THE AVRO ARROW

AVRO CANADA

TO DOUG & DONETTE
WITH MY VERY
BEST REGARDS

A BOOK BY

THOMAS B DUGELBY

CHAPTER 6

CONTENTS

TITLE PAGE

ILLUSTRATIONS

NOTES

LEADING PARTICULARS.

FUEL SYSTEM TANK CAPACITIES

Tank No.	No. Of Tanks.	Tank Capacity(Gals.)	Usable Fuel(Gals.)
1. Fuselage	1	308 Imp.-371 US	263 Imp,-316 US
2. Fuselage	1	307 Imp.- 370 US	259 Imp.-311 US
3. Wing	2	165 Imp.-198 US	302 IMP.-362 US
4. Wing	2	101 Imp.-121 US	180 Imp.-216 US
5. Collector	2	170 Imp.- 204 US	292 Imp.-350 US
6. Wing	2	176 Imp.-211 US	308 Imp.-370 US
7. Wing	2	322 Imp.-386 US	558 Imp.-670 US
8. Wing	2	207 Imp.-248 US	346 Imp.-415 US
Total fuel capacity		2508 Imp 3030 US	19562 lbs.

Tank pressure - Wings: 25 psia (initial flights 1st A/C.)
19 psia (subsequently.)

- Fuselage: 10 psi differential (initial flights 1st A/C.)
7.5 psi Differential (subsequently.)

Pressure Refueling: One Point in each wing.

ENGINES.

Designation: Pratt and Whitney J75 P3 (1st A/C.)
J75 (subsequently.)
Twin spool axial flow gas turbine with afterburner.

Fuel specification: 3GP-22B-1 Ref 34A/159.
MIL-F 5624 Grade JP4 (US.)
D.Eng R.D. 2486 (UK.)
F-4 (NATO symbol.)

Oil specification	MIL-L-7808C Ref 34A/226. C-148 (NATO symbol.)
Oil tank capacity	5.5 Gallons US.
Usable oil	3.5 Gallons US.

ACCESSORIES GEARBOX

Manufacturer	Sargeant Engineering.
Accessories gearbox to engine ratio	0.823:1.
Engine starter to engine ratio	0.823:1
Oil specification	As for engines.
Gearbox oil capacity	1 Imp. gallon.

MAIN LANDING GEAR

Type	Hydraulically retracted with twin wheels in tandem.
Manufacturer and model	Dowty - XV 1283-1A LH. - XV 1283-1B RH.
Track	25ft. - 9ins. Static. 25 ft. - 7.6ins. Touchdown.
Shock absorber	Dowty liquid spring with recuperator.
Fluid specification	Dowcan 200 silicone fluid.
Recuperator	Dowty - V 1283-6A LH. - V 1283-6B RH.
Wheels	Goodyear
Tires	Goodyear 29 x 7.7 Type V11 tubeless. 15 in. rim.
Inflation pressure	255 psi.
Brakes	Goodyear hydraulically operated.

NOSE LANDING GEAR

Type	Hydraulically retracted, steerable twin twin unit.
Manufacturer and model	Jarry Hydraulics 1500.
Shock absorber	Dowty liquid spring.
Fluid specification	Dowcan 200 silicone fluid.
Wheels	Dunlop
Tires	Dunlop 18 x 5.5 Type V11 tubeless. 8in rim
Inflation pressure	170 psi.

UTILITY HYDRAULICS

Fluid specification	3GP-26A Ref 34A/100 MIL-H-5606A. US. D.T.D. 585 (UK.) H-515 (NATO symbol.)
Pumps (2)	Vickers constant delivery.
Pressure regulator setting	4200 - 4250 psi.
Reduced pressure	1500 psi.
Accumulators System (1)	200 cu.in.
Emergency brakes (2)	110 cu.in.
Return surge damping	60 cu.in.
Compensator (1)	Loud
Compensator capacity	5 Imp. gallons.

EMERGENCY NITROGEN SYSTEM

Manufacturer	Walter Kidde.
Charging pressure	5000 psi.
Bottle capacity	300 cu.ins.

FLYING CONTROL HYDRAULICS

Fluid specification	As for utility hydraulics.
Pumps (2 each system)	Vickers variable delivery.
Pump pressure	4000 psi.
Reduced pressure	1250 psi.
Accumulators (1 each system)	Self displacing 100 cu.in.
Return surge damping (1 each system)	60 cu.in.
Booster circuit (1 each System)	25 cu.in.
Compensators (1 each system)	Loud dual pressurized.
Compensator capacity	5 Imp. gallons.

EJECTION SEATS - 2

Manufacturer and type	Martin-Baker Mk C5.

OXYGEN SYSTEM

Liquid oxygen converter (1)	Aro Equipment Corp.
Converter capacity	5.0 litres.

Regulators (2)	Firewell F 2400 - 11C.
Supply pressure to regulators	70 psi.

EMERGENCY OXYGEN SYSTEM

Bottles (2) gaseous	Walter Kidde.
Bottle capacity	50 cu.in.
Charging pressure	1800 psi.

FIRE EXTINGUISHER SYSTEM

Bottles (2)	Walter Kidde.
Extinguishant	Freon 12B2.
Capacity of each bottle	12 lbs.
Nitrogen pressure	400 psi. At 70oF.

ENGINE DE-ICING

Type	Hot air bleed from compressor.

AIRFRAME DE-ICING

Pilot's windshield and side panels	Electro-thermal.
Engine intake and ramp	Electro-thermal.

ELECTRICAL SYSTEM AC

Constant speed unit	General Electric.
Alternators	Lucas Rotax 115/200 volts AC. 400 cycles 3 phase.

ELECTRICAL SYSTEM DC

Transformer rectifier unit	Lucas Rotax 28 volts.
Battery	Societe Des Accumulateurs et de Traction. 24 volts-15amp/hr nickel cadmium.

AIR CONDITIONING SYSTEM

Cooling turbine and fan unit	Airesearch 201970.
Air-to-air heat exchanger	Airesearch 83940.
Air-to-water heat exchanger	Surface Combustion SK 6424.

PRINCIPAL DIMENSIONS

AIRCRAFT DIMENSIONS

Wing span	50 ft.
Fuselage length (without probe)	74ft. 5in.
Overall length of aircraft	83ft.
Height to canopy top (static)	14ft. 6 in. (Approx).
Height to top of vertical stabilizer (static)	20ft. 6in.
Height to wing tip (static)	6ft. 10in. (Approx).
Angle of datum line to ground (static)	4 degrees 33 minutes.

WEIGHT

Operational weight (empty)	49,040 lbs.
Maximum A.U.W.	68,602 lbs. (Ballasted to 31% MAC.
Maximum landing weight	55,000 lbs.

WINGS

Type	Delta.
Aerofoil section inner wing -Profile	NACA.0003.5-6-3.7 (Modified).
-Camber	.0075 (Modified).
Aerofoil section outer wing -Profile	NACA.0003.5-6-3.7 (Modified). .0003.8-6-3.7)Modified).
-Camber	.0075 (Modified).
Chord at root	45ft.
Incidence at root	0 degrees.
Incidence at tip	0 degrees.
Anhedral	4 degrees.
Sweepback at leading edge inner wing	61 degrees 28 minutes.
Sweepback at leading edge outer wing	63 degrees 23 minutes.
Mean Aerodynamic Chord	30ft. 2.6ins.

VERTICAL STABILIZER

Aerofoil section	NACA.0004-6-3.7 (Modified).
Chord at root	19 ft.
Chord at tip	5 ft. 8 ins.
Mean Aerodynamic Chord	13 ft. 6.ins.
Sweepback st leading edge	59 degrees 20 minutes.
Sweepback at trailing edge	33 degrees 5 minutes.

FUSELAGE

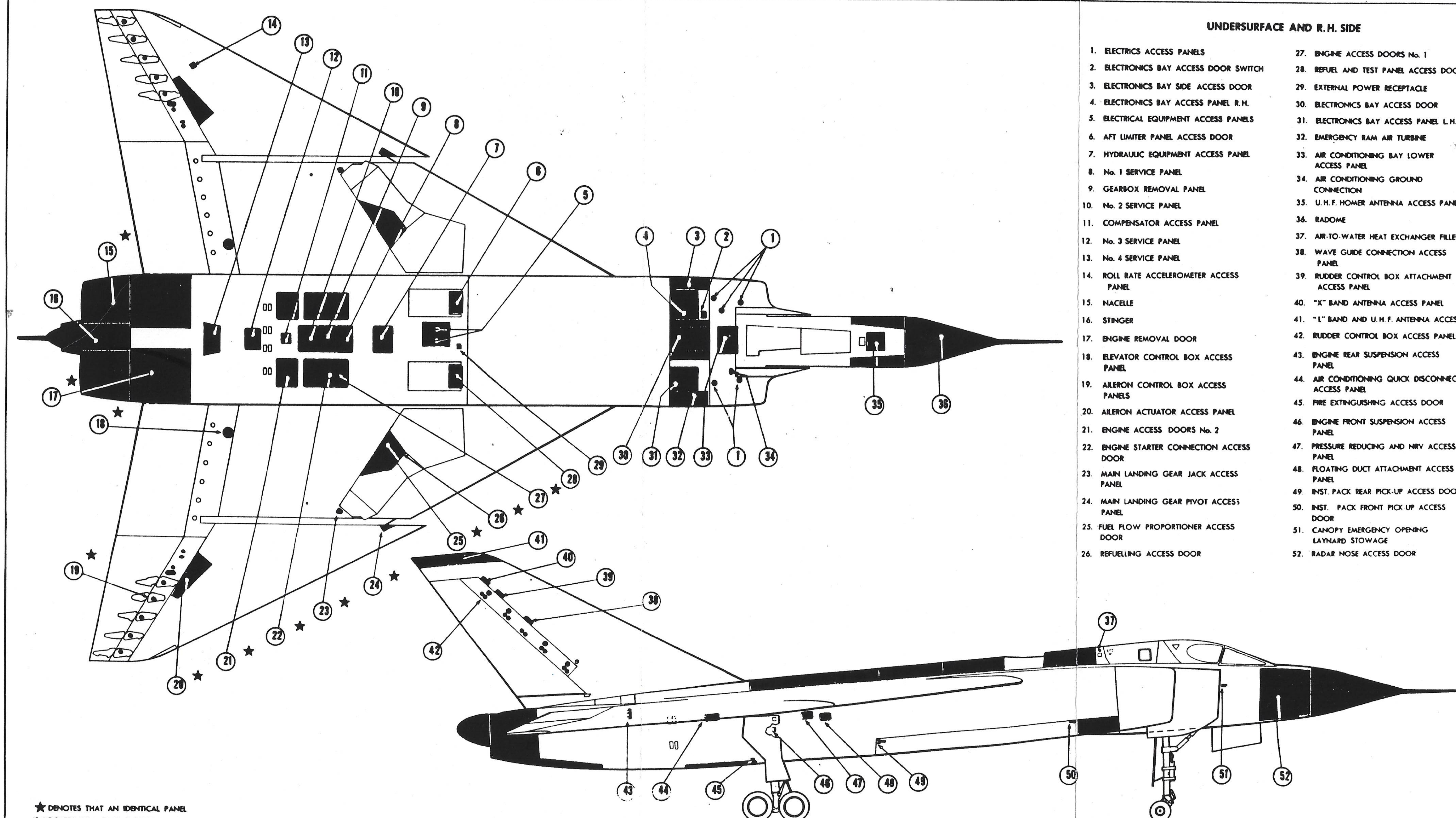
Width	9 ft. 9 ins.

AREAS

Wings inc. ailerons, elevators and 390 sq.ft. Of fuselage.	1225 sq. ft.
Ailerons (2)	66.55 sq. ft.
Elevators (2)	106.9 sq. ft.
Vertical stabilizer inc. rudder	158.79 sq.ft.
Rudder	38.17 sq. ft.
Speed brakes (2)	14.367 sq. ft.

C of G LIMITS

Forward limit	28% of M.A.C Station 537.35.
Aft limit	31% of M.A.C Station 548.23.



UNDERSURFACE AND R.H. SIDE

1. ELECTRICS ACCESS PANELS
2. ELECTRONICS BAY ACCESS DOOR SWITCH
3. ELECTRONICS BAY SIDE ACCESS DOOR
4. ELECTRONICS BAY ACCESS PANEL R.H.
5. ELECTRICAL EQUIPMENT ACCESS PANELS
6. AFT LIMITER PANEL ACCESS DOOR
7. HYDRAULIC EQUIPMENT ACCESS PANEL
8. No. 1 SERVICE PANEL
9. GEARBOX REMOVAL PANEL
10. No. 2 SERVICE PANEL
11. COMPENSATOR ACCESS PANEL
12. No. 3 SERVICE PANEL
13. No. 4 SERVICE PANEL
14. ROLL RATE ACCELEROMETER ACCESS PANEL
15. NACELLE
16. STINGER
17. ENGINE REMOVAL DOOR
18. ELEVATOR CONTROL BOX ACCESS PANEL
19. AILERON CONTROL BOX ACCESS PANELS
20. AILERON ACTUATOR ACCESS PANEL
21. ENGINE ACCESS DOORS No. 2
22. ENGINE STARTER CONNECTION ACCESS DOOR
23. MAIN LANDING GEAR JACK ACCESS PANEL
24. MAIN LANDING GEAR PIVOT ACCESS PANEL
25. FUEL FLOW PROPORTIONER ACCESS DOOR
26. REFUELLING ACCESS DOOR
27. ENGINE ACCESS DOORS No. 1
28. REFUEL AND TEST PANEL ACCESS DOOR
29. EXTERNAL POWER RECEPTACLE
30. ELECTRONICS BAY ACCESS DOOR
31. ELECTRONICS BAY ACCESS PANEL L.H.
32. EMERGENCY RAM AIR TURBINE
33. AIR CONDITIONING BAY LOWER ACCESS PANEL
34. AIR CONDITIONING GROUND CONNECTION
35. U.H.F. HOMER ANTENNA ACCESS PANEL
36. RADOME
37. AIR-TO-WATER HEAT EXCHANGER FILLER
38. WAVE GUIDE CONNECTION ACCESS PANEL
39. RUDDER CONTROL BOX ATTACHMENT ACCESS PANEL
40. "X" BAND ANTENNA ACCESS PANEL
41. "L" BAND AND U.H.F. ANTENNA ACCESS
42. RUDDER CONTROL BOX ACCESS PANELS
43. ENGINE REAR SUSPENSION ACCESS PANEL
44. AIR CONDITIONING QUICK DISCONNECT ACCESS PANEL
45. FIRE EXTINGUISHING ACCESS DOOR
46. ENGINE FRONT SUSPENSION ACCESS PANEL
47. PRESSURE REDUCING AND NRV ACCESS PANEL
48. FLOATING DUCT ATTACHMENT ACCESS PANEL
49. INST. PACK REAR PICK-UP ACCESS DOOR
50. INST. PACK FRONT PICK UP ACCESS DOOR
51. CANOPY EMERGENCY OPENING LAYNARD STOWAGE
52. RADAR NOSE ACCESS DOOR

★ DENOTES THAT AN IDENTICAL PANEL IS LOCATED IN A SIMILAR POSITION ON THE OPPOSITE SIDE OF THE AIRCRAFT

7MI-1517-1

ARROW Mk1. ACCESS PANELS

UPPER SURFACE AND LH SIDE

1. RADOME.
2. INTAKE DE-ICING ELECTRICAL ACCESS.
3. FRONT FUSELAGE SLINGING POINT.
4. AIR CONDITIONING AND OXYGEN CONVERTER ACCESS.
5. NO. 1 FUSELAGE TANK BAY FAIRING.
6. NO. 1 FUSELAGE TANK ACCESS PANEL.
7. NO. 2 FUSELAGE TANK BAY FAIRING.
8. NO. 2 FUSELAGE TANK ACCESS PANEL.
9. J4 COMPASS TRANSMITTER AND COMPENSATOR ACCESS.
10. FW'D DORSAL ELECTRONICS FAIRING.
11. BOOSTER PUMP ACCESS PANEL.
12. REAR DORSAL ELECTRONICS FAIRING.
13. INNER WING SLINGING POINT.
14. AILERON BELLCRANK ACCESS PANELS.
15. ELEVATOR CONTROL BOX ACCESS PANELS.
16. ELEVATOR ACTUATOR ACCESS PANEL.
17. ENGINE LATERAL ALIGNMENT ACCESS PANELS.
18. ENGINE CROSS ARM ACCESS PANEL.
19. NACELLE.
20. STINGER.
21. NO. 8 FUEL TANK ACCESS PANELS.
22. NO. 7 FUEL TANK ACCESS PANELS.
23. NO. 6 FUEL TANK ACCESS PANELS.
24. NO. 5 FUEL TANK ACCESS PANELS.
25. NO. 4 FUEL TANK ACCESS PANELS.
26. NO. 3 FUEL TANK ACCESS PANELS.
27. RADAR NOSE ACCESS DOOR.
28. CANOPY ACTUATOR SWITCH ACCESS DOOR.
29. RUDDER HINGE LIMITER ACCESS PANEL.
30. RUDDER ACTUATOR ACCESS PANEL.
31. WAVEGUIDE CONNECTION ACCESS PANEL.
32. "L" BAND AND UHF ANTENNAE ACCESS.
33. "X" BAND ANTENNA ACCESS PANEL.
34. RUDDER CONTROL BOX ATTACHMENT ACCESS PANEL.
35. WAVEGUIDE CONNECTION ACCESS PANEL.
36. ENGINE REAR SUSPENSION ACCESS PANEL.
37. AIR CONDITIONING QUICK DISCONNECT ACCESS PANEL.
38. FIRE EXTINGUISHING ACCESS DOOR.
39. ENGINE FRONT SUSPENSION ACCESS PANEL.
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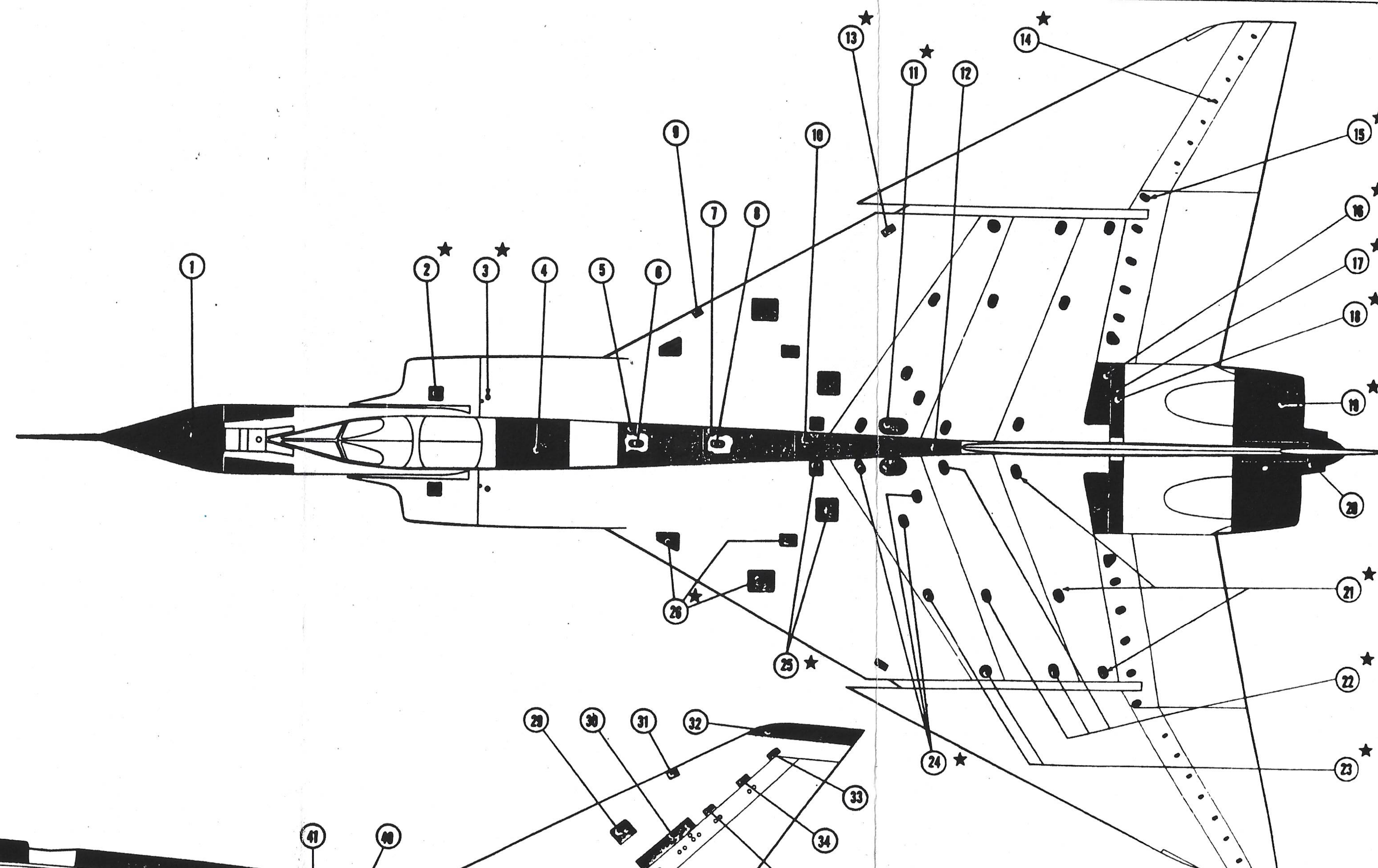
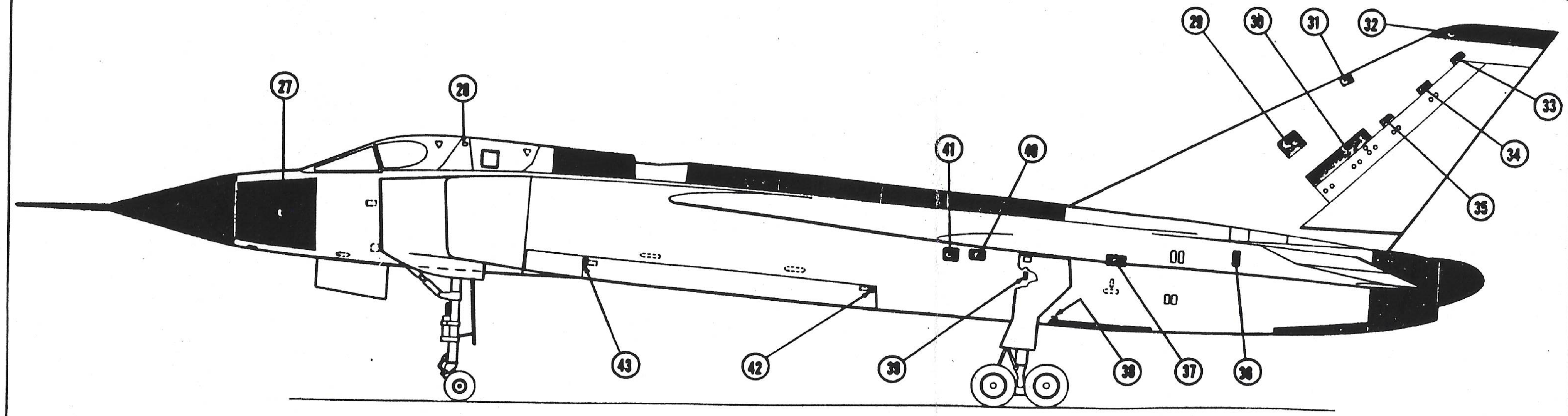
42. INST. PACK REAR PICK-UP ACCESS DOOR.
43. INST. PACK FRONT PICK-UP ACCESS DOOR.





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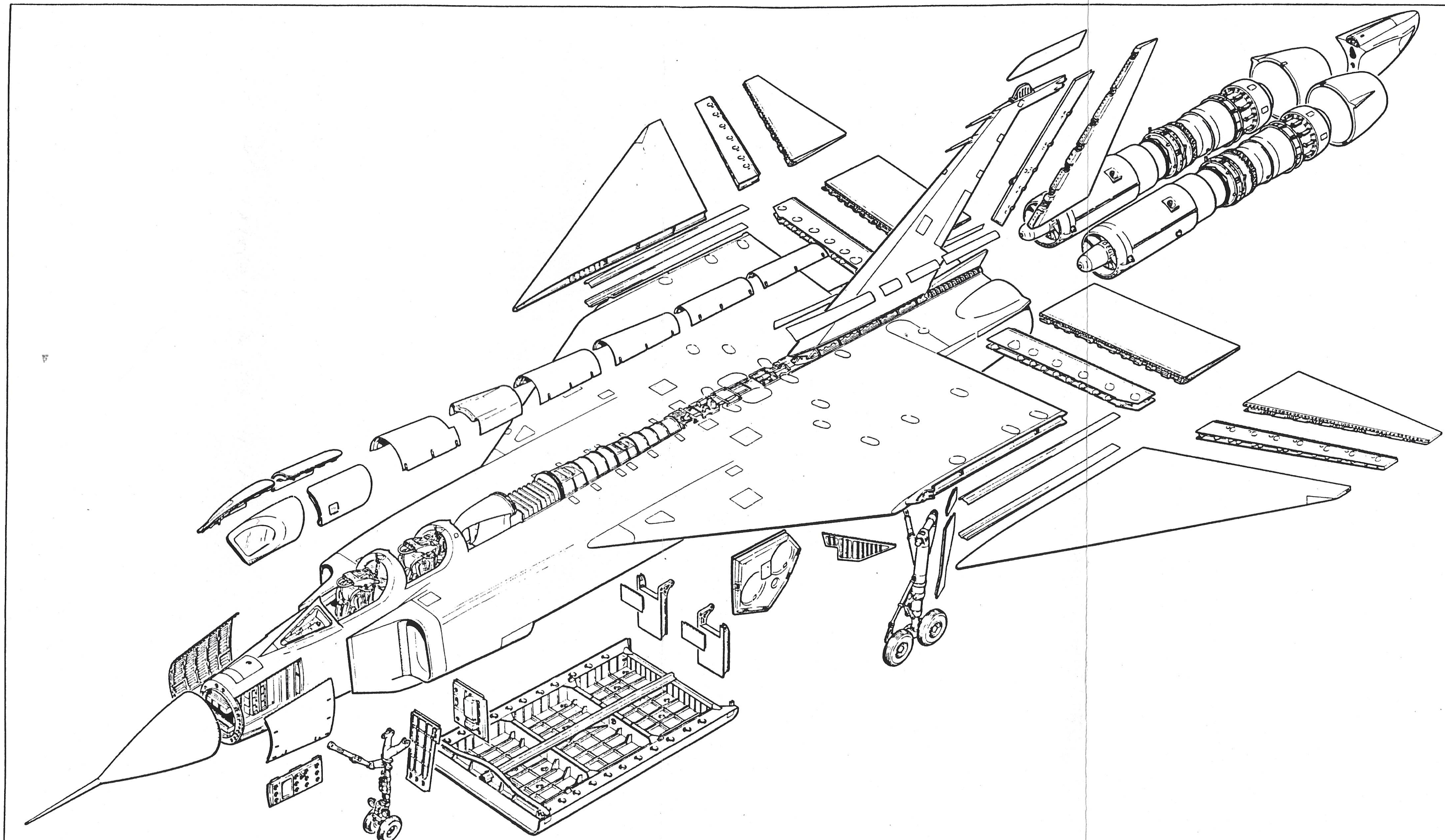
ARROW Mk1. ACCESS PANELS



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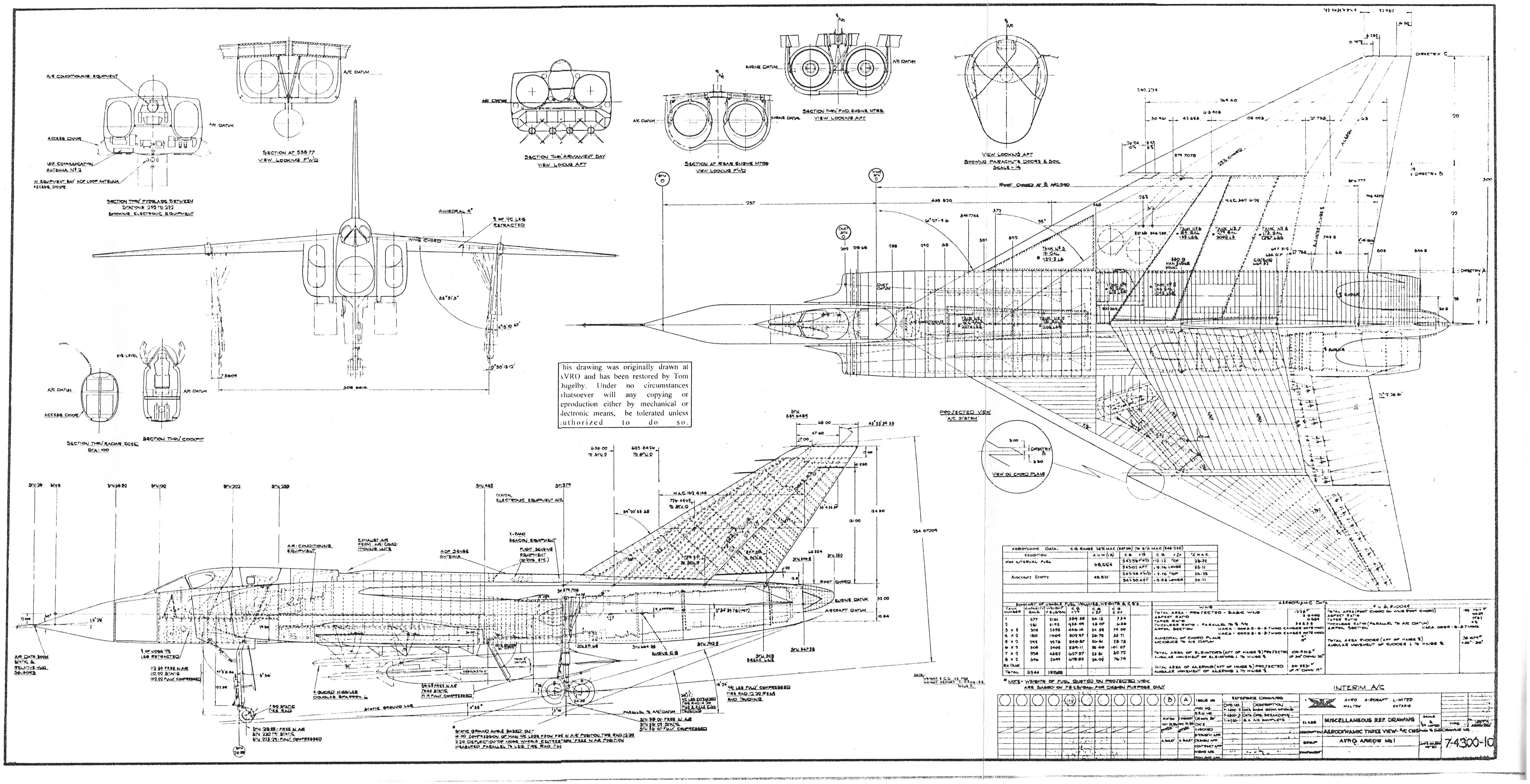
EXPLODED VIEW. ARROW Mk1.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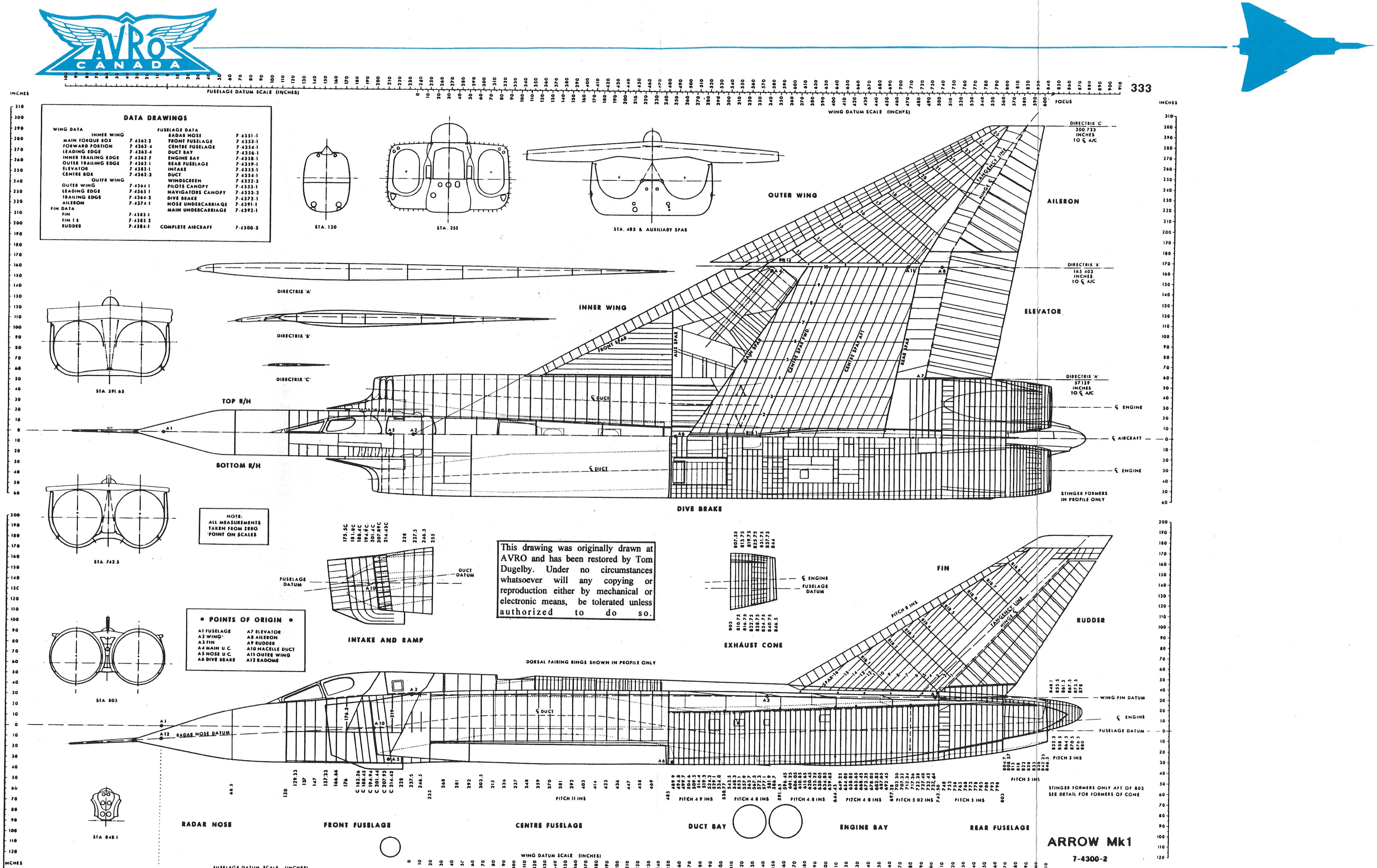
SECTION THRU FUSELAGE BETWEEN STATIONS 255 TO 272 SHOWING ELECTRONIC EQUIPMENT
SECTION AT 538.77 VIEW LOOKING FWD
SECTION THRU ARMAMENT BAY VIEW LOOKING AFT
SECTION AT REAR ENGINE MTGS VIEW LOOKING FWD
SECTION THRU FWD ENGINE MTGS VIEW LOOKING AFT
VIEW LOOKING AFT SHOWING PARACHUTE DOORS & BOX
SECTION THRU RADAR NOSE
SECTION THRU COCKPIT
PROJECTED VIEW A/C DATUM
VIEW ON CHORD PLANE
INTERIM A/C
AVRO AIRCRAFT LIMITED
MALTON ONTARIO
MISCELLANEOUS REF. DRAWING
AERODYNAMIC THREE VIEW
AVRO ARROW MK 1
7-4300-10


