

VULCAN B MK.2 AIRFRAME

Reference: AP 4505B, Volume 1.

1. Introduction

The Vulcan is an all metal monoplane of delta planform, powered by four Bristol Olympus Mk.201 or 301 engines. It can carry an extensively variable bomb load a long way at appreciable speed and high altitude. Provision is made for in-flight refuelling.

2. Leading Particulars

Span	111 feet
Length	99 feet 11 ins. (less probe)
Mainplane area	3965 square feet (including elevons)
Incidence	5°
Dihedral	0°
Sweepback (leading edge at wing joint)	49° 54 minutes
Fin area (including rudder)	224 square feet
Fin sweepback	49° 30 minutes
Height (top of fin)	27 feet 1 in.
Track	31 feet 1 in.

3. Construction

The fuselage is manufactured in four separate sections, each of light alloy, stressed skin structure, of circular cross section and incorporating transverse formers braced by longitudinal stringers. The four sections are:-

a. Nose Section

The upper portion of the nose section fairing is of orthodox metal construction and houses flight refuelling equipment, H2S Scanner, Scanner pneumatic system, and 12 gallon de-icing tank. Below the metal fairing is a dielectric structure of fibreglass and hycar, which constitutes the radome, and is attached by toggle fasteners, amal fasteners and safety lock catches.

b. Front Section

The front section is circular in shape, and constitutes the pressurised crew cabin, and contains all the controls for operating all the services. Structurally it is built up of two pressure bulkheads, one forward and one rear, and a series of formers circular in shape, joined by longitudinal stringers. Attached to the rear pressure bulkhead are the nose wheel mounting brackets. The floor structure is built on two levels, the forward higher level to accommodate the two pilots, the rear lower level to accommodate the other three crew members. The canopy is jettisonable, but the windscreen is integral with the structure. The two pressure heads are mounted externally on the fuselage, forward. On the under surface is a bomb aimers blister, and to the rear is a flush fitting entrance/escape door.

/c.

c. Centre Section

The centre section extends from the rear pressure bulkhead of the crews compartment to a point aft of the rear spar. The structure between the rear pressure bulkhead and the front spar forms the nosewheel bay, No.1 tank bays and No.2 tank bays. The area between the front and rear spars form an extensive compartment which is the bomb bay, and formed by bomb arches and inner ribs. From the rear spar to the termination of the centre section forms the power compartment (electrical). On either side of the nosewheel bay are the air intake structures consisting of diaphragm ribs skinned internally to form the air intake apertures. On either side of the bomb bay the structure is divided into engine compartments by centrally disposed ribs, whilst at the rear of these compartments are the jet pipe tunnels. The bomb doors, when opened, fold upward inside the bomb bay to reduce drag. Between the main ribs in the engine compartment area, aft of the front spar, the air brakes are mounted.

d. Rear Section

The rear section is constructed almost entirely of light alloy pressings, and circular formers, and forms the support to carry the detachable jet pipe end caps and the composite tail cone radome and houses the ECM equipment. In the top of the rear section, aft of the rudder, is a light alloy box-shaped compartment housing the brake parachute installation.

e. Dorsal Fin

A swept back dorsal fin fairing, which is a pressed rib and skin assembly, is mounted above the rear of the centre section to improve directional stability, and is considerably extended along the fuselage.

f. Mainplanes

Each wing is a two spar cantilever structure and is manufactured in three main sections:- inner portion, outer portion and wing tip, and the inner and outer portions are joined by conventional shackle joints. The main wheel units are housed in the root end of each mainplane, to the rear of the front spar, between the transport rib and the first main rib. Between the first main rib and the second main rib are nine intermediate ribs, each with three apertures which, when lined with an alloy sheet, form Nos. 3, 4 and 6 fuel tank bays. Between the second main rib and the third main rib are also nine intermediate ribs. These ribs have only two apertures, which when lined with alloy sheet, form Nos. 5 and 7 fuel tank bays. Nos. 5, 6 and 7 fuel tank ribs, due to their lesser depth because of the tapering of the mainplane in plan and elevation are supported by tie rods which pass up from the underside of the mainplane, through the rib and tank and screw into housings on the underside of the mainplane upper skin. These tie rods are NOT interchangeable and are coloured and lettered according to their respective tank and rib. Outboard of the third main rib and mounted on its outboard face are six fire bottles for mainplane fuel tank fires. Access to these bottles is through a quick release

/panel.

panel. Four main ribs interspaced by intermediate ribs make up the rest of the mainplane structure. Into the compartments formed by the tank bays are fitted the collapsible bag type tanks and their components. To the rear of the rear spar are mounted the PPU's and the elevons. Forward of the front spar is the leading edge skinning, in which provision is made for passing hot air along the inside of the leading edge for anti-icing.

#### g. Control Surfaces

The control surfaces consist of elevons divided into eight sections and a rudder. The elevons are numbered from port to starboard as Nos. 1, 2, 3, 4, 5, 6, 7 and 8, the inboard elevons (Nos. 3, 4, 5 and 6) having an extended beak to form an aerodynamic balance and it also carries the mass balance. A sealing strip of rubberised fabric is attached between the forward edge of the latter and the mainplane shroud skin. This relieves the control surface loads and the sealing leads to increased wing aerodynamic efficiency. Each elevon is powered independantly by a separate power control unit, two further control units being provided for the rudder. Electrically operated rotating slat type air brakes are mounted in the mainplane, above and below the engine air intakes.

#### h. Flying Controls

The 1st and 2nd pilots control consist of combined push-pull and twist hand-grip for elevon control, and pendulum type pedals for rudder control. Incorporated in the rudder pedals are foot motors for wheel brake application. Tubular push-pull rods are used throughout, from the cockpit to the power units, the circuits governing aileron and elevator sense uniting at a mixing unit at the rear spar, from where a single control run into each wing operates all the elevon power units. Due to the use of powered units, the pilots controls are not sensitive to control surface loadings. Therefore the pilots control 'feel' is simulated by three artificial feel units, one for each control axis, situated in the bomb bay. Stick and pedal forces can be trimmed by the pilots via linear actuators adjacent to the feel units.

#### j. Alighting Gear

The alighting gear comprises two main wheel units retracting forwards and upwards into the main plane, and a single nose wheel unit retracting rearwards and upwards into the fuselage aft of the crew compartment. Each main wheel unit has a four wheeled, eight tyred bogie and hydraulically operated brakes incorporating Maxaret (anti-skid) units. The nose wheel unit has two wheels secured to a common axle to eliminate shimmy and is steered hydraulically. On all three units, landing and taxiing shocks are taken by a Dowty Liquid Spring on each unit. The main wheel units are completely faired in by a hydraulically operated door and a fairing connected by spring loaded struts to the rear face of the main fitting. Two hydraulically operated doors fair the nose wheel unit.

#### k. Hydraulic System

The hydraulic system is electrically controlled and is installed to operate the alighting gear and associated doors, /bomb doors,

bomb doors, nose wheel steering, wheel brakes. The various circuits are separately controlled by electrically operated selector valves with the exception of the nose wheel centring jack, which is connected to the main supply line. Separate hydraulic circuits for ground and emergency operation of the bomb doors are provided.

l. Pneumatic System

The pneumatic systems, charged from a ground source, are installed to operate the main entrance door (for closing on the ground, and for emergency opening in flight), jettison the canopy, pressurise the canopy seal and entrance door seal, and also to pressurise the windscreen de-icing tank; T/4 bomb sight computer, H2S scanner and NBS conditioning. Ancillary pneumatic systems supplied by a tapping off the engine axial compressors supply air to the bomb door seals, hydraulic reservoir and power pack.

m. Air Conditioning

An air conditioning unit, utilising hot air from the engines and a combined valve assembly, incorporated in the main cabin system, maintains air in the crews compartment at reasonable temperatures and pressures over the whole range of conditions likely to be encountered when flying at extreme and varying altitudes. A similar conditioning plant to that used for cabin supply, is included in the suit ventilation system and maintains a flow of conditioned air to the supply line of the individual units at crew stations.

n. Anti-icing

The thermal anti-icing of the airframe is accomplished by circulating hot air from the engine axial compressors, through ducting in the leading edges of the wings and fin, within predetermined limits. The fluid anti-icing system is provided for the pilots and air-bombers windows.

o. Electrical Power

Power for the electrical services is provided by four engine driven alternators giving constant frequency alternating current. Transformer rectifier units provide the 28 volt direct current supplies. A ROVER GAS TURBINE is installed to provide an emergency electrical power supply for driving essential services should the main engine alternators fail during flight. The Rover Gas Turbine may also be used for ground servicing.

p. Radar and Radio Equipment

Radio equipment consists of a general purpose high frequency transmitter/receiver (STR 18) under control of the AEO, two radio altimeters (high and low range), Smith flight system, radio compass, and normal R/T equipment. Radar installations consists of Gee, IFF, ECM and Green Satin equipment.

q. Emergency Equipment

Emergency equipment includes ejection seats for the pilots, dinghy with survival pack, signal pistol and cartridges, first aid outfits, fire axes, asbestos gloves, and hand operated fire extinguishers, ~~and leak stoppers~~. A ram air turbine is installed, which when lowered into the airstream in flight, will supply electrical power for flying controls and fuel pumps in event of failure of the main engine alternators in flight, prior to the starting of the Rover Gas Turbine.

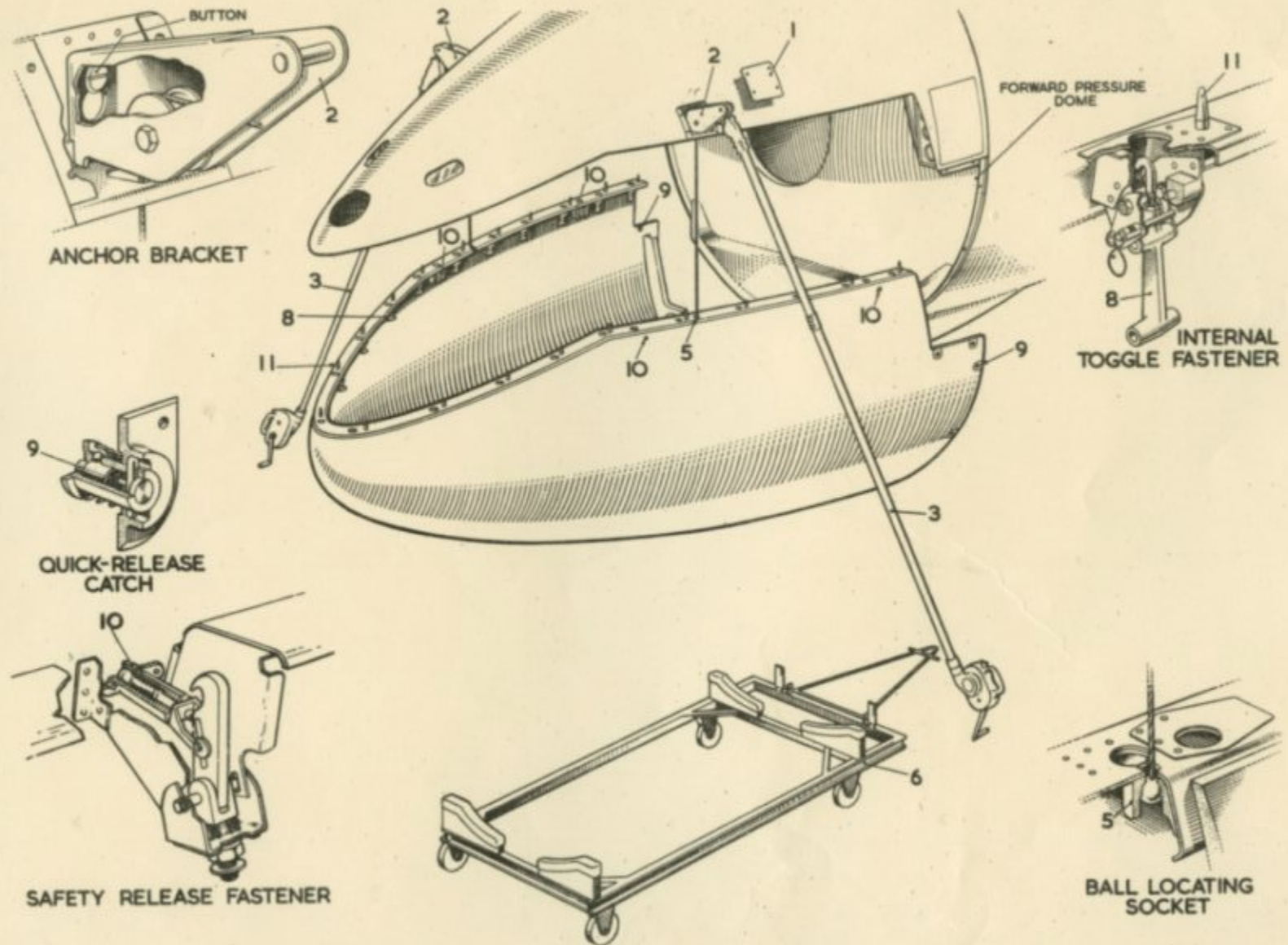


Fig. 16. Removal of nose radome.

