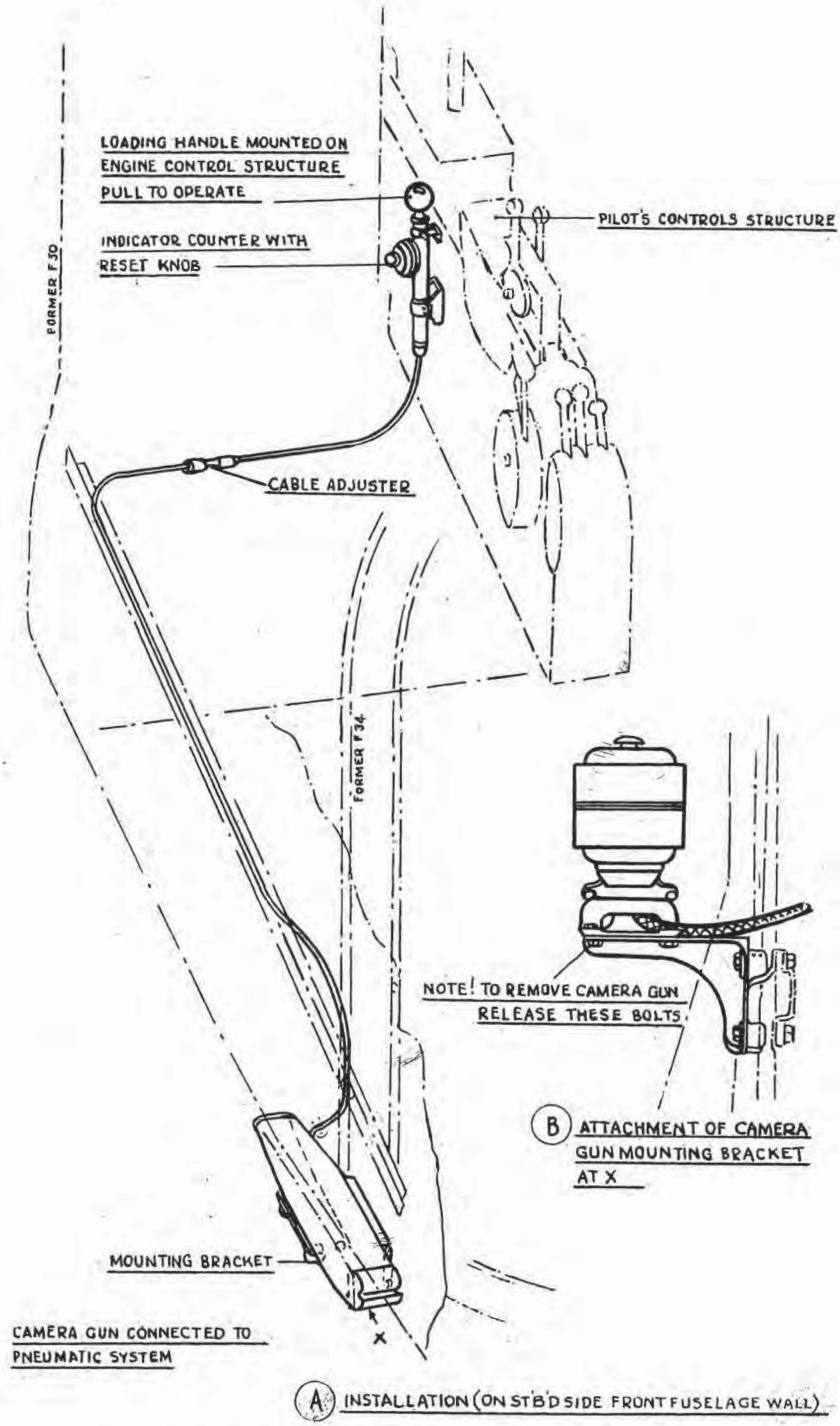


FIG.3 G.22. CAMERA GUN

CHAPTER 6

ENGINE INSTALLATION

1. GENERAL.

The two engines are each installed in a separate nacelle, being located near the extremities of the centre plane, and are fitted with either Constant Speed, or Constant Speed and Full Feathering Airscrews. The engine cowling is of the Lockheed long chord type with cowl gills fitted at the trailing edge to control the flow of the cooling air. Fuel is carried in four main tanks, two in the centre plane (one each between motor and fuselage, port and starboard, and one in each outer plane, and is delivered to the carburettor by an engine driven pump, and, in emergency, by a hand operated pump.

Provision is made for jettisoning the fuel in the outer planes, via chutes fitted on underneath surface of the planes. An auxiliary fuel tank may be installed in the bomb cell, under the fuselage; this tank may only be filled by opening (1) auxiliary tank cock, (2) auxiliary and balance cock, and then one of the four main tanks cocks which allows the fuel to balance out, thus filling the auxiliary tank.

Each engine has a separate oil tank mounted in the centre plane outboard of the engine, and a separate oil cooler mounted in the outer plane. The engines are fitted with electrical starters, and hand turning gear is provided for maintenance.

2. AIRSCREWS.

(i) Curtiss Electric Constant Speed, Full Feathering Type. Refer to Maker's Handbook and Assembly and Removal Operations, paras. 4 and 5.

(ii) De Havilland Constant Speed. Refer to Maker's Handbook.

3. ENGINES.

(a) PRATT & WHITNEY.

(i) S3C4G—Twin row, air cooled radial two stage blower.

(ii) S1C3G—Twin row, air cooled radial single stage blower.

Refer to Operator's and Overhaul Manual.

(b) ENGINE MOUNTING.

Is an electrically welded steel tubular structure attached to an adaptor structure of similar construction, which, in turn, is attached to the centre plane at five points — three on the front spar and two on the nacelle structure.

4. FUEL SYSTEM.

(a) GENERAL.

Four main fuel tanks are carried between the spars of the centre and outer-planes, two on each side of junction of fuselage and main plane; an auxiliary tank for long range operation may be installed in the bomb cell.

Fuel contents gauges for each tank are mounted on the starboard side of the fuselage below the emergency exit window sill, just on opposite side to pilot's position. The fuel pressure gauges are mounted on the pilot's instrument panel. The emergency hand pump is mounted on the starboard side of the engine control structure, and the priming pump on lower face of hydraulic panel.

(b) FUEL COCK CONTROLS.

This covers the main cocks for the four main plane and auxiliary tanks mounted on aft end of engine control structure; auxiliary and balance and emergency and priming cock controls are fitted on the starboard side of fuselage just forward of junction of front and rear fuselage. Each tank has an independent cock control.

(c) OPERATION (Refer to M.R.C.).

(d) FUEL TANKS.

Welded aluminium construction is employed for the fuel tanks, transverse and fore and aft baffles, with flanged holes in the webs, are inside the tank. The transverse bulkhead, and also the intermediate fore and aft bulkheads on the outer plane tanks, have tee-section flanges, and the edges of the main skin panels are butt-welded to the edges of the horizontal part of the tee-sections. The fore and aft bulkheads have angle-section flanges on both sides of the web, and the webs are riveted on to the webs of the transverse bulkheads, but no other attachment of these bulkheads is made to the skin. The edges of the tanks ends are welded to the skin and also to a special strip on the middle of the transverse bulkhead. Skin panels on upper and lower surface of all tanks except auxiliary are corrugated. Filler caps, vent adaptors, inspection doors, fuel contents, gauge attachments, and sumps are fitted on the tank.

The tanks are strapped to bearers that are riveted to detachable panels on the under surface of the planes. The bearers in turn are bolted to brackets at the front and rear spars and set screws round the panel edges. Pet-cocks are fitted to the tank sumps for draining accumulated water and foreign matter. The auxiliary tank is strapped to three cradles that can be attached to six lugs on the aeroplane structure, inside the bomb cell.

NOTE.—All tanks are fitted with "Cima" leakproof covering.

5. FUEL SYSTEM — BEAUFORT.

(a) VENTING.

Venting is provided for in tank bays (port and starboard), and for auxiliary tank approximately at former "O."

Fuel storage (normal range) provision for fuel storage is arranged for by four tanks, two outer and two inner plane.

(b) FUEL STORAGE — AUXILIARY.

Long range flights are provided for by the addition of an auxiliary tank installed in bomb cell structure.

(b) EMERGENCY SYSTEM (Refer 5 (g)).

In the event of normal system becoming inoperative, an emergency system is incorporated.

(c) CONTROLS.

Independent control of tanks is provided for on port and starboard system by M.R.C. controls terminating at a point in front fuselage adjacent to pilot and co-pilot.

(d) DESCRIPTION ON FUEL FLOW FOR NORMAL RANGE.

Fuel is drawn first from outer tanks (port and starboard), and flows to a junction located on nacelle structure. At this point a balance line is incorporated with a control valve. It can then be followed that, with the above mentioned valve opened, port and starboard tanks are common to each other.

NOTE.—Port and starboard C/P. tanks also junction at the abovementioned location.

(e) FROM JUNCTION (PORT AND STARBOARD).

Positioned below is a non-return valve; fuel is drawn (port and starboard) through filter by engine pump, thence to carburettor.

NOTE.—The non-return valve mentioned above is non-essential for this system.

(f) AUXILIARY SYSTEM.

Auxiliary or long range system introduces a tank and control valve with necessary piping to include it in the normal system (the previously mentioned non-return valve is not essential for this system).

(g) EMERGENCY SYSTEM.

At the point in balance and suction the emergency system is junctioned and consists of a suction line and hand pump. From pump, fuel flow is controlled by valve, thence through two non-return valves (port and starboard). At this point fuel is delivered through to the engine as in the normal range system.

NOTE.—The object of non-return valves is to confine the fuel flow to the system serving emergency requirement. Failure or non-existence of these valves would permit fuel to flow through a section of the system not directly feeding carburettors; thus causing a complete engine cut-out. Control valve in the above system will direct flow of fuel, either port or starboard engines, or if required to both.

6. FUEL SUB-SYSTEMS.

(a) **PRIMING.**

The system joins the emergency line on the suction side of hand pump; fuel is drawn per medium of a priming pump to a distributor (port and starboard). From distributor, fuel is distributed to eight points representing the upper banks of cylinders, and their purpose being to facilitate starting.

(b) **BOOST.**

The system is connected to induction casing at a point approximately centre line of engine, from whence it terminates at gauge on panel forward of pilot; within the system a fuel trap is incorporated, and is located on bulkheads (port and starboard).

(c) **ALTITUDE — BALANCE.**

This is incorporated to control fuel pressure under varying atmospheric pressures, and is controlled by the use of the syphon tube located in fuel pump, from which a pipe is connected to carburettor. Actual pressure is then transferred per medium of the pipe from carburetter to syphon tube, which reacts immediately to either increased or decreased atmospheric pressure, thus maintaining a fuel pressure constant to requirement.

(For description of syphon tube operation, refer to Overhaul Manual.)

(d) **VAPOR LINES.**

Fuel vaporises under pressure and results in vapor lock unless provision is made for its relief. Two reliefs are provided for in upper section of main fuel chamber of carburettor. The two relief pipes junctioning and forming a common return to wing tanks (port and starboard).

7. OIL SYSTEM.

The oil system is separate for each motor, port and starboard. It incorporates a separate oil cooler mounted in leading edge of the outer planes, and the oil tanks for each system are fitted in centre plane outboard of engine nacelle.

(a) **OIL COOLERS.**

They are of the 10.5 ins. diameter, R.A.E. 2-element type, and are mounted on tubular struts in the leading edge of the outer planes. The cooling air is collected by ducts from the leading edge, and exhausted through the top surface of the outer plane (just forward of the front spar). The cooling air enters the cooler at the oil outlet end. Each element is fitted with a relief valve, which by-passes the oil at a certain pressure. The setting of these valves: 12½ lbs. per sq. in. rear element, and 19 lbs. per sq. in. front element. These pressures are clearly marked on each valve.

NOTE.—

(b) **OIL LEVEL IN OIL TANKS.**

It has been proved on experiment that the correct quantity cannot be obtained by draining the oil through the oil level vent. Best method of checking with craft in tail down position is to measure 5 in. from top of filler opening to oil level.

(c) **SYSTEM.**

The feed pipe line to the engine leads from the tank sump to the pressure pump on the engine; a drain cock is fitted in this pipe aft of the bulkhead. The return oil from the engine passes through the oil cooler, and thence to the oil tank in the centre plane. A thermometer is fitted into the engine. The oil pressure gauge connection is fitted to the connection provided on the rear of the engine. A pressure gauge is fitted on pilot's instrument panel. The vent pipe from the tank is taken to the engine rear cover.

8. **ENGINE ACCESSORIES AND GEAR BOXES.**

(a) **ACCESSORY GEAR BOX.**

An accessory gear box type G.B.11.H. is fitted to forward face of engine bulkhead, and supported by gear box mounting structure fitted behind bulkhead and attached to engine adaptor and nacelle structure. It is driven by a flexibly jointed carden shaft coupled to the gear box reduction bolted on the rear case of the engine.

(b) **ALIGNMENT OF GEAR BOX** (tolerance ± .010 in. of C/L.).

This alignment is carried out with special jigs at the factory, and should not be touched unless absolutely necessary. If it is necessary to do so, care must be taken to line up the engine and gear box drive points.

This alignment can be carried out with dial indicator test rig for alignment of gear box (ACT40456). If it is necessary to replace gear box mount structure, another special jig is required for drilling and reaming of gear box attachment holes (ACT38424). It will assist in installation of mount and picks up on four engine bearer attachment points (two on adaptor structure and two on nacelle structure).

(c) **ENGINE ACCESSORIES.**

The accessories driven by the gear boxes are as follows:—

Port:

(i) Pesco B. 3X. vacuum pump mounted on the rear face.

(ii) Hydraulic oil pump Mk. 4 mounted outboard face.

(iii) Generator 1000 watts dual purpose type O.H. mounted on inboard face.

Starboard:

(i) Generator Type E mounted on the outboard face.

(ii) B.T.H. compressor on the forward face.

(iii) Pesco B. 3X. vacuum pump mounted on the rear face.

NOTE.—Accessory gear box must be drained and refilled with oil as used in the engine every 60 hours. Check oil level every 10 hours.

9. ENGINE STARTING EQUIPMENT.

The engines are started electrically. Push buttons for the starter motors are in the cockpit on top left-hand corner of instrument panel, and are fitted with spring loaded covers.

The hand turning handle is stowed immediately below the rear entrance hatch, and the booster switches for starting the engines are mounted beside the respective engine starter buttons on instrument panel. For external starting, a B.T.H. Type E.1 socket is fitted below the pilot's seat, and is accessible through a door in the fuselage. To connect the external trolley accumulator, insert the two pins of the plug on the end of the flexible cable with their respective holes in the top of the B.T.H. bracket. Turn the plug clockwise until the pins meet the holes in the main body of the socket, and push right home. This action disconnects the aeroplane accumulator, and connects the external accumulator to the system. After the engines are started, disconnect the plug.

10. CYLINDER TEMPERATURE CIRCUIT.

Two "Weston" pyrometers are fitted on the pilot's instrument panel. They show the port and starboard engine No. 13 cylinder head temperature. The cables for these follow the same run as that for the oil temperature, oil pressure, and the boost pipe lines.

11. COWL GILLS (LOCKHEED).

The electrically operated cowl flaps, located immediately aft of the engine nose cowl, are mounted on a supporting ring which, in turn, is bolted to lugs on the rocker boxes of the rear bank cylinders. Push-pull tubes are connected to the actuating mechanism, and are supported by means of bracket and roller assemblies, thus being free to move as the actuating mechanism operates. The flap segments, of which there are thirteen on each engine, are hinged at the above mentioned support brackets, and are connected to the push-pull tubes by means of short links, with the exception of the top centre segment which is linked, in the closed position, to the flap actuating mechanism. This mechanism is secured to the support ring by means of a yoke type mounting bracket, and is free to move up or down during retraction or extension. The flaps are controllable from the cockpit and may be opened or closed, or maintained in any intermediate position.

(a) OPERATION.

A small gear, located in the lower portion of the actuating mechanism housing, is meshed with a ring gear riveted to the flange of a barrel extending axially through it. The barrel is threaded on its inner surface at the right end of it to receive a hollow actuating screw. A cap, screwed into the left end of the barrel, and secured with a set screw, is threaded on its inner surface to receive the left hand actuating screw, which telescopes into the above mentioned hollow actuating screw when in the retracted position. The cowl flap drive motor (controlled by limit switches set to stop at closed position, and at angle of opening by means of a cam) turns a flexible drive shaft which is connected to the small worm gear, thereby causing the ring gear to rotate, and with it the barrel and barrel cap. The actuating screws, held from turning by the flap push-pull tubes, are thus extended or retracted, dependent upon the direction of rotation of the drive motor. Flap segments, linked to the actuating screws, and are thereby moved about their hinge line, thus opening or closing them.

(b) TO REMOVE COWL FLAPS.

The following procedure is based on the assumption that the engine cowling has been removed:—

(i) Disconnect drive shaft from cowl flap actuating mechanism.

(ii) Remove actuating mechanism:—

- (a) Disconnect push pull tubes from either side of mechanism.
- (b) Disconnect link attaching segment to mechanism.
- (c) Remove two bolts securing yoke mounting bracket to support ring and remove mechanism by moving aft and upward.

(iii) Remove bolts attaching support ring to cylinder locker boxes, and remove assembly.

(c) **TO DISASSEMBLE ACTUATING MECHANISM.**

(i) Remove lockwire and seven screws holding cover on large end of mechanism and remove cover.

(ii) Remove set screw cap on opposite end of mechanism.

(iii) Cap may now be unscrewed and removed, and with it the small actuating screw.

(iv) Barrel and ring gear assembly may now be removed, along with the hollow actuating screw.

(v) Torrington needle bearings are pressed in place, and may be removed if necessary.

(vi) Worm gear may be removed, if necessary, by driving out the pin just forward of the worm, and removing sleeve, thus freeing the gear.

(d) **TO ASSEMBLE ACTUATING MECHANISM.**

Reverse the order of the preceding pararaph, describing disassembly of the unit.

NOTE.—Upon assembly, make certain that housing is packed witn medium graphite grease to specification FJ4 (Shell), and that gasket is in place between cover and housing. See that all screws are properly secured with lockwire.

(e) **TO REMOVE DRIVE MOTOR.**

(i) Disconnect electrical conduit at motor.

(ii) Disconnect flexible drive shaft at motor.

(iii) Remove four bolts securing motor clamp to engine mount, and remove unit.

NOTE.—Motor may be removed from mounting clamp by removing four screws on either side of clamp.

(f) **INSPECTION.**

Great care should be exercised in the inspection of the actuating gear of the cowl gills, with special attention to the tendency to chafe on other parts of the structure; also keep the over run switches in good condition.

Due to mechanical features of this equipment, constant attention must be paid to all wearing parts, and any worn parts must be replaced or reconditioned immediately.

(g) **COWL GILLS (C.A.C.).**

These manually operated cowl gills are similar in construction and attachment to engine rocker boxes. Their operation arrangement is different to the extent that each gill is connected to one another (except to top flap, which is fixed) by sliding universal joints. They are operated from two points, one either side of engine, and connected by push-pull rods to fulcrum levers fitted on the engine mount. These levers are connected together by means of cable and pulley guides; the attachment is inboard to outboard on connecting cable between fulcrum levers. The other two points of levers connect by cable relay and pulley guides to actuating screw jack assembly drum behind pilot's seat on port side just forward of spar. The actuating jack drum is connected by a continuous cable with drum on pilot's wheel control, wound in such a manner on each drum, and so connected that as one end is unwinding the other is winding on.

NOTE.—Same action on actuating jack drum.

(h) **OPERATION.**

To "OPEN": Turn the hand wheel "AFT."

To "CLOSE": Turn the hand wheel "FORWARD."

12. **FUEL COCK CONTROLS** (Refer Teleflex (M.R.C.) Sec. 4A, Chap. 7).

(a) **GENERAL** (Refer Sect. 1, Para. 5).

The pilot has control over all tank cocks, including auxiliary tanks (namely bomb cell and wing jettison tanks); also under his control is a balance selector for balancing out of tanks. In emergency, he has at his disposal a selector cock which enables him to bring into operation a hand operated pump, which has a capacity of 160 gallons an hour, at 15 lbs. per sq. in. Incorporated in this control is the priming pump system, which connects with the suction side of the wobble pump; thus this control must be used for priming the engines. These controls actuate the following cocks:—

(i) Tank cocks (main, wing, and auxiliary).

(ii) Auxiliary and balance selector.

(iii) Emergency and priming selector.

(b) **OPERATION OF CONTROLS.**

Refer to Teleflex, Sec. 4A, Chap. 7.

(c) **ADJUSTMENT OF CONTROLS.**

Refer to Teleflex, Sec. 4A, Chap. 7.

(d) **ADJUSTMENT OF BOMB CELL COCKS.**

These cocks are situated in the bomb-cell, and, looking forward from port side, are as follows:—

(i) Emergency and priming cock.

(ii) Auxiliary and balance cock.

(iii) Auxiliary tank cock (both bomb cell and wing jettison tanks).

Trouble may be experienced with leaking cock glands or insufficient fuel flowing owing to the cock not being completely opened. To guard against these troubles, the following sequence of operations must be adhered to:—

1st OPERATION:

Is to first ascertain that the tapered core is a good fit in the body of the cock. This can be found out by use of engineer's blue; also check by same means that the bottom of the core is not fouling the body. If this is the case, it will be necessary to machine the core bottom face back to give .010 in. to .015 in. clearance, or a new cock will have to be fitted.

2nd OPERATION:

When the above operation is finalised, it is now necessary to fit the compression spring and spindle bearing nut, making note that the cellulose treated spring packing is in place; then tighten down securely.

3rd OPERATION:

Then pack around the cock spindle with gland packing No. A251 or graphite cord. Then place in position six-legged tab washer and fit outer gland nut.

4th OPERATION:

Tighten down gland nut sufficiently to compress the packing to make a good seal. Now check the torque loading of the spindle, which should not be greater than 8 in. lbs. When satisfied, lock with the tab washer by turning up three of its legs and the other three down.

(e) **LEAK TEST.**

(i) **EXTERNAL LEAK TEST.**—There must be no leak from the gland or porous metal under air pressure of 25 lbs. per sq. in., when immersed in paraffin.

(ii) **INTERNAL LEAK TEST.**—Allowing 5 minutes to settle down, there must not be less than 60 seconds between drips when subjected to a petrol pressure of 25 lbs. per sq. in.

(f) **INSTALLATION — FUEL COCKS (BOMB CELL).**

(i) The circular anchor plate is first fitted to the cock body with three countersunk screws (2BA). Care must be taken to see that the screws are well home, and lock the screws with a centre punch.

NOTE.—It will be evident, after this operation, that this is the main anchorage for the cock, and care must be taken in carrying out the above operation to make it secure.

(ii) **FITTING M.R.C. WRAP BOX.**—Loosen the four small hexagon headed bolts situated in the four elongated slots in the serrated vernier centre section of the wrap box. Then put the respective cock lever in the pilot's cockpit to the "ON" position. Now adjust the cock for the "FULLY OPEN" position, and fit the serrated vernier centre and replace the four hexagon headed belts, making sure that the universal socket is a snug fit on the cock spindle square. It will be found that the ratio of the serrations to the small bolts, plus the elongated slots, are adequate. Lock bolts securely with locking wire.

13. **AUXILIARY WING JETTISON TANKS** (Refer Fig. 3A).

To allow range for torpedo or bombing operations, two tanks are provided, carried by the external wing bomb racks, and each with a capacity of 73 imp. galls. Of plywood construction, they incorporate a glass elbow in the fuel suction line which fractures when tank is jettisoned.

(a) **FUEL FLOW.**

The fuel from both tanks flows through petrolflex lines along the face of the front spar and junction in the bomb cell with the auxiliary tank three-way cock.

(b) **JETTISON TANKS COCKS CONTROLS.**

(i) **AUXILIARY TANK COCK (BOMB CELL) ADJUSTMENT.**— This cock is adjusted by turning it through a 90° angle anti-clockwise, thereby reversing the cocks opening, and thus allowing one tank to be switched "OFF" and the other "ON," and vice versa.

(c) **OPERATION OF TANK CONTROLS (WING JETTISON).**

(i) For operation of auxiliary tank cock in standard auxiliary system refer to Sec. 1, Para. 5B.

(ii) Operation of controls is by moving control lever to "ON" position marked on quadrant, thus the starboard tank is "ON," and the port "OFF." By moving the control lever to the position marked "OFF" on the quadrant, the procedure is reversed—that is, port is "ON" and starboard "OFF."

(iii) Switch the "AUXILIARY AND BALANCE SELECTOR" to the auxiliary "OFF," with balance "ON." In this position the jettison wing tanks are "OFF," and the fuel system operates normally.

(iv) Jettison tanks are jettisoned in the same manner as when bombs are carried externally. To allow the severing of the suction line a glass elbow of 90° is incorporated, which breaks away when tanks are jettisoned.

NOTE.—Balance selector must not be moved from "AUXILIARY OFF WITH BALANCE ON" position, when using normal system, otherwise flow of fuel will be interrupted if wing tanks (jettison) are empty.

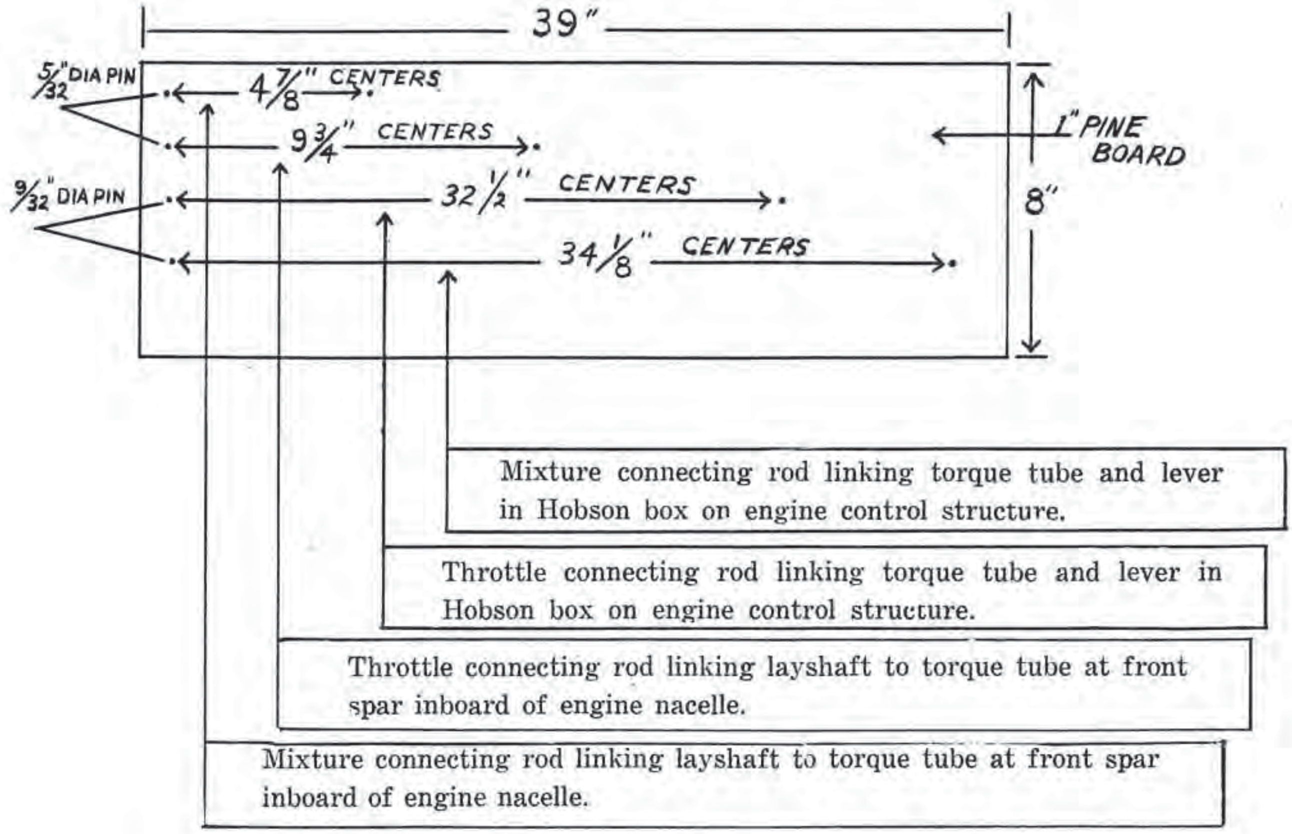
14. POWER PLANT CONTROLS.

(a) ENGINE CONTROLS (Refer Figs. 6 and 7).

Throttle controls are mounted on the extreme front end of the engine control structure, the complete unit comprising throttle and mixture levers for port and starboard engines, and where S3C4G engines are installed (two stage blower), the blower control levers are fitted to the front curved face of the control box. The complete unit being a modified Hobson type, the action of both mixture and throttle levers is transmitted to the engine by torque tube and lay shaft method, with mixture and throttle rods with adjustable end led through the bulkhead to their respective stations on the carburettor. The blower control, used only on S3C4G (two stage blower engines) is by M.R.C. led from the Hobson box levers along the front spar through the bulkhead, to the stage lever on the left hand top side of the rear spar gear case section of the engine.

(b) ADJUSTMENT.

To adjust the throttle and mixture controls it is essential that the linkage throughout be set to correct measurements before assembly; a simple and quick means of executing these adjustments is by a layout board illustrated below. Otherwise it will be found that considerable time is wasted in trying to obtain the correct movement, together with clearances and spring back on the throttle and mixture levers, which are essentially necessary for the correct function and synchronisation of this unit. With this in mind, first take the throttle connecting link joining the layshaft to torque tube at the front spar inboard of the engine nacelle. This should measure $9\frac{3}{4}$ in. centres, and the mixture control link at the same station $4\frac{7}{8}$ in. centres. Now, with regard to the Hobson box end, the distance between centres of the link from the throttle lever to torque tube is $32\frac{1}{2}$ in., and the mixture link at the same station, $34\frac{1}{8}$ in. centres. This method will leave only slight adjustment to be made, and this at the carburettor ball coupling. The amount of spring back desired between the throttle lever and the gate in the shut off position is $\frac{1}{8}$ in., and the mixture levers 3/32 in. The forked adjusting bolt on the mixture layshaft inboard of the engine nacelle should be adjusted so that $\frac{1}{4}$ in. protrudes through the threaded quadrant lug. This will give the desired radius travel to the mixture unit on the carburettor.



(c) SUPERCHARGER CONTROLS.

On S3C4G Pratt & Whitney engines a two-stage supercharger or blower is incorporated, and either high or low stage can be operated manually by the pilot with two levers, one for port and the other for starboard, situated on the front face of the Hobson control box on the engine control structure. In the case of S1C3G Pratt & Whitney engines, a single stage blower only is incorporated, and these engines have no manual control, the blower speed being governed by the engine r.p.m. The single stage blower ratio is 7.15 to 1 (S1C3G), and the two stage blower ratios are high 8.47 to 1, and low 7.15 to 1 (S3C4G), the same as single stage engines. The levers controlling the blower selector lever on the rear gear case on the engine is by M.R.C., so for maintenance and adjustment refer to Teleflex, Chap. 8.

(d) THE CARBURETTOR AIRSCOOP CONTROLS.

These controls are situated on the vertical panel mounted on the tubular hand loop at the rear end of the engine control structure. The two levers are fitted to the slotted panel, and are suitably red and green to represent port and starboard respectively, and they control the hot air shutters which are fitted in the throat of the carburettor airscoops front face, just over and behind the exhaust ring. Thus, it will be evident that when this shutter is in the open position hot air will be drawn from the engine baffles over the exhaust ring, the top fixed gill deflecting the draught down and inwards towards the opening, thence into the carburettor. The transmission of movement of the levers to the shutter is by M.R.C., and for adjustment see Chap. 8, Teleflex Controls.

OPERATION.—The manual lever operation is: Up (hot air).
Down (cold air).

(e) **AIRSCREW MANUAL GOVERNOR CONTROL.**

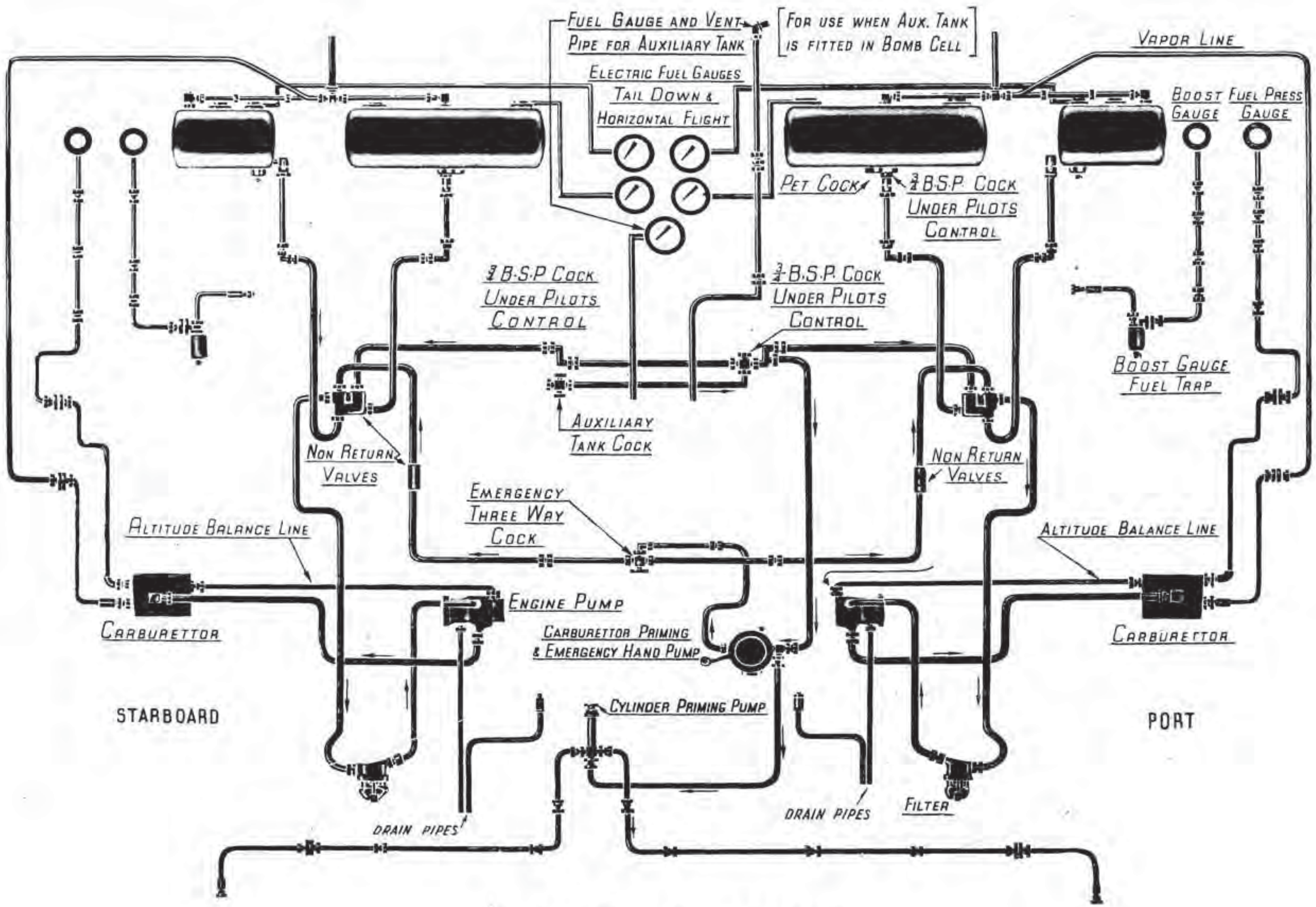
This control comprises two levers, one for the port and one for the starboard airscrew governor units, and embodies twin bracketed M.R.C. wrap boxes with a knurled dampening hand-operated disc which can be tightened to suit and so stop lever creep. The movement of the levers is transmitted to the governors by M.R.C., and operated in the following manner: Forward for increased r.p.m., and right back for decreased r.p.m. Any range can be obtained by the pilot in flight between the above two limits. The lever control unit is situated on the engine control structure at the pilot's right hand. The blade range for Hamilton Constant Speed Airscrews is 21° low angle to 42° high angle. In the case of Curtiss Electric Constant Speed and Fully feathering Airscrews, the blades are from 21.5° low angle to 46.5° high angle, and in emergency fully feathering. For all adjustments to this control, reference will have to be made to the maker's handbook for the governor unit, and to Teleflex Controls, Chap. 8, for the wrap boxes and the conduit run.

(f) **THROTTLE WARNING SWITCH** (Refer to Fig. 6, Sec. 4A, Chap. 3).

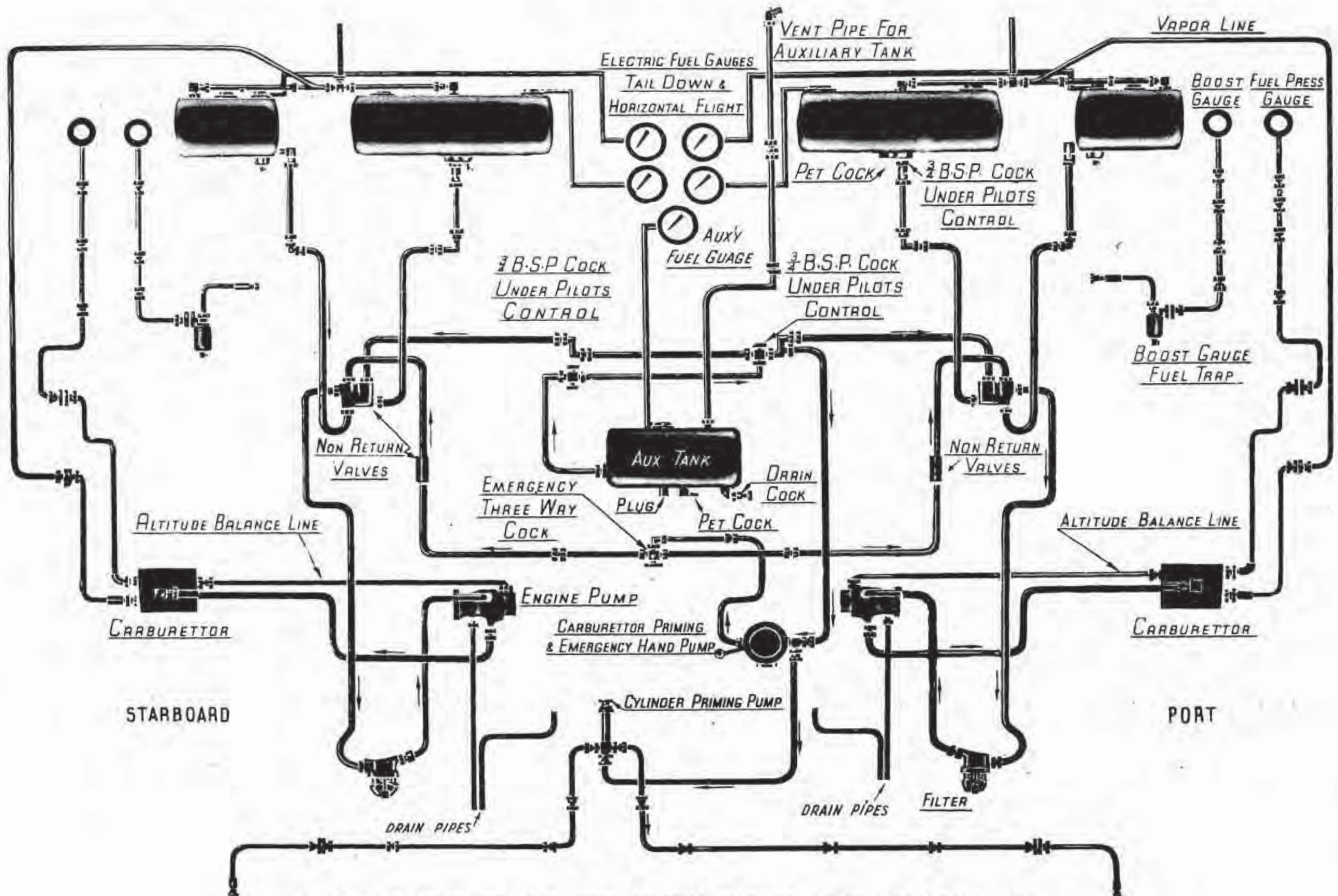
(i) This switch is situated at the extreme front end of the engine control structure, inside and below the Hobson control box, and its function is to warn the pilot that the undercarriage is "UP" when making his approach and taking back his throttles to reduce the engine r.p.m. The switch device operates when the boost is reduced and reaches from 15 to 16 in. HG. The starboard throttle lever has a small roller fitted to its lower end, which pushes forward the adjustable switch lever arm when the throttle levers are brought back and the boost, as before mentioned, is reduced to 15 to 16 in. HG, and so functions the warning horn.

(ii) When the pilot throttles back the buzzer notifies him that his undercarriage is not "DOWN"; it will also continue if his undercarriage is not locked "DOWN." The action of the undercarriage "DOWN" switches is to open the buzzer circuit and thus cut it out altogether. This circuit is closed in all positions; that is with undercarriage locked up and within its range of movement from "UP" to "DOWN."

(iii) To adjust this switch remove the cover plate on the side of the engine control structure. The three bolts attaching and anchoring the plate to the wobble pump must also be removed. Loosen off the switches body anchoring screws, then move the complete unit clockwise to decrease the boost setting and anti-clockwise to increase the boost setting. When position is set tighten up attachment screws.

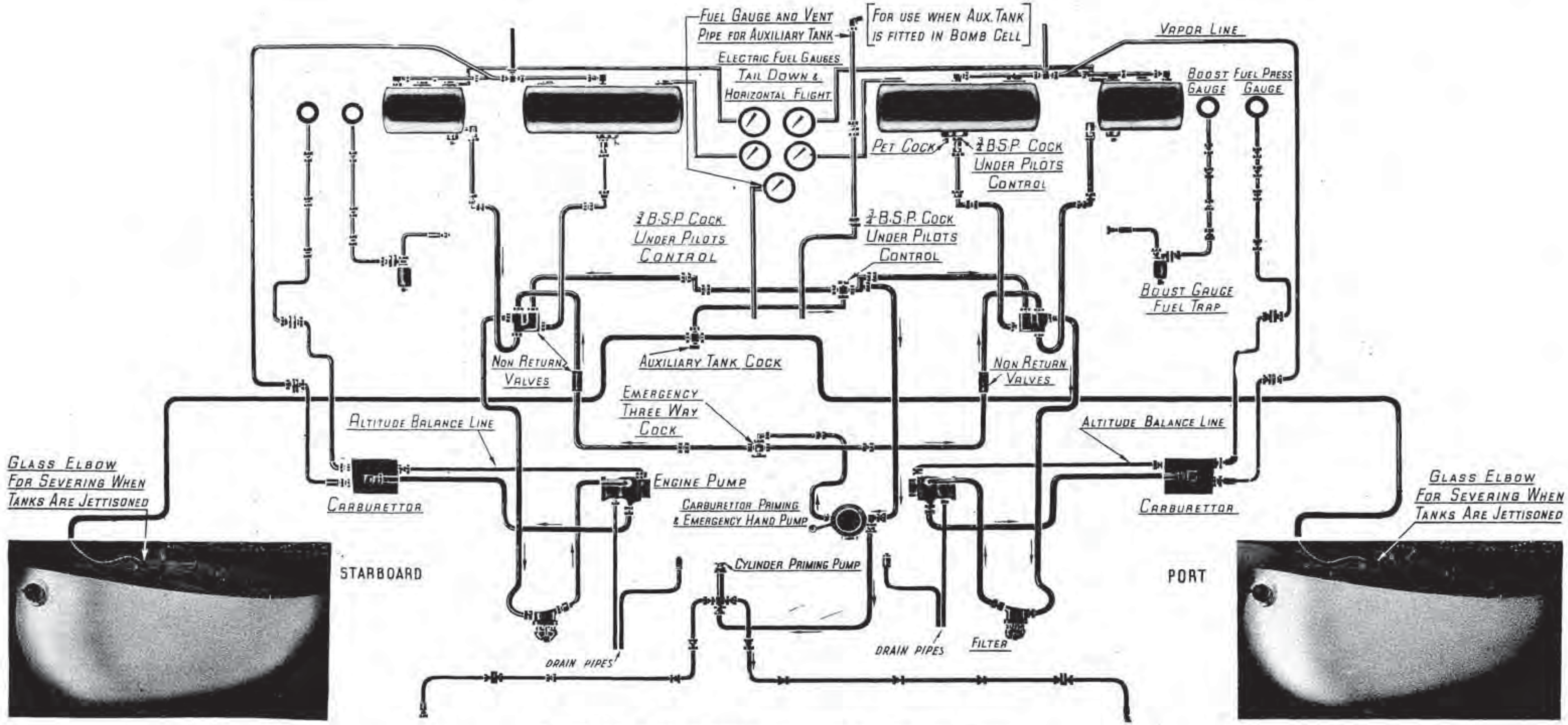


STANDARD FUEL SYSTEM
DIAGRAMMATIC

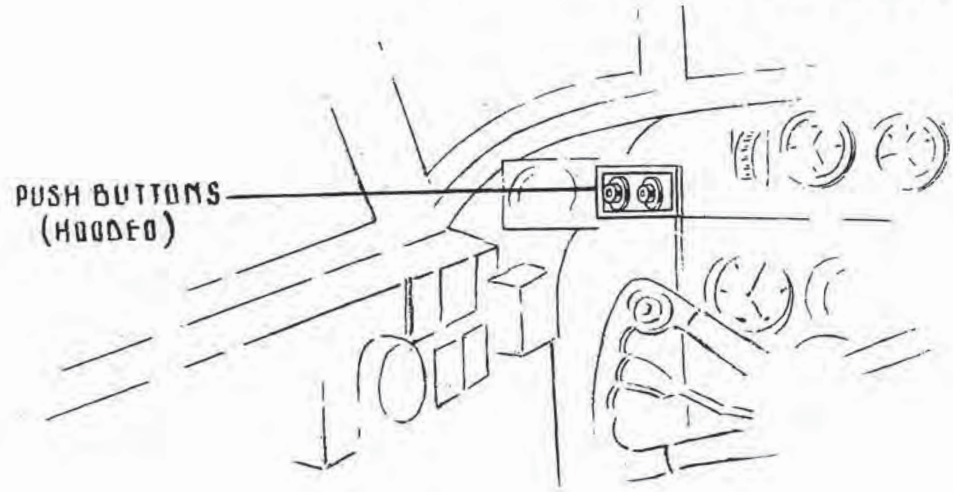


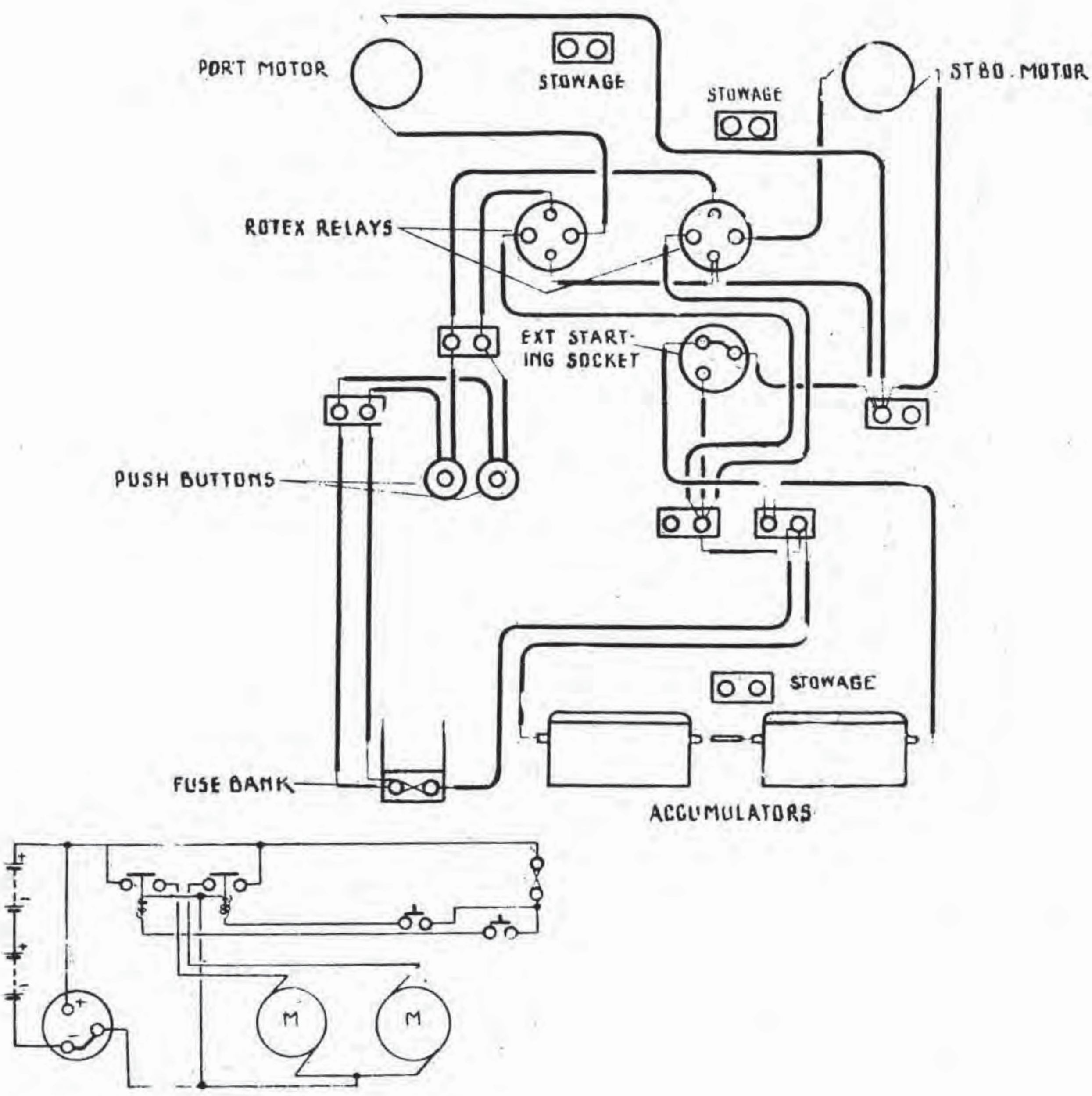
STANDARD FUEL SYSTEM WITH AUXILIARY TANK FITTED IN BOMB CELL

DIAGRAMMATIC



STANDARD FUEL SYSTEM WITH WING JETTISON TANKS
DIAGRAMMATIC





ENGINE STARTING WIRING DIAGRAM

FIG. 8.