AVRO CANADA
FUSELAGE DATUM SCALE (INCHES)
WING DATUM SCALE (INCHES)
FOCUS
DATA DRAWINGS
WING DATA
INNER WING
MAIN TORQUE BOX 7-4362-2
FORWARD PORTION 7-4362-4
LEADING EDGE 7-4362-4
INNER TRAILING EDGE 7-4362-5
OUTER TRAILING EDGE 7-4362-1
ELEVATOR 7-4382-1
CENTRE BOX 7-4362-3
OUTER WING
OUTER WING 7-4364-1
LEADING EDGE 7-4365-1
TRAILING EDGE 7-4364-2
AILERON 7-4374-1
FIN DATA
FIN 7-4383-1
FIN T E 7-4383-2
RUDDER 7-4384-1
FUSELAGE DATA
RADAR NOSE 7-4351-1
FRONT FUSELAGE 7-4352-1
CENTRE FUSELAGE 7-4354-1
DUCT BAY 7-4356-1
ENGINE BAY 7-4358-1
REAR FUSELAGE 7-4359-1
INTAKE 7-4355-1
DUCT 7-4354-1
WINDSCREEN 7-4352-5
PILOTS CANOPY 7-4353-1
NAVIGATORS CANOPY 7-4353-2
DIVE BRAKE 7-4372-1
NOSE UNDERCARRIAGE 7-4391-1
MAIN UNDERCARRIAGE 7-4392-1
COMPLETE AIRCRAFT 7-4300-3
STA. 120
STA. 255
STA. 485 & AUXILIARY SPAR
DIRECTRIX 'A'
DIRECTRIX 'B'
DIRECTRIX 'C'
STA. 591.65
STA. 742.5
STA. 803
STA. 848.1
TOP R/H
BOTTOM R/H
OUTER WING
INNER WING
AILERON
ELEVATOR
DIRECTRIX 'C' 300.733 INCHES TO ℄ A/C
DIRECTRIX 'B' 165.403 INCHES TO ℄ A/C
DIRECTRIX 'A' 57.139 INCHES TO ℄ A/C
FRONT SPAR
AUX SPAR
MAIN SPAR
CENTRE SPAR FWD
CENTRE SPAR AFT
REAR SPAR
TANGENCY LINE
HINGE ℄
℄ DUCT
℄ ENGINE
℄ AIRCRAFT
STRINGER FORMERS IN PROFILE ONLY
DIVE BRAKE
NOTE: ALL MEASUREMENTS TAKEN FROM ZERO POINT ON SCALES
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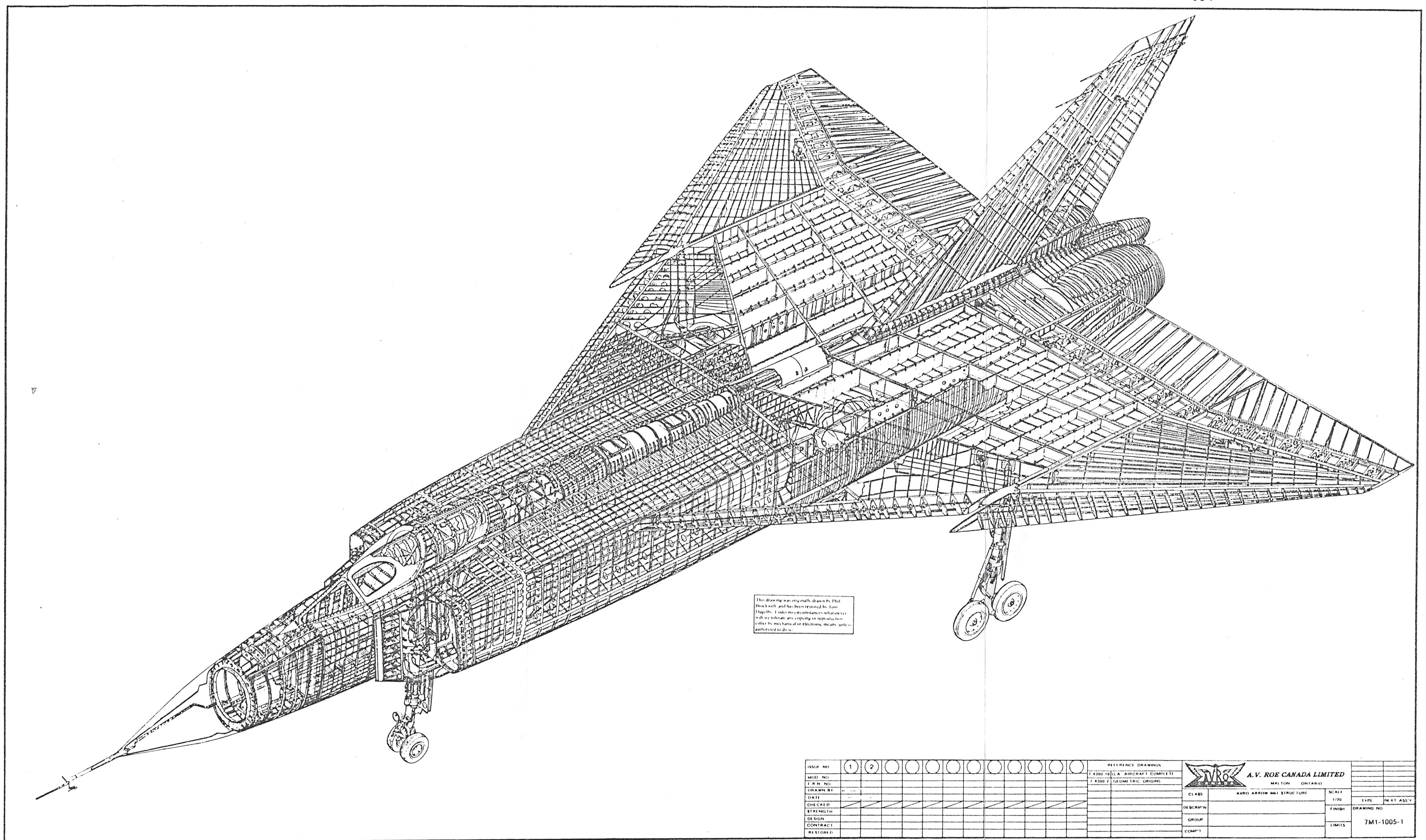
FUSELAGE DATUM
DUCT DATUM
INTAKE AND RAMP
EXHAUST CONE
FIN
RUDDER
PITCH 8 INS
• POINTS OF ORIGIN •
A1 FUSELAGE
A2 WING
A3 FIN
A4 MAIN U.C.
A5 NOSE U.C.
A6 DIVE BRAKE
A7 ELEVATOR
A8 AILERON
A9 RUDDER
A10 NACELLE DUCT
A11 OUTER WING
A12 RADOME
DORSAL FAIRING RINGS SHOWN IN PROFILE ONLY
RADAR NOSE DATUM
WING-FIN DATUM
FUSELAGE DATUM
PITCH 11 INS
PITCH 4.9 INS
PITCH 4.8 INS
PITCH 5.02 INS
PITCH 5 INS
PITCH 3 INS
STINGER FORMERS ONLY AFT OF 803 SEE DETAIL FOR FORMERS OF CONE
RADAR NOSE
FRONT FUSELAGE
CENTRE FUSELAGE
DUCT BAY
ENGINE BAY
REAR FUSELAGE
ARROW Mk1
7-4300-2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REFERENCE DRAWINGS
7 4300 10 G.A. AIRCRAFT COMPLETE
7 4300 2 GEOMETRIC ORIGINS
A.V. ROE CANADA LIMITED
MALTON ONTARIO
CLASS
AVRO ARROW MK1 STRUCTURE
SCALE
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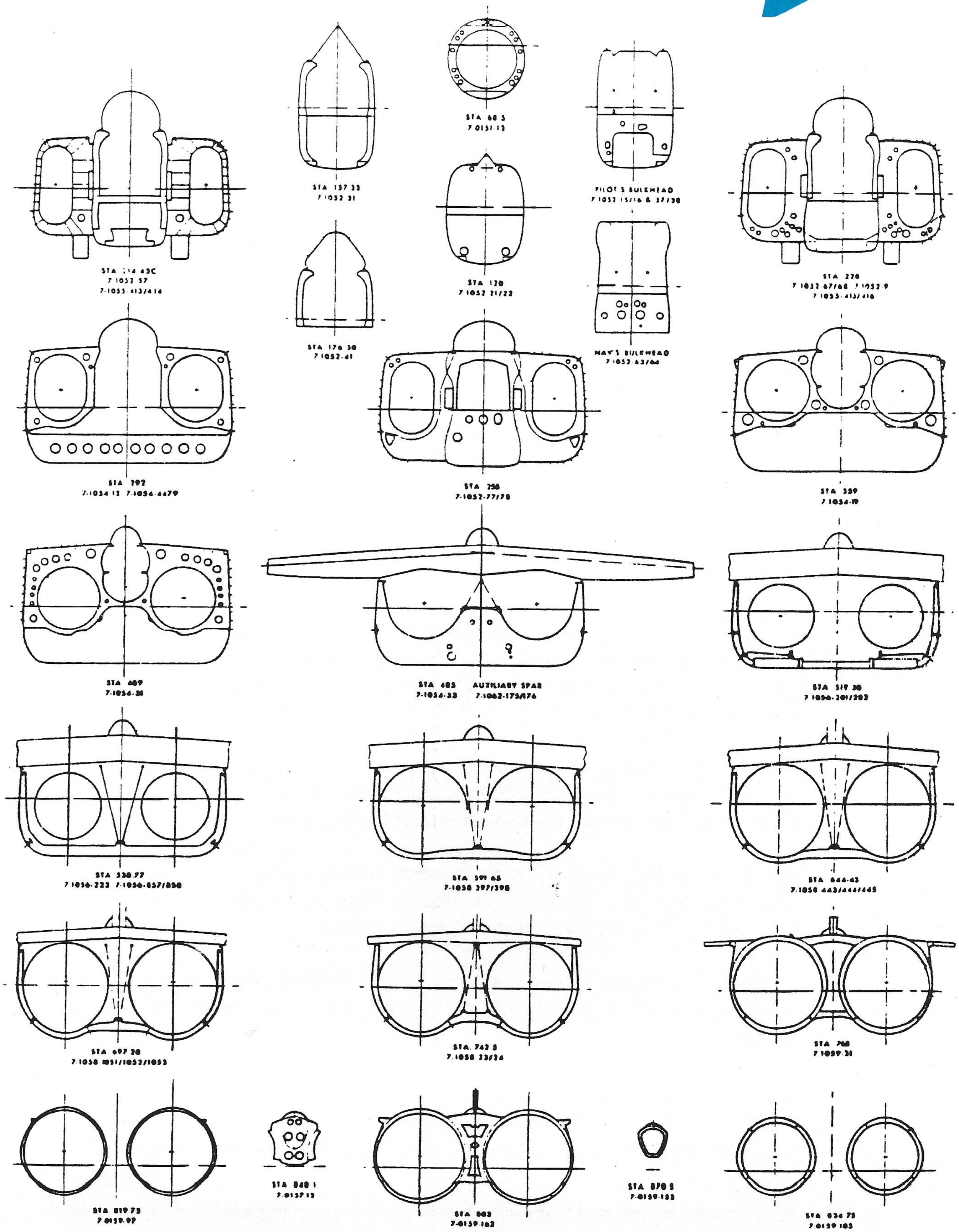
LIMITS
7M1-1005-1
COMP'T



CROSS-SECTIONS OF ARROW Mk1 FUSELAGE

DESCRIPTION

GENERAL.

1. The aircraft structure is one integral assembly with the centre and torsion boxes of the inner wing forming the basis of the structure. The fuselage and engines are suspended from the inner wing with bearings and hinges to provide a degree of flexibility. The outer wing is attached to the inner wing at a transport joint to form an aerodynamic step at the leading edge. The vertical stabilizer is attached to the inner wing centre box.

2. Access panels and service doors are incorporated to facilitate the removal, replacement and servicing of the aircraft systems and components.

3. For station referencing, the fuselage is measured along the longitudinal datum line from the radar nose datum point in inches. Forward of the radar nose datum point, minus station numbers are used. Wing station referencing is measured from the wing datum point at fuselage station 237.0.

ADHESIVES.

4. Doublers are attached to various sections of the structure by the Narmco Metlbond 4021 synthetic resin adhesive process. This is carried out during manufacture using pressure and heat to cure the synthetic resin adhesive. (The large Autoclave at Avro was used for this process.)

5. Honeycomb sandwich construction is used on various panels and fairings. The aluminum honeycomb is attached to the inner and outer skins using Shell Epon 422 adhesive and the tie-in of the two skins is by Narmco Metlbond 4021 adhesive.

6. Glass cloth honeycomb sandwich construction is used in the fabrication of the two rear dorsal fairings. The adhesive used is Narmco Conolon 302 with Narmco Metlbond 4021 for the attachment of the metal edges.

7. The cabin pressure sealing is achieved with EC 1291 sealing compound, which is diluted for use on the faying surfaces. External gaps are filled with Epon 828 Filler compound.

INNER - WING.

8. A centre box forms the joint between the LH and RH inner wing torsion boxes. It extends from station 571.25 to station 742.50 and is built in the form of a rectangular box. Forward of station 571.25 the box tapers to an 'I' sectioned centre rib. Fitted to

the upper surface of the centre box are the vertical stabilizer attachment and shear fittings. On the undersurface of the centre box are fittings for the attachment of engine bay support struts, engine thrust beam, front support struts and miscellaneous fairleads and mounting brackets. The inner wing torsion boxes are each attached to the centre box and rib by shear fittings and double lap joints to form an integral assembly.

9. The LH and RH inner wing torsion boxes each consist of spars, ribs and outer skins. The spars and ribs 1 and 10 are milled from solid billets of aluminum alloy. Rib 4 is also milled from solid, but is formed in three sections to fit between the spars. The intermediate ribs are of built-up construction and are each fitted in three sections. The upper and lower skins are manufactured in sections, with the skin joints along the spars. The sections are contour milled from solid billets to form integral stringers and provide increased skin thickness at access panel and attachment areas.

10. Each torsion box is sealed to form four integral fuel cells.

11. Provision is made for fitting a jacking adaptor on rib 9 just aft of the centre forward spar.

12. The inner wing is extended forward from the torsion box main spar to the wing leading edge, to form the inner wing forward section. It houses two integral fuel tanks and a bay for fuel system components.

13. The main structural members of the forward section are an auxiliary spar, a front spar and a fuselage rib which are all milled from solid billets. The auxiliary spar is a straight transverse spar extending from the aircraft centre line at station 485.00 to the front spar. The front spar forms the main member of the leading edge and extends from the forward end of rib 10 to join with the forward end of the fuselage rib. The fuselage rib is in two sections which are joined at the auxiliary spar, the rear section forming an extension of rib 4.

14. The centre fuselage is joined to the inner wing along the auxiliary spar and by a swinging link to the fuselage rib at station 359.00. A flexible stainless steel seal is fitted between the centre fuselage and the inner wing fuselage rib.

15. The inner wing leading edge is built up on the front spar and comprises ribs and stringers with an outer skin. The leading edge of the aerodynamic step is formed by the main landing gear forward pivot fitting.

16. The main landing gear forward pivot fitting is attached to the forward end of rib 10 and to the outboard end of the front spar. It is the attachment point for the outer wing front spar and carries the main landing gear front pivot bearing. The rear pivot

bearing and the side stay bearing for the main landing gear are mounted in the main spar of the torsion box.

17. The landing gear bay upper skin is reinforced by stringers and a built-up beam at the landing gear 'up' position stops.

18. An integral fuel cell is formed between the fuselage rib, the auxiliary spar and another between the auxiliary spar, the torsion box and the fuselage rib. Both fuel cells are internally braced by diagonal trusses and are sealed during manufacture. A small bay located at the rear of the landing bay is fitted with an access door and houses fuel system components.

19. The inner wing trailing edge is divided into two sections at an extension of rib 4 of the torsion box. The inboard section consists of six milled transverse beams, diagonally braced, and connected between an extension of rib 4 and the centre box. The two forward transverse beams carry the engine rear support and locating attachments. The bay between the forward transverse beam and the main torsion box houses the elevator actuator. The lower skin is contour milled and the upper skin houses the elevator actuator access panels.

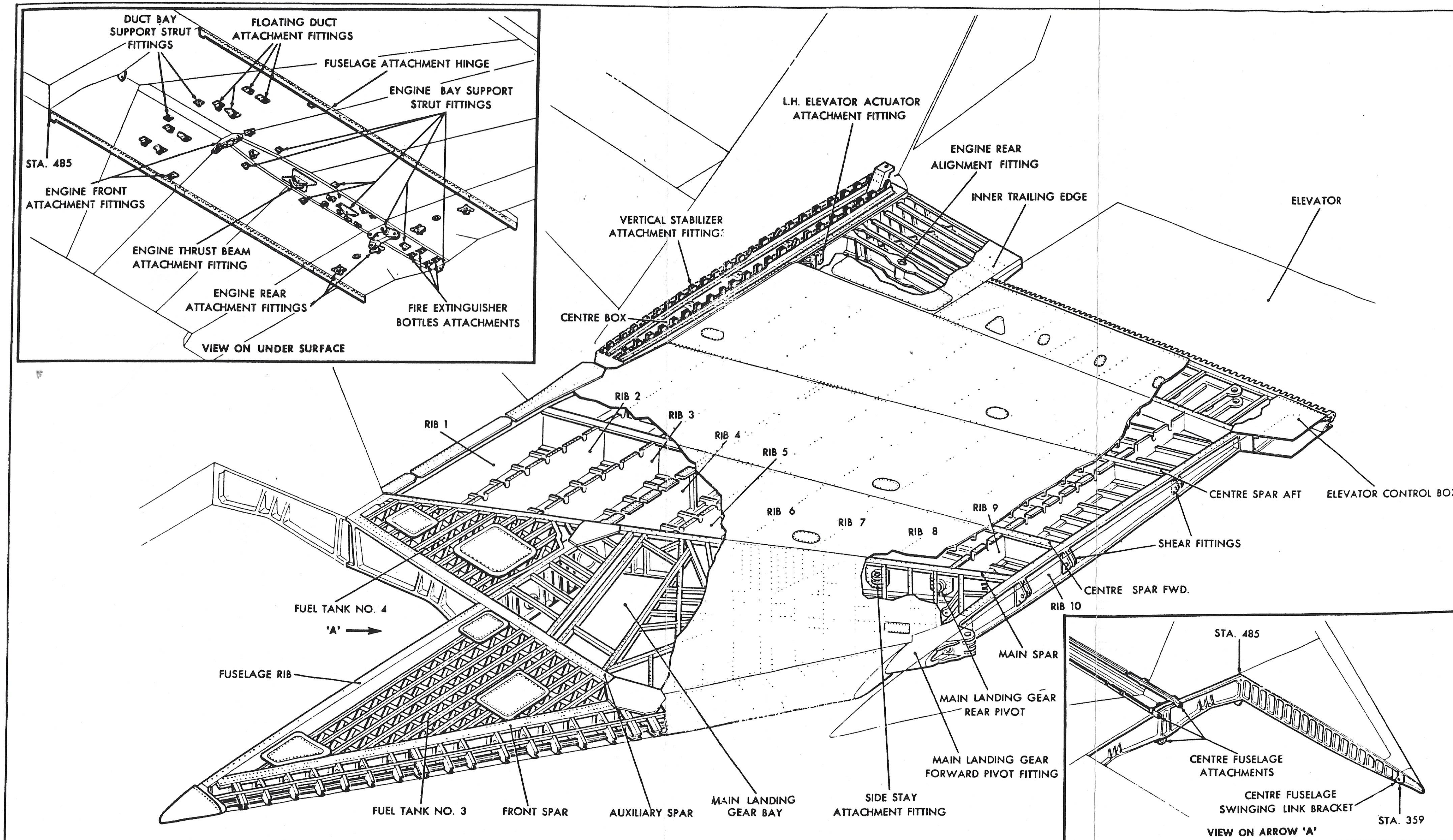
20. The inner wing outboard trailing edge forms the elevator control box. It consists of six main and five intermediate ribs, a trailing edge spar and an upper and a lower skin. The control box is attached to the inner and outer wing rear spars. The main ribs house the bearings for the elevator control linkage bell-crank pivot bolts. The upper skin houses access panels and the lower skin is removable as a complete unit to facilitate servicing of the control linkages. The trailing edge spar supports a piano type hinge for the elevator.

ELEVATORS.

21. The elevators are mounted on piano type hinges on the elevator control box trailing edge and extend from the fuselage side to the inboard end of the aileron. Each elevator is of stressed skin construction and consists of a hinge spar, fifteen ribs, a trailing edge member and an upper and a lower skin. Six ribs are reinforced to support the control link fittings and the skins are reinforced by doublers attached by the Narmco Metlbond 4021 process. A shroud fitted in sections along the bottom of the leading edge is detachable and provides access to the control link assemblies. Below each control link fitting an arm is fitted for locking the control link eccentric bearing locking plate.

OUTER - WING.

22. Each outer wing consists of a torsion box, a leading edge assembly and an aileron control box. The outer wing is attached to the inner wing at a transport joint. The



INNER WING STRUCTURE

joint is attached by a split-tapered sleeve and bolt at the front spar, four attachment bolts at the rear spar, double butt straps bolted to the upper and lower skins and three shear fittings.

23. The torsion box consists of the five spars interposed with ribs, and an upper and a lower skin reinforced by stringers. The skin sections are taper rolled, decreasing in thickness towards the tip and reinforced by stringers which are interconnected by vertical compression struts. A bay with an access panel in the lower skin is formed forward of the rear spar to house the aileron actuator.

24. A detachable control box aft of the rear spar houses the aileron control mechanism. It consists of seven main and ten intermediate ribs and a trailing edge spar covered by an upper and a lower skin. The seven main ribs support the aileron control linkage bell-crank levers. The upper and lower skins are taper rolled and reinforced by doublers.

25. Bolts attach the control box to the torsion box rear spar and the outboard end of the elevator control box. Access panels in the upper and lower skins facilitate the lubrication and adjustment of the control linkage.

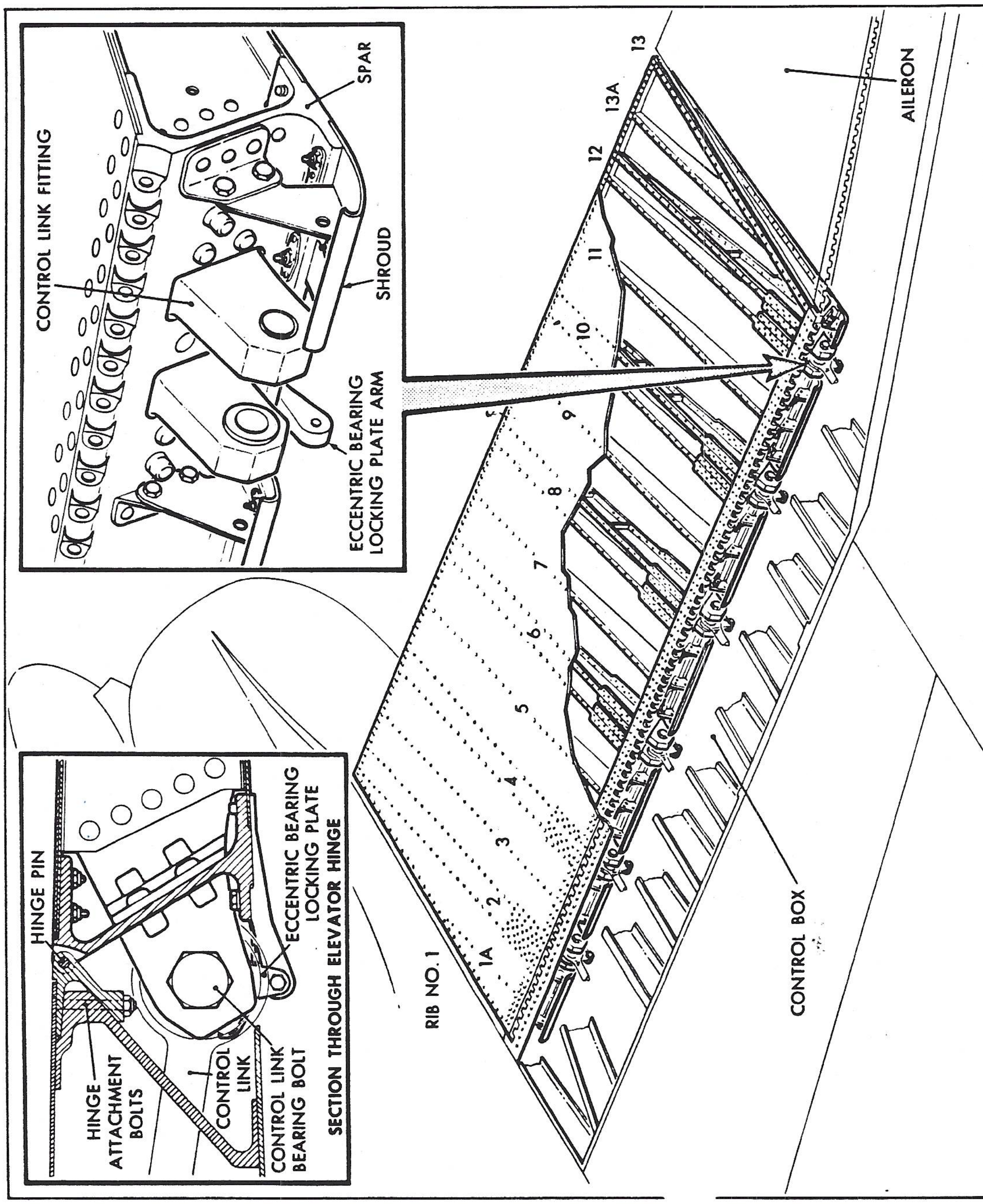
AILERONS.

26. The ailerons extend from the outboard end of the elevators to the wing tip and are attached by piano type hinges to the top edge of each control box spar. Each aileron consists of a spar at the leading edge to which are attached seven main and nine intermediate ribs and an upper and a lower skin. The main ribs are reinforced to carry the control link fittings while the upper and lower skins are reinforced by doublers. A detachable shroud is fitted in sections along the lower leading edge. The five outboard control link assemblies are faired in by detachable fairings.

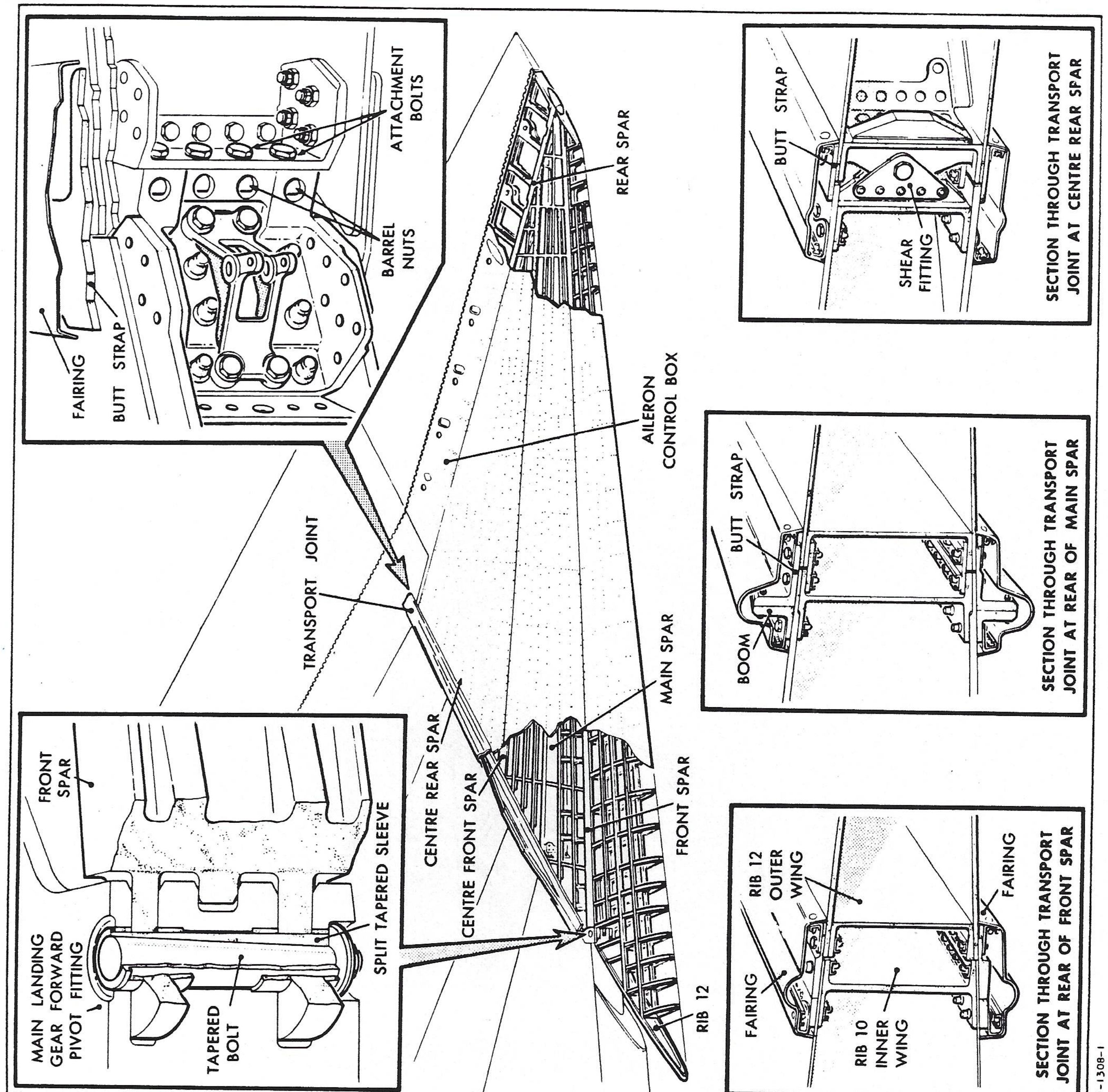
VERTICAL STABILIZER.

27. The vertical stabilizer is attached to the inner wing centre box upper surface by four shear fittings and attachment fittings on each side of the fin skin. A detachable control box fitted to the trailing edge houses the rudder control linkage and supports the rudder hinge fittings.