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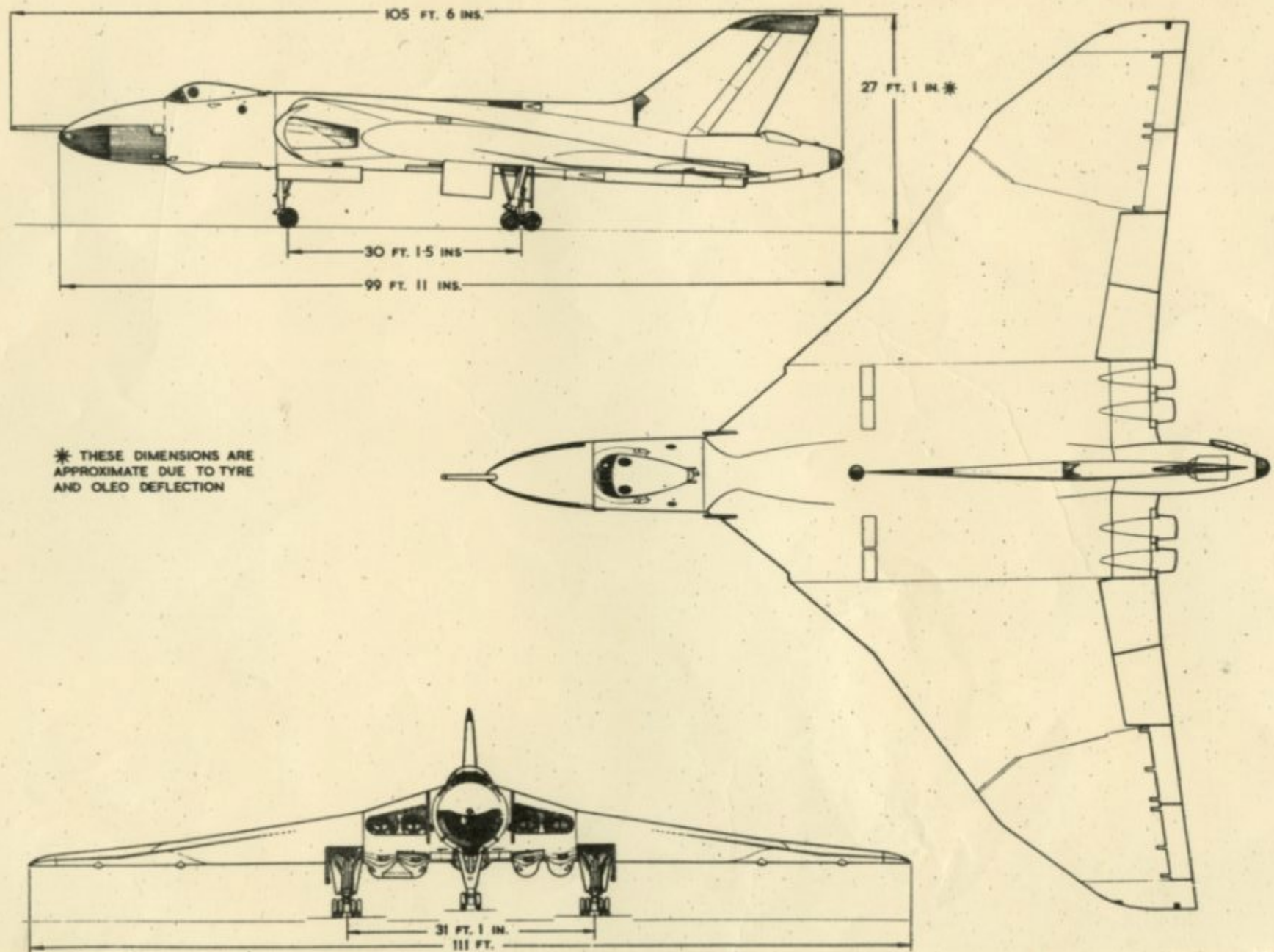


Fig. 1. General arrangement.

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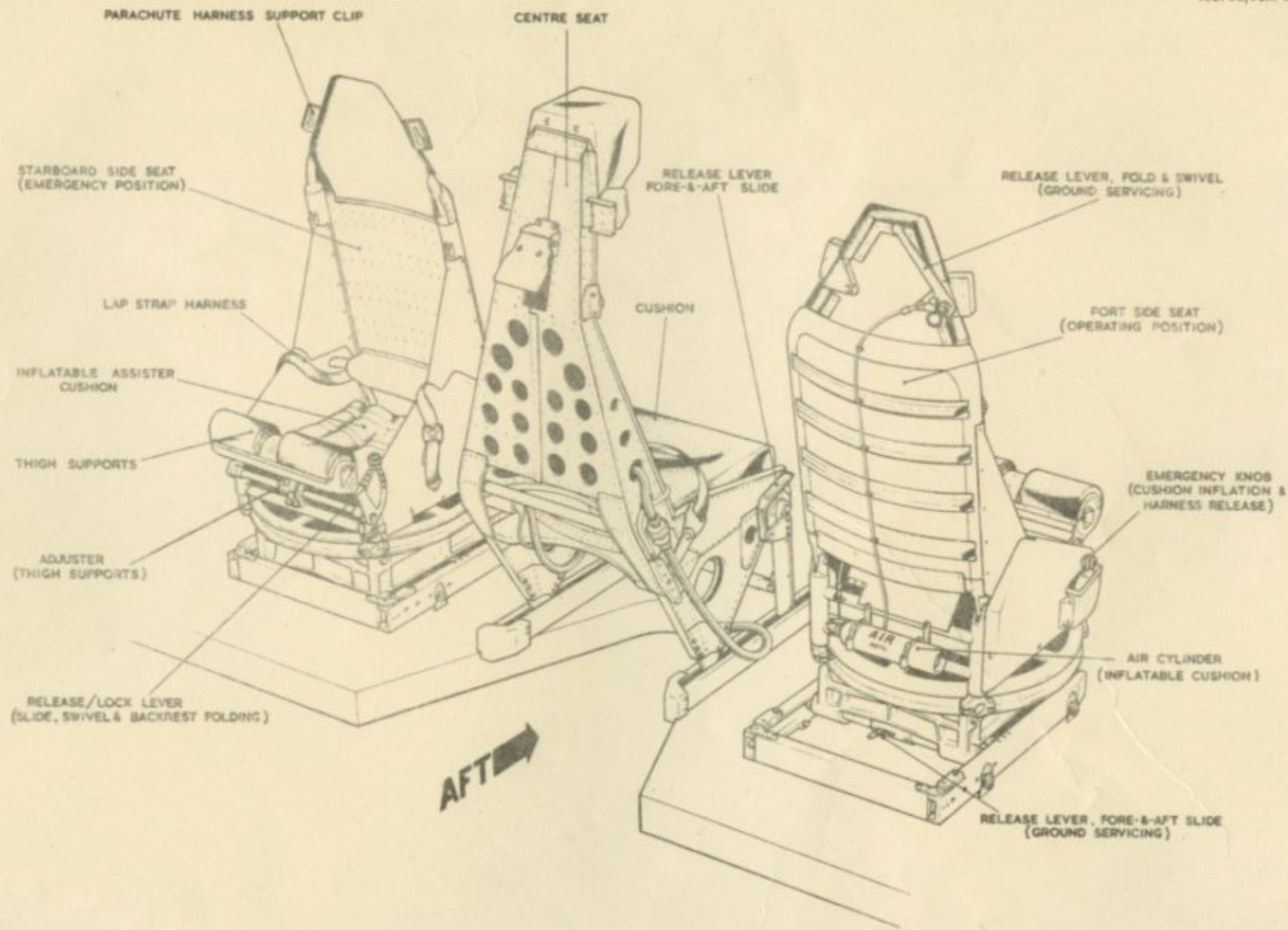
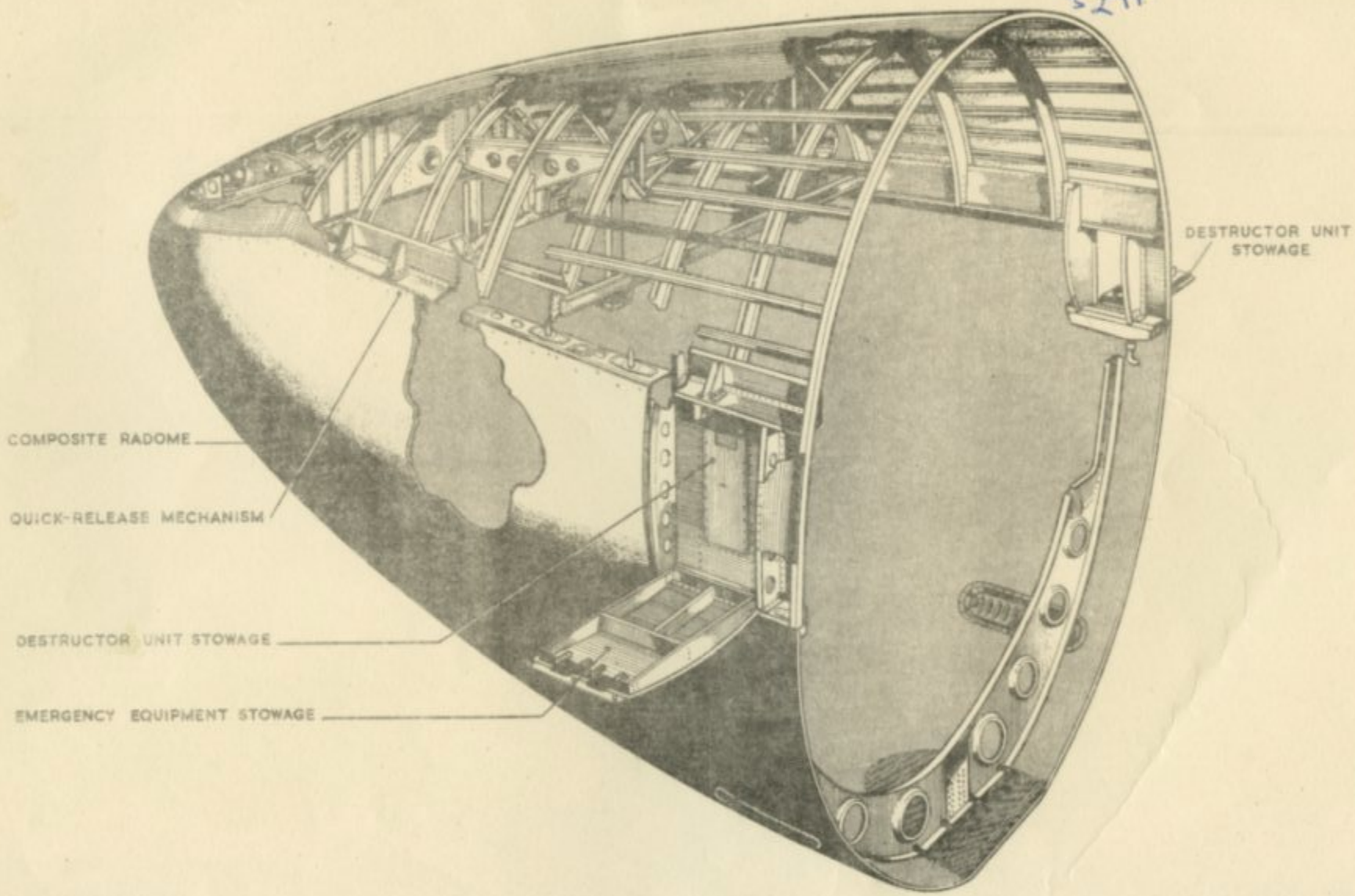