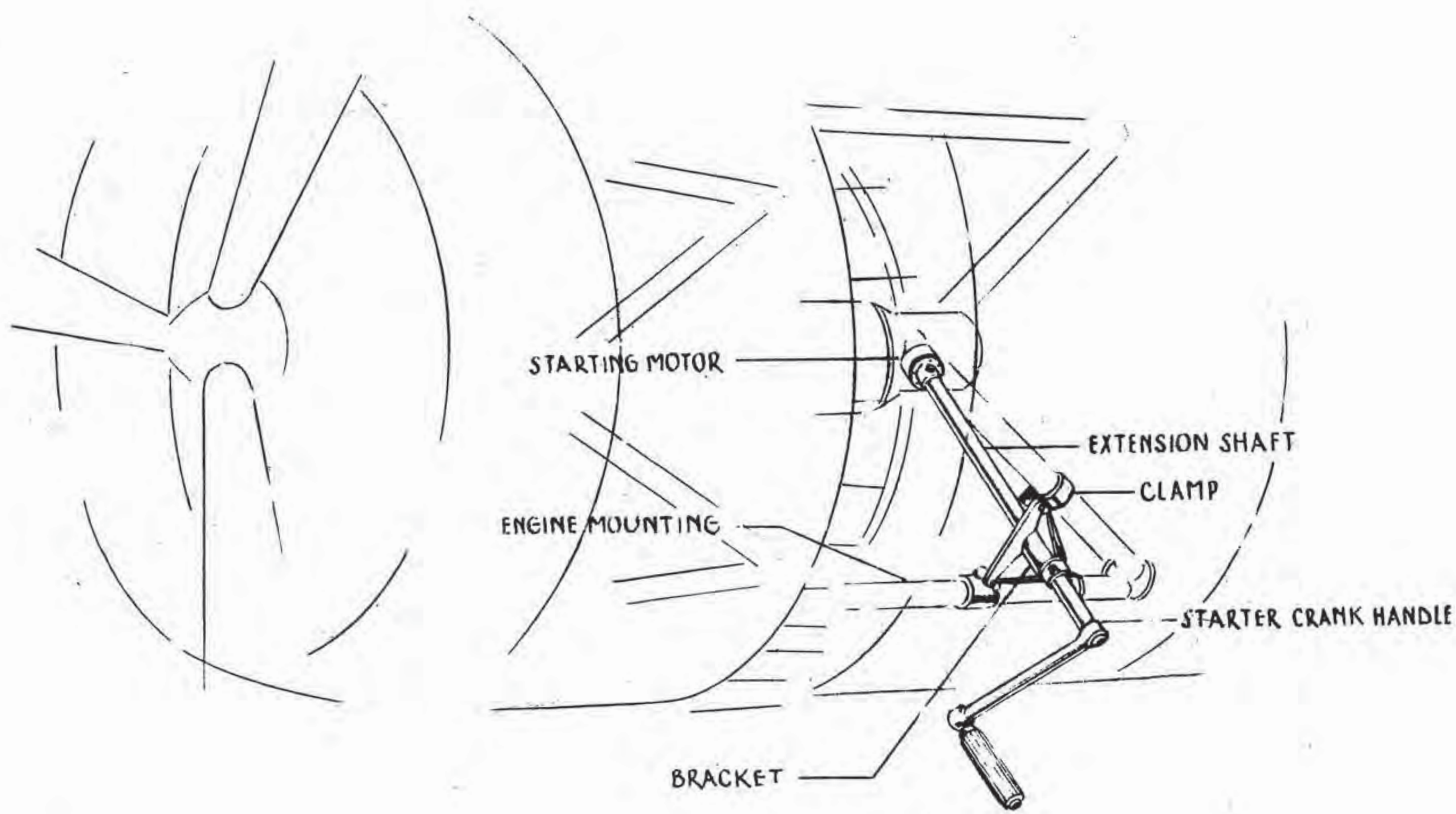


FIG. 9

HAND STARTING GEAR

CHAPTER
7

CHAPTER 7

GRAVINER FIRE EXTINGUISHER SYSTEM

1. GENERAL. Refer Fig. 1.

The "Graviner" system is fitted on all Beauforts to help reduce the hazards of fire around the engine carburettor. It is fitted behind both motors and can be brought into operation:

(1) Automatically by flame switches and inertia impact switch.

(2) Manually by the pilot operating a shielded push button mounted on the left hand side of the pilot's instrument panel.

Incorporated in the system is a bronze bottle filled with "methyl-bromide" under pressure, which is released electrically on operation of any of the above switches by the firing of a small element, which breaks the retaining seal. The following is a description, testing, and operation of the complete system.

(a) GRAVINER BOTTLE.

Is a bronze container which is filled with "methyl-bromide" under pressure, and is electrically operated. The only test carried out is to make sure that the bottle is full, and this is generally carried out by weighing the full one against the empty one.

(b) FLAME SWITCH.

This switch is automatic in its operation, this being brought about by a wax composition on the end of the knurled nut pressing the contact back. When the temperature around the flame switch reaches the vicinity of 140°C, the wax melts and the contact, which is loaded with a low tension spring, slides out and makes contact, thus completing the circuit. This unit can be tested for operation by connecting in series with a lamp, and giving the knurled nut approx. 2 turns, by which time it should make contact. Care should be taken not to damage wax on end of knurled nut.

(c) GRAVITY SWITCH.

Arrangements have been made for the fitting of a modified type, though none have been actually fitted as yet. The wiring being completed on all aircraft.

(d) INERTIA SWITCH (Impact)

This unit is an electrical switch incorporated to automatically bring into operation the Graviner circuit in case of a crash landing, depending on the angle of impact and the resulting poundage.

The mechanism is enclosed, but a square spindle projects at one side, and a knurled key disc is provided for resetting in the event of it being dropped or operated accidentally before mounting.

(e) SETTING OR RESETTING.

To reset, suspend the pendulum vertically, rotate the knob on the switch case, so that the arrow points to "set"; rotate the key disc on the square spindle in a clockwise direction, as far as it will go (about 120°). Press the knob firmly down until the pendulum engages the co-acting pin when the disc is released, and the switch is set (contacts open).

The switch is set to operate when the aeroplane is subjected to an acceleration or deceleration of 6G. and should not be altered.

If it is desired to test the switch after setting before being fitted, the switch can be given a smart smack with the palm of the hand, and the trip switch will be heard to fall; if necessary a lamp in series can be used and the above test carried out.

(f) GRAVINER SPRAY NOZZLE.

This is a two-way nozzle fitted on starboard side of carburettor intake, one way being to the inside of the intake, and the other to the carburettor discharge tube.

There is no adjustment on this nozzle, it being a standard Graviner fitting.

(g) ASSEMBLY OF SYSTEM. Refer Fig. 1.

This is carried out in four stages on aircraft:

(1) Bulkhead assy.	Bottle and flame switches.
(2) Engine assy.	Main discharge tube fitted to lugs on rear face of engine mount ring.
(3) Airscoop sub. assy. ..	Graviner two-spray nozzle and carburettor discharge tube.
(4) Inertia switch	Underneath navigator's table.

(h) SEQUENCE OF OPERATIONS. (Port).

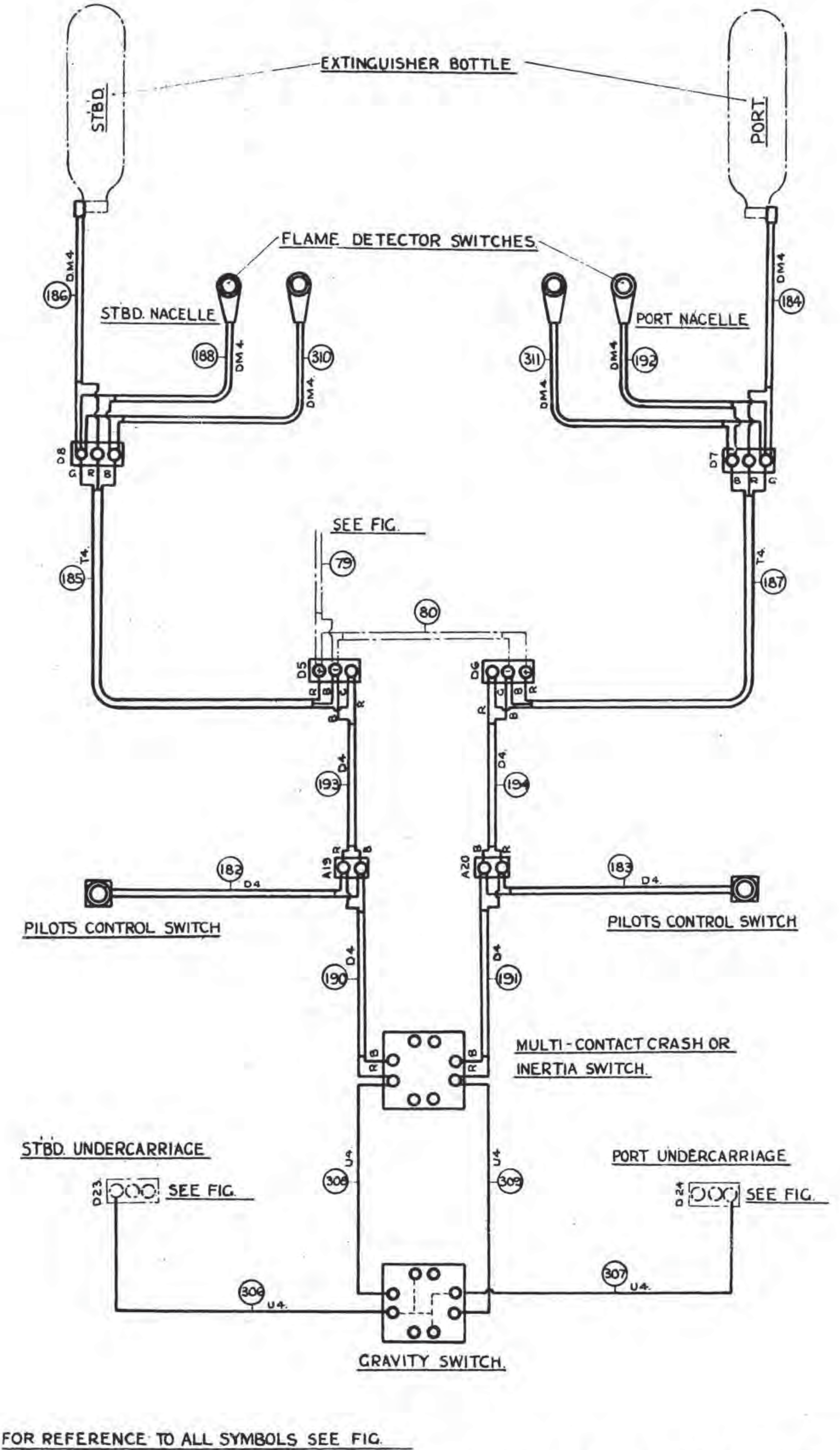
The bulkhead assy. having been completed and offered up, and then the engine assembly in turn, the airscoop is then fitted. These stages having been completed, the assembly of the pipes can be started.

Care must be taken on assembly to make certain that the holes drilled in the carburettor discharge tube are facing downwards and those in the main discharge are facing aft towards the bulkhead. These tubes being of soft alloy and anodised, should be carefully handled.

The flexible lead from the bottle, and another from the spray nozzle, to which the carburettor discharge tube is also connected, are joined together at a "T" union, from which another line, though not flexible like the others, connects up the main discharge tube with the system.

The flame switches, of which two are mounted on each bulkhead, plus the inertia switch under the navigator's table, are incorporated in the electrical circuit, and either of these, plus the button in the pilot's cockpit, can electrically fire the discharge from the Graviner bottle.

(i) STARBOARD SIDE. Refer to Port.



FOR REFERENCE TO ALL SYMBOLS SEE FIG.

FIG.2 "GRAVINER" FIRE EXTINGUISHER WIRING DIAGRAM

CHAPTER 8.

1. TELEFLEX CONTROLS.

(a) GENERAL.

The teleflex system of "mechanical remote control" (M.R.C.) comprises a patented cable operating in a rigid light alloy or flexible conduit. The cable is designed to transmit tension and compression loads without distortion, and is built upon a tension member core over which various layers are wound up to take compression.

The final winding, consisting of a large diameter wire interspaced by three wires of smaller diameter, alters the cable into a helically wound flexible rack. Toothed wheels of any pitch, diameter, or other forms of terminal actuation, are easily engaged with the helical winding, giving rotary or push-pull movement to suit any specification required.

It is not always essential to operate teleflex controls with wheel drives, and in various cases push-pull units with sliding and swivel or rod ends can be fitted.

(b) EASE OF OPERATION.

Smooth operation results from the following reasons:

(i) The area of contact between the cable and conduit is reduced to a minimum by virtue of the cross-sectional area of the helically wound wire.

(ii) The helix itself forms a perfect lubricating channel between the coils, thereby allowing an adequate supply of lubricant to form between the cable and conduit.

(iii) Due to special methods of manufacturing the cable, great flexibility is maintained without sacrificing resilience, minimising friction caused by the tendency of the cable to take a permanent set after passing around a bend.

(c) OPERATING LOADS.

Due to the various lengths of runs and number of bends to be catered for on different installations, the size of the control to be used should be recommended by the maker of these fittings on receipt of drawings showing the load required to be operated, the number of 90° bends and length of control.

LOAD FACTORS:

No. 1	Wrapped wheel	= 25 lb.	Factor	8
No. 2	„ „	= 50 „	„	8
No. 2	Straight lead	= 25 „	„	$4\frac{1}{2}$
No. 1	Push-pull and sliding ends	= 50 „	„	5
No. 2	Push-pull and sliding ends	= 75 „	„	5

NOTE: These loads are to be taken at maximum point of control.

2. **TELEFLEX FITTINGS.** Refer Fig. 1 and 2.

(a) COMPONENTS.

The following is a list of the components used, description of composition, assembly, and precautions to take, also remedy of faults found:

(i) TELEFLEX SHAFTING (CABLE).

Method of manufacture described in general description of teleflex controls. The cable is made of steel wires. The only precaution to take is with close limit conduit, that the cable is not up in size as the clearance is only from .002-.006.

(b) FITTING NEW CABLE.

Measure the required length of new cable, leaving an additional 2 or 3 in. on. Cut off the cable with wire cutters and before final adjustment pull the cable tight. Each cable end should be well radiused on a grindstone or a file. Before insertion into the conduit, grease the cable thoroughly with anti-freezing grease.

(ii) CONDUIT.

Is made of aluminium in 20 ft. lengths, and is very easily worked.

A minimum of bend of 3 in. radius is allowed and all conduit should be bent with a piece of cable inside to give support to conduit walls, and after bending pulled backwards and forwards to see that it moves freely. All ends of conduit, after cutting, should be squared and deburred. This squaring up should be done, especially where a junction is being made between two conduits, with a conduit clamp connector so that they meet squarely.

(iii) CLOSE-LIMIT (UNI-CONDUIT). Refer to Conduit.

NOTE: Do not overtighten screws or nipples in conduit connectors, as with this conduit the clearance being very close, .002-.006, can be overtightened easily, thus fouling the cable.

(iv) FLEXIBLE CONDUIT.

Is made of steel with a composition covering. The minimum radius is $5\frac{3}{4}$ in. and is made by the maker to lengths ordered by the user. If ends are located securely and the radius is correct, no trouble should be found, apart from signs of wear.

(c) CONDUIT CONNECTORS.

The conduits are connected together by a box type unit by means of a nipple or clamp fitting:

(i) Conduit clamp connector (is used the most).

(ii) Control break units (used for joining cables and conduits together).

(d) CONDUIT CLAMP CONNECTOR.

The clamp is made of dural, and the locking pin (Fig. 2) provided in the lug on the box must be removed before inserting the conduit, also loosen off the connector bolts (Fig. 2). It is essential that the end of the conduit be pushed right home to the limit of the hole. Drill right through the lock pin hole with a clearance drill (not exceeding 0.0005 larger than pin diameter), thereby cutting a locking groove in the conduit. Insert locking pin and turn over the bifurcated ends. Tighten up the locking bolt on the lug, and the operation is complete.

(e) CONTROL BREAK UNITS.

This clamp also is made of dural, and serves a dual purpose. It joints the conduits together as well as the cable (Fig. 2). This clamp is in four pieces—two nipples and the body in two pieces split lengthwise and held together with four 4 BA steel bolts and Simmonds locknuts.

When assembling, the nipples should be removed and slided over the conduit with the thread towards the end of the conduit, and then the conduit must be suitably bell-mouthed, using a teleflex bell-mouthing tool. The end of the conduit must be annealed to comply with standard practice, although it can be done without this if necessary. It is essential that the conduit should project about $^1/_{16}$ in. in from the screwed end of the nipple when bell-mouthing is completed.

The next move is to junction the cable together and pull the cable through the conduit so that the join of the cables just goes into the conduit and the junction therefore cannot come undone. The clamp body is then broken in two pieces by undoing the four 4 B.A. bolts, then each half is placed on opposite sides of the conduit junction and bolted together. The nipples are then tightened up (not too tight) and locked to the clamp body with locking wires.

NOTE: The control break unit is incorporated in all runs where it is necessary, like the landing lamp run in the wing junction with the run in the centre plane. If a wing has to be taken off, a break in the landing lamp M.R.C. run can be made. As there is something like .5 ins. between the conduits, when cutting the M.R.C. cable to length make sure that this junction in the cable moves through this space when the run is finished so that the join can be broken without dismantling the whole run.

(f) ROD ENDS.

These are made of steel and can be obtained in 4 BA, 2 BA, $\frac{1}{4}$ BSF, and $^5/_{16}$ BSF. Beaufort only uses the first two: 4 BA and 2 BA. These can be cut to any length desired and then sweated or swaged on to end of M.R.C. cable. Except for inspection of this joint and locking of adjustment with lock nut, should cause no trouble.

(g) SLIDING FORK

These are made of steel tube, and their length controls the range of travel. All sliding forks incorporate the spring method of attachment (see assy. instruction). To assemble, unscrew the fork and push the cable through the sleeve. Screw the spring on to the end of the cable and adjust the spring along the cable until the required length is obtained. On determining the position of the spring, cut off the surplus cable to leave $\frac{1}{8}$ in. to $^3/_{16}$ in. projecting beyond the end of the lock spring and radius the end of the cable.

Prevent the fork from rotating and screw up the sleeve into the fork tightly; lock the fork end with the lock nut. After assembly the cable should be visible, or project slightly within the hole at the bottom of the fork. The fork end is then ready for attachment to its relevant lever.

(h) SLIDING SCREWED ADAPTOR.

Refer to sliding fork, as this is the same in every respect except for adaptor end.

(i) SWIVEL COUPLINGS.

These are in three parts: The steel tube with the ball fitting on the end, the cup to hold it, and the retaining fitting, which also holds the end of the M.R.C. conduit, and all these end fittings are either dural or tungum. The assembly is locked together by a circlip. The swivel couplings are located between two fibre clamps with recesses in the face of each. These are placed around the retaining cup and locates it by two 2 BA bolts and Simmonds lock nuts. The ball joint allows a deflection either side of centre line of 10° and allows a 20° angle of movement. The M.R.C. conduit is fitted in the other end after the locking pin is removed and the connector screw is loosened. The procedure of assembly there is the same as the conduit clamp connector. The M.R.C. cable is fed then after being greased well, through the run area down through the swivel joint and thus to the sliding end.

(j) BOX CONTROL UNITS.

The following units are used in the Beaufort aircraft:

Unit	Material of Case	Material of Wheel	Rewards
(1) Single entry	Dural	Steel	All controls except fuel cock controls
(2) Two lead	,,	,,	Mounted on airscrew governor.
(3) ,, ,,	Fibre	Fibre	Fuel cock controls
(4) ,, ,,	,,	Tungum	

(k) SINGLE ENTRY WRAP BOX.

All cockpit controls. Refer to assembly instructions.

(l) TWO-LEAD ENTRY WRAP BOX (180° Constant Speed Airscrew Unit)

This unit, which is of the double entry type, being made of light alloy, both case and cover, the toothed wheel is of steel, and for adjustment of relation of wheel to governor spindle is made through a serrated bush, making contact between the two. Except for proper alignment with governor when fixing to governor locating bracket, precautions should be taken to see that the conduit approached the wrap box in a straight line and that the cable is not up in size as this will cause stiffness, as close limit conduit is used.

NOTE: Uni-conduit is close limit in tables of sizes given earlier.

(m) TWO-LEAD ENTRY WRAP BOX.

This is used in the cockpit end of fuel cock controls and works the Vickers $\frac{3}{4}$ fuel cock. This type is used for the auxiliary and balance, emergency and priming and auxiliary cock.

NOTE: The balance cock balances between the two O/plane and two outer plane tanks and the auxiliary balance only when auxiliary fuel system is used.

NOTE: On the single entry box as fitted in the cockpit, on airscrew and supercharger ratio, etc. Controls at the end of the cable must tuck into the slot of the wheel. Care should be taken to ensure that the minimum tooth engagement gives a wrap of at least 40°. The control handle on this type of box has a vernier adjustment for range inside at gate. These controls have a damper adjustment also for locking in position.

Where the box unit has two entry holes like fuel cocks and aileron trimming controls the end of the cable must always pass through the box and appear beyond the lead-out hole at any position of the movement required.

The conduit carrying the spent travel should have the end flattened to prevent dirt and moisture entering.

Care should be taken that the cable does not foul the flattened end.

In fitting the cable to the box unit end, the lever or handwheel must be in the extended or maximum position.

All boxes must be packed with anti-freezing grease before final assembly.

(n) SWIVEL MOUNTING BLOCKS.

These are made either of fibre or laminex, the blocks which are in two pieces have a round recess in each half, so making a complete circle these are then located on each side of the swivel ball retaining cup, and then bolted together on to the swivel coupling mounting bracket with 2 BA bolts and Simmonds elastic nuts.

(o) CONDUIT CLAMP BLOCKS.

These are made in the same way as the "swivel mounting blocks" from the same material only with the diameter of the conduit instead and secured the same way.

(p) CONDUIT FORMERS.

These are made different diameters, so that conduit can be bent to different radii, the formers controlling the bend radius.

NOTE: Do not bend any conduit without having a piece of cable inside to give support to the walls of the conduit. After bending, pull the cable backwards and forwards through the conduit to see if it flows through smoothly.

(q) TELEFLEX CONTROLS.

GENERAL: The following is a list of the Teleflex controls fitted to:

Ref. No.	From	To	Reference
I	Airscrew pitch control lever	Governor control on engine	See Figs. 1
II	Air-intake control lever	Engine connections	,, ,, 2
III	Supercharger	Ratio control	,, ,, 2
IV	Flap indicator	Inboard end of starboard flap	,, ,, 2
V	Aileron trimming tab handwheel	Box on aft of rear spar starboard side of fuselage	,, ,, 1
VI	Aileron trimming tab handwheel	Aileron trimming tab indicator on hydraulic control panel	,, ,, 1
VII	Fuel cock control levers	Fuel cocks on tanks	,, ,, 2
VIII	Landing lamp control lever	Landing lamps in port wing	,, ,, 5
IX	Undercarriage safety lock on hydraulic control panel	Inboard leg of starboard undercarriage	,, ,, 2
X	Reconnaissance flare control lever	Reconnaissance flare chute on starboard side of R/F	,, ,, 3
XI	Parachute flare control lever	Wire cable at pulley above flare chutes situated aft P.O.G.M.	,, ,, 4

(r) ASSEMBLY INSTRUCTIONS.

Boxes: On boxes with two lead holes the end of the cable must always pass through the box and appear beyond the lead out hole at any position of the movement required. A short piece of conduit encloses the spent travel, and it is preferable that this is a straight piece; in cases where clearance is restricted the lead out tube can be bent, provided that the end of the cable operates in a straight length during its travel. For attaching the conduit to the box the ends of the tube must be bell-mouthed. On single lead in boxes the end of the cable must tuck in a slot in the wheel. Care should be taken that the minimum tooth engagement is not less than 40° throughout the operation.

The lock pin should be removed before clamping the conduit. Drill through $^3/_{32}$ in. clearance, drill with conduit in position and replace pin. Bend over end of pin to lock.

Sliding Ends: All sliding ends incorporate the spring method of attachment. Unscrew fork and push cable through. Screw on spring and obtain adjustment by screwing spring along the cable. On determining the position of the spring, cut off the cable within $\frac{1}{8}$ in. to $^3/_{16}$ in. from the end of the spring. Hold fork end from rotating and screw up sleeve into fork end tightly, lock up fork end with lock nut. After assembly the cable should be visible or project slightly within the hole at the bottom of the fork. On all eye ends and screw ends an inspection hole is provided, and on assembly the cable must project beyond the hole.

Clamp Connectors: The pins must be removed before assembly, and after clamping up the lock pin, holes must be drilled with a clearance drill not exceeding .005 in. larger than the pin diameter.

Push-Pull Units: A loose spring housed in the knob must be removed; the knob being screwed on to the plunger with a left-hand thread. The cable can then be passed through the plunger. Screw the spring on to the cable, allowing $\frac{1}{8}$ in. projection of cable beyond the spring. The knob must be screwed up tight before locking with the lock nut. Adjustment on all push-pull controls should be made at the sliding ends where possible.

Conduit: Dural conduit must be bent on a standard grooved block which can be supplied by us, to avoid distortion of the tube on the bend. Min. bend radii: Size 1, $2\frac{1}{4}$ in.; size 2, 3 in. The bore should be well cleaned of all foreign matter before bending. After cutting the conduit the inside of the bore must be well chamfered at the end.

Cable: After cutting the cable the ends should be well radiused on a grindstone.

Lubrication: The cable should be well greased on insertion in the conduit with anti-freezing grease DTD.143B.

(s) FAULTS AND REMEDIES.

If a control becomes stiff in operation it may be due to any of the following causes:

(i) The conduit in some portion of control, as this tends to become harsh in operation. The damaged part can, after inner cable has been removed, be cut out and replaced by a short length of conduit and joined by a clamp connector.

NOTE: The cable, during this operation, must be removed.

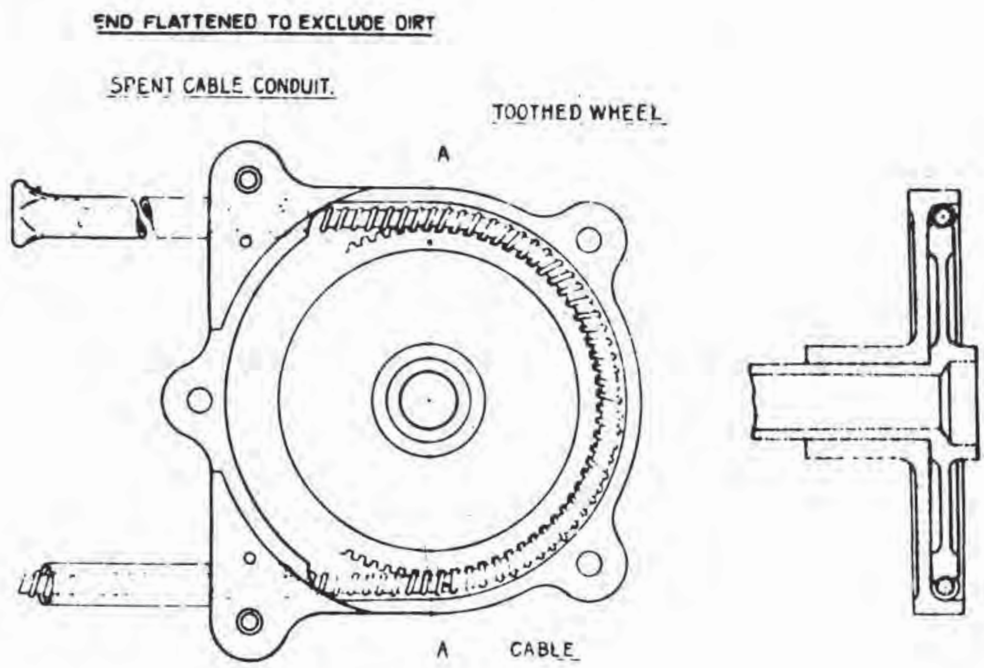
(ii) The casting of an operating box unit has become excessively worn, causing the cable to over-ride the wheel during a push operation; this fault will only become apparent on a push operation. If undue stiffening occurs on a pull operation, the fault will not be located in the box unit. If a box casing is badly worn it should be renewed with a new part, and the old one returned, for checking purposes. The wheel should be examined for wear, broken teeth, etc.

(iii) **Lack of Grease in Conduit:** Dismantle the end fittings and remove the cable from the conduit. Thoroughly cleanse the cable and conduit. Re-grease the cable well with anti-freezing grease.

(iv) **Bent Slider Fitting:** Stiffness may occur due to the sliding ends becoming bent. This can be checked by removing the sliding tube from the cable and testing for freedom of movement between the inner and outer sliding members. If these parts are considered stiff, fit new parts. Check also the alignment of the swivel, where applicable.

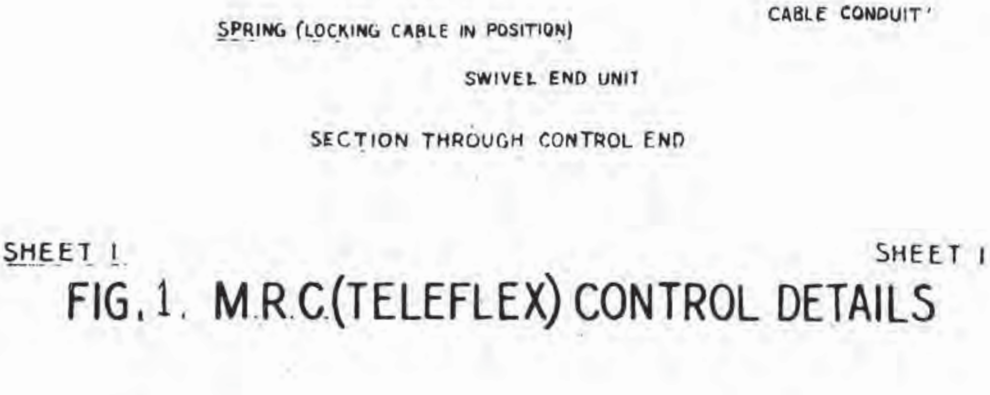
(v) **Fouling:** This may occur between the end fittings and the structure members, due to faulty assembly or subsequent misuse.

VIEW SHOWING CONSTRUCTION OF CABLE



VIEW OF TYPICAL BOX UNIT (COVER REMOVED)

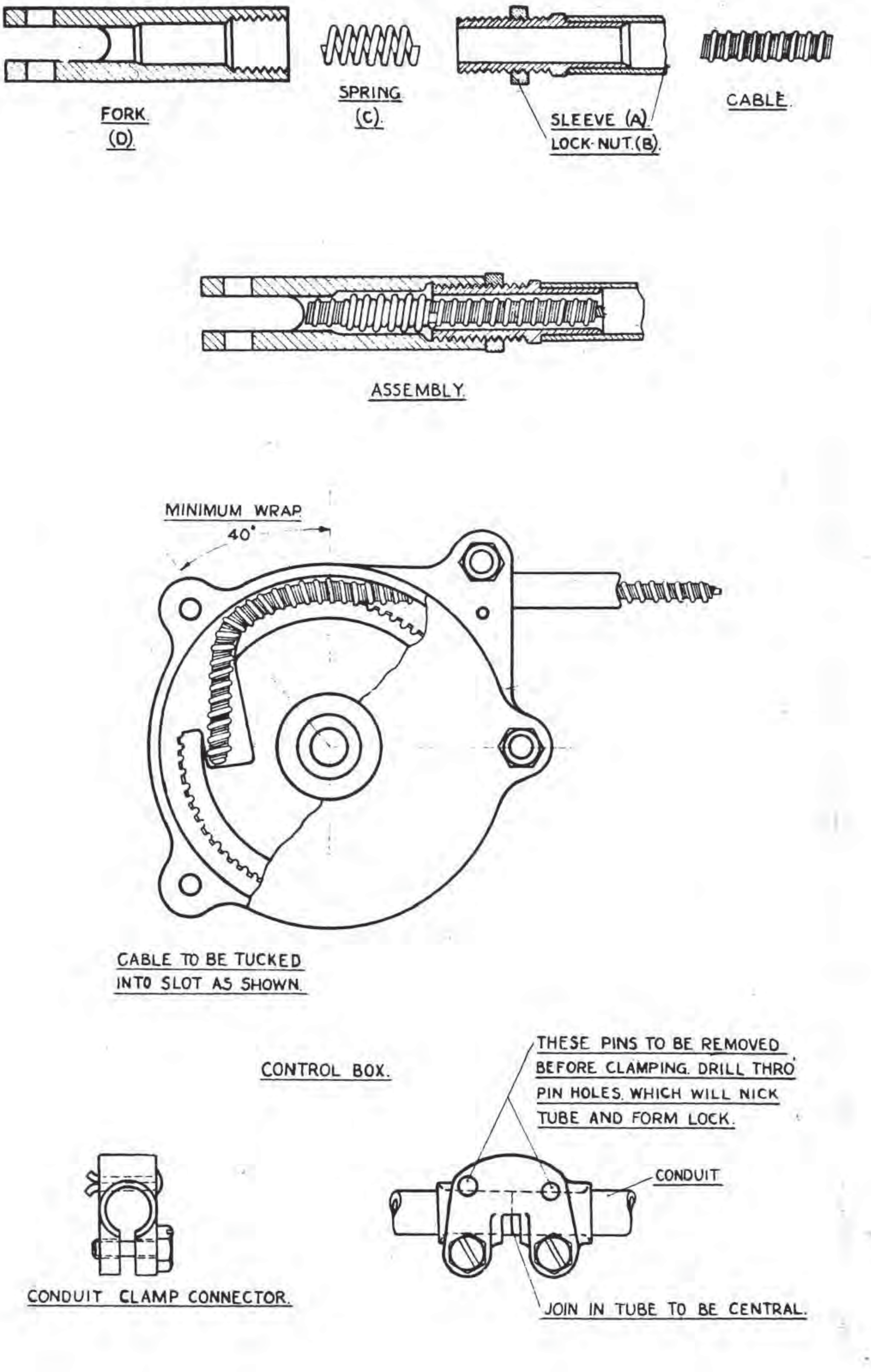
SECTION A-A



SECTION THROUGH CONTROL END

SHEET 1 SHEET 1

FIG. 1. M.R.C.(TELEFLEX) CONTROL DETAILS



SHEET 2. SHEET 2

FIG. 2 M.R.C. (TELEFLEX) CONTROL DETAILS

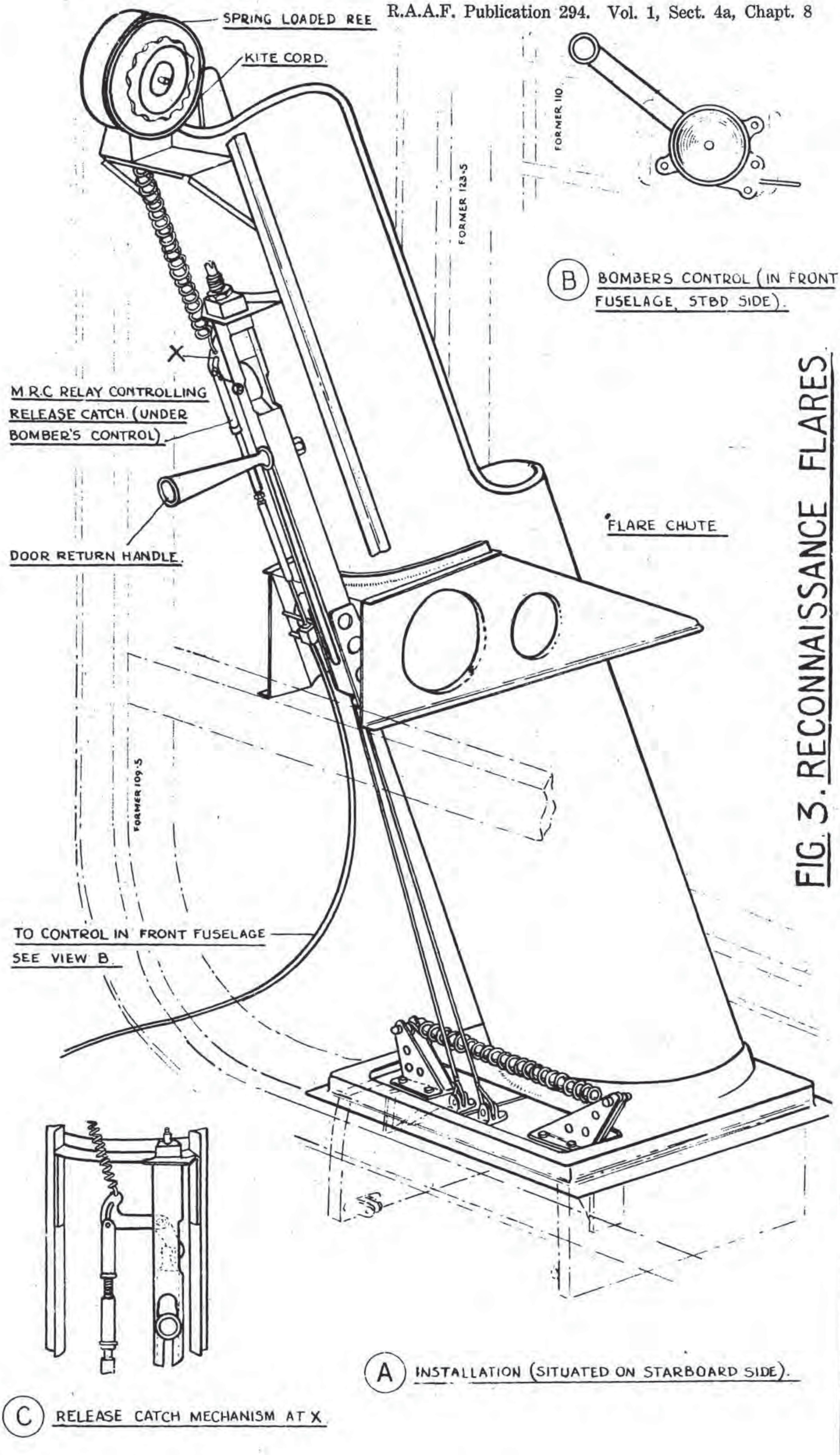


FIG. 3. RECONNAISSANCE FLARES

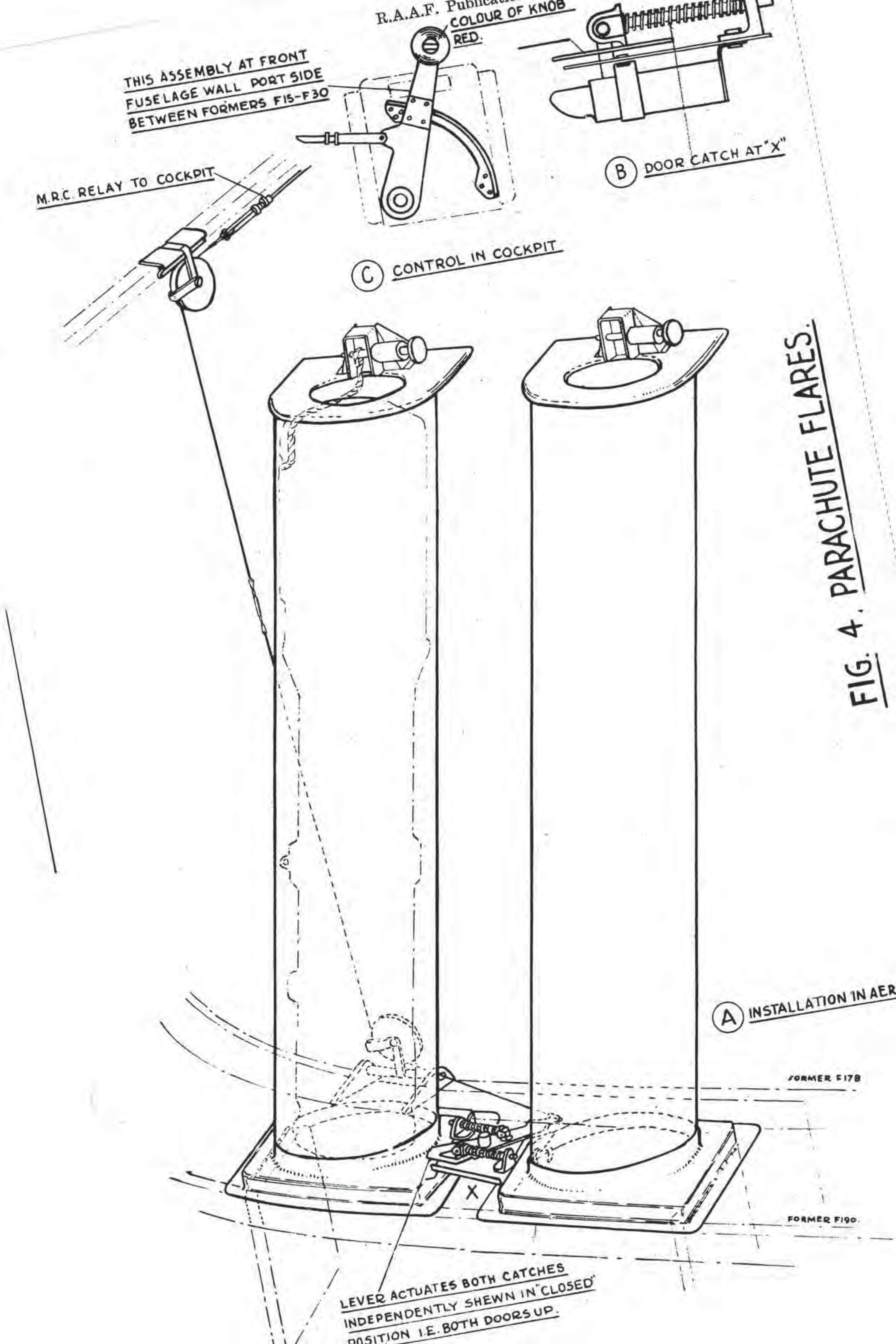


FIG. 4. PARACHUTE FLARES.

CHAPTER 9

CHAPTER 9

MISCELLANEOUS

MAINTENANCE NOTES

1. Recharging pneumatic system air cylinders from outside supply.

   (i) Remove the valve cover and cap from the recharging valve situated on the starboard nacelle on the rear face of the front spar.

   (ii) Connect up the pipe-line from the outside source of supply to the recharging valve.

   (iii) Pump air into the storage cylinder up to about 160 lb. per sq. in. pressure. The maximum pressure is 200 lbs. per sq. in., minimum pressure is 110 lbs. per sq. in.

   (iv) Disconnect the pipe-line from the recharging valve and replace the valve cap and cover.

2. REPLENISHING PNEUMATIC SYSTEM OIL RESERVOIR.

The oil level in the reservoir should be checked periodically. The correct level is to the top of the filler plug. Should oil be found in the oil trap, air filter, or air container, this will denote a loss in the oil reservoir, which should be replenished. It should be noted that the oil reservoir should be replenished with treated castor oil. This oil is also used in the air compressor pump.

3. REMOVAL OF ACCUMULATORS.

(i) Open the lid of the accumulator cupboard.

(ii) Open, as required, the inner and outer front doors of the accumulator cupboard.

NOTE: Before the outer front door can be opened it will be necessary to disconnect and remove the crate carrying either the reconnaissance flares or desert equipment.

(iii) Disconnect the front cable at the top of the accumulators.

(iv) Lift the catch at the front of the tray and pull the tray with accumulator forward about 5 ins. on the slides.

(v) Disconnect the rear cable at the top of the accumulator.

(vi) Complete the withdrawal of the accumulator by lifting it out of the cupboard.

(vii) Connect the loose cables to the dummy terminals provided on the panel behind the accumulators and replace the tray.

4. BONDING.

It is essential that there shall be electrical continuity between parts of the main structure and any secondary members, such as tanks, seats, gun fittings, etc., attached to such parts. Great care must be taken in refitting bonding clamps and clips to metal parts of the aeroplane to ensure that the surface in contact are perfectly clean and free from paint and grease.

When installing the wireless equipment, care should be taken that the following earth connections are securely made, because if they are not made, there will be interference under listening: through conditions:

(i) From the power crate to the main frame.

(ii) From the receiver to the main frame.

(iii) From the neutralising unit to the main earth terminal on former 17.5.

5. ENGINE CYLINDER TEMPERATURE CONSTANT CABLES.

In the event of damage to the special copper constant cables, the damaged cable must be replaced by the correct spare part, otherwise the resistance will be altered and the reading on the pyrometer incorrect. A terminal block is fitted in each circuit on the engine mounting.

6. FUEL AND OIL SYSTEM.

(a) CLEANING FUEL TANKS.

(i) Drain and remove the fuel tanks as described in section 4a.

(ii) Secure the lower arm of the contents gauge unit to the top portion inside the tank.

(iii) Remove the cocks from the sump and plug the holes.

(iv) Clean each tank thoroughly by flushing with filtered petrol.

(v) Remove the plugs from the sump holes and unfasten the lower arm of the contents gauge unit, prior to re-fitting the tank.

(b) CLEANING CARBURETTOR FILTERS.

(i) Remove the lock nut; this releases the filter housing.

(ii) Remove the filter gauze and clean with filtered petrol, dry off with compressed air. (See also para. 16, chapt. 6, sect. 4a.)

(c) CLEANING OIL TANKS AND FILTERS.

(i) Drain the oil tank (as described in section 4a) when the oil is hot, to ensure complete draining.

(ii) Remove the filter (which is in the tank sump) by lifting the rod attached to it, through the top of the tank, and clean with paraffin and finally flush with petrol, dry off with compressed air.

(iii) Remove the oil tank, as described in section 4a.

(iv) Plug all holes in the sump and tank.

(v) Wash out the tank with paraffin and finally flush with petrol.

(vi) Remove the plugs from the holes prior to re-mounting the tank and make sure that all the paraffin and petrol has cleared before filling with new oil.

(d) CLEANING OIL COOLERS.

(i) Drain and remove the oil coolers as described in section 4a.

(ii) Plug the inlet and outlet pipe ends.

(iii) Wash out with paraffin and finally flush with petrol. NOTE: White spirit.

(iv) Remove the plugs from the pipe ends and make sure that no paraffin or petrol remains prior to re-mounting the cooler.

(e) AIR LOCKS IN FUEL SYSTEM.

It is essential that there is no air in any part of the fuel system. Care should be taken that all air is expelled, particularly from the suction balance pipe, after including cleaning of the filters.

(f) To expel the air from the suction balance pipe, proceed as follows:

(i) Shut all fuel cocks.

(ii) Disconnect the suction pipe from the filter to the fuel pump at the filter on one engine.

(iii) Open the suction balance cock.

(iv) Open a fuel cock on the opposite side of the aeroplane to the engine from which the pipe has been disconnected (i.e., with the port engine system disconnected, open a starboard cock).

(v) Wait until fuel flows freely from the filter then, with fuel still flowing, connect the pipe to the filter.

(g) To expel the air from the main fuel system, proceed as follows:

(i) Shut all fuel cocks.

(ii) Disconnect the suction pipe between the filter and the fuel pump at the filter.

(iii) Open a fuel cock on the same side of the aeroplane as the engine from which the pipe has been disconnected.

(iv) Wait until fuel flows freely from the filter and then, with fuel still flowing, connect the pipe to the filter.