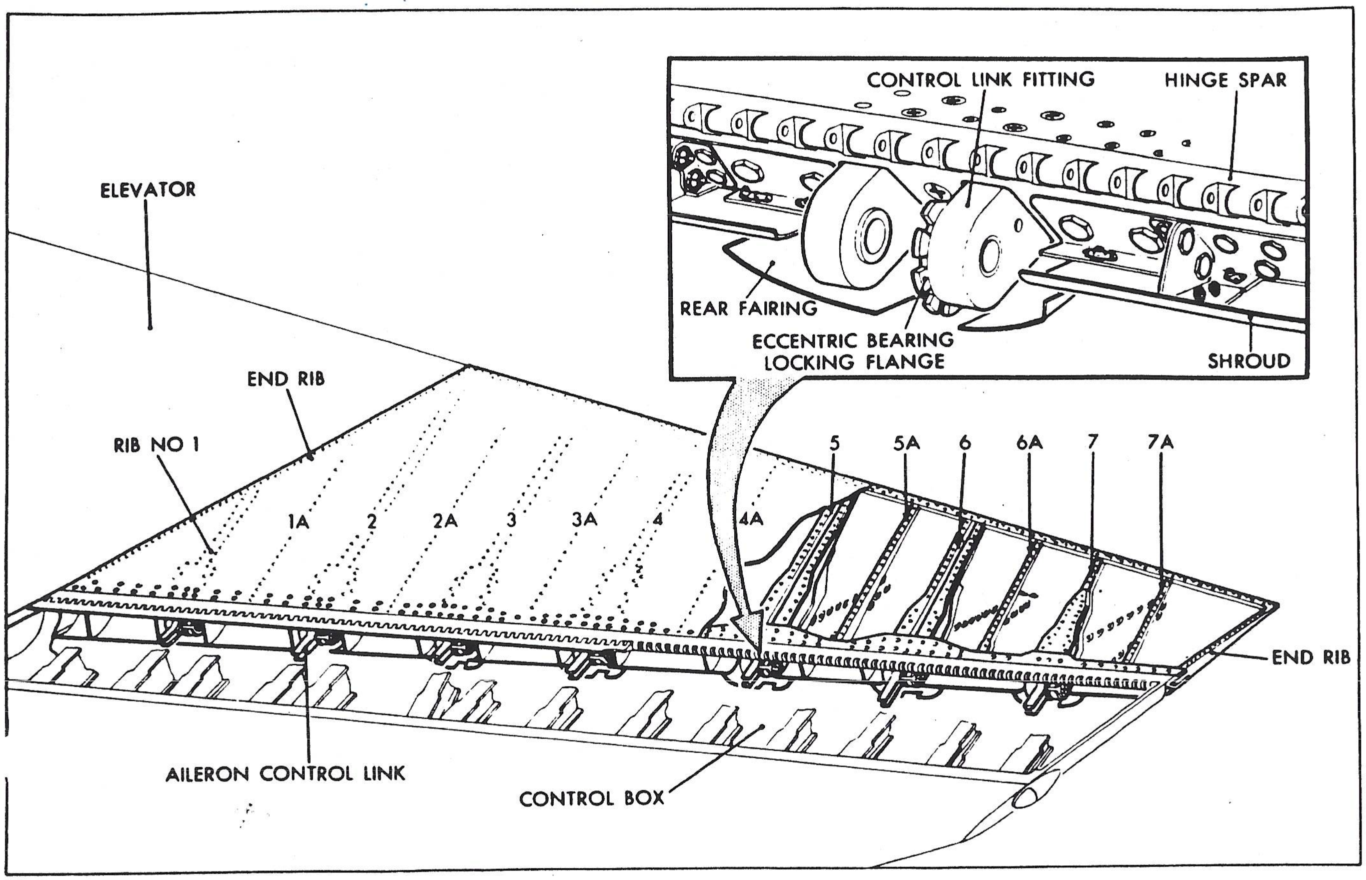
28. The vertical stabilizer consists of seventeen spars, eight ribs normal to the rudder hinge line, the outer skin sections and the rudder control box. The spars are parallel to the rudder hinge line with the exception of the front spar which forms the main member of the leading edge. The spars are numbered from rear to front. The main spars are numbered 3, 7, 10 and 14 and these with the front spar carry the outer skin joints. Intermediate spars consisting of 'L' shaped section stringers interconnected by compression struts support the outer skin between the main spars. The eight ribs are


CONTROL LINK FITTING
SPAR
SHROUD
ECCENTRIC BEARING
LOCKING PLATE ARM
AILERON
13
13A
12
11
10
9
8
7
6
5
4
3
2
1A
RIB NO. 1
CONTROL BOX
HINGE PIN
HINGE
ATTACHMENT
BOLTS
CONTROL
LINK
CONTROL LINK
BEARING BOLT
ECCENTRIC BEARING
LOCKING PLATE
SECTION THROUGH ELEVATOR HINGE
7M1-1311-1

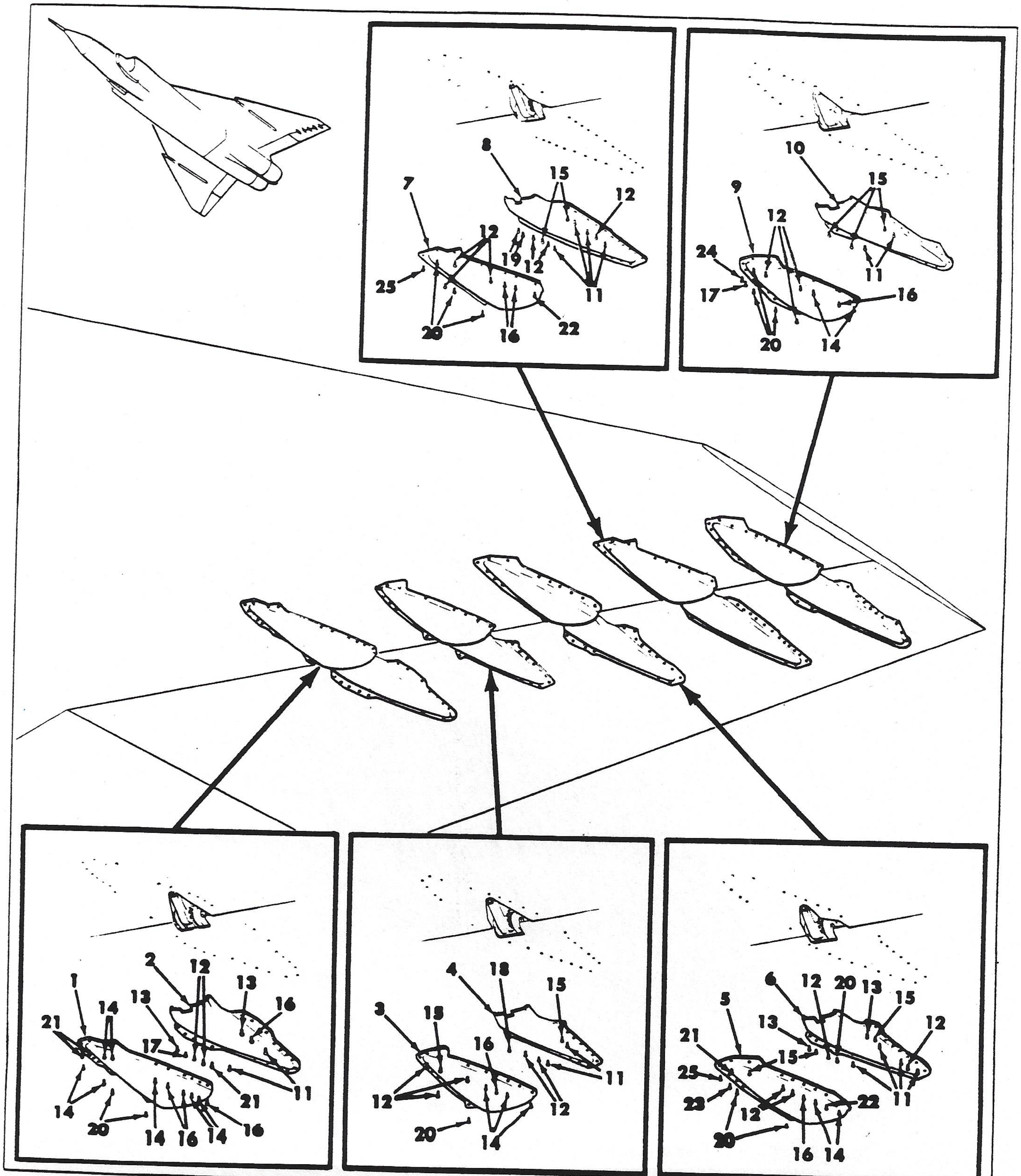
ELEVATOR


ATTACHMENT BOLTS
BARREL NUTS
FAIRING
BUTT STRAP
REAR SPAR
AILERON CONTROL BOX
TRANSPORT JOINT
MAIN SPAR
CENTRE REAR SPAR
CENTRE FRONT SPAR
FRONT SPAR
RIB 12
FRONT SPAR
MAIN LANDING GEAR FORWARD PIVOT FITTING
TAPERED BOLT
SPLIT TAPERED SLEEVE
BUTT STRAP
SHEAR FITTING
SECTION THROUGH TRANSPORT JOINT AT CENTRE REAR SPAR
BOOM
BUTT STRAP
SECTION THROUGH TRANSPORT JOINT AT REAR OF MAIN SPAR
RIB 12 OUTER WING
FAIRING
FAIRING
RIB 10 INNER WING
SECTION THROUGH TRANSPORT JOINT AT REAR OF FRONT SPAR
7M1-1308-1

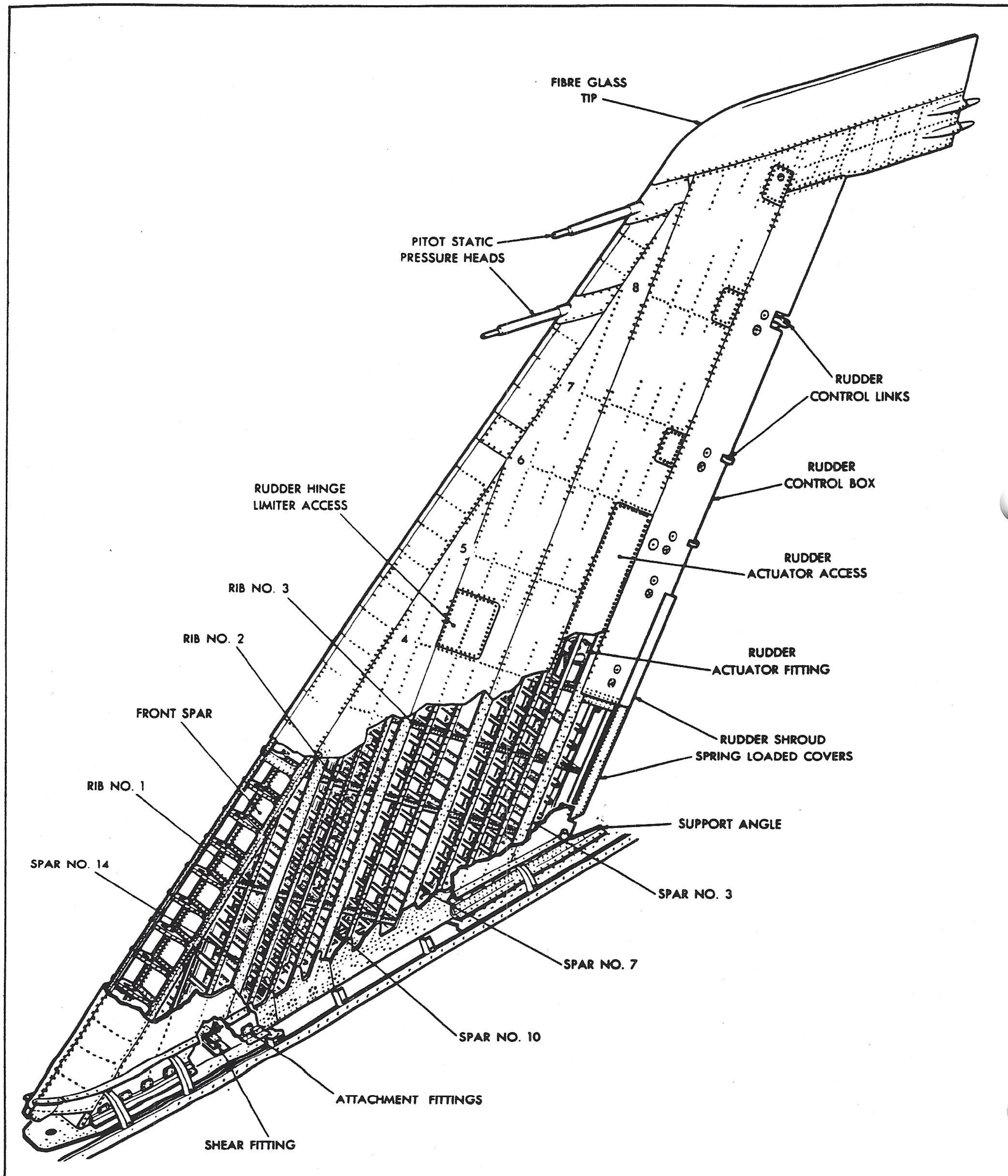
OUTER WING


CONTROL LINK FITTING
HINGE SPAR
REAR FAIRING
ECCENTRIC BEARING
LOCKING FLANGE
SHROUD
ELEVATOR
END RIB
RIB NO 1
1A
2
2A
3
3A
4
4A
5
5A
6
6A
7
7A
END RIB
AILERON CONTROL LINK
CONTROL BOX

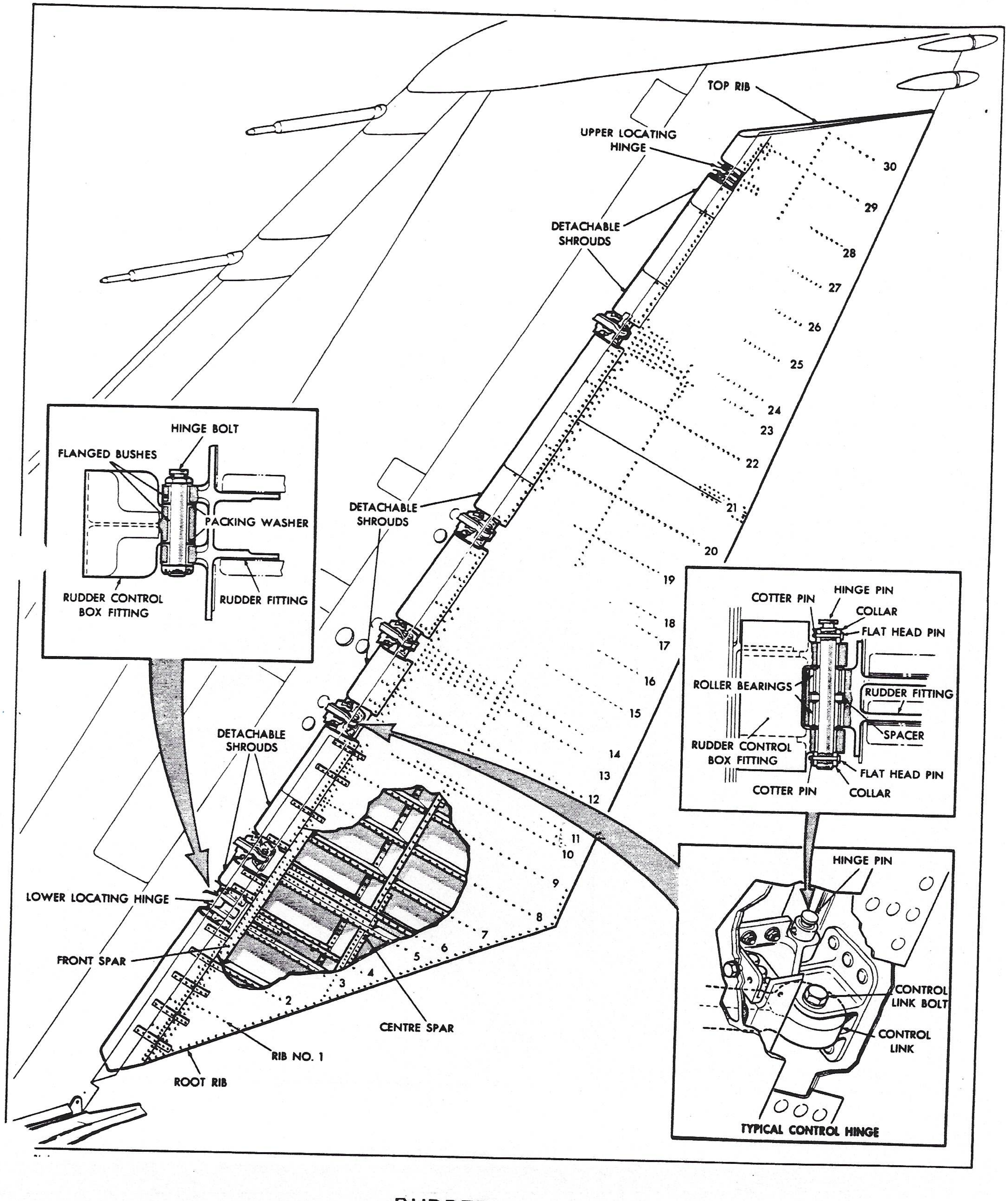
AILERON



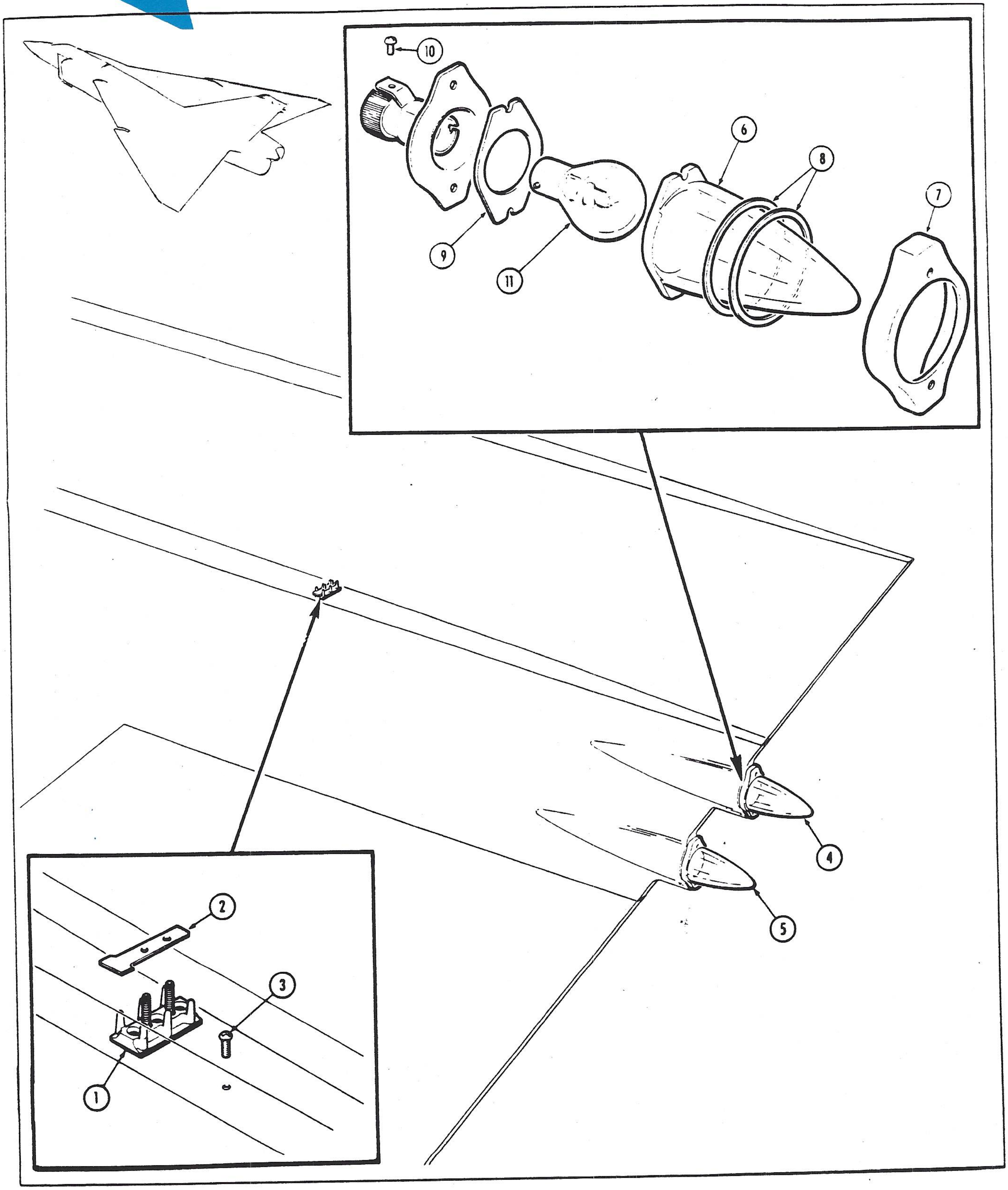
AILERON HINGE FAIRINGS



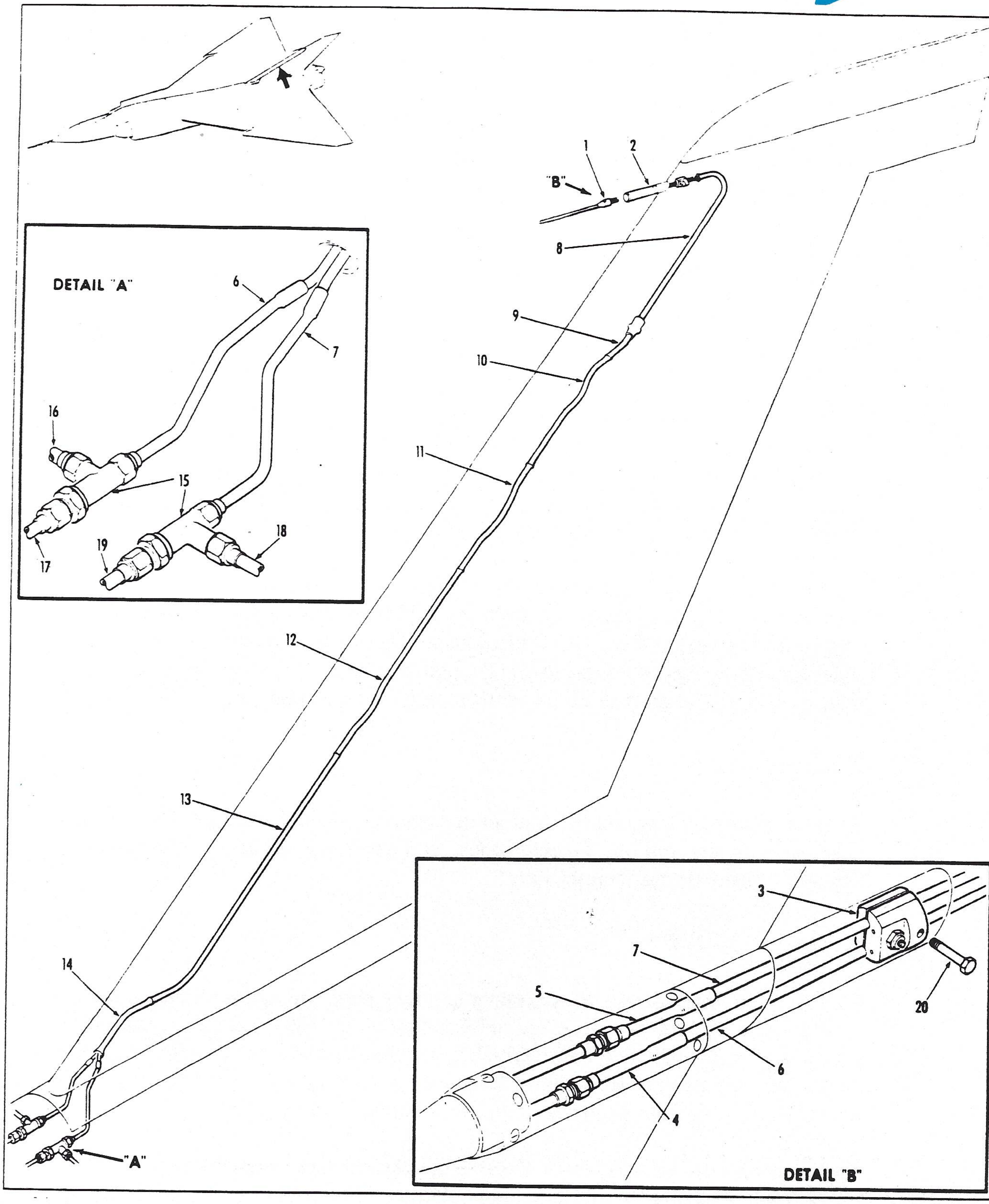
VERTICAL STABILIZER


TOP RIB
UPPER LOCATING HINGE
DETACHABLE SHROUDS
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
HINGE BOLT
FLANGED BUSHES
PACKING WASHER
RUDDER CONTROL BOX FITTING
RUDDER FITTING
DETACHABLE SHROUDS
DETACHABLE SHROUDS
LOWER LOCATING HINGE
FRONT SPAR
CENTRE SPAR
RIB NO. 1
ROOT RIB
COTTER PIN
HINGE PIN
COLLAR
FLAT HEAD PIN
ROLLER BEARINGS
RUDDER FITTING
SPACER
RUDDER CONTROL BOX FITTING
FLAT HEAD PIN
COTTER PIN
COLLAR
HINGE PIN
CONTROL LINK BOLT
CONTROL LINK
TYPICAL CONTROL HINGE

RUDDER



FIN-TAIL LIGHTS



PITOT-STATIC PRESSURE HEAD

fitted normal to the rudder hinge centre line and the short ribs of the leading edge are fitted normal to the front spar. A detachable fibre glass tip is fitted to the top of the vertical stabilizer.

29. The taper rolled outer skin is fitted in sections butt jointed at the main spars. Two detachable panels are fitted to the LH skin to provide access to the rudder actuator and hinge moment limiter.

30. The rudder control box is attached by bolts and shear pins to the rear of spar No. 3. It consists of two outer skins each milled from solid billets to form integral stringers with milled ribs at the hinge fittings and reinforced plates at the control linkage pivots. Small access panels are fitted to facilitate servicing of the control linkage.

RUDDER.

31. The rudder is mounted on seven bearings on the RH trailing edge of the rudder control box. It consists of a front and a centre spar, twenty six ribs normal to the rudder hinge line and outer skins reinforced by doublers.

32. Fourteen of the ribs are reinforced in pairs to carry the hinge and control link fittings. The rudder is located by the upper and lower locating hinges which are shimmed on assembly to take the vertical loads. The remaining five fittings contain roller hinge bearings and also provide the attachment points for the rudder control linkage. Detachable shrouds at the leading edge facilitate servicing.

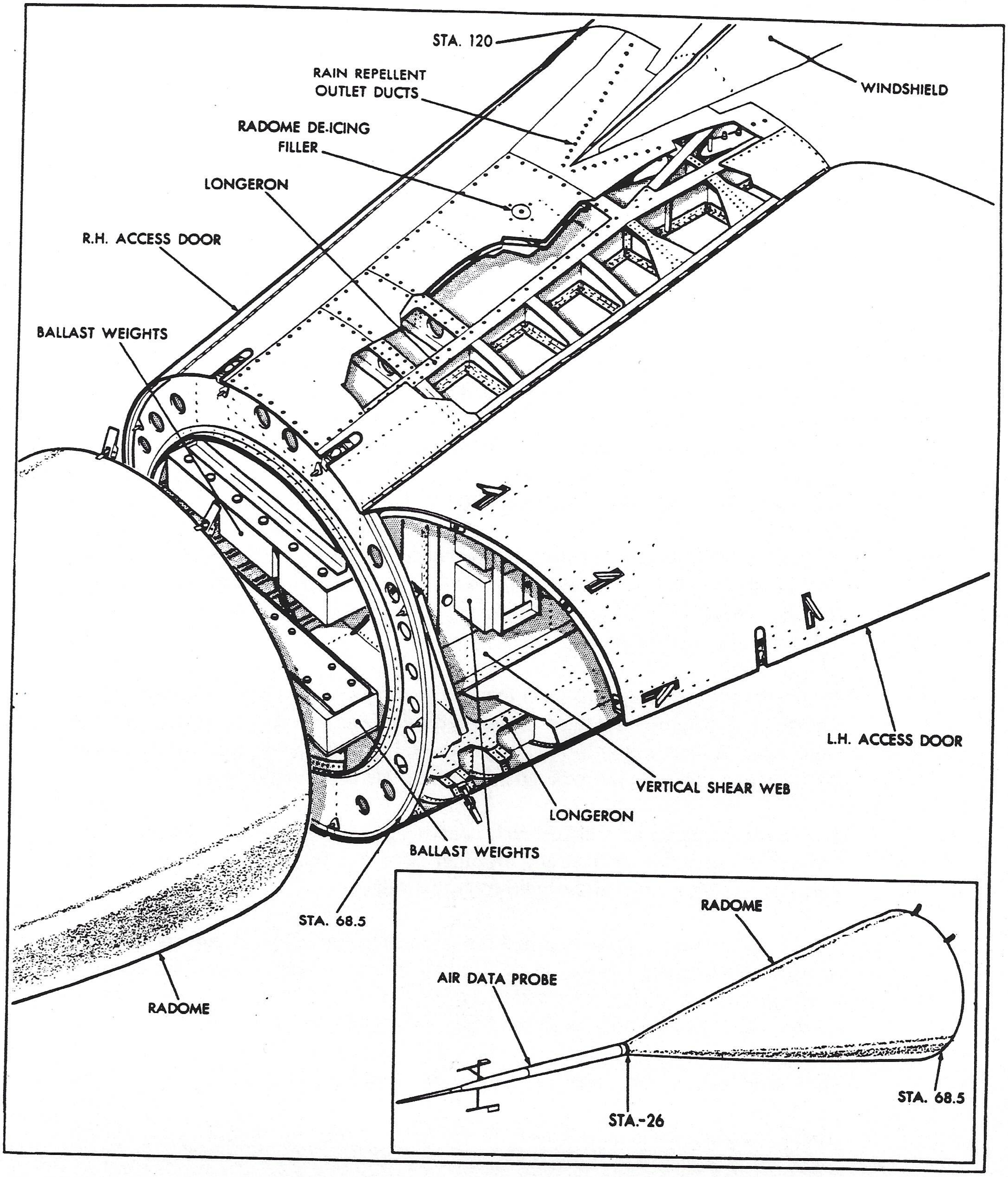
RADOME.

33. The radome is a synthetic resin bonded fibre glass shell attached to the radar nose by shear pins and four toggle latches. At the forward end an air data probe is fitted to support air data components.

RADAR NOSE.

34. The radar nose consists of two upper and two lower longerons joining a frame at station 68.5 to the front fuselage bulkhead at station 120. A vertical shear web braces and divides the radar nose which is attached to the front fuselage by shear pins on the vertical shear web and riveted joints at the longerons. The longerons are interconnected by frames, and skinned both internally and externally.

35. Detachable ballast weights are fitted to the vertical shear web and to two plates on the frame at station 68.5. Access doors, fitted to both sides of the radar nose, are attached to the top longerons by piano type higes and held closed by both toggle and shear pin latches.



RADOME AND RADAR NOSE

FRONT FUSELAGE.

36. For the purposes of description the front fuselage is divided into the fuselage section between station 120 and station 255 and the engine air intakes up to station 255.

37. The fuselage section is formed by four longerons, two vertical bulkheads and a canted bulkhead at the rear of each cockpit. The bulkhead at station 255 is common to both the fuselage section and the engine air intakes. Sixteen frames interconnected by stringers are fitted between the bulkheads and support the fuselage skin which is continued up to station 255 to form the cabin sides. The cabin floor is reinforced by frames and stringers and extends from the bulkhead at station 120 to the navigator's rear bulkhead.

38. The two upper longerons form the edges of the cockpits and support the windshield, the canopies and two sealing arches. The windshield frame is fitted with two laminated glass panels and is mounted on the forward end of the longerons. The four sections of the canopy are attached by piano type hinges bolted to the longerons. The space between the front and rear canopies is sealed by the centre arch. A transparent access panel fitted in the arch provides access between the two cockpits. The rear arch completes the seal at the rear of the navigator's canopy.

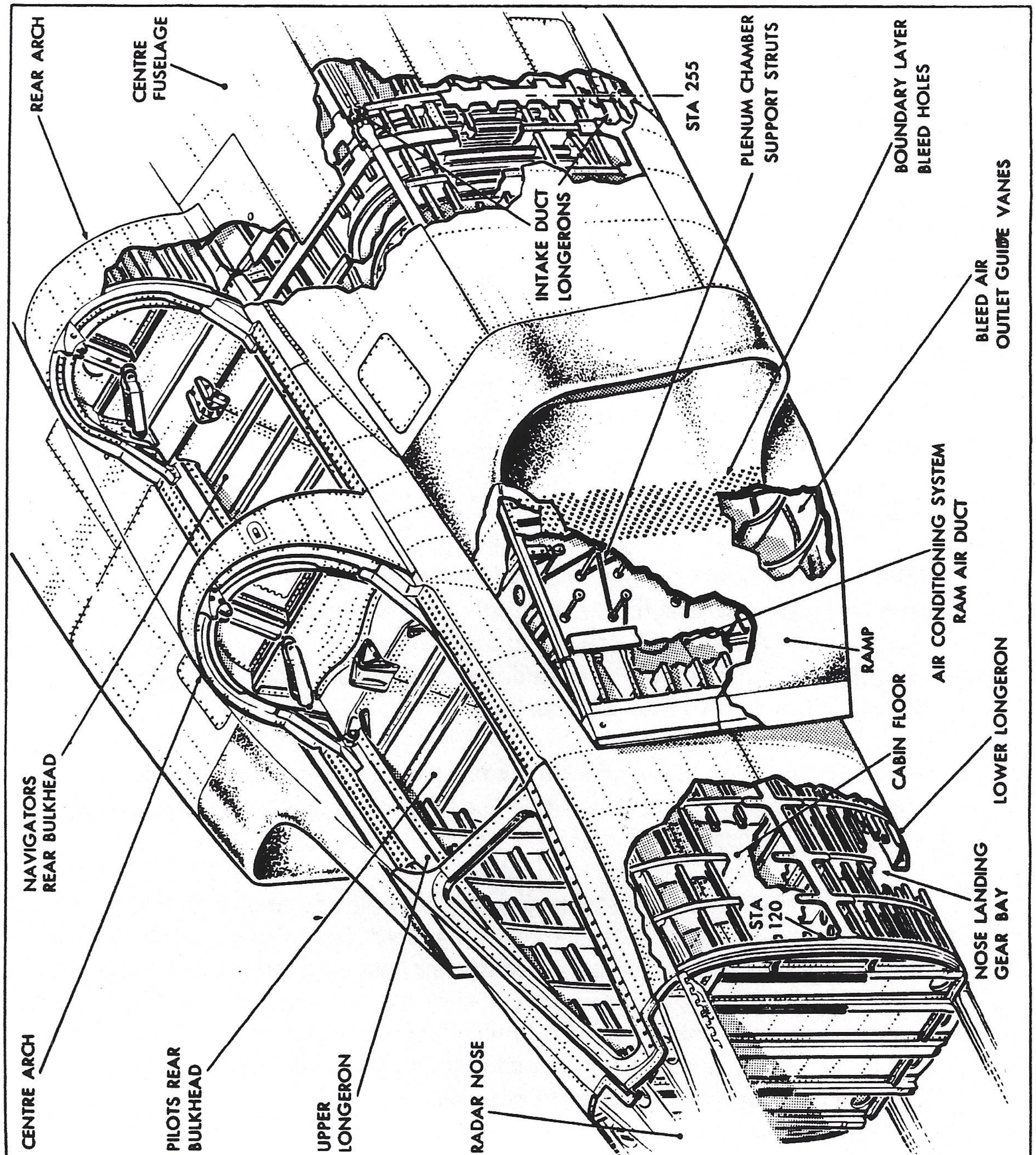
39. Sealing of the cabin structure is effected on assembly with sealing compound EC 1291 on the inside of all joints and diluted EC 1291 sealing compound on all faying surfaces. Insulation is fitted on the insides of the cabin to limit the transfer of skin friction heat to the cabin.

