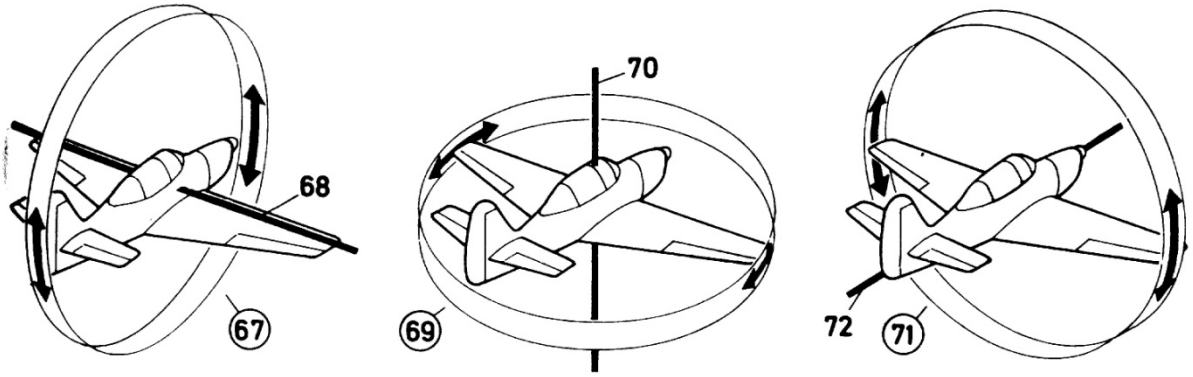
Introdução às Estruturas Aeronáuticas

Escola Politécnica da USP
Departamento de Engenharia Mecânica
2013

Introdução às Estruturas Aeronáuticas

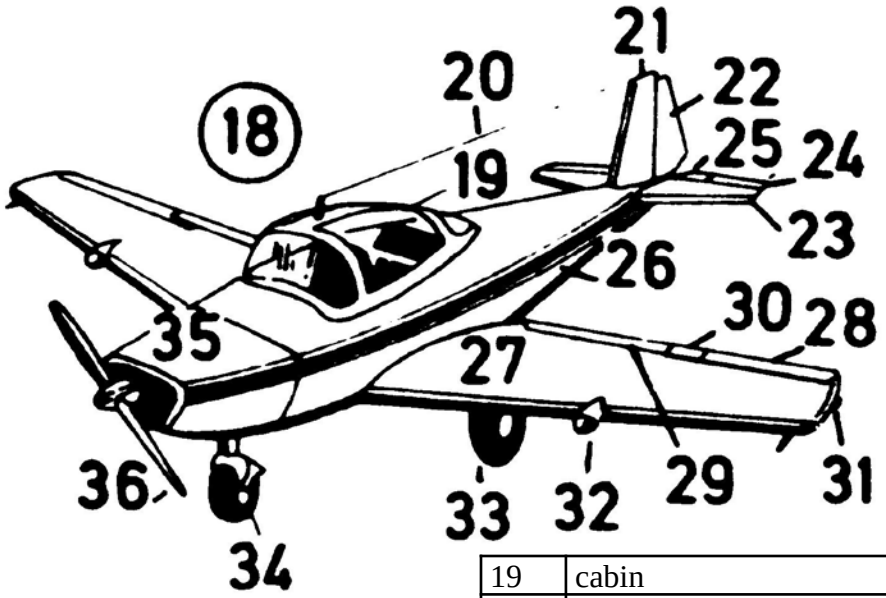
TERMINOLOGIA & COMPONENTES ESTRUTURAIS