Fig. 5. Seats at crew stations

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COMPOSITE RADOME

QUICK-RELEASE MECHANISM

DESTRUCTOR UNIT STOWAGE

EMERGENCY EQUIPMENT STOWAGE

DESTRUCTOR UNIT STOWAGE

Fig.2. Nose fairing

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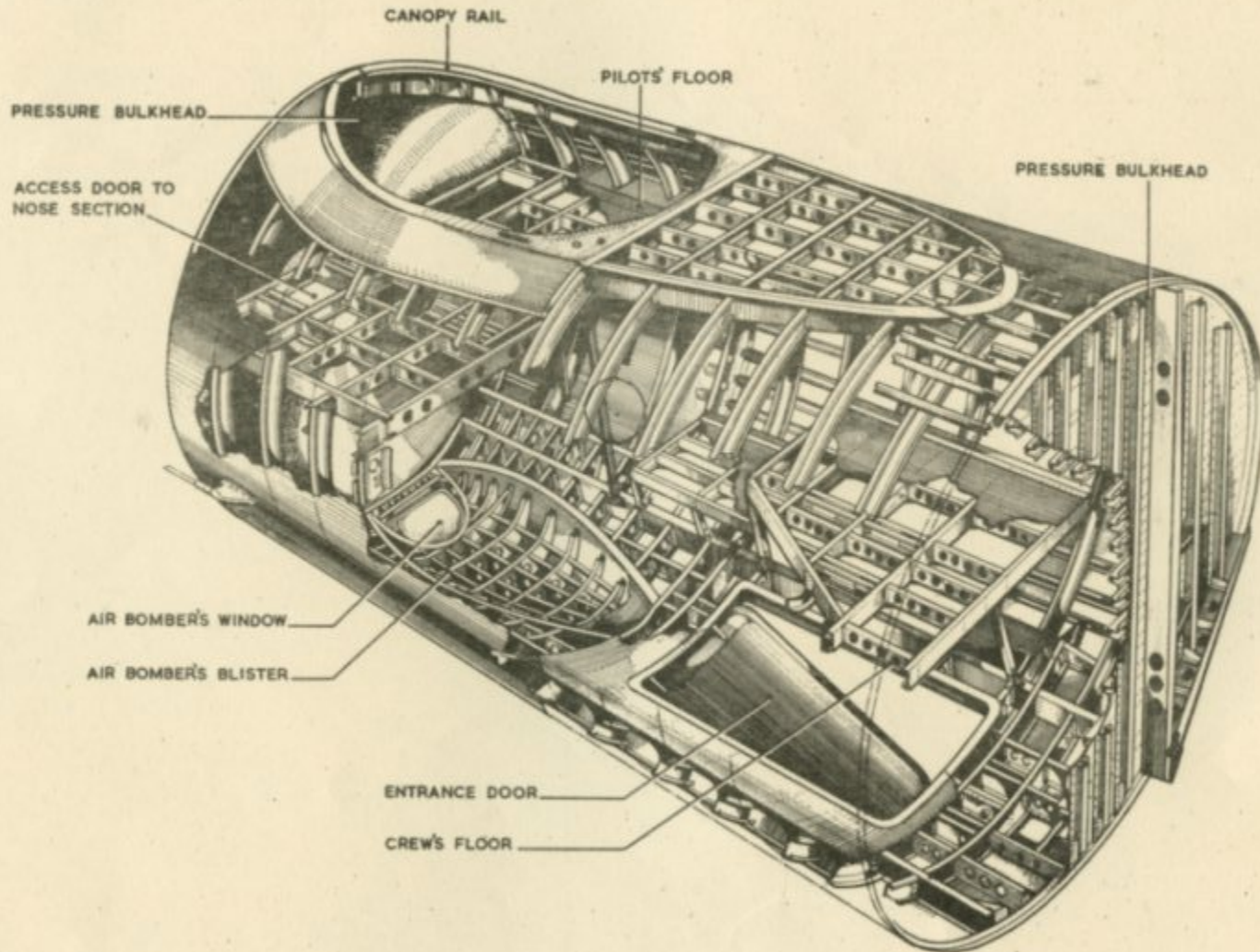
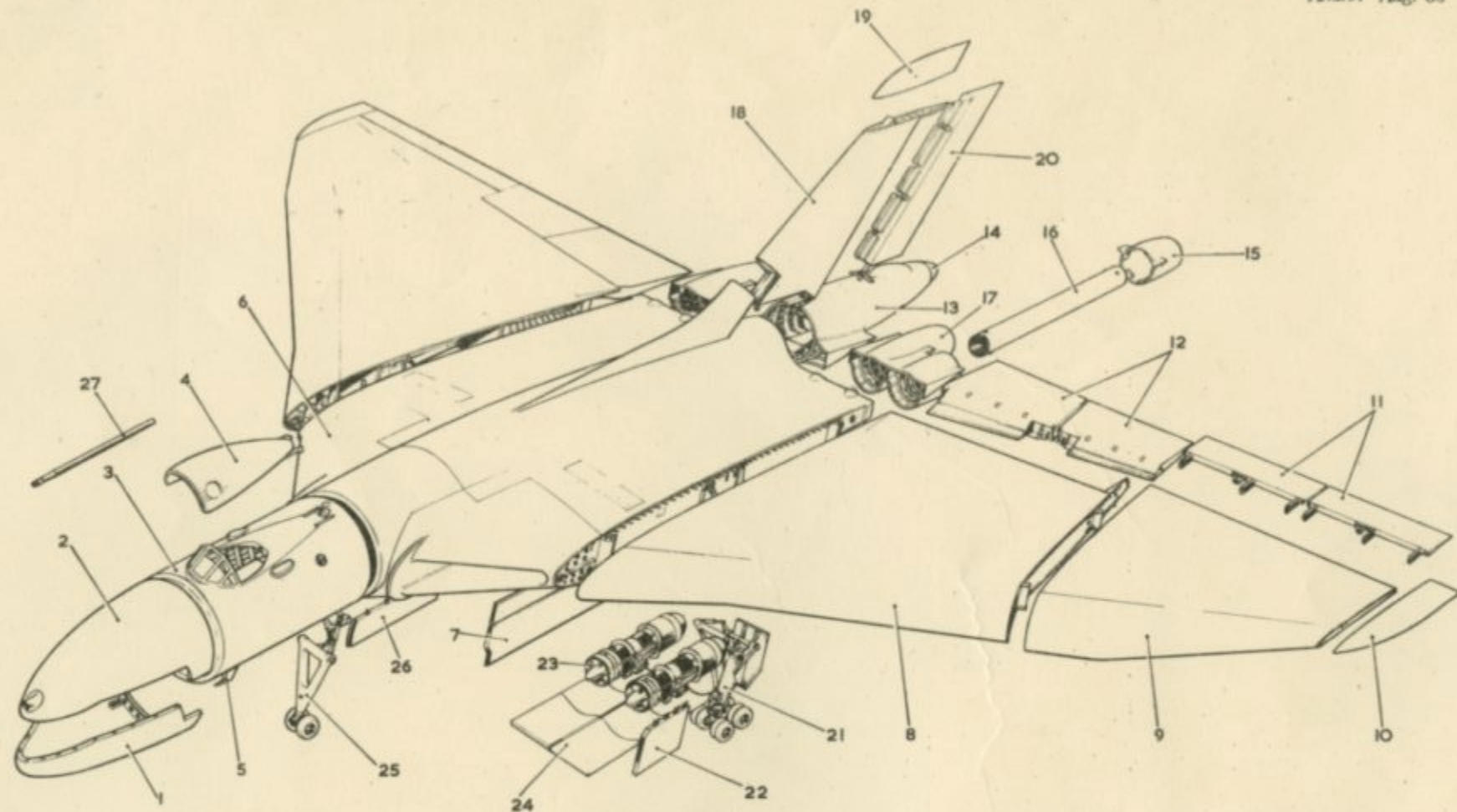


Fig. 3. F-104 fuselage.  
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- |                           |               |                     |               |                            |               |
|---------------------------|---------------|---------------------|---------------|----------------------------|---------------|
| 1 NOSE RADOME             | SECT.3 CHAR 1 | 9 OUTER WING        | SECT.3 CHAR 2 | 18 FIN                     | SECT.3 CHAR 3 |
| 2 NOSE FAIRING            | SECT.3 CHAR 1 | 10 WING TIP         | SECT.3 CHAR 2 | 19 FIN CAP                 | SECT.3 CHAR 3 |
| 3 FRONT FUSELAGE          | SECT.3 CHAR 1 | 11 OUTER ELEVON     | SECT.3 CHAR 2 | 20 RUDDER                  | SECT.3 CHAR 3 |
| 4 CANOPY                  | SECT.3 CHAR 1 | 12 INNER ELEVON     | SECT.3 CHAR 2 | 21 MAIN WHEEL UNIT         | SECT.3 CHAR 5 |
| 5 PITOT HEADS             | SECT.5 CHAR 2 | 13 REAR FUSELAGE    | SECT.3 CHAR 1 | 22 MAIN WHEEL DOORS        | SECT.3 CHAR 2 |
| 6 CENTRE SECTION FUSELAGE | SECT.3 CHAR 1 | 14 REAR RADOME      | SECT.3 CHAR 1 | 23 ENGINES                 | SECT.4 CHAR 1 |
| 7 BOMB BAY DOORS          | SECT.3 CHAR 1 | 15 JET PIPE END CAP | SECT.4 CHAR 1 | 24 ENGINE BAY DOORS        | SECT.4 CHAR 1 |
| 8 INNER WING              | SECT.3 CHAR 2 | 16 JET PIPE         | SECT.4 CHAR 1 | 25 NOSE WHEEL UNIT         | SECT.3 CHAR 5 |
|                           |               | 17 JET PIPE FAIRING | SECT.3 CHAR 1 | 26 NOSE WHEEL DOORS        | SECT.3 CHAR 1 |
|                           |               |                     |               | 27 FLIGHT REFUELLING PROBE | SECT.4 CHAR 2 |

Fig.2 Sections of aircraft

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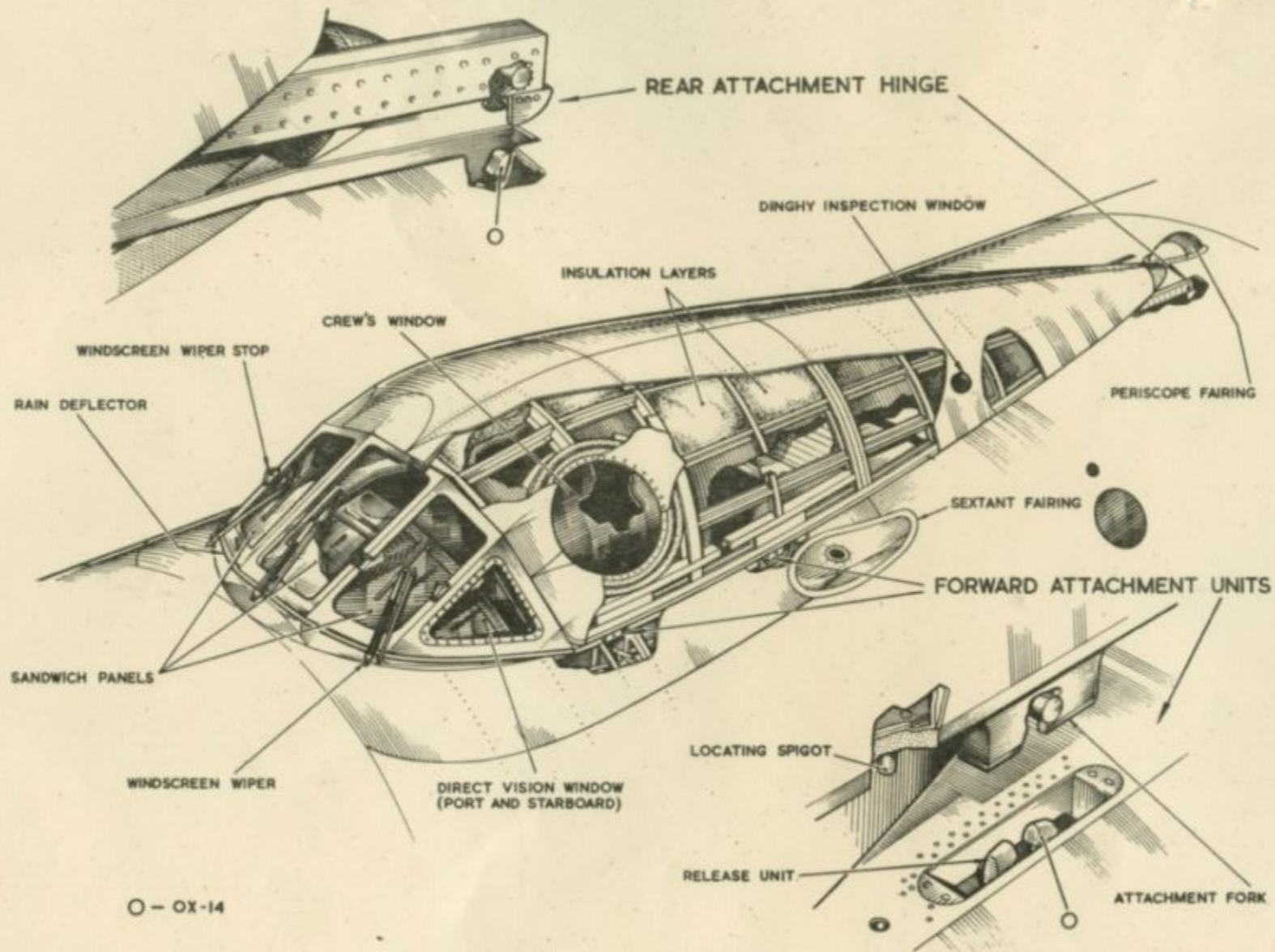


Fig. 5. Canopy structure.  
(4 Mod. No. 959)  
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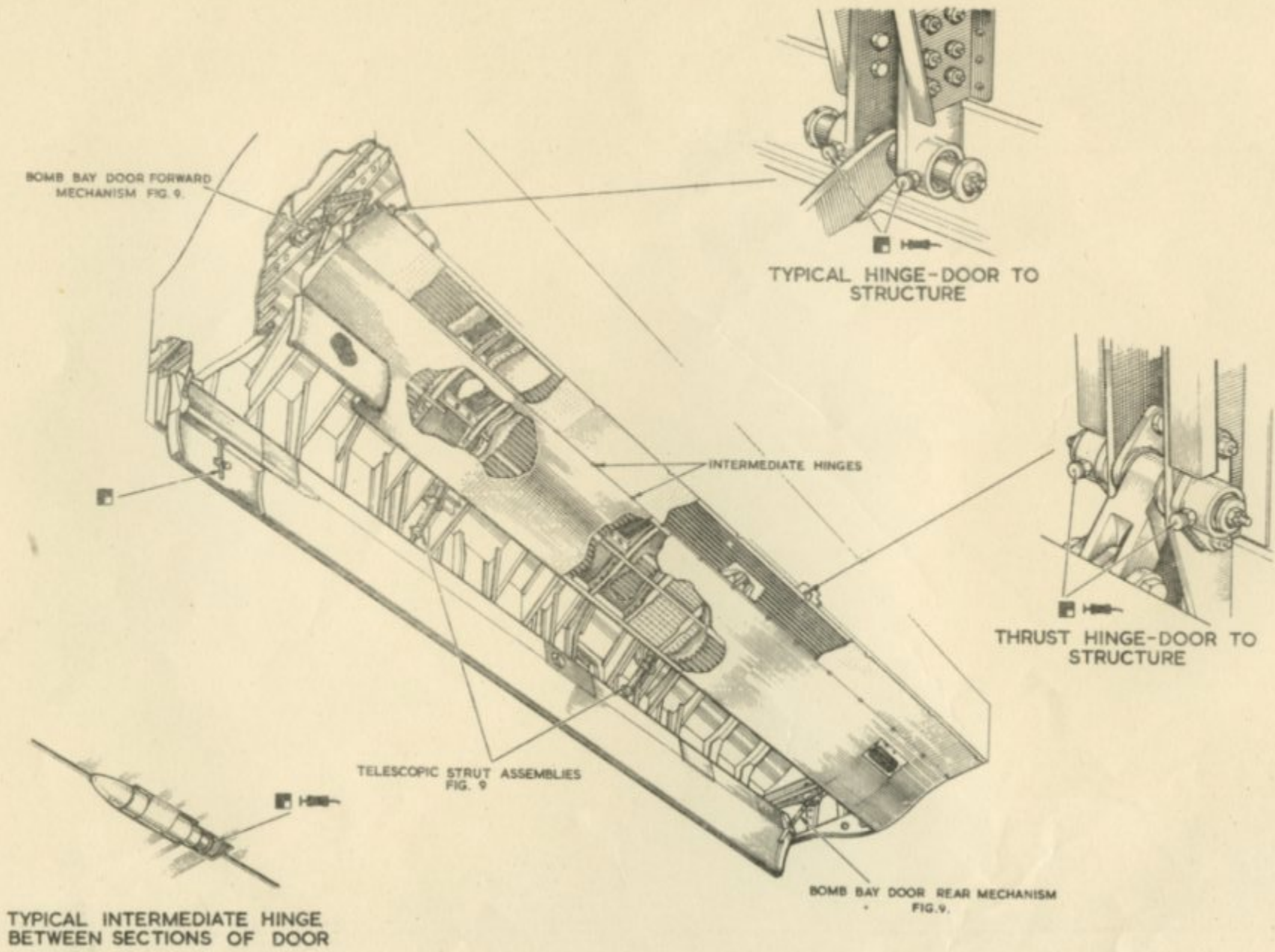


Fig. 8. Bomb bay doors.