40. The two lower longerons form the side members of the nose landing gear bay. The RH longeron provides the attachment for the nose gear drag strut and the nose wheel door. A torque box fitting at the intersection of the navigator's bulkhead and the longerons provides the attachment point for the nose landing gear pivots.

41. The two engine air intakes each consist of an upper and a lower longeron, frames, stringers, an air duct and an outer skin. The intakes are attached to the fuselage by splice joints at the bulkheads and frames.

42. An aerodynamic ramp is formed forward of the intake lips. A gap between the ramp and the fuselage provides an air bleed off to ensure a clean flow of air over the ramp to the intake. A duct is formed in the leading edge structure between the ramp and the fuselage and supplies air to the air conditioning system.

43. A series of boundary layer bleed holes are formed on the outer face of the ramp just forward of the intake lips. Boundary layer air is bled through the holes into a plenum chamber in the ramp, which is connected to a rearward facing square section



FRONT FUSELAGE

outlet duct below the intake leading edge. Airflow over the outlet duct produces a depression which draws boundary layer air through the bleed holes, into the plenum chamber and overboard.

CENTRE FUSELAGE.

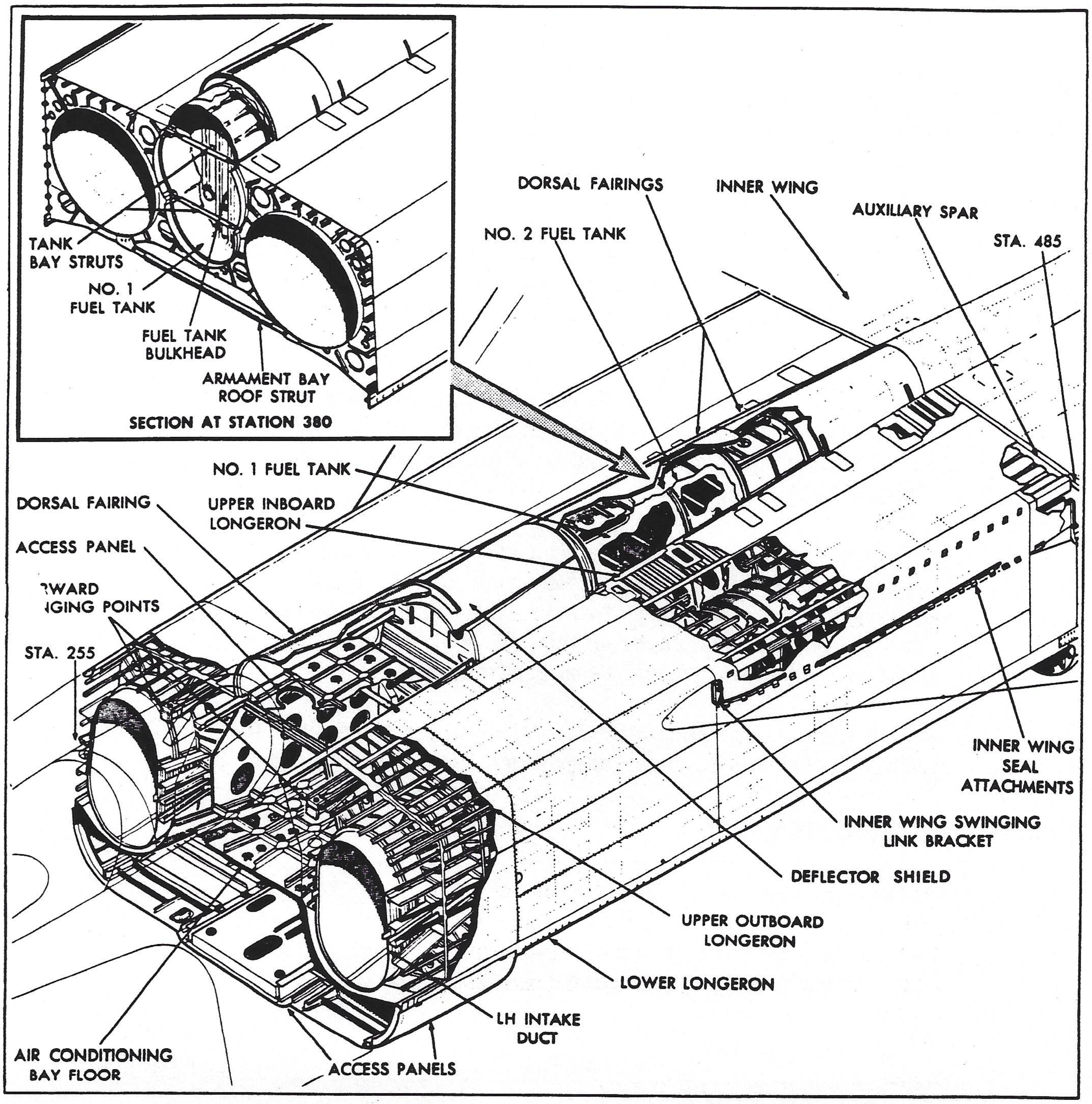
44. The centre fuselage extends from the front fuselage bulkhead at station 255 to the duct bay and inner wing joint at station 485. It consists of two intake ducts with a fuel tank bay and an air conditioning bay formed on the aircraft centre line between the ducts. The duct shape changes from approximately elliptical to circular in the length of the centre fuselage. Between stations 292 and 483 and extending the full width of the underside of the fuselage is the armament bay, which is used on the Arrow Mk1 to house a detachable instrument pack. Forward of the armament bay between stations 255 and 292 is the electronics bay.

45. Six longerons extend the full length of the centre fuselage. The four upper longerons connect with the upper fuselage and intake duct longerons of the front fuselage and with the auxiliary spar of the inner wing. The two lower longerons connect with the intake duct lower longerons of the front fuselage and the upper longerons of the duct bay. Eighteen frames interconnected by stringers support the intake ducts, the fuel tank bay skin and armament bay skins. Three bulkheads divide the tank bay into two fuel cells. Transverse struts in the armament bay roof and the fuel tank bays, connect the LH and RH sides of the frames.

46. Three detachable fairings, each held in position by six toggle latches are fitted over the dorsal area. One fitted directly aft of the rear arch provides access to the air conditioning system. A deflector shield fitted behind the air conditioning bay fairing provides an outlet for the Air conditioning system exhaust air. The remaining fairings cover the two fuselage tank bays.

47. The centre fuselage is attched to the inner wing by swinging links at station 359 and to the auxiliary spar at station 485. The joint to the duct bay is by a spliced joint at the lower longeron.

48. Four support fittings, two on the forward face of the frame at station 485 and two suspended from the frame at station 303.5 support the instrument pack. This pack is located by the two rear fittings which take the load in all three planes. The forward RH fitting has a degree of movement in the fore-and-aft direction and takes loads in the lateral and vertical planes. The forward LH fitting takes only vertical loads and is free to move in a lateral and fore-and-aft direction. This prevents the transfer of bending loads from the structure to the pack.



CENTRE FUSELAGE

DUCT BAY.

49. The duct bay is suspended from the inner wing by piano type support hinges at each side and a "V" support strut at station 538.77. It is attached to the centre fuselage bulkhead at station 485 and the engine bay frame at station 591.65. The bay houses two floating sections of the engine air intake ducts and two speed brakes. It consists of a main frame, four longerons and twenty intermediate frames covered by an outer skin.

50. The upper longerons connect with the lower longerons of the centre fuselage and terminate at the main frame at station 538.77. The lower two longerons are connected to bulkhead 485 at the instrument pack rear attachment points and extend the full length of the duct bay to connect with the engine bay main frame at station 591.65.

51. Two longitudinal beams, inboard of the speed brakes connect the bulkhead at station 485 to the main frame at station 538.77 and form the main members for the speed brake inboard hinges and the speed brake actuating jack attachments. The support hinges securing the duct bay to the inner wing are sealed by a stainless steel seal.

52. Each speed brake consists of two beams, interconnected by frames and covered by an upper and a lower skin. Each speed brake is pivoted independently at the forward end on two hinge pins and is actuated by a jack enclosed in a sealed compartment in the duct bay.

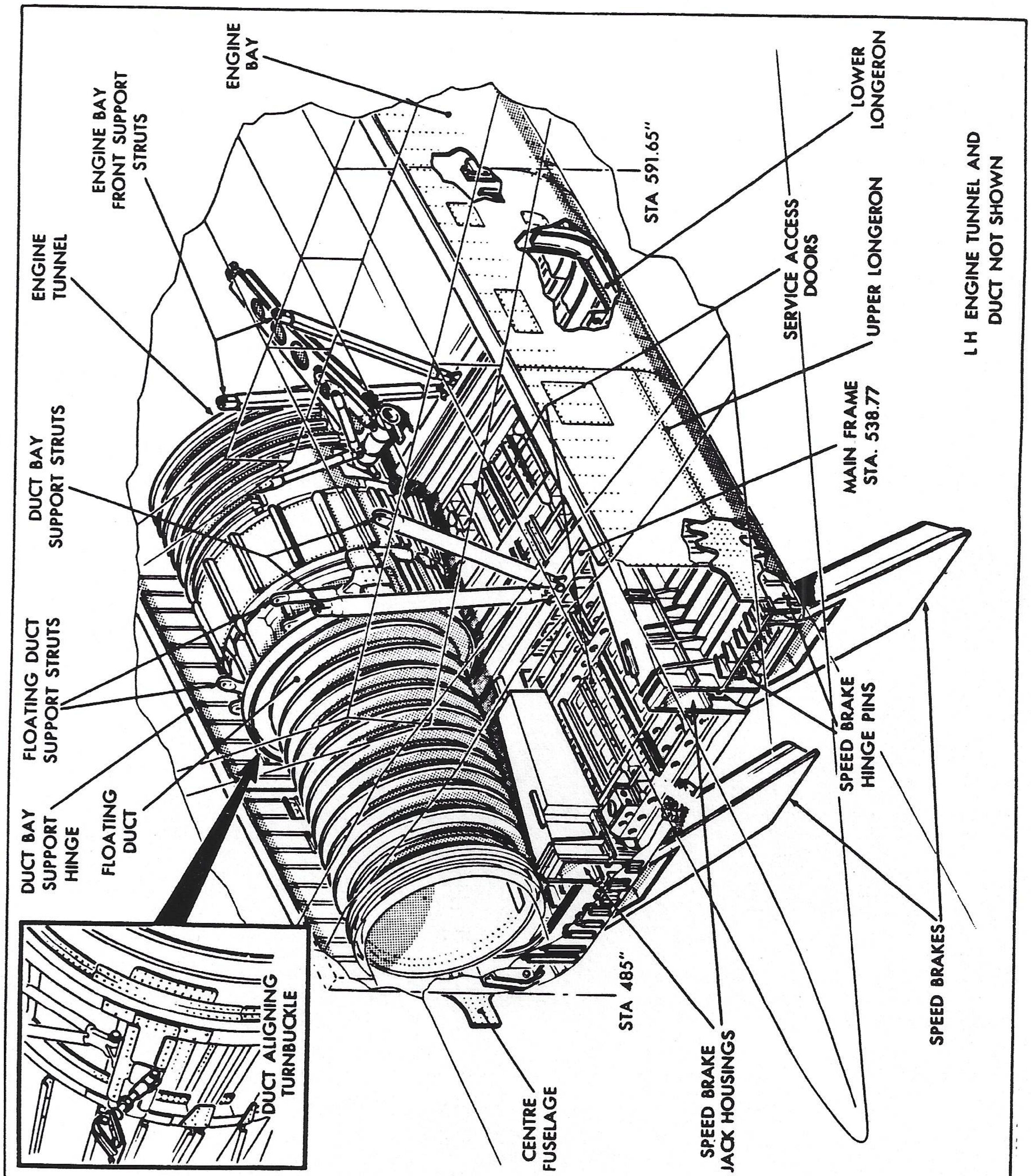
53. The forward faces of the two floating duct sections are connected to the ducts in the centre fuselage by flexible joints which are sealed by rubber "O" rings. The aft end of each duct is supported by two "V" struts from the inner wing and is located laterally by a turnbuckle from the structure. The joint between the aft end of the duct and the engine tunnel is sealed by a sheet rubber seal.

54. Twenty four gills, spring-loaded to the open position are fitted to the inside of each duct in line with the engine adaptor ring. These allow for engine cooling.

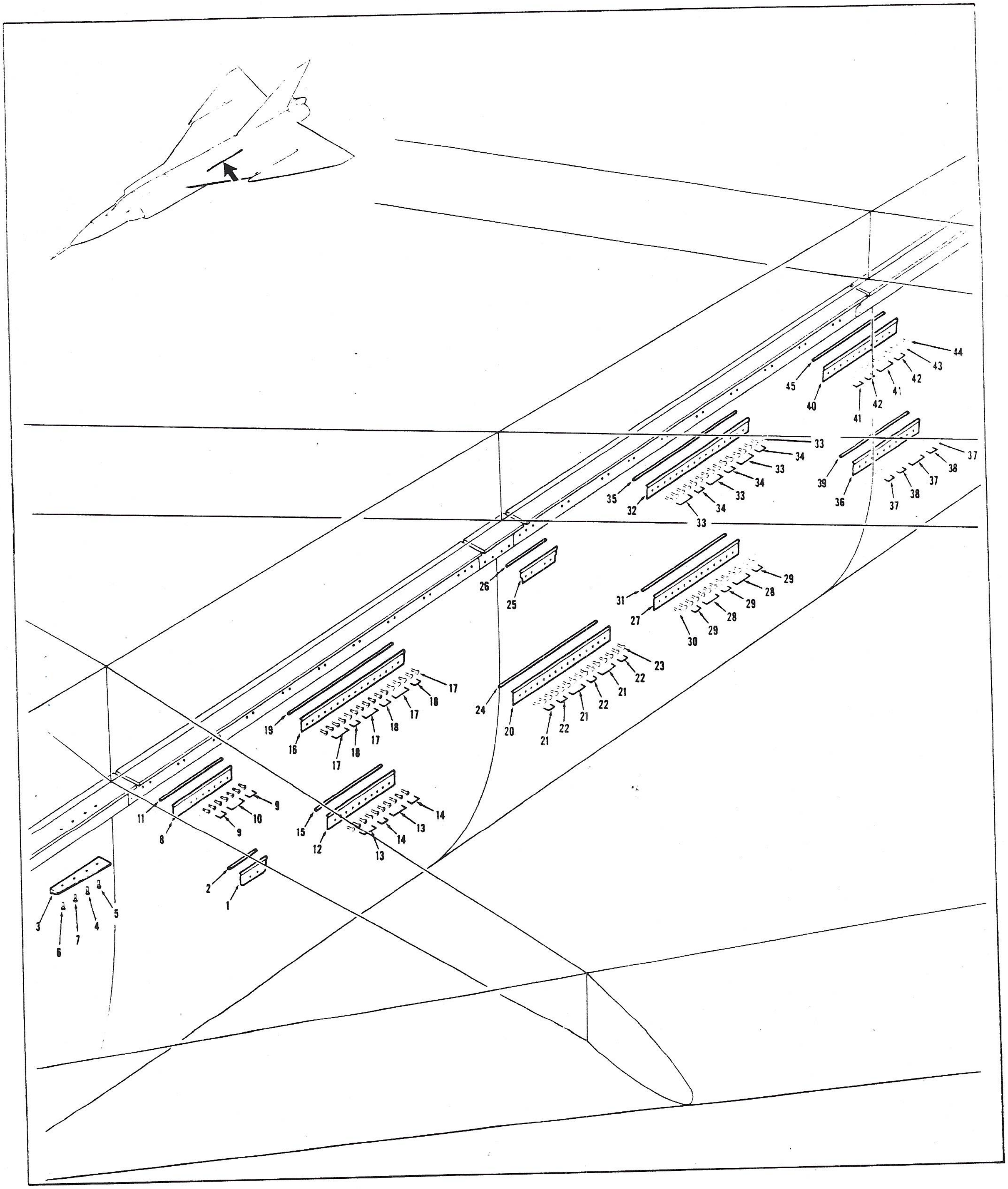
ENGINE BAY.

55. The engine bay extends from Station 591.65 to Station 742.50. It is suspended from the inner wing by piano type support hinges on each side ans by three "V" struts, one inverted "V" strut and two single struts. It is attached at the forward end to the duct bay and at the aft end to the rear fuselage by splice joints.

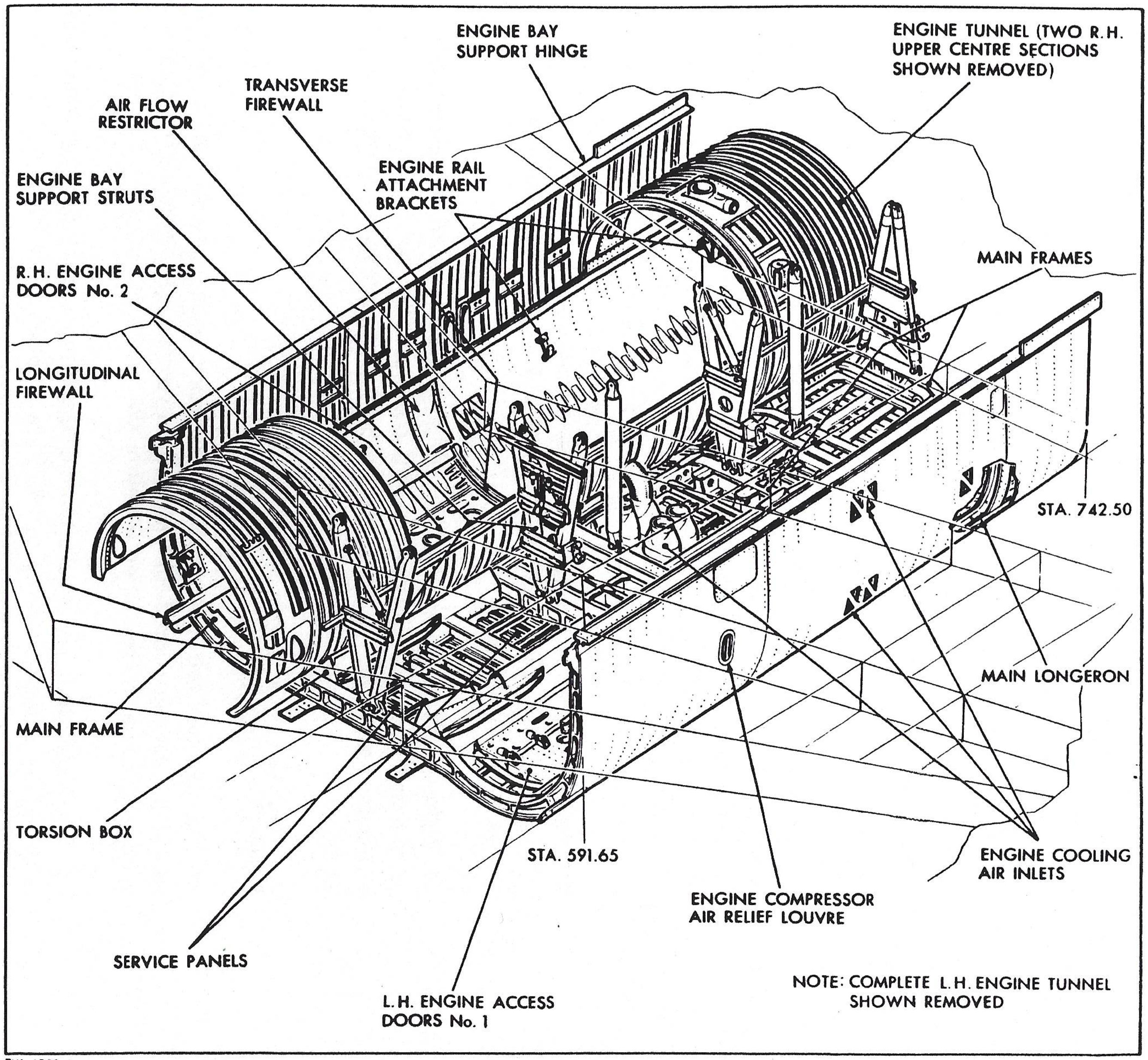
56. Two longerons extend the length of the bay and are connected with the main frames at stations 591.65 and 742.50. The longerons connect with the duct bay and


ENGINE BAY
ENGINE BAY FRONT SUPPORT STRUTS
ENGINE TUNNEL
DUCT BAY SUPPORT STRUTS
FLOATING DUCT SUPPORT STRUTS
DUCT BAY SUPPORT HINGE
FLOATING DUCT
DUCT ALIGNING TURNBUCKLE
CENTRE FUSELAGE
STA 485"
SPEED BRAKE JACK HOUSINGS
SPEED BRAKES
SPEED BRAKE HINGE PINS
MAIN FRAME STA. 538.77
UPPER LONGERON
SERVICE ACCESS DOORS
LOWER LONGERON
STA 591.65"
L H ENGINE TUNNEL AND DUCT NOT SHOWN

DUCT BAY



HINGE ATTACHMENT TO UNDERSIDE OF WING



7MI-1309-1

ENGINE BAY

the rear fuselage longerons through the main frames and through splice plates. Two torsion boxes are formed inboard of the engine access doors No.1 between the main frames at station 591.65 and station 644.43. Twenty-seven intermediate frames are fitted between the main frames and are connected in pairs by short inter-costals.

57. Four service panels and two access panels are fitted along the centre line of the bay. Two engine access doors are fitted under each engine and each door is hinged in two sections. The doors are held closed by tension hook and fork end fittings, combined tension and shear pin latches, and Camloc fasteners. An engine starter connection access door, spring-loaded closed and locked by two spring-loaded latches is fitted in each engine access door No.1. A rearward facing duct fitted in each engine access door N0.2, is the outlet for the engine cooling air ejection nozzle. Cooling air is admitted into the engine tunnels through a series of spring-loaded blow in flaps on the outer surface of the engine bay.

58. The engine tunnel is a circular duct enclosing the engine and extending from the rear of the duct bay to station 742.50. It is attached to the structure frames and is reinforced by ribs. The two upper sections between stations 610 and 707 are detachable when the engine is removed. Cut-outs, formed in the tunnel for the various engine connections are sealed to prevent any leakage of cooling air. A restricter is fitted at station 664 on the inner surface of the tunnel to proportion the flow of engine cooling air. Two longitudinal fire-walls form a seal between the engine tunnel and the lower edges of the engine shroud. A transverse fire-seal located at station 664 in the bottom of the tunnel is spring-loaded to form a seal with the engine shroud transverse firewall.

59. A glass-fibre insulating blanket is installed in sections on the inside surface of each tunnel to prevent excessive heat transfer from the engine tunnel to the surrounding structure. These blankets are held in position by clips and Camloc fasteners.

REAR FUSELAGE.

60. The rear fuselage consists of a fixed section extending from station 742.50 to station 803.06 with a detachable stinger and two detachable nacelles completing the section, the stinger terminating at station 880.

61. The fixed section is attached to the engine bay frame, the inner wing trailing edge and the centre box at station 742,50 by a bolted and riveted joint. It is formed by six longerons interconnected by eleven frames covered by an outer skin and skinned internally to form a rearward extension of the engine bay tunnel. On the centre line above the ducts a fairing for the lower end of the rudder is formed.

62. The undersurface of each duct is completed by an engine access door attached

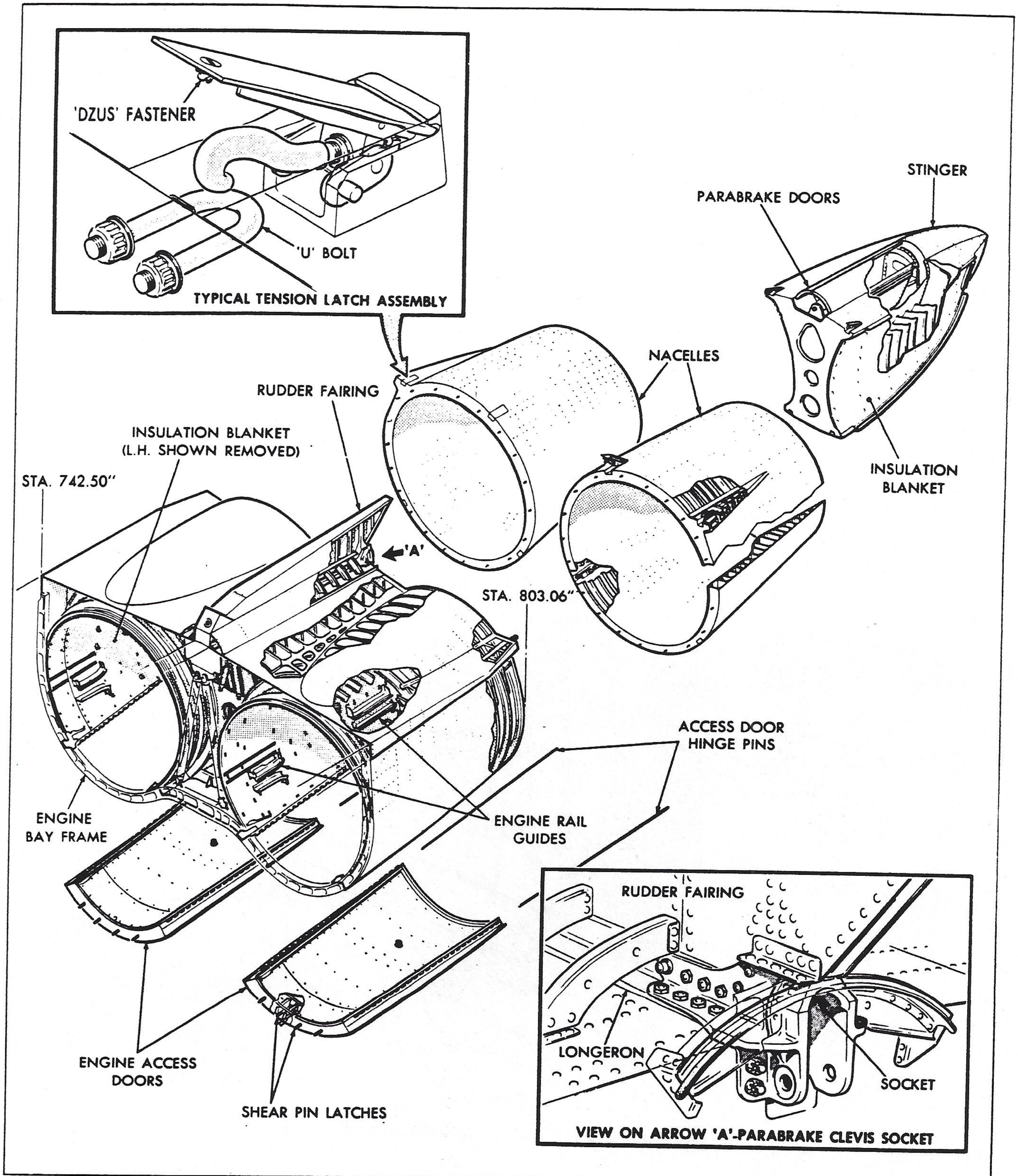
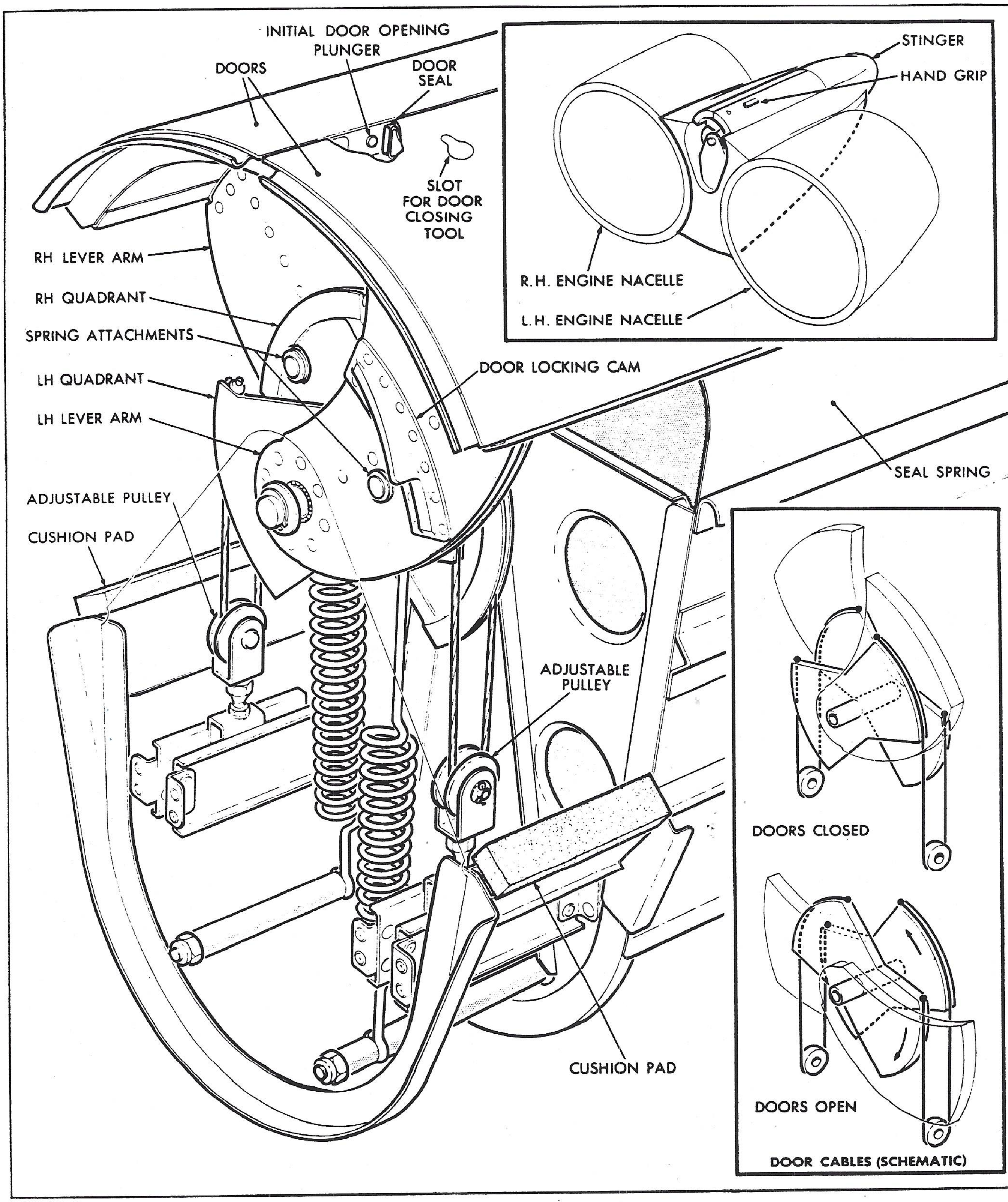
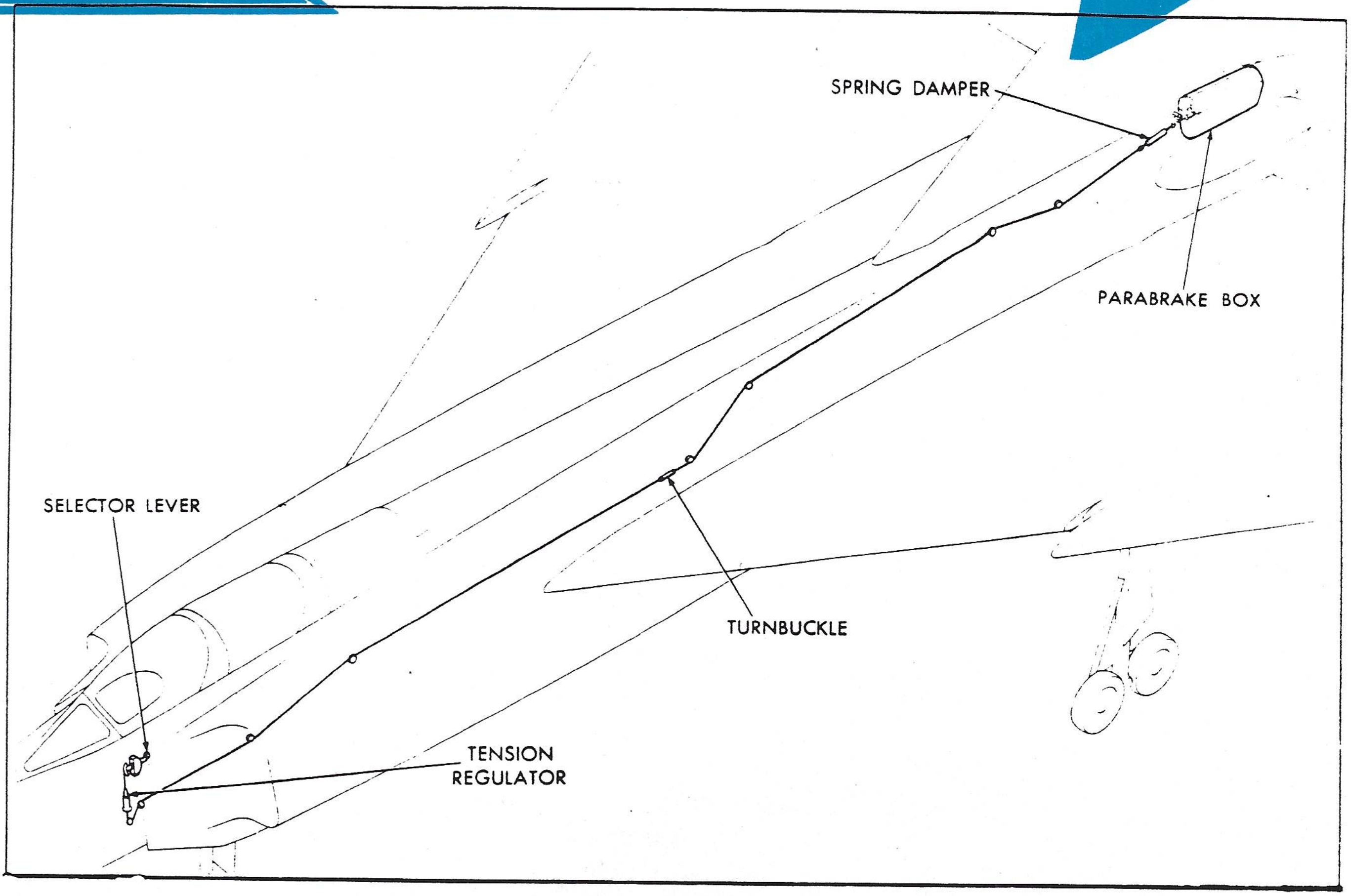