7. CLEANING SANITARY CLOSET.

The closet can be moved from the aeroplane by removing the five wing nuts, three at the base and two at the top. Having removed the closet, the tray can be washed down. An outlet for the water is provided.

To clean and recharge the closet, remove the sewerage container, empty it and swill it out. Add ½ to ¾ gallons of water to the container. Add one pint of Elsanol or other suitable liquid, to the water and stir well. Replace the container in the closet.

Care should be taken that the chemical is not exposed to naked light. Always keep excreta covered with liquid; if necessary, add water.

8. SUCTION PUMP: INSTALLING THE PUMP.

Before installing the pump make certain that it can be turned with the fingers; if otherwise, the pump should not be installed. See that the mounting flange and gaskets are clean. A gasket of $^1/_{32}$ in. thick langite or fibre should be placed between the gear housing mounting flange and the mounting flange for the pump; this gasket should be drilled as shown on the inset in Fig. 4. Locate the relief valve in the suction pipe as close to the pump as possible; the screen should face downwards or to one side, and **never upwards.** The valve, which is set for a suction of 5 in. of mercury when installed in the aeroplane, provides approximately 4 in. of mercury at the instruments. The inlet port for the pump for either direction of rotation is marked by arrows on the pump body.

(a) ADJUSTMENTS.

When setting the correct suction for the instruments, be sure that all the instruments are functioning, and that proper provision has been made for lubrication of the pump and gears. Unless the lubrication is adequate, considerable damage may result. The suction should be checked on the suction gauge on the instrument panel. To alter the suction adjustment on the relief valve, loosen the locknut and turn the adjusting nut clockwise to decrease the suction and counter-clockwise to increase the suction. Suction, under pressure loads, should be measured during ground tests, with the engine revolutions at a minimum of 1,000 r.p.m. After five minutes of operation the lubrication of the pump can be checked by placing the hand under the "oil out" connection of the oil separator.

(b) INSPECTION AND MAINTENANCE.

Daily inspection of the suction pump is not required and the pump is capable of operating for considerable periods without special attention. At the appropriate inspection period, the relief valve gauze should be cleaned, and it is recommended that the pump be checked as follows to ensure proper lubrication.

(i) Remove the discharge line from the pump and run the engine for a period of at least 10 minutes at a speed of not less than 1000 r.p.m.

(ii) A piece of white paper held close to the discharge port of the pump will indicate roughly the amount and condition of the oil passing through the pump. This discharge should show a constant deposit of a small quantity of oil as clean as it should be in the engine pressure system. Any scarcity of oil, or oil in a dirty condition, justifies the immediate removal of the pump.

(iii) If a check has disclosed that there is no suction at the instruments, place a piece of white paper over the gauze of the relief valve (while the engine is turning at 1,000 r.p.m.) to check whether the valve is seating properly. In order to clean the relief valve gauze without removing the valve from the suction pipe the gauze should not be dismantled from the relief valve, but should be brushed with a small, stiff brush dipped in petrol.

At the appropriate inspection period, remove the pump from the engine and examine the coupling and drive for wear, and for signs of twisting at the shear section. Check the general condition of the pump by rotating it with the fingers. The pump should turn freely.

9. A.S.I. PRESSURE HEAD POSITION. Refer Fig. 4.

The extreme forward end of the A.S.I. pressure head is 19½ in. from the fuselage nose, or 20½ in. from the forward extremity of the head lamp in the nose, and is offset 2 in. to port of the aeroplane centre line (i.e., 22 in. from a vertical on the fuselage port side former 110). The centre-line of the pressure head is parallel to the datum line of the fuselage. Allowable tolerances are: ½ in. on the linear dimensions and 2° on the angular setting.

10. INSTRUCTIONS FOR REPAIR TO C.I.M.A. PROCESS 397H BEAUFORT FUEL TANKS.

Damage to the C.I.M.A. covering of fuel tanks may occur from various causes, and if the damage to tank is not extensive it can be repaired without difficulty with the C.I.M.A. repair kit supplied, without the return of the tank to the factory.

Damage may occur due to the accidental tearing of the material when being installed in, or removed from, the aircraft, or damage by gunfire or other causes.

In many cases where a fuel tank has been damaged by concentrated gunfire, the tank itself may have become so deformed on the side from which the bullets have made their exit that the internal bracing structure of the tank no longer gives the necessary support, and therefore is unsafe for future use, even if the metal skin can be rendered petrol-tight, and the C.I.M.A. covering repaired.

Cases occur, however, where the damage is not extensive, and the entry and exit holes are such as enable the tank skin to be repaired in the usual manner, and the C.I.M.A. covering renewed in such part so repaired. In such cases it is possible to remove the C.I.M.A. protective covering and effect a repair under these instructions, which will enable the tank to be put into service again.

Where a repair to the metal tank skin by welding is required, it will be necessary to remove all trace of petrol by steaming, or other approved method. The presence, however, of C.I.M.A. protection does not contribute to the difficulty of the process. Provided that the C.I.M.A. material adjacent to the damaged part of the tank is allowed to dry in the open air, there should be no danger of fire due to the welding flame.

Strict cleanliness should be observed in the handling of the materials, and precautions should be taken against them making contact with dust, oil, grease, or any foreign matter that would prevent efficient adhesion required between the various layers.

C.I.M.A. protection service type 397K consists of layers of Dunlopillo C.I.M.A. sponge rubber, vulcanised rubber, and textile netting, all enclosed in a cover of aero fabric, the layers being arranged as follows:

1st layer: FP/2 Dunlopillo applied to tank skin, with the smooth side outward.

2nd layer: FY/2 C.I.M.A. sponge rubber applied, with the vulcanised layer outward.

3rd layer: FU/2 vulcanised rubber.

4th layer: C.I.M.A. FY/2 sponge rubber applied, with vulcanised layer outward.

5th layer: FU/2 vulcanised rubber.

6th layer: FS/2 C.I.M.A. textile netting (leno weave).

7th layer: Aero fabric DTD.407, doped after fitting.

For the purpose of effecting repairs to tanks covered with process 397K, the following equipment and material will be required, except where otherwise indicated:

1. C.I.M.A. FP/2 Dunlopillo, supplied in sheets.
2. C.I.M.A. FY/2 sponge rubber.
3. C.I.M.A. FU/2 vulcanised rubber.
4. C.I.M.A. FS/2 textile netting.
5. Aero fabric DTD.407.
6. Serrated tape DTD.407.
7. Red dope D.T.D.83A.
8. Coloured dope, DTD.63A.

9. Needle and linen thread, spec. 3F34, No. 18s/3, and spec. 3F34 3 cord 40.

10. C.I.M.A. FQ/2 solution.

11. C.I.M.A. cement, D.3639.

12. C.I.M.A. duck, 1/D/44. In certain cases this is substitute for textile netting, and supplies of 1/D/44 will be included in kits. It is dealt with in repair work in exactly the same way as instructions contained herein for the use of textile netting.

13. Scissors, brushes, needle, etc.

(ALL THE ABOVE EQUIPMENT AND MATERIALS ARE CONTAINED IN C.I.M.A. REPAIR KIT.)

397K REPAIR MODIFICATION

Owing to material shortage Neoprene cement FT/w4 may have originally been used on tank skin in place of C.I.M.A. cement D.3639. In this event the use for D.3639 will be unaltered in repair work as per instructions contained herein.

1/D/44R RUBBERISED DUCK

This may be substituted for FS/2 textile netting and/or 1/D/44 unrubberised duck in original covering. For repair work, if 1/D/44 rubberised duck is available, no sewing is required for this layer. The previous layer is covered with FQ/2 solution and left until tacky, when 1/D/44 is applied, with the rubberised side inwards to the rubber, and well pressed down. The duck is doped and the balance of the operation carried out the same as provided for in main instructions.

Repairs to damaged tanks and covers should be effected by patching, and the procedure to be adopted is described in the following subparagraphs.

(i) The fuel should first be drained from the tank and then the damaged portion of the protective covering cut out until the full extent of the damage to the tank is disclosed. The hole cut in the covering should be square or rectangular in shape, and the edges of the various layers should be stepped in order that each layer of the patch, in addition to cementing, can be separately stitched in position where specified to the corresponding layer of the same material on the tank cover.

(ii) The covering should be eased away from the tank in the vicinity of the hole to allow any fuel to evaporate from the rubber layers. The tank shell should then be straightened up as much as possible and the metal tank skin repaired in the usual way.

(iii) In the cutting of patches it is recommended that each patch be at least ½ in. larger than the preceding patch, so that the stitches will not fall on top of each other and cause a ridge, or that the stitching be staggered.

(iv) After thorough cleaning, apply a coating of C.I.M.A. solution D.3639 to the tank skin, cut a patch of FP/2 Dunlopillo to size and insert into hole prepared, and rub out to remove any air bubbles. (NOTE: During this operation it is advisable for the fuel tank to be earthed to to prevent possibility of fire from static electricity generated.) (See illustration No. 1.)

(v) A piece of C.I.M.A. FY/2 sponge rubber should then be cut to fit the hole in the second layer and an application of FQ/2 solution applied to the unvulcanised side of the rubber to within $\frac{3}{4}$ inch of the edge all round, and when tacky placed into position. The joints should now be stitched all round, the pitch of the stitching being approximately five stitches per two inches. (See illustration No. 2).

(vi) The next layer, C.I.M.A. FU/2 vulcanised rubber, should be cut to shape about 1 inch larger than the patch, and one side coated with C.I.M.A. FQ/2 solution. The surface of the C.I.M.A. FY/2 sponge rubber should also be coated with the same kind of solution, and when both are tacky the FU/2 vulcanised rubber should be applied. (See illustration No. 3.)

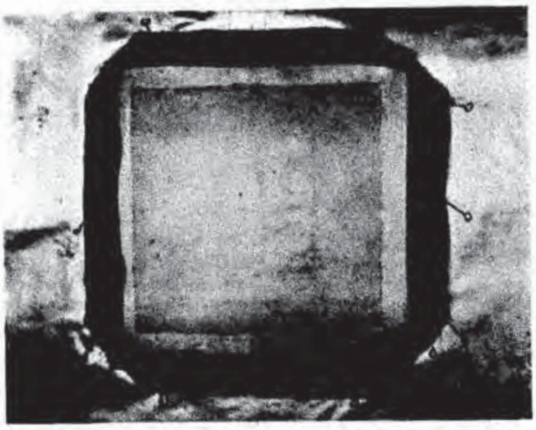
(vii) When the upper one-third is thinned by the omission of certain layers the following will apply: If the damage sustained by the tank is within the lower two-thirds of the tank, the next layer will be C.I.M.A. FY/2 sponge rubber, and a patch of the same material should be cut to shape and then cemented and stitched into position. It is possible that the damage may have occurred at a position at the edge of the sponge rubber, in which case a piece of FY/2 sponge rubber should be cut to the shape of that material which has been removed. (See illustration No. 4.)

(viii) A layer of FU/2 vulcanised rubber should now be cut to shape and solutioned down in a similar manner to the previous layer of the same material. (See illustration No. 5.)

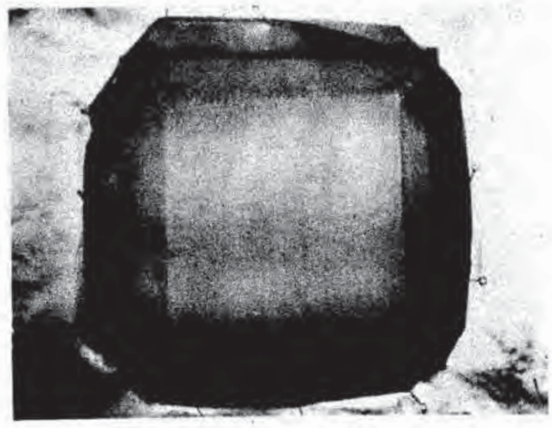
(ix) A piece of C.I.M.A. FS/2 textile netting (leno weave) should then be cut to shape large enough to allow the edges of the netting to be doubled under all round. The netting should be stitched in position, the pitch of the stitching being such that the thread passes through every other hole in the netting, and an application of FQ/2 solution applied. (See illustration No. 6.)

(x) A piece of aero fabric DTD.407 should now be cut to shape and solutioned on one side, allowed to become tacky, and then sewn in position, with the edges of the patch and the cover doubled under, the pitch of the stitching being approximately six stitches to the inch. (See illustration No. 7.)

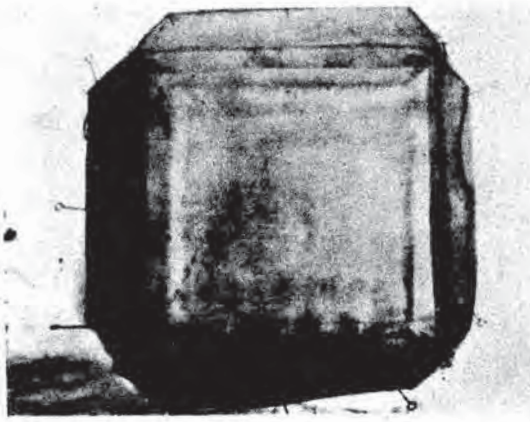
(xi) The stitching should then be covered by means of serrated tape, doped down, and two coats of red dope should then be applied to the patch, and when these have dried, a finishing coat of dope to colour required. (See illustration No. 8.)



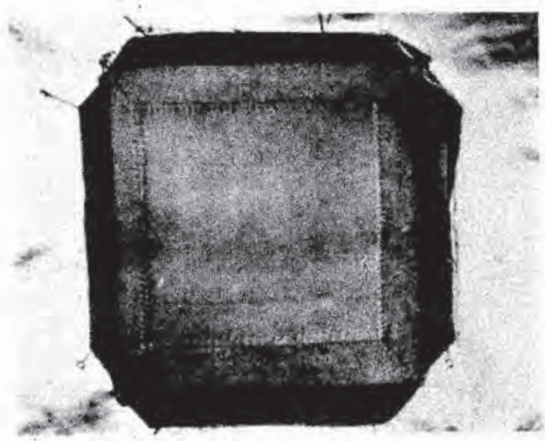
I.—C.I.M.A. FP/2 Dunlopillo cemented into position to tank skin with C.I.M.A. Solution D.3639.



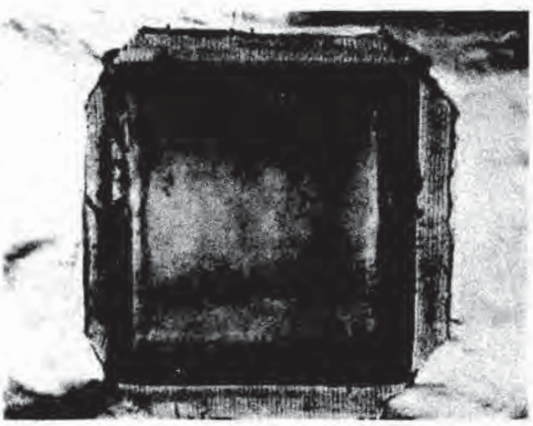
II.—C.I.M.A. FY/2 Sponge Rubber cemented to previous layer and sewn.



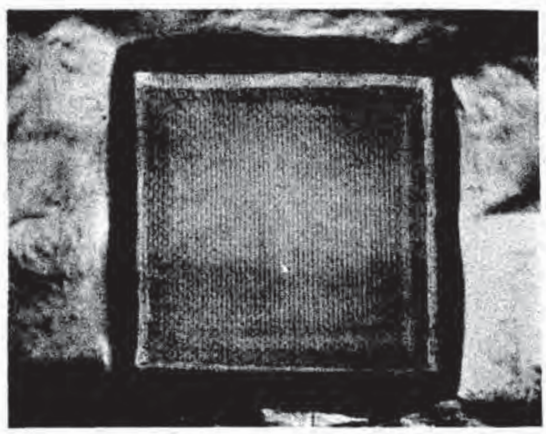
III.—C.I.M.A. FU/2 Vulcanised Rubber cemented into position (must be tacky before applying).



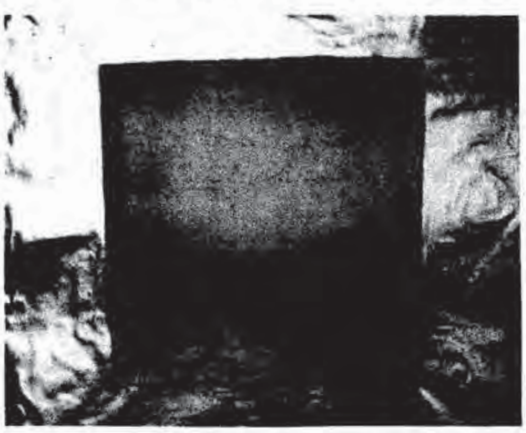
IV.—Second layer of C.I.M.A. FY/2 Sponge Rubber cemented to previous layer and sewn.



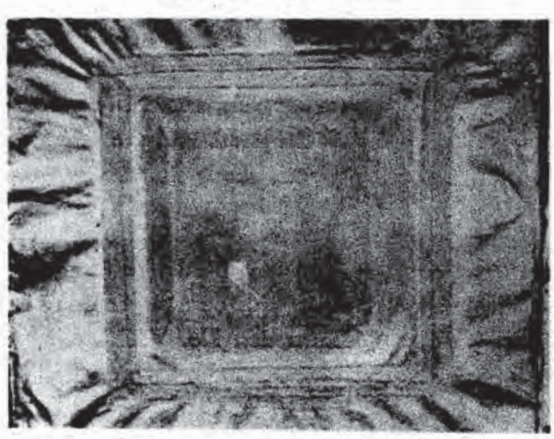
V.—Second layer of C.I.M.A. FU 2 Vulcanised treated as 1st layer of Vulcanised.



VI.—FS/2 Textile Netting sewn into position and then treated with FQ/2 Solution.



VII.—DTD 407 Aero Fabric sewn into position. preparatory to Red doping.



VIII.—Coloured Dope required applied to DTD.407 Aero Fabric after Serrated Tape has been applied over Stitching and Dope.

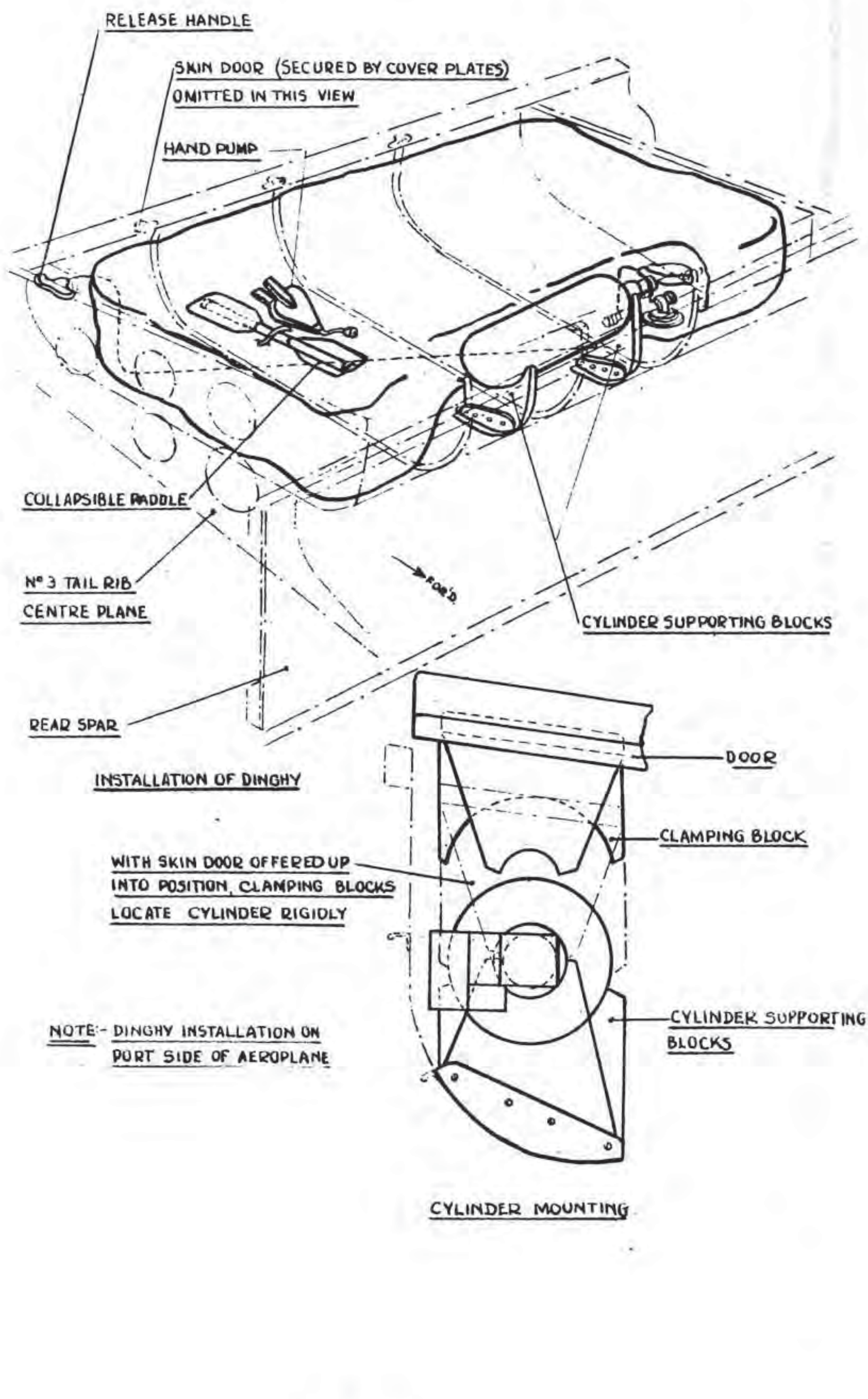

RELEASE HANDLE
SKIN DOOR (SECURED BY COVER PLATES)
OMITTED IN THIS VIEW
HAND PUMP
COLLAPSIBLE PADDLE
Nº 3 TAIL RIB
CENTRE PLANE
FOR'D
CYLINDER SUPPORTING BLOCKS
REAR SPAR
INSTALLATION OF DINGHY
DOOR
CLAMPING BLOCK
WITH SKIN DOOR OFFERED UP
INTO POSITION, CLAMPING BLOCKS
LOCATE CYLINDER RIGIDLY
CYLINDER SUPPORTING
BLOCKS
NOTE:- DINGHY INSTALLATION ON
PORT SIDE OF AEROPLANE
CYLINDER MOUNTING

FIG. 3 .DINGHY

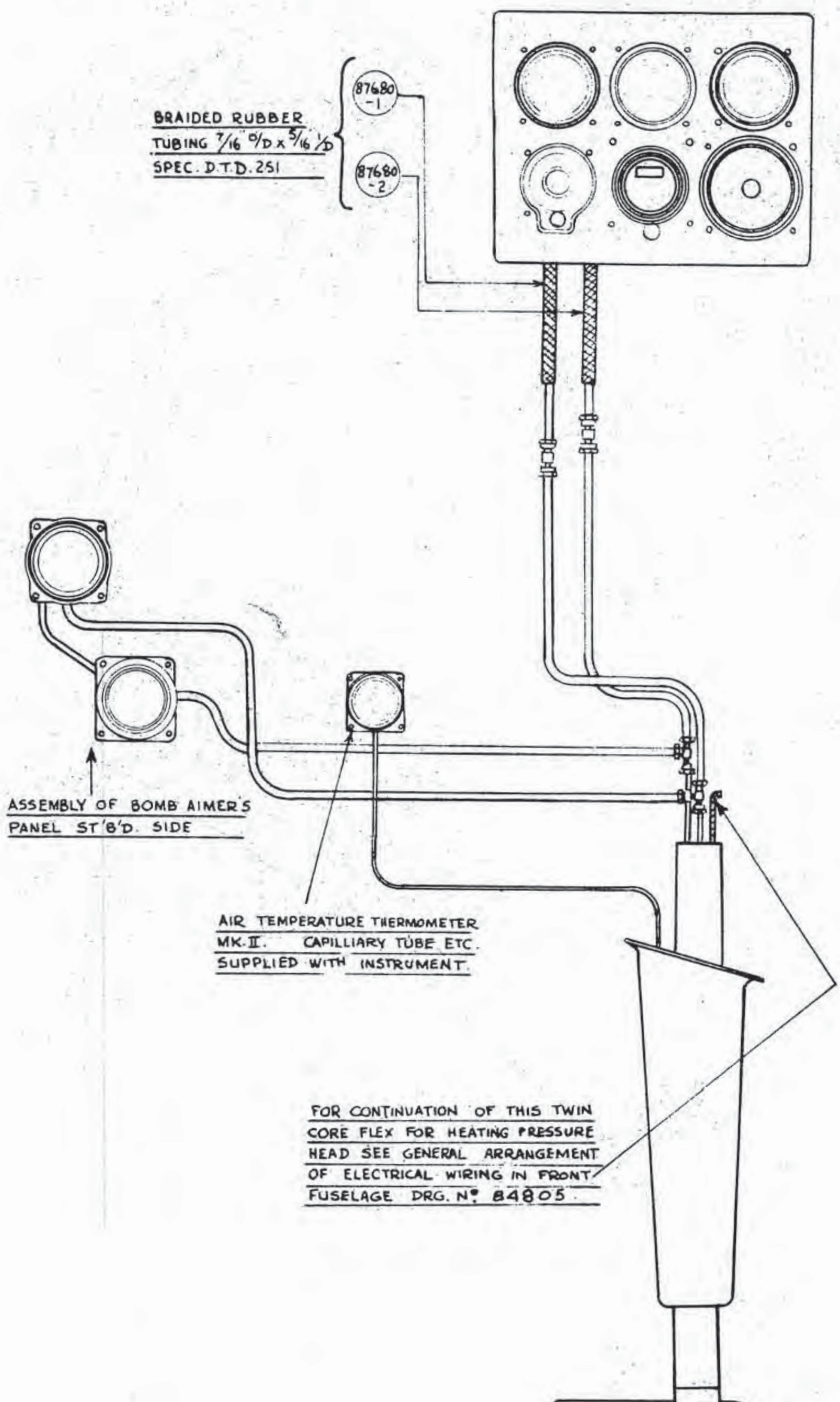


FIG. 4. DIAGRAM OF PRESSURE HEAD & SYSTEM

SECTION 5

REMOVAL AND ASSEMBLY OPERATIONS

SECTION 5

REMOVAL AND ASSEMBLY OPERATIONS

CHAPTER 1

CHAPTER 2

ASSEMBLY OF AIRFRAME

ILLUSTRATIONS

CHAPTER 1

1. REMOVAL.

(a) INTRODUCTORY.

Trestling and jacking arrangement are shown in Fig. 1. The positions recommended for trestles are painted in black on the underside of the various components. Inspection and access doors are indicated in the relevant illustration in Sec. 4, Chap. 1. Dismantling operations are described for the major structures and components. The sequence of operations for assembly is usually the reverse of that for the other.

2. DISMANTLING SEQUENCE.

After draining the fuel tanks (see Para. 9), the oil system (see Para. 9), and the hydraulic system (see Sec. 4A, Chap. 4), the sequence for dismantling the aeroplane is as follows:—

(i) Airscrews.
(ii) Engines and cowling.
(iii) Outer main planes with flaps, ailerons, and tabs attached.
(iv) Stern frame and tail unit.
(v) Bomb cell doors and skirts.
(vi) Front fuselage.
(vii) Engine driven accessories and nacelle fairings.
(viii) Undercarriage.
(ix) Rear fuselage.
(x) Centre plane.

(a) AIRSCREWS — REMOVAL.

(i) Remove brush holder from slip ring housing.
(ii) Remove spinner.
(iii) Detach power unit by removing hold down studs.
(iv) Remove internal spring loaded adaptor lock.
(v) Insert four foot bar, and screw off propellor nut, thereby removing propellor from propellor shaft.

(b) CAUTION.

(vi) Upon removing propellor, be careful not to damage threader portion of propellor shaft.
(vii) For details of installation refer to Chapter 2 and Maker's Handbook.

(c) ENGINE AND COWLING REMOVAL.

(i) Remove all cowls with the exception of the nose cowl and the cowl gills, situated at the rear of the engine cowl ring, as these may be more readily removed after engine has been detached from the aircraft. For removal of cowl gills (electric) refer Section 8.

(ii) Disconnect all controls, fuel, and oil lines, capillary runs, pressure lines, and the accessory gearbox drive and electrical and magneto connections. Attach lifting tackle as per Pratt & Whitney instructions. Lift engine per medium of a suitable hoist sufficient to enable engine bolts to be withdrawn. (WARNING: Do not lift any further than stated, as this will achieve no useful purpose, but will possibly strain the aircraft and engine mounting structure.)

(iii) After removal of the engine bolts, the engine and mounting may be broken away from the bulkhead.

(d) **OUTER PLANE — COMPLETE.**

REMOVAL.—It will facilitate the removal of the outer plane if the fuel tank is first removed (see Para. 9). Whether the fuel tank is removed or not, the screws securing inboard side of the tank skin to the centre plane must be removed.

(i) Remove the junction covers and the doors over the aileron and flap controls between the centre plane and the outer plane.

(ii) Disconnect the aileron and flap control cables at the turn-buckles, which are now accessible.

(iii) When the starboard outer plane is being removed, disconnect the aileron trimming tab cables at the turn-buckles. Remove the cable guard from the aileron tab pulley bracket, situated at the inboard end of the outer plane rear spar, by removing the nut from the pulley bolt. Remove the cables from the pulleys by slipping the pulley from the bolt. Replace the pulley, guard, and nut; also disconnect pneumatic lines to wing gun.

(iv) When the port outer plane is being removed, uncouple the landing lamp cable and the pneumatic system pipes.

(v) Disconnect the electrical connection at the terminal blocks situated at the ends of the centre plane adjacent to the top of the front spar.

(vi) Remove the bolts connecting the outer plane webs to the centre plane webs.

(vii) Remove the joint fitting bolts, two at each spar.

(e) **OUTER PLANE FLAP.**

(i) Remove the bolt securing the link to the flap control lever.

(ii) Remove the bolts securing the flap control lever, hinge to the quadrant support bracket, if necessary.

(iii) Remove the screws from the entire length of the flap hinge.

(iv) Remove the flap.

(f) **AILERON.**

(i) On the starboard side, disconnect the trimming tab cables, at the turn-buckles, through the inspection door. Aft of rear spar outboard of root fittings.

(ii) On the starboard side, remove the cable guards from the two pulley brackets by removing the quick release pins; remove the cables from the pulleys and replace the guards.

(iii) Depress the leading edge of the aileron.

(iv) Disconnect the lower end of the control link from the aileron master actuating lever.

(v) Remove the split-pin and the nuts that hold the three bearing housings into their female portions on the outer plane ribs.

(vi) Remove the aileron.

(g) **AILERON TRIMMING TAB (PORT).**

REMOVAL:

Remove the screws securing the tab to the aileron and remove the trimming tab.

(h) **AILERON TRIMMING TAB (STARBOARD).**

REMOVAL:

Remove the split-pin, collar, shims, and pin from the trimming tab lever, and remove the screws securing the tab hinge to the aileron.

ASSEMBLING:

When assembling the tab to the aileron, ensure that there is an equal length of chain on each side of the sprocket, with the tab in the neutral position.

(i) **WING TIPS.**

REMOVAL:

Disconnect the electrical cables at the terminal blocks on rib 17, through the inspection door; remove the screws along the joint to the outer plane, and remove the wing tip.

3. **STERN FRAME AND TAIL UNIT.**

(a) **STERN FRAME.**

REMOVAL:

(i) Remove the transverse members from the flare crate on the starboard side just aft of the gun turret to permit access to the aft end of the rear fuselage.

(ii) Uncouple the hydraulic pipes and electrical cables situated on the starboard side at the stern frame joint.

(iii) Uncouple the elevator and rudder control cables at the countershaft levers.

(iv) Uncouple the four trimming tab cables at the turn-buckles.

(v) Remove the set screws securing the forward end of the stern frame to the rear fuselage.

(vi) Remove the stern frame.

(b) **RUDDER**

REMOVAL:

(i) Disconnect the electrical leads at the terminal blocks at the front of the stern post.

(ii) Uncouple the rudder cables at the rudder levers.

(iii) Uncouple the trimming tab control at the rear end of the breeze unit.

(iv) Withdraw the bolts from the top and bottom hinges.

(v) Remove the rudder.

(c) **RUDDER TRIMMING TAB.**

REMOVAL:

(i) Disconnect the trimming tab control at the lever.

(ii) Remove the split-pin and nut from the bolt at either end through the hinge pin.

(iii) Remove the trimming tab by sliding the bolts along the slots, thus withdrawing the hinge pin from the bearings.

(d) **FIN.**

REMOVAL:

(i) Remove the wood screws securing the acetate fillet.

(ii) Remove the detachable panel at the rear end of the fin.

(iii) Disconnect the wireless aerial from the fin attachment.

(iv) Remove the metal fairing on the stern post.

(v) Remove the four bolts securing the fin to the stern post.

(vi) Remove the attachment bolts securing the fin to the tail plane.

(vii) Remove the fin.

(e) **ELEVATORS.**

REMOVAL:

(i) Disconnect the flexible drives in the elevators from the trimming tab actuators.

(ii) Uncouple the control tube from the central lever.

(iii) Unbolt the two halves of the lever, thus separating the port and the starboard elevators.

(iv) Remcve the forward bolts cn the outer hinges.

(v) Remove the elevators.

NOTE.—Care should be taken when assembling elevators that there is no end play at the spar end bearings. If necessary, adjustment can be made by fitting a shorter distance between operating levers. Five distance tube lengths are provided, giving a tolerance of nominal to minus 0.040 ins.

(f) **ELEVATOR TRIMMING TABS.**

REMOVAL:

This is the same as for the rudder trimming tab (see Para. 3C).

REMOVAL:

(i) Remove the screws in the acetate fillet from the stern frame on the underside of the tail plane.

(ii) Remove the stiffening brackets, port and starboard, between the tail plane and the stern frame.

(iii) Slacken the elevator trimming tab cables off in the stern frame by means of the turn-buckles.

(iv) Remove the bolt supporting the double sprocket of the trimming tab controls on the underside of the tail plane.

(v) Remove the double sprocket assembly, and slip off the chain that runs into the stern frame.

(vi) Temporarily replace the double sprocket assembly.

(vii) Remove the two front attachment bolts and the bolt at the rear, connecting the tail plane to the stern frame.

(viii) Remove the tail plane.

(g) **TAIL WHEEL UNIT.**

REMOVAL:

(i) Remove the set screws securing the acetate casing. (The tail wheel should be in the down position.)

(ii) Remove the two top bolts from the tail wheel anchorage.

(iii) Uncouple the two hydraulic pipes at the jack.

(iv) Remove the four bolts securing the tail wheel unit to the formers 308.5 and 310.5.

(v) Disconnect the connecting rod of the electrical switch mechanism for the position of the indicator.

4. BOMB CELL DOORS AND SKIRTS.

(a) **BOMB DOORS** (Refer Fig. 1).

REMOVAL:

(i) Remove the three bolts connecting the two levers from the bomb door and flaps to their connecting lever situated at both ends of the doors, port and starboard.

(ii) Remove the pin, port and starboard, connecting the lower end of the electrical safety switch link to the bracket at the forward end of the doors.

NOTE.—Para. 4, Part (ii) affects aircraft fitted with tumbler switches, as micro-switches are incorporated from aircraft 83 onwards.

(iii) Remove the pin connecting each end of the doors, two to the front fuselage and two to the rear fuselage.

(iv) Remove the bomb doors.

(b) **BOMB CELL SKIRTS.**

REMOVAL:

(i) Remove the set screws from along the top edge and both ends of bomb skirts.

(ii) Remove the six bolts at the top of each of the three formers on the bomb skirts, port and starboard, which connect to the inner box rib of the centre plane.

(iii) Remove the bomb cell skirts.

5. **FRONT FUSELAGE.**

(a) **FRONT FUSELAGE.**

REMOVAL:

(i) Remove the floor and the conduit covers on the starboard side, also the guard over the hydraulic pipes at the navigator's seat.

(ii) Disconnect all pipe lines control cables, electrical wiring, and M.R.C. junctions between the front fuselage and the rear fuselage or the centre plane. The capillaries for the oil pressure and temperature lines cannot be disconnected, and, therefore, the instruments must be removed from the panel and the leads coiled and stowed carefully.

(iii) To disconnect the air intake and supercharger ratio controls, disconnect both ends of the system and pull the inner core into the front fuselage through the conduit until the free end has passed the conduit junction between the front fuselage and centre plane, and carefully stow the free inner core.

(iv) To disconnect the variable pitch control, disconnect both ends and pull out the inner core at the engine end until the free end has passed from the front fuselage into the conduit in the centre plane. Carefully stow the free inner core.

(v) Remove the hydraulic tank from its mounting.

(vi) Remove the following connections to the front spar:—

(a) The two bolts connecting the pilot's seat.

(b) The two bolts connecting the engine control structure.

(c) The nine bolts connecting the controls relay post.

(d) The bolt connecting the front spar bracing tube.

(vii) Remove the screws from the forward length of fillet at the junction of the front fuselage, and the centre plane. This fillet partly overlaps on the rear fuselage.

(viii) Remove the main bolt, port and starboard, adjacent to the lower boom of the front spar, which connects the inner box rib of the centre plane to the front fuselage.

(ix) Remove the front fuselage after removing 2 B.A. screws from butt joint.

6. ENGINE NACELLE FAIRING STRUCTURE ACCESSORY GEAR BOX AND ACCESSORIES.

(i) Remove all nacelle fairings.

(ii) Detach accessory gear box by removing the four locating bolts.

(iii) Remove engine bulkhead and engine adaptor structure, taking care to disconnect all capillary and pressure lines, etc., and carefully coil and stow all capillary lines in a convenient and safe place in the centre plane.

(iv) Disconnect hydraulic lines as required, but be CERTAIN to blank off all lines, and so prevent ingress of foreign matter or dirt into the lines.

(v) Remove the main tubular nacelle structure by removing the nacelle structure attachment bolts located in the wheel well in the centre plane at rear of the bulkhead.

7. UNDERCARRIAGE.

(a) REMOVAL.

(i) Uncouple the hydraulic ram piston attachment from the oleo frame. (The undercarriage should be in the down position.)

(ii) Uncouple the ground safety lock on the starboard oleo frame.

(iii) Uncouple the pneumatic brake connection.

(iv) Remove the bolts from the upper and lower end of the radius rods.

(v) Remove the bolts from the top points of the oleo legs.

(vi) Disconnect the remaining structure attached to the centre plane and the nacelle structure.

8. REAR FUSELAGE, COMPLETE WITH TURRET.

(a) REMOVAL.

(i) Disconnect the stern frame, complete with tail unit (see Para. 13).

(ii) Disconnect the front fuselage (see Para. 5a).

(iii) Remove the bomb doors and skirts (see Paras. 4a and b).

(iv) Remove the centre plane with complete outer plane attached (see Paras. 4 and 5).

(v) Remove the rear fuselage.

(b) **TURRET GUN.**

REMOVAL FROM TURRET.

(i) Unscrew and withdraw the plug from the reflector sight cable on the right hand side of the head of the central pivot. The reflector sight may be removed from the gun by unscrewing the nut from the bracket attaching it to the gun and sliding the bracket out of the dove-tailed slot.

(ii) Disconnect the gun-firing cable from the end of the actuating lever at the rear of the gun.

(iii) Remove the quick-release pin at the front.

(iv) Loosen the wing nut on the rear attachment bolt.

(v) Slide the gun forward and towards the right until the lugs are clear of the rear fitting, and remove the gun.

(c) **TURRET.**

REMOVAL:

(i) Remove the top fairing forward of the turret by withdrawing the mushroom headed fixing screws.

(ii) Remove the gun from the turret (see Para. 8B).

(iii) Elevate the gun chassis to its fullest extent.

(iv) Remove the two nuts that attach the cupola to the turret frame, after first removing the protecting caps.

(v) Disconnect the empty cartridges case container from top support brackets by withdrawing the two fixing bolts.

(vi) Lift the cupola, with the empty cartridge case container attached, from the turret.

(vii) Disconnect the piston rod of the turret rotating jack from its driving link by removing the pin after withdrawing the locking screw.

(viii) Remove the external hydraulic pipes from the swivel feed unit at the base of the turret. This operation necessitates the removal of the trap door in the rear torpedo cell below the turret.

(ix) Remove the four fixing bolts below the cable drum to disengage the turret from its floor attachment.

(x) Disconnect the electrical cables to the gun sight and camera gun from the bracket support tube between the upper pivot bearing and the aeroplane structure.

(xi) Remove the five bolts attaching the support tube aeroplane structure.

(xii) Remove the turret from the aeroplane.

9. FUEL AND OIL TANKS.

(a) FUEL TANKS.

Draining and Removing:

(i) Remove the nacelle fairings and the inspection door adjacent to the fairing under the centre plane.

(ii) Close the tank cocks by operating the controls in the cockpit.

(iii) On the aft side of the engine bulkhead, disconnect the superflexit pipe from the adaptor to the filter, open the tank cocks and, when the tanks have drained, turn the cock off.

(iv) For the outer tank, disconnect the superflexit at the superflexit pipe at the sump end and, for the inner tank, disconnect the superflexit pipe where it picks up on the underside of the tank.

(v) Disconnect the vent pipes; access to these is provided by inspection doors on the top of the centre and outer plane.

(vi) Disconnect the cock controls for the inner and outer tanks, the inner tank at the lever projecting through the tank door on the underside of the centre plane, and the outer tank at the cock on the inboard side of the tank.

(vii) Disconnect the fuel gauge, electrical wiring from the tank attachment, accessible through the doors on the top of the centre and outer plane.

(viii) Disconnect the bonding wires at the setscrews on the clips fixed to the fillercap base, accessible through the doors provided for re-fueling.

(ix) Remove the setscrews round the edges of the panels on the underside of the centre and outer planes, and then main bolts through the brackets on the front and rear spars. During this operation suitable support must be placed under the panels in line with the tank bearers to take the weight of the tanks.

(x) Lower the tank to the ground and release the securing straps.

(b) OIL TANKS.

Draining and Removing:

(i) Drain the tank by unlocking and opening the cock in the bottom of the main feed pipe aft of the engine bulkhead.

(ii) Remove the panel on the centre plane below the oil tank, and also the nacelle outboard fairing.

(iii) Uncouple the pipe connections and the bonding wires to the tank. The vent pipe and bonding wires are accessible through doors on the top of the centre plane.

(c) **OIL COOLER.**

REMOVAL:

(i) Remove the fairing between nose ribs 1 and 4 by removing the screws.

(ii) Disconnect the two pipe connections to the cooler.

(iii) Slacken the straps at the inner and outer ends of the cooler assembly and slide them into the ducts.

(iv) Disconnect the bolts and nuts attaching the cooler assembly to the lower end of the support struts.

(v) Remove the cooler.

(d) **AUXILIARY FUEL TANK.**

INSTALLING:

(i) Attach the two rear cradles to the four lugs, with bolts (these lugs are permanent fittings).

(ii) Attach the additional two lugs (part No. 86075) with bolts to the underside of the front spar, and mount the front cradle.

(iii) Remove the blanking caps from their connecting points on pipe Nos. 73, 74 and 75 (see the relevant illustration Figs. 26 and 27, Chap. 6, Section 4A).

(iv) Fit pipes Nos. 73, 74, and 75.

(v) Strap the tank, complete with fittings, in position on the three cradles.

(vi) Wire up the electrical fuel contents gauge from the terminal blocks adjacent to the gauge and above the floor near the tank.

(e) **REMOVAL.**

(i) Close the cocks of the inner and outer tanks (if these cocks are left open the other fuel tanks can drain through the auxiliary tank).

(ii) Open the drain cock on the auxiliary tank and drain the cock.

(iii) Remove pipes Nos. 73, 74, and 75 (see the relevant illustrations in Figs. 26 and 27, Chap. 6, Section 4A).

(iv) Replace the blanking caps where pipes Nos. 73, 74, and 75 connect.

(v) Remove the cables (described in Para. 9D, sub-Para. vi).

(vi) Disconnect the straps and lower the tank.

(vii) Remove the three cradles.

(viii) Remove the two forward lugs only.

10. CENTRE PLANE.

REMOVAL:

The following operations must be carried out for the removal of the centre plane:—

(i) Removal of airscrews (refer Sec. 5, Chap. 1, Paras. 2A and 2B).

(ii) Engines and cowling (refer Sec. 5, Chap. 1, Para. 2C).

(iii) Outer main planes with flaps, ailerons, and wing tips attached (refer Sec. 5, Chap. 1, Para. 4).

(iv) Bomb cell and skirts (refer Sec. 5, Para. 4, Chap. 1).

(v) Removal of front fuselage (refer Sec. 5, Chap. 1, Para. 5).

(vi) Removal of rear fuselage (refer Sec. 5. Chap. 1, Para. 8A).

11. MISCELLANEOUS.

(a) INSTALLING DUAL CONTROLS.

GENERAL.—When dual is fitted, the back of the navigator's seat is folded down and forms a step of the dual control seat.

(b) RUDDER, ELEVATOR, AND AILERON CONTROLS.

The control column and the rudder pedals for the second pilot are mounted as a unit on a platform casting, and are inter-connected with the controls for the first pilot. The following is the procedure of assembly:—

(i) Pass the main unit through the hinged roof door and locate the rear adjustable pegs on the slotted brackets on the starboard wall of the front.

(ii) Drop the mounting floor in position, connect up the elevator torque tube to both the normal and dual control columns. Fix the floor by means of the adjustable screws, and lock them.

(iii) Fit the rudder connecting tube to the normal and dual control relay levers. Adjust the connecting rod so that both the normal and dual rudder pedals are in their neutral positions.

(iv) Set both wheel controls neutral, connect up the aileron chain to the aileron relay sprockets. The dual control aileron relay chain is adjustable by means of turn-buckles.

(c) DUAL CONTROL SEAT.

To fit the dual control seat on the starboard side, proceed as follows:—

(i) Attach the vertical tubular structure to the points on the torpedo cell.

(ii) Attach the seat and top tubular structure to the formers Nos. 30 and 46 at the fuselage side.

(iii) Join both the tubular structures together with the bolts and nuts provided.

(iv) Add the cushion and cover.

(d) RUDDER MASS BALANCE WEIGHT.

REMOVAL:

Remove the inspection door situated between ribs 2 and 3; remove the five nuts securing the balance weight, and remove the balance weight.

12. FIXED GUN (PORT OUTER PLANE)

REMOVAL:

(i) Remove the panel in the top surface of the outer plane by releasing the fasteners.

(ii) Remove the two screws securing the blast tube to the leading edge.

(iii) Slacken the wing bolt at the gun end of the blast tube.

(iv) Remove the blast tube by sliding it out through the leading edge.

(v) Release the spring catches on the feed neck and hinge the feed neck away

(vi) Disconnect the pneumatic system at the fire-and-safe unit.

(vii) Remove the four wing nuts, one at each end of the support tubes.

(viii) Remove the gun mounting by lifting them clear of the holding-down studs, lifting the aft end of the mounting clear of the outer plane, and withdrawing aft over the rear spar.

(ix) The gun now can be removed from the mounting by removing the two T-head bolts.

(b) **FIXED GUN (STARBOARD OUTER PLANE).**

REMOVAL:

This operation is the same as that for the removal for the gun in the port outer plane.

13. ENGINE DRIVEN ACCESSORIES.

(a) **GENERATOR (STARBOARD ENGINE).**

REMOVAL:

(i) Slacken the jubilee clips on the hose connecting the cooling duct to the generator.

(ii) Remove the rubber hose.

(iii) Disconnect the cable from the terminal block on top of the generator.

(iv) Connect the loose cable to the dummy terminal block on face of the engine bulkhead.

(v) Remove the four nuts securing the generator to the gear box.

(vi) Remove the generator.

(b) **REPLACEMENT.**

(i) Clear the joint faces and apply approved jointing compound.

(ii) Assemble the generator to the drive.

(iii) Replace the washers and nuts, and securely tighten.

(iv) Replace the connecting rubber hoses and tighten the jubilee clips.

(v) Connect the electric cables to the appropriate coloured terminals.

(c) **SUCTION PUMP (BOTH ENGINES).**

REMOVAL:

(i) Disconnect all pipes from the pump.

(ii) Remove the six nuts securing the pump to rear face of gear box.

(iii) Withdraw the pump.

(d) **REPLACEMENT.**

(i) Clean the joint faces and apply approved jointing compound.

(ii) Assemble the pump to the drive.

(iii) Replace the washers and nuts, and securely tighten.

(iv) Refit all pipes in their original positions.

(e) **B.T.H. AIR COMPRESSOR (STARBOARD ENGINE).**

REMOVAL:

(i) Slacken off jubilee clips holding hose connecting cooling duct to compressor.

(ii) Remove rubber hose.

(iii) Disconnect flexible delivery line between compressor and bulkhead adapter.

(iv) Remove the six nuts securing the compressor to the gear box.

(v) Withdraw the compressor.

(f) **REPLACEMENT.**

(i) Clean the joint faces and apply approved jointing compound.

(ii) Assemble the compressor to the drive.