Principais Manobras da Aeronave

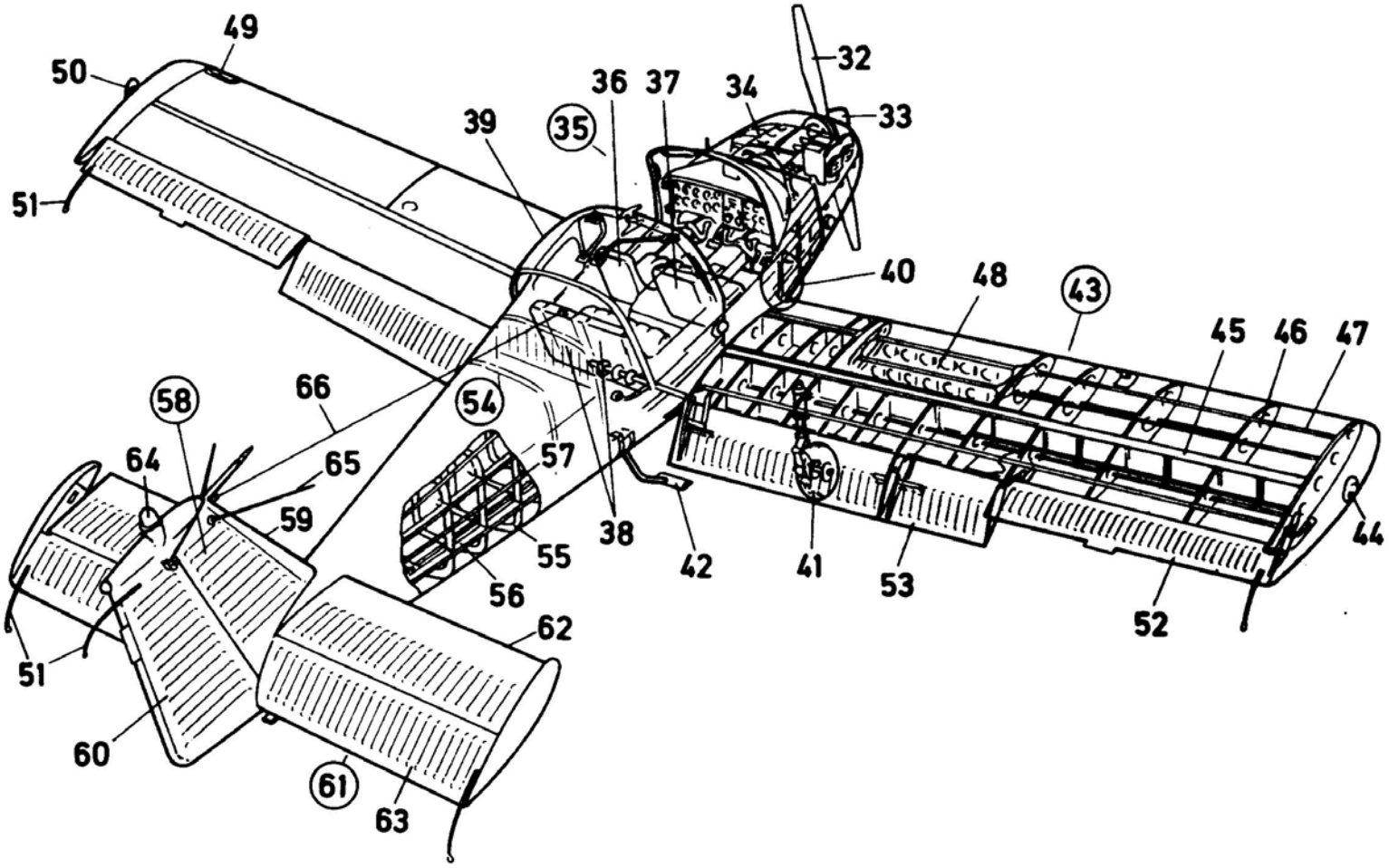


67	pitch (pitching)	arfar (arfagem), cabrar
68	lateral axis	eixo lateral
69	yaw (yawing)	guinar (guinada)
70	vertical axis	eixo vertical
71	roll (rolling)	rolamento
72	longitudinal axis	eixo longitudinal