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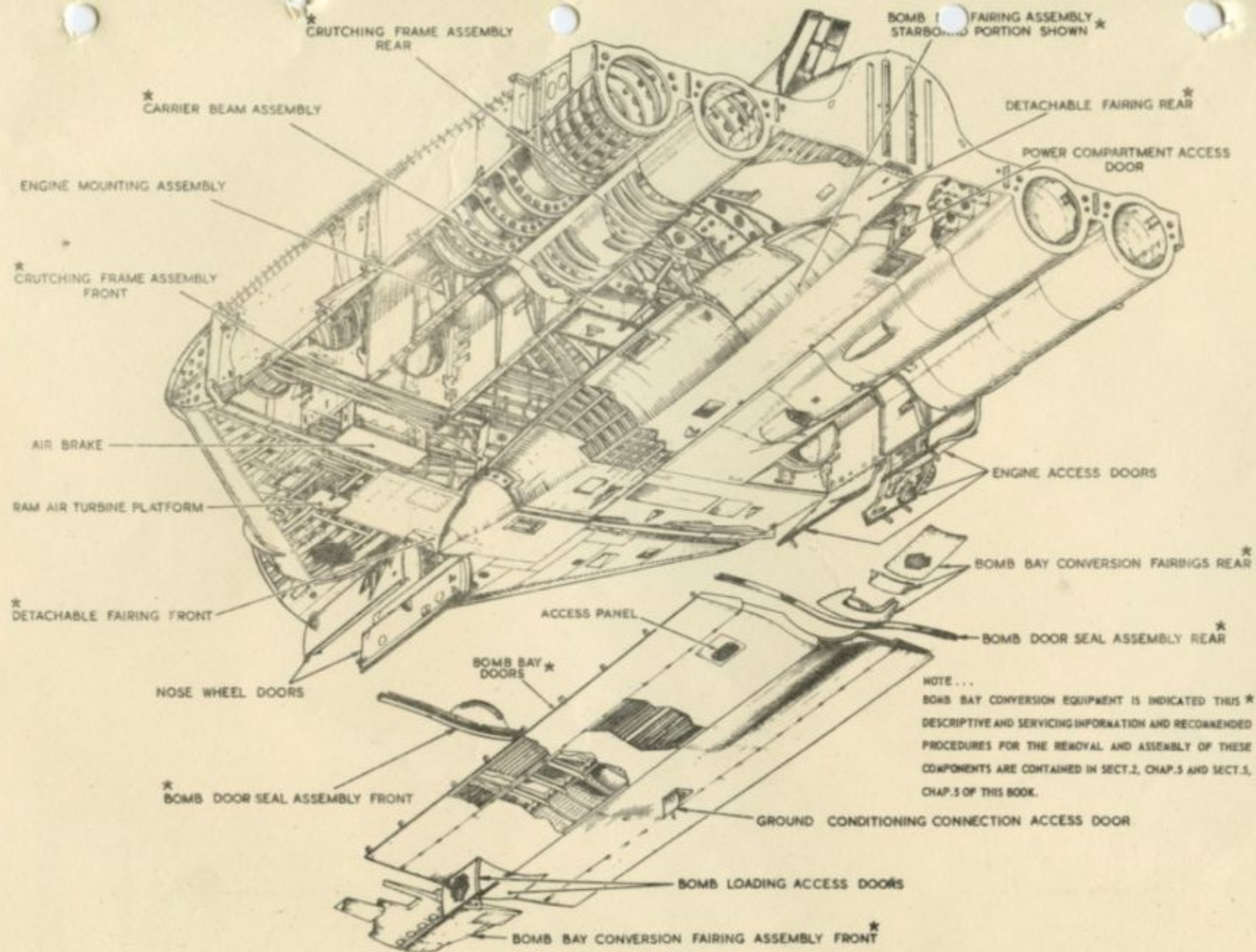


Fig. 7 Centre section (2)

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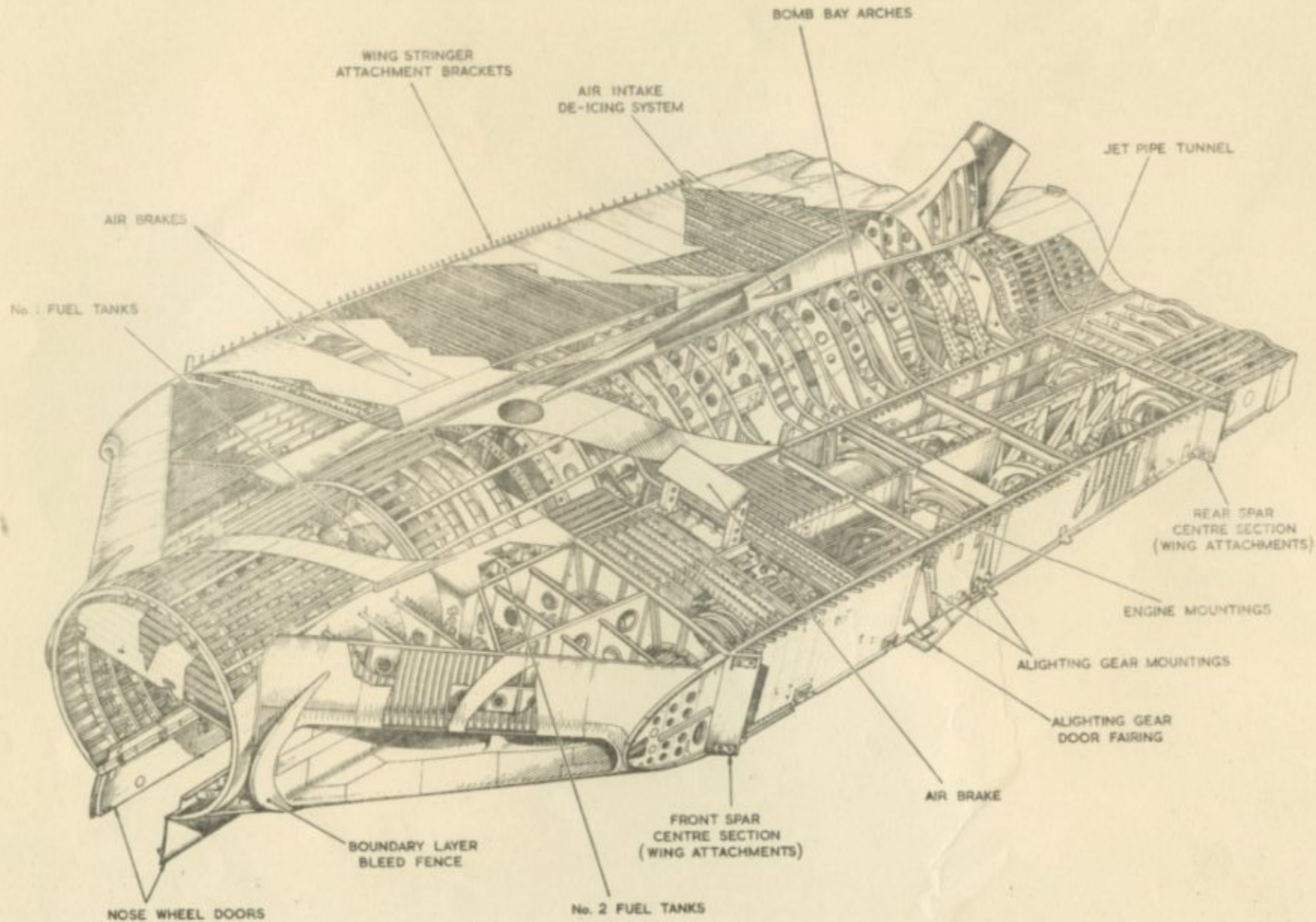


Fig.6. Centre section (1)

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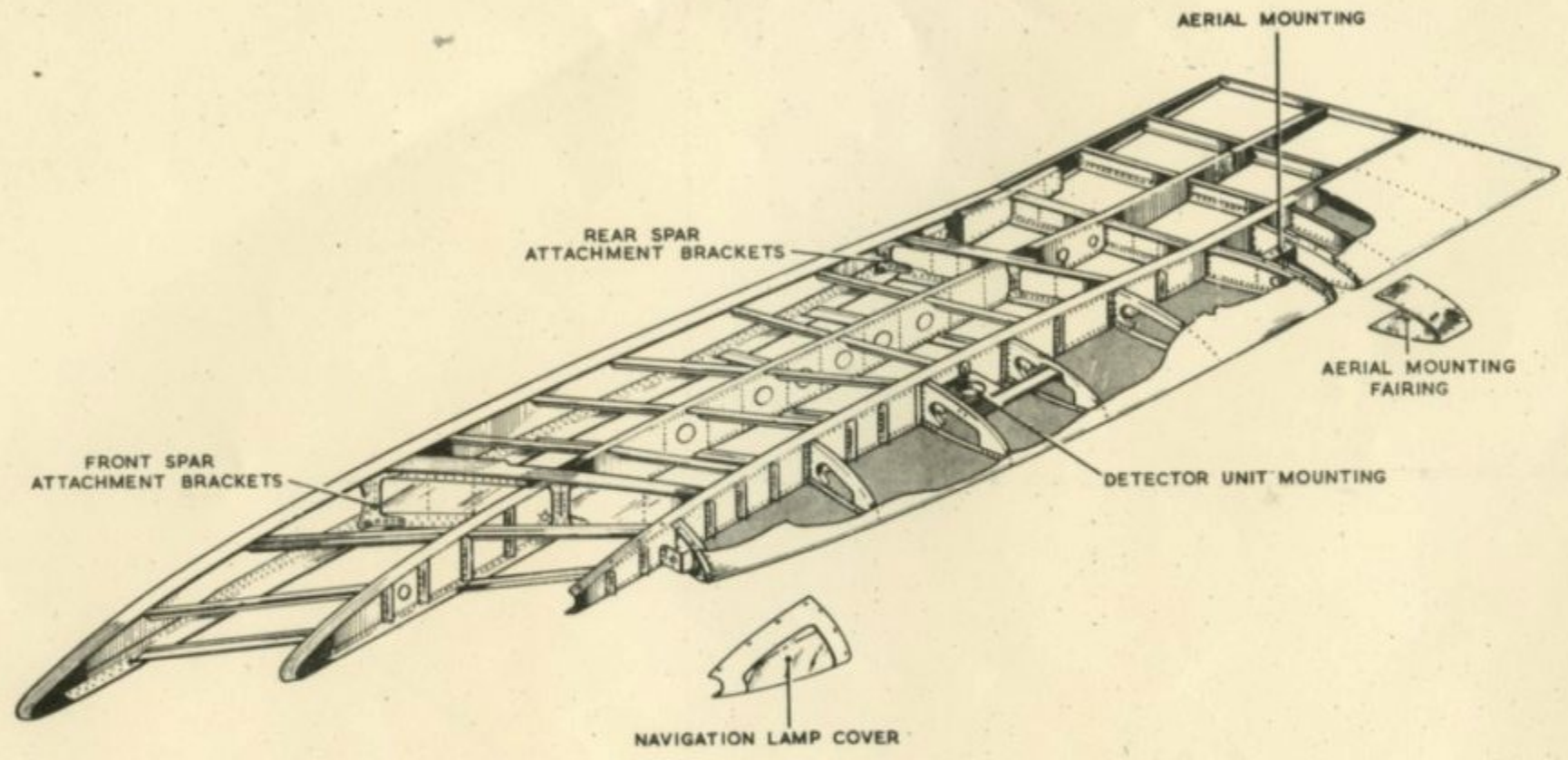
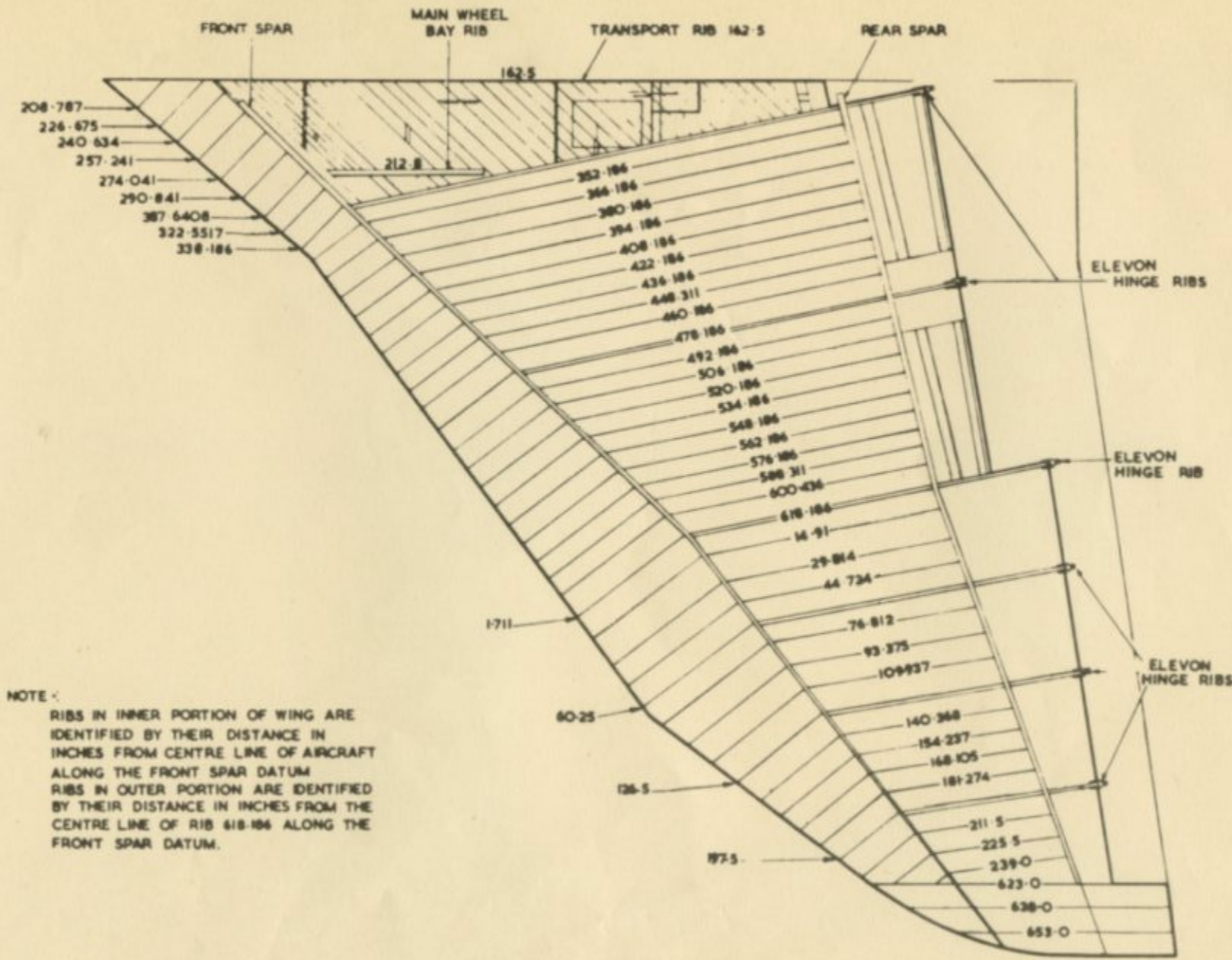