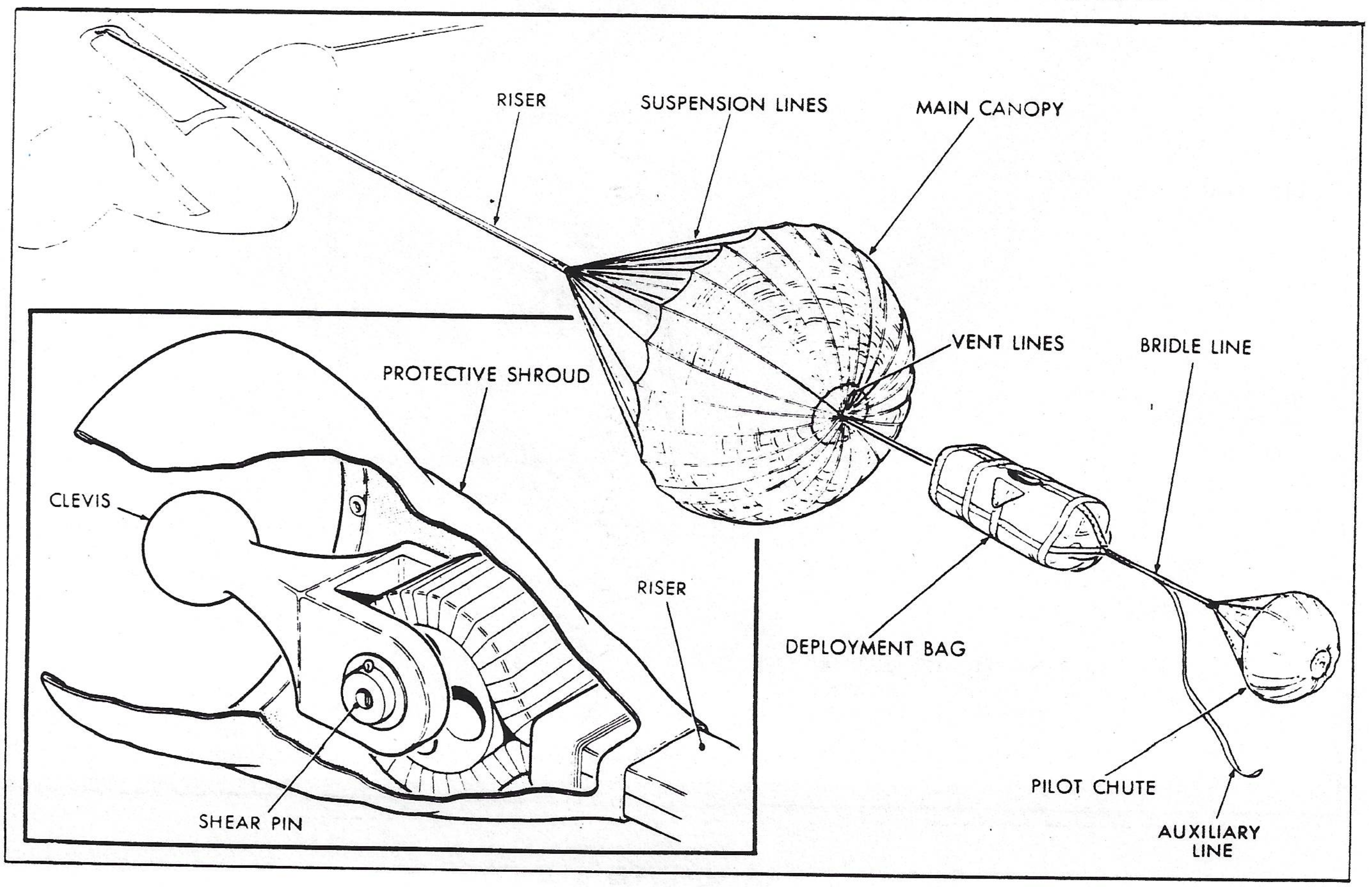
FIG.17 REAR FUSELAGE

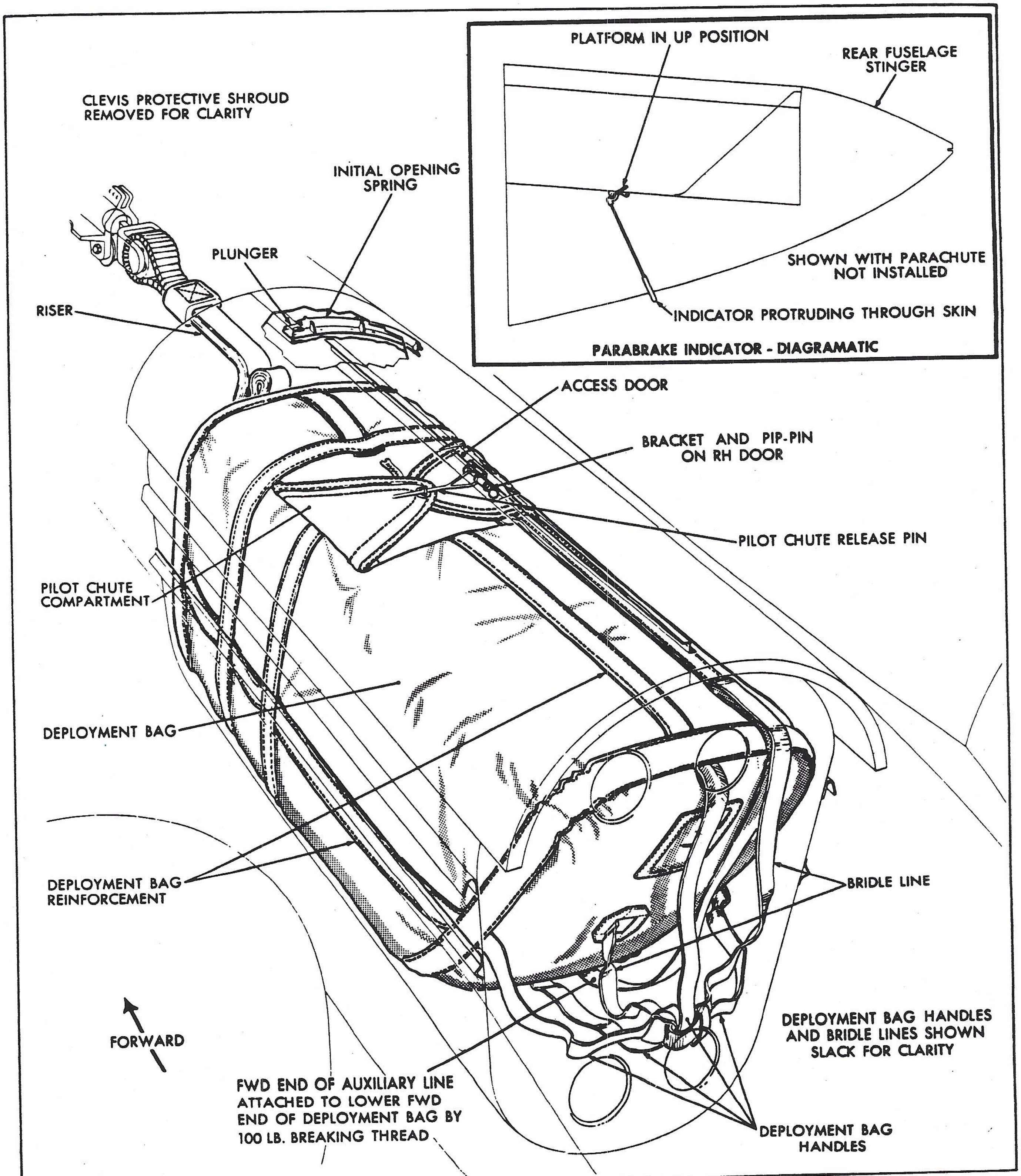


BRAKING PARACHUTE DOOR MECHANISM



RIGGING AND DEPLOYMENT OF BRAKING PARACHUTE





BRAKING PARACHUTE STOWAGE-Mk2

to the rear fuselage by two piano type hinges and to the engine bay rear frame by four shear pin latches.

63. A clevis socket fitting is attached to the two upper inboard longerons at the rear of the rudder fairing to retain the parabrake clevis.

64. Guides are fitted to the inner skins to facilitate installation of the engine guide rails.

65. The inner skin of the fixed section is covered by detachable glass-cloth insulating blankets to limit the transfer of heat to the surrounding structure.

66. Two nacelles formed by stringers, frames and an inner and an outer skin are each attached to the rear fuselage frame at station 803.06 by four tension latches.

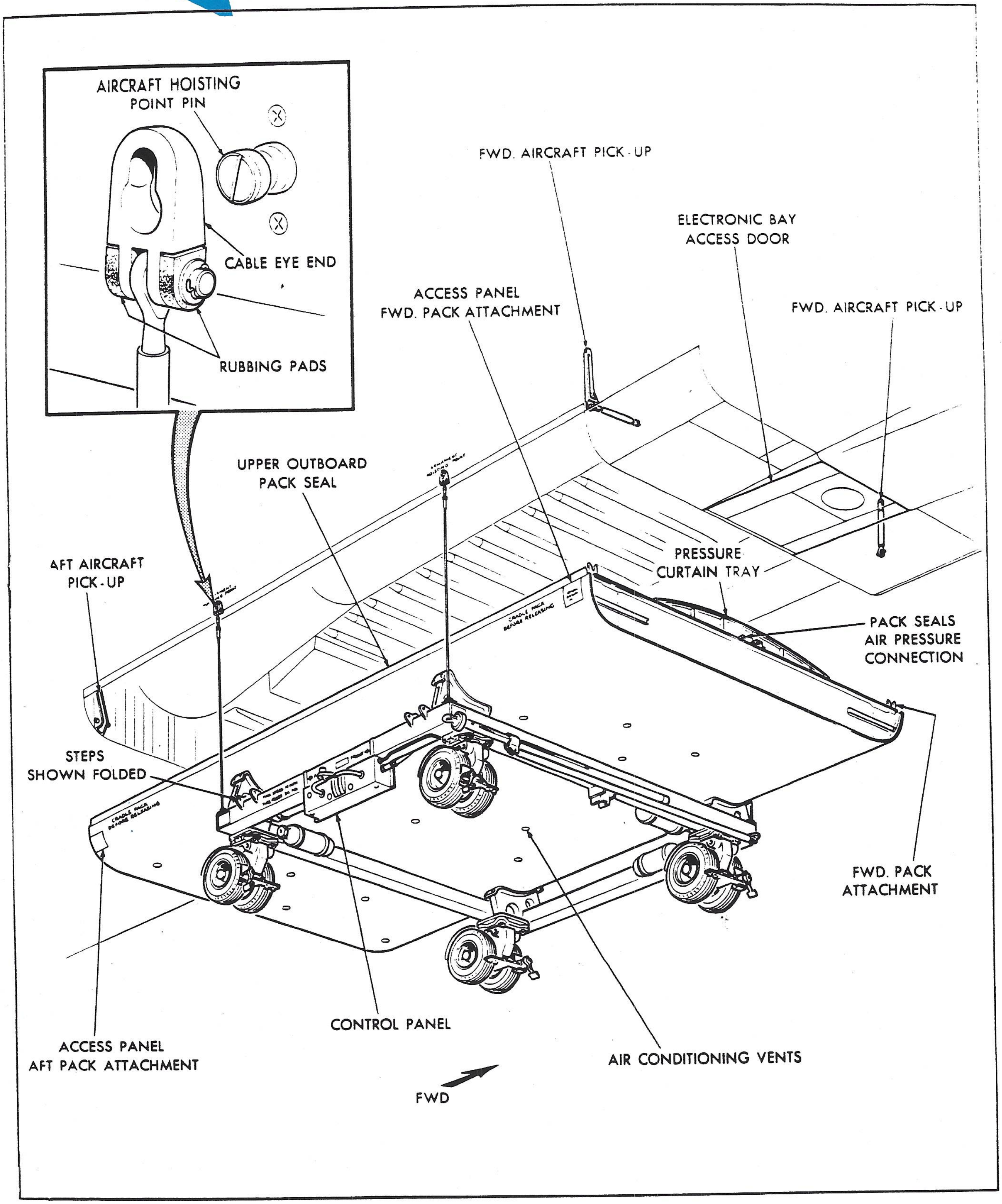
67. The stinger is fitted between the two nacelles and consists of frames, stringers, and an outer skin. It is attached to the fuselage frame at station 803.06 by four tension latches. A box enclosed by two curved doors is formed in the top of the stinger to house the parabrake assembly. The outer surfaces of the stinger adjacent to the nacelles are covered by two detachable insulating blankets to limit the transfer of heat to the stinger and parabrake assembly.

INSTRUMENT PACK.

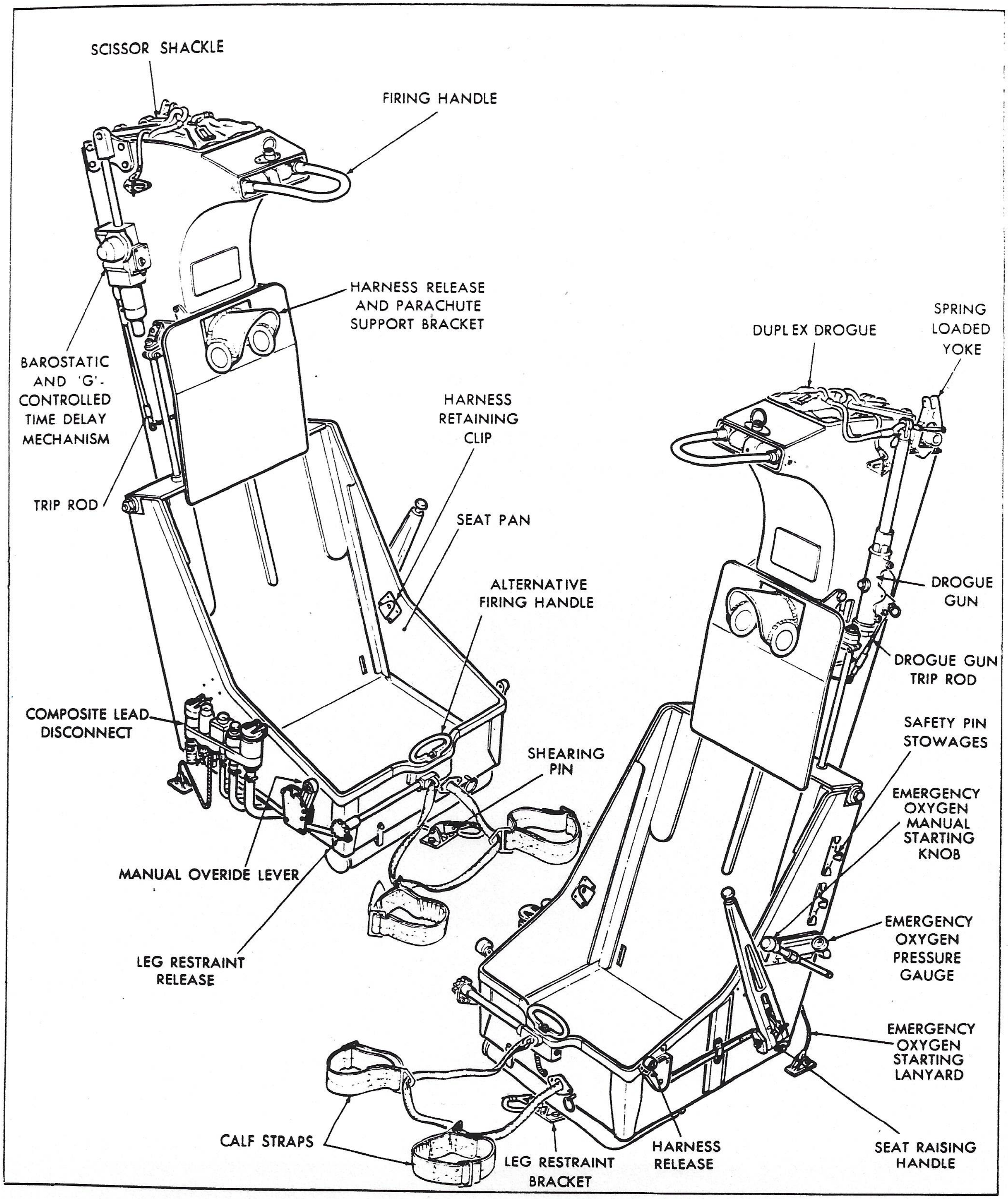
68. The Arrow 1 aircraft utilizes the armament bay for carrying a flight test instrument pack. The method of attachment of this pack is similar to that employed for the missile pack which will be used in later aircraft. The instrument pack consists structurally of a box beam frame, strengthened by lateral beams and longitudinal stringers. It is enclosed on the underside by a light alloy skin. Four attachment assemblies mounted at the upper four corners of the pack lock onto four pick-ups in the centre fuselage of the aircraft, the two front pick-ups at station 294 and the two aft pick-ups at station 482. The pack is air conditioned and up to fifteen access panels may be installed in the bottom skin for easy access to the various instruments. The instrument pack is installed in the aircraft by means of pneumatic hoist which attaches by four cables to hoisting pins located , two on each side of the aircraft fuselage, above the armament bay.

CANOPIES.

69. The front and rear cockpits are enclosed by sep type canopies, each consisting of two shell-halves, hinged to the front fuselage upper longerons. Each are of similar construction, consisting of a light alloy frame covered by an inner and outer skin with insulating material between the two skins. A clear vision panel is incorporated in the forward end of each half shell. The front panels are of larger area than the rear



INSTRUMENT PACK WITH DOLLY



MARTIN BAKER C5 EJECTION SEAT

panels and are electrically heated for de-icing purposes.

The canopies are opened by

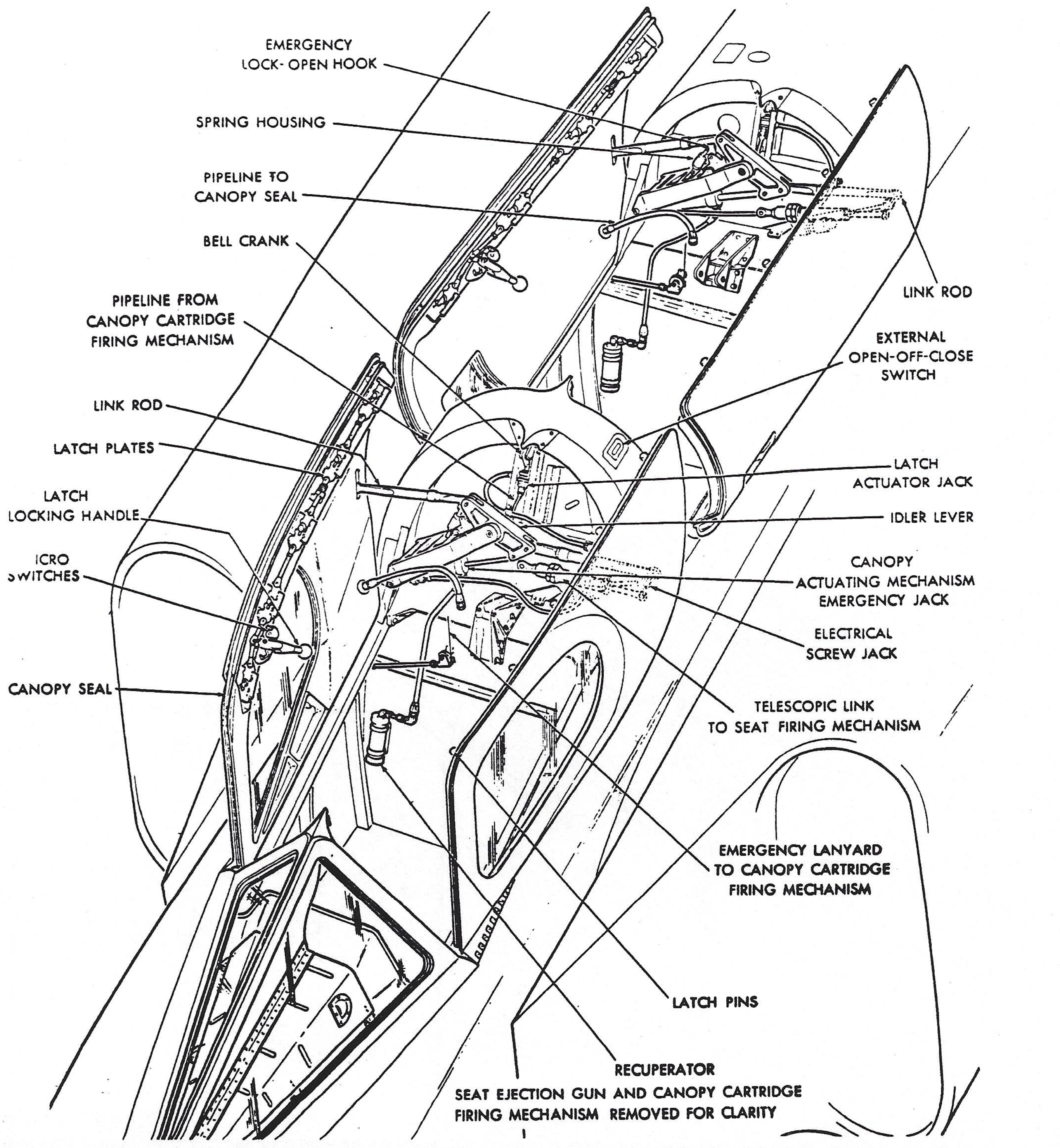
1. Electrically from the inside.
2. Electrically from the outside.
3. By pulling the ejection seat firing handle.

EJECTION SEAT.

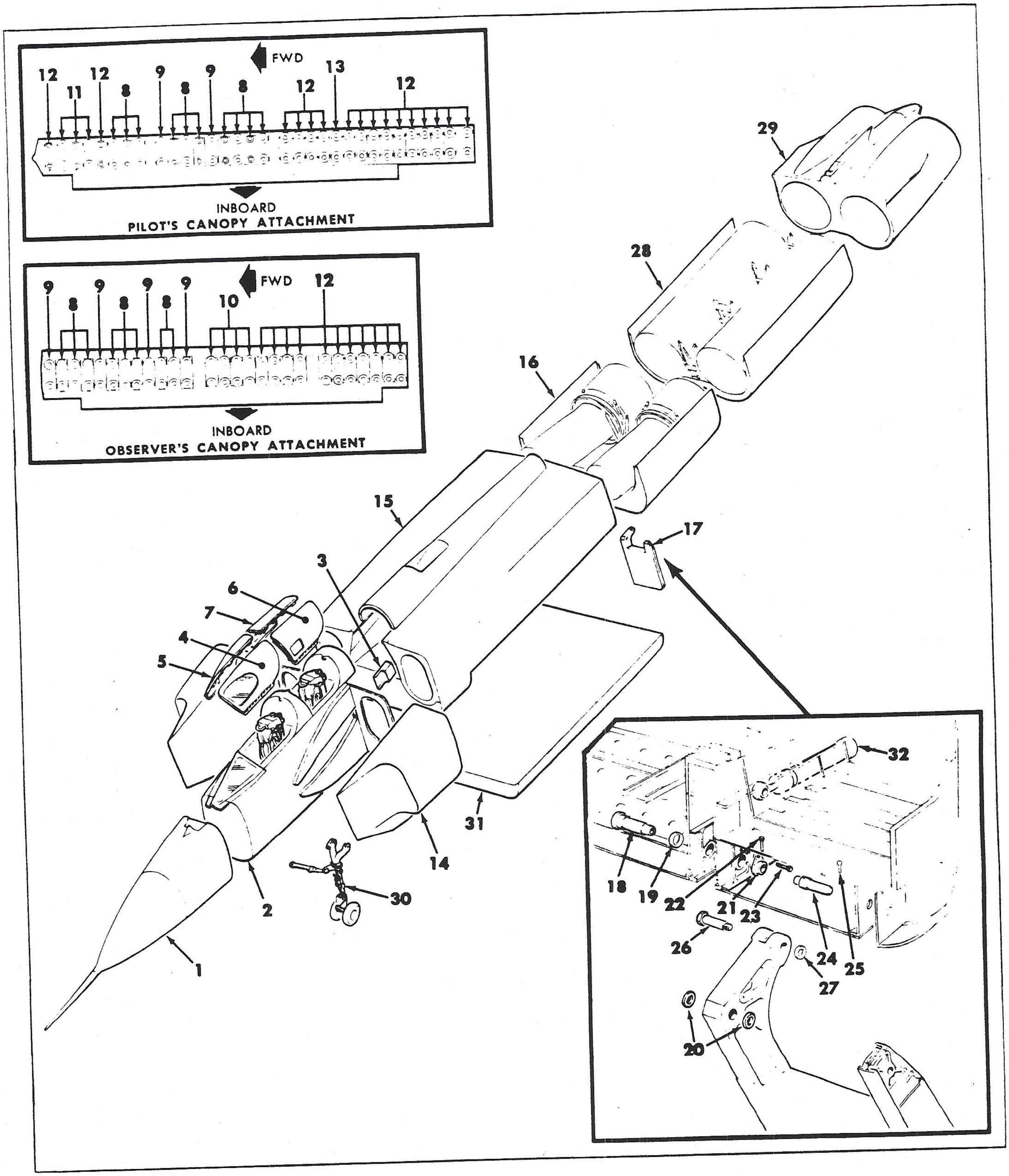
70. The Martin-Baker Mk C5 ejection seat is an automatic ejection seat which enables the crew members to abandon the aircraft safely at all altitudes within the aircraft range. Ejection at ground level at speeds over 80 knots is possible due to the high ejection velocity and rapid deployment of the parachute. Each seat is ejected from the aircraft by pulling on a firing handle which pulls a protective face screen over the crew member's face, fires the cartridge operated canopy emergency system and then fires the cartridge operated seat ejection system.

COCKPIT LAYOUTS.

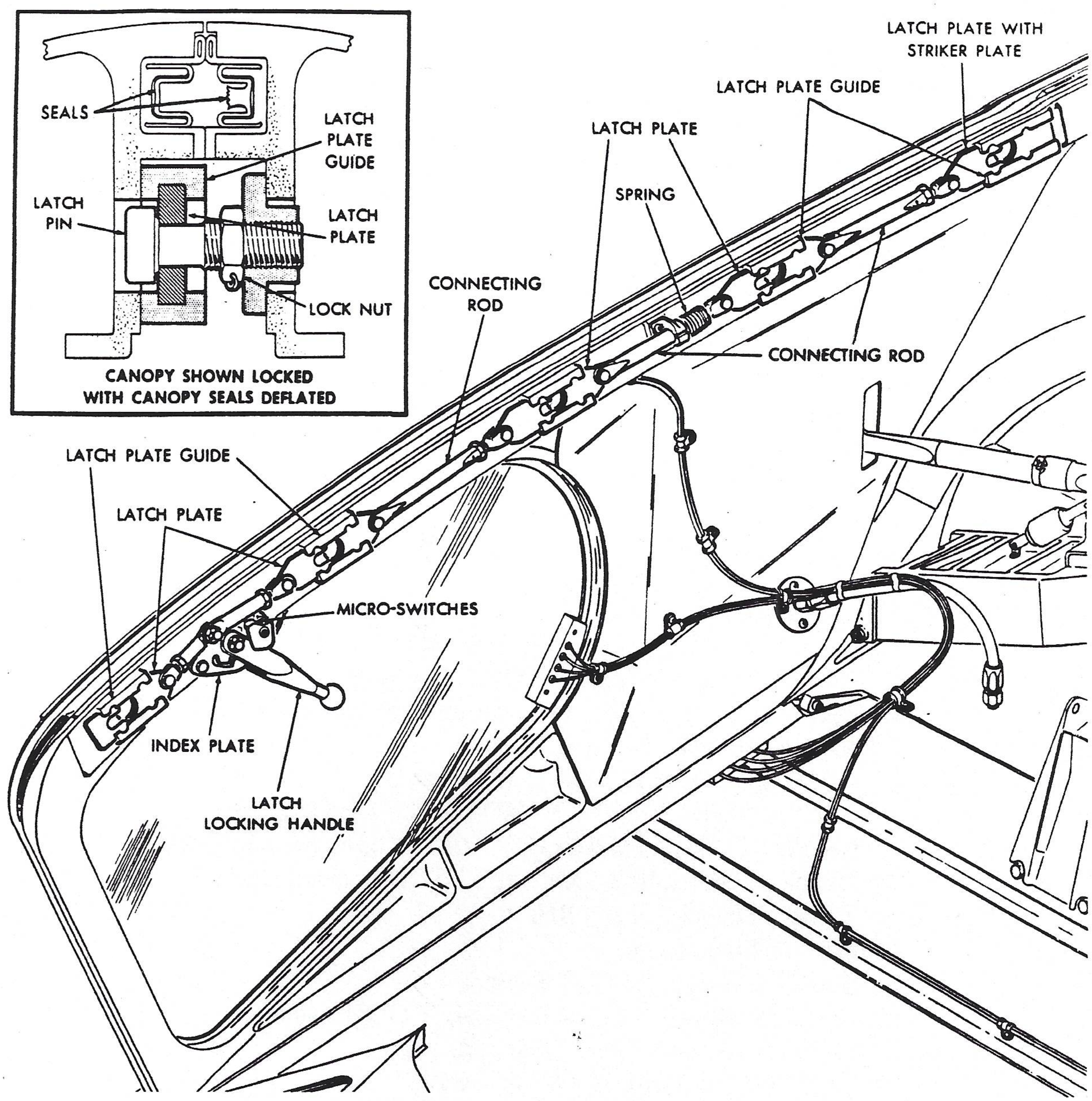
71. Illustrations of the pilot's and navigator's cockpit instrument panels are shown together with their inventories.