(iii) Replace the washers and nuts, and securely tighten.

(iv) Refit the delivery pipe.

(v) Assemble the cooling duct.

(g) **HYDRAULIC SYSTEM PUMP (PORT ENGINE).**

REMOVAL:

(i) Disconnect all oil pipes from the pump.

(ii) Remove the six nuts securing the pump to gear box.

(iii) Withdraw the pump.

(h) **REPLACEMENT.**

(i) Clean the joint faces, and apply approved jointing compound.

(ii) Assemble the pump to the drive.

(iii) Replace the washers and nuts, and securely tighten.

(iv) Refit all pipes in their original positions.

(i) **ENGINE SPEED INDICATOR GENERATORS (PORT AND STARBOARD).**

REMOVAL:

Disconnect the electrical connections, remove the flexible drive from engine to tacho-generator, remove tacho-generator from the engine mount structure.

(j) **INSTALLATION.**

Reverse the removal procedure for installation. Keep flexible drive shaft well greased and free from kinks.

CHAPTER 2

ASSEMBLY OF AIR FRAME (Refer Fig. 6)

1. PREPARATION OF COMPONENTS.

(a) **CENTRE PLANE.**

The following are the finished sizes after bushing and reaming and of all attachment points on the centre plane:—

Rear fuselage attachment points on C/F.:—

$\frac{1}{2}$ in. B fit—6 points (4 lugs and 2 forks).

Front fuselage attachment points on C/F.:—

$\frac{1}{2}$ in. B fit—2 points (2 forks).

Spar end root fittings:—

1 in. B fit—8 points.

(b) **REAR FUSELAGE.**

Finished sizes of rear fuselage attachment points are as follows:—

Attachment points, rear fuselage to C/P.:—

$\frac{1}{2}$ in. B fit—6 points (4 forks and 2 lugs).

NOTE.—Butt strap joint to front fuselage with cheese-headed screws and elasta nuts, after necessary fitting of front fuselage.

(c) **FRONT FUSELAGE.**

Finished sizes of front fuselage attachment points after bushing and reaming:—

17/32 in. B fit—2 points (2 lugs).

NOTE.—Refer NOTE, Para. (b).

(d) **STERN FRAME.**

Finished sizes of stern frame attachment points after bushing and reaming:—

$\frac{1}{2}$ in. B fit—1 point.

$\frac{3}{8}$ in. B fit—3 points.

NOTE.—Stern frame is butt jointed and strapped to rear fuselage by cheese-headed screws and elasta nuts.

(e) **TAIL PLANE.**

Finished sizes of tail plane attachment points after bushing and reaming:—

Attachment points to stern frame:—

$\frac{1}{2}$ in. B fit—1 point (lower surface).

$\frac{3}{8}$ in. B fit—3 points (lower surface).

Attachment points to fin:—

$\frac{1}{2}$ in. B fit—1 point (upper surface).

$\frac{3}{8}$ in. B fit—3 points (upper surface).

(f) **FIN.**

Finished sizes of fin attachment points after bushing and reaming:—
Attachment points to upper surface of tail plane:—

½ in. B fit—2 points (rear lugs).
⅝ in. B fit—2 points (front forks).

(g) **WINGS (PORT AND STARBOARD).**

Finished sizes of wing attachment points after bushing and reaming:—
Attachment points to centre plane:—

1 in. B fit—8 points (upper 4 points, forks; lower 4 points, lugs).

(h) **RUDDER.**

Fitting of rudder bearing blocks until high spots are removed and bearings revolve freely; check alignment, as supporting sections may have to be eased.

(i) **ELEVATORS.**

Fit bearing blocks until high spots are removed and bearing revolves freely. Elevators must be fitted to drop under their own weight.

(j) **AILERONS.**

Ready as delivered, but certain points need to be checked. Refer "Assembly of Airframe."

(k) **INSTALLATION OF DATUM PEGS.**

This operation must be performed while plane is in the jigs (either fixed or portable), and if necessary can be carried out on adjustable assembly trestles. (NOTE.—If latter method is used, aeroplane must be completely assembled before an attempt is made to carry out this operation. Levelling for datum pegs is located from datum line to top of peg. Four formers back from top rear attachment lugs is the position of front pegs. Rear datum pegs are located six formers forward from rear end of rear fuselage.)

(l) **OPERATION.**

Rivet one side on front, clamp opposite peg, and level between port and starboard before riveting other peg. The rear pegs are clamped on both sides and tested for level, port and starboard, and fore and aft, before riveting. Check with clinometer and rivet remaining pegs.

(m) **NOTE** (Special Tools).

The following special and standard reamers are required for final cleaning out of all attachment-hole bushes:—

½ in. reamer, standard.	17/32 in. reamer, standard.
⅝ in. reamer, standard.	1 in. reamer, ACT 45507.

2. SUB-ASSEMBLY.

(a) TAIL UNIT ASSEMBLY.

After preparation of all components in this sub-assembly, the shop method is to fit tail plane and fin on stern frame; but in the field this is not necessary, as all checking can be done by joining the stern frame and tail plane together as detailed below.

OPERATION.—Fit shackles to two front lugs on lower surface of tail plane. Locate tail plane with temporary pins, then fit rear bolts with necessary shimming between lugs on tail plane and forks on stern frame to take up any side play. Fit front bolts alternatively (port and starboard), and if necessary place shims between shackles and front lugs on stern frame. Drill for 1/16 in. split pin after assembly, and pin.

NOTE.—When fitting bolts in front positions, place a cover plate over former opening to avoid dropping bolts into inaccessible places.

NOTE.—**INSTALLATION OF TRIMMING CONTROLS IN TAIL PLANE:** Flexible shafts are first coupled to unit and locked. Unit is then dropped into position in tail plane. Endless chain is fitted on the double sprocket; also the breeze chain is attached. Guards are placed in position and spindle bolted and drilled for split pin.

(b) WINGS, PORT AND STARBOARD.

Fit wing and acetate tips and ailerons. Prior to fitting ailerons, check bearings at attachment points for freedom of movement; also trim cables for correct attachment, the latter being fitted to starboard only. Fit landing lamps in port wing only.

3. ASSEMBLY OF AIR FRAME.

(a) Place centre plane in jig; if unavailable, mount on adjustable trestles. In latter case, rig centre plane in flying position by use of spar datum lines and centre plane incidence boards.

NOTE.—If centre plane is supplied already bushed and reamed to finished size, it cannot be placed in jigs.

(b) Rear fuselage is next joined up to centre plane at 6 points, floor or rear fuselage is fitted on top of centre plane floor, and bolted with cheese-headed screws and elasta nuts, the heads being in the bomb cell. Attachment bolts are tightened from the inside and are split-pinned with $\frac{1}{8}$ in. pins.

(c) Front fuselage is placed in position and connected with temporary bolts with skin faces butting; front and rear fuselage are then clamped together. Inclination of front fuselage is then checked by clinometer and straight edges (3 off), on small blocks on lower sill tubes on side emergency escape windows. (NOTE.—It is necessary to remove the windows.)

Tolerances: + Up 15′ minutes; — Down 0 minutes.

NOTE.—Desired inclination is approximately 5′ to 10′ minutes. It is necessary to fit butt joints to obtain necessary reading; 1/16″ removed from this joint equals approximately 5′ minutes. The object of fitting to finally join the sections together with a 5′ minutes up reading on the clinometer with jacks or support removed. The sections are bolted together with cheese-headed screws, washers, and elastic nuts; before doing so it is advisable to remove front fuse and clean away filings, and deburr holes. During this operation it is necessary to adjust and finalise the engine control structure, and pilot's seat eye bolts attachment to centre plane front spar.

(d) JOINING UP OF STERN FRAME TO REAR FUSELAGE.

Rear end of fuselage is supported on an adjustable trestle and stern frame is supported on two trestles or slung from roof and adjusted to correct height. Stern frame is placed in position and clamped with special clamp boards ACT 4016, 4017, 4018. Alignment blocks ATF 56225 are placed in rudder hinge brackets and plumb bob is dropped from top block. Error is then noted and sections of stern skin which fail to butt or cause misalignment are marked. Stern frame is then removed for fitting until faces meet and plumb bob reads vertical (lateral) and vertical (fore and aft).

Correct distance of rear fuselage former edge to skin = 15/16 inch.

Stern frame having been positioned and clamped, tail plane incidence boards, port and starboard, are placed on fourth rib from centre line of tail plane on each side, and inclination reading taken with clinometer. Incidence tolerance being 0° + or — 15′ minutes.

Check can be made on lateral reading by placing a straight-edge against side of alignment blocks and reading taken on clinometer.

Lateral tolerance 0° + or — 5′ minutes.

Also check rigging of tail plane in relation to rear fuselage with steel tape by taking measurement from rigging pin on top of second former aft of turret to elevator bearing brackets on tail plane; the same position being selected on each side of tail plane.

Permissible error in diagonal measurements is 3/8″ port or starboard of centre line.

(e) ASSEMBLY OF FIN TO TAIL PLANE AND STERN POST.

Remove four bolts from top rudder bearing bracket on stern post, and then mount fin; then connect to attachment points on tail plane, stern frame, and post. Check for verticality; tolerance being 0° + or — 15′ minutes.

(f) RUDDER.

When fitting, place bearings in locations and note alignment (supporting section of bearings may have to be eased). Electric cables and rudder trimming tab breeze control must be pushed through before finalising rudder.

(g) **ELEVATORS.**

When fitting, place bearings in locations and check alignment (supporting section of bearings may have to be eased). Elevator trimming tab breeze controls must be pushed through before finalising elevators.

(h) **BOMB CELL SKIRTS AND ROOT FILLETS.**

These may be fitted during fitting of stern frame, and care should be taken when fitting bomb cell skirts. It is advisable to temporarily clamp until fitting is satisfactory, as it may be necessary to compromise. A straight edge should be placed along bottom edge, so that this edge will be parallel with top edge of bomb doors and presents a neat fit.

Root fillets should not present any difficulty.

(i) **UNDERCARRIAGE AND NACELLE STRUCTURE.**

This unit must be positioned with temporary pins. All holes must be reamed to take ferrules, so as to have minimum movement. Special set of reamers are used for this job.

Special reamers set ACT 45507.

(j) **INSTALLATION OF BOMB CELL DOORS** (Refer Fig. 1).

The following is the sequence of operations for installation:—

(1) Fit hinge brackets.
(2) Cut section out of stiffening plate on lower edge of bomb cell skirts to allow fork to clear same.
(3) Lever assembly is then attached to doors.
(4) Cut ends of doors to fit structure.
(5) Skin is then filed and edge may have to be hammered out to give clearance to doors in open or closed positions. From $\frac{1}{8}$ in. to $\frac{1}{4}$ in. may have to be filed off.
(6) Bushes are now positioned and reamed to take $\frac{1}{8}$ in. taper pins.
(7) Spring and catch assembly may be now positioned to suit doors.
(8) Flaps may now be attached to doors.
(9) Doors may now be bolted and split pinned where necessary.
(10) Doors must now be planed for clearance.
(11) Levers may be attached to torque rod of hydraulic jack.
(12) Jack must be adjusted to eyebolt on end of torque rod.

NOTE.—Door stops must also be adjusted.

POWER FUNCTIONING BOMB DOORS.—Adjust jack with approximate 1 in. of thread showing. Edges of doors to line in closed position. Test with hand pump first.

(k) **ASSEMBLY OF WINGS TO CENTRE PLANE.**

Level aircraft approximately and align wings to centre plane either by jacks or block and tackle, slightly raising the wing tip. The top front lugs must be carefully aligned before closing wing to centre plane. Locate upper lugs with tapered drifts, then fit bolt heads towards leading edges in all cases. Shim rear spar links to nearest .004 in. Fit channel plates, and rivet wing side only, and bolts on centre plane (nuts inside). Locate links to give correct dihedral.

4. NACELLE FAIRINGS.

(a) CONSTRUCTION.

(i) Side panels are wheeled sections correctly formed to contour and checked to a mock up approved by A.I.D.

(ii) There are three supporting sections or diaphragms positioned to side panels in their correct locations, with proved (1) hinge point (rear) for large doors and 2 for the small doors (port and starboard).

(iii) Doors are of tubular section, jig constructed, and are received from the manufacturer ready for installing.

(iv) Rear fairing is fabricated on jigs with 3 main attachment points positively located in order to ensure correct alignment to C/L. of nacelle structure.

(v) Forward hinge for large doors is located on nacelle structure (port and starboard).

(b) ORDER OF ASSEMBLY.

(i) Locate and finalise rear fairing.

(ii) Locate side panels (inner and outer), using jib No. ACT 45525.

(iii) Secure side panels to tank door at diaphragm attachment points. NOTE.—Check for undue stress at jigging points.

(iv) Secure panels to bulkhead, rear fairing, and top attachments to skin angle.

(v) Swing doors and check for clearances in the opened and closed positions.

(vi) Locate bumper rail; check opening and closing function with hand pump.

(vii) Fit bungees.

(viii) Check undercarriage top catches for specified C/L.

(ix) Fit tail pipes.

(x) Function doors (power).

5. INSTALLATION OF CURTISS ELECTRIC AIRSCREWS.

(i) Remove brush assembly from holder.

(ii) Install locking adaptor in engine shaft.

(iii) Clean splined and threaded portions of engine shaft, fit cone, and lubricate splined portion of shaft with castor oil and threaded portion with thin white lead.

(iv) (a) Offer up airscrew on to engine shaft.
(b) Tighten propellor shaft nut and lock by inserting spring loader locking adaptor.

(v) (a) Check with Prussian blue, brush alignment on slip ring.
(b) Brushes should be as near to the centre of the slip ring as possible.

(c) Should it be necessary, remove airscrew and pack out by placing .020 in. or .040 in. shim washers behind the rear cone. (WARNING. — Before removing airscrew remove brush assembly.)

(vi) Check spring loaded locking adaptor.

(vii) Set the airscrew blades in the low pitch position by indexing the mark stencilled on the front of the hub barrel with the appropriate mark stencilled on the blade shank, i.e., the low pitch angle is stencilled on the front side, and at the root of every blade. On the Beaufort fitted with S3C4G engine, low pitch setting is 21.5° (SEE Fig. 2).

(viii) **POWER UNIT.**

(a) Remove master gear adaptor plate by detaching master gear locking ring and removing the three power gear attaching screws.

(b) Withdraw the master gear adaptor plate assembly.

(c) Inspect the power unit for the position of the low pitch cut out switch cam, which should be in the "cut off" position, i.e., with the switch and pawl riding on the cam as illustrated in Fig. 3.

(d) NOTE.—Should the power unit NOT be in the low pitch position, it will be necessary to first remove the mechanical stop. WARNING PLATE on power unit adjacent to mechanical stop at the base of the power unit.

(e) Connect a 12 volt battery to the motor by piercing the wax plugs in the power unit body, and run the motor until the cam has reached the low pitch position as illustrated in Fig. 3.

(f) Offer the up power gear to drive shaft, but be careful to index the appropriate mark inside bore of the gear with the stencilling mark in bore of splined drive shaft. (NOTE.— The setting of power gear index should correspond with low pitch blade setting 21.5—see Fig. 2A.)

(g) Fit the three countersunk power gear attaching screws and fit the power gear locking ring. Install felt grease seal and neoprene seal as illustrated in Figs. 1 and 2A.

(h) The power unit is now ready for installation, and when offered up to the airscrew assembly the power gear should exactly mesh with the blade gears. Bolt on the power unit with the six studs; tighten up and lock.

(i) Install brush assembly.

(j) Grease airscrew hub with Intava grease, grade A.

(k) Test operation of airscrew in manual control in the increase and decrease directions.

(l) Run the engine and test in automatic.

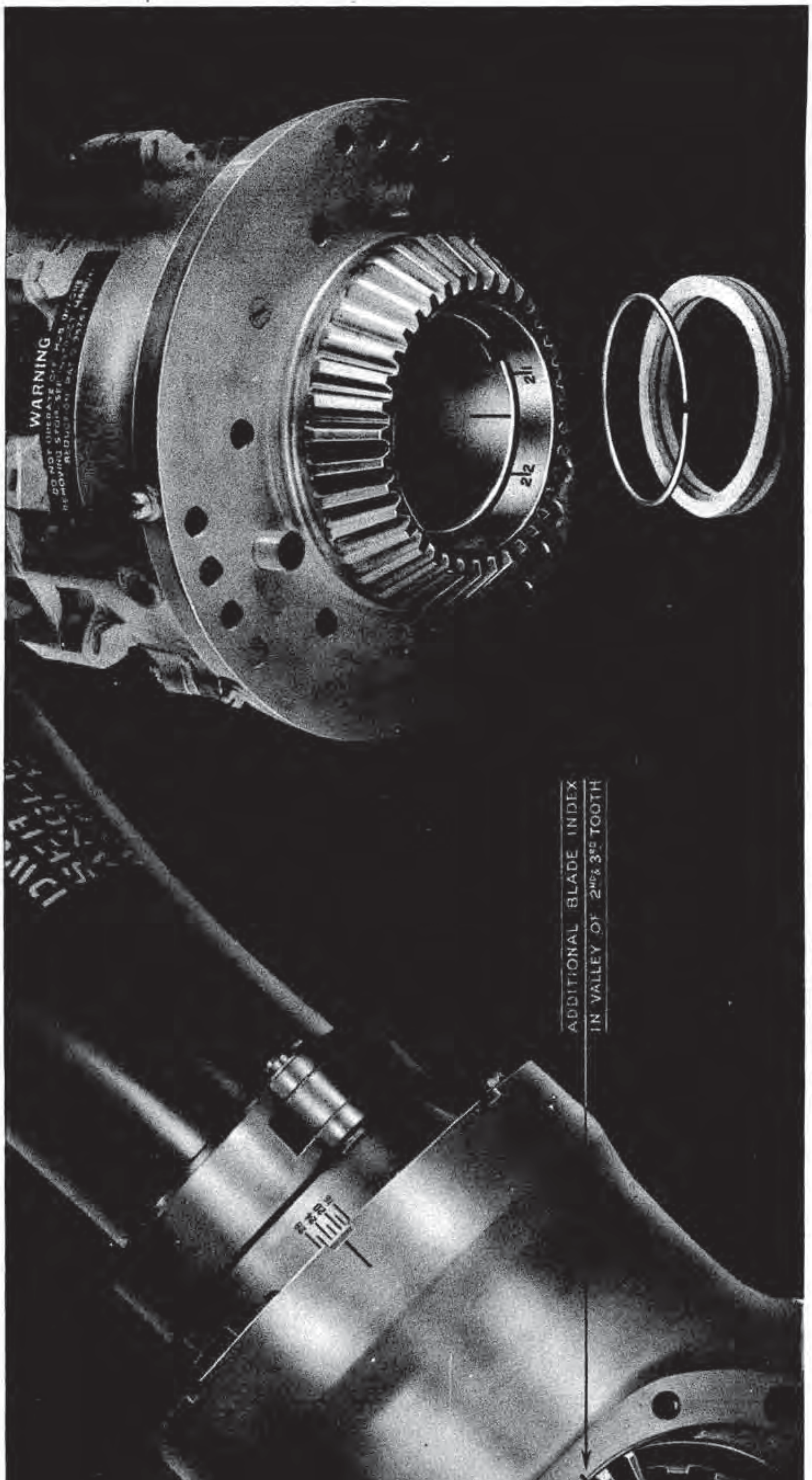


FIG. 3—AIRSCREW INDEXING.

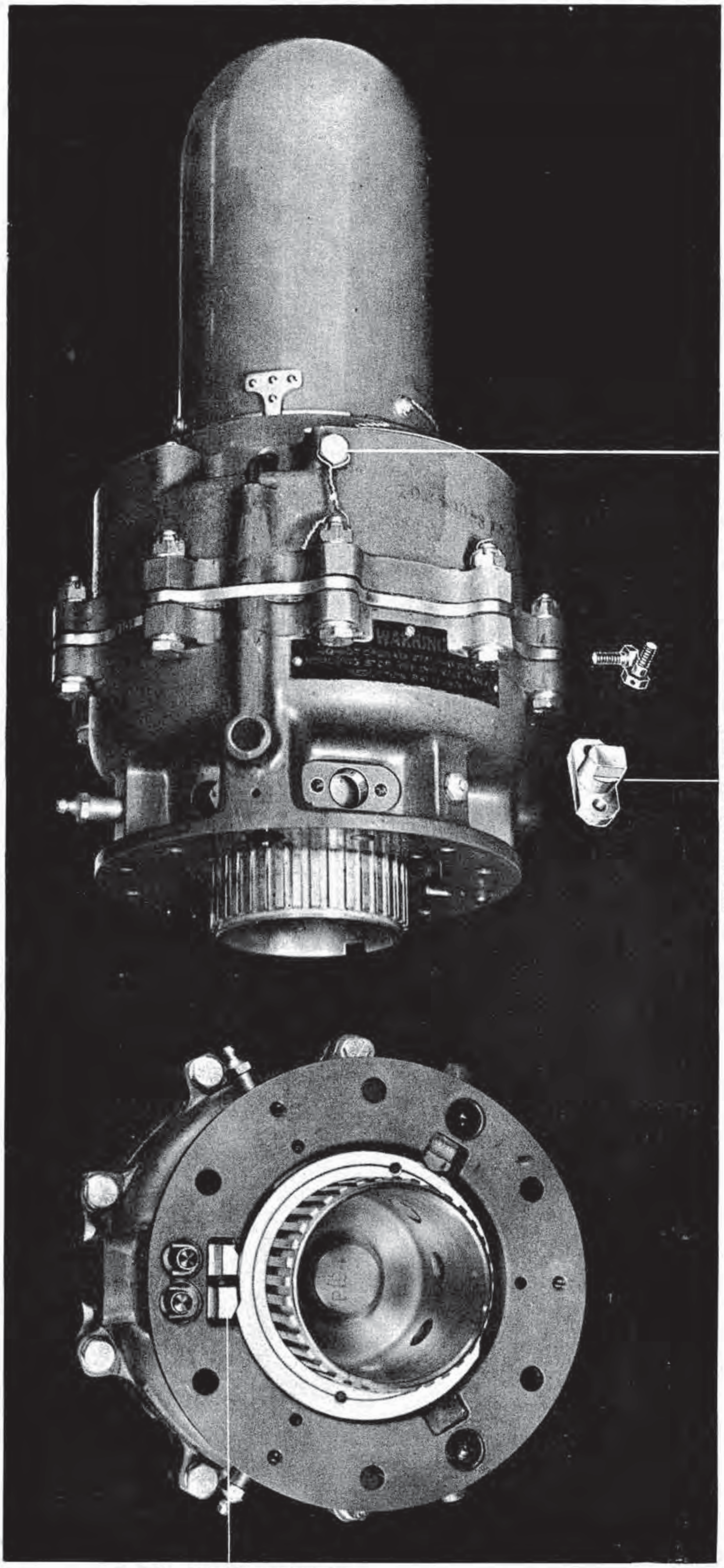


FIG. 4—AIRSCREW POWER PLANT.

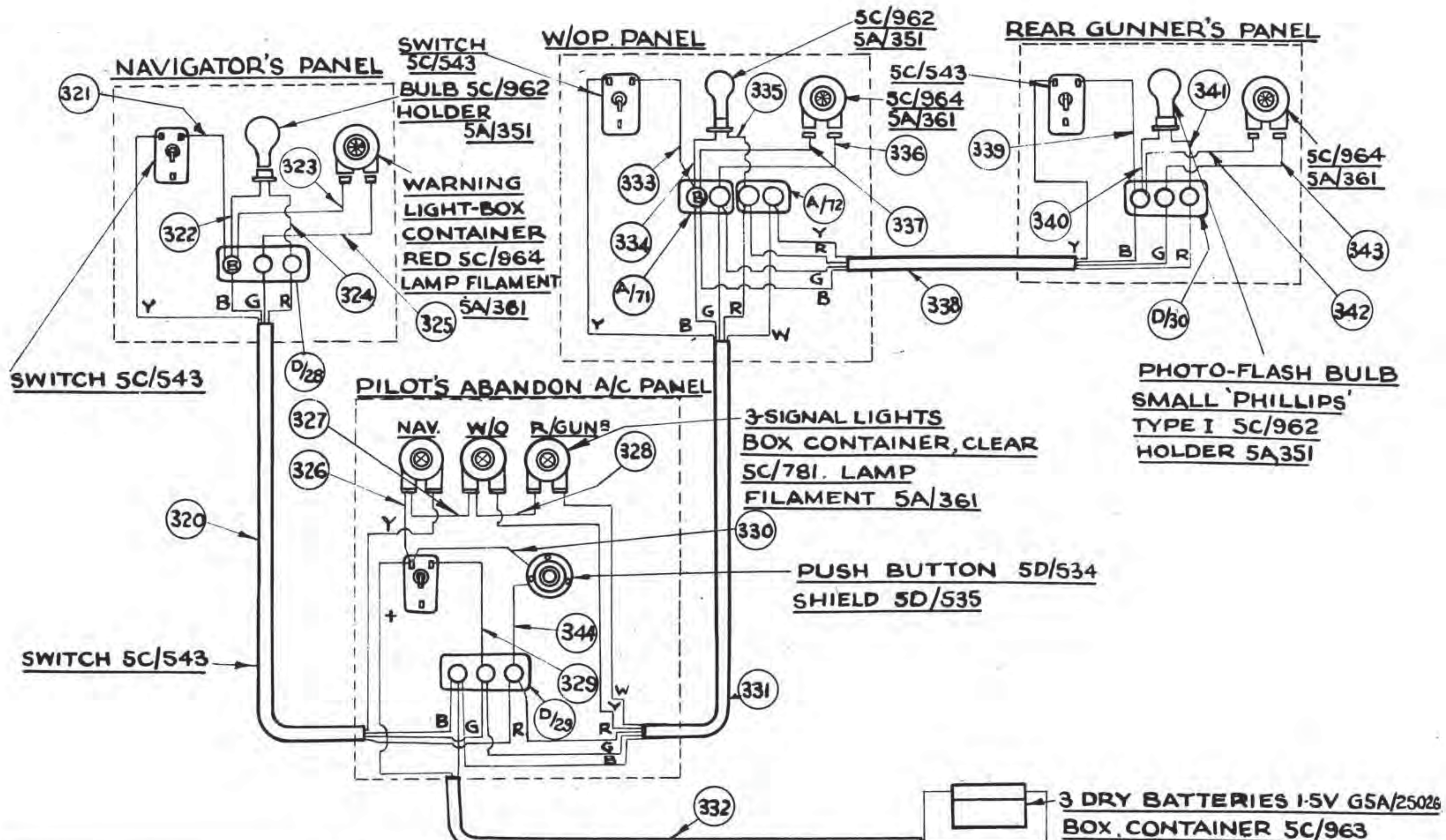
SECTION 6

ELECTRICAL DIAGRAMS

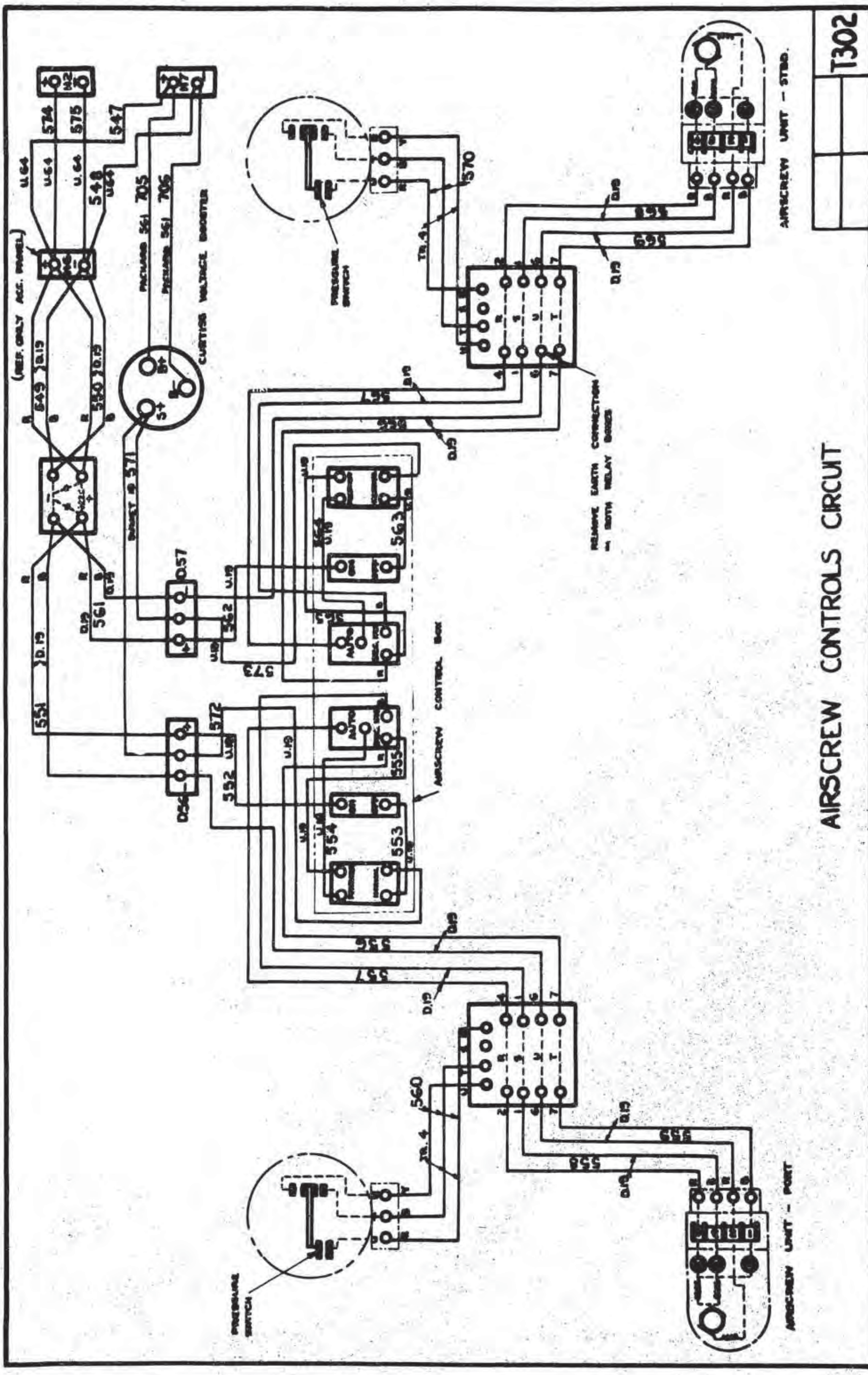
SECTION
6

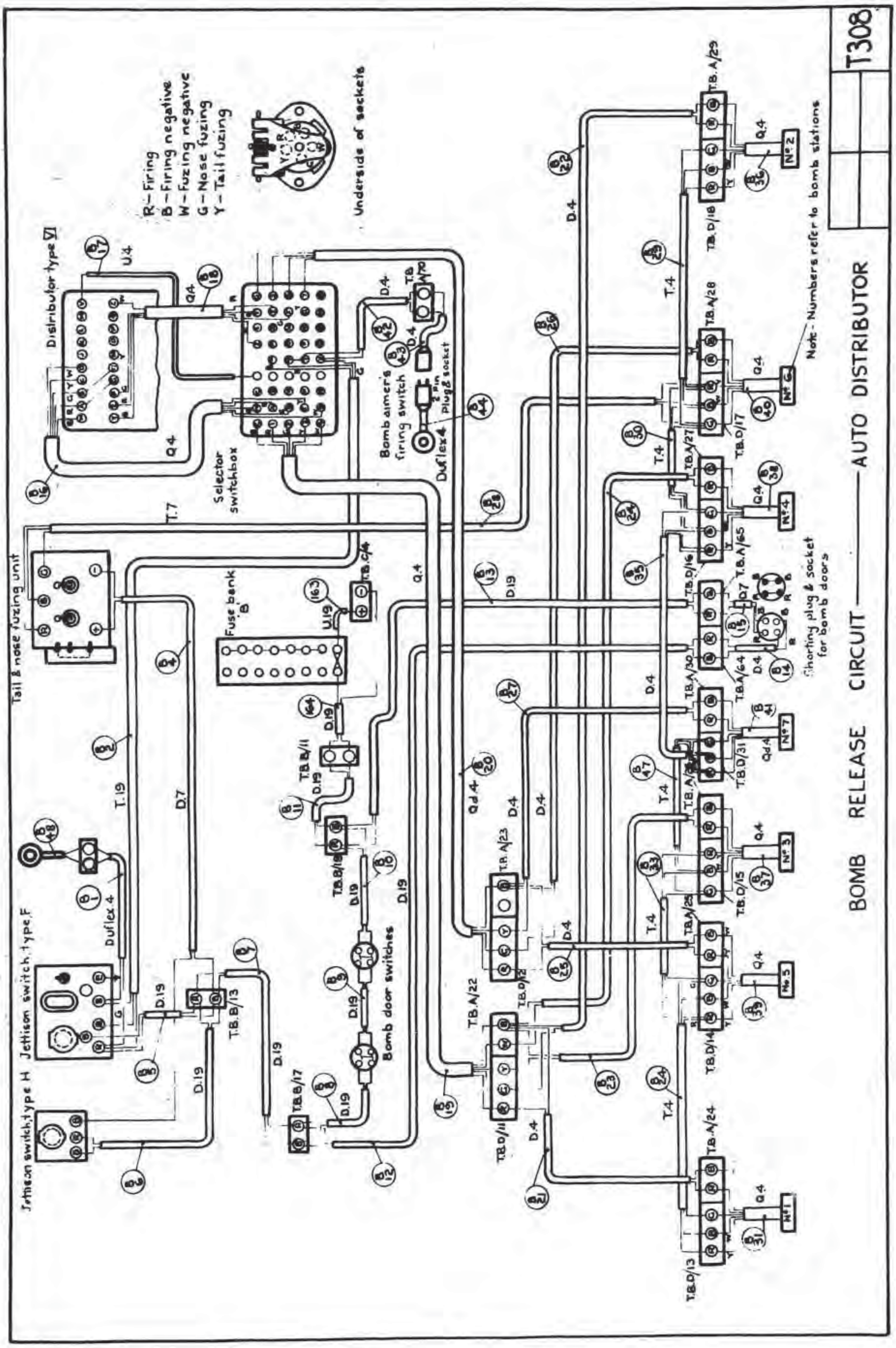
SECTION 6

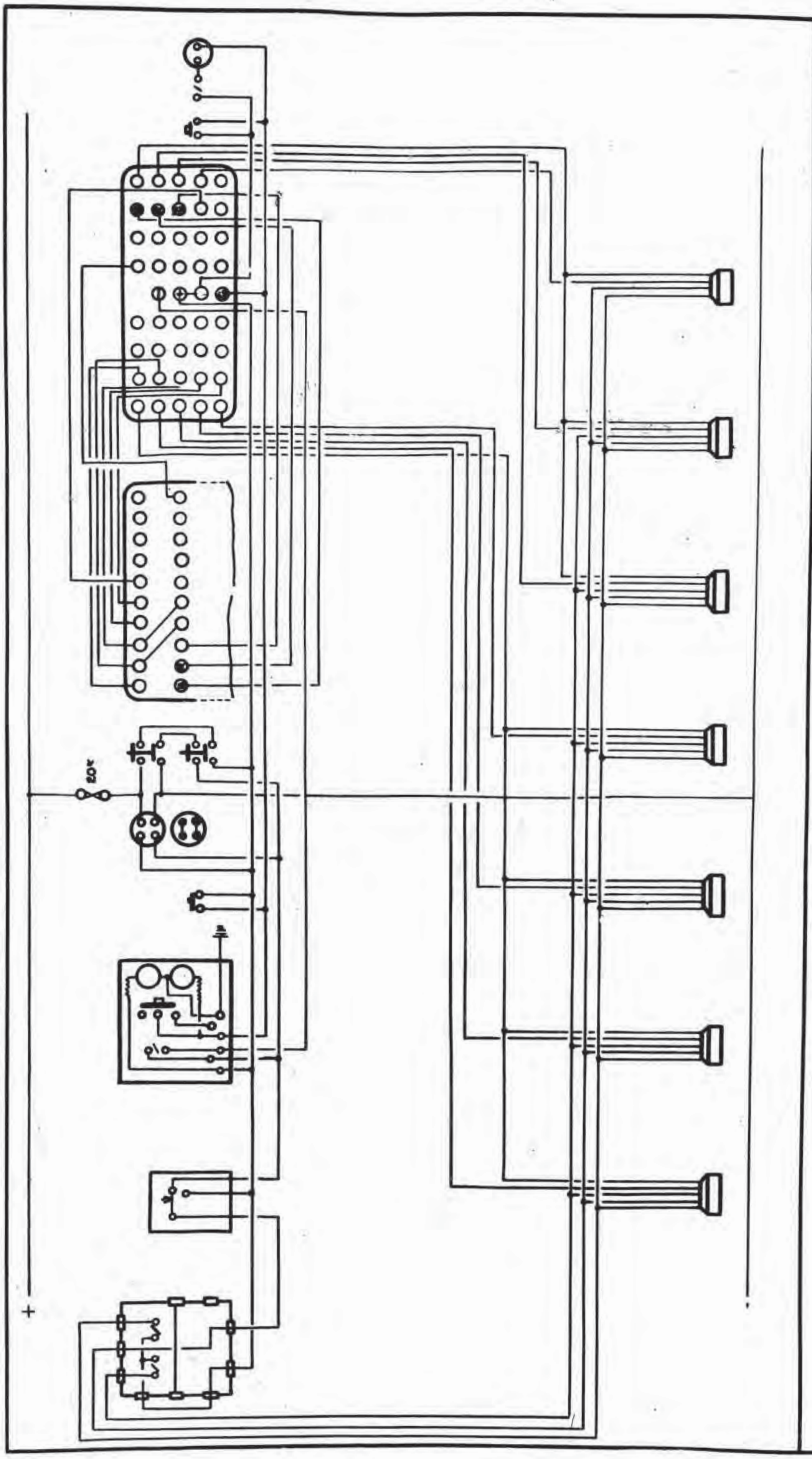
ELECTRICAL DIAGRAMS



ABANDON AIRCRAFT EMERGENCY SIGNALLING CIRCUIT

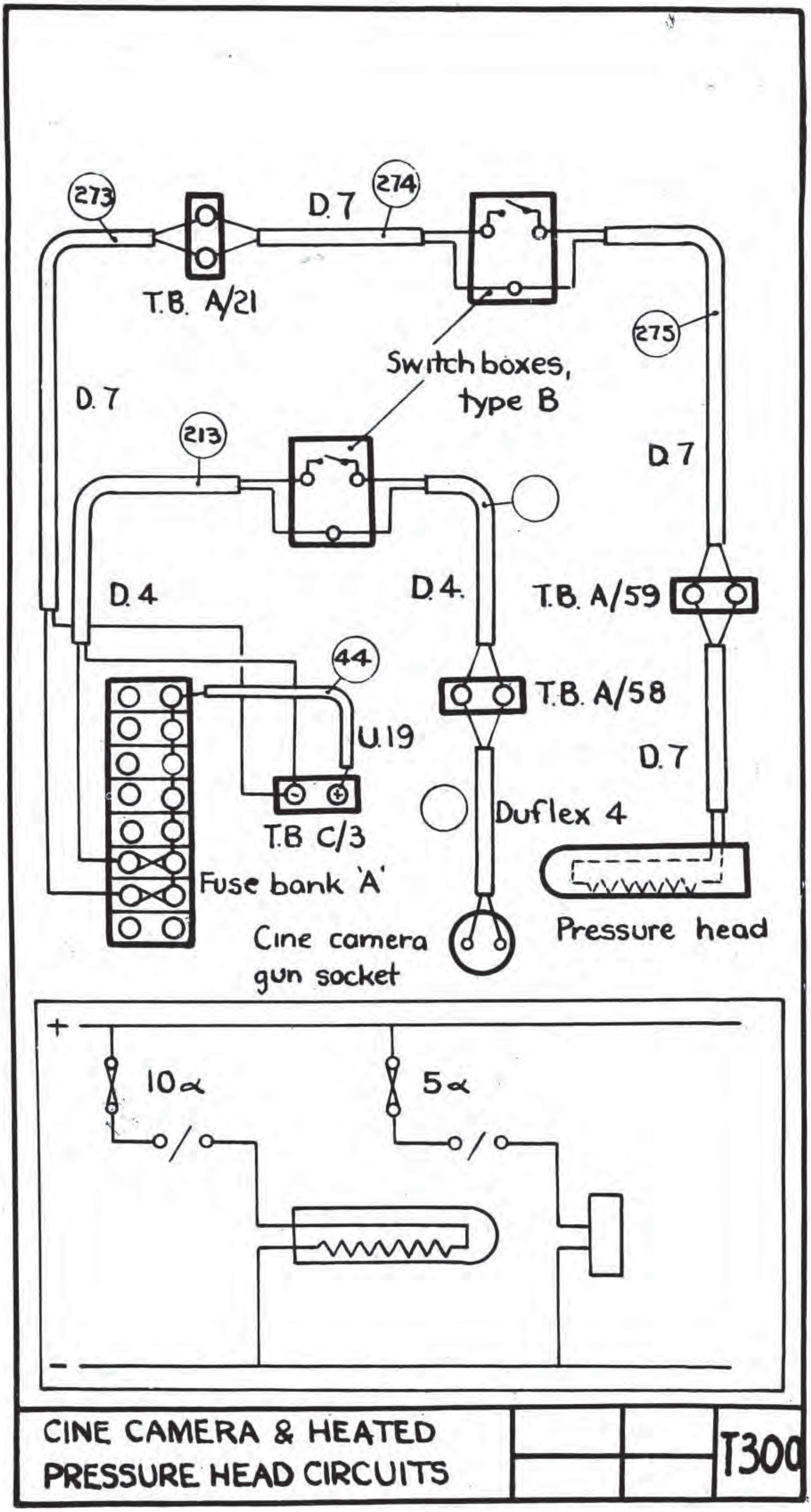

T302
AIRSCREW CONTROLS CIRCUIT
AIRSCREW CONTROL BOX
CURTISS VOLTAGE BOOSTER
PRESSURE SWITCH
AIRSCREW UNIT - PORT
AIRSCREW UNIT - STBD.
REMOVE EARTH CONNECTION ON BOTH RELAY BASES
D.56
D.57

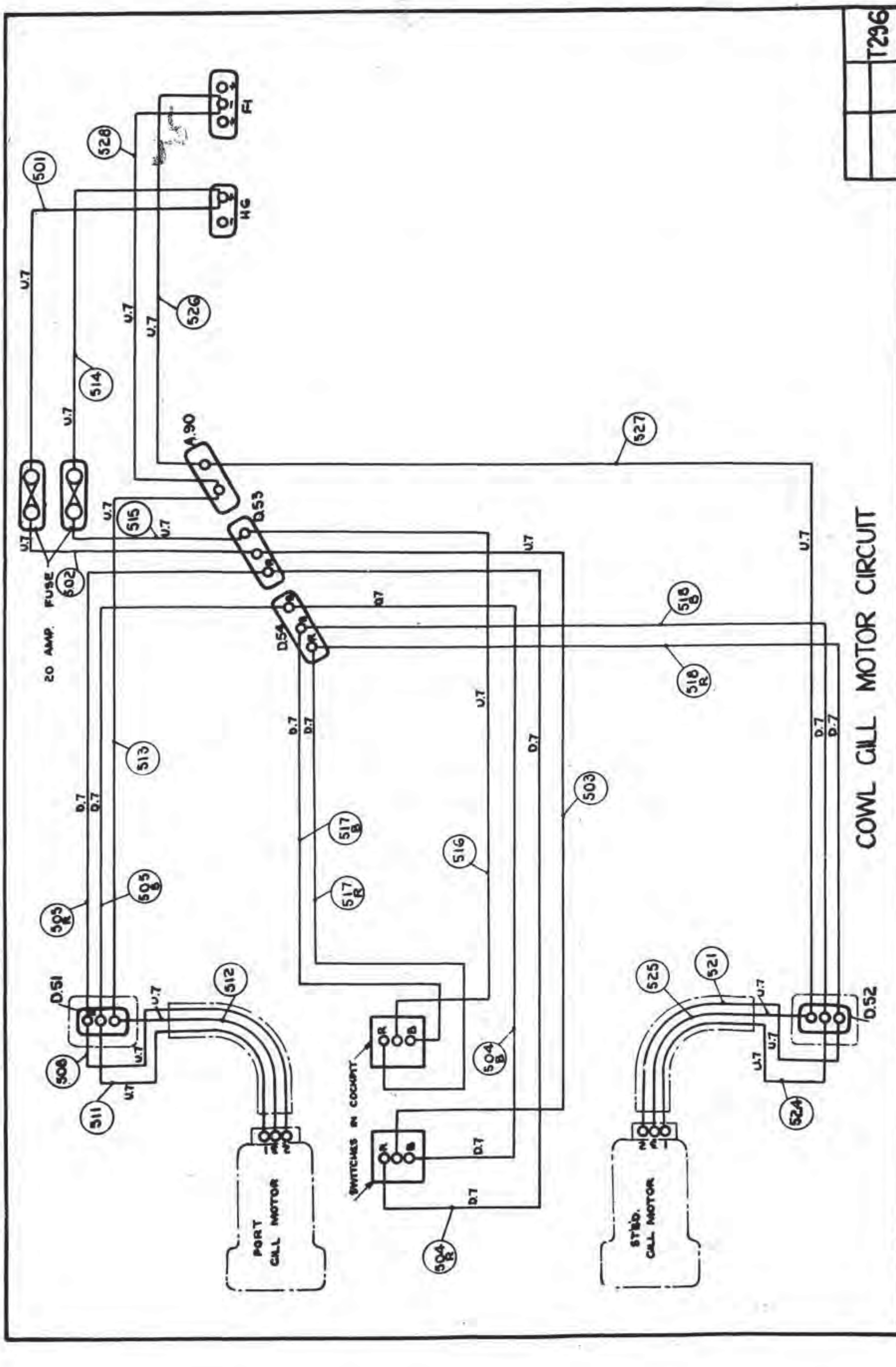

T308
BOMB RELEASE CIRCUIT —— AUTO DISTRIBUTOR
R - Firing
B - Firing negative
W - Fuzing negative
G - Nose fuzing
Y - Tail fuzing
Underside of sockets
Distributor type V
Selector switchbox
Bomb aimer's firing switch
Fuse bank 'B'
Tail & nose fuzing unit
Jettison switch, type H
Jettison switch, type F
Bomb door switches
Shorting plug & socket for bomb doors
Note - Numbers refer to bomb stations

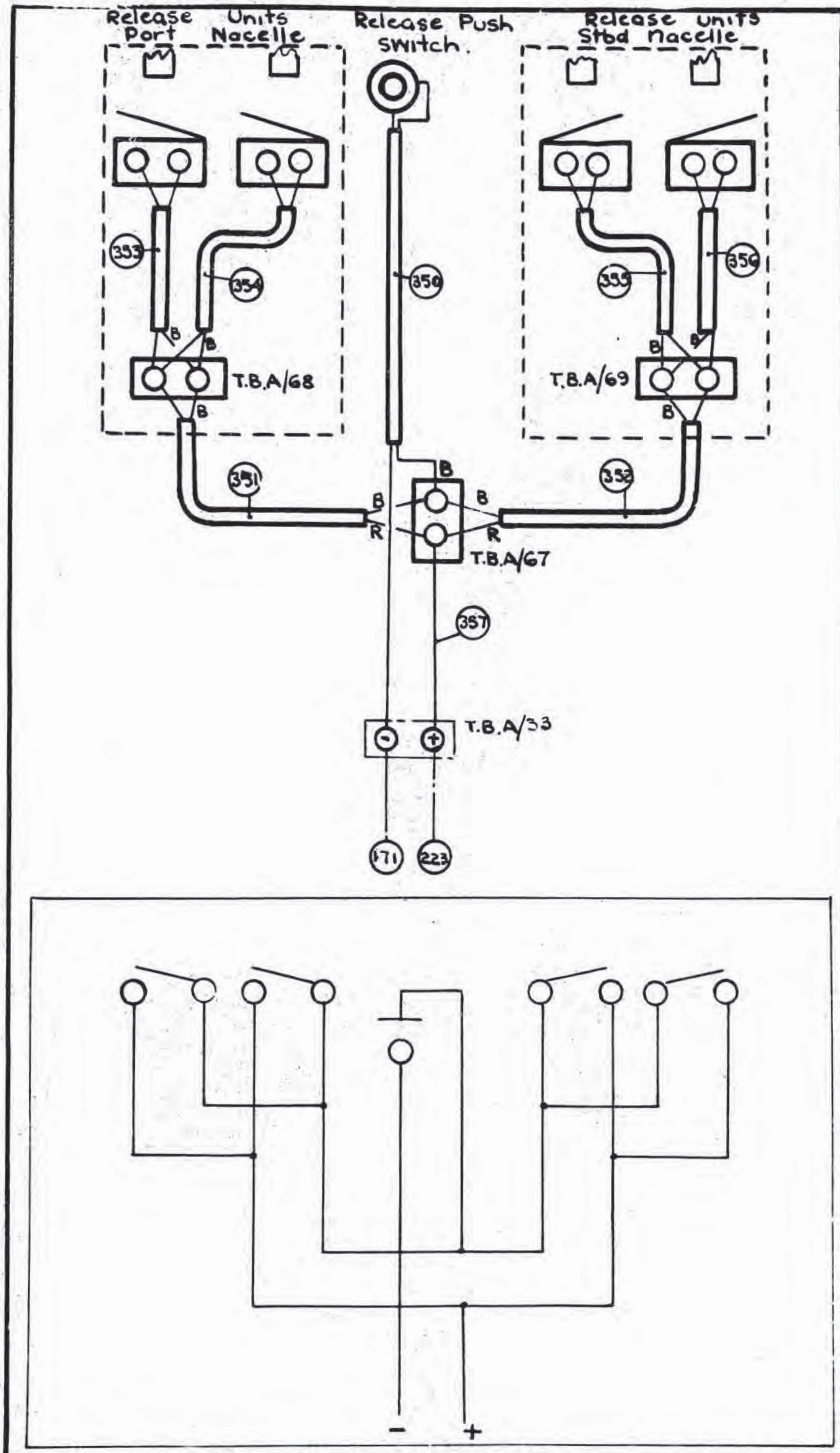


BOMB RELEASE CIRCUIT — AUTO DISTRIBUTOR (THEORETICAL).