18 - Two-seater plane for racing and aerobatics



19	cabin	cabine
20	antenna	antena
21	vertical stabilizer, vertical fin, tail fin	estabilizador vertical, empenagem vertical
22	rudder	leme direcional
23	tailplane, horizontal stabilizer	estabilizador horizontal, empenagem horizontal
24	elevator	profundor
25	trim tab, trimming tab	tab de trimagem
26	fuselage, body	fuselagem
27	wing	asa
28	aileron	aileron
29	landing flap	flapes de aterrissagem
30	trim tab	tab de trimagem
31	navigation light	lanterna de navegação
32	landing light	farol de aterrissagem
33	main undercarriage unit main landing gear unit	trem de pouso principal
34	nose wheel	trem de pouso secundário de nariz
35	engine	motor
36	propeller	hélice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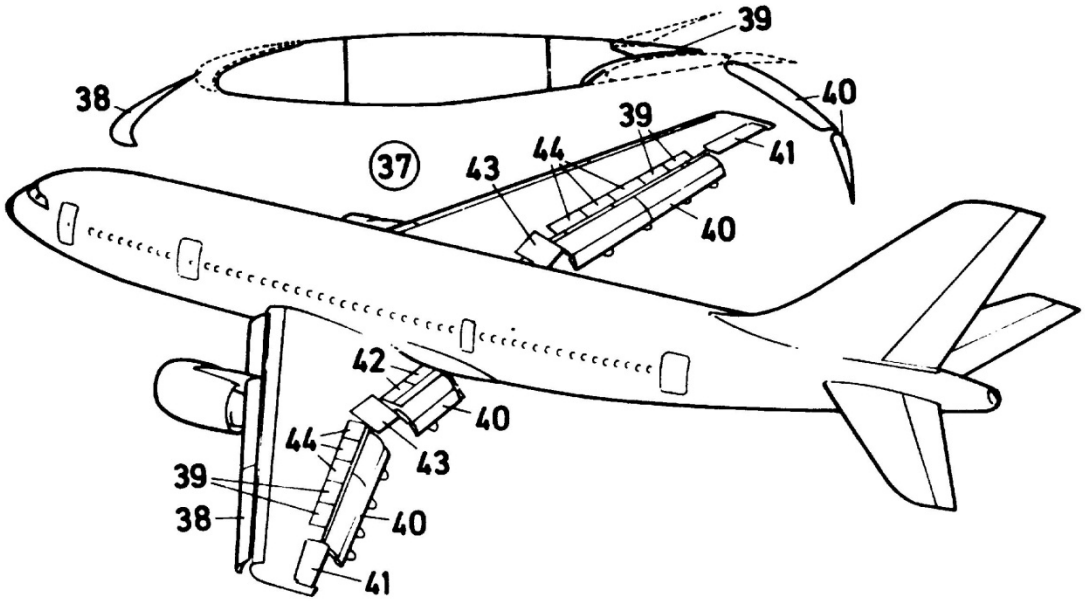
Componentes Estruturais do Avião

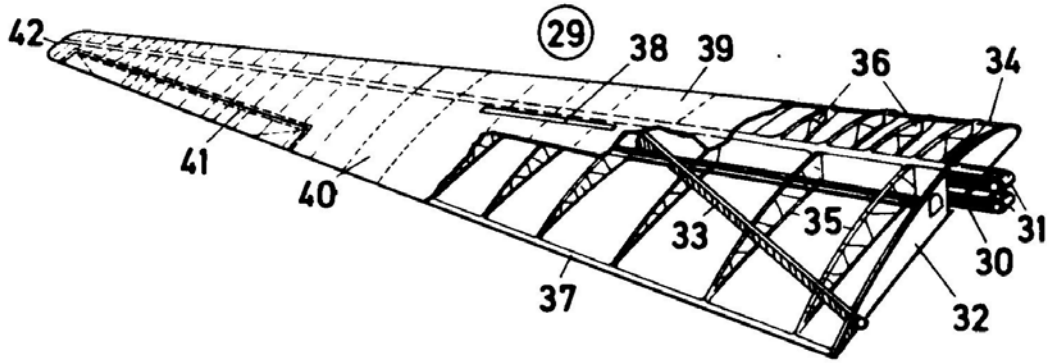
32	propeller, airscrew	hélice
33	spinner	
34	flat four engine	motor de quatro cilindros
35	cockpit	cockpit
36	pilot’s seat	assento do piloto
37	co-pilot’s seat	assento do co-piloto
38	passenger seats	assento dos passageiros
39	hood, canopy, cockpit hood, cockpit canopy	
40	steerable nose wheel	roda dianteira de direção
41	main undercarriage unit, main landing gear unit	trem de pouso principal
42	step	
43	wing	asa
44	right navigation light (right position light)	
45	spar	longarina
46	rib	nervura
47	stringer, longitudinal reinforcing member	reforçador
48	fuel tank	tanque de combustível
49	landing light	farol de aterrissagem
50	left navigation light (left position light)	
51	electrostatic conductor	
52	aileron	aileron
53	landing flap	flape de aterrissagem
54	fuselage (body)	fuselagem
55	frame (former)	caverna
56	chord	
57	stringer, longitudinal reinforcing member	reforçador
58	vertical tail, vertical stabilizer and rudder	calda (vertical)
59	vertical stabilizer, vertical fin, tail fin	empenagem vertical, estabilizador vertical
60	rudder	leme de direção
61	horizontal tail	calda (horizontal)
62	tailplane, horizontal stabilizer	estabilizador horizontal, empenagem horiz.
63	elevator	profundor
64	warning light, anticollision light	
65	dipole antenna	
66	long-wire antenna, long conductor antenna	