PILOT'S AND NAVIGATOR'S CANOPIES



CANOPY AND DIVE BRAKE ATTACHMENTS



PILOT'S CANOPY

LEGEND

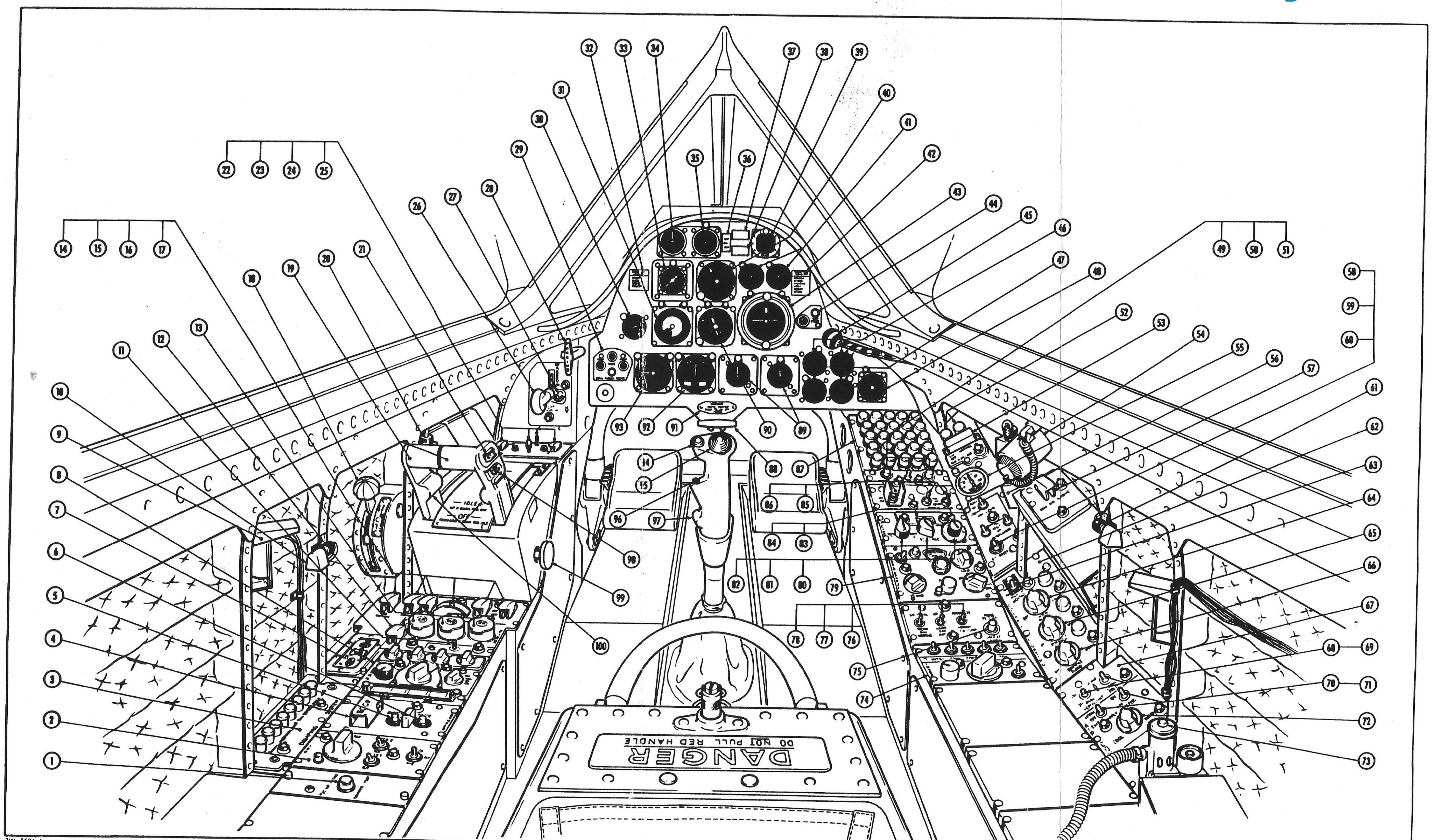
LOCATION OF FRONT COCKPIT CONTROLS AND INSTRUMENTS

ITEM AND DESCRIPTION

1. U/C UP MODE - DAMPER TEST SWITCH.
2. IFF Control PANEL.
3. DAMPING SYSTEM Circuit Breaker Panel.
4. DAMPER, POWER ON _ OFF Switch.
5. DAMPER, EMERGENCY Push Button Switch.
6. DAMPER, ENGAGE Push Button Switch.
7. Control Surface Response Indicator.
8. COMM. Radio Control Panel - ARC-34.
9. High Altitude Flood Light.
10. Console Flood Light.
11. RUDDER TRIM, LEFT-RIGHT Switch.
12. FIRE Extinguisher, SECOND SHOT Switch.
13. FIRE - Combined Warning Lights and Selector Switches. LH, HYD, RH.
14. NAV BAIL OUT Warning Switch.
15. L.P. FUEL COCKS Switches and Guards.
16. CROSS-FEED - LH ONLY - NORMAL - RH ONLY Switch.
17. ENGINE FUEL, EMERGENCY RESET Switches and Guards.
18. Parachute Brake, STREAM - JETTISON Selector Lever.
19. Throttle Levers, LH and RH.
20. Console Flood Light.
21. SPEED BRAKE, IN-OUT Switch.
22. ANTI-SKID, NORM - EMERGENCY OFF Switch.
23. LIGHTS-LAND-TAXI-OFF Switch.
24. CANOPY CLOSE-OFF-OPEN Switch.
25. ELEVATOR TRIM DISENGAGE Switch.
26. Landing Gear Control Lever UP - DOWN.
27. Landing Gear EMERGENCY EXTENSION Locking Latch Push Button.
28. Parking Brake Handle.
29. LANDING GEAR POSITION Indicator.
30. SKIN TEMP Indicator.
31. Mach/Airspeed Indicator.
32. CHECK LIST LANDING.
33. Accelerometer.
34. Sideslip Indicator.
35. Angle of Attack Indicator.
36. NAV BAIL OUT Indicator.

37. Red Master Warning Light.
38. Amber Master Warning Light.
39. Standby Magnetic Compass.
40. RADIO MAGNETIC INDICATOR.
41. FUEL QUANTITY Gauges.
42. CHECK LIST TAKE OFF.
43. Artificial Horizon Indicator.
44. GYRO ERECT Push Button.
45. EMERGENCY CANOPY OPENING Lever.
46. Engine PRESSURE RATIO Gauges. LH and RH.
47. EXHAUST TEMP Gauges. LH and RH.
48. CABIN PRESSURE ALTITUDE Gauge.
49. PRESS TO RESET Push Button.
50. DAY - NIGHT Switch.
51. PRESS TO TEST Switch.
52. ENGINE BLEED Air Conditioning Warning Lights.
53. ENGINE BLEED AIR LH OFF-NORMAL-RH OFF Switch.
54. Map Light.
55. OXYGEN Quantity Gauge.
56. Console Flood Lights (2).
57. RAM AIR TURBINE Switch.
58. NAV LIGHTS. FLASH-OFF-STEADY Switch.
59. ALTERNATORS RESET ON-OFF LH and RH Switches.
60. DC RESET Push Button.
61. Console light.
62. COCKPIT LIGHTING Panel.
63. HIGH ALTITUDE LIGHTING ON-OFF Switch.
64. MAIN PANEL OFF-BRIGHT Selector.
65. CONSOLE PANELS OFF-BRIGHT Selector.
66. CONSOLE FLOOD OFF-BRIGHT Selector.
67. AIR CONDITIONER Panel.
68. RAIN REPELLANT ON-OFF Switch. (TEMP CONTROL/EMERGENCY OFF First Aircraft).
69. CABIN PRESS-DUMP Switch.
70. AIR SUPPLY NORM-OFF-EMERGENCY Switch.
71. DE-FOG ON-OFF Switch.
72. TEMP COOL-WARM Selector.
73. Anto-g Valve Manual Override Button.
74. INTER Control Panel.
75. UHF/IFF EMERGENCY, PRESS TO TEST Button.
76. J4 COMP, AEROBATICS - NORMAL Switch.
77. UHF ANT, UPPER - LOWER Switch.
78. RMI NEEDLE, TACAN-UHF HOMER Switch.
79. RADIO COMPASS Panel.
80. J4 COMP - LAT Correction Controller.

81. J4 COMP - MAG/DG Selector Switch.
82. J4 COMP - DECR/INCR/SET Switch.
83. J4 COMP - Hemisphere Selector Switch.
84. J4 COMP - Synchronizing Indicator (Annunciator).
85. ENGINE START, START-OFF-RESET, LH and RH Switches.
86. MASTER ELEC. ON-OFF Switch.
87. Warning Lights Panel.
88. Rudder PEDAL ADJUST Handle.
89. RPM Indicators.
90. Altimeter.
91. Rudder Pedal Adjustment Label.
92. Turn and Slip Indicator.
93. Rate of Climb Indicator.
94. Automatic Mode Disengage Switch.
95. Elevator and Aileron Trim Button.
96. Emergency Damping Engage Switch.
97. Nose Wheel Steering Selector.
98. Press-to-Transmit Push Button.
99. Throttles Friction Damper.
100. Engine Relight Switches, LH and RH.



PILOT'S COCKPIT CONTROLS AND INSTRUMENTS

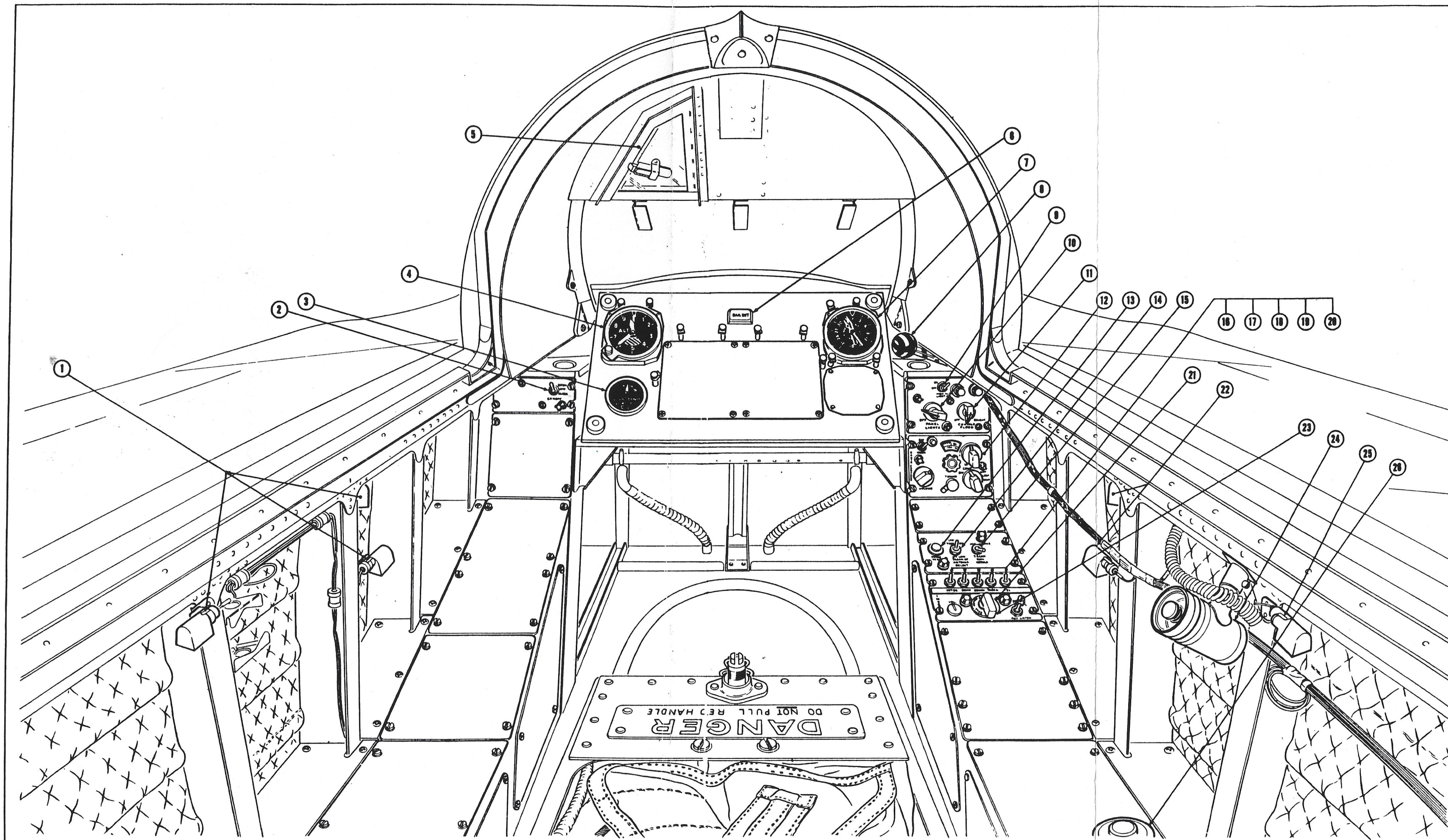
LEGEND

LOCATION OF REAR COCKPIT CONTROLS AND INSTRUMENTS.

ITEM AND DESCRIPTION

1. Console Flood Lights (3).
2. CANOPY OPEN - OFF CLOSE Switch.
3. OXYGEN Quantity Gauge.
4. Altimeter.
5. Access Panel to Navigator's Canopy Locking Handle From Front Cockpit.
6. Navigator's BAIL OUT Warning Light.
7. RADIO MAGNETIC INDICATOR.
8. EMERGENCY CANOPY OPENING Lever.
9. HIGH ALT LIGHTING, ON-OFF Switch (Non-operative).
10. PANEL LIGHTS Control.
11. CONSOLE FLOOD Lights, Control.
12. RADIO COMPASS Control Panel ARN-6.
13. PRESS TO TALK Switch.
14. IFF-TACAN Antenna Selector.
15. UHF HOMER-TACAN RMI NEEDLE Selector.
16. INTER, Interphone Mixing Switch.
17. COMP, Radio Compass Mixing Switch.
18. COMP, Command Receiver Mixing Switch.
19. TACAN Mixing Switch.
20. TEL, Telescramble Mixing Switch.
21. INTER Control Panel AIC-10.
22. Console Flood Lights.
23. CALL, INTER, COMM, TEL Selector.
24. Map and Emergency Light.
25. Console Flood Light.
26. Anti-g Suit Pressure Regulator.

NOTES



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OBSERVER'S/NAVIGATOR'S COCKPIT CONTROLS AND INSTRUMENTS

MAIN LANDING GEAR.

MAIN LANDING GEAR DESIGN.

In a paper written in February, 1958, by H. Ralph Stratford, Design Section Head of Dowty Equipment of Canada Limited, Mr Stratford wrote of the problems concerning the design of the Arrow undercarriage.

"A landing gear is regarded by an aircraft designer, as a necessary evil. Having accepted the necessity for such equipment, the designers of the Avro Arrow sought integration of the gear with the minimum disturbance of the more primary aspects of the aircraft design.

The longitudinal location of the main gear was the first point to be established. During the evolution of the retraction geometry, a request was made for a two inch aft displacement of the bogie assembly. But it was calculated by Avro that such a step would result in the minimum speed at which the nose gear could be lifted during the takeoff run being increased by something over 20 knots. Needless to say, the request was refused.

The length of the gear was next established. This had to be sufficient to ensure ground clearance of the jet pipes during the most tail down attitude in landing and take-off.

These factors alone precipitated the first major design problem. The gear was attached to the most forward point in the wing that structural considerations permitted. It was not possible to retract the gear forward and inboard from this position without the wheels trespassing on the space reserved for the air intakes unless a considerable shortening of the gear could be effected during retraction.

Retraction directly inboard would have resulted in a thicker wing section in which to stow the bogie assembly. The shortening problem would have been even greater and the encroachment on the basic wing structure totally unacceptable.

SCALE MODEL BUILT.

Considerable discussion preceded the decision to make a working half-scale model of the gear. To provide the design assistance which was its prime purpose, the model had to be completed before the schedule date for freezing the design proper. It was inevitable therefore, that considerable time wastage occurred due to changes during the building of the model. On reflection however, it is generally agreed that the decision and its timing were correct. The benefits derived justified the diversion of effort at that very busy period.

In addition to the stowage problems associated with the wing and gear relationship, new problems with respect to the considerable structural elasticity of this configuration arose. The magnitude of these was such as to render the standard stressing requirements for dynamic spin-up and spring back of a landing gear totally inadequate.

A detailed analysis had to be undertaken, primarily by Avro, to establish a rational design basis for this case. The order of the resulting dynamic loads is significant. It was found that the equivalent forward force, assumed to act at the bogie hinge at the cessation of wheel spin-up, was significantly greater than the maximum drag force acting during spin-up.

About this time, Avro made a basic decision that the forward and inboard retraction should be effected by retraction about an axis inclined to the fore-and-aft centre line and twisting of the bogie rather than a fore-and-aft retraction axis and a horizontal hinge line located immediately below it. A telescopic rather than a folding stay was dictated by the space available and the location of the airframe strong points. The next major design issue to be resolved was the location of such a stay.

Once it was established that retraction could be effected without fouling of the cross shaft, a strong case was made for a stay going almost directly aft from the gear design standpoint. However, such an arrangement had to be waived in the face of substantial airframe design difficulties. The resulting selection of an inboard located stay made the design of this unit a considerable problem in itself.

200,000 POUND LOAD.

A compressive load in the order of 200,000 lbs. had to be carried with the unit extended and a bearing overlap of less than 9% of the extended centre length. By evolving a lock for this unit which did not impair its column qualities, the need for a further lock in the main leg was also met.

Twisting and shortening of the leg during retraction did not provide a complete solution to the basic stowage problem. It was necessary to achieve a greater degree of shortening at the rear wheel, and this was accomplished by utilizing a tie member inherent in the suspension design to effect the necessary trimming.

In the early stages of the design of the Avro Vulcan gear at Cheltenham, a study had been made of the merits of utilizing the main shock absorber element of the gear to restrict bogie rotation during the time when only one set of wheels was in contact with the ground. In so doing, a useful contribution is made to the energy-absorbtion capacity during this interval.

As a result of this, two patents were lodged. One formed the basis of the suspension geometry of the Vulcan gear and the other that of the Arrow gear. In both cases, the single shock absorber is coupled to the mid-point of the bogie beam. To the extremity of the beam which mounts the wheels which are to touch the ground last, is an attached structure which freely collapses but will not further extend. In this manner, the effect of a levered suspension, using one set of wheels only, is achieved in the initial stage of the landing. The normal telescopic suspension takes effect after the second set of wheels has made contact with the ground. As they had previously, on both the Jetliner and the CF-100, Avro stipulated that the shock absorbing elements for both the main and nose landing gear should be of the liquid spring type. The straighter spring curve associated with this type of shock absorber was particularly important in the Arrow configuration. Here the rate of build-up of the landing reaction had an important influence on its dynamic magnification. Also by keeping the shock absorber a relatively short capsule, the task of shortening the gear during retraction, without endeavoring to close the shock absorber was considerably eased.

In selecting a single beam with cantilever axle in preference to a symmetrical twin beam structure, prime consideration was given to the ease of removal and replacement of the wheels and brakes. The question of space also arose and was a significant consideration in the selected arrangement.

A problem common to all types of pin-jointed suspensions is that of transmitting the braking torque back to the main structure without imparting pitching moments into the bogie assembly. The parallelogram configuration formed by the brake links, brake torque arms, bogie beam and lower end of the sliding member provides a complete solution in this gear.

NEW MATERIAL USED.

The strength/weight ratio of aluminum alloy and steel structure are fairly similar when other factors are not a major influence. But with the overall size of the members restricted by the available stowage space, the use of aluminum alloy was precluded in almost every major part. This same restriction tended to result in an undesirably heavy arrangement if the previously accepted maximum ultimate tensile strength for steel of 180 - 200,000 psi. was adopted. Avro recognized this problem. They decided to specify the relatively unexplored high tensile steel and "modern fabrication techniques" in their basic requirement for the gear. A paper given by Dowty's chief engineer, G.F.W. McCaffrey during the 1957 annual meeting of the Canadian Aeronautical Institute outlined the design significance of this material. Interesting metallurgical, manufacturing and testing aspects were revealed. Comment here can be confined to the note that a weight saving in the order of 112 lbs. per gear resulted from the adoption of this material. The customer's requirement for modern fabrication techniques led to an intensive study of the various welding processes employed throughout the American industry. While flash butt-welding had been extensively used with steels having an ultimate strength of 200,000 ps1. and below, very limited experience existed with the ultra high strength steel.

This led to a desire to use more conservative design assumptions in this strength range. Also, the practice of leaving the bore of the members "as welded" with no further machining was considered ill-advised. This precluded the welding of two members both having blind bores which in several applications was otherwise desirable. While gas pressure welding was considered a more attractive proposition in respect to the grain flow adjacent to the weld, here again the necessity to clean up the inner bore after the weld proved a restriction.

The advocates of the various welding techniques readily admitted that no weld is structurally as good as the continuous parent metal. Therefore renewed study, with eventual success, was given to the prospect of obtaining larger, more complex forgings in which no welding would be necessary. Even with the best available controlled atmosphere or neutral salt heat treatment baths, some practical decarburization of the material on the surface was inevitable. This had an adverse effect on the fatigue resistance of these surfaces, and so it will be recognized that further metal removal after heat treatment, should be practiced on as many surfaces as possible.

Since by far the most expensive machining is that after heat treatment and any welding must, of course, precede the heat treatment, the main economy arguments in favor of a welded-up structure appeared to lose weight.

PRODUCTION TOOLING.

To avoid delay at a later stage, Avro requested that the initial quantity of gears be manufactured using production tools and techniques, and to this end, it was decided to utilize closed die forgings for all of the major members from the outset.

The nature of the retraction geometry and the importance of the dynamic behavior of the elastic structure led to particular emphasis being applied to the various structural joints to make them as rigid as possible. In general, this was achieved by extremely close fits used on all pinned joints. As far as possible, threaded joints were omitted to avoid notches of any type in the material. These could not be completely eliminated however, and to give reasonable assurance of their acceptability, a special test program was undertaken.

The following brief selection of the design features will serve to illustrate the nature of the problems encountered. An early one was that of achieving 8.5 inches shortening of the leg during retraction. Another was the choice of an airframe attachment point, and the final envelope of the mechanism which were severely restricted by the shallow depth of the wing in this area.

Being aware of the considerable complexity of the initial solution to this problem, the opportunity to substitute a later conceived linkage arrangement on the Arrow 2 was welcomed by all parties. A feature of this linkage which is not immediately apparent, is the shape of the curve obtained when the shortening achieved is plotted against the retraction angle. The curve is almost sinusoidal with the benefit of low acceleration forces and a minimum of over travel resulting from the effect of wing deflection after the gear is stowed which approximates to 2.5 degrees of further retraction.

The wing deflection under "g" loads also considerably complicated the clearance studies of the stowed gear and in fact, in the extreme case, the gear was lifted clear of the up-lock by the lower fairing door.

Deflection of the gear under ground loads also posed peculiar problems. Perhaps the best illustration of these is the fact that the shortening mechanism housed in the upper portion of the main outer fitting (which at that point, is approximately 6.5 inches diameter and 0.3 inches thick) had to embody a universal joint at approximately its mid-length to ensure that no damage to the mechanism resulted from its bending in sympathy with the main fitting.

Many illustrations could be given of the impact of the space restrictions on detail design. The following is typical. The problem was that of finding a suitable strong point around the lower portion of the gear for the attachment of a towing bridle so that it could radiate throughout the required angle without fouling the gear. The final solution was the insertion of a towing eye inside the main bogie hinge pin, with spring loading to ensure that whenever the towing shackle was disconnected it would be retracted into the pin and so was clear of the upper wing surface when the gear was retracted.

The bogie assembly had to be twisted through some 40 degrees during retraction. It was necessary therefore, to embody within the torque carrying members, a device free from backlash which would automatically disengage and engage respectively on commencement of the retraction and completion of the extension. A search for an extremely precise, vertical-toothed dog clutch led eventually to the "Curvic Coupling" pioneered in North America by the Gleason Company of Rochester. While the manufacturing techniques used in these couplings ensured a high order of concentricity and freedom from backlash, there was not, at that time, any knowledge of a comparable application and a searching test program became necessary.

Changes of ambient temperature detract from the energy absorbing performance of a liquid spring in a rather different manner than from an oleo-pneumatic shock absorber. While in the latter, the effect is one of variations in the load to cause initial closure and the slope of the curve spring, a liquid spring may find itself entirely dependent on dashpot for energy absorption during the initial axle travel.

While this was generally quite acceptable in most landing conditions, a by-product of this phenomenon is the lack of an internal force to effect final extension after takeoff. To ensure full extension of the gear within four seconds of the aircraft becoming airborne under all climatic conditions, and automatic compensator was mounted on, and utilized the internal volume of, the front brake link. The compensator was coupled to the liquid spring through rigid swivelling pipes and a special valve.

Rigid swivelling pipes also formed the basis for hydraulic feed to the brakes. In addition to the temperature difficulties associated with flexible hose, flexure in an undesirable direction would require so much control as to make rigid pipes the natural choice. With the manufacture of the gear well advanced before the piping requirements were known, the routing of the pipe runs was particularly tricky but the back of the problem was broken when Avro found a solution for bridging the area between the fixed upper end and the shortening and twisting lower end of the gear. This solution comprised very small rigid dog-leg swivels coupling directly to the lower unsupported lower end of the telescopic assemblies".

GENERAL.

1. Each main landing gear is equipped with a liquid spring shock absorber and two wheels, arranged in tandem, mounted on a bogie beam. The wheels have hydraulic disc type brakes which are applied automatically during retraction of the gear.

2. The landing gear is retracted hydraulically into a bay in the inner wing and when retracted is enclosed by a leg fairing, a pivot door and a wheel door. Extension of the gear is by gravity assisted by air loads when in flight.

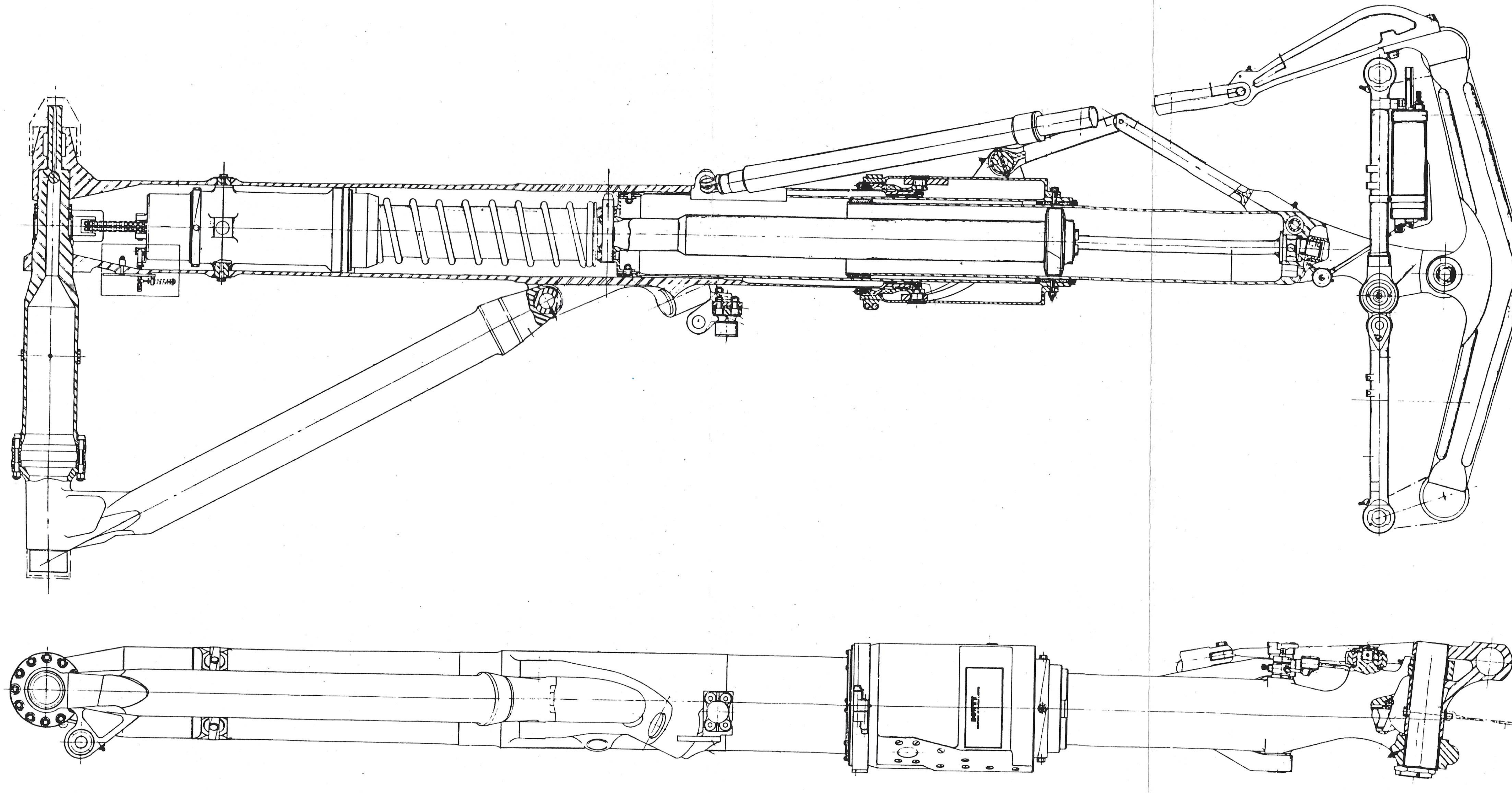
3. The gear retracts forwards at an angle of approximately 45 degrees to the aircraft centre line. This is achieved by setting the main pivot shaft at the appropriate angle. To bring the wheels into the same plane as the wheel bay, the lower portion of the main leg is rotated through an angle of 37 1/2 degrees during retraction. To accommodate the wheels in the wheel bay they must be tilted rearwards during retraction. This is accomplished by shortening the leg, and pivoting the bogie beam from a tie-rod attached to the front of the leg. The shortening mechanism is arranged so that the liquid spring is unaffected by the shortening action.

4. The leg is braced fore and aft by a back-stay, and laterally by a telescopic side stay which also contains the down lock, which is locked mechanically and unlocked hydraulically.

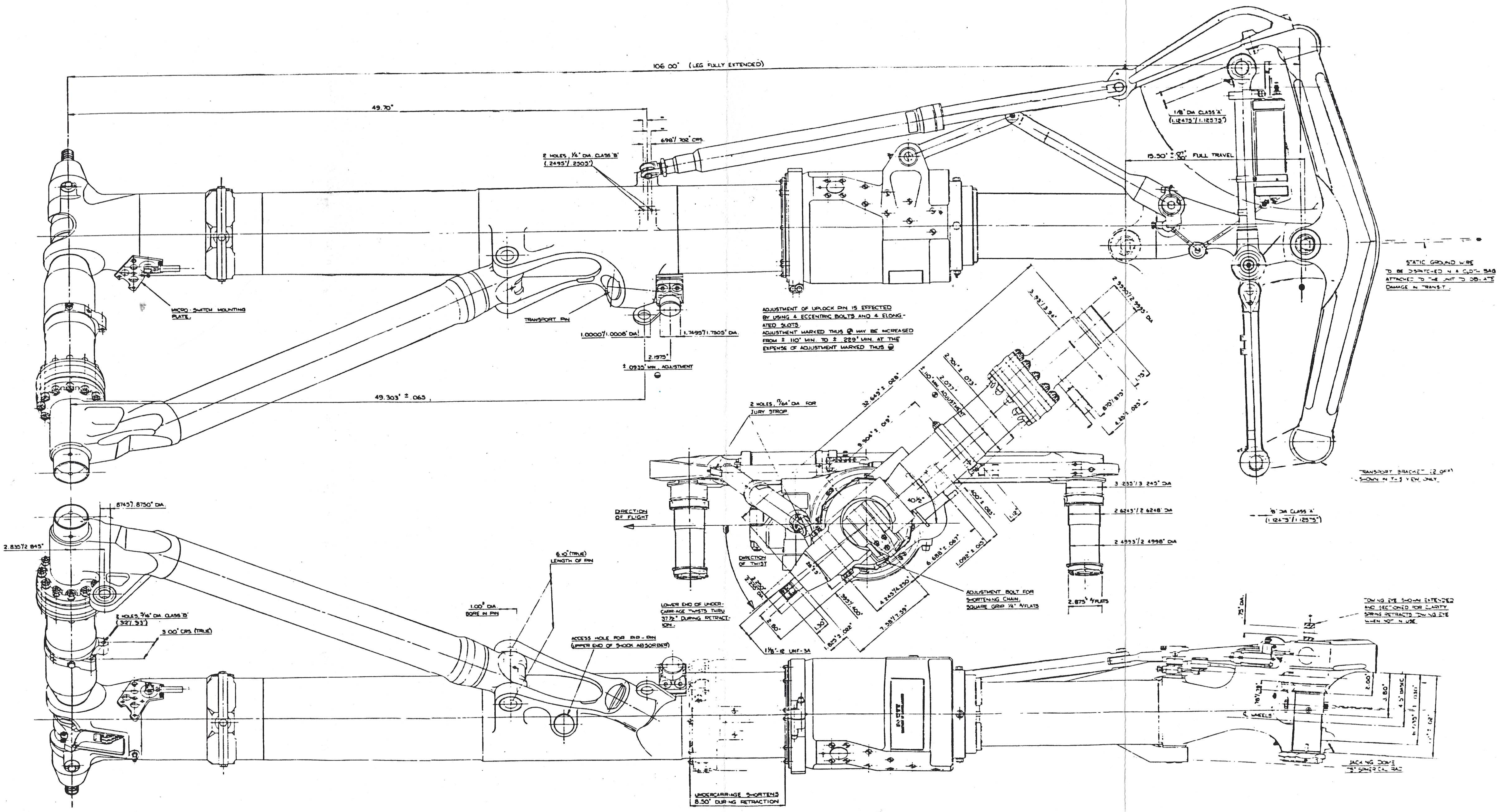
5. The up-lock is fitted in the wheel bay. It engages mechanically with a roller on the leg and is unlocked hydraulically.

MAIN LANDING GEAR.