T301

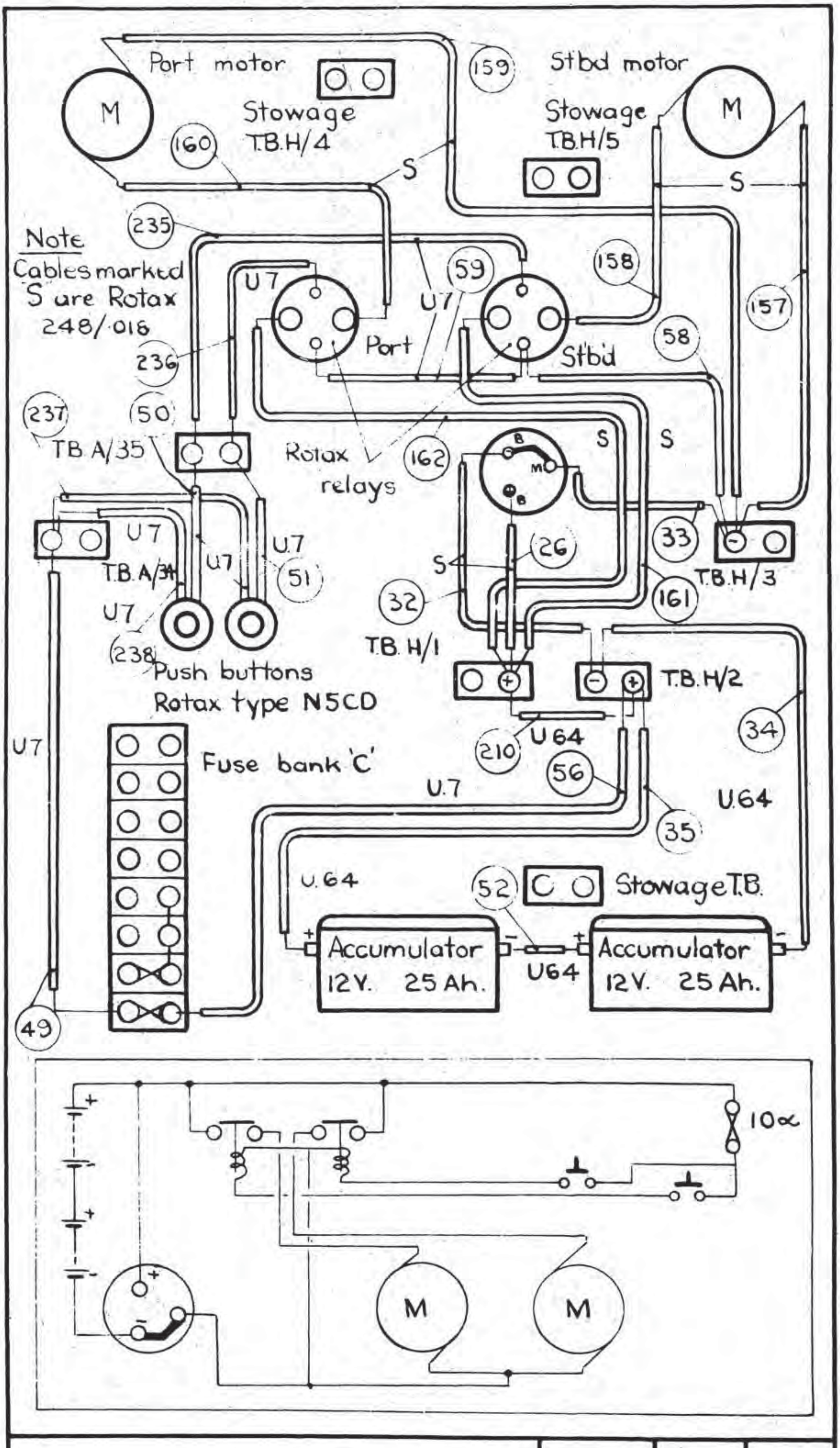

273
T.B. A/21
D.7
274
Switch boxes, type B
275
D.7
213
D.7
D.4
D.4.
T.B. A/59
44
T.B. A/58
U.19
D.7
T.B C/3
Duflex 4
Fuse bank 'A'
Cine camera gun socket
Pressure head
+
10α
5α
–
CINE CAMERA & HEATED PRESSURE HEAD CIRCUITS
T300


T296
COWL GILL MOTOR CIRCUIT
20 AMP. FUSE
PORT GILL MOTOR
STBD. GILL MOTOR
SWITCHES IN COCKPIT
D.51
D.52
D.53
D.54
A.90
HG
F1
501
502
503
504 R
504 B
505 R
505 B
508
511
512
513
514
515
516
517 B
517 R
518 B
518 R
521
524
525
526
527
528



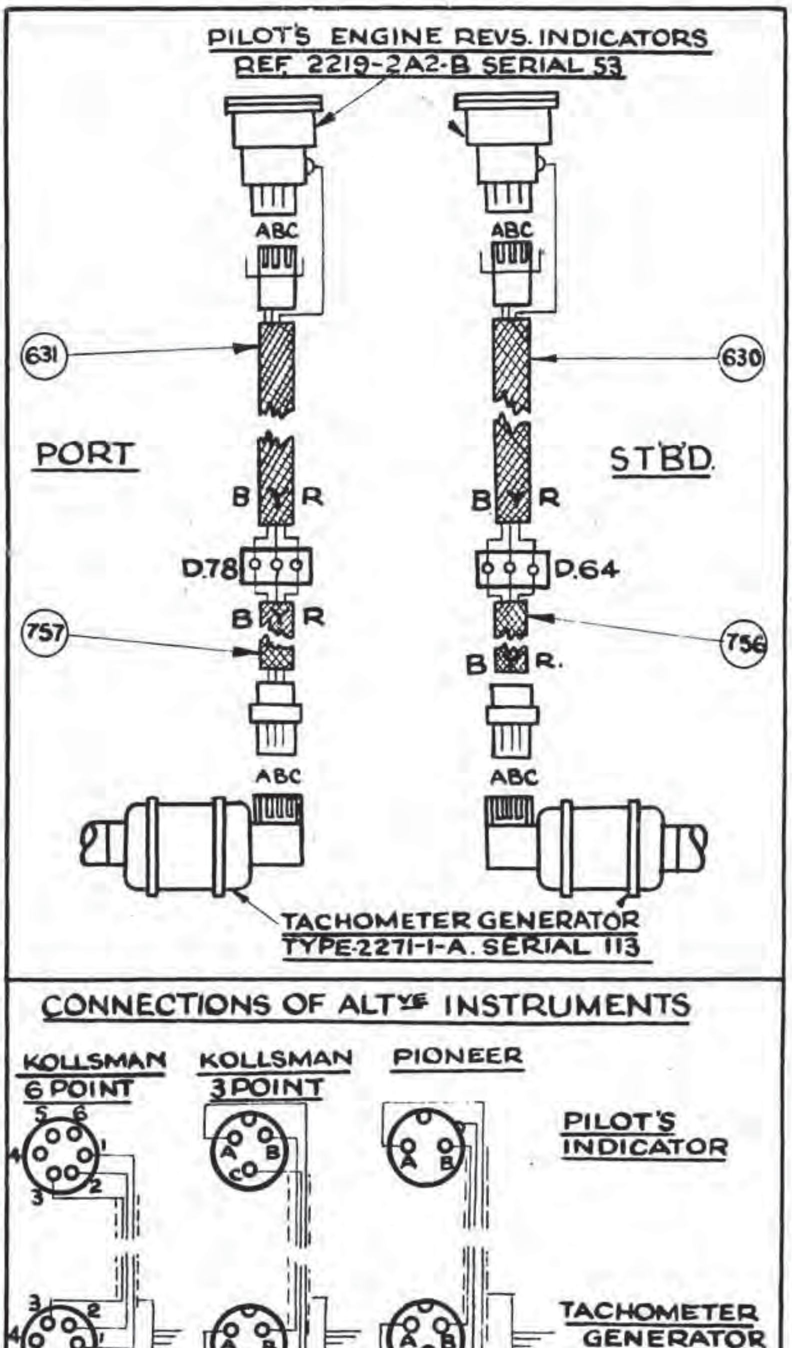
EMERGENCY U/C LOWERING CIRCUITS

T310

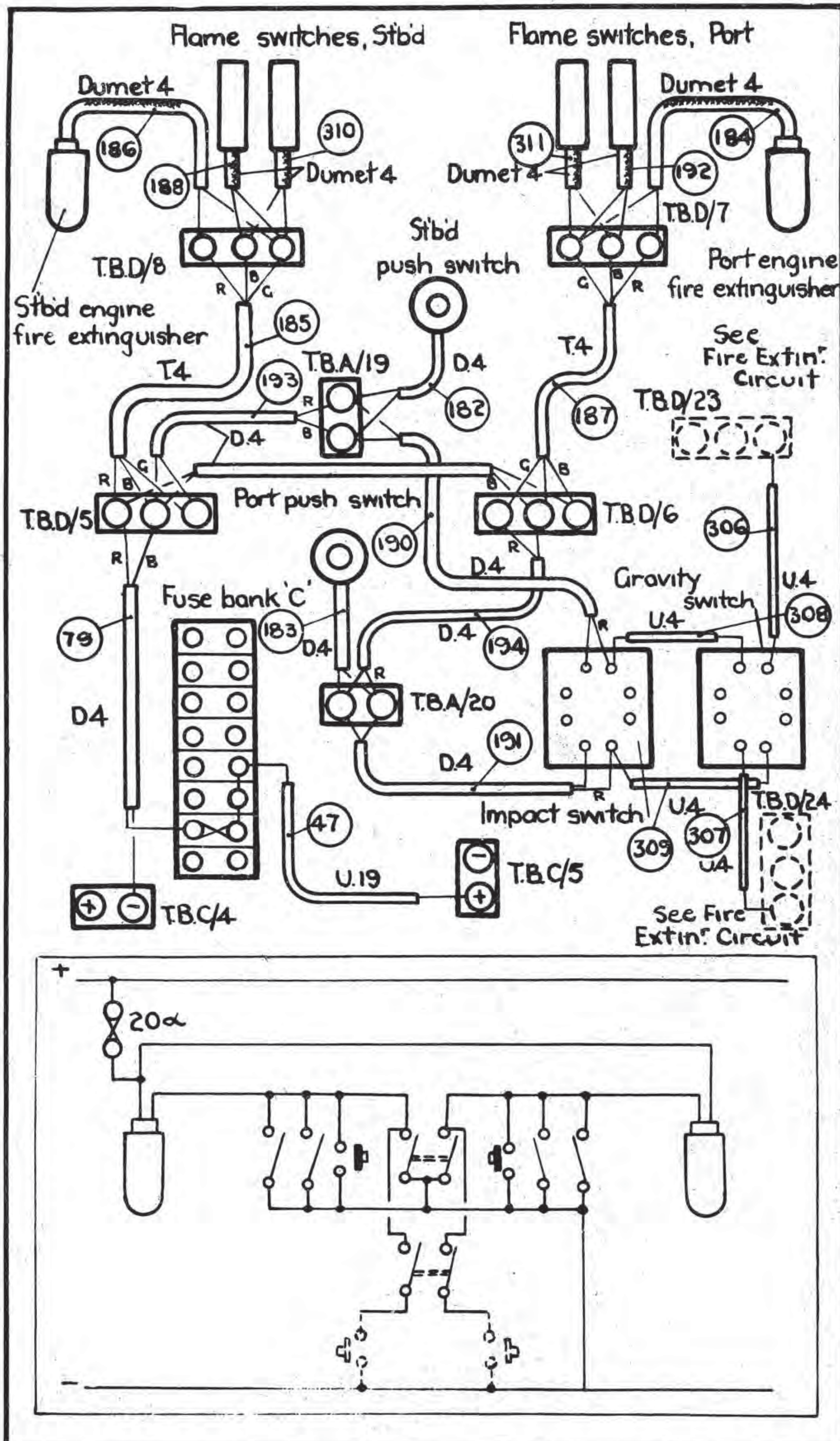


ENGINE STARTING CIRCUIT

T306

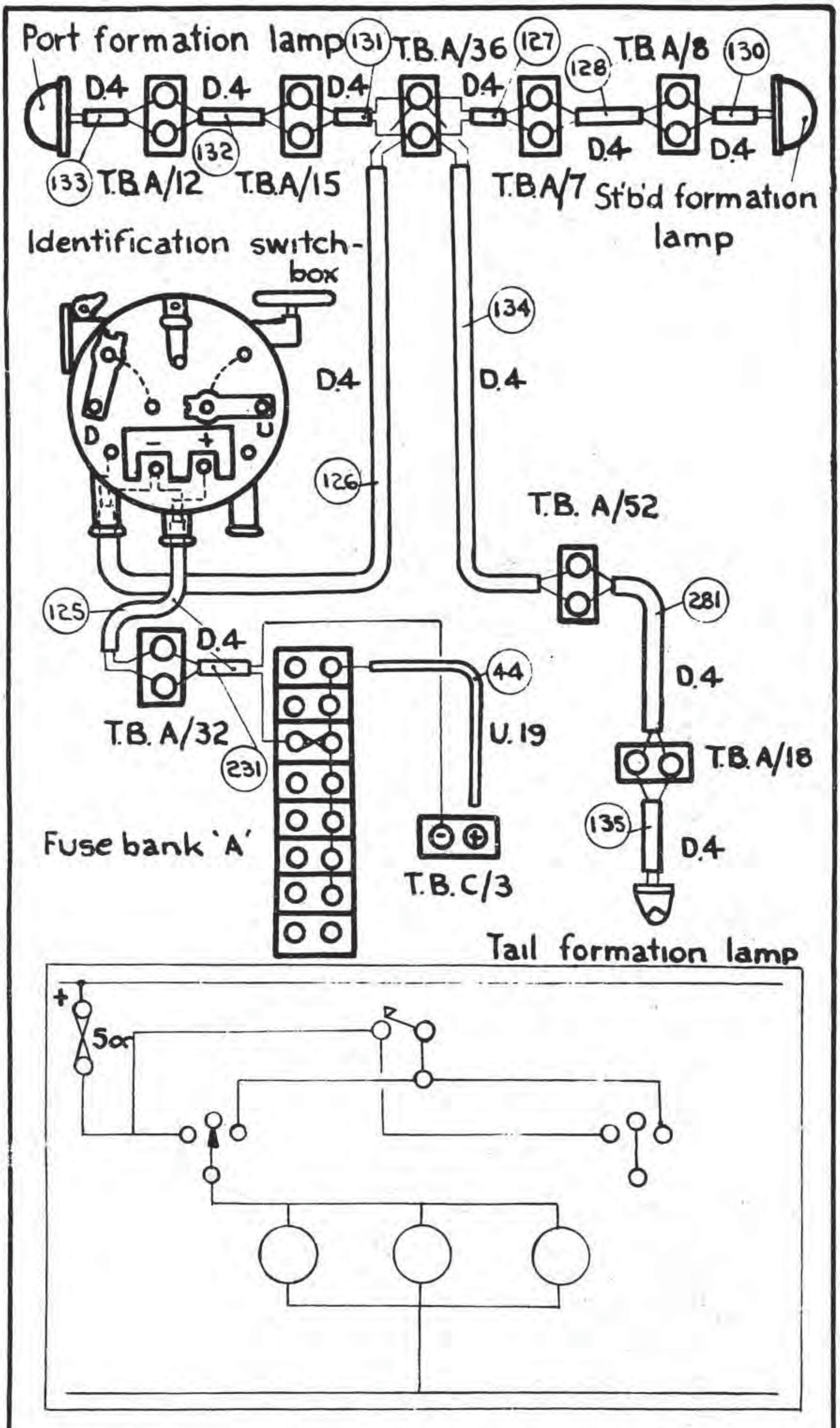


ENGINE REVOLUTIONS INDICATORS

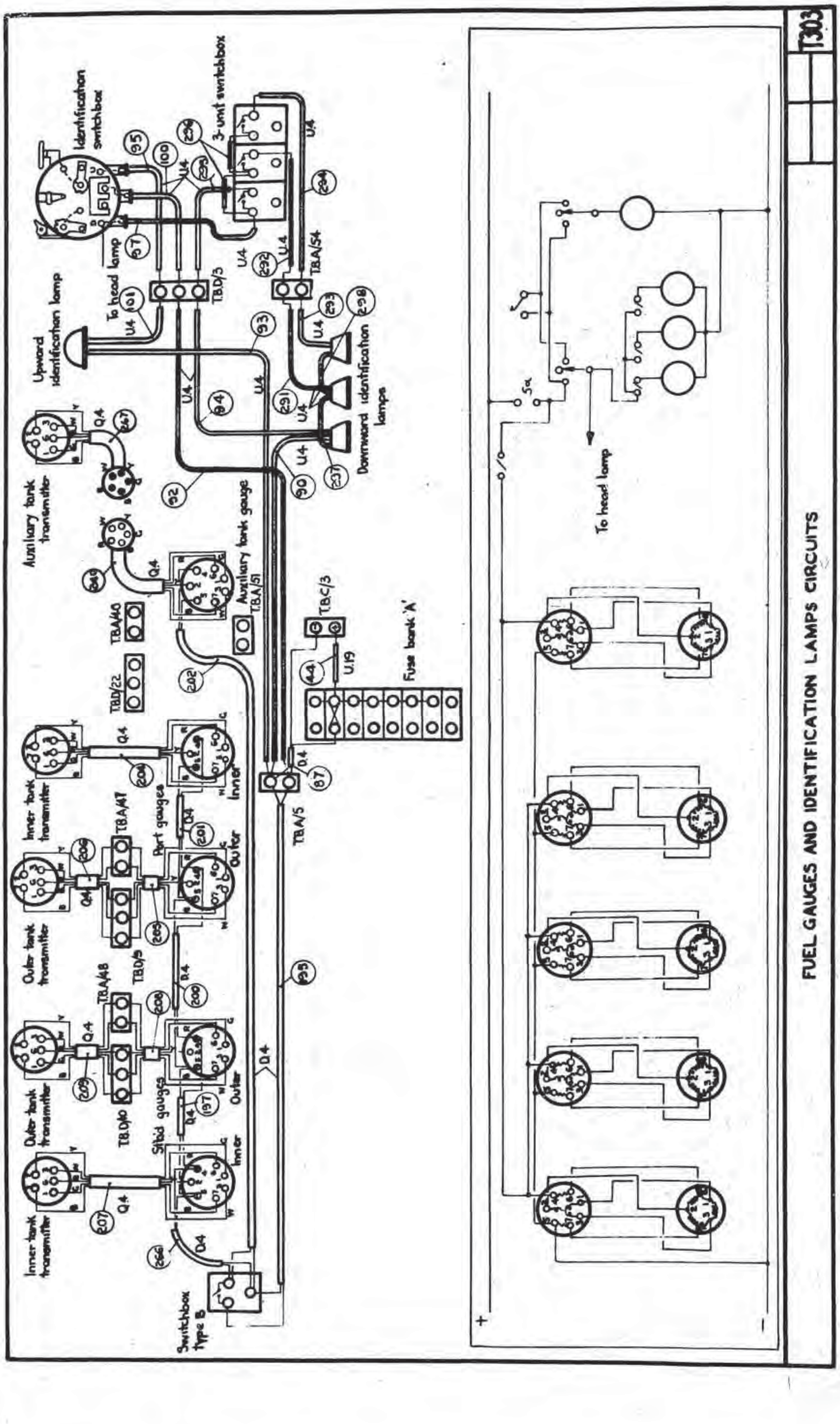


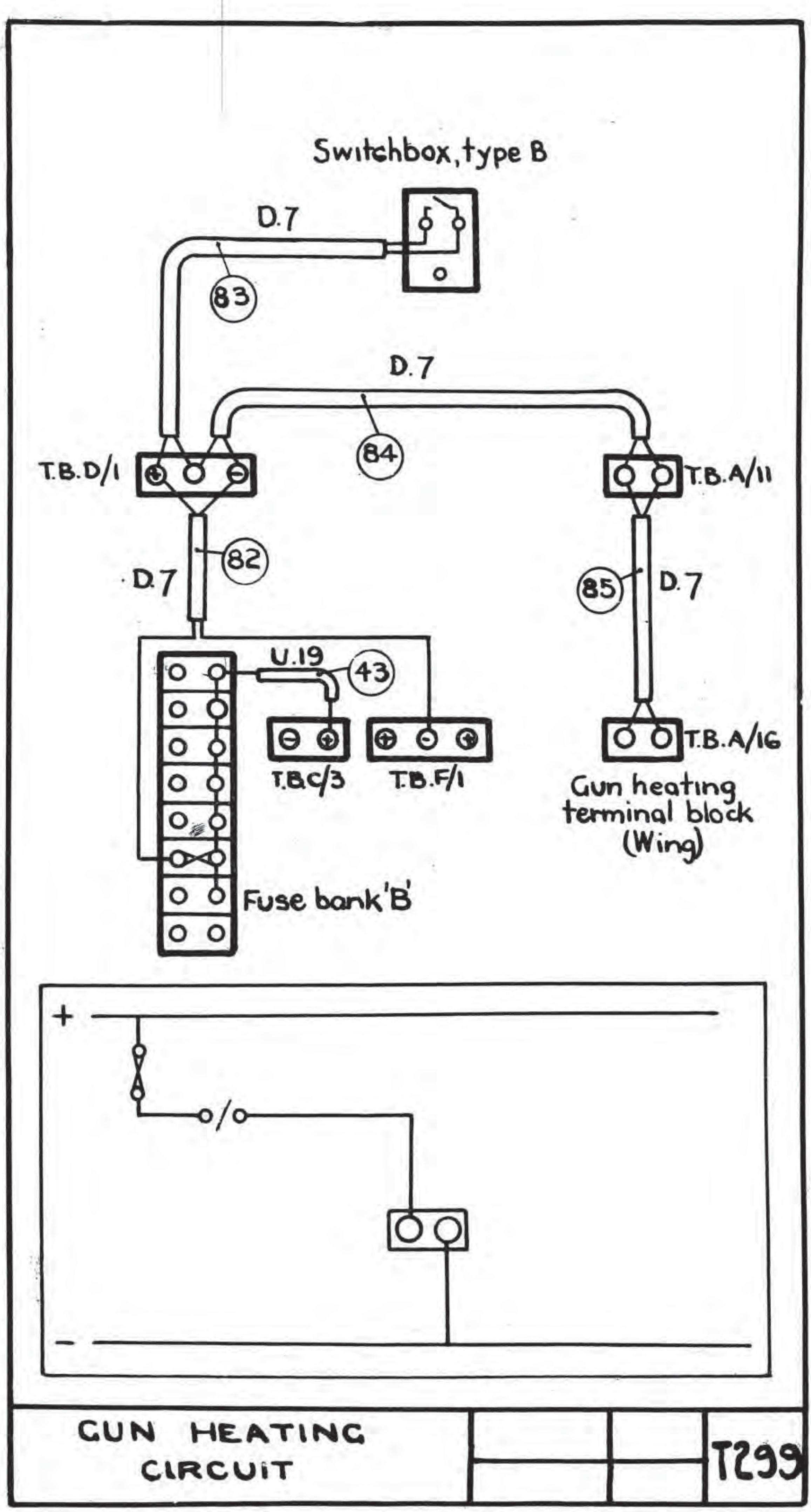
FIRE EXTINGUISHER CIRCUIT

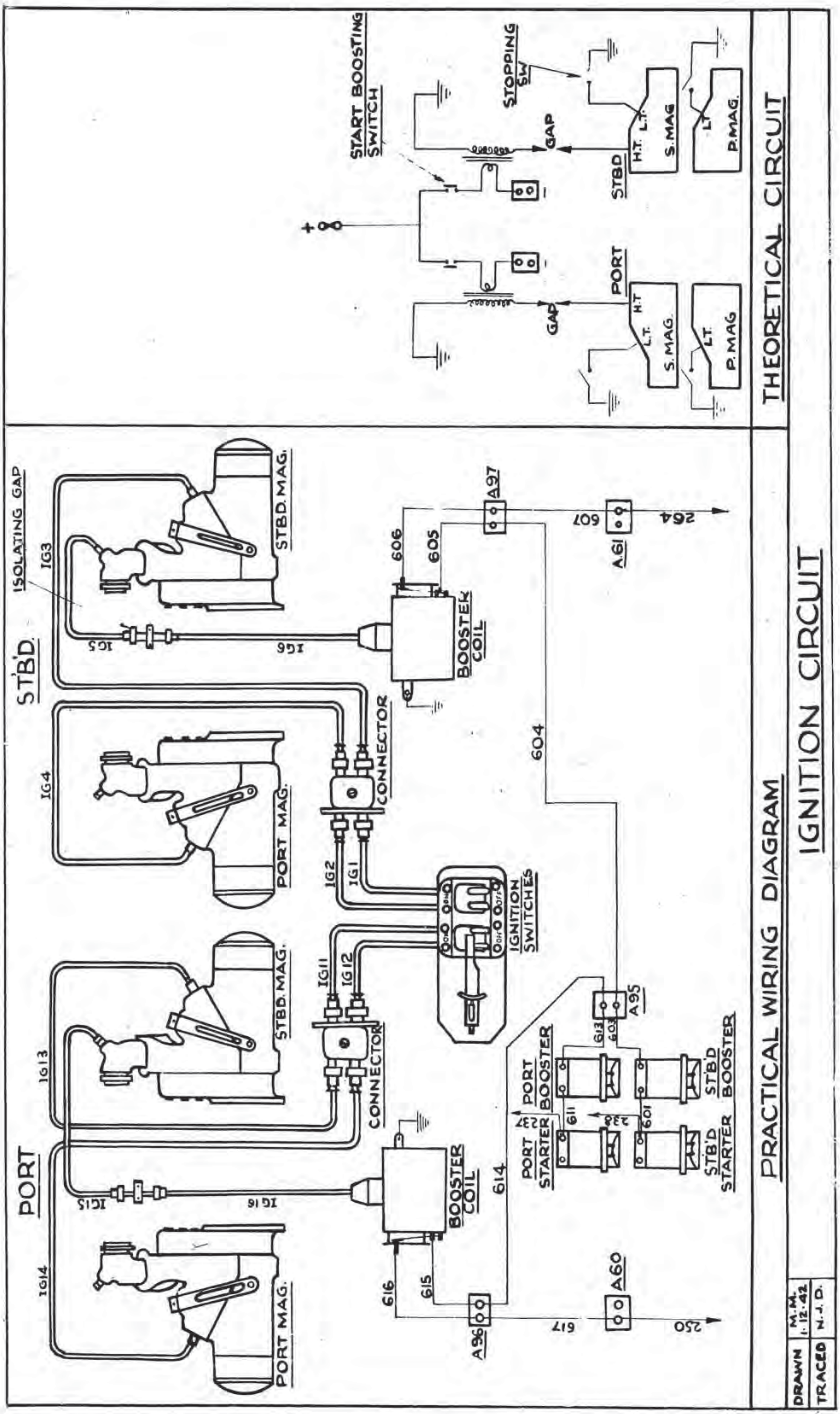
T309

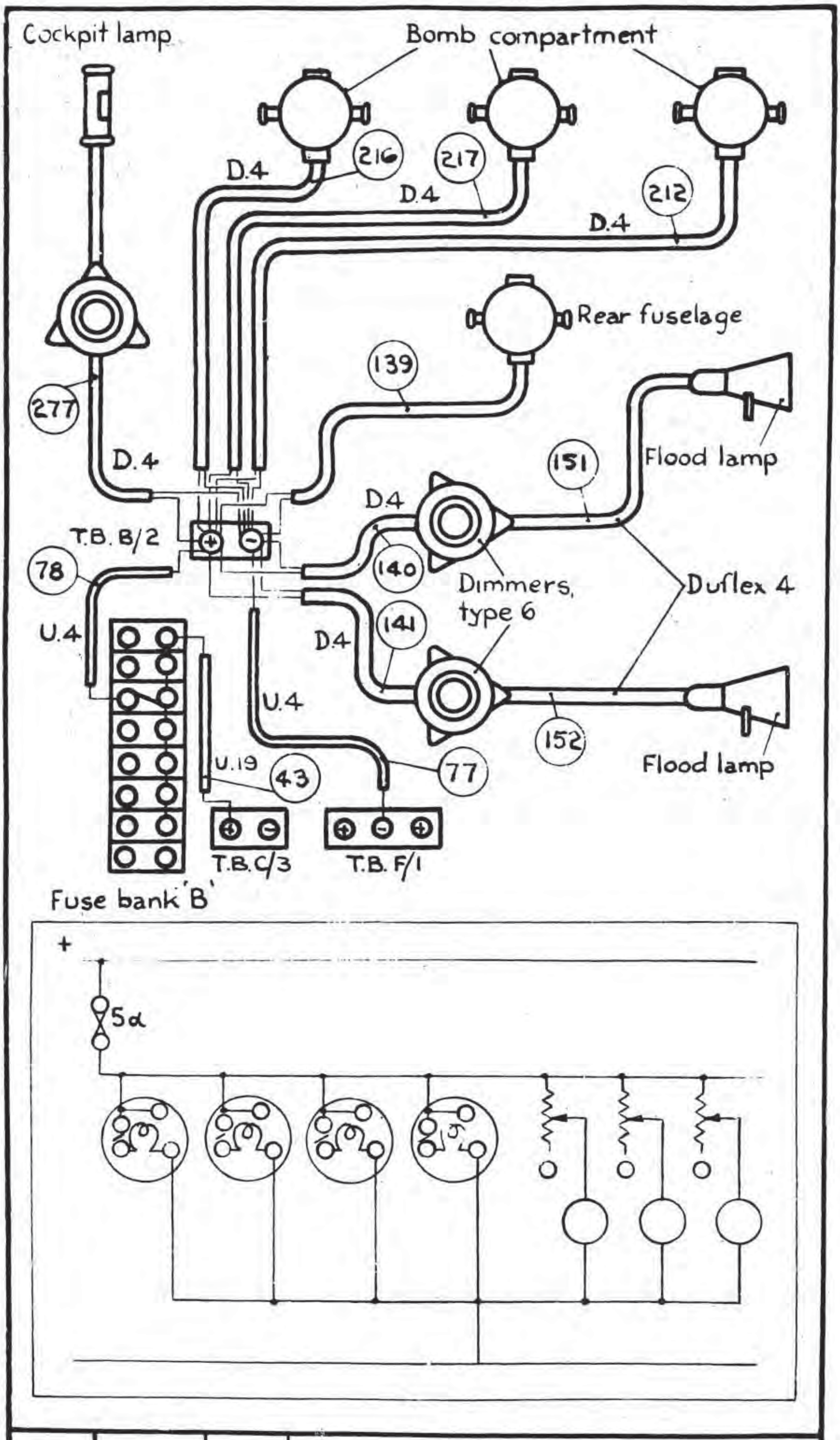


T305			FORMATION LAMPS CIRCUIT

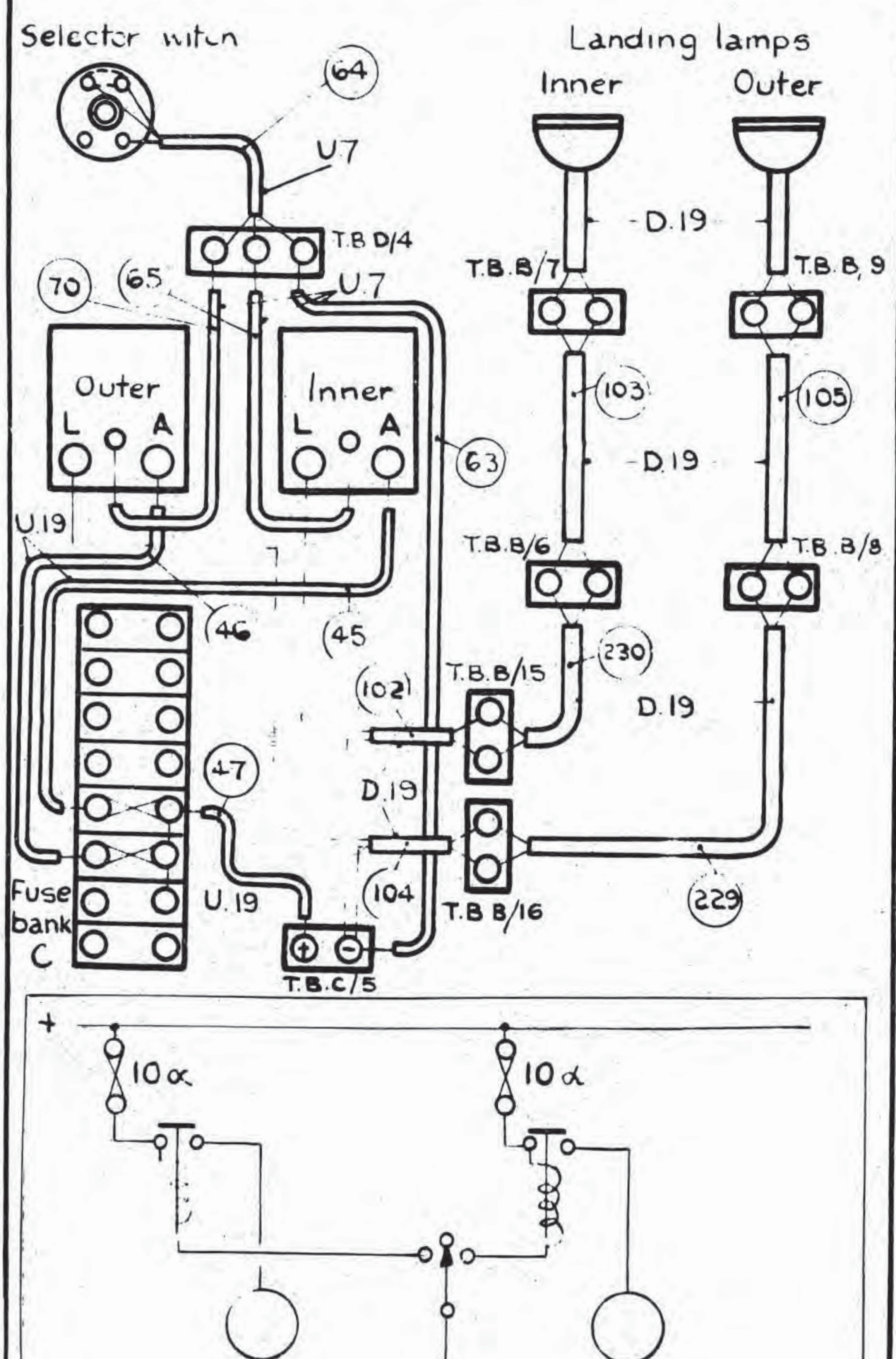

T303
FUEL GAUGES AND IDENTIFICATION LAMPS CIRCUITS
Identification switchbox
3-unit switchbox
To head lamp
Upward identification lamp
Downward identification lamps
Auxiliary tank transmitter
Auxiliary tank gauge
Inner-tank transmitter
Outer-tank transmitter
Port gauges
Stbd gauges
Inner
Outer
Fuse bank 'A'
Switchbox type B
T.B.D/3
T.B.A/54
T.B.A/51
T.B.A/40
T.B.D/22
T.B.C/3
T.B.A/47
T.B.D/5
T.B.A/48
T.B.D/10
T.B.A/5
U.4
U.19
Q.4
P.4
To head lamp
+
−


Switchbox, type B
D.7
83
D.7
84
T.B.D/1
T.B.A/11
82
D.7
85
D.7
U.19
43
T.B.C/3
T.B.F/1
T.B.A/16
Gun heating terminal block (Wing)
Fuse bank 'B'
+
-
GUN HEATING CIRCUIT
T299


PORT
STB'D.
PORT MAG.
STBD. MAG.
ISOLATING GAP
IG3
IG4
IG5
IG6
IG13
IG14
IG15
IG16
IG1
IG2
IG11
IG12
CONNECTOR
BOOSTER COIL
IGNITION SWITCHES
PORT STARTER
PORT BOOSTER
STB'D STARTER
STB'D BOOSTER
A96
A60
A95
A97
A.61
606
605
604
607
264
614
616
615
617
250
611
601
613
603
237
238
START BOOSTING SWITCH
STOPPING SW
GAP
PORT
STBD
H.T.
L.T.
S. MAG.
P. MAG.
THEORETICAL CIRCUIT
PRACTICAL WIRING DIAGRAM
IGNITION CIRCUIT
DRAWN M.M. 1.12.42
TRACED N.J.D.