37 - Sistema de Flapes



38	extensible slat	stat
39	spoiler	spoiler
40	double-slotted Fowler flap	flape
41	outer aileron (low-speed aileron)	aileron externo
42	inner spoiler (landing flap, lift dump)	spoiler interno
43	inner aileron (low-speed aileron)	aileron interno
44	brake flap (air brake)	flape de frenagem

29 - Elementos Estruturais da Asa de Planador



30	main spar, a box spar	longarina principal
31	connector fitting	junta de conexão
32	anchor rib	nervura de fixação
33	diagonal spar	longarina diagonal
34	leading edge	bordo de ataque
35	main rib	nervura principal
36	nose rib (false rib)	falsa longarina do bordo de ataque
37	trailing edge	bordo de fuga
38	brake flap (spoiler)	spoiler
39	torsional clamp	
40	covering (skin)	revespimento
41	aileron	aileron
42	wing tip	ponta de asa

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COMPONENTES ESTRUTURAIS

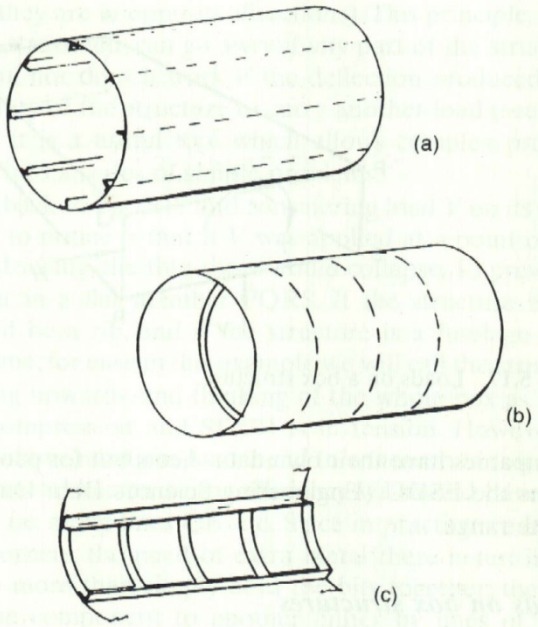


Fig. 5.16 Thin wall tubes with stiffeners.