Fig.3 Wing tip (port side)

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NOTE:  
 RIBS IN INNER PORTION OF WING ARE IDENTIFIED BY THEIR DISTANCE IN INCHES FROM CENTRE LINE OF AIRCRAFT ALONG THE FRONT SPAR DATUM  
 RIBS IN OUTER PORTION ARE IDENTIFIED BY THEIR DISTANCE IN INCHES FROM THE CENTRE LINE OF RIB 618-186 ALONG THE FRONT SPAR DATUM.

Job No. 1988  
 WAD/1/8CVSS/V2

FIG. I RIB POSITIONS

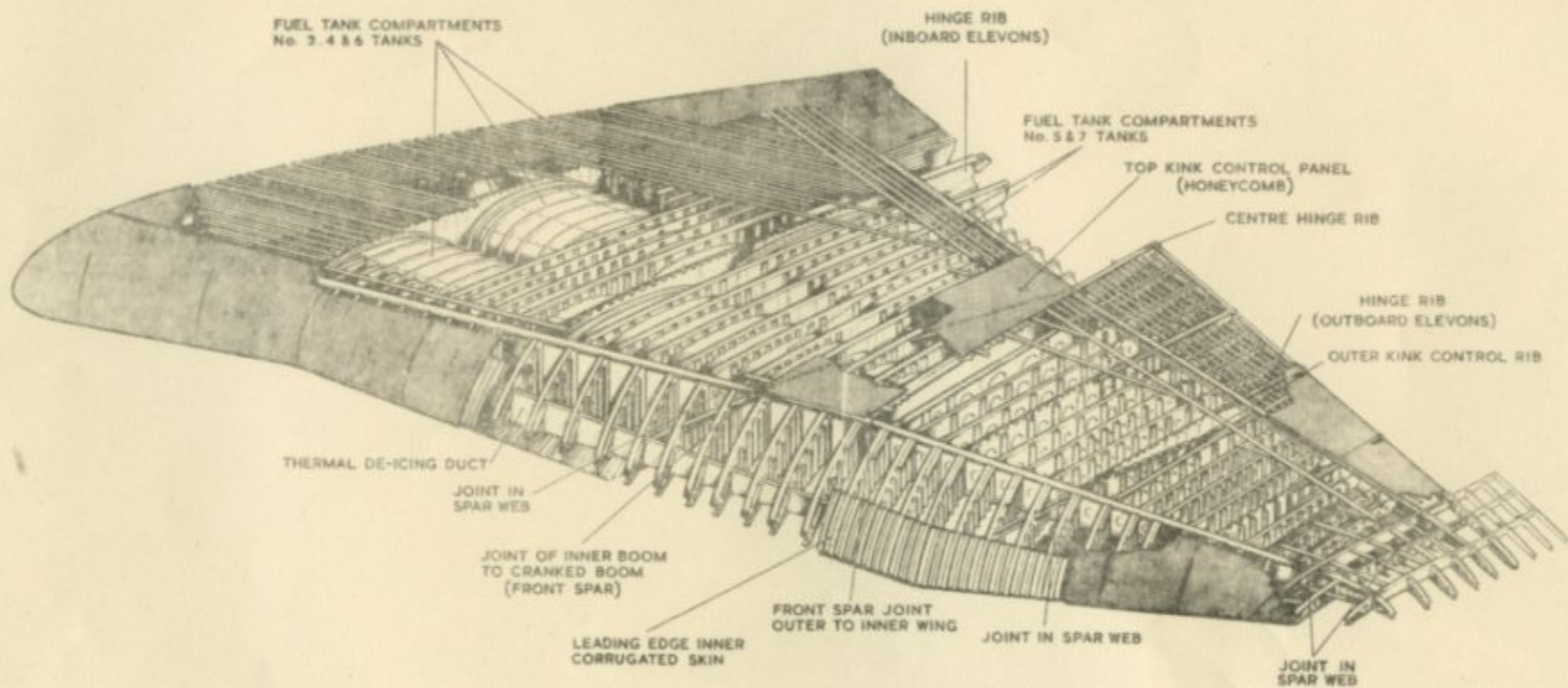


Fig.1 Outer wing structure

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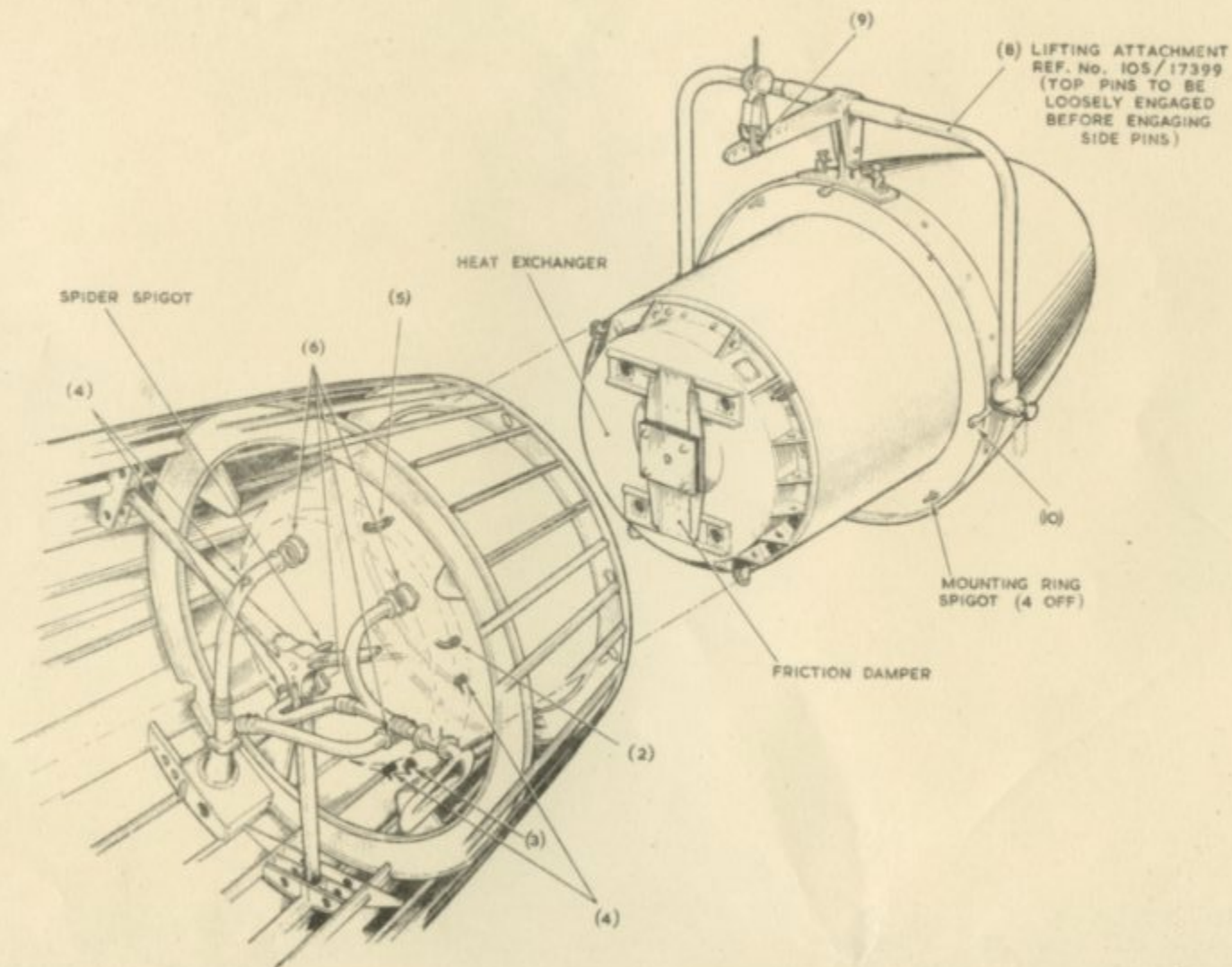
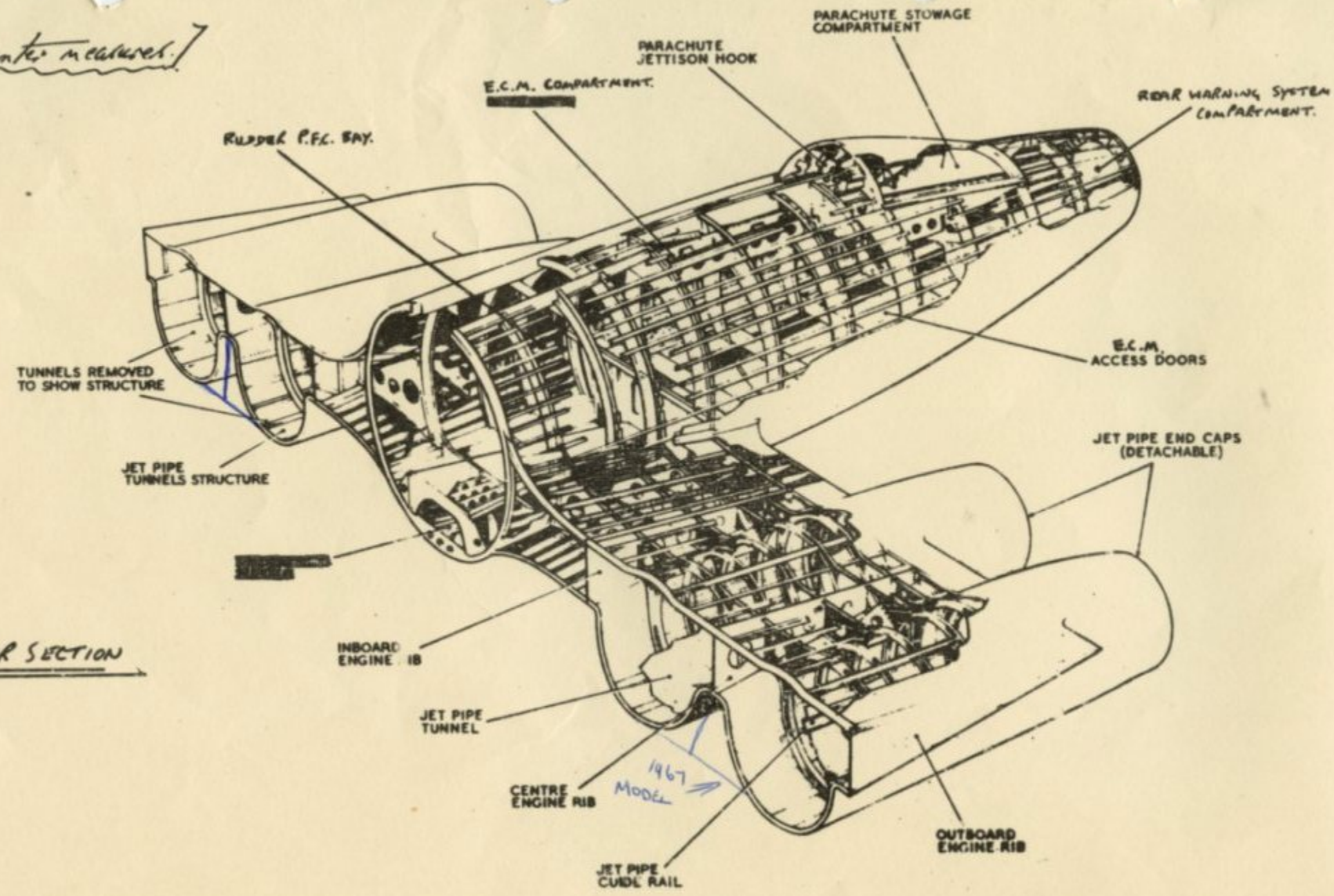


Fig. 12. Removal of radar head  
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Rev 7/4: incorporating E.C.M.

Electronic counter measures.