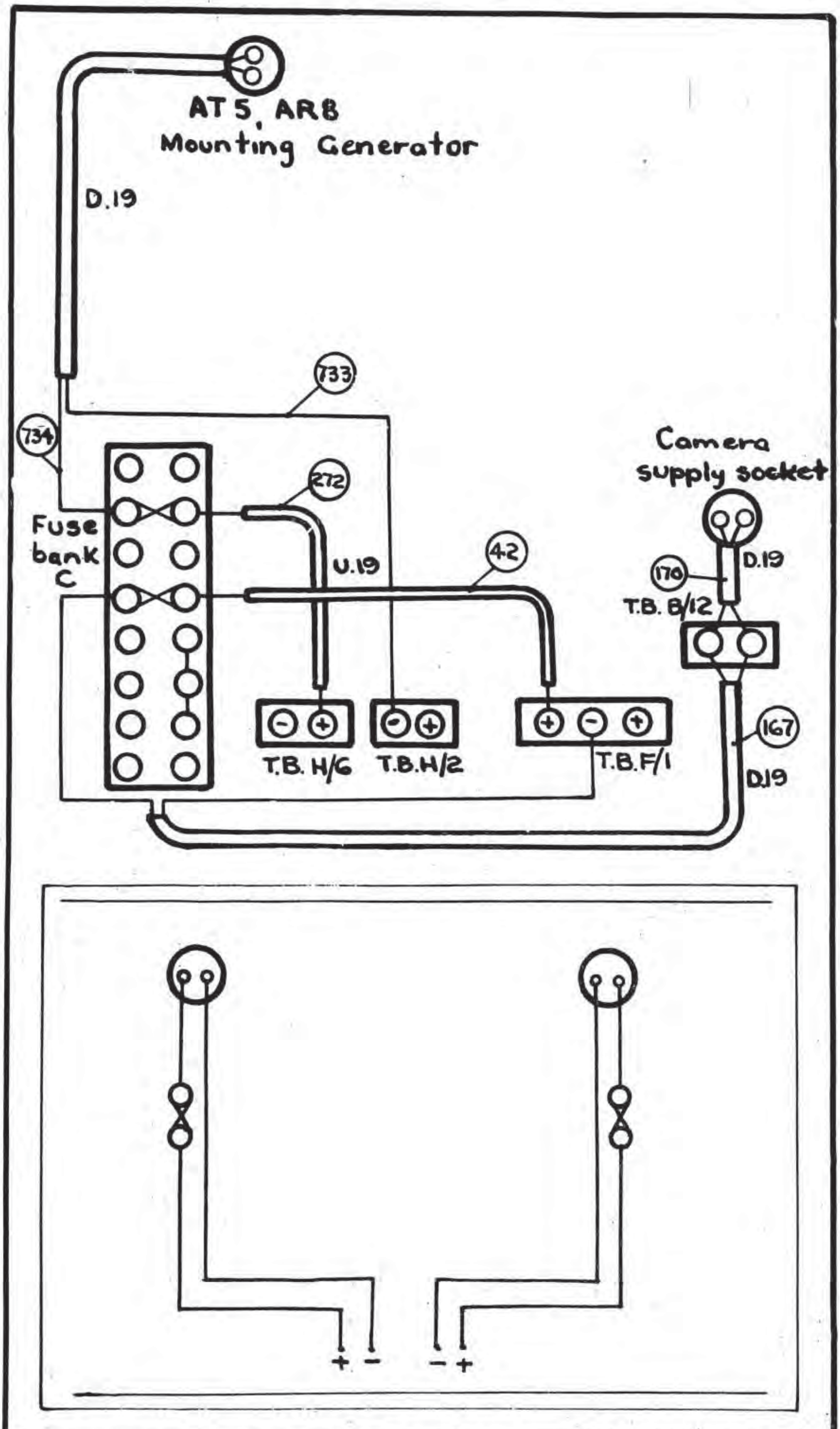


T297 INTERIOR LIGHTING CIRCUIT



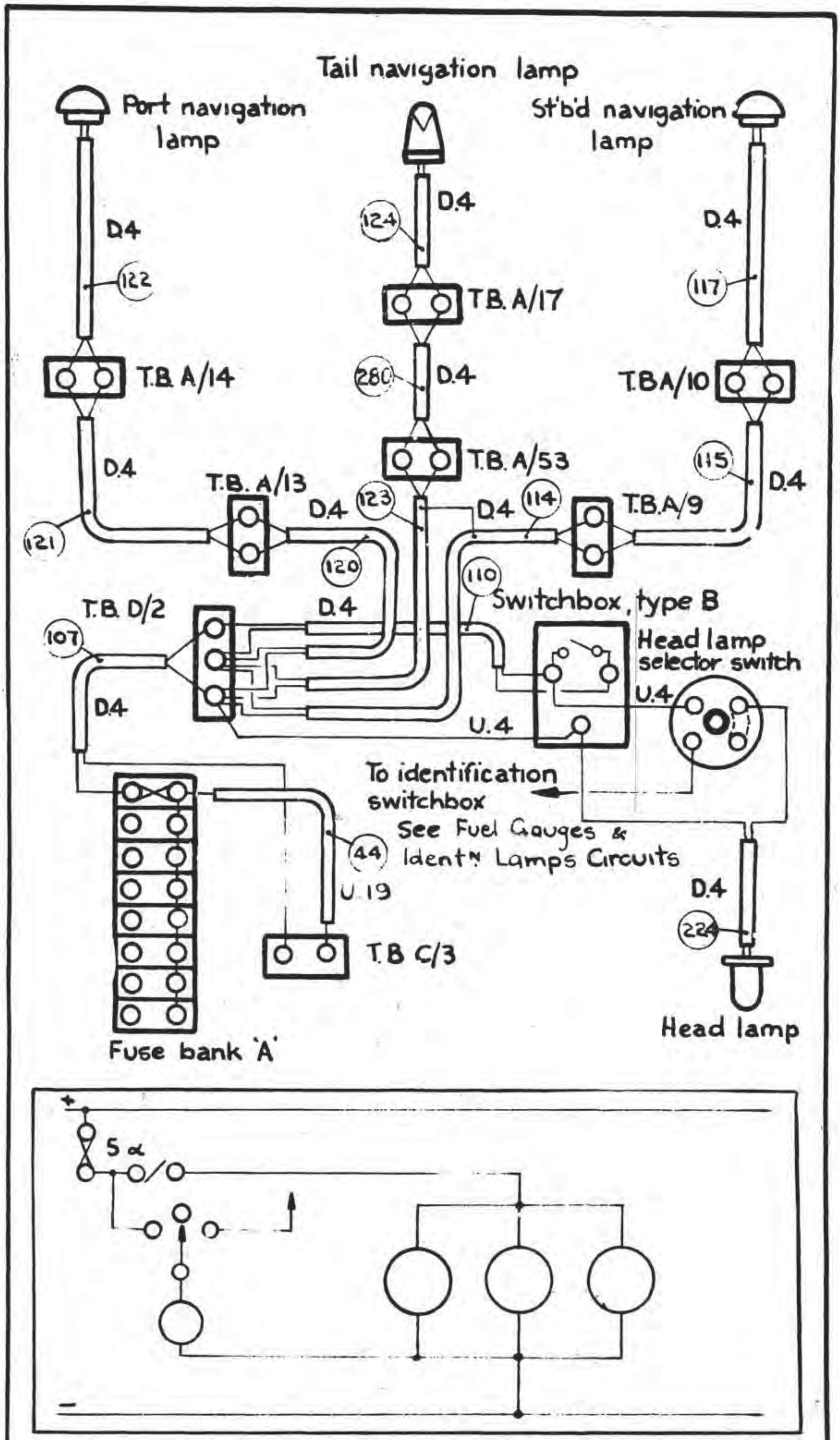
T298

LANDING LAMPS CIRCUITS



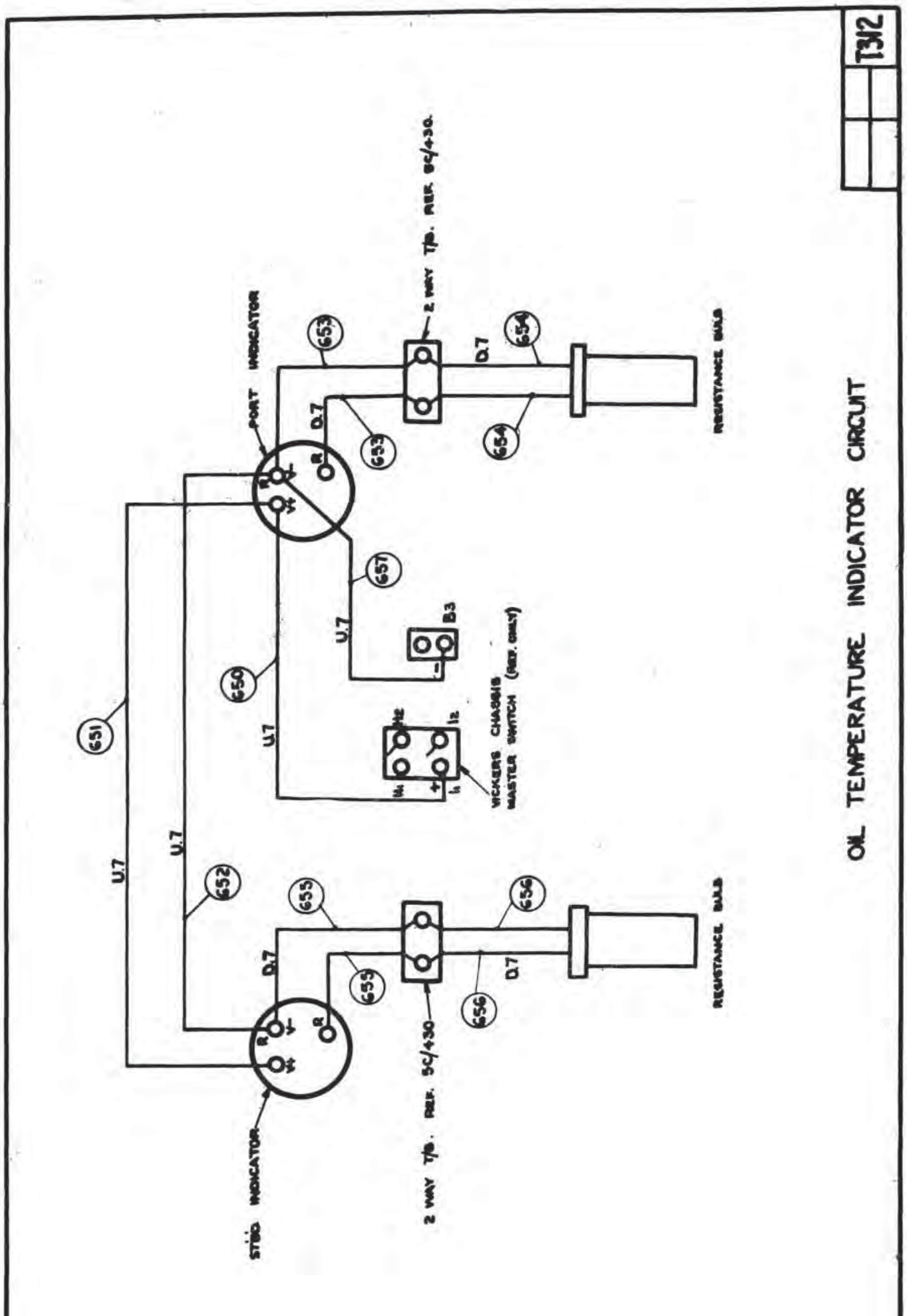
M/G AND CAMERA SUPPLY CIRCUITS

T304

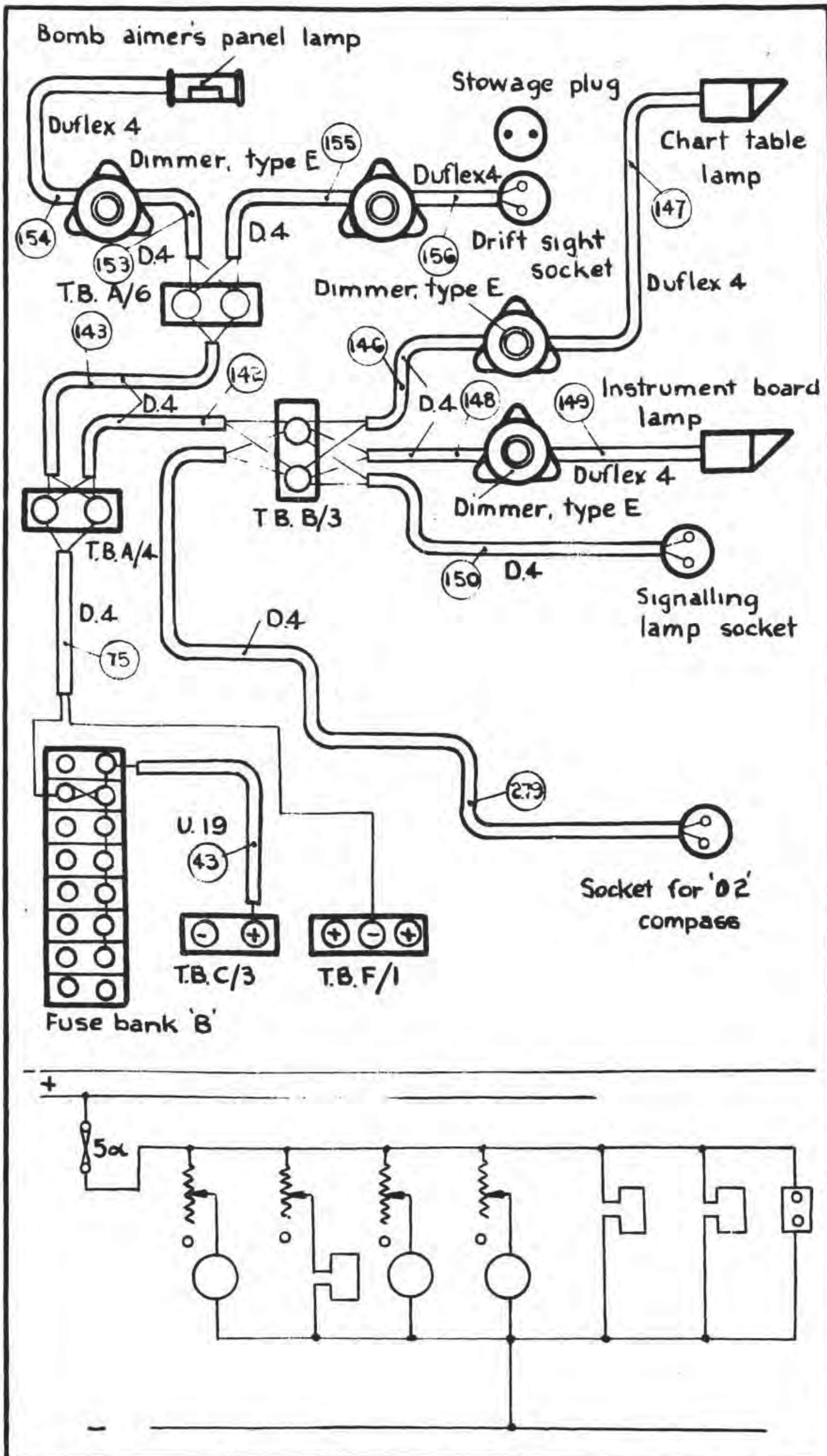


NAVIGATION LAMPS CIRCUIT

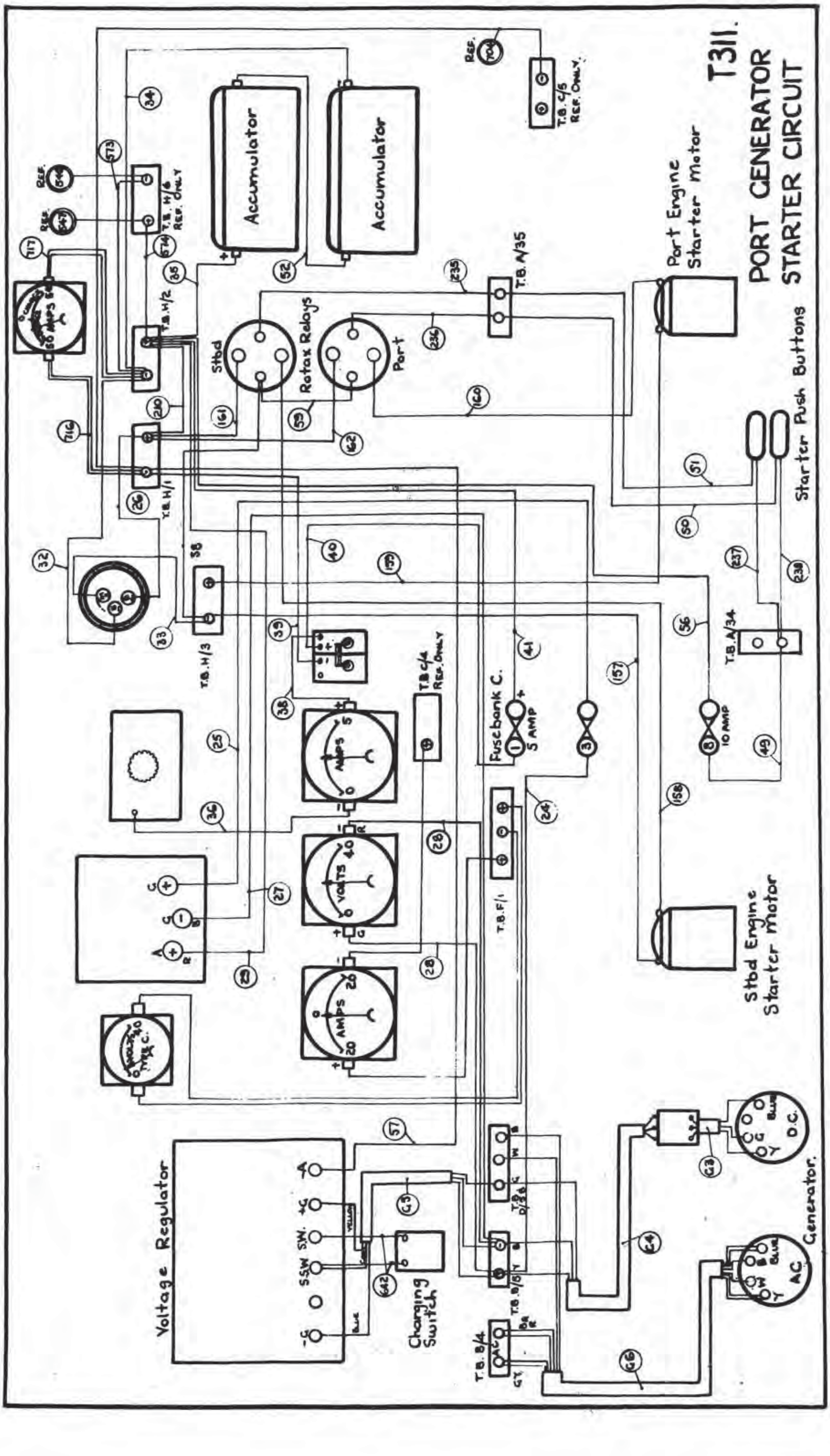
T294

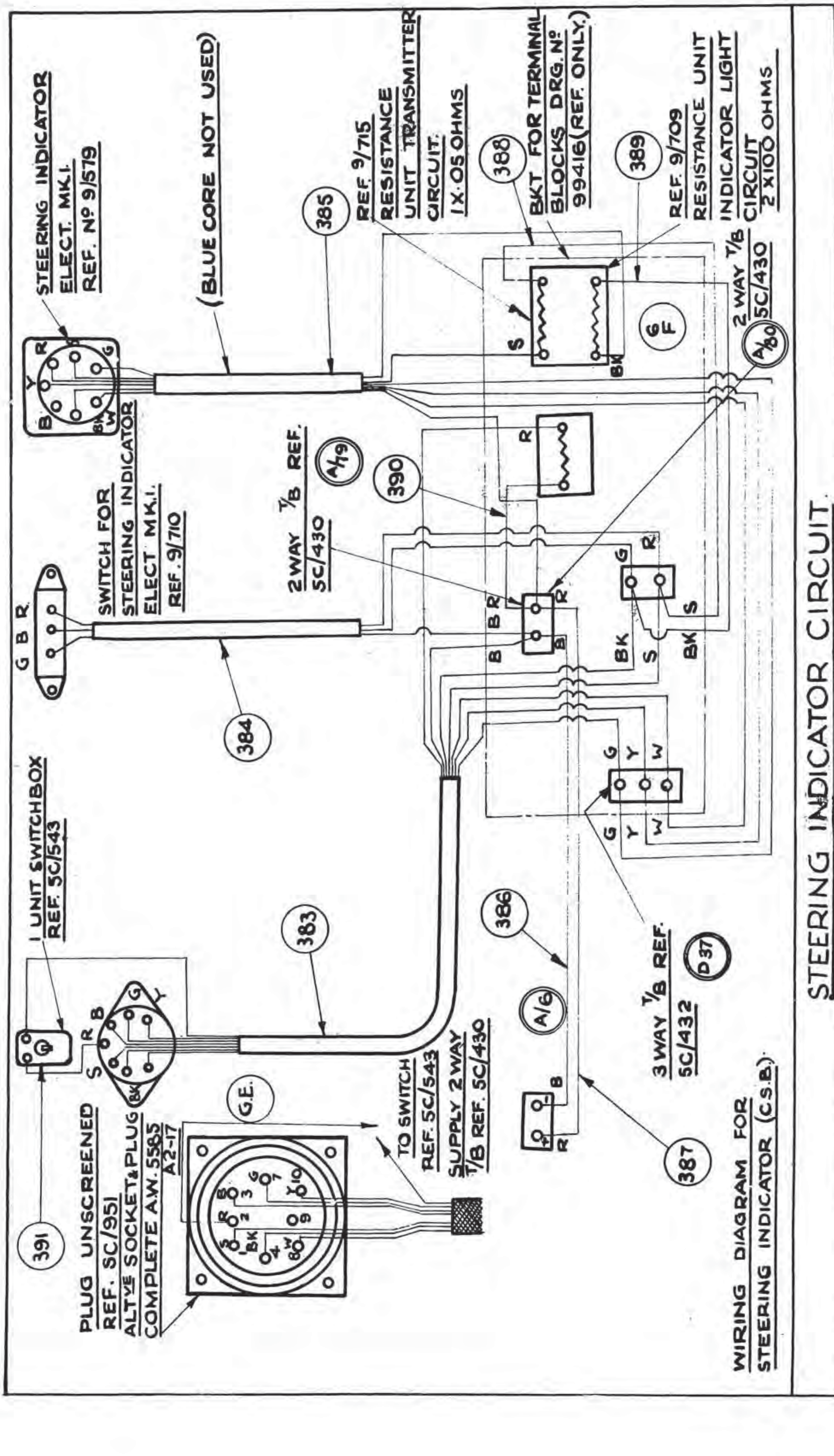


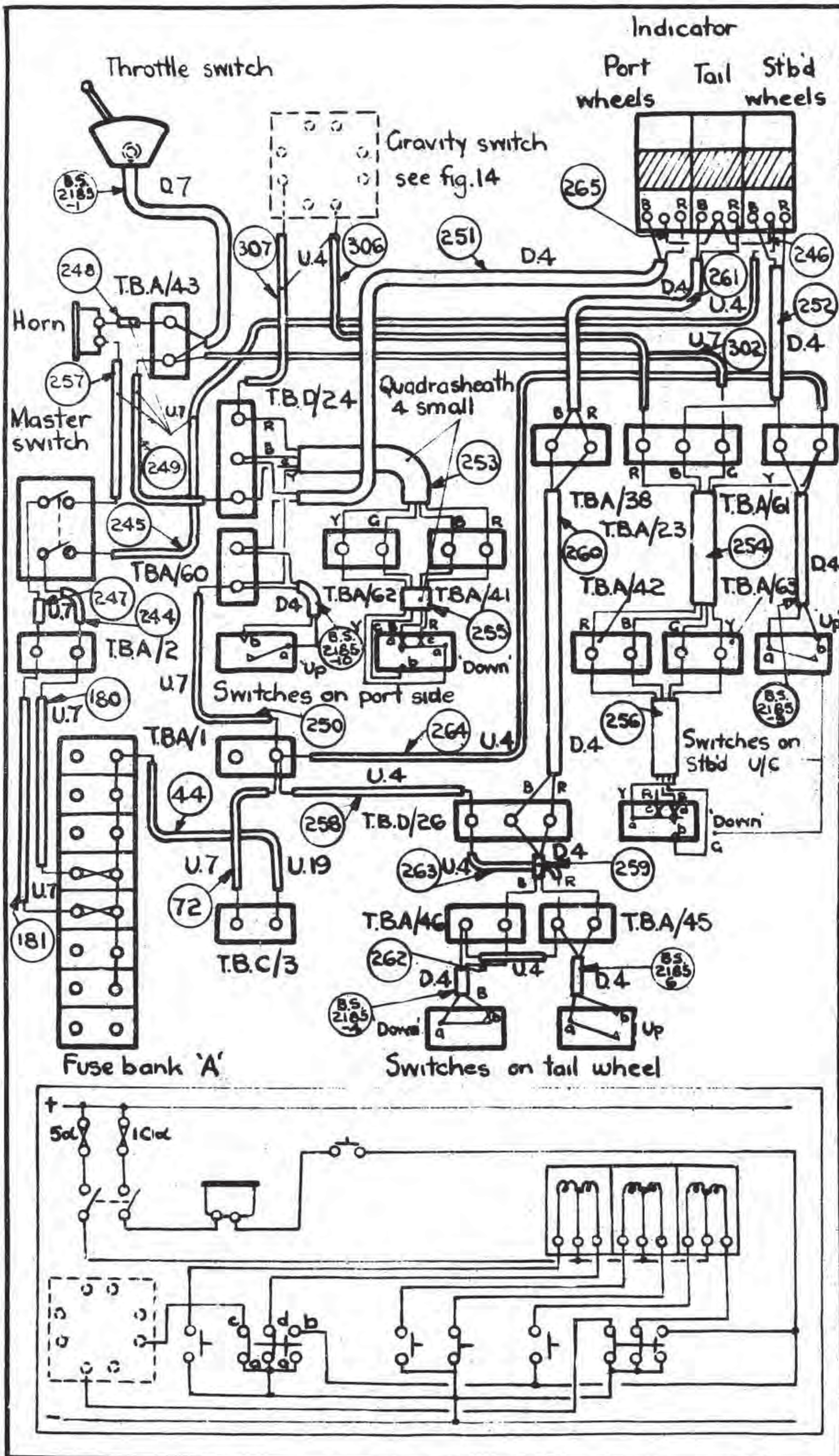
OIL TEMPERATURE INDICATOR CIRCUIT



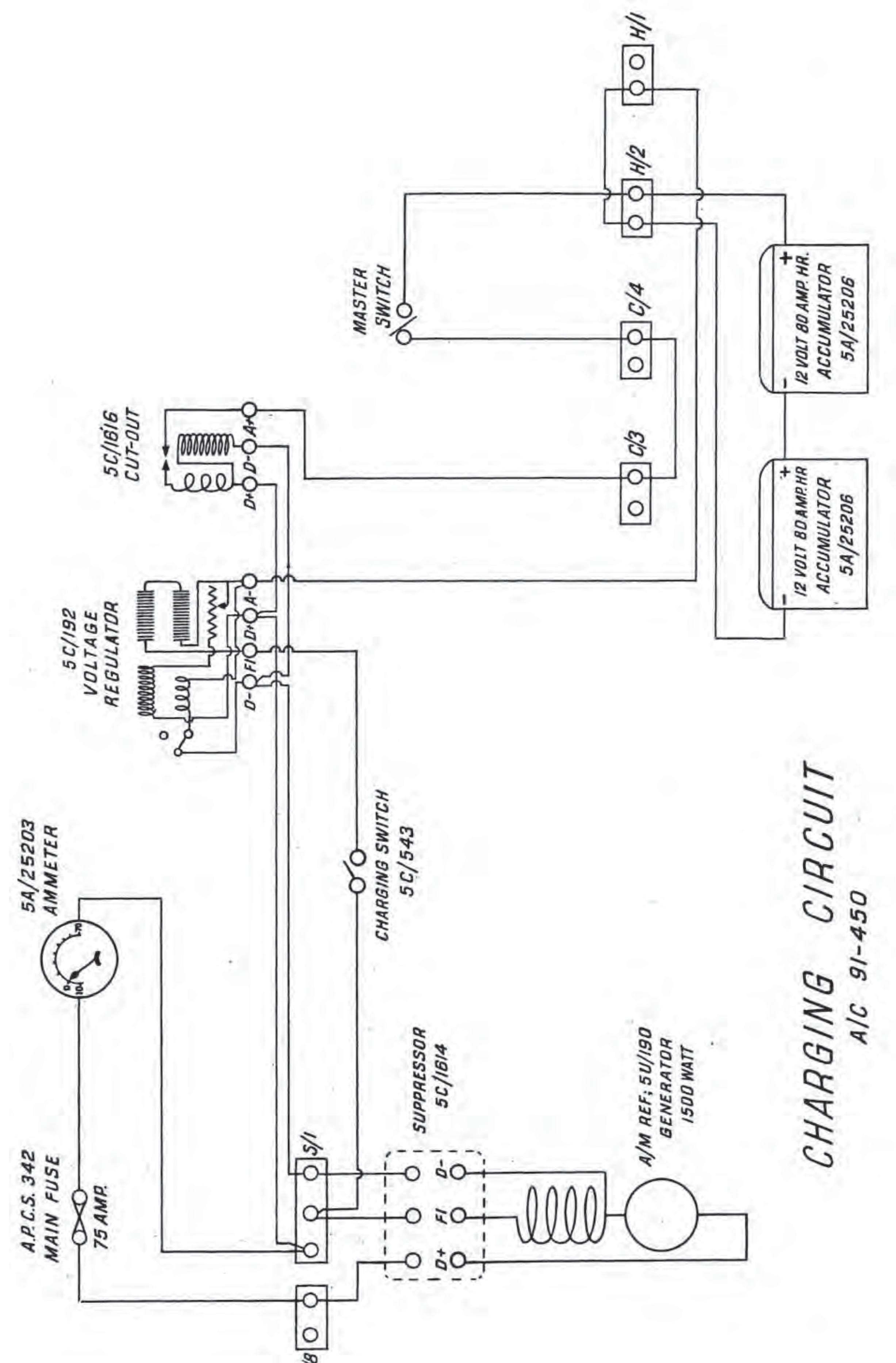
T295			PILOT'S INSTRUMENT LAMPS CIRCUIT


T311.
PORT GENERATOR
STARTER CIRCUIT
Accumulator
Accumulator
Stbd
Rotax Relays
Port
Port Engine
Starter Motor
Stbd Engine
Starter Motor
Starter Push Buttons
Fusebank C.
5 AMP
10 AMP
Voltage Regulator
Charging Switch
Generator.
A.C.
D.C.
T.B. H/1
T.B. H/2
T.B. H/3
T.B. H/6 REF. ONLY
T.B. C/5 REF. ONLY
T.B. C/4 REF. ONLY
T.B. A/35
T.B. A/34
T.B. F/1
T.B. B/4
T.B. B/5
AMPS
VOLTS
-G
SSW
SW.
+G
A


STEERING INDICATOR ELECT. MK.I. REF. No 9/579
(BLUE CORE NOT USED)
385
REF. 9/715 RESISTANCE UNIT TRANSMITTER CIRCUIT. 1 X ·05 OHMS
388
BKT. FOR TERMINAL BLOCKS DRG. No 99416 (REF. ONLY)
389
REF. 9/709 RESISTANCE UNIT INDICATOR LIGHT CIRCUIT 2 X 100 OHMS
2 WAY T/B 5C/430
A/80
A/19
390
SWITCH FOR STEERING INDICATOR ELECT. MK.I. REF. 9/710
2 WAY T/B REF. 5C/430
384
1 UNIT SWITCHBOX REF. 5C/543
383
386
3 WAY T/B REF. 5C/432
D37
A/6
387
391
PLUG UNSCREENED REF. 5C/951
ALTVE SOCKET & PLUG COMPLETE A.W. 5585 A2-17
G.E.
TO SWITCH REF. 5C/543
SUPPLY 2 WAY T/B REF. 5C/430
STEERING INDICATOR CIRCUIT.
WIRING DIAGRAM FOR STEERING INDICATOR (C.S.B.)



UNDERCARRIAGE INDICATOR CIRCUIT		T307



CHARGING CIRCUIT
A/C 91-450

SECTION 7

DESIGN AND CONSTRUCTION OF AIRFRAME

CHAPTER 1

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

FUSELAGE

GENERAL.

1. The fuselage is in three sections, all of which are of all-metal monocoque construction, consisting of alclad formers, mainly of lipped Z-section, extruded hiduminium lipped angle-section stringers and alclad skin plating. Mushroom-head aluminium alloy rivets secure the formers and stringers to the skin, but they are not attached to each other, the formers being notched to clear the stringers.

2. The three sections are the front fuselage, the rear fuselage, and the stern frame. The front fuselage extends forward of the front spar of the main plane, and houses the pilot and his controls and equipment, and, in the extreme nose, provides a station for the bomb aimer or navigator; the rear fuselage extends aft to the stern frame and incorporates a gun turret about midway along its length; and the stern frame carries the tail unit and tail wheel unit.

3. The fuselage formers are numbered according to their distance measured in inches from the aft side of the rear former of the front fuselage, which is called former 0. For example, former 30 in the front portion is 30 in. forward of former 0, and former 297.75 in the stern frame is 297.75 in. aft of former 0. The former stations are shown in Fig. 1 in Sec. 4, Chap. 2.

FRONT FUSELAGE.

4. The main structure of the front fuselage (see Fig. 1) is built up of alclad Z-section and channel-section formers, and skin plating with lipped extruded angle-section fore-and-aft stringers (see Fig. 7). A semi-conical cell for the nose of the torpedo is formed at the rear bottom end of the front fuselage, and a substantial keel member extending from former 79 to former 15 is built up round the top of the cell on the centre-line of the aeroplane; the centre-line of the cell is slightly to port of the centre-line of the aeroplane. A duralumin tube structure providing support for various fittings, including the bomb aimer's seat and table and the hydraulic and other controls, is fitted on the centre line, from the nose to just aft of former 62.

5. The roof and part of the sides of the pilot's cockpit are covered with transparent sheeting and a V-shaped windscreen is fitted at the front. A pointed nose extending forward of the windscreen provides a station for the bomb aimer or navigator. The top of the nose portion is covered with transparent sheeting and two flat windows giving a view downwards are fitted in the skin at the extreme nose; provision is made for preventing ice formation on the starboard window by spraying it with anti-freezing mixture. The transparent panels are mounted on rubber on a duralumin tube framework, and are secured by cover strip and set-screws. Tubes are fitted round the horizontal edges or sills of

the monocoque structure both at the nose and at the pilot's cockpit. Chobert hollow rivets, through the wall of the tube next to the skin only, secure the sill tubes to the skin, and the holes in the rivets are plugged with sealing pins.

REAR FUSELAGE.

6. The construction of the rear fuselage (see 2, 3 and 4) is generally similar to that of main structure of the front fuselage. The gun turret (see Sec. 3) is built into the rear fuselage about midway along its length; the top of the structure is cut away to accommodate the turret, and aft of it the top of the fuselage is shaped like an inverted V to afford a wider field of fire for the gun. The main bomb cell (see Sec. 11) extends under the bottom of the fuselage and centre plane from front fuselage former 19 to the rear fuselage former 81, and a small auxiliary cell for the tail of the torpedo extends under the gun turret. A curtained partition bulkhead is fitted at former 81 to divide the wireless compartment from the gunner's station.

7. In the rear fuselage the formers are of lipped Z-and-channel section, with the exception of those at the centre plane spars, at the partition bulkhead, and the two formers forward of the gun turret. The double formers at the spars (2.75-5.25 and 55.36-57.86), and forward of the gun turret (108-109.5 and 123.5-125), consist of two lipped channel-sections placed back to back some distance apart, and having a plate riveted across the flanges of the channels on the inboard side. The formers at the centre plane spars have hiduminium forked blocks riveted and bolted to the web of the channels at the bottom for attachment to the spars. At the partition bulkhead, the former consists of two channel sections placed back to back with the bulkhead skin sandwiched between them. The middle portion of the rear fuselage is strengthened by three longerons on each side. The top and middle longerons are unlipped channel-sections riveted to lipped angle-sections on the skin; the bottom longerons are lipped channel-riveted to the fuselage side (see Fig. 7). At the turret an additional lipped angle-section is riveted on the inboard face of the channel of the top longeron, and at the centre of the longeron a built-up channel-section is riveted to the outside of the longeron channel.

STERN FRAME.

8. The stern frame (see Fig. 5) has lipped Z-section formers, lipped extruded angle-section stringers and alclad skin plating. The front end is of lipped channel-section, and formers 308.5-310.5 and 330-332 for the tail plane attachments are of built-up form. The rear end of the stern frame is formed by a stern post which carries the bottom hinge of the rudder and is extended upwards to carry the top hinge. A stringer of special section (see Fig. 7) is fitted near the bottom of the structure on each side. An aperture in the underside of the stern frame is boxed in

with aluminium-manganese-alloy and acetate sheet, and provides for the tail wheel unit when the latter is retracted. Attachments for the tail wheel unit are provided on formers 308.5-310, and on a small partial former 299.75. A bridge piece at the top, and a bracket at the bottom, are fitted between formers 249 and 258 for the rudder and elevator countershafts. The stern frame is attached to the rear fuselage by set-screws and Simmonds nuts as shown in Fig. 5.

ATTACHMENT OF FRONT FUSELAGE, REAR FUSELAGE, AND CENTRE PLANE.

9. The ends of the skin plating of the front fuselage and the rear fuselage butt together and are secured by set-screws and Simmonds nuts to butt straps underneath. The other attachments are made at the hiduminium blocks on the box ribs of the centre plane. Two blocks near the bottom of the front fuselage are riveted to channel-sections that are riveted to angle-sections on the skin and are secured by high-tensile steel bolts in steel bushes to the forward horizontal pair of blocks at the bottom of the centre plane box ribs. At the top, the centre plane is attached to the rear fuselage by bolts in steel bushes through the blocks at formers 2.75-5.25 and 55.36-57.86, and the two pairs of vertical blocks on the box ribs. Extruded and plate angle-sections strengthen the curve of the fuselage over the top surface of the centre plane. The rear pair of horizontal blocks on the box ribs are attached by bolts and steel bushes to a block riveted to each middle longeron of the rear fuselage.

ENTRANCE HATCH.

10. The entrance hatch between formers 81 and 108 consists of the two doors constructed of a double skin of birch plywood on spruce formers. The lower door has a circular window, and on the outer surface of the upper door, a hand grip and a flush handle for opening the hatch are fitted. At the top of the flush handle is a spring loaded hinge plate that can be forced inwards, enabling a grip to be obtained on the handle. The handle is riveted to a shaft that is connected by levers and cables to a draw bolt in a stop at each end of the hatch. In the open position the upper door can be secured in a clip at the top of the fuselage. A handle is also provided on the inside for opening the door.

ENTRANCE LADDER.

11. The retractable entrance ladder is illustrated in Fig. 7.

12. The pilot's seat is constructed to take a seat-type parachute, and is adjustable for height. It is attached to a duralumin tube structure extending between former 30 and the main plane front spar by two links at the back near the top and by two levers hinged to the tube structure and attached at the other end to a tube across the bottom of the seat. Fixed to the lever on the port side is the seat adjusting handle, by means

of which the seat can be raised 4 in. from the lowest position. A twist grip is fitted to the front end of the handle, and when it is rotated an internal cam forces down a spring-loaded sleeve and disengages a locking bolt from a toothed quadrant attached to the tube structure. Elastic tension cords are fitted at the back of the seat to relieve the levers of the weight of the occupant and facilitate raising of the seat.

13. The seats at the crew stations are described in Sec. 3.

PARTITION BULKHEAD.

14. Aft of the wireless operator, a partition bulkhead is fitted at former 81. The bulkhead has a door opening near the starboard side, across which a curtain can be drawn and secured in clips at the port side. The vertical edges of the door opening are bounded by tubes and armour plate is fitted to the bulkhead to afford protection to the wireless operator against gunfire from the rear.

EMERGENCY EXITS.

15. The releases for the emergency exits in the floor of the bomb aimer's station, and in the sides and roof of the pilot's cockpit, are illustrated in Fig. 6. Reference should also be made to Sec. 1.

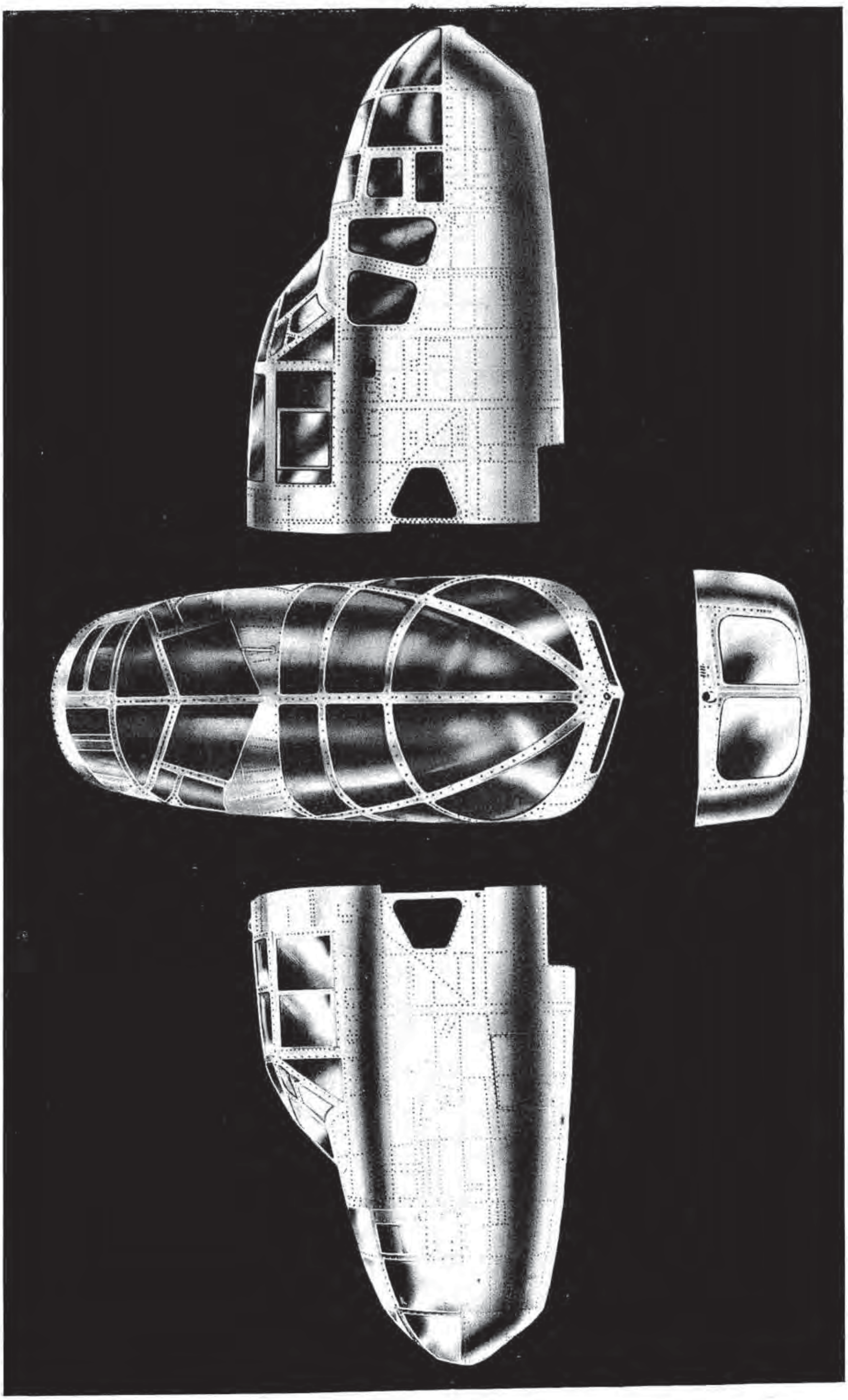


FIG. 1—FRONT FUSELAGE.

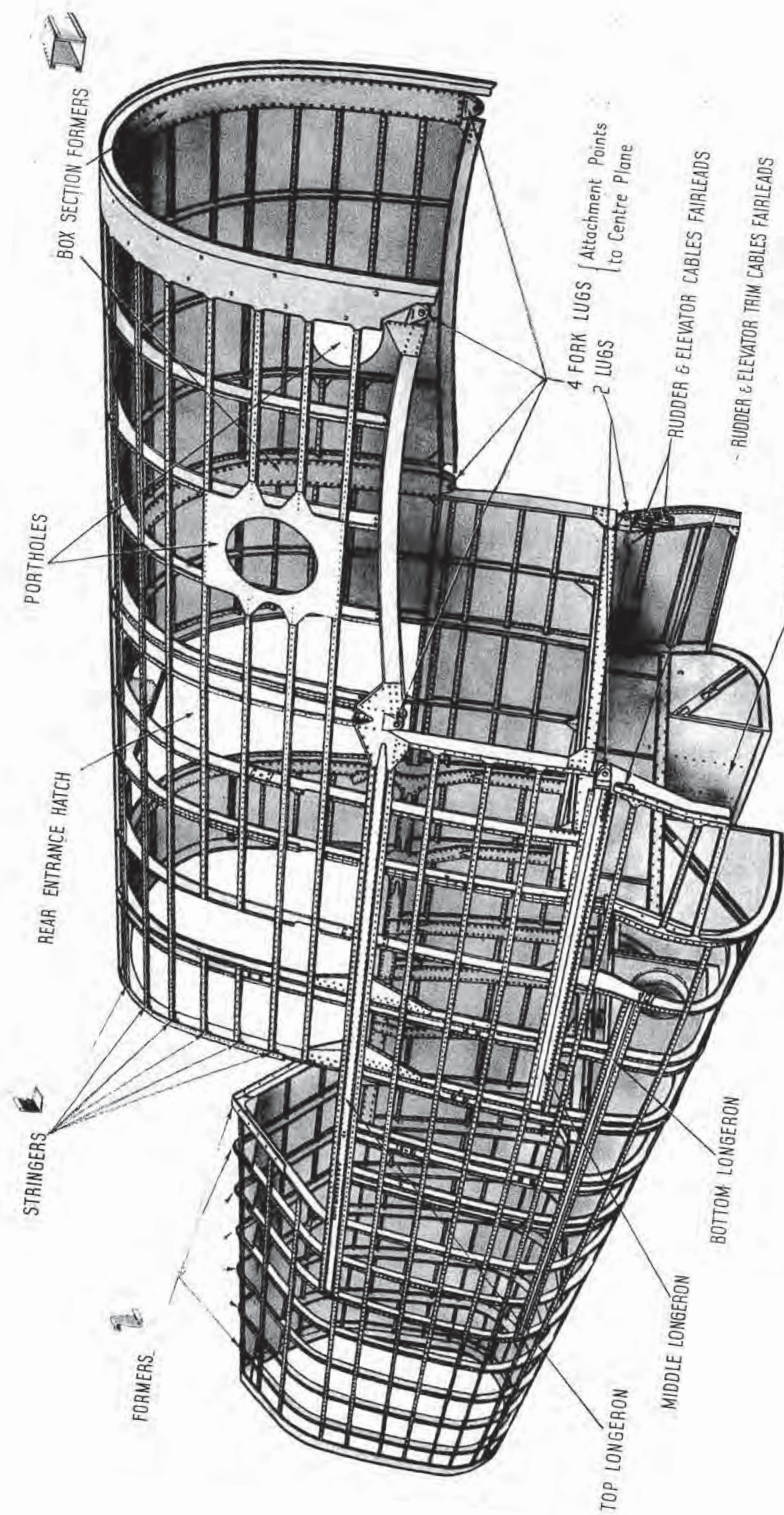


FIG. 2—REAR FUSELAGE (EXTERIOR).

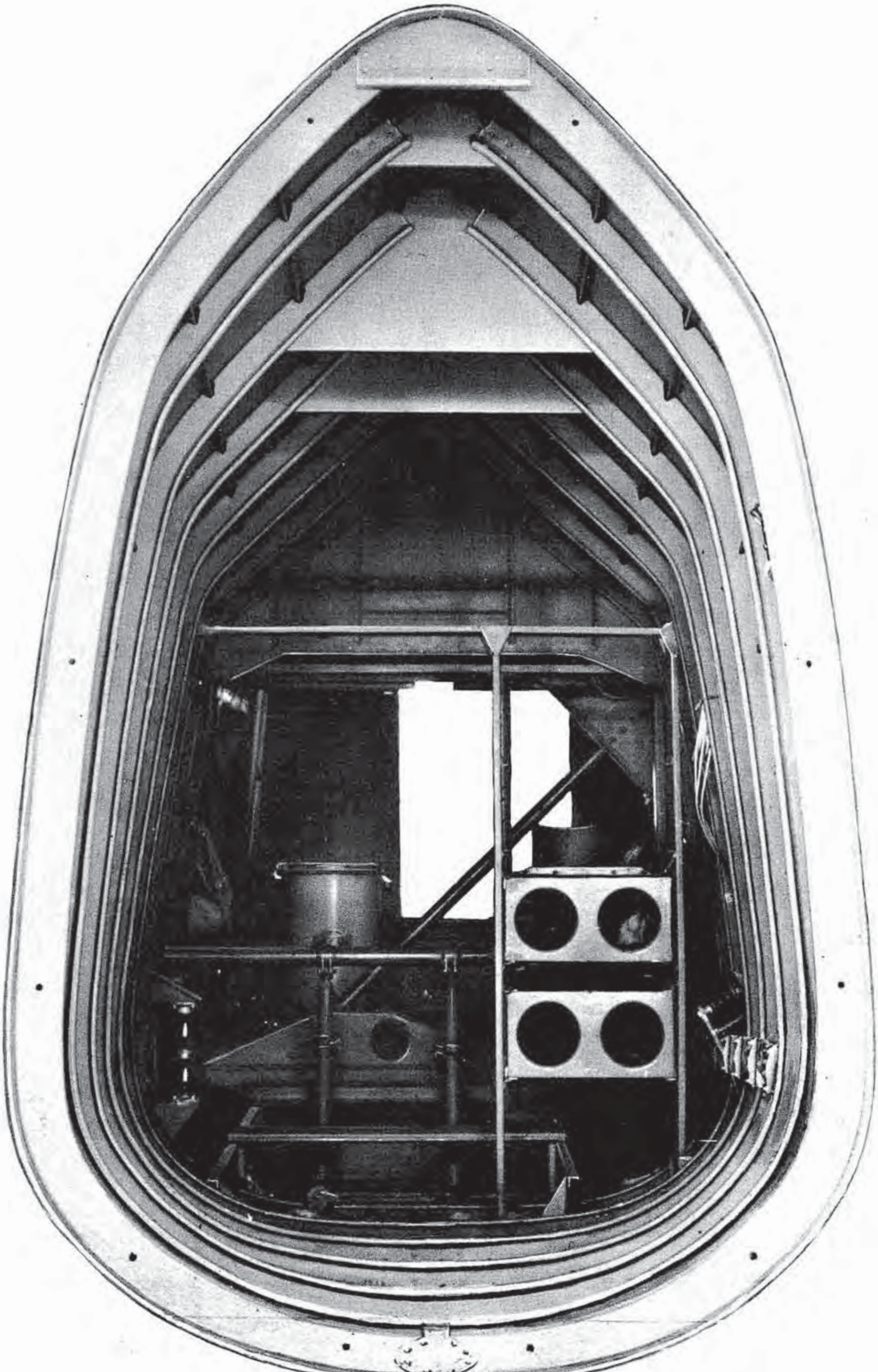


FIG. 3—REAR FUSELAGE (INTERIOR), REAR.

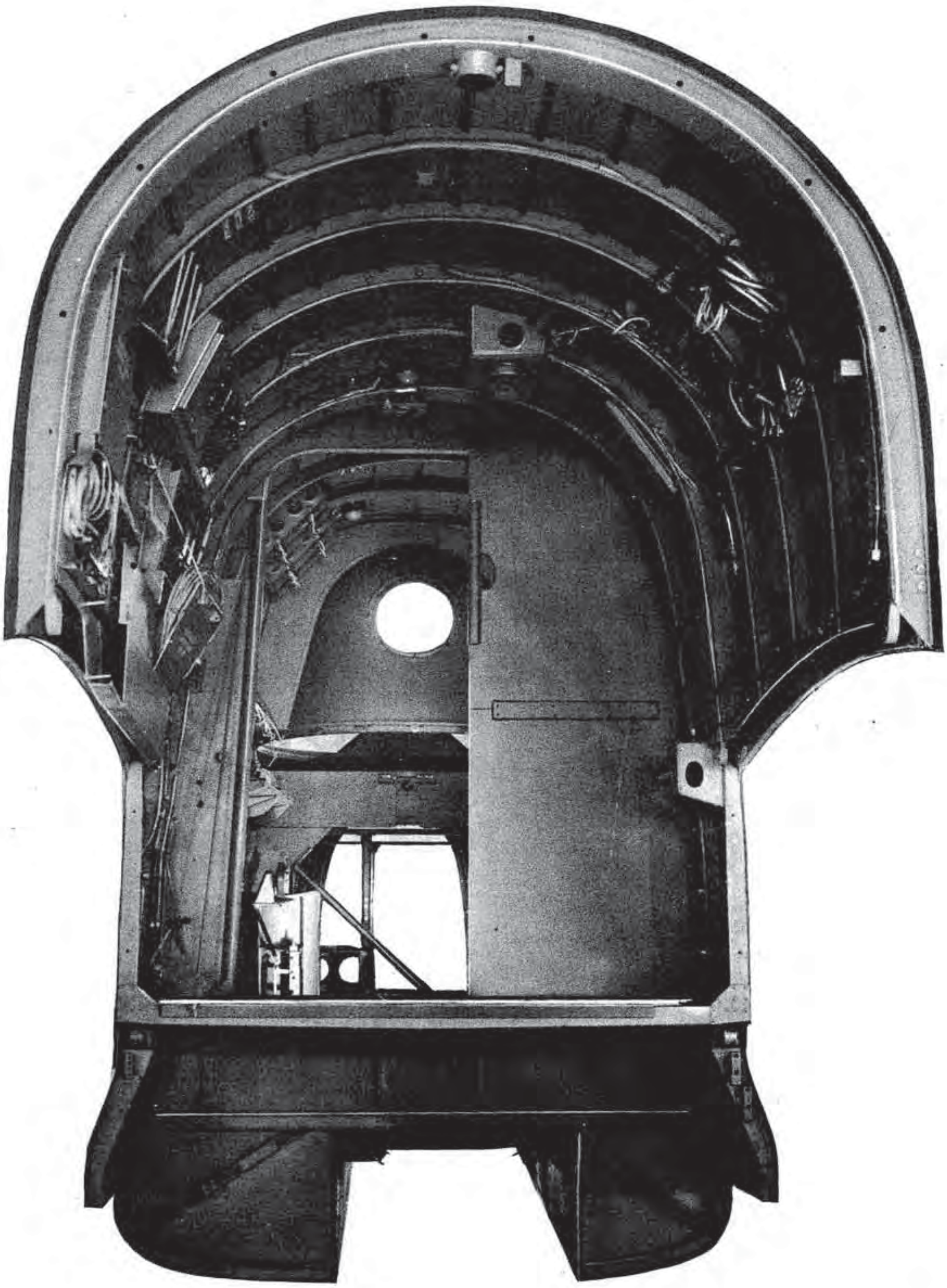


FIG. 4—REAR FUSELAGE (INTERIOR), FRONT.

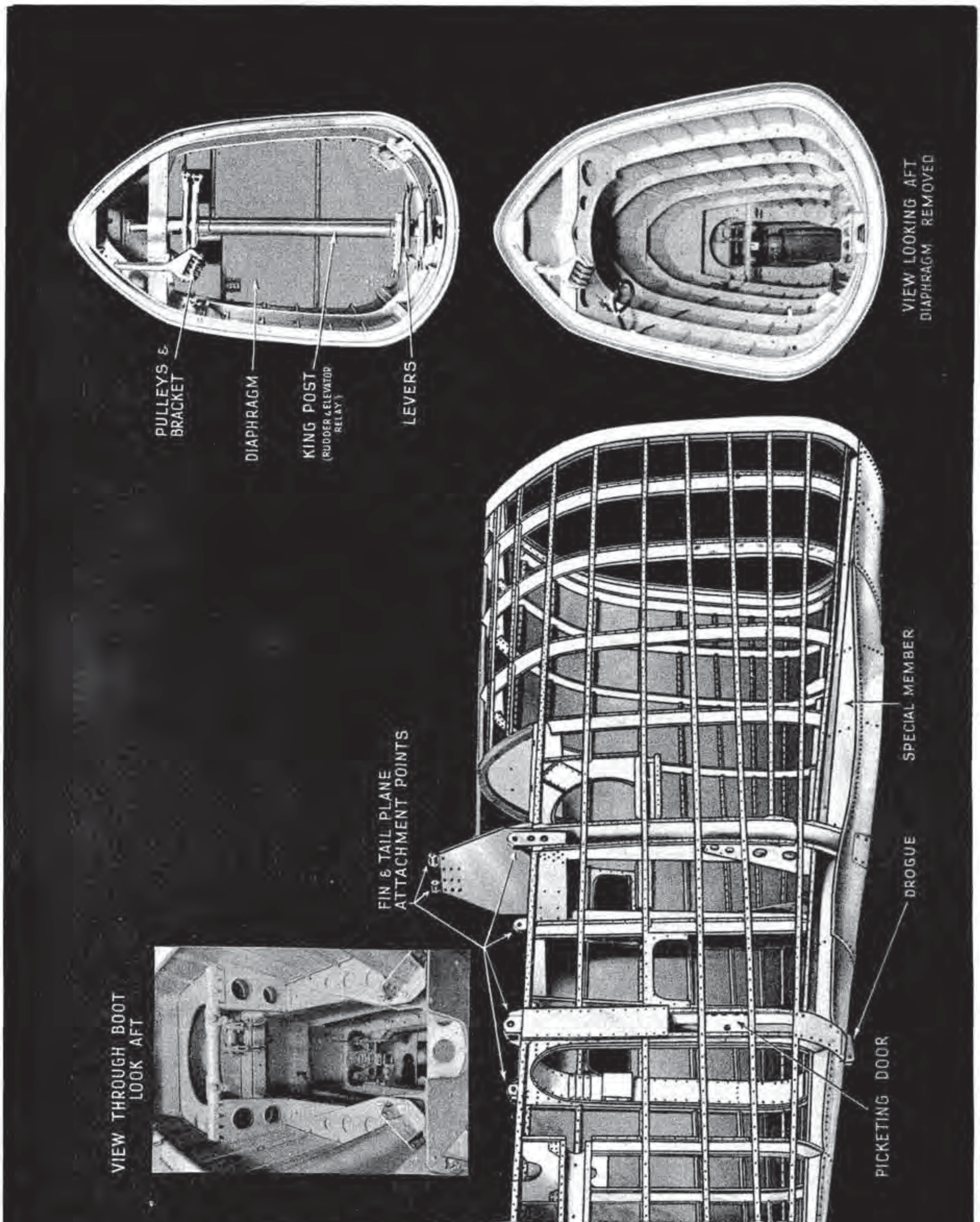


FIG. 5—STERN FRAME.

CHAPTER
2

CHAPTER 2

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LIST OF ILLUSTRATIONS

MAIN PLANE

GENERAL.

1. The main plane is a cantilever two-spar metal-covered structure tapered in chord and thickness, and is constructed in three portions, the centre plane and the two outer planes. The centre plane spars are continuous through the fuselage and are bolted to it. Hydraulically-operated split-trailing-edge flaps are fitted inboard of the ailerons and extending to the fuselage sides. Provision is made for attaching the bomb or torpedo load to the underside of the portions of the centre plane within the fuselage. Near the outboard ends of the centre plane are mounted structures of square steel tube for the engine mounting nacelles and for the undercarriage units. Two fuel tanks are carried in the centre plane on each side of the centre-line, and one fuel tank is carried in each outer plane. Two landing lamps are fitted under a transparent panel in the leading edge of the port outer plane. An inflatable dinghy is stowed in the inboard trailing edge of the port centre plane, and a fixed Browning gun is mounted in the port and starboard outer plane. Bombs may also be carried externally under the main plane between ribs 5 and 6 of each outer plane.