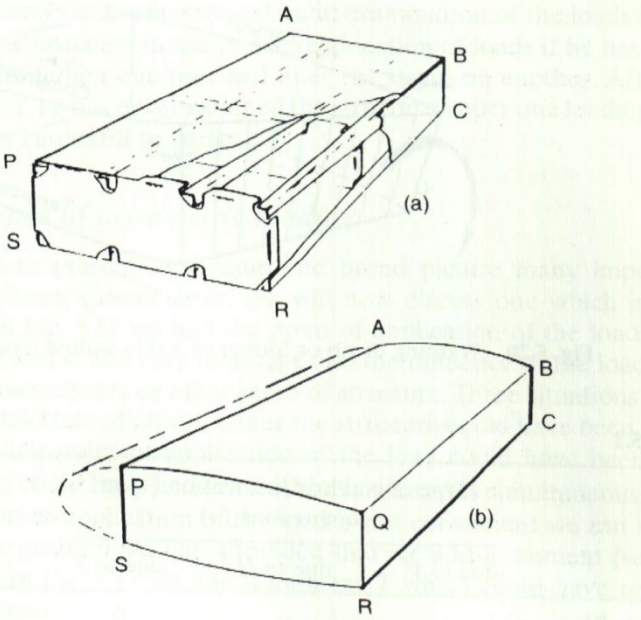
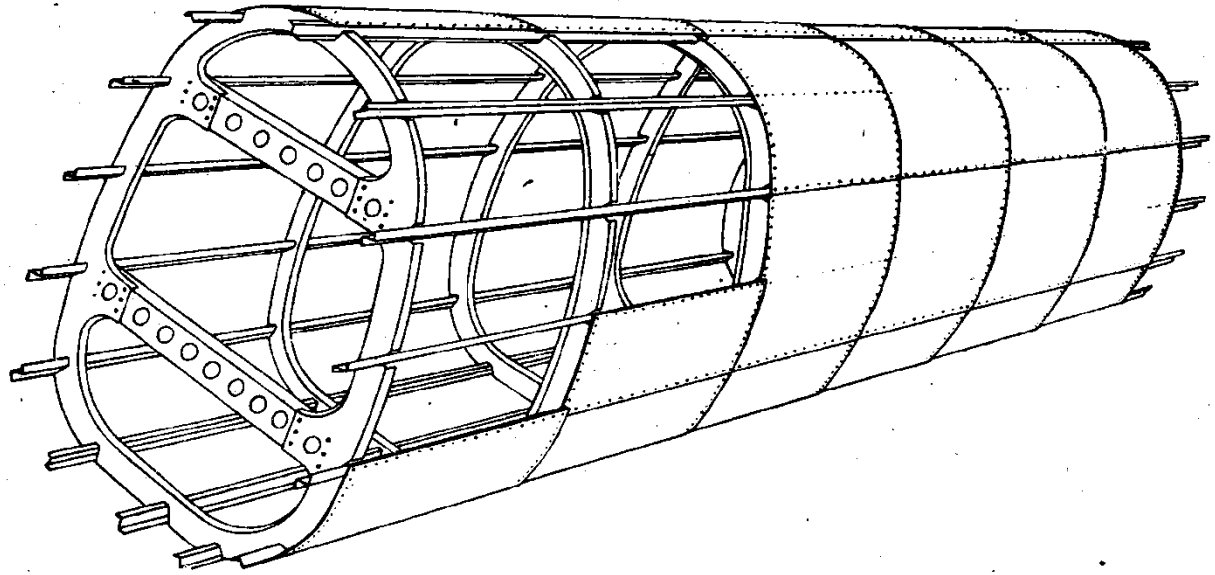
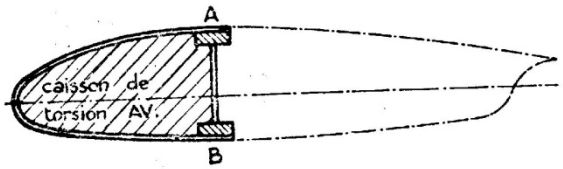
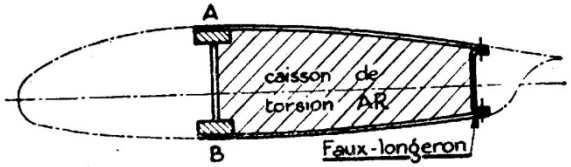
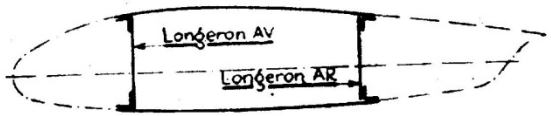


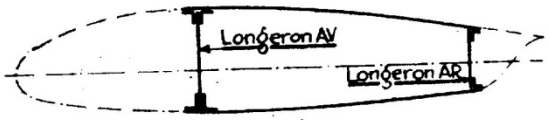
Fig. 5.19 Completed box structure.