REAR SECTION →

Tail Side Only

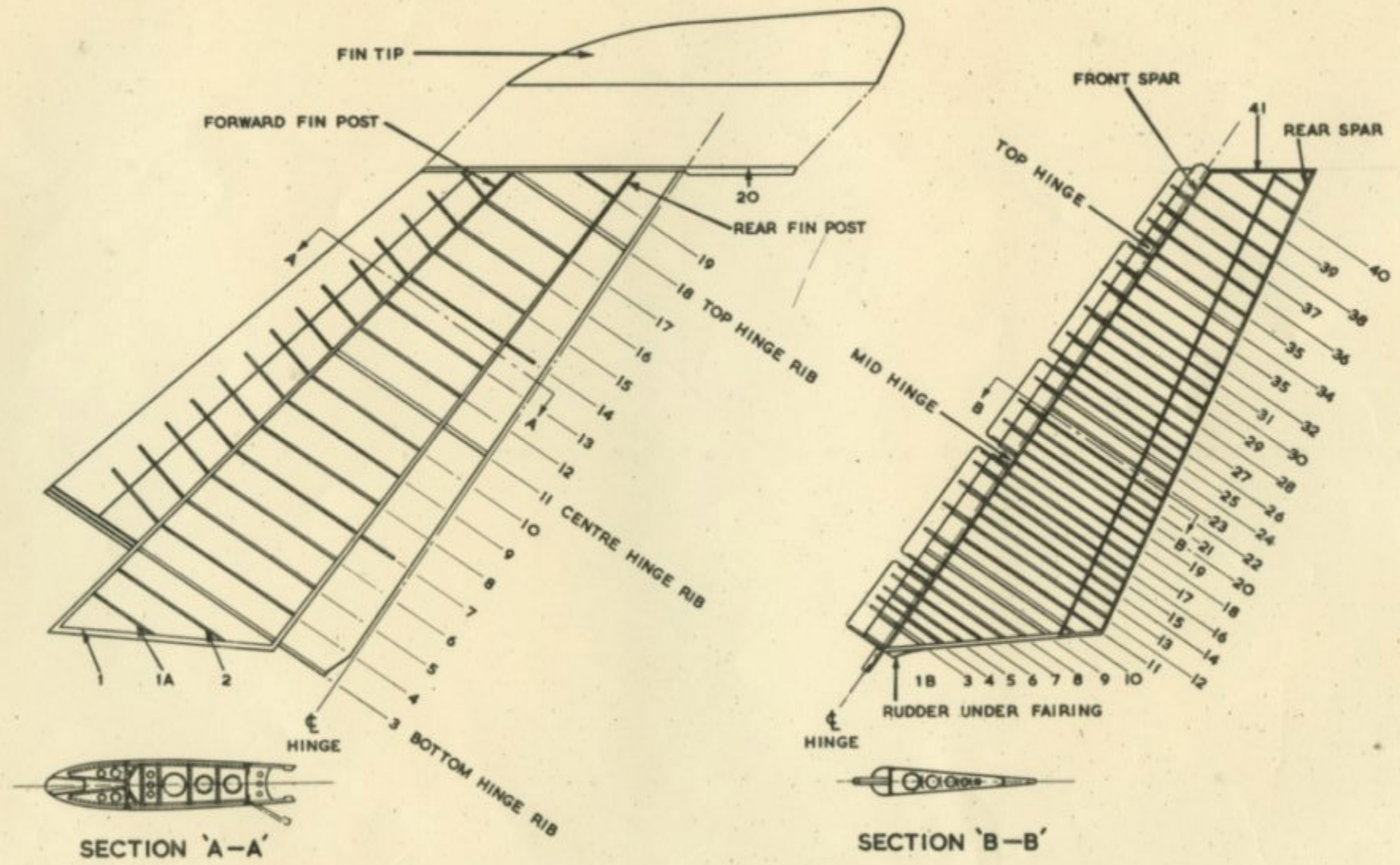


Fig. 1 Rib positions - fin and rudder  
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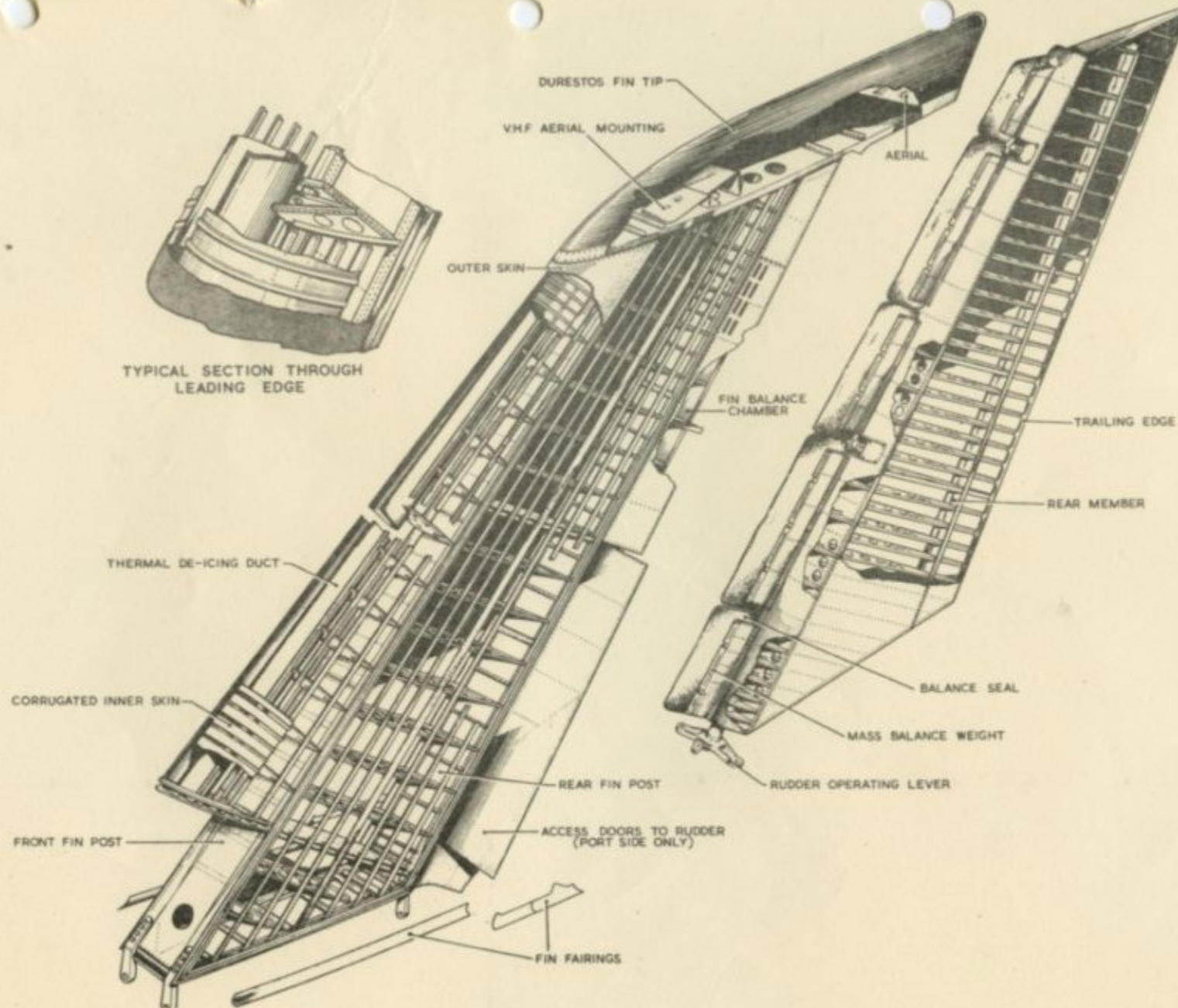
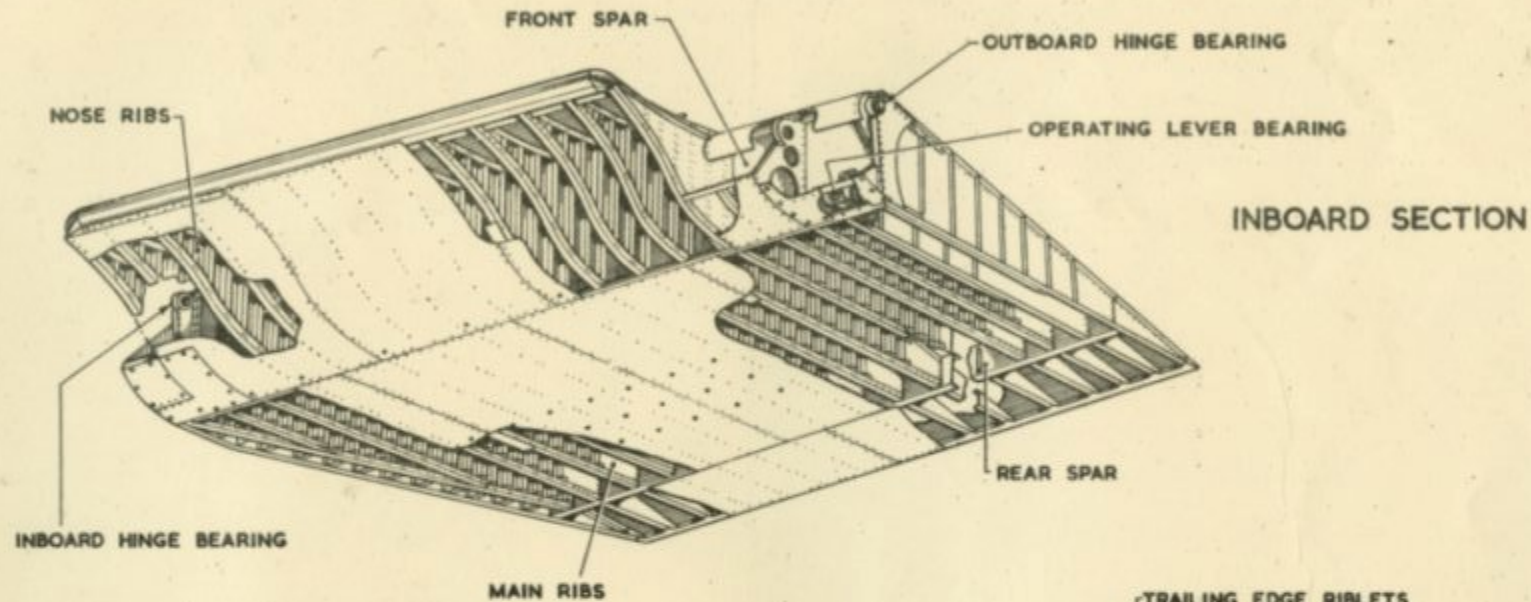


Fig. 2 Fin and rudder structure

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NOTE--THIS ILLUSTRATION SHOWS THE SECTIONS OF INBOARD AND OUTBOARD INNER ELEVONS IN THE PORT WING. THOSE IN THE STARBOARD WING ARE CONSTRUCTED SIMILARLY.