CENTRE PLANE.

2. The centre plane, which is shown (viewed on the underside) in Fig. 1, has two spars with alclad webs and extruded hiduminium booms, alclad ribs and skin covering and spanwise skin stiffeners of extruded lipped angle-section hiduminium similar in section to the fuselage stringers. The main ribs extend between the spars only and the leading edge and the trailing edge ribs are separate structures. Between the engine nacelles and the fuselage sides, the lower surface of the leading edge is hinged to permit access to the controls in the leading edge. Four fittings are provided on each box rib on the fuselage sides for attachment of the centre plane for the fuselage (see Chap. 1), and fairing fillets are fitted at the junction of the two parts, and secure by wood-screws to a wood strip underneath.

3. **SPARS.**—The spars have a web plate of alclad sheet, to which booms of special section extruded hiduminium are riveted. An angle-section for the attachment of the skin is also fitted at the booms. Lipped angle-sections are riveted to the inner faces of the web to provide attachment for the ribs and to stabilise the web. The ends of the booms are drilled and have steel bushes for the centre and outer plane joint bolts. End fittings are bolted to each side of the booms and an extra web plate is also fitted near the end of the spar.

4. **TRAILING EDGE.**—The trailing edge is in two portions, and is built up of alclad flanged ribs and skin covering. The skin overlap of the forward portion is secured to the angle-section skin bracket on the rear spar, and the ribs are bolted to the rear spar booms. The after portion,

which is open on the bottom surface for the flaps, is secured by set-screws and bolts in Simmonds nuts to a false spar at the aft end of the forward portion. There is also a lipped angle-section stringer on the top and bottom skin at about mid-chord on the forward portion. Provision for stowage of the inflatable dinghy is made in the port trailing edge.

5. **RIBS.**—Rib 1 at each fuselage side is of built-up box form and has horizontal forked blocks of hiduminium riveted to the bottom corners, and vertical forked blocks bolted to it at the top corners. These blocks have pressed-in steel bushes for the centre plane to fuselage attachment bolts. The undercarriage attachment ribs have an alclad plate web with top and bottom flanges of alclad lipped angle-section, and are reinforced by a bracing of square duralumin tubes and vertical hiduminium angle-section stiffeners and top and bottom flanges of alclad channel-section riveted on one side. The remaining interspar ribs have no web plate or bracing, and consist of channel-section and I-section booms riveted to the skin.

OUTER PLANES.

6. The outer planes (see Fig. 2) are generally similar in construction to the centre plane, and are attached to it at the spars. The top booms of the outer plane spars have forked steel-bushed end fittings which interlock with and are bolted direct to the centre plane spar end fittings. The steel-bushed end fittings on the bottom boom are secured to the centre plane spar by bolts and link plates on each side. In addition, the webs of the centre and outer plane spars are connected by bolted attachment channels and tie plates. A sealing strip over the gap between the skin of the centre plane and of the outer plane is secured by set-screws.

7. **RIBS.**—The main interspar ribs have an alclad web plate stiffened by hiduminium vertical angle-sections and flanges of alclad lipped angle-section. The remaining ribs have a top and bottom boom of alclad channel-section interconnected by hiduminium lipped angle-sections. At the fuel tank position the upper ribs have a diaphragm reinforced by a top and bottom angle-section on one side, thus forming a channel-section, and the lower ribs have a channel-section boom similar to the other ribs. The nose ribs are of flanged alclad plate construction.

8. **WING TIP.**—Each wing tip (see Fig. 3) is constructed of alclad angle-section ribs and formers, and alclad skin covering. It is secured by screws to rib 17, and is detachable. The outer end of the wing tip is made of transparent sheet, enclosing the navigation and formation-keeping lamps, which are mounted on the outer end rib.

AILERONS.

9. Each aileron has a duralumin spar, ribs, nosing, and trailing edge of alclad sheet, and fabric covering. Mass-balance weights are fitted in the nose of the ailerons, and the hinge points are inset to obtain aero-

dynamic balance. An uncovered aileron, viewed from the underside, is illustrated in Fig. 4.

10. The spar is a duralumin tube on which flanged alclad plate ribs are secured by collars and taper pins. Eyelets for the fabric stringing are incorporated in the rib flanges. The alclad sheet nosing is bent round and riveted to the nose of the ribs, and lead mass balance weights are riveted inside the nose of the balance portion along its entire length. Outboard and inboard of the trimming tab, the trailing edge is of alclad sheet riveted to the ribs. A duralumin tube from the rear outboard corner to an eyebolt through the spar reinforces the outboard end of the aileron. The fabric covering extends right round the nosing of the aileron. Three ball bearing hinges are provided on each aileron, and are attached to the false spar of the outer plane trailing edge.

11. **TRIMMING TABS.**—The trimming tab on the port aileron is made of light gauge stainless steel sheet secured to a former between ribs 5 and 7 by countersunk-head screws on the top surface and by dome-head screws in elongated holes on the underside, thus allowing a small amount of adjustment for lateral trimming of the aeroplane to be made on the ground. The fabric covering of the aileron passes round the fabric former to which the tab is secured, but does not pass over the tab.

12. The trimming tab on the starboard aileron is adjustable when the aeroplane is flying, and consists of alclad sheet bent to shape and hinged to the trimming tab fabric former. An operating lever is fitted to the underside of the tab.

FLAPS.

13. The main plane flaps are constructed in four sections, the port and starboard centre plane flaps and the outer plane flaps, and extend from the fuseage sides out to the aileron. They are operated by two hydraulic jacks, and the port and starboard flaps are inter-connected by balance cables to ensure that they operate simultaneously (SEE Chap. 5).

14. The construction of the flaps is illustrated in Fig. 5. They are constructed mainly of alclad and have channel-section ribs, a Z-section spar at the forward face, channel-section transverse stiffeners at about mid-chord, and a rectangular tube trailing edge. Snap-head rivets secure the major portion of the bottom skin covering to the ribs and stringers, but Chobert rivets are used on the top surface, as there is no accessibility for holding up snap-head rivets after assembly of the bottom skin. Chobert rivets are also used at the last three rows of the rivets on the bottom surface. The lower skin surface projects beyond the trailing edge and, when the flap is raised, closes the rear end of the gap on the under-surface of the main plane. Piano-type hinges at the bottom corner of the forward face connect the flaps to the structure. A duralumin operating lever is bolted to the outboard end of each plane flap, and to the inboard end of each outer plane flap.

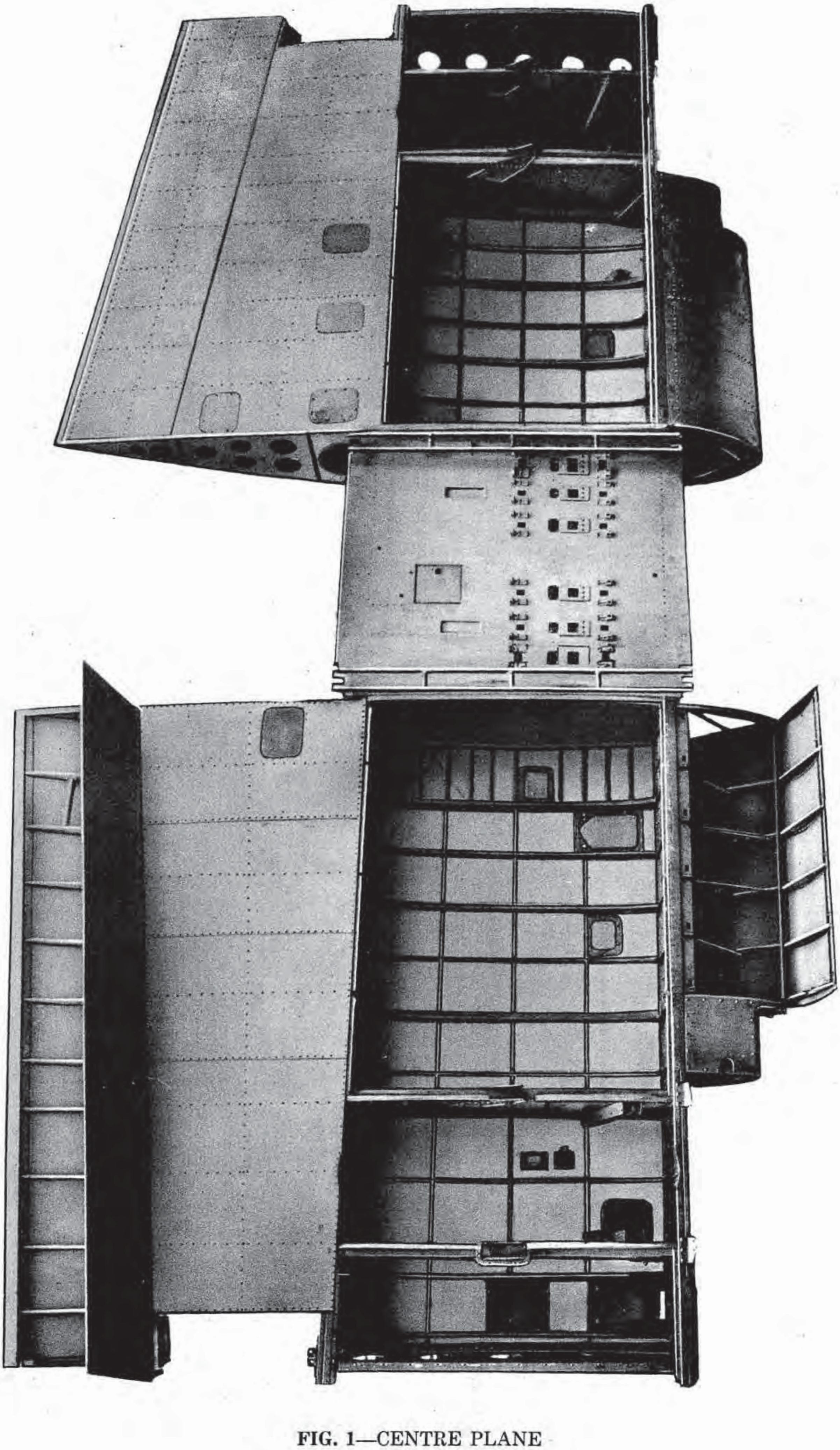

FIG. 1—CENTRE PLANE

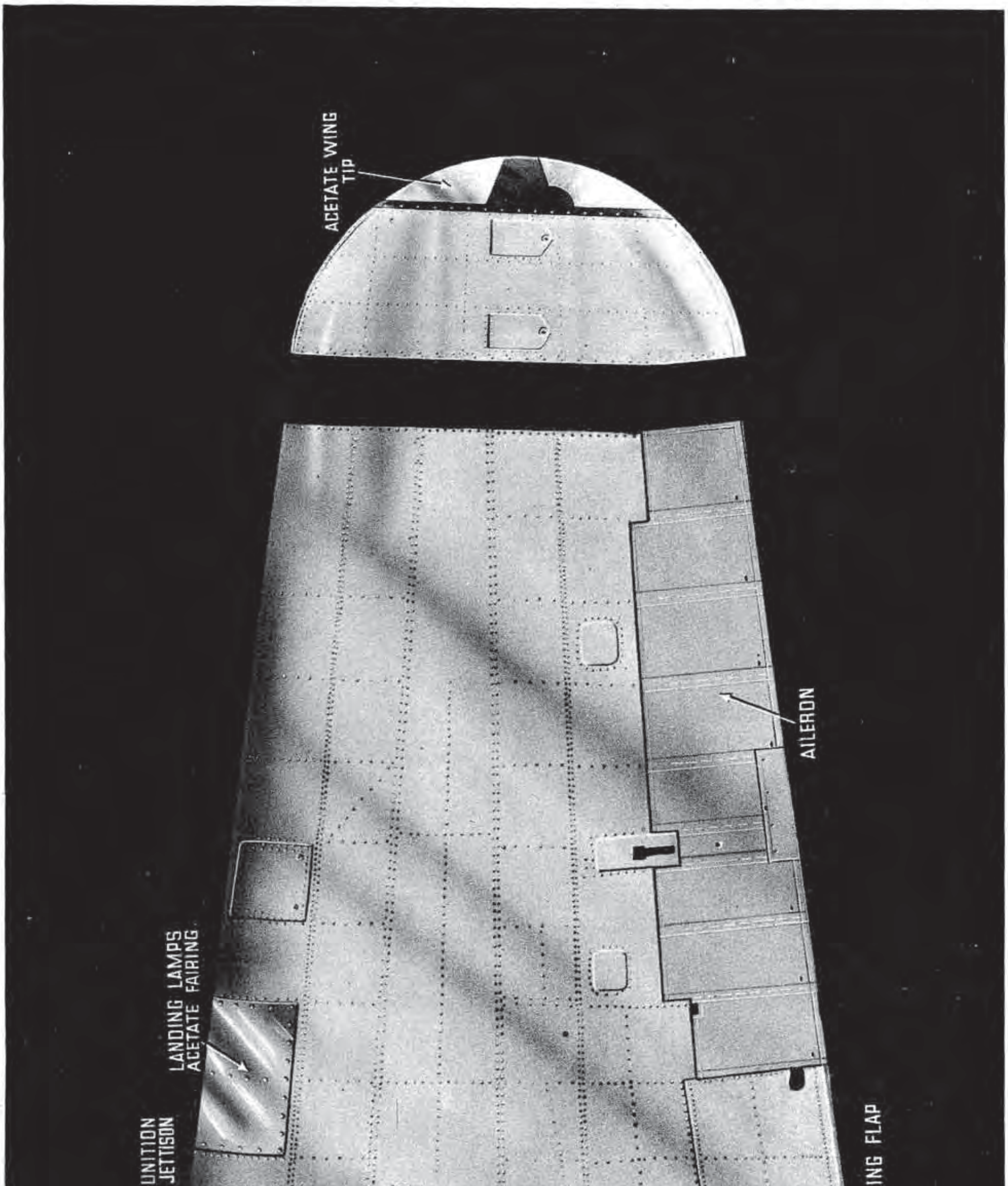

FIG. 2—OUTER PLANE AND WING TIP.

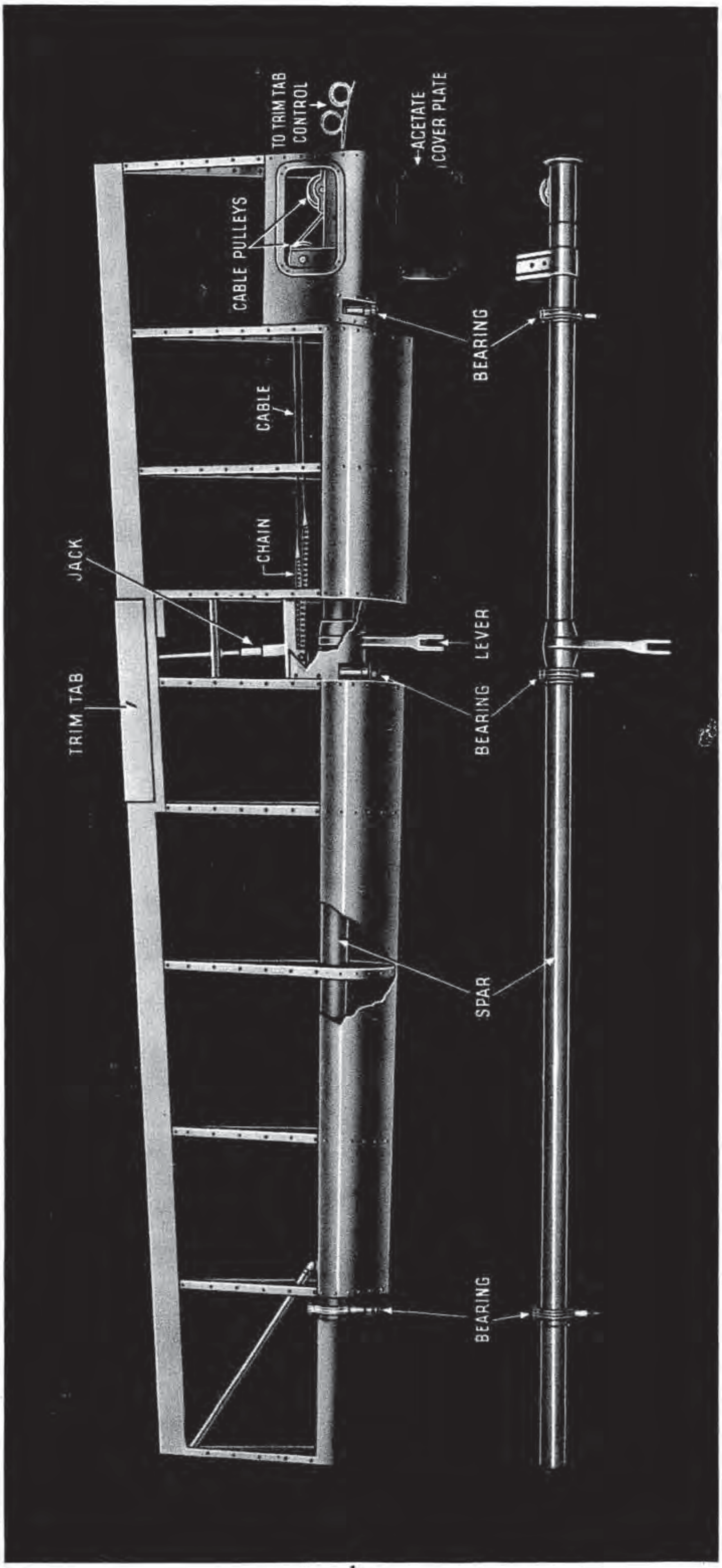

FIG. 4—AILERON.

CHAPTER 3

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UNDERCARRIAGE

TAIL WHEEL UNIT

LIST OF ILLUSTRATIONS

ALIGHTING GEAR

GENERAL.

1. The alighting gear consists of two independent undercarriage units and a tail wheel unit. All three units are retractable, and are normally operated by hydraulic power. The undercarriage unit swinging backwards and upwards into a recess on the underside of the stern frame. The normal system is described in Sec. 4A, Chap. 4. The indicating warning devices include three electrical position indicators, one for each unit, and an electrical buzzer. Oleo pneumatic shock-absorber legs are fitted to the undercarriage and tail wheel units, and Dunlop pneumatic brakes are fitted to the undercarriage.

POSITION INDICATORS AND WARNING BUZZER.

2. In the pilot's cockpit, three electrical position indicators, one for each unit, and a warning buzzer, indicate the positions of the alighting gear units. The undercarriage indicator switches are operated by the locking catches (see Para. 6) on the undercarriage, the tail wheel indicator switch by the tail wheel retracting mechanism, and the buzzer switch by the engine levers, as shown in Fig. 6 in Sec. 4A, Chap. 6. Further information is given in Secs. 1 and 4A.

CONTROL SAFETY LOCK AND LOCKING PINS.

3. The control safety lock and the locking pins for preventing inadvertent retraction of the undercarriage when the aeroplane is on the ground are described in Sec. 1. Reference should also be made to Fig. 1 in Sec. 4A, Chap. 3.

UNDERCARRIAGE

GENERAL.

4. Each undercarriage unit (SEE Fig. 1 at the end of this Chapter, and also Fig. 1, Chap. 3, Sec. 4A), has a single wheel carried on an axle between two oleo struts that are cross braced to form a rigid frame. The oleo frame is connected to the tube structure of the engine nacelle at pivot points at the top of the oleo legs, and is braced in the "down" position by a pair of knee-jointed radius rods, the upper portions of which are fixed to a transverse torque shaft supported in bearings on the rear tube of the nacelle structure. When the undercarriage is retracted, doors held shut by shock-absorber cords fair in the gap at the bottom of the nacelle. The doors are pushed open by fenders on the oleo frame as the undercarriage is lowered.

RETRACTING MECHANISM.

5. Pivoted above the transverse torque shaft are two levers with trunnion bearings, on which the cylinder of the hydraulic operating jack is mounted about midway along its length. At the middle of the torque shaft are twin levers, which are linked to the jack trunnion lever. The end of the jack ram is connected by an adjustable fitting to a pin working in a pair of slots in a lifting bracket attached to the oleo frame

at the junction of the cross bracing. A pair of knee-jointed radius rods brace the oleo frame in the "down" position; the lower portions of the rods are connected by adjustable eye-ends to brackets near the bottom of the oleo cylinders, and the top portions are rigidly fixed to the torque shaft.

6. **LOCKING CATCHES.**—Mechanical locking catches are provided for each undercarriage unit in both the lowered and the retracted positions. On each oleo leg a latch, toothed on the upper and lower sides, is pivoted on a bracket below the level of the lifting bracket, and is linked by a connecting rod and lever to the lifting pin in the slots in the lifting bracket; the latches, port and starboard, are interconnected by a counter-shaft so that they both work together. The catch in which the lower tooth engages when the undercarriage is lowered is a spring-loaded lever catch fitted on the lower portion of the radius rod, and the catch in which the upper tooth of the latch engages when the undercarriage is retracted is a spring-loaded plunger catch fitted on the rear tube of the nacelle structure forward of the torque shaft.

7. **OPERATION.**—When the undercarriage is in the lowered position, and hydraulic pressure is admitted to the jack, the ram moves inwards and the lifting pin in the lifting bracket slides along the slots. This movement rotates the latch interconnecting shaft and raises both latches, disengaging them from the catches on the radius rods. Continued movement of the jack ram brings it against the end of the slots in the lifting bracket, thereby pulling directly on the oleo frame, and simultaneous movement of the jack cylinder on its trunnions and pivot levers rotates the torque shaft, thus breaking the knee-joints of the radius rods. Further inward movement of the jack ram and rotation of the jack on its trunnion folds the radius rods and lifts the oleo frame until the upper tooth of each latch engages with the top catches on the nacelle structure. An adjustable stop for the oleo leg is fitted at the rear end of the rear tube of the nacelle.

OLEO LEGS.

8. Each undercarriage oleo leg consists essentially of two members, an upper cylinder containing air under pressure and a lower member or sustaining ram sliding within the upper cylinder and forming an oil chamber. Light loads are absorbed by air cushioning only, but heavier loads are absorbed by progressive hydraulic loading caused by forcing the oil through an annular orifice that decreases in area as the ram moves upwards. Fig. 3 in Sec. 4, Chap. 2, illustrates the construction of the oleo leg, and Fig. 4 in the same Chapter, shows the principle of operation.

9. **CONSTRUCTION.**—The top end of the upper cylinder has an integral attachment that provides one of the pivot points for the oleo frame, and is fitted with an air valve, an oil level plug and tube, and a hollow plunger; the plunger is tapered and has a small leak hole at the bottom end and holes for oil overflow into the plunger at the top end. At the lower end of the upper cylinder, a gland, comprising U-section

leather packing rings, a gland bearing sleeve, a retaining nut, and a packing support ring, is fitted. The retaining nut is locked in position by a screw which is itself locked by a safety strap connected to the oil level plug; before the gland locking screw can be unscrewed, the oil level plug must be removed. A lubrication nipple is provided for the gland, and an oil-retaining nut with L-section packing is screwed over the lower end of the gland nut.

10. The ram is a hollow tube attached at the bottom end of one side of the wheel axle (see Fig. 3 in Sec. 4A, Chap. 2). Near the top end of the ram is an integral partition that forms the base of the oil chamber, and at the top a piston constructed in two halves is screwed on the ram. The inner diameter of the piston is sufficiently great to allow an annular clearance between it and the tapered outer diameter of the plunger. An annular channel between the halves of the piston is connected by holes to the top and bottom of the piston, and is fitted with a damper valve ring drilled with holes. On the outside of the ram a collar is screwed, and, bearing against a buffer ring above the packing support ring, acts as a stop for the downward movement of the ram.

NOTE.—For the operation of oleo leg refer to Sec. 4A, Chap. 3.

BRAKES.

11. Dunlop pneumatically-operated brakes are fitted to the undercarriage wheels. A complete description of this type of braking system is given in A.P. 1464B, Vol. 1, but the pneumatic system as a particular installation in this aeroplane is described in Sec. 5.

TAIL WHEEL UNIT

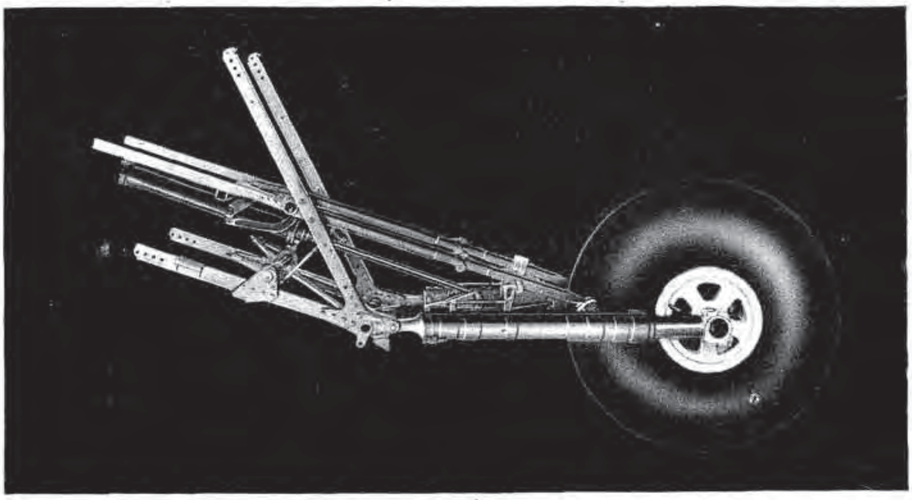
GENERAL.

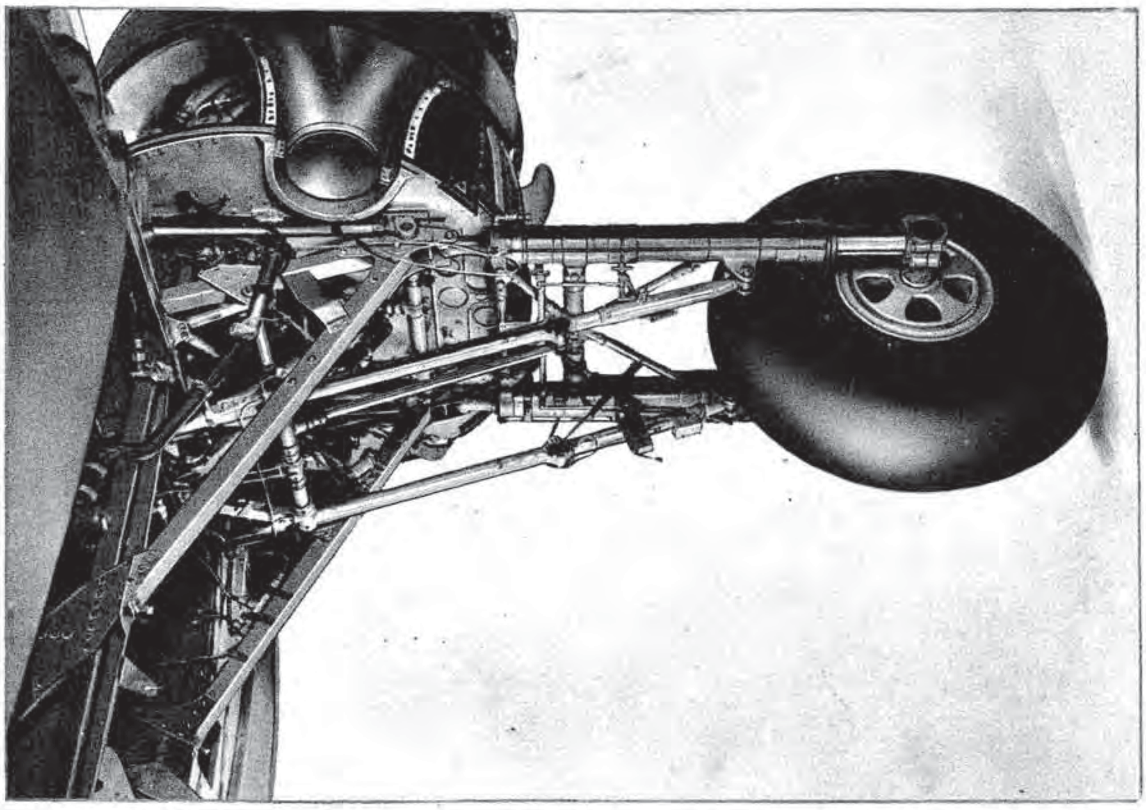
12. The tail wheel oleo leg is mounted in a double frame attached to former 308.5-310.5, and to a special partial former 299.75 forward of former 308.5-310.5 (SEE Figs. 5 and 7 in Sec. 4A, Chap. 2). The rear ends of the top and rear frame members provide bearings for a cross shaft to which the operating lever is connected, and the oleo leg is pivoted centrally at the lower ends of the rear frame members.

The cylinder head of the operating jack is pivoted on a fitting on a cross member at the forward ends of the top frame members, and the jack piston rod is connected to the operating lever on the cross shaft. When the piston rod moves inwards to retract the tail wheel unit, the cross shaft is rotated, and the retracting arms connected to the cross shaft move along a retracting slide fitted to the oleo leg, and bring the leg over the vertical position into the horizontal retracted position.

TAIL WHEEL BUFFER.

13. Generally speaking, the tail wheel buffer fulfills three conditions: (a) Energy absorption on landing; (b) rotational damping; and (c) self-centring action at all degrees of travel to the fore-and-act position. The action of the tail wheel buffer is outlined in Sec. 4A.





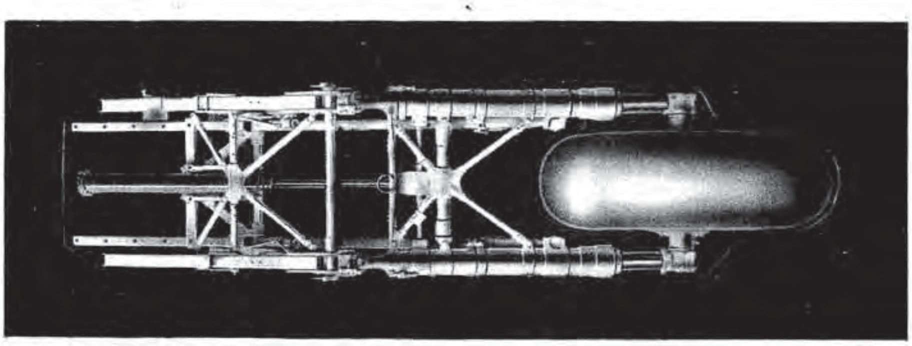


FIG. 1—UNDERCARRIAGE.

CHAPTER
4

CHAPTER 4

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LIST OF ILLUSTRATIONS

TAIL UNIT

GENERAL.

1. The tail unit comprises a cantilever tail plane and fin of all-metal construction, and elevators and a rudder, which are each a fabric covered metal framework. Trimming tabs controlled from the pilot's cockpit are inset in the trailing edges of the rudder and elevators. The attachment fittings for the tail plane extend to the upper surface of the tail plane and serve also as attachment points for the fin. A fairing fillet of acetate sheet is fitted at the junction of the tail plane, fin and stern frame, and is secured by wood-screws to wood fillet strips on the fin and stern frame.

TAIL PLANE.

2. The tail plane, half of which is illustrated in Fig. 1, is built in one piece, and has two alclad channel-section spars, with the flanges reinforced by riveted-on extruded hiduminium booms, flanged alclad sheet ribs, and alclad skin covering. Between the spars, the skin is stiffened by transverse stringers and, aft of the rear spar, inboard of the cut-aways for the elevator balance portions, a false spar is fitted. On either side of the centre-line of the tail plane, a steel interspar tube between the tail-plane-to-fuselage attachment fittings reinforces the structure. On the upper surface between the two stringers, a panel of skin covering is secured by wood-screws to wood strips underneath the stringers to permit its removal for inspection purposes. A bracket secured to the rear spar and false spar on the tail plane centre-line, and a bracket on each side, immediately inboard of the elevator balance cut-aways, carry the elevator hinge bearings. The tail plane tip edge is made of wood, and is secured to the skin overlap by wood-screws.

3. The two attachment fittings riveted on the rear spar are bolted direct to former 330-332, and the two fittings on the front spar are connected to former 308.5-310.5 by link plates that can be set to accommodate small variations in the attachment centres. The attachment fittings extend to the upper skin of the tail plane and serve also as attachment points for the fin. At the top, the forward attachments are additionally secured by link plates to a fork fitting at the top of the diaphragm extension on the forward face of former 308.5.

ELEVATORS.

4. The elevators are fabric covered and are built in separate halves, each having a duralumin tubular spar, alclad ribs and nosing, and a trailing edge of oval-section tube. A trimming tab, controllable from the pilot's cockpit, is inset in the inboard trailing edge of each elevator. An uncovered elevator is illustrated in Fig. 2.

5. The spar is a duralumin tube with a sleeve and a liner at the outboard hinge point, and a flanged plate extension bolted on at the tip. The ribs are of flanged alclad plate, with flanged lightening holes, and are secured to the spar by collars riveted to the ribs and secured on the spar by Chobert rivets. Eyelets for the fabric stringing are incorporated in the

flanges. An oval-section steel tube forms the trailing edge outboard of the trimming tab. From the inboard end to the balance portion, the nosing is of alclad sheet bent round and riveted to the nose of the ribs. The balance portion is covered with alclad sheet, and has a wood nose fillet secured to the sheet by wood-screws; mass-balance weights are secured to the nose. At the inboard end of the elevator, where it is cut away for the rudder movement, a fairing of aluminium-manganese alloy sheet is fitted aft of the alclad nosing. The fabric covering extends right round the nosing and the balance portion.

6. The elevator actuating lever is bolted to a socket on the inboard end of the spar; the pin for the final connecting tube from the elevator control passes through both the port and starboard levers, and, together with a bolt and distance piece, interconnects both elevators. A spigot at the inboard end of each spar engages in a ball bearing on the tail plane bracket and forms the centre hinge; the outboard hinge has two split bearings on which the spar rotates (see Fig. 3, in Sec. 4A, Chap. 2).

7. **TRIMMING TABS.**—Each elevator trimming tab has a duralumin tube spindle, alclad ribs and covering, and oval tube trailing edge. Mild steel hinge pins bolted in slots at the ends of the spindle (see Fig. 6 in Sec. 4A, Chap. 2), engage with ball bearings in the elevator ribs and form the tab hinges; the pins can be moved inwards to clear the ball bearings when removing the tabs. The actuating lever is fitted on the underside at the inboard end, and is connected to the Breeze actuator in the elevator.

FIN.

8. The fin (see Fig. 3) has front and rear fin posts and a rear member of channel-section alclad sheet, alclad ribs and skin covering, and aluminium-manganese-alloy nosing. The front and rear posts are reinforced at the lower ends to form box sections to which the fin attachment legs are bolted. A removable panel secured by set-screws covers the gap between the bottom rear channel member and the stern post on each side. A mahogany filling piece is fitted inside the top rear channel member, and a spruce strip for the attachment of the fairing fillets is secured by wood-screws to the flanges of the bottom rib on each side. The aerial attachment bracket is made of steel, and is riveted to the apex of the fin.

9. The attachment lugs are of hiduminium with steel bushes; the front lugs are bolted direct to the attachment fittings on the tail plane front spar (see Para. 3), and the rear lugs are connected to the tail plane rear fittings by link plates that can be set to accommodate small variations of the attachment centres. In addition, a rearward extension of the second rib from the bottom is bolted to the stern post at the end of the stern frame.

RUDDER.

10. The rudder is generally similar in construction to the elevators, and has a duralumin tubular spar, alclad ribs and nosing, a trailing edge

of duralumin or mild steel tube, and is fabric covered. A trimming tab, controllable from the pilot's cockpit, is inset in the trailing edge, and, in addition to its trimming function, is arranged to give a servo action. An uncovered rudder is illustrated in Fig. 4.

11. The spar is of duralumin tube with a flattened tube extension near the tip. The ribs and their attachments are similar to the elevator ribs (see Para. 5). Above the trimming tab and along the top to the foremost point of the balance portion, the trailing edge is of mild steel tube, and below the trimming tab it is of duralumin tube. The nosing and balance portion are similar to those on the elevator; mass-balance weights are bolted to the balance portion underneath the nose fillets. At the bottom of the rudder, a fairing of aluminium-manganese-alloy is secured to the bottom rib by Chobert rivets plugged with sealing pins. Two tail lamps are inset in the trailing edge and the cables of the lamp are led in conduits along a rib and out through a door in the nosing. The fabric covering extends right round the nosing and the balance portion. Inspection doors are provided on the port side at the mass-balance weights, and over the trimming tab actuator, and, on the starboard side, at the rudder lever.

12. The rudder is hinged to the fuselage at two points by means of double split bearings bolted to the stern post. The operating lever is in separate halves, bolted to a socket on the spar above the bottom hinge.

13. **TRIMMING TAB.**—The trimming tab has a duralumin tube spindle, alclad end formers and skin covering, and a mild steel tubular trailing edge. Mild steel hinge pins bolted in slots at the ends of the spindle (see Fig. 7, in Sec. 4A, Chap. 2), engage with ball bearings in the rudder ribs and form the tab hinges; for removal of the tab, the hinge pins can be moved inwards to clear the ball bearings. The actuating lever is fitted on the starboard side at the bottom end, and is linked to the Breeze actuator on the stern post.

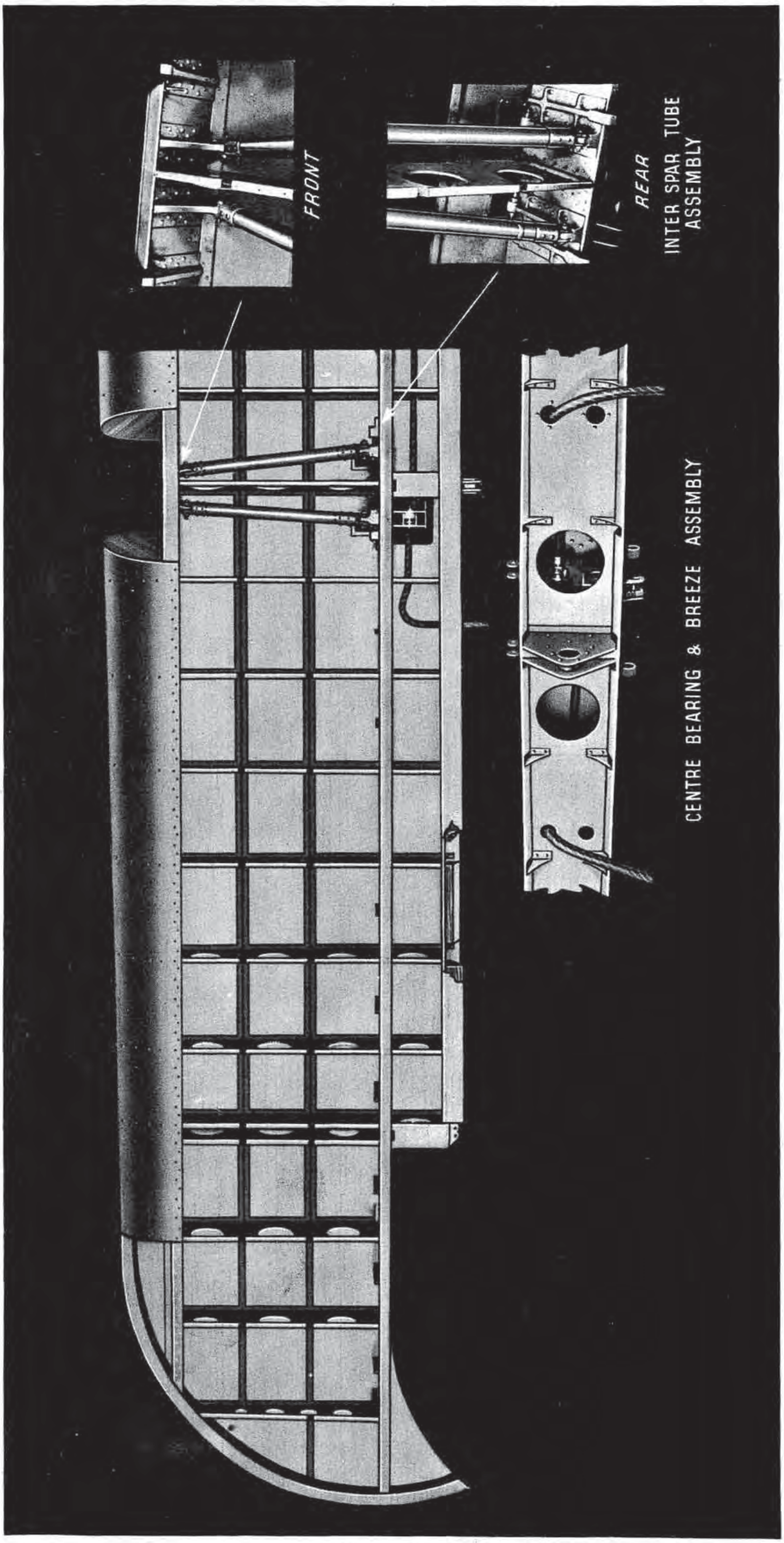

FIG. 1—TAIL PLANE.

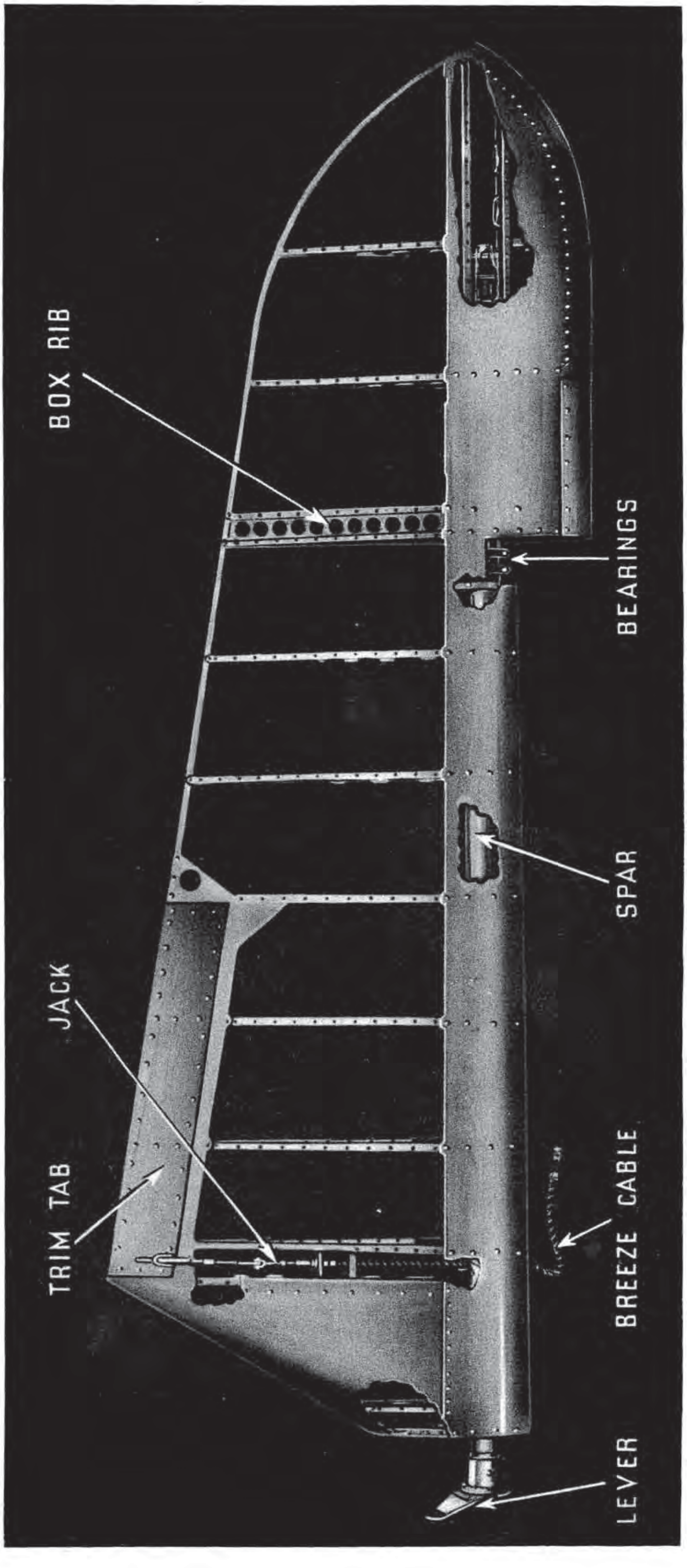

FIG. 2—ELEVATOR.

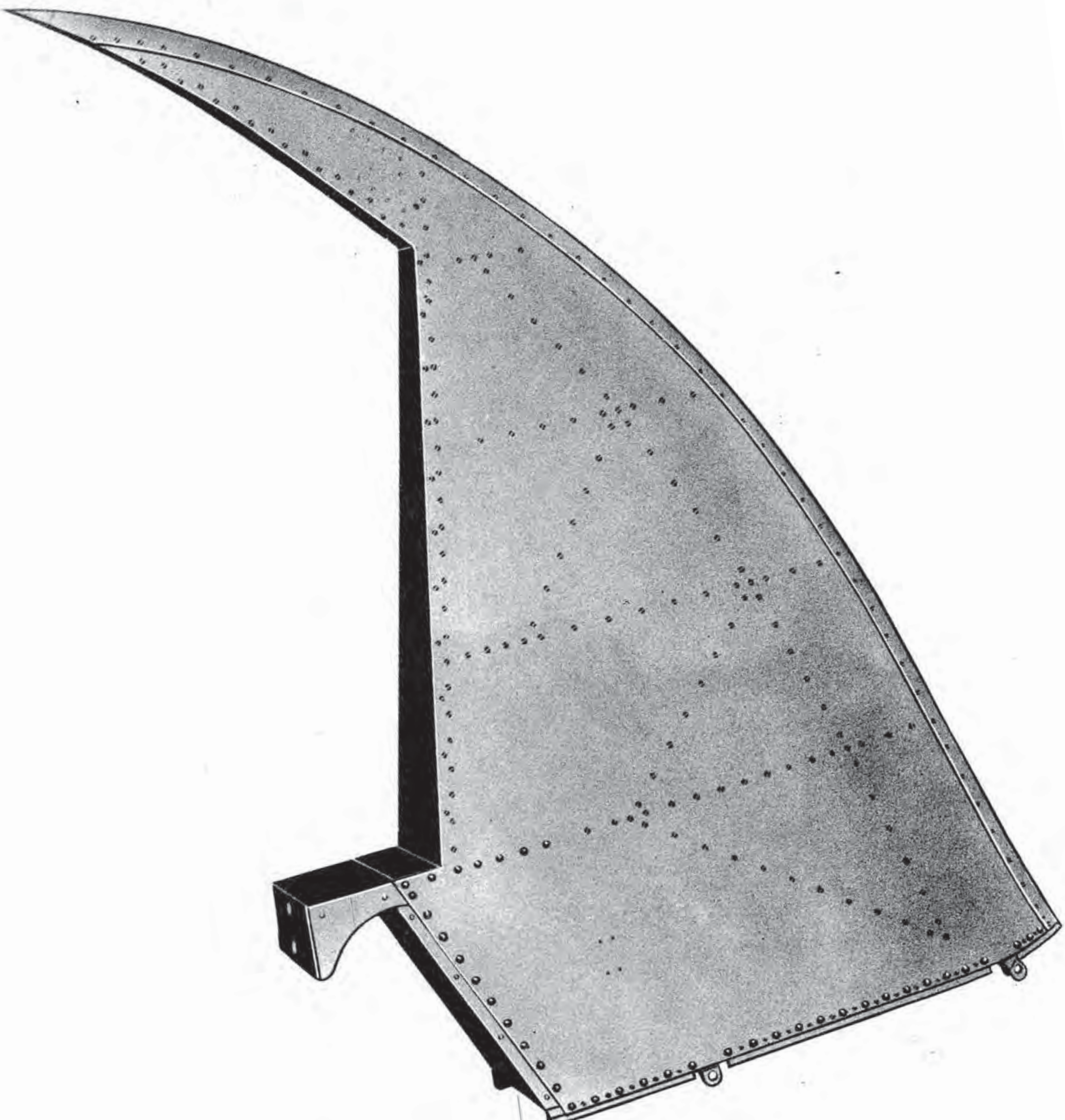

FIG. 3—FIN.