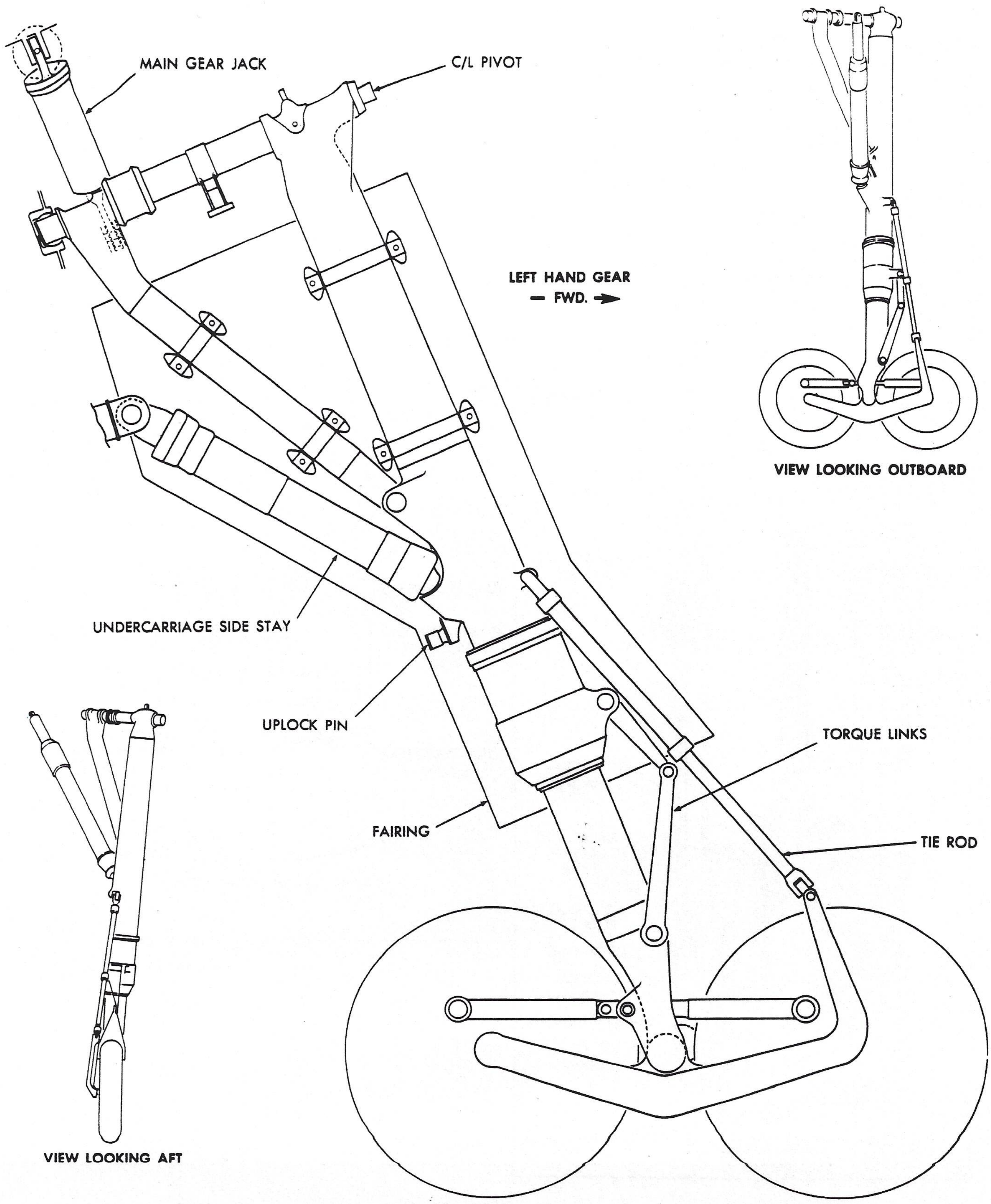
6. The main leg incorporates a shortening mechanism, a torque fitting and a sliding member which houses the shock absorber. At the lower part of the leg are located a pair of torque links, a bogie beam with two integral wheel axles and a telescopic tie-rod. Between the sliding member and the wheel brake assemblies are located two



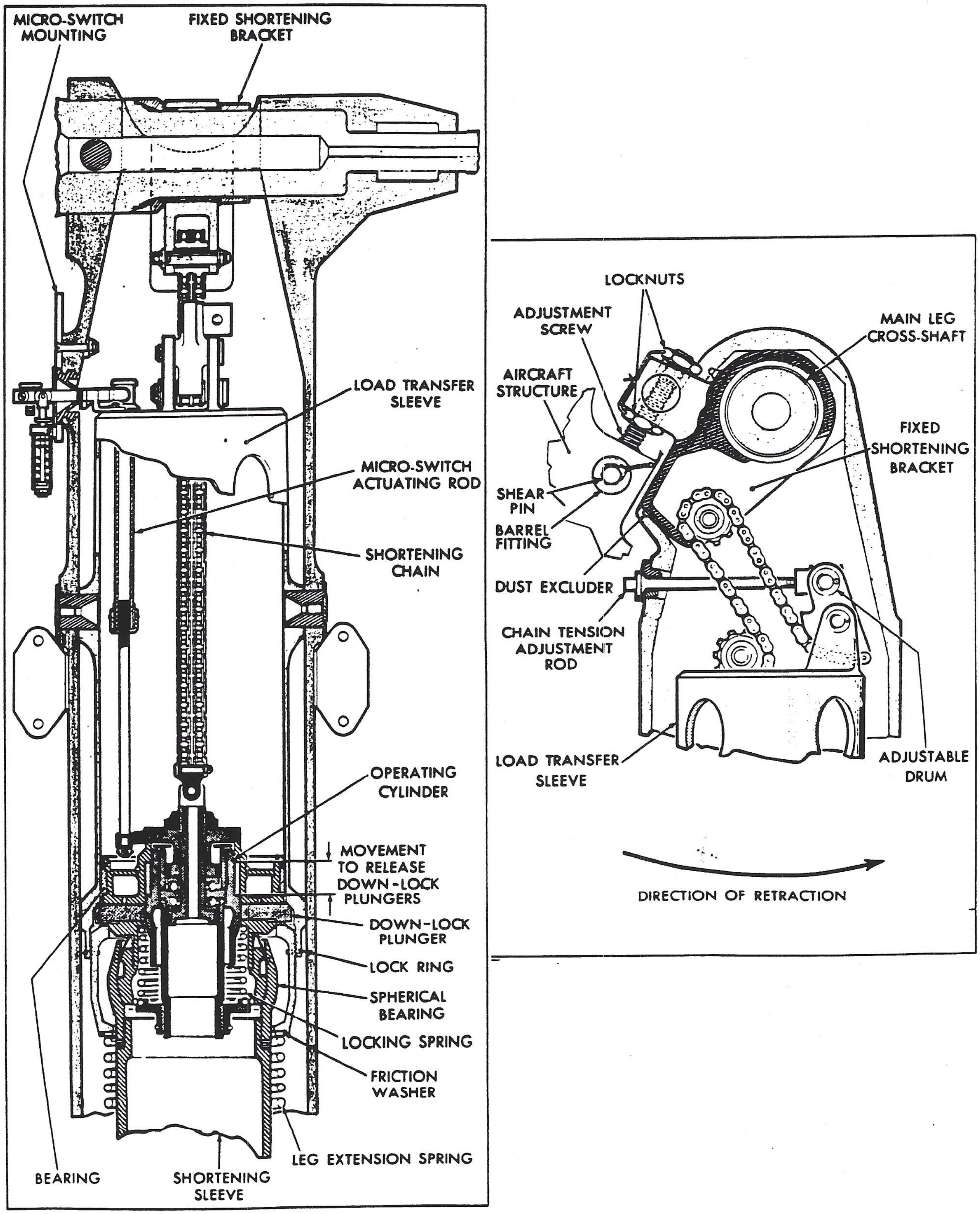
ARROW Mk1 SECTIONED UNDERCARRIAGE. FROM DOWTY DRG No XV 1283-1 A/B



ARROW Mk1 UNDERCARRIAGE. FROM DOWTY DRG No XV 1283 A/B



VIEWS OF THE MAIN LANDING GEAR - DEPLOYED AND RETRACTED



SECTIONS SHOWING CHAIN RETRACTION MECHANISM brake torque links, one of which mounts a recuperator for the shock absorber. This recuperator is rendered inoperative on Arrow Mk1 aircraft.

CROSS SHAFT AND BACK STAY.

7. The cross shaft assembly on which the main leg is mounted, is located between the main spar and the front spar of the inner wing. The cross shaft is in two sections. A spacer is fitted between the flanged inner face of each section to facilitate removal of the main leg from the aircraft. An integral lug on the spacer is the attachment point for the retraction jack rod. (This is an interim measure that was employed after the failure of the lug that was originally on the back stay). The rear section of the cross shaft is integral with the back stay and incorporates a journal locating in a self-aligning rear bearing housed in a fitting attached to the main spar.

8. The main casing of the leg is mounted on the front half of the cross shaft and is secured by a shear pin. The top of the main casing is tapered at its forward end and locates in a self-aligning bearing housed in a fitting attached to the front spar. The cross shaft is retained in this bearing by a thrust collar which fits against the tapered face of the bearing and is secured by a washer and thrust nut. Protruding from the end of the shaft is a locking stud retained by a roll-pin. A lock washer and nut fitted on this stud locks the thrust nut.

9. The back stay, which is integral with the rear section of the cross shaft, is fitted to brace the main leg fore-and-aft. The lower end of the stay is attached to two lugs on the main casing.

MAIN CASING - EXTERNAL.

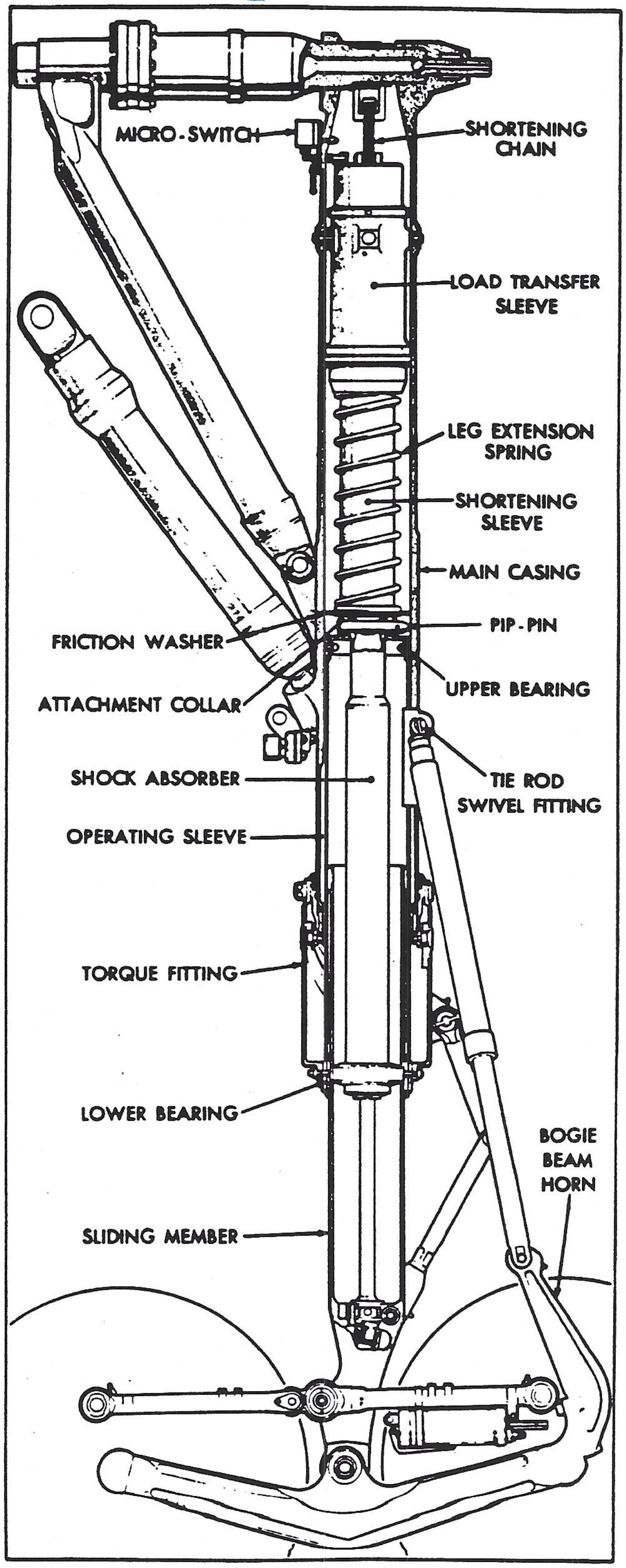
10. The main casing provides the lower attachment points for the back stay and the side stay, and the upper attachment point for the tie-rod. The back stay is attached to the main casing by a pin passing through two lugs on the casing. The lower end of the telescopic side stay is retained in an integral lug on the main casing. The lug also locates a fitting which carries the up-lock roller assembly.

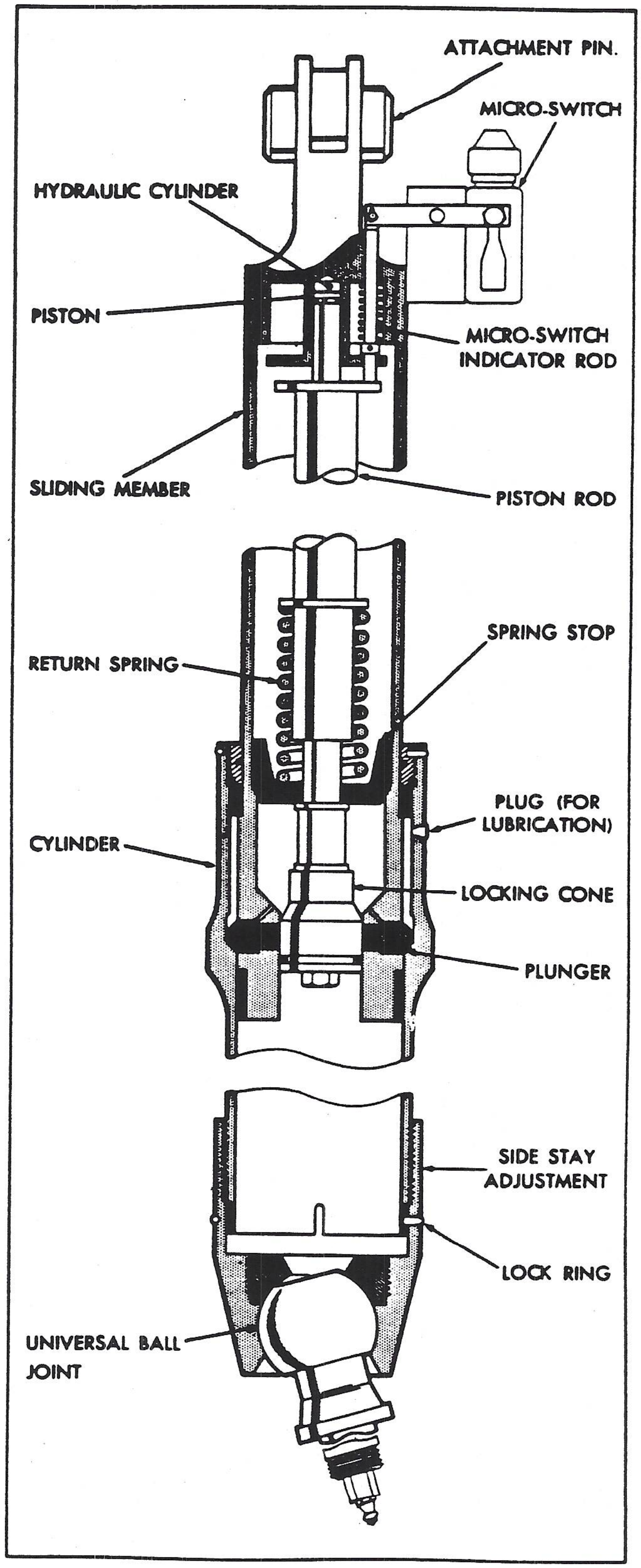
UP-LOCK ROLLER ASSEMBLY.

11. The fitting securing the lower end of the side stay incorporates an integral lug which carries a spring housing for the leg fairing and also provides a vertically serrated back plate for the up-lock roller assembly. The roller assembly is attached to a horizontally serrated plate which is secured by four eccentric screws. A plate with horizontal and vertical serrations is fitted between the back plate and the roller assembly. The serrations together with the eccentric screws, provide a two-way adjustment for the roller.

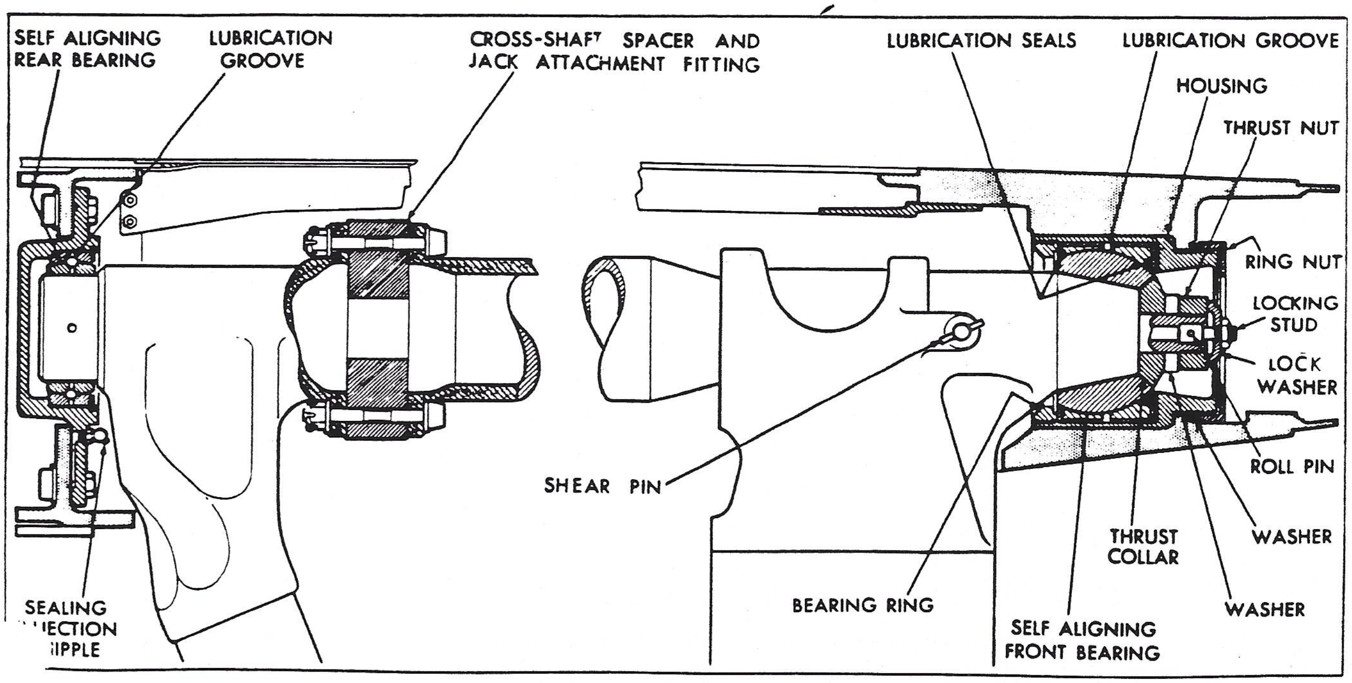
MAIN CASING - INTERNAL.

12. Housed within the upper section of the leg is a shortening mechanism which withdraws the shock absorber together with the lower leg into the main casing during

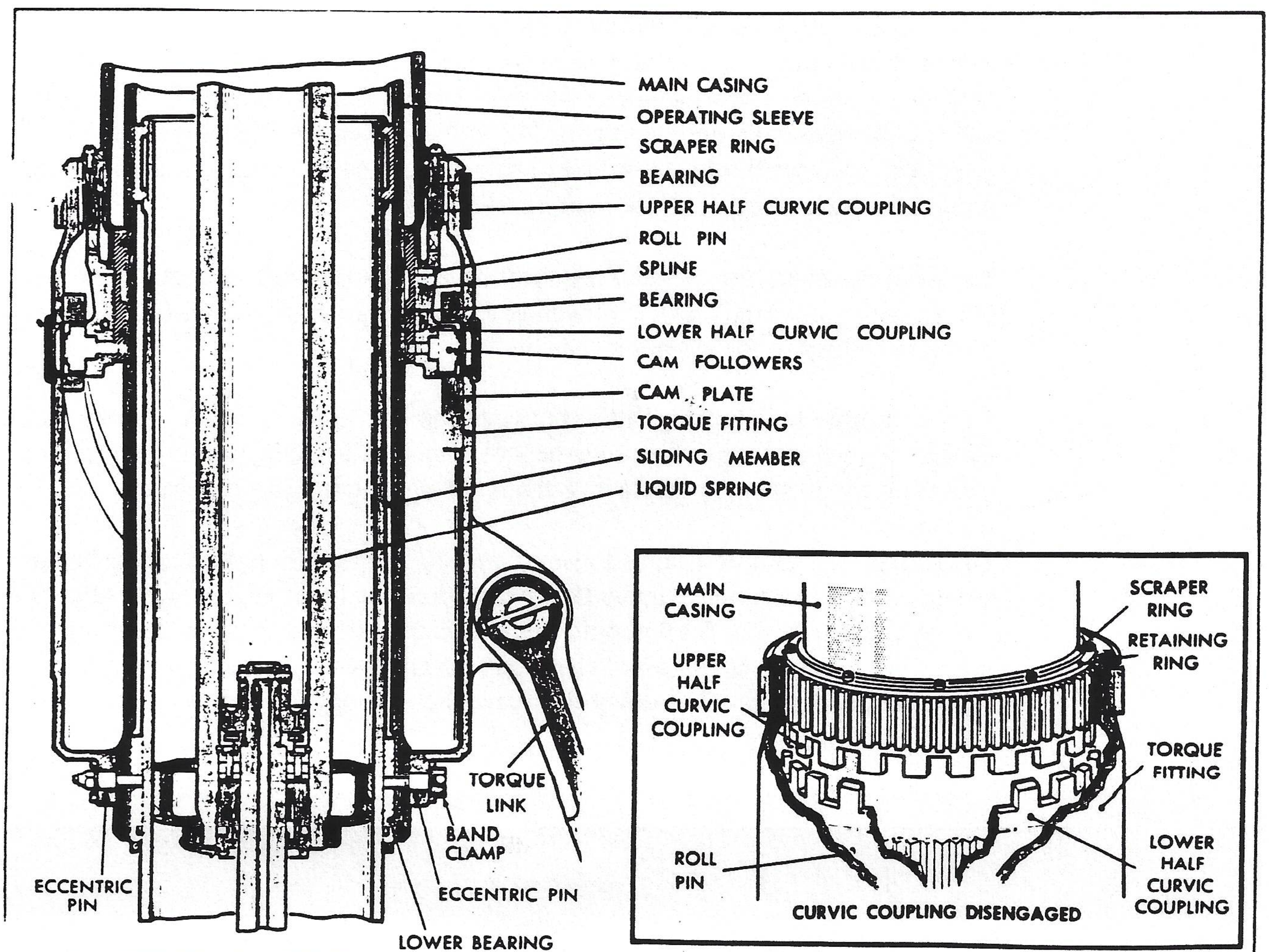




SECTIONS THROUGH COMPLETE LEG AND SIDE STAY



SECTIONS THROUGH CROSS SHAFT AND CURVIC COUPLING



landing gear retraction. The shortening mechanism comprises a chain and sprocket assembly, a down lock mechanism and a shortening sleeve.

CHAIN AND SPROCKET ASSEMBLY.

13. The chain and sprocket assembly consists of a double chain with one end attached to an adjustable drum mounted on top of a load transfer sleeve, and the other end to an operating cylinder in the down-lock mechanism. The drum is anchored to the main casing by a chain tension adjustment rod. The double chain passes around two sprockets attached to a fixed shortening bracket mounted on the front half of the cross shaft, and also passes around a double sprocket attached to the top of the load transfer sleeve. The geometric arrangement of the chain and sprockets is such that, the chain pulls up the operating cylinder.

14. The fixed shortening bracket is attached to the aircraft structure by an adjustment screw which passes through a barrel fitting and is retained in the fitting by a shear pin. Two locknuts secure the screw to the shortening bracket. Adjustment of the locknuts re-positions the shortening bracket in relation to the structure and provides the adjustment for varying the amount of leg shortening. The chain tension adjustment is provided to remove any slack in the chain when the down lock is fully engaged.

SHORTENING MECHANISM DOWN LOCK.

15. The shortening mechanism down-lock engages to lock the leg in the fully extended position. The down-lock consists of an operating cylinder, a locking spring and a set of eight down-lock plungers. When the leg retracts, the operating cylinder is pulled upwards by the shortening chain to release the plungers from a recess around the lower section of the load transfer sleeve.

16. After the operating cylinder has moved upwards one inch, it contacts the body of the down-lock and further movement of the shortening chain is transmitted through the lock to the shortening sleeve.

17. A double ball bearing fitted between the operating cylinder and the chain attachment prevents the rotary movement of the lower leg being transmitted from the operating cylinder to the shortening chain during landing gear retraction.

18. When the landing gear is lowered and the leg is fully extended, the locking spring pulls the operating cylinder downwards to force the plungers outward to lock the leg in this position. A telescopic rod attached to the operating cylinder moves a pivot lever to actuate a micro-switch mounted on the main casing. This micro-switch in conjunction with other down-lock switches supplies electrical power to the cockpit indicators.

SHORTENING SLEEVE.

19. The shortening sleeve is connected to the down-lock by a spherical bearing. This bearing provides the inner section of the leg with a flexible joint which absorbs any movement from within the main casing during landing. A pip-pin connects the lower part of the shortening sleeve to an attachment collar and to the top of the shock absorber cylinder.

20. Shortening movement is transmitted from the chain through the down-lock and shortening sleeve to the top of the shock absorber cylinder. As the shortening loads are applied to the shock absorber cylinder, it is withdrawn into the main casing without compressing the shock absorber piston rod.

21. A leg extension spring is fitted around the outside of the shortening sleeve and extends the leg as the landing gear is lowered. The spring is located between two friction washers, one being fitted at the bottom of the load transfer sleeve and the other supported by a flange at the base of the shortening sleeve.

OPERATING SLEEVE.

22. The operating sleeve serves to transmit the shortening movement from the attachment collar to a torque fitting located on the lower part of the main casing. The upper part of the sleeve, which carries the upper bearing, is bolted to the attachment collar. The lower end, which carries the lower bearing, is attached to the torque fitting by four eccentric pins. The four pins protrude through the sleeve and retain the lower bearing.

23. The torque fitting is located at the base of the main casing with its lower end attached to the bottom of the operating sleeve. A bearing located on the upper end of the fitting slides over the finished surface of the main casing when the gear is retracted.

24. The torque fitting converts the shortening movement of the leg into a rotary motion and transmits this through the torque links to the lower leg. Secured to the inner surface of the torque fitting are two sets of helical cam tracks. Two cam followers are located between the cam tracks. The followers rotate on needle rollers and are secured to the main casing. During leg retraction the torque fitting is pulled upwards and the cam tracks impart the rotary motion to the torque fitting. The contour of the cam tracks is such that the first movement of the torque fitting is straight upwards and allows a castellated curvic coupling to disengage.

25. The curvic coupling is engaged during the final movement of the leg extension and prevents the torque fitting from rotating when the gear is fully extended. The curvic coupling consists of an upper half and a lower half. The upper half is splined to the torque fitting and is retained by pins and a band clamp. This half forms the upper section of the torque fitting which, together with the upper bearing, slides over

the lower surface of the main casing. A scraper ring is attached to the upper end of the coupling to remove any accumulation of foreign matter from the sliding surface. The lower half is splined to the base of the main casing and is located by roll pins.

26. The four eccentric pins which locate the torque fitting to the operating sleeve also provide the means of positioning the torque fitting alignment with the cam roller. A locking pad is fitted over each pin and these are secured by a band clamp around the base of the torque fitting.

SLIDING MEMBER.

27. The sliding member carries the lower part of the main leg assembly. The upper part of the member slides within the bore of the operating sleeve where it is located by a bearing and retained by the shock absorber. The bottom of the member is forked to accommodate a pivot pin which carries the bogie beam. An integral lug on the lower part of the member forms the main attachment point for two brake torque links. A ball type jacking point for jacking the main wheels is located on the bottom of the member.

SHOCK ABSORBER.

28. The liquid spring type shock absorber is housed within the sliding member and the operating sleeve. The cylinder of the shock absorber is connected to the shortening sleeve by a pip-pin and the piston rod end is attached to the bottom of the sliding member by a special retaining nut. The nut is locked by a tubular locking socket located between the fork of the sliding member.

TORQUE LINKS

29. The torque links are fitted to prevent rotation of the lower leg during taxying and landing and to transmit the rotary motion of the torque fitting to the lower part of the leg during landing gear retraction.

30. The upper link is attached to the two lugs on the lower part of the torque fitting and is connected to the lower link by a bolt, nut and a distance washer. The lower torque link fork end is attached to the sliding member by a hinge pin. The inboard fork of the lower torque link mounts a cam which actuates a recuperator valve housed in the sliding member. (Not fitted on Arrow Mk1).

BOGIE BEAM.

31. The bogie beam pivots between the fork at the bottom of the sliding member. The pivot pin is secured to the beam by a bolt passing through the centre of the beam and is supported in two plain bearings, one in each arm of the fork. An earthing wire is attached to the lower end of the retaining bolt. Housed within the hollow pivot pin is a retractable towing eye which is spring loaded to the housed position.

32. An integral axle at each end of the beam carries the tandem wheels. A bogie

beam horn attached to the front of the beam provides the attachment point for the lower end of a telescopic tie-rod.

TIE-ROD.

33. The telescopic tie-rod is fitted between a swivel fitting, attached to a lug on the main casing, and a bogie beam horn. The tie-rod is spring loaded to the extended position and tilts the bogie beam forward when the landing gear is retracting. This locates the wheels in the correct position for stowage in the wheel bay. The spring loaded tie-rod also dampens oscillation of the bogie beam when the aircraft lands.

LEG SHORTENING AND ROTATION

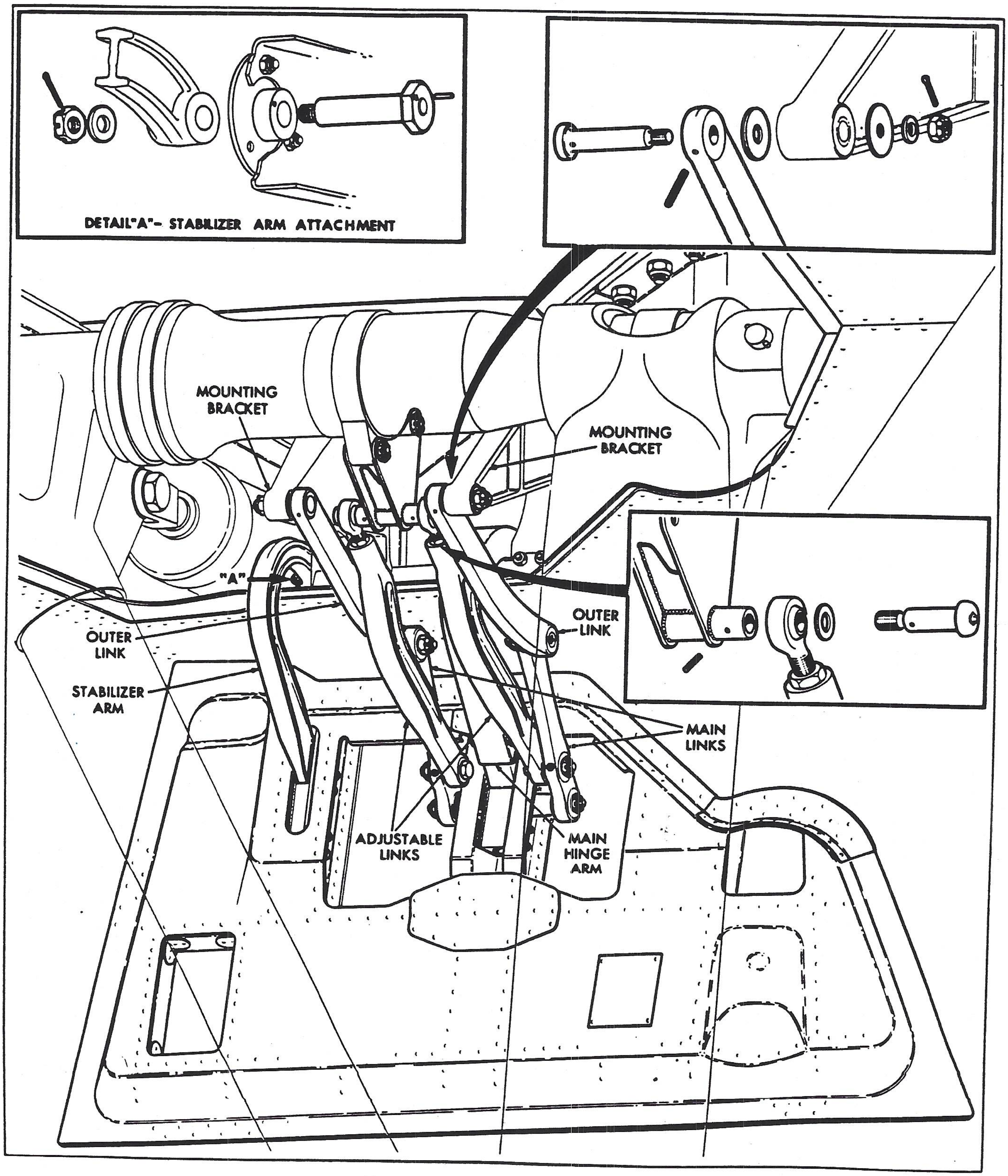
34. When the landing gear retracts, the distance between the sprocket on the fixed shortening bracket and the chain attachment point increases. This action pulls the free end of the chain attached to the operating cylinder, in an upwards direction. The operating cylinder is lifted, compressing the locking spring. When the lower and smaller end of the cylinder aligns itself with the down-lock plungers, the plungers are forced inwards by the action of the tapered face and the down-lock is released. After the operating cylinder has lifted approximately one inch, the plungers are fully released and the cylinder contacts the down-lock body. The chain movement is now transmitted through the down-lock to the shortening sleeve.

35. Further retraction of the leg now pulls the shortening sleeve upwards and compresses the leg extension spring. The shock absorber and operating sleeve, which are secured to the shortening sleeve, are pulled into the main casing and the leg is shortened progressively as the leg retracts. The sliding member and shock absorber which remain fully extended throughout the operation are lifted upwards with the operating sleeve. The spring loaded telescopic tie-rod, which is secured to the main casing, tilts the bogie beam forward as the sliding member, shock absorber and operating sleeve are pulled into the main casing.