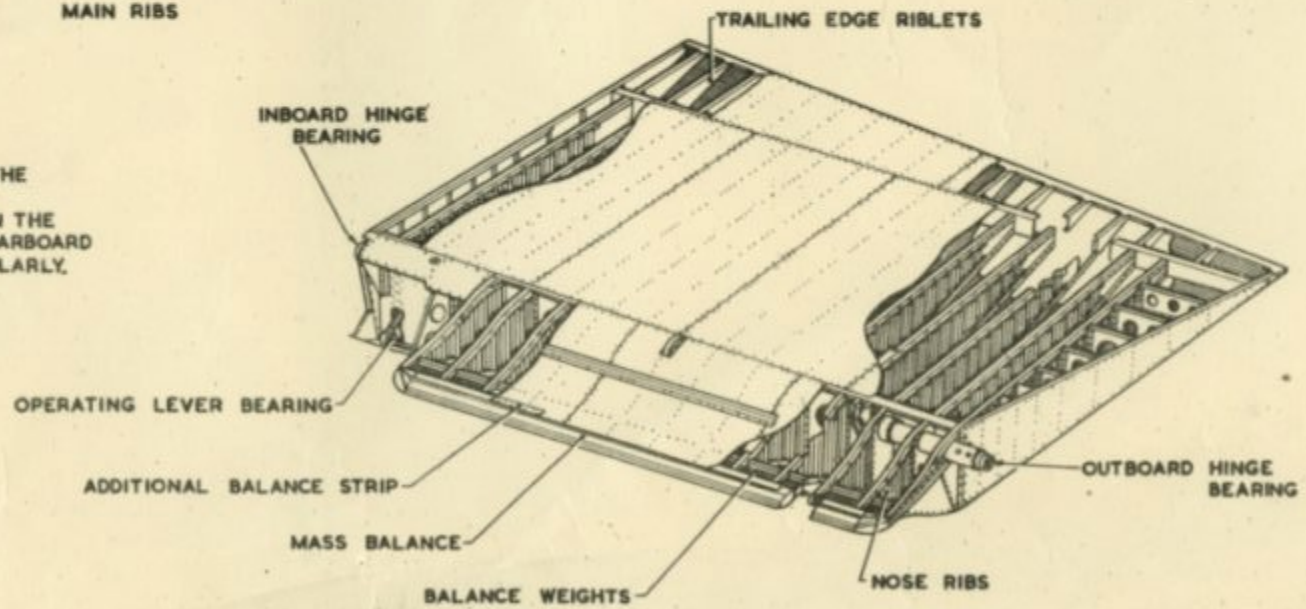


Fig.5 Inboard elevons

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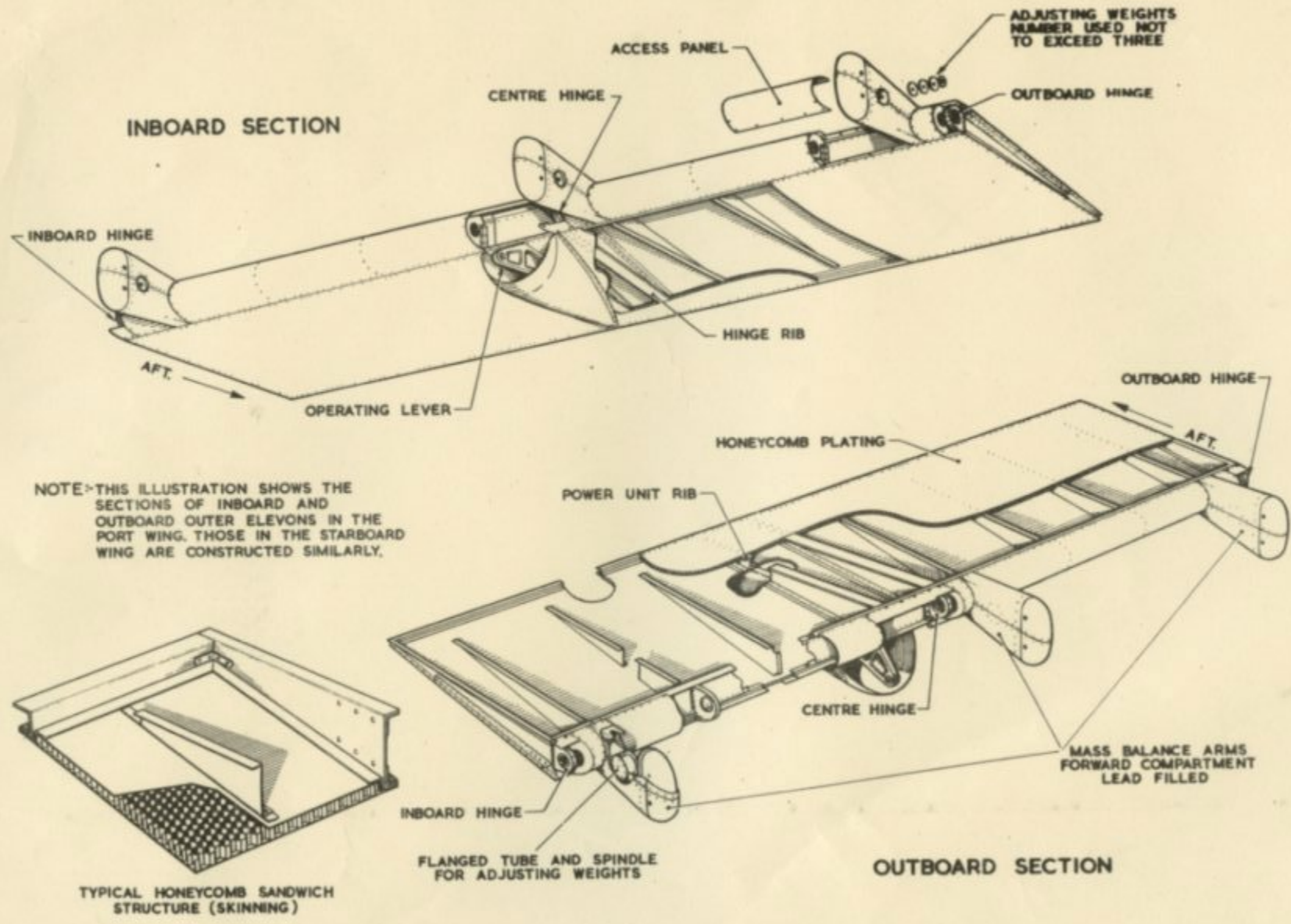


Fig.4 Outboard elevons

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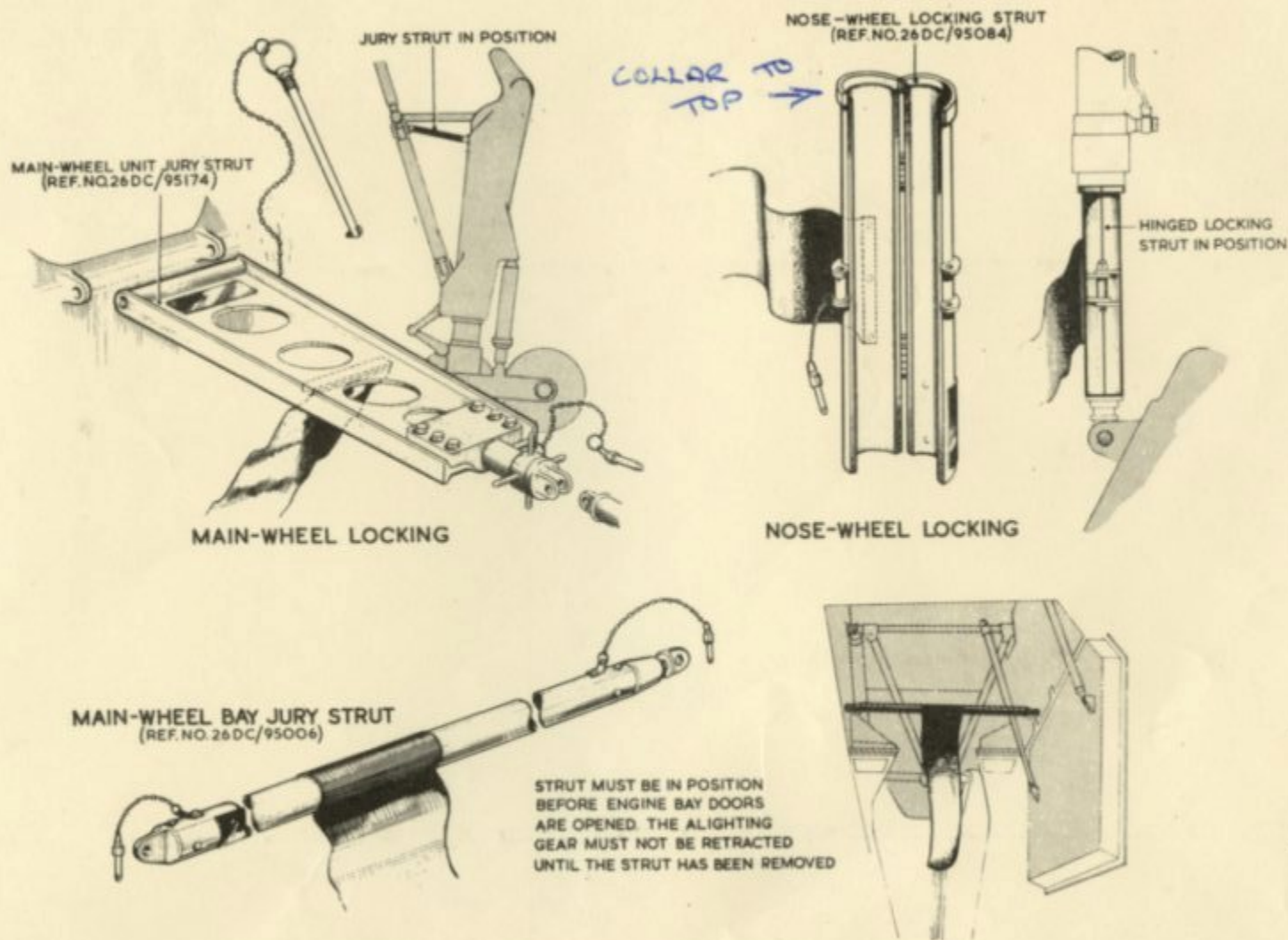
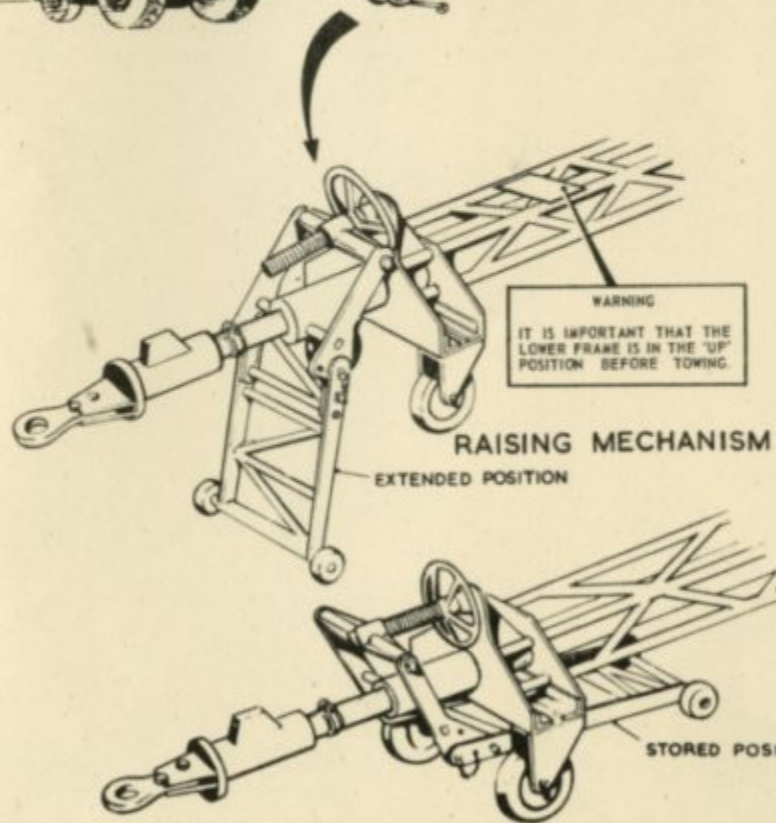
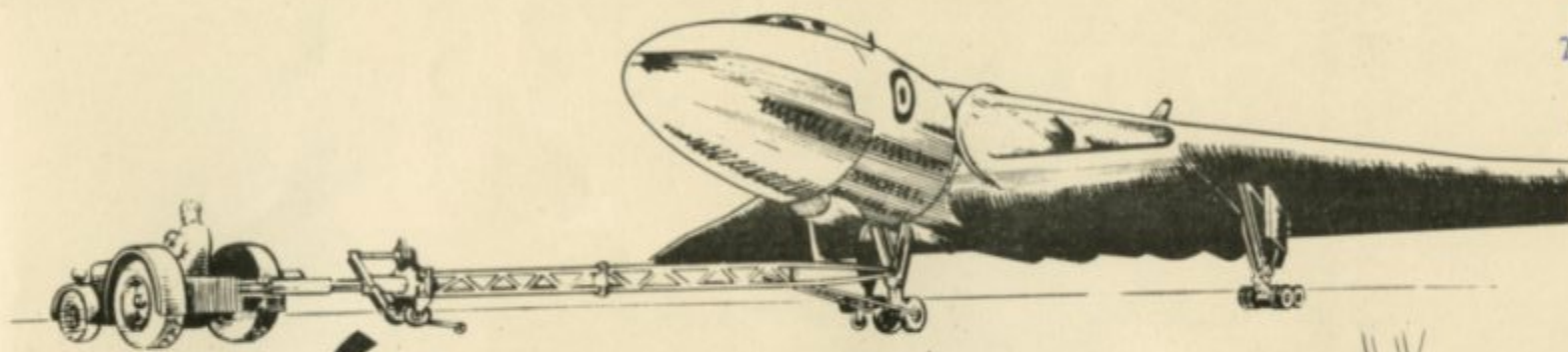
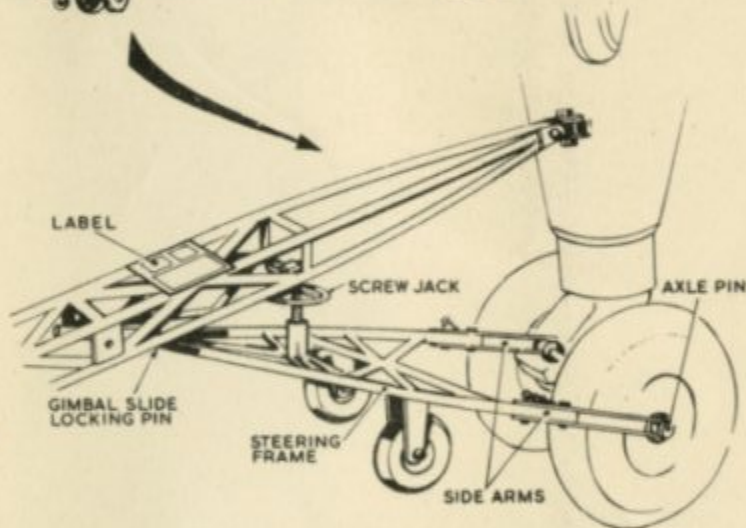


Fig. 6. Ground safety locks and struts  
(Ref. No. altered)  
**RESTRICTED**



**WARNING**  
IT IS IMPORTANT THAT THE LOWER FRAME IS IN THE "UP" POSITION BEFORE TOWING.

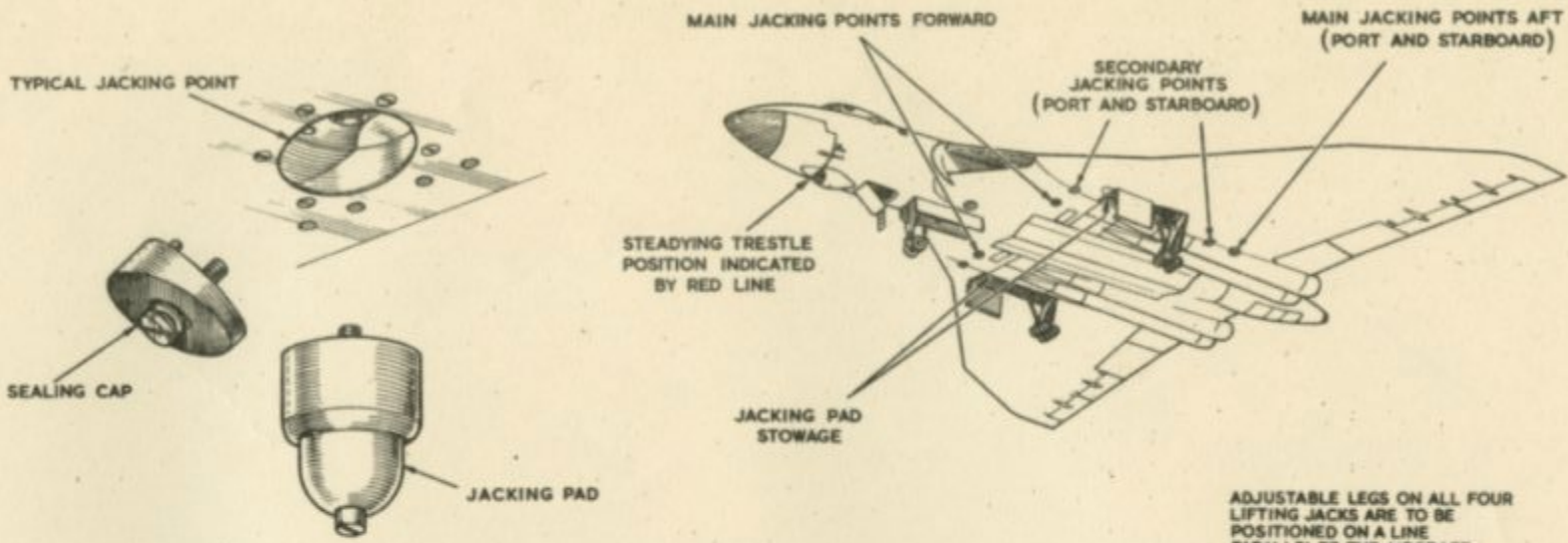


TOWING BAR ATTACHMENT	TOWING BAR REMOVAL
1. REMOVE AXLE PIN	1. RAISE SCREW JACK AND FIX IN POSITION
2. SWING SIDE ARMS OUTWARDS	2. RELIEVE LOAD FROM AXLE PIN AND REMOVE PIN
3. JACK UP TOW BAR UNTIL IT CAN BE ATTACHED TO AIRCRAFT	3. INSERT GIMBAL SLIDE LOCKING PIN
4. REVERSE JACK TO BRING STEERING FRAME INTO POSITION	4. SWING STEERING FRAME SIDE ARMS OUTWARDS
5. REMOVE GIMBAL SLIDE LOCKING PIN	5. LOWER STEERING FRAME UNTIL WHEELS TOUCH GROUND
6. CLOSE SIDE ARMS AND INSERT PIN THROUGH AXLE	6. CONTINUE OPERATING SCREW JACK UNTIL TOW BAR CAN BE DETACHED FROM AIRCRAFT
7. FINALLY, DETACH AND FOLD SCREW JACK	7. OPERATE SCREW JACK TO CLOSE POSITION
	8. SWING SIDE ARMS INWARDS AND INSERT AXLE PIN