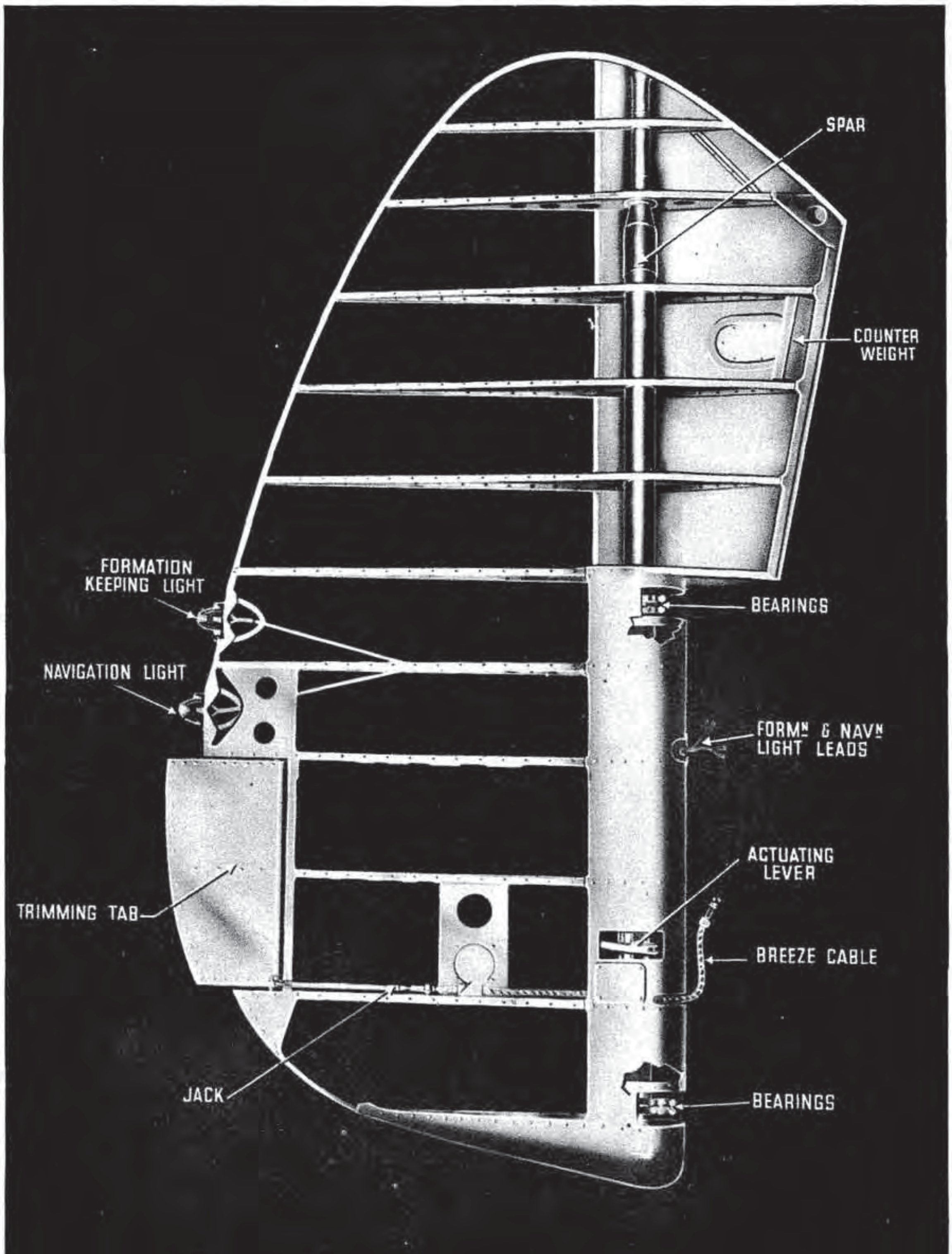
SPAR
COUNTER WEIGHT
FORMATION KEEPING LIGHT
BEARINGS
NAVIGATION LIGHT
FORMN & NAVN LIGHT LEADS
ACTUATING LEVER
TRIMMING TAB
BREEZE CABLE
JACK
BEARINGS

FIG. 4—RUDDER.

CHAPTER 5

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LIST OF ILLUSTRATIONS

FLYING CONTROLS

GENERAL.

1. The pendulum-type rudder pedals and the spectacle-type control column are connected to their respective control surfaces by chains and cables. A ground adjusted trimming tab is fitted to the port aileron, and, for directional, longitudinal, and lateral trimming, tabs controllable by the pilot are inset in the trailing edges of the rudder, elevators, and starboard aileron. The rudder tab, in addition to its trimming function, is arranged to give a servo action. All sprockets, pulleys, and levers for the chains and cables in the flying control system are carried on ball bearings. Locking gear is provided for the main flying controls (see Fig. 1 and also Sec. 1). Mk. IV automatic controls are fitted to the 21st and all subsequent aircraft, and dual controls may be installed side-by-side with the main controls. The split-trailing edge flaps are hydraulically operated.

CONTROL COLUMN.

2. The control column (see Figs. 3 and 5 in Sec. 4A, Chap. 2) is pivoted on a box bracket secured to the pilot's floor structure, and consists of a duralumin tube, to the top of which is bolted the control column head. The control column head is in two halves, and has an oilite bush for the spindle of the spectacle-type aileron control handwheel. At the centre of the handwheel, the undercarriage brake lever and parking lock are fitted, and at the top left-hand corner is the firing button for the fixed gun. A sprocket is fitted on the handwheel spindle, and from it a chain extends downwards inside the control column and over two sprockets mounted on ball bearings on a spindle fitted to the mounting bracket aft of the pivot point of the column. A socket bolted to the control column at the bottom is secured to spigots pivoted on ball bearings on the mounting; the inboard spigot has a lug that enables a torque tube to be fitted between it and a similar lugged spigot on the dual control column. The lever for the elevator control is riveted to the socket and spigots, and extends down below the mounting bracket. Adjustable stops, restricting the movement of the lever, are provided at the forward and after ends of the bracket.

RUDDER PEDALS.

3. The two rudder pedals (see Fig. 4 in Sec. 4A, Chap. 2) are pivoted at the top on a transverse support tube mounted between the port side of the fuselage and the control tube structure, and are of stirrup form with leather toe straps. Each pedal lever, at approximately mid-length, is connected by a link tube to a lever that rotates a vertical countershaft. At the bottom of the countershaft there is a forward-pointing lever for the dual control connection, and an inboard-pointing lever for the normal control. Adjustable stops are mounted on the structure and restrict the movement of the dual control lever. To provide adjustment for leg reach, the two levers at the top of the countershaft

are rigidly fixed to a trunnion sliding within an adjusting box (SEE Fig. 4 in Sec. 4A, Chap. 2) pinned to the countershaft. The trunnion can be moved backwards or forwards to give a 3 in. adjustment to the pedals on either side of the normal position by means of a threaded rod that is connected by a universal joint and a tube to a crank handle below the instrument panel. To allow for the movement of the connecting tube when the rudder control is operated, the tube is supported at the handle end in a loose ring connected to the bottom support of the instrument panel.

ELEVATOR CONTROL.

4. The run of the elevator control and details aι various points are illustrated in Fig. 3 in Sec. 4A, Chap. 2. The lever at the bottom of the control column is joined by a connecting tube to a double relay post at former 30, that carries levers for the rudder and elevator normal and automatic controls. From the relay post, cables with turn-buckles at formers 139 and 166 extend along the port side of the fuselage over pulleys forward of formers 150 and 190 to a vertical double countershaft on the centre-line of the aeroplane at former 249. The countershaft carrying the elevator levers is mounted on ball bearings outside the countershaft for the rudder control. From this countershaft, the elevator control movement is transmitted by an adjustable connecting tube to a horizontal countershaft at former 308.5, and thence to the elevators by a final adjustable connecting tube to which the operating levers for the port and starboard elevators are secured by a special bolt.

RUDDER CONTROL.

5. The rudder control system and constructional details are illustrated in Fig. 4 in Sec. 4A, Chap. 2. From the lever at the bottom of the rudder pedal vertical countershaft, the movement is transmitted by a connecting tube to the rudder and elevator relay post, and thence by a cable run similar to the elevator control to the countershaft at former 249 (see Para. 4). From the top of this countershaft, cables with turnbuckles at the countershaft lever ends lead over pulleys at former 330 to the rudder operating lever.

AILERON CONTROL.

6. The run of the aileron control and details at various points are illustrated in Fig. 5 in Sec. 4A, Chap. 2. The aileron control chains at the foot of the control column are connected by cable and chain to a double sprocket on the aileron relay post mounted on the main plane front spar. Four quadrants for the normal aileron control and one for the automatic control are fitted on the relay post, and the aileron dual control is connected at the double sprocket. From the relay post, chains and cables extend outboard over jockey sprockets on the front top face of the front spar, port and starboard, to a point between ribs 11 and 12,

where their direction is altered rearwards towards the ailerons. Turnbuckles for adjusting the cables are fitted between the control column and the relay post, and also just outboard of the outer and centre plane joint. A telescoping conduit encloses the chains and cables from the front spar to the rear spar. The final chain passes over the sprocket mounted behind the rear spar, and then round a sprocket on the differential gear.

7. Two special tail ribs behind the rear spar at rib 12 support the aileron differential gear. The differential gear consists of a sprocket mounted on the inboard tail rib and having an integral differential lever that is connected by a link to the aileron operating lever. A lever on the outboard tail rib also supports the connecting link. The top point of the connecting link in the neutral position of the aileron is mounted above the horizontal line, through the centre of the sprocket, so that, for the same angle of rotation of the sprocket on either side of the neutral position, the amount of vertical movement of the pivot point, and therefore the angular movement of the aileron, is greater when the aileron is being raised than when it is being lowered.

TRIMMING TAB CONTROLS.

8. The trimming tabs inset in the trailing edges of the elevators and of the rudder are controlled from the hydraulic control panel on the starboard side of the pilot's instrument panel by means of cables and chains connected to Breeze actuating units at the stern frame. The aileron trimming tab on the port aileron can be adjusted only when the aeroplane is on the ground, but the tab on the starboard aileron is controllable by the pilot.

9. **ELEVATOR TABS.**—The elevator tab control wheel and indicator is mounted at the top of the hydraulic control panel, and operates a drum from which cables extend along the starboard side to former 294 (SEE Fig. 6 in Sec. 4A, Chap. 2). At this former, the cables are connected by turn-buckles to chains that operate a drive unit mounted in the tail plane behind the rear spar. From the drive unit, flexible drives are connected to a screw jack or actuator mounted at the inboard end of each elevator, and coupled directly to the tab operating lever by an adjustable rod. When the control wheel is turned towards the NOSE DOWN position on the indicator the trimming tabs are raised; the air load on the tabs then forces the elevators down and relieves the pilot from the prolonged effort of countering any slight "tail heavy" tendency. When the control wheel is turned towards the NOSE UP position, the effect is reversed.

10. **RUDDER TAB.**—The rudder tab control handle and indicator are mounted on the hydraulic control panel below the undercarriage and flap controls, and is connected to a drive unit in the stern frame below the elevator tab drive unit by a run of cable and chain (SEE Fig. 7 in Sec. 4A, Chap. 2), similar to that for the elevator tab control. From the drive unit, a flexible drive operates a screw jack or actuator mounted on the stern post. The tab operates similarly to the elevator tabs.

11. **AILERON TRIMMING TAB.**—The controllable tab on the starboard aileron is operated by a handwheel mounted forward of the engine throttle levers. Behind the handwheel is a control box which is connected by Teleflex controls to another control box on the aft side of the rear spar (see Fig. 8 of Sec. 4A, Chap. 2). Cables and chains couple up this control box to the actuating unit mounted behind the aileron spar, and an adjustable tube connects the actuating unit to the tab operating lever. The trimming position indicator on the hydraulic control panel is operated by Teleflex controls from a control box mounted below the handwheel and driven from it by a chain and sprockets.

FLAP OPERATING GEAR.

12. The two flaps on each side of the main plane are operated by a hydraulic jack pivoted on the rear face of the rear spar inboard of the centre and outer plane joint. The ram of the jack is coupled to the bottom of a quadrant pulley mounted on a support frame extending behind the rear spar, and two links pivoted at the top of the pulley are connected to the operating levers of the centre and outer plane flaps (see Fig. 9 in Sec. 4A, Chap. 2). A cable round the quadrant pulley is connected by a chain to a small sprocket on a relay shaft further inboard. From the large sprocket, on the relay shaft, chains and cables extend across the centre plane behind the rear spar to another relay shaft on the other side of the centre plane, and interconnect the flaps on each side so that they are raised and lowered simultaneously.

13. The handle for the flap control is mounted on the hydraulic control panel. Instructions for operating the flaps are given in Sec. 1. An indicator beside the control handle shows the position of the flaps, and is connected by Teleflex controls to a lever on the flap hinge at the starboard side of the fuselage (SEE Fig. 9 in Sec. 4A, Chap. 2).

DUAL CONTROLS.

14. If required, dual controls (SEE Fig. 1) may be installed on the starboard side of the cockpit side-by-side with the first pilot's controls. The dual control conversion set consists of a control column and rudder bar mounted on a cast floor structure and a seat mounted on a separate tube structure. Instructions for installing the dual controls are given in Sec. 5.

15. The dual control floor structure is an aluminium alloy casting. It is attached to the fuselage structure at four points, and has a stay tube from the control column bracket to the aileron dual relay post forward of former 0.

16. The second pilot's control column, which is generally similar to that of the first pilot's (see Para. 2), except that it has no gunfiring button or undercarriage brake lever, and no lever at the bottom for elevator control, is pivoted on a bracket at the rear of the floor structure. The chains from the aileron handwheel are connected to the relay sprocket

shaft forward of former 0, from which a chain leads to the double sprocket on the aileron relay post. For elevator control, the two control coumns are interconnected by a transverse torque tube between the two columns at the pivot points.

17. The rudder pedals are pivoted at the bottom on the tube for the rear support points, and are each coupled by a link tube to levers on an adjusting box, similar to the box on the first pilot's rudder control (see Para. 3), and pivoted at the front end of the floor structure. A lever pointing forward is fixed to the adjusting box, and from it a tube connects to the lever on the vertical countershaft for the first pilot's rudder control. The connecting tube and handle for the adjusting box are supported on a bracket between the pedals; the handle can be folded back and secured in a clip on the support bracket. The connecting tube from the handle is not directly connected to the adjusting box, but has a fork joint that engages with a pin on the adjusting box when the handle is pushed forward against the action of a spring at the handle end. To adjust the pedals, centralise the pedals in order to allow the fork joint to engage with the pin, push the handle forward and turn. As use of the adjusting handle locks the rudder controls, the pedals should be adjusted only when the aeroplane is on the ground and, after use, the handle should be secured in the clip.

18. The second pilot's seat is mounted on a tube structure that can be attached to the formers over the torpedo cell and to formers 46 and 30 at the fuselage sides. The back of the seat is arranged to fold down.

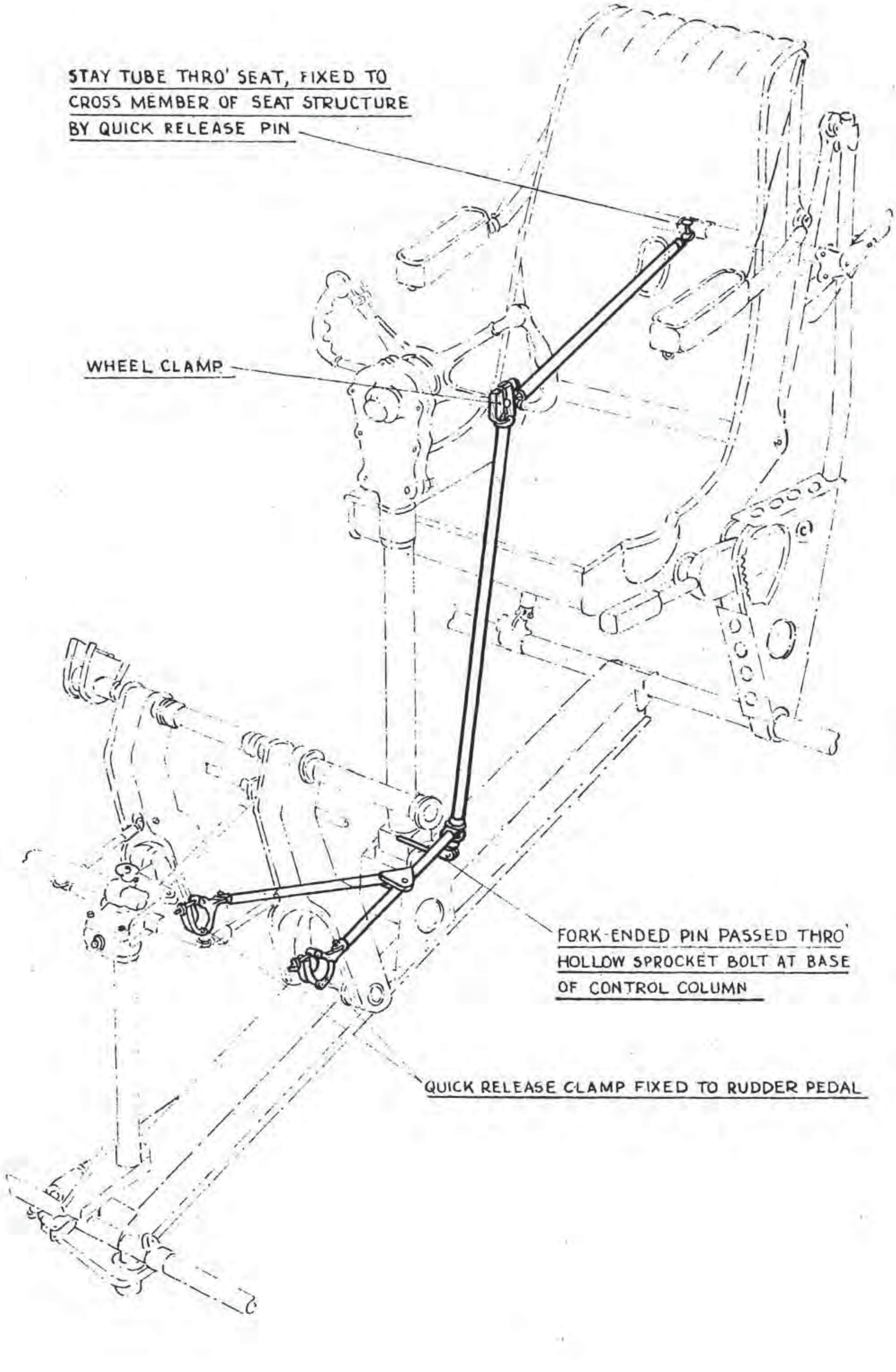


FIG. 2 FLYING CONTROLS LOCKING GEAR.

CHAPTER 8

ENGINE INSTALLATION

SECTION 8

SECTION 8

ENGINE INSTALLATION

CHAPTER 8

ENGINE INSTALLATION

1. GENERAL.

The two engines are each installed in a nacelle, one each at the extremities of the centre plane, and are fitted with either constant speed, or constant speed and full feathering airscrews. The engine cowling is of the Lockheed Longchord type, with cowl gills fitted at the trailing edge to control the flow of the cooling air. Fuel is carried in four main tanks, two in the centre plane (one each between motor and fuselage, port and starboard), and one in each outer plane, and is delivered to the carburettor by an engine driven pump, and, in emergency, by a hand-operated pump.

Provision is made for jettisoning the fuel in the outer planes, via chutes fitted on underneath surface of the planes. An auxiliary fuel tank may be installed in the bomb cell, under the fuselage; this tank may only be filled by opening (i) auxiliary tank cock, (ii) auxiliary and balance cock, and then one of the four main tank cocks, which allows the fuel to balance out, thus filling the auxiliary tank.

Each engine has a separate oil tank mounted in the centre-plane outboard of the engine, and a separate oil cooler mounted in the outer plane. The engines are fitted with electrical starters and hand turning gear is provided for maintenance.

2. AIRSCREWS.

(i) Curtiss Electric constant-speed, full-feathering type.
Refer to maker's handbook, assembly and removal, operations, Paras. 4 and 5.

(ii) De Havilland Constant Speed. Refer to maker's handbook.

3. ENGINES.

(a) PRATT & WHITNEY.

(i) S3C4G—Twin row, air-cooled radial two-stage blower.

(ii) S1C3G—Twin row, air-cooled radial single stage blower.
Refer to operator's and overhaul manual.

(b) ENGINE MOUNTING.

Is an electrically welded steel tubular structure attached to an adaptor structure of similar construction, which in turn is attached to the centre plane at five points — three on the front spar and two on the nacelle structure.

4. FUEL SYSTEM.

(a) GENERAL.

Four main fuel tanks are carried between the spars of the centre and outer planes, two on each side of junction of fuselage and main plane; an auxiliary tank for long range operation may be installed in the bomb cell.

Fuel contents gauges for each tank are mounted on the starboard side of the fuselage below the emergency exit window sill, just on opposite side to pilot's position. The fuel pressure gauges are mounted on the pilot's instrument panel. The emergency hand pump is mounted on the starboard side of the engine control structure, and the priming pump on lower face of hydraulic panel.

(b) FUEL COCK CONTROLS.

This covers the main cocks for the four main plane and auxiliary tanks mounted on aft end of engine control structure; auxiliary and balance and emergency and priming cock controls are fitted on the starboard side of fuselage just forward of junction of front and rear fuselage. Each tank has an independent cock control.

(c) OPERATION.—Refer to M.R.C.

(d) FUEL TANKS.

Welded aluminium construction is employed for the fuel tanks, transverse and fore and aft baffles with flanged holes in the webs are fitted inside the tank. The transverse bulkheads, and also the intermediate fore and aft bulkheads on the outer plane tanks, have tee-section flanges, and the edges of the main skin panels are butt-welded to the edges of the horizontal part of the tee-sections. The fore and aft bulkheads have angle-section flanges on both sides of the web, and the webs are riveted on to the webs of the transverse bulkheads, but no other attachment of these bulkheads is made to the skin. The edges of the tanks ends are welded to the skin, and also to a special strip on the middle of the transverse bulkhead. Skin panels on upper and lower surface of all tanks except auxiliary are corrugated. Filler caps, vent adaptors, inspection doors, fuel contents, gauge attachments, and sumps, are fitted on the tank.

The tanks are strapped to bearers that are riveted to detachable panels on the under surface of the planes. The bearers in turn are bolted to brackets at the front and rear spars and set-screws round the panel edges. Pet-cocks are fitted to the tank sumps for draining accumulated water and foreign matter. The auxiliary tank is strapped to three cradles that can be attached to six lugs on the aeroplane structure inside the bomb cell.

NOTE.—All tanks are fitted with "Cima" leakproof covering.

5. OIL SYSTEM.

The oil system is separate for each motor, port and starboard. It incorporates a separate oil cooler mounted in leading edge of the outer planes, and the oil tank for each system is fitted in centre plane outboard of engine nacelle.

(a) OIL COOLERS.

They are of the 10.5 ins. diameter R.A.E. 2-element type, and are mounted on tubular struts in the nose of the outer planes. The cooling air is collected by ducts from the leading edge, and exhausted through the top surface of the outer plane (just forward of the front spar). The cooling air enters the cooler at the oil outlet end. Each element is fitted with a relief valve, which by-passes the oil at a certain pressure. The setting of these valves $12\frac{1}{2}$ lbs. per sq. in. rear element, and 19 lbs. per sq. in. front element; these pressures are clearly marked on each valve.

NOTE.—

(b) OIL LEVEL IN OIL TANKS.

It has been proved on experiment that the correct quantity cannot be obtained by draining through oil level vent. Best method of checking, with craft in tail down position, is to measure 5 in. from top of filler opening.

(c) SYSTEM.

The feed pipe line to the engine leads from the tank sump to the pressure pump on the engine; a drain cock is fitted in this pipe, aft of the bulkhead. The return oil from the engine passes through the oil cooler and thence to the oil tank in the centre plane. A thermometer is fitted into the engine. The oil pressure gauge connection is fitted to the connection provided on the rear of the engine. A pressure gauge is fitted on pilot's instrument panel. A vent pipe from the tank is taken to the engine rear cover.

6. ENGINE ACCESSORIES AND GEAR BOXES.

(a) ACCESSORY GEAR BOX.

An accessory gear box, type G.B.11.H., is mounted on the port and starboard nacelle structures, and is fitted to forward face of engine bulkhead, and supported by gear box mounting structure fitted behind bulkhead and attached to engine adaptor and nacelle structure. It is driven by a flexibly jointed carden shaft coupled to the gear box reduction bolted on the rear case of the engine.

(b) **ENGINE ACCESSORIES.**

The accessories driven by the gear boxes are as follows:—

PORT:

(i) Pesco B.3X vacuum pump mounted on the rear face.

(ii) Hydraulic oil pump Mk. 4 mounted outboard face.

(iii) Generator 1000 watts dual purpose type O.H. mounted on inboard face.

STARBOARD:

(i) Generator type E mounted on the outboard face.

(ii) B.T.H. compressor on the forward face.

(iii) Pesco B.3X vacuum pump mounted on the rear face.

NOTE.—Accessory gear box must be drained and refilled with oil as used in the engine every 60 hours.

7. ENGINE STARTING EQUIPMENT.

The engines are started electrically. Push buttons for the starter motors are in the cockpit on top left-hand corner of instrument panel, and are fitted with spring-loaded covers.

The hand turning handle is stowed immediately below the rear entrance hatch, and the booster switches for starting the engines are mounted beside the respective engine starter buttons on instrument panel. For external starting a B.T.H. type E.1 socket is fitted below the pilot's seat, and is accessible through a door in the fuselage. To connect the external trolley accumulator, insert the two pins of the plug on the end of the flexible cable, with their respective holes in the top of the B.T.H. bracket. Turn the plug clockwise until the pins meet the holes in the main body of the socket, and push right home. This action disconnects the aeroplane accumulator and connects the external accumulator to the system. After the engines are started, disconnect the plug.

8. CYLINDER TEMPERATURE CIRCUIT.

Two "Weston" pyrometers are fitted on the pilot's instrument panel. They show the port and starboard engine No. 13 cylinder head temperature. The cables for these follow the same run as that for the oil temperature, oil pressure, and the boost pipe lines

9. COWL GILLS (LOCKHEED).

The electrically operated cowl flaps, located immediately aft of the engine nose cowl gill, are mounted on a supporting ring which, in turn, is bolted to lugs on the rocker boxes of the rear bank cylinders. Push-pull tubes are connected to the actuating mechanism, and are supported by means of bracket and roller assemblies, thus being free to move as the actuating mechanism operates. The flap segments, of which there are thirteen on each engine, are hinged at the above-mentioned support brackets, and connected to the push-pull tubes by means of short links, with the exception of the top centre segment, which is linked, in the closed position, to the flap actuating mechanism. This mechanism is secured to the support ring by means of a yoke type mounting bracket, and is free to move up or down during retracting or extension. The flaps, controllable from the cockpit, may be opened, closed, or maintained in any intermediate position.

10. COWL GILLS (C.A.C.).

These manually operated cowl gills are similar in construction and attachment to engine rocker boxes. Their operation arrangement is different to the extent that each gill is connected to one another (except to top flap, which is fixed), by sliding universal joints. They are operated from two points, one either side of engine, and connected by push-pull rods to fulcrum levers fitted on the engine mount. These levers are connected together by means of cable and pulley guides; the attachment is inboard to outboard on connecting cable between fulcrum levers. The other two points of levers connect by cable relay and pulley guides to actuating screw jack assembly drum behind pilot's seat on port side, just forward of spar. The actuating jack drum is connected by a continuous cable with drum on pilot's wheel control, wound in such a manner in each drum, and so connected, that as one end is unwinding the other is winding on.

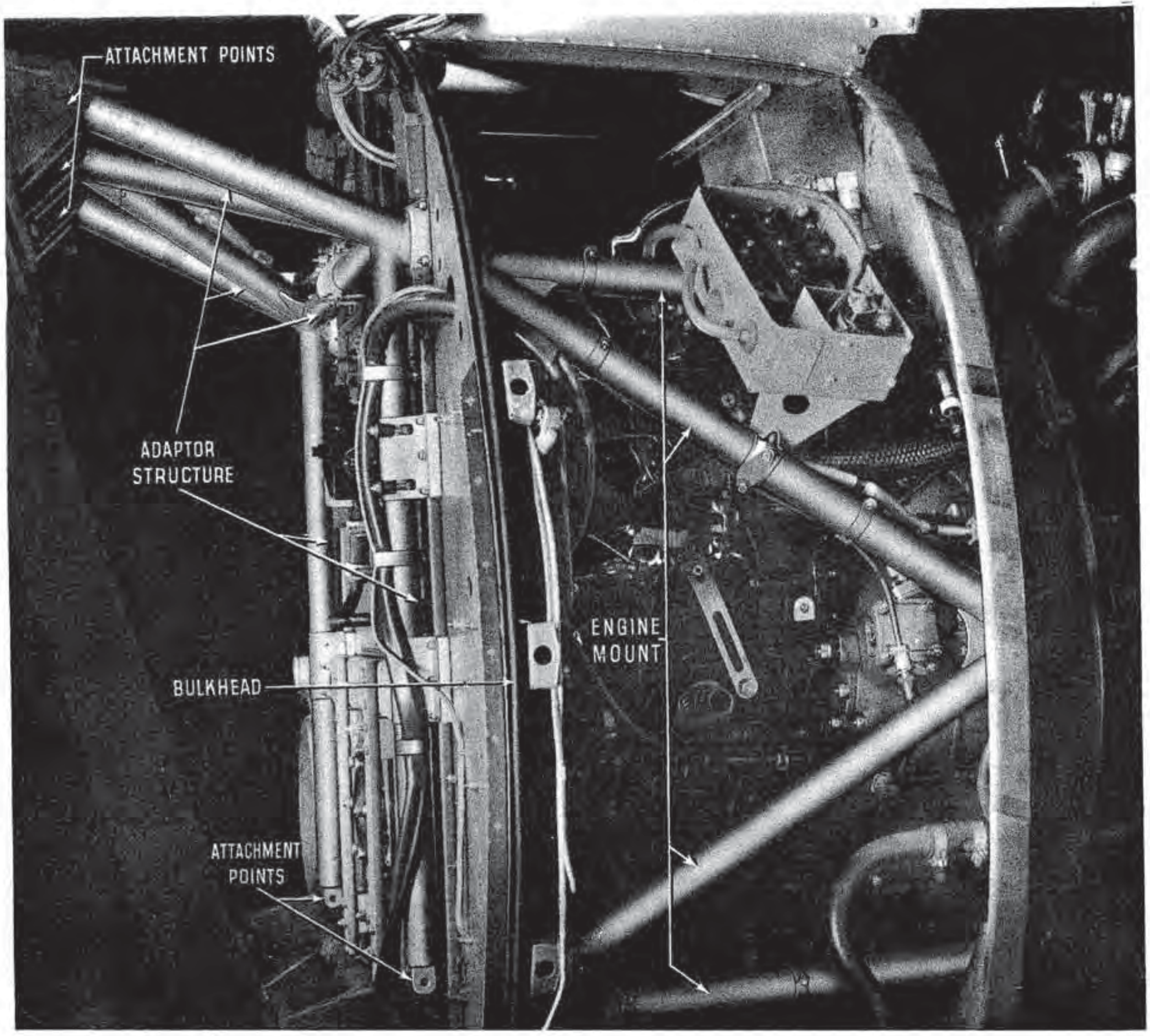
NOTE.—Same action on actuating jack drum.

OPERATION:

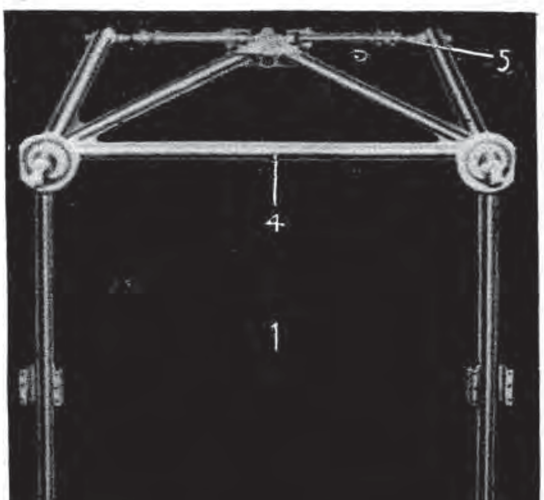
To "OPEN": Turn the handwheel "AFT."

To "CLOSE": Turn the handwheel "FORWARD."

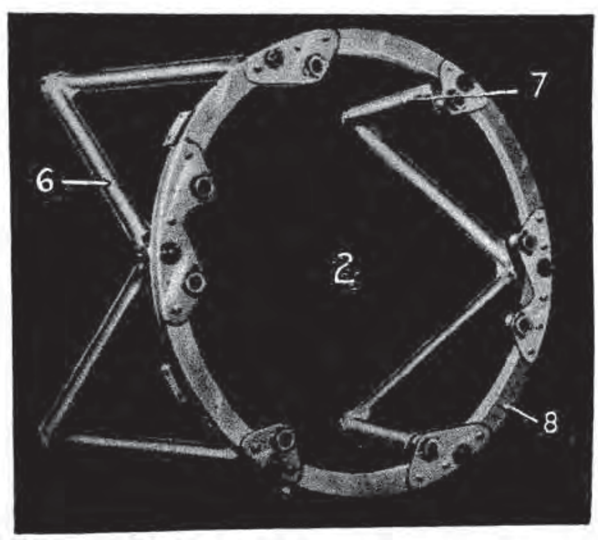
11. POWER PLANT CONTROLS.—Refer Sec. 4A, Chap. 6.



View of Engine Mount and Adaptor Structure in Position.



Adaptor Structure.



Engine Mount.

FIG. 1—ADAPTOR STRUCTURE AND ENGINE MOUNT.

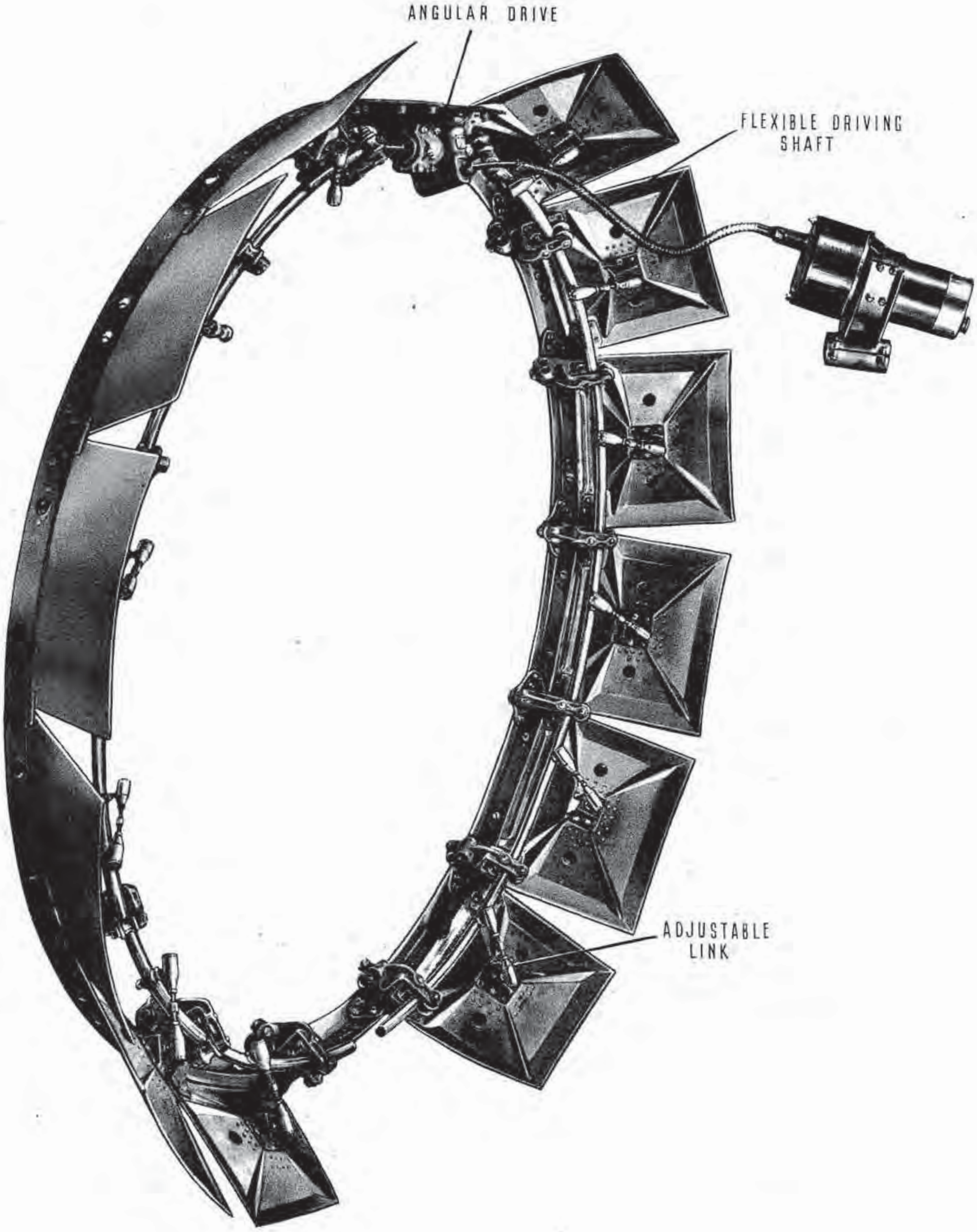


FIG. 2—COWL FLAP (ELECTRIC).

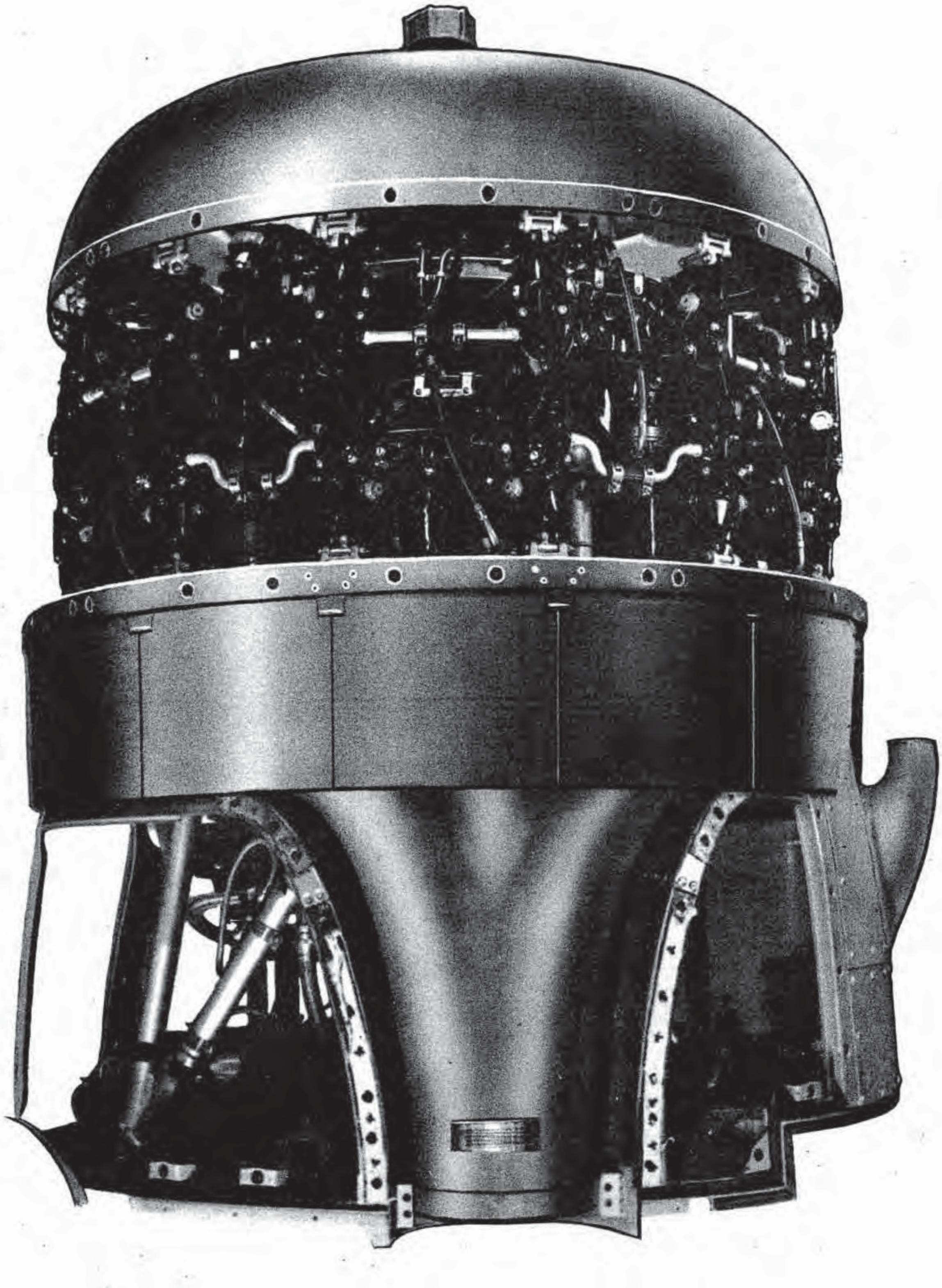


FIG. 3--ENGINE INSTALLATION.

SECTION
9

ASSEMBLY No. 1 — AEROFOILS

Component.	Drawing No.
Aileron—Port	82009
Aileron—Starboard	82008
Centre Plane	88600
Elevator—Port	83002
Elevator—Starboard	83005
Fin	83004
Fillet and Closing Plates—Port	88623B
Fillet and Closing Plates—Starboard	88623A
Flaps Centre Plane—Port	88615
Flaps Centre Plane—Starboard	88616
Flaps Outer Plane—Port	82010
Flaps Outer Plane—Starboard	82011
Outer Plane—Port	82003
Outer Plane—Starboard	82002
Outer Plane Tips—Port	82007
Outer Plane Tips—Starboard	82006
Rudder	99551
Tail Plane	83001

ASSEMBLY No. 2 — ALIGHTING GEAR

Firing Chamber Cartridge Emergency Unit	156104
Firing Chamber Non-Return Valve	156046
Oleo Legs and Bracing	90450
Tail Wheel Self-Centering Strut	AIR 16468
Tail Wheel Jack (Hydraulic)	87077
Tail Wheel	83990
Undercarriage—Port	83700
Undercarriage—Starboard	83701
Undercarriage Jack (Hydraulic)	87075
Undercarriage Port Transfer Valve	87115C
Undercarriage Stbd. Transfer Valve	87115D

ASSEMBLY No. 3 — ARMAMENT

Ammunition Drum Container	87360
Bomb Gear in Outer Plane—Port	88002
Bomb Gear in Outer Plane—Starboard	88321
Bomb Gear	88000
Bomb Door (Hydraulic)	87080
Elevating Jack P.O.G.M.	89723
Gun Firing and Brake System (Browning)	E180305
Gun Mounting Outer Plane—Port	87551
Gun Mounting Outer Plane—Starboard	126010
Power Operated Gun Mounting	159210
Rotating Jack P.O.G.M.	89882
Torpedo Gear	88001

ASSEMBLY No. 4 — CONTROLS

Aileron Controls in Centre Plane	88617
Aileron Controls in Outer Plane—Port	82016B
Aileron Controls in Outer Plane—Starboard	82016A
Aileron Trimming Controls	86500
Airscrew Controls	E180134
Air Intake Controls	E180128
Auto Pilot Cables and Chains	84383
Auxiliary Fuel Tank Controls	86313
Brake and Gun Firing System (Brow)	E180305
Control Locking	84382
Controls in Cockpit	84010
Controls in Stern Frame	84260
Control Valve Emergency (Hydraulic)	84579
Control Column	84001
Drum Control Gear, Type D	96600
Dual Control Seat	87650
Dual Controls	84040
Engine Controls	E180060
Flap Indicator Controls	86325
Flap Controls	89100
Fuel Jettison Controls	86326
Fuel Cock Controls	86200
Landing Lamp Controls	86254
Ratio Controls M.R.C.	E180085
Rudder and Elevator Controls in Rear Fuselage	84360
Rudder Controls in Cockpit	84021
Trimmer Controls	84400
Undercarriage Indicator Controls	86281

ASSEMBLY No. 5 — ELECTRICAL

ASSEMBLY No. 6 — FUEL SYSTEM

Fuel Cock Control	86200
Fuel System	E180314
Fuel Tank Mounting	98223
Fuel Tank Inner Centre Plane—Port	98230A
Fuel Tank Inner Centre Plane—Starboard	98230B
Fuel Tank Outer Plane—Port	98229A
Fuel Tank Outer Plane—Starboard	98229B

ASSEMBLY No. 7 — FUSELAGE

Bomb Cell Skirt—Port	81800
Bomb Cell Skirt—Starboard	81801
Bomb Doors	81820
Engine Control Structure	80760
Fixed Fittings in Front Fuselage	87230
Fixed Fittings in Rear Fuselage	87310

Flooring in Rear Fuselage	81018
Front Fuselage Shell	80000
General Equipment Front Fuselage	87200
General Equipment Rear Fuselage	87280
Navigator's Seat	80011
Observer's Seat	80035
Parachute Flare Installation	81425
Pipes, Conduits, Brackets, etc., in Front Fuselage	86807
Pilot's Floor Structure	80600
Pilot's Seating	80152
Pressure Head System	87680
Rear Fuselage Shell	81000
Rear Fuselage Hatch	81009
Seat Structure Unit in Cockpit	80151
Stern Frame	81900
Tail Unit	83000
Wireless Operator's Seat	88500

ASSEMBLY No. 8 — GROUND EQUIPMENT

Covers Ground Equipment	87830
Fuselage Outer Plane Jacking	87801
Hand Starter—Port and Starboard	E180425
Maintenance Ladder	88370
Tail Picket Sling	87835
Tail Wheel Steering Arm	87814
Towing Arm	89405
Towing Cables	87833

ASSEMBLY No. 9 — HYDRAULIC SYSTEM

By-Pass Valve	87127
Choke Adjustable	87126
Choke Valve	156548
Control Valve	87000
Control Valve	69267
Control Valve Emergency	156047
Control Valve Multiple	89696
Control Panel	87057
Double Relief and Non-Return Valve	87006
Emergency By-Pass Valve	156401
Emergency Valve Control	84579
Filter	BS1500
Firing Chamber Emergency Cartridge Unit	156104
Hand Pump Emergency	87074
Hydraulic System Mk. II	126402
Hydraulic Lock P.O.G.M.	69335
Jack Bomb Doors	87080
Jack Elevating P.O.G.M.	89723
Jack Flaps	87076

Jack Rotating P.O.G.M. (Vickers)	89882
Jack Rotating P.O.G.M. (Browning)	157070
Jack Tail Wheel	87077
Jack Undercarriage	87075
Lock Double	87081
Non-Return Valve Cartridge Emergency Unit	156046
Oil Tank (Large)	87854
Oil Sealing Valve	156210
Operating Plunger	99938
Pipe Runs and Clips	129872
Pressure Release Valve	156087
Relief Valve	87157
Relief Valve	87158
Swivel Feed Valve	64110
Transfer Valve Flaps—Port and Starboard	87115A
Transfer Valve Tail Wheel	87115B
Transfer Valve Undercarriage—Port	87115C
Transfer Valve Undercarriage—Starboard	87115D

ASSEMBLY No. 10 — MISCELLANEOUS EQUIPMENT

Accessory Cooling—Port	E180101
Accessory Cooling—Starboard	E180100
Anticer Installation	98100
Camera Installation	81021
Camera Gun Installation G. 22	80930
Dashboard and Instruments	80970
Desert Equipment	87520
Elsan Closet	81044
Equipment in Centre Plane	87540
Equipment in Outer Plane—Port	87550
Equipment in Outer Plane—Starboard	126034
Flare Chute	81025
Graviner Fire Extinguisher	E180230
Gyro Angling Gear	84434
Harness Gear	87484
Night Flying Blinds	88300
Oxygen Installation	87620
Pilot's Gun Sight	87578
Pressure Head System	87680
Speaking Tube	87633
Sun Blinds	89490
Target Towing Attachment	86641
Vacuum Pump System	129785

ASSEMBLY No. 11 — OIL SYSTEM

Oil System—Port	126571
Oil System—Starboard	126570
Oil Tank Mounting	86025

Oil Tank	86004
R.A.E. Cooler—Port	A200A
R.A.E. Cooler—Starboard	A200B

ASSEMBLY No. 12 — OPERATIONAL EQUIPMENT

Auxiliary Fuel Tank	98232
Auxiliary Fuel Tank Mounting	98246
Auxiliary Fuel System	86147
Flare Crates in Rear Fuselage	87293

ASSEMBLY No. 13 — POWER UNIT

Accessory Cooling—Port	E180101
Accessory Cooling—Starboard	E180100
Accessory Gear Box, Type 2 GB 11H	FB66929
Engine Attachment	E180098
Engine Cowling, L.H.	L163530
Engine Cowling, R.H.	L163547
Engine Driven Hydraulic Pump	C287
Engine Mounting	129600
Engine Mounting Adaptor Structure	126070
Exhaust System—Port	L163544A
Exhaust System—Starboard	L163544B
Gear Box Drive	FB92636
Gear Box Reduction Gear	FB90249
Ignition System	126670
Nacelle Fairing—Port	126145
Nacelle Fairing—Starboard	126146
Nacelle Structure—Port	83900A
Nacelle Structure—Starboard	83900B

ASSEMBLY No. 14 — W/T. INSTALLATION

D.F. Loop Installation	82970
Wireless Installation	84600
Wiring Diagram Switch Unit, Type D	84652