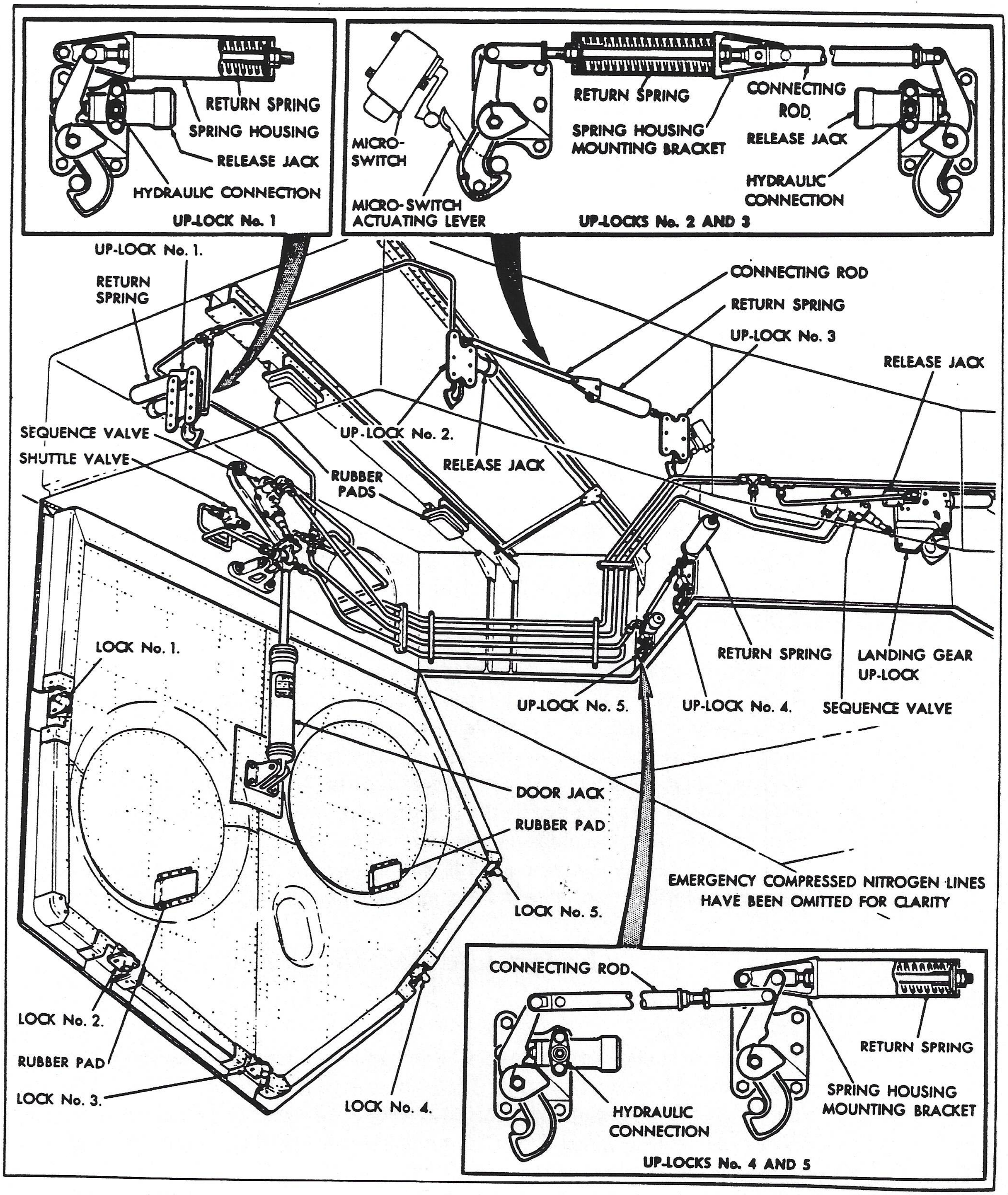
36. Simultaneously with leg shortening, the movement of the operating sleeve is transmitted to the torque fitting. The initial movement of the operating sleeve lifts the torque fitting upwards and disengages the castellated teeth of the curvic coupling. Further movement of the operating sleeve causes the stationary cam-followers to impart a rotary motion to the cam-tracks and the torque fitting. This motion is transmitted through the torque links to the sliding member and the bogie beam.

37. With the main leg shortened and partially rotated, and with the main wheels tilted by the tie-rod, the main leg and wheels are correctly positioned for stowage into the wheel bay.

38. Leg extension together with rotation of the lower leg occurs as the landing gear is lowered. Lowering the leg progressively releases the tension on the leg extension spring, and the operating sleeve is forced out of the main casing. The downward



PIVOT DOOR MECHANISM



MAIN UNDERCARRIAGE DOOR

movement of the torque fitting rotates the lower leg until the wheels are aligned with the centre line of the aircraft. The final movement of the torque fitting engages the castellated teeth of the curvic coupling and locks the leg against rotation. When the leg is fully extended, the final movement of the shortening chain permits the down-lock locking spring to extend and the operating cylinder is pulled upwards. The down-lock plungers are forced outward and the leg is locked in the fully extended position. The final movement of the operating cylinder actuates a micro-switch which supplies electrical power to the cockpit indication.

SIDE STAY.

39. The telescopic side stay if fitted between the main spar of the inner wing and the main casing to brace the main leg against side loads. The side stay also provides the down-lock for the main leg by an internal locking mechanism which is locked mechanically and unlocked hydraulically.

40. The unit consists of a cylinder and a sliding member incorporating a spring-loaded piston rod and a plunger assembly. The lower end fitting of the cylinder houses a ball joint which is retained in the lug on the main casing. The upper end of the sliding member is secured by an attachment pin locating in a swivel bearing, housed in a fitting attached to the main spar. The two sections are coupled at their inner ends by a bearing and a retaining nut recessed into the inner end of the cylinder.

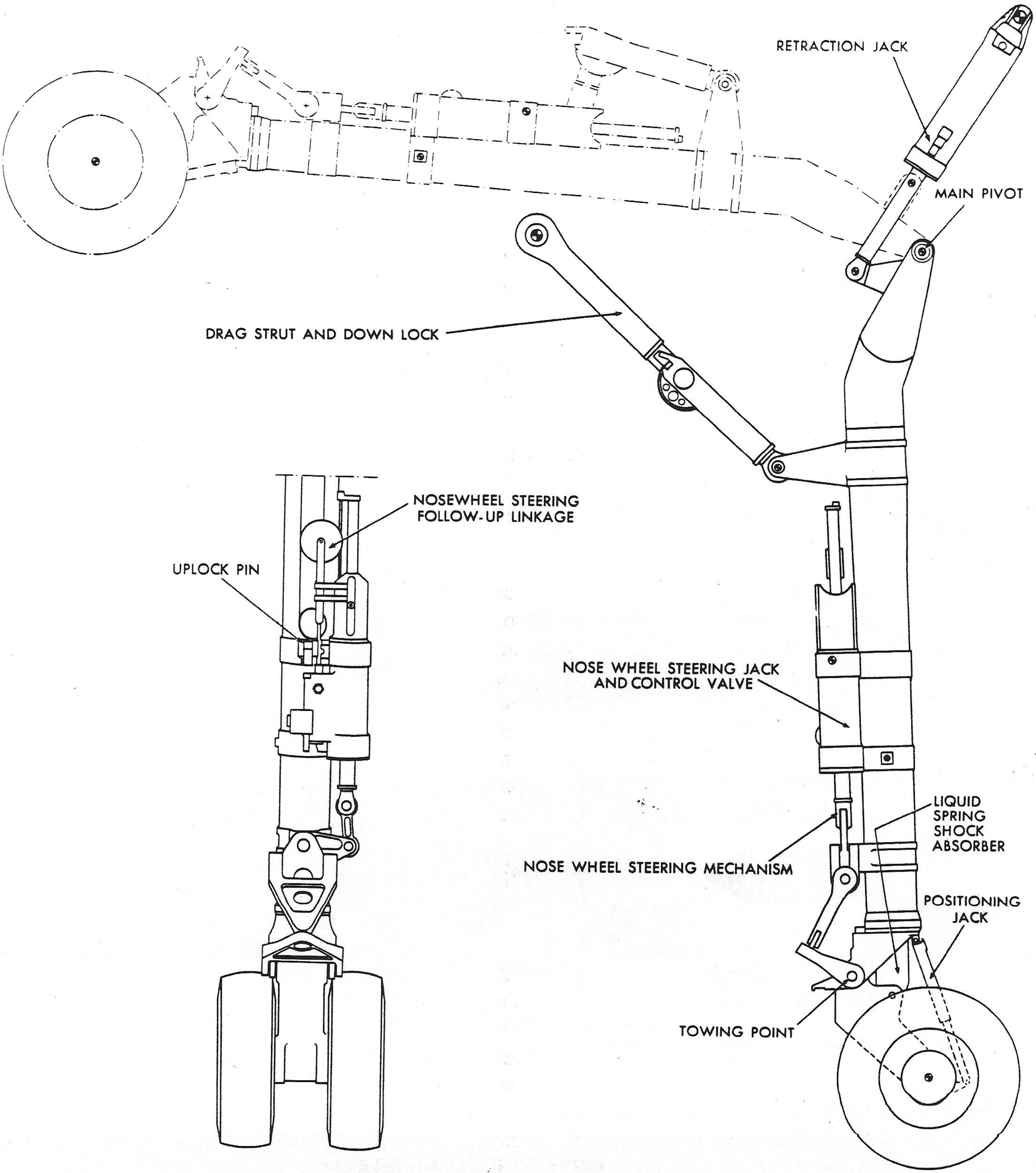
41. When the landing gear is selected up, hydraulic pressure is supplied to the end of the piston rod. This moves the locking cone downward, disengages the plungers and unlocks the side stay. As the landing gear retracts, the cylinder and the sliding member telescope until the landing gear engages its up-lock in the wheel bay. When the landing gear is selected down, the return spring remains compressed due to the locking cone being retained by the plungers. As the landing gear extends, the side stay extends until the plungers reach the recess in the inner end of the cylinder. When this occurs the return spring lifts the locking cone and the plungers are forced outward to lock the side stay and the main landing gear in the down position.

NOSE LANDING GEAR.

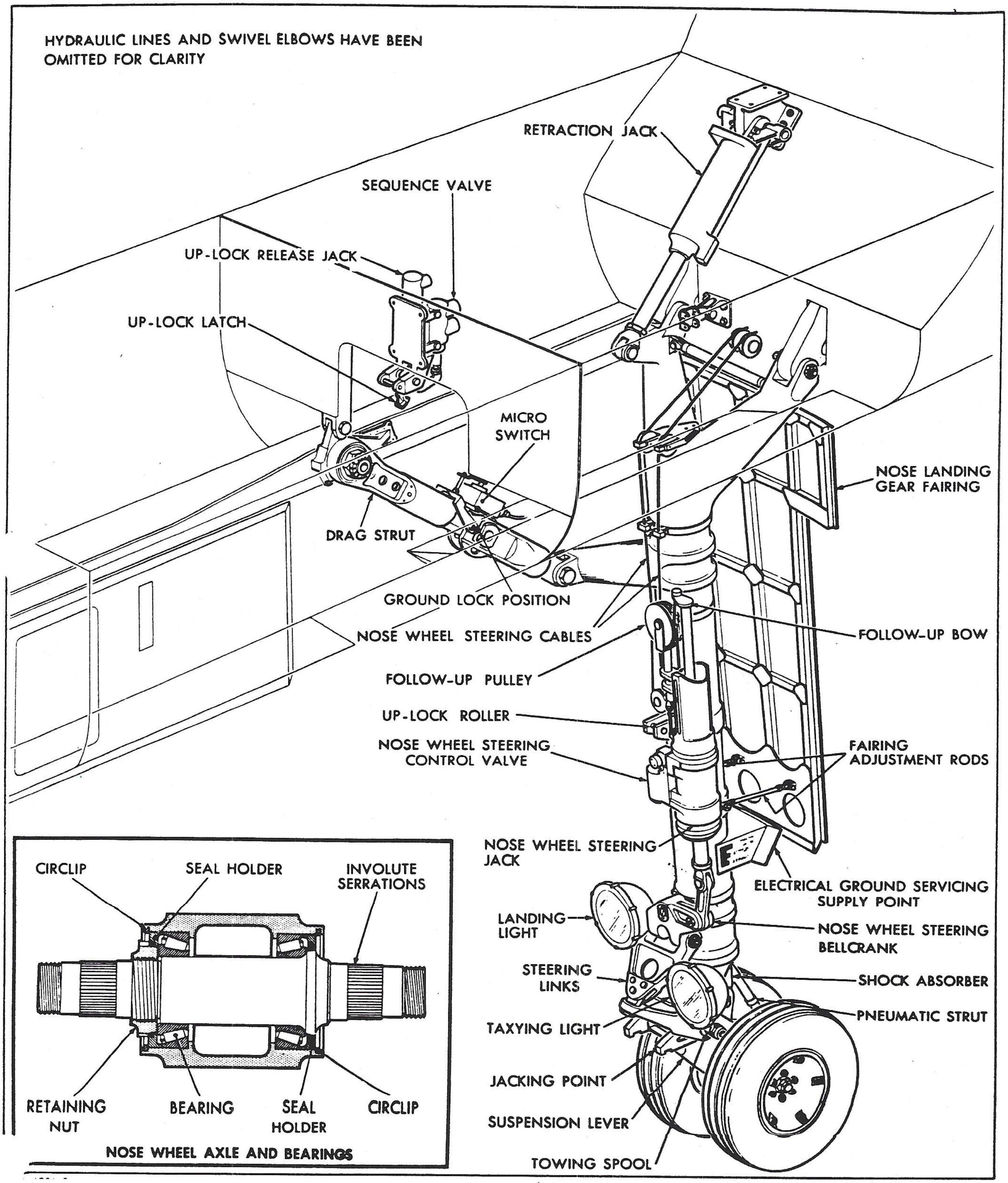
GENERAL.

1. The nose landing gear is a twin wheeled unit incorporating a liquid spring shock absorber and hydraulic steering. The landing gear retracts forwards and upwards, under hydraulic pressure, into the nose wheel bay where it is faired by a nose leg fairing and a nose wheel door. The assembly is lowered by gravity after the nose wheel door is opened and the up-lock is released by hydraulic pressure.

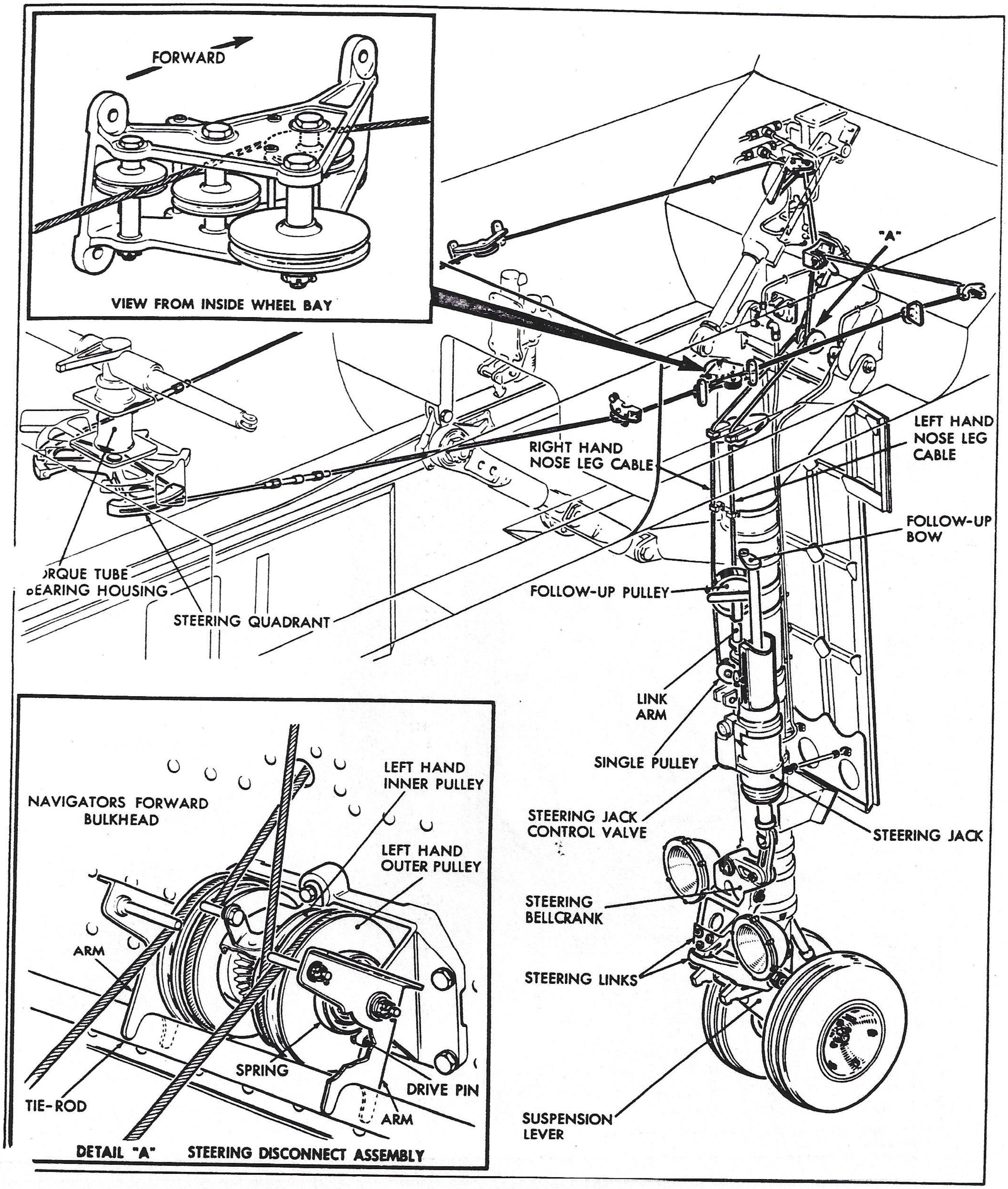
2. Hydraulic steering is obtained by a control valve and a steering jack mounted on the nose wheel leg main casing. The jack also makes provision for nose wheel



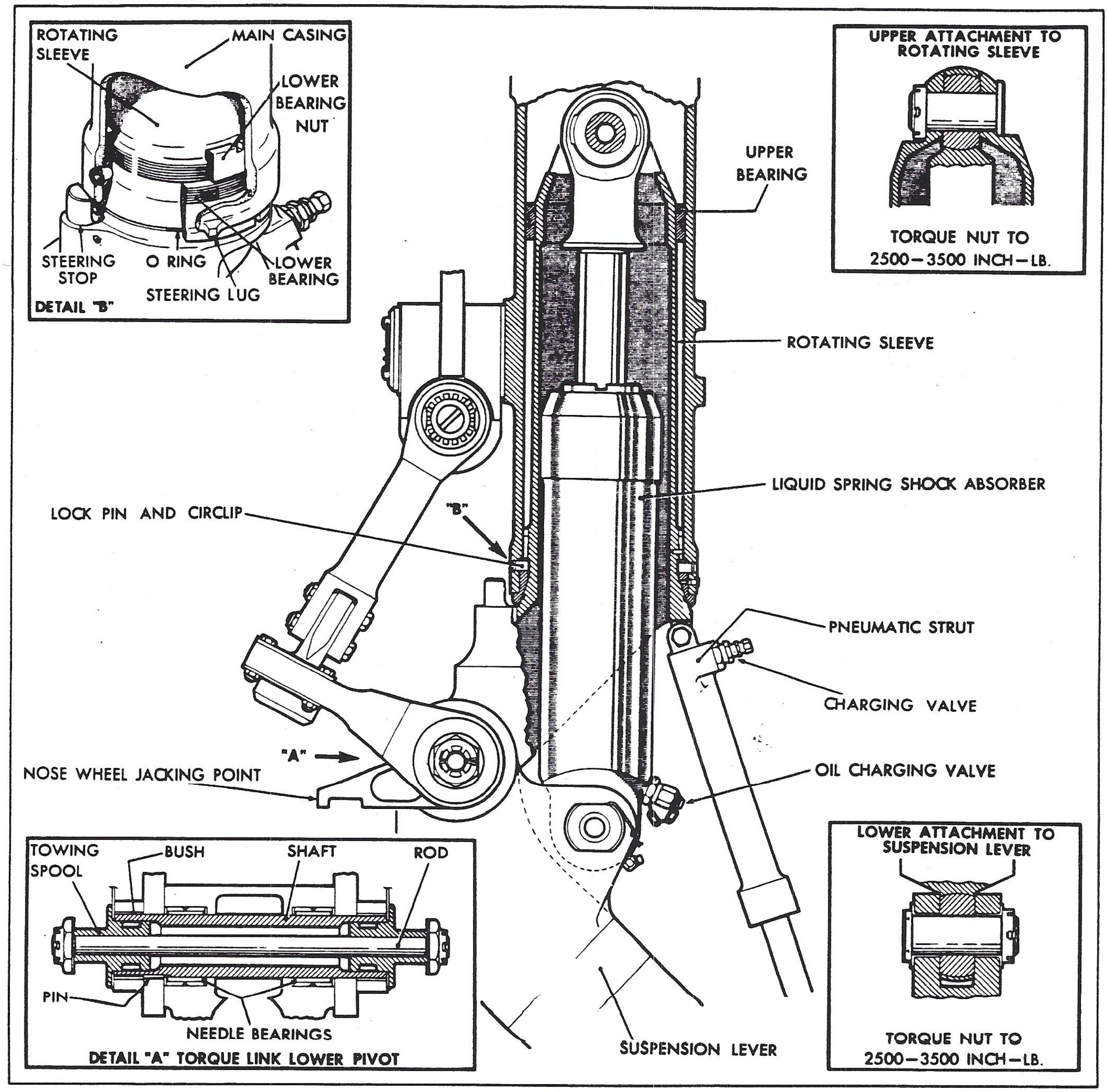
NOSE WHEEL IN RETRACTED AND DEPLOYED POSITIONS



NOSE WHEEL ASSEMBLY

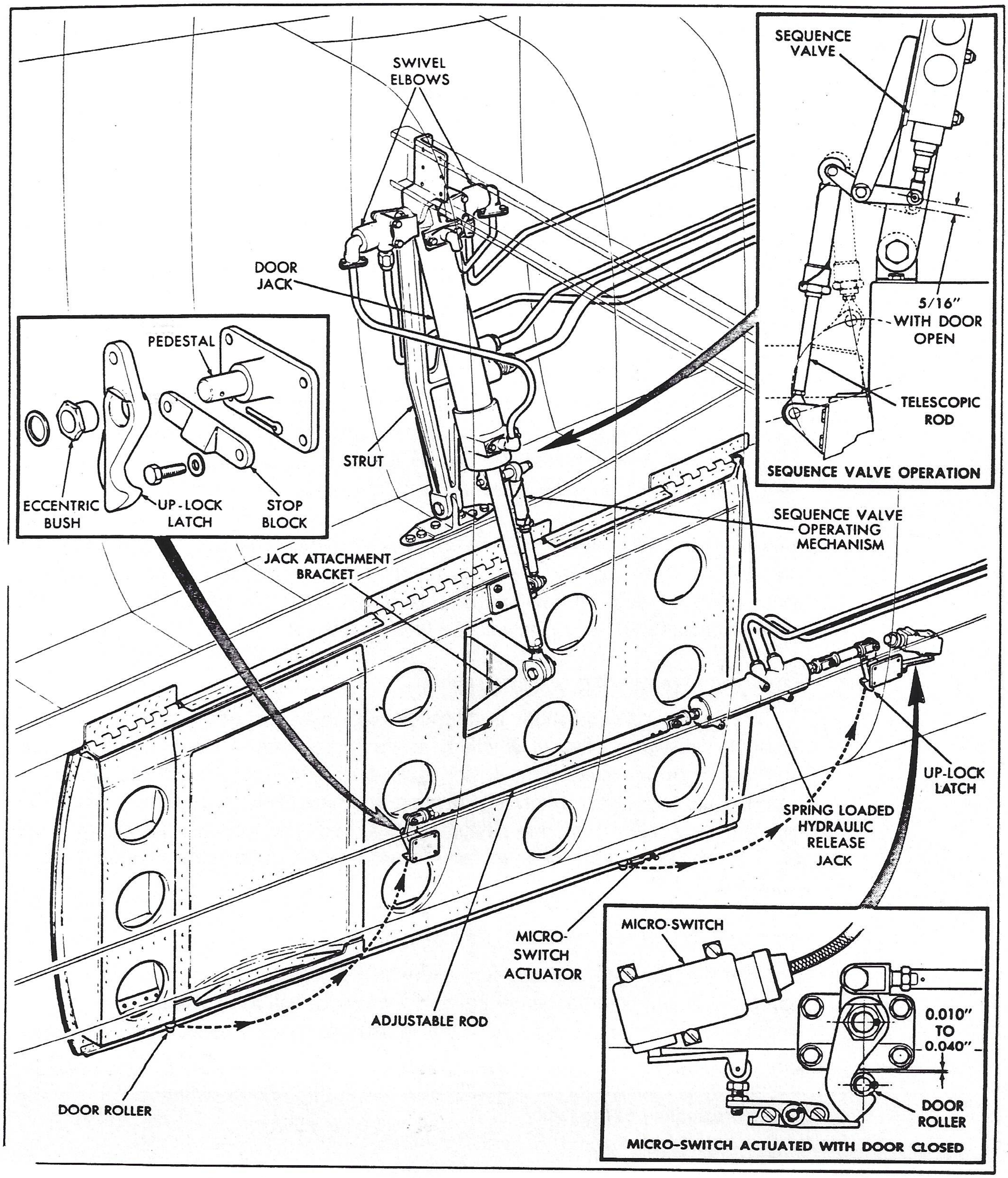


NOSE WHEEL STEERING MECHANISM



SHOCK ABSORBER

NOSE WHEEL DOOR



castoring, centering and shimmy damping. The maximum degree of steering and castoring from the central position of the nose wheel is 55 degrees in either direction.

3. A landing light and a taxying light are mounted on the lower part of the nose leg assembly. An electrical connection is also attached to the nose leg as a supply point for engine starting and telecommunication. (The landing and taxying lights were not fitted to the Arrow Mk1 aircraft prior to cancellation).

NOSE LEG ASSEMBLY.

4. The nose leg assembly consists of a main casing to which is attached the hydraulic steering jack together with its control valve, a picketing point and an adjustable up-lock roller. Connected to the casing are the steering links, a suspension lever which carries the axle assembly , and a pneumatic strut. The bore of the casing houses a rotating sleeve assembly which in turn houses the liquid spring shock absorber.

5. The upper part of the main casing is Y shaped and is attached to the navigator's forward bulkhead by two pivot pins. (see Fig). The two pins pass through two pick-up points in each arm. The pick-up points incorporate two flanged bushes on the right-hand arm and two plain bushes on the left. The flanged bushes transmit the side loads through the right-hand attachment point to the aircraft structure.

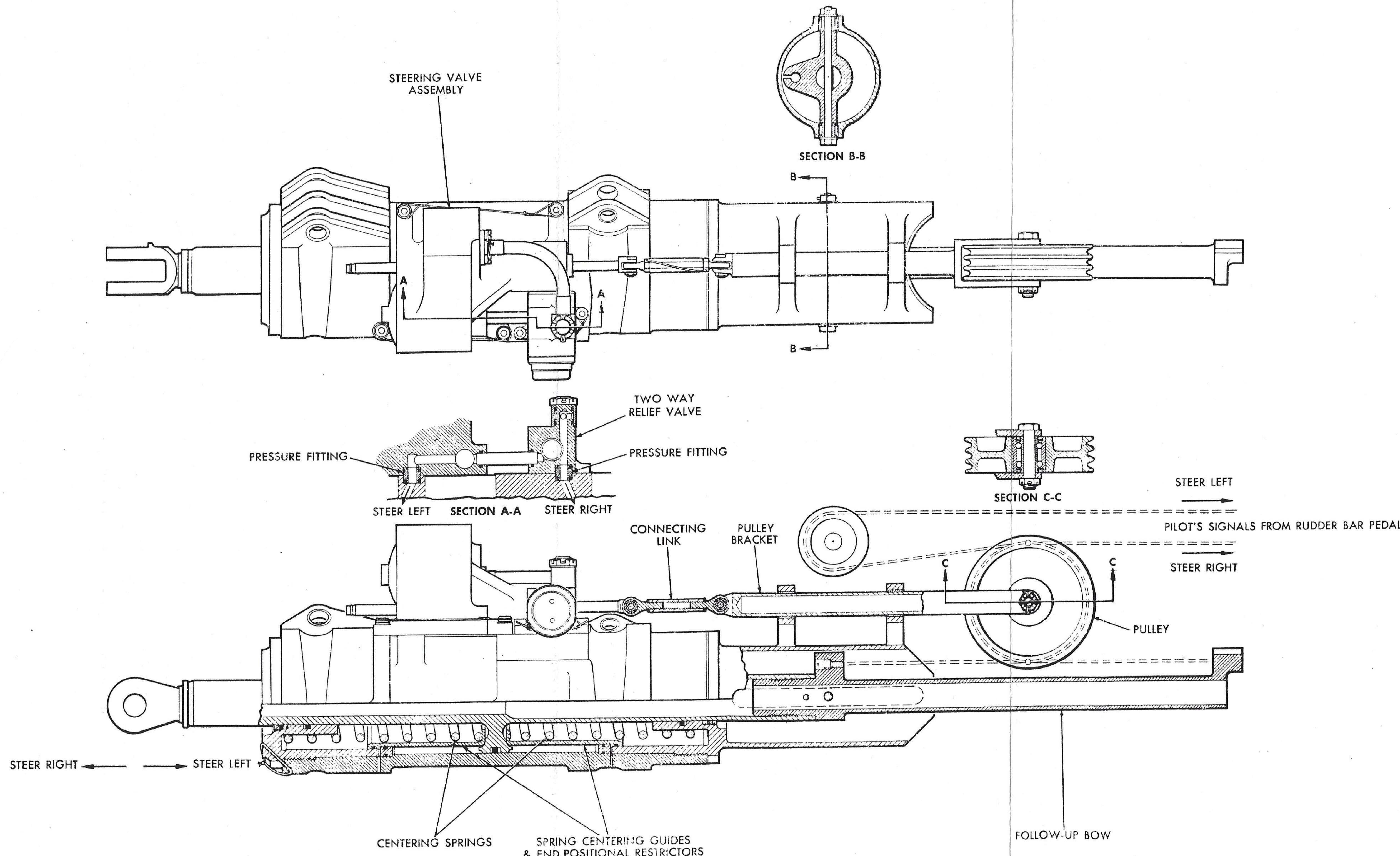
6. An integral lug on the right-hand arm provides attachment for the hydraulic jack for nose wheel retraction. A tie-rod, attached to a lug on the inboard side of each arm, acts as a brace. An integral arm protrudes from the top right-hand side of the main casing and tom this is attached a folding drag strut.

UP-LOCK ROLLER ASSEMBLY.

7. The up-lock roller assembly is attached to the upper part of the main casing. The assembly consists of a face plate which locates in the groove between two shoulders on the main casing while the other side of the plate is serrated to mate with a bracket carrying the adjustable roller. The bracket and face plate are secured to the main casing by two bolts fitting into elongated slots. The serrations and the slots provide the adjustment for the roller in the fore-and-aft direction when the nose leg is retracted.

STEERING JACK AND CONTROL VALVE.

8. The steering jack provides for nose wheel steering, self centring and shimmy damping. The upper attachment point of the jack is bolted to a single lug adjacent to the up-lock roller assembly to which is also attached a bracket carrying a single pulley. The lower attachment point of the jack comprises three lugs on the leg which mate with, and are bolted to, corresponding lugs on the body of the jack. The control valve is attached to the jack.



STEERING JACK AND CONTROL VALVE

BELL-CRANK.

10. At the lower end of the main casing a journal carries the nose wheel steering bell-crank and a flanged bush. The assembly is retained by a washer and a special bolt which screws into internal threads in the journal. The bolt is secured by two lock-screws which are wire-locked together after assembly. To ensure the bell-crank is free to pivot on the journal a clearance is maintained between the underside of the bolt head and the washer.

ROTATING SLEEVE.

11. The rotating sleeve assembly permits the lower portion of the nose leg assembly to be partially rotated for steering and castoring. The assembly is secured and housed in the bore of the main casing and consists of a tapered sleeve with an integral 45 degree fork end.

STEERING LINKS

12. The upper steering link is attached to the nose wheel steering bell-crank by a main link axle which passes through the bore of the bell-crank. At each end of the main link axle a needle bearing carries the fork end of the upper steering link. The assembly is secured by a nut at each end and is prevented from rotating by a roll pin passing through a hole mid-way along the axle. To ensure that the bell-crank has freedom of movement, a clearance is maintained between the underside of the nut and the steering link at each end.

13. A ball joint connecting the steering links provides a scissors movement for landing and taxying and also a swinging movement for nose wheel steering. The main body of the joint is located in a hole at the forward end of the lower steering link and is enclosed with two covers. The ball joint is sealed and is attached to the upper steering link by three nuts and bolts.

NOSE WHEEL STEERING.

14. The nose wheel steering is a cable controlled and hydraulically powered system. The system is activated electrically by a push button on the control column which energizes a hydraulic steering selector valve. The steering mechanism caters for any intermediate degree of turning required between the central position of the nose wheel and its maximum range of movement of 55 degrees in either direction.

NOTES