**DETAIL OF LABEL**

- 1) BRAKE PRESSURE <sup>min.</sup> 3000 PSI.
- 2) GLOW PLUGS LOCKS FITTED
- 3) ENGINE DOORS CLOSED
- 4) Max. turning 430
- 5) MEN: 1 cabin  
2 on wing tips  
1 at rear of regl.
- 6) Inter-com.
- 7) Towing speed 4 max.

**Fig. 2. Forward towing**  
4 Labels added  
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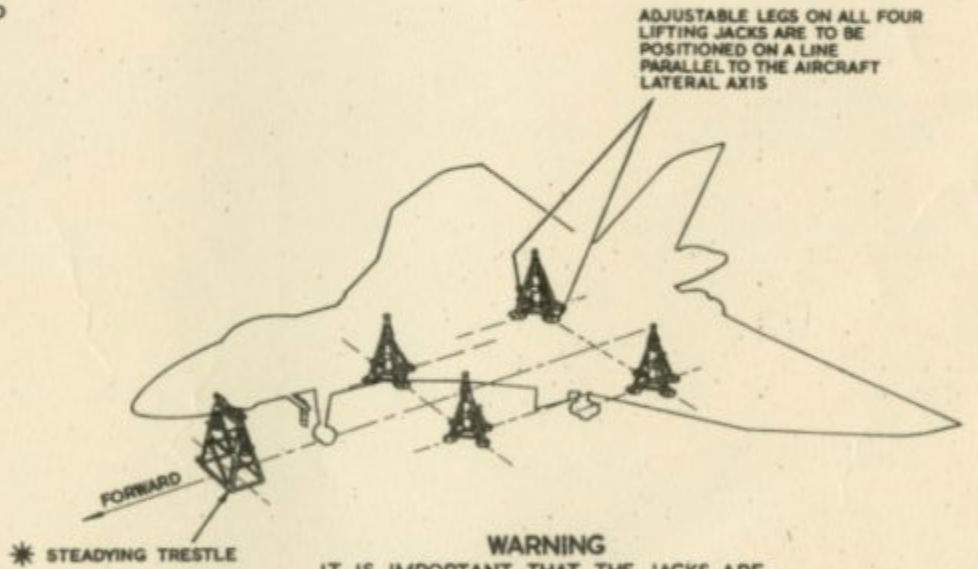
THE COMPLETE AIRCRAFT IS TO BE LIFTED AT THE FOUR MAIN JACKING POINTS  
 SECONDARY JACKING POSITIONS MAY BE USED WHEN THE MAIN JACKING POINTS ARE INACCESSIBLE

EQUIPMENT CONSISTS OF THE FOLLOWING ITEMS:-

TRESTLE MK. 2	REF. 4Q/2612
JACK BODY	REF. 4Q/2610
ADAPTER HEAD MK.107	REF. 4Q/2654
PADS, JACKING	REF. 26DC/95063

- \* FORMER. NOSE SUPPORTING REF. 26DC/95005
- \* TRESTLE U.J. No. 18. REF. 4G/-

NOTE:-  
 ITEMS MARKED THUS \* ARE ONLY REQUIRED WHEN ALL ENGINE DOORS ARE OPENED  
 THE ENGINE CENTRE DOORS MAY BE OPENED WITHOUT THESE ITEMS IN POSITION



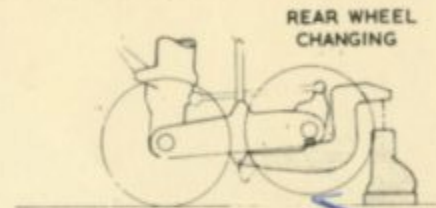
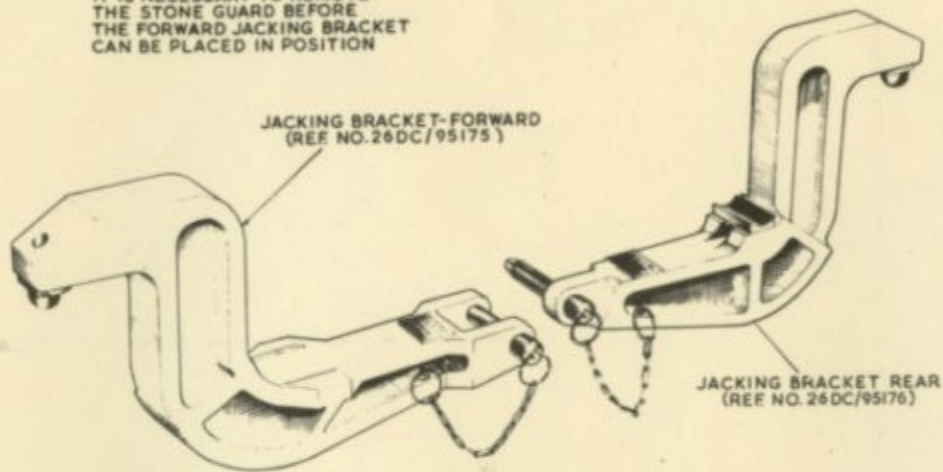
**WARNING**  
 IT IS IMPORTANT THAT THE JACKS ARE RAISED EVENLY AND SIMULTANEOUSLY TO ENSURE EQUAL DISTRIBUTION OF LOADING

*Jacking for retraction main points 10% fuel - aux points 0 fuel jacked to rigging position.  
 Eng doors closed.  
 Brakes off - 6 1/2 ground clearance rear wheel min.  
 Snodles to be fitted. wire bridle for wings.  
 Brakes off*

Fig. 5. Jacking Complete Aircraft

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NOTE:-  
IT IS NECESSARY TO REMOVE  
THE STONE GUARD BEFORE  
THE FORWARD JACKING BRACKET  
CAN BE PLACED IN POSITION



*Brakes off.*

WARNING:-  
WHEN CHANGING WHEELS ONLY ONE  
PAIR OF WHEELS ARE TO BE JACKED  
AT A TIME FRONT AND REAR WHEELS  
MUST NOT BE JACKED SIMULTANEOUSLY.

*MAX. 1"*

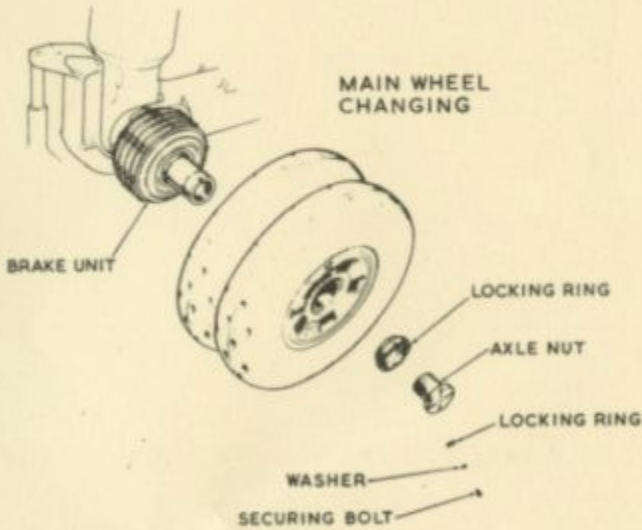
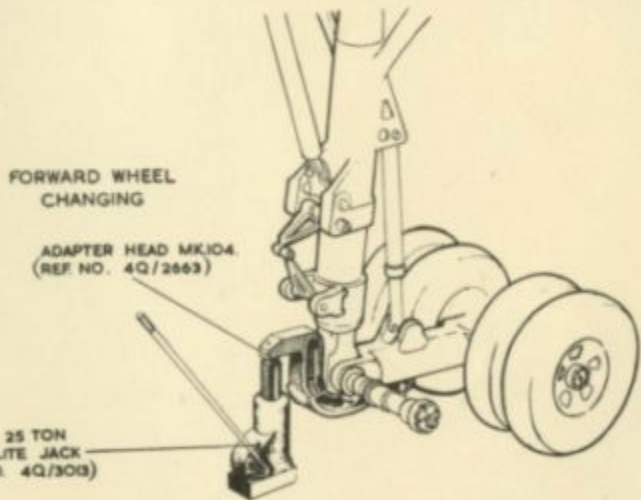


Fig.15. Main - wheel changing.

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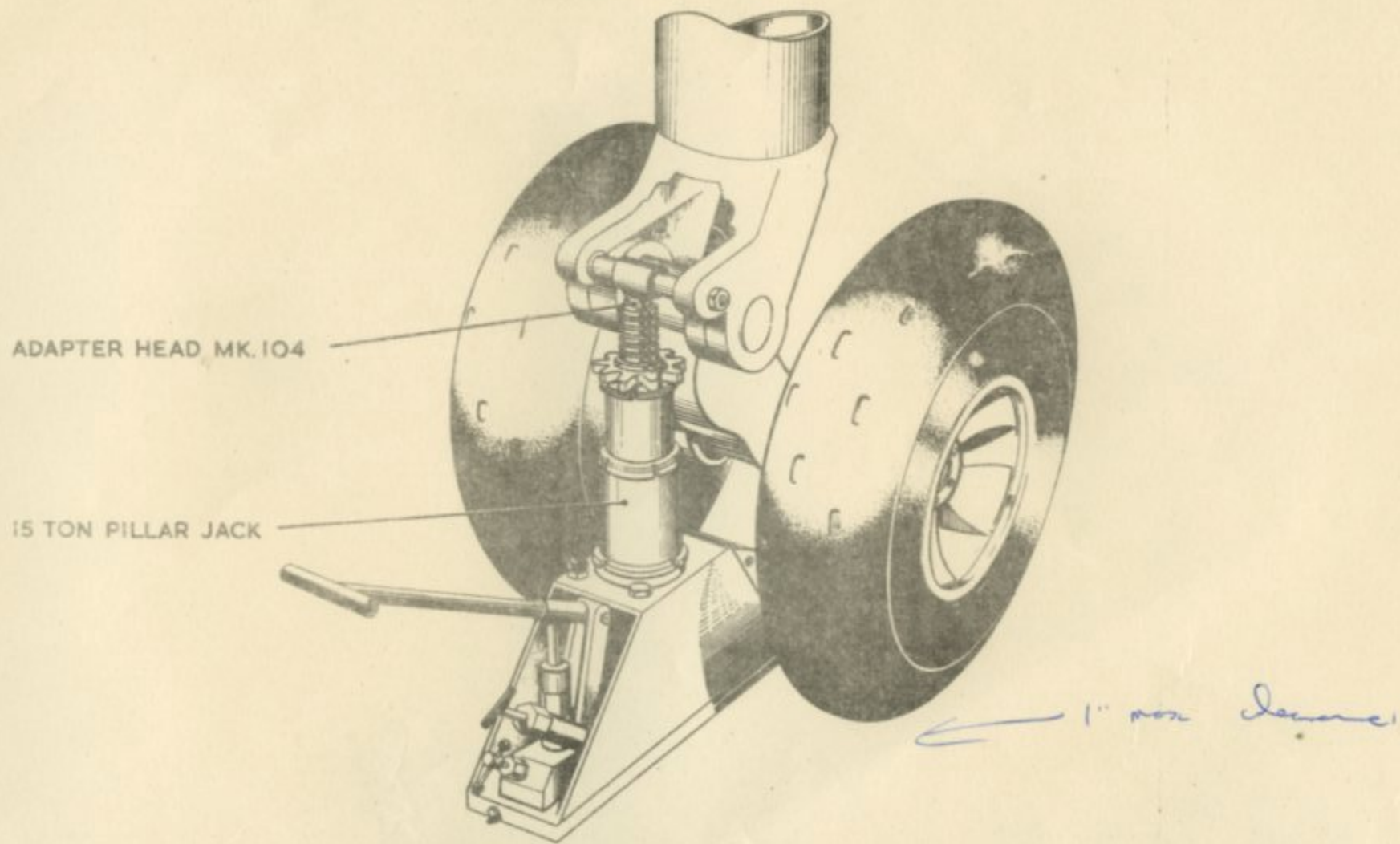


Fig. 19 Jacking for nose-wheel changing.

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