A
caisson de torsion AV.
B


A
caisson de torsion AR
B
Faux-longeron


Longeron AV
Longeron AR


Longeron AV
Longeron AR

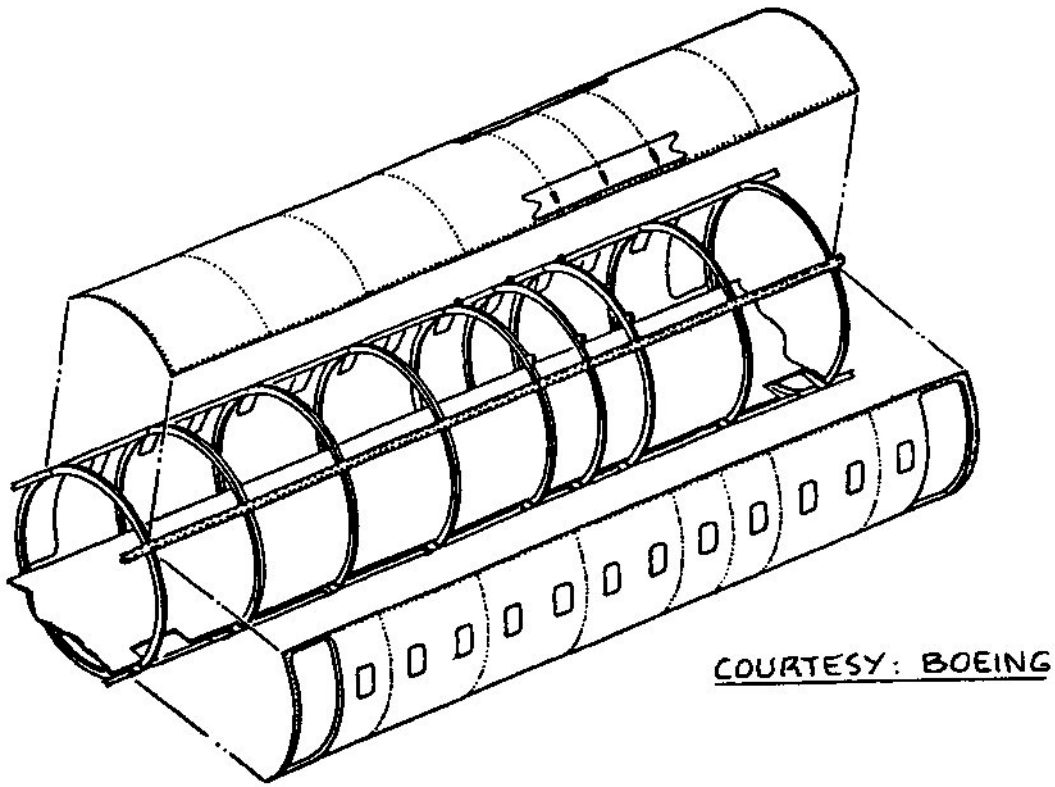


Figure 3.68 Example of a Fuselage with Honeycomb Skin Panels According to a Boeing Proposal

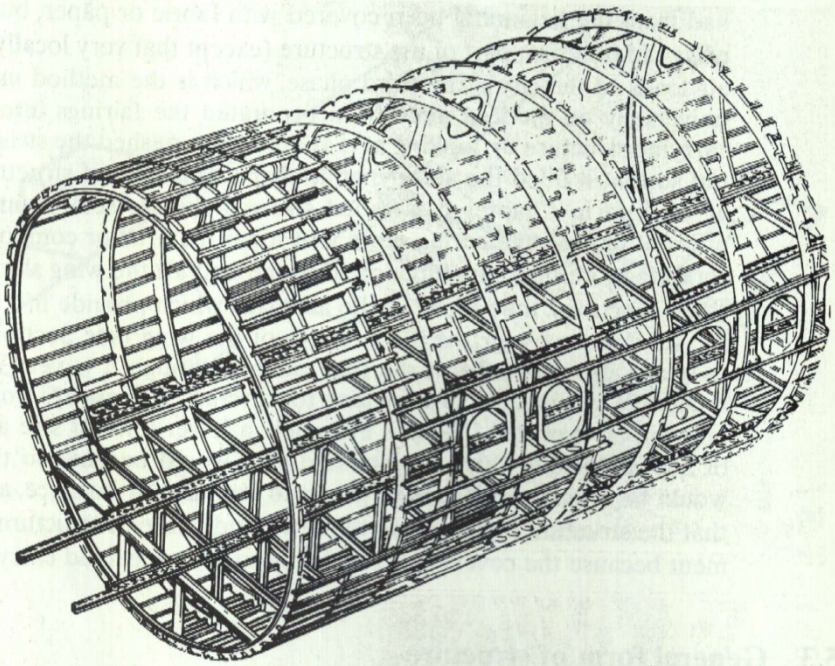


Fig. 5.2(a) Conventional stressed skin construction – de Havilland Canada Dash 7. (Courtesy of The de Havilland Aircraft of Canada Ltd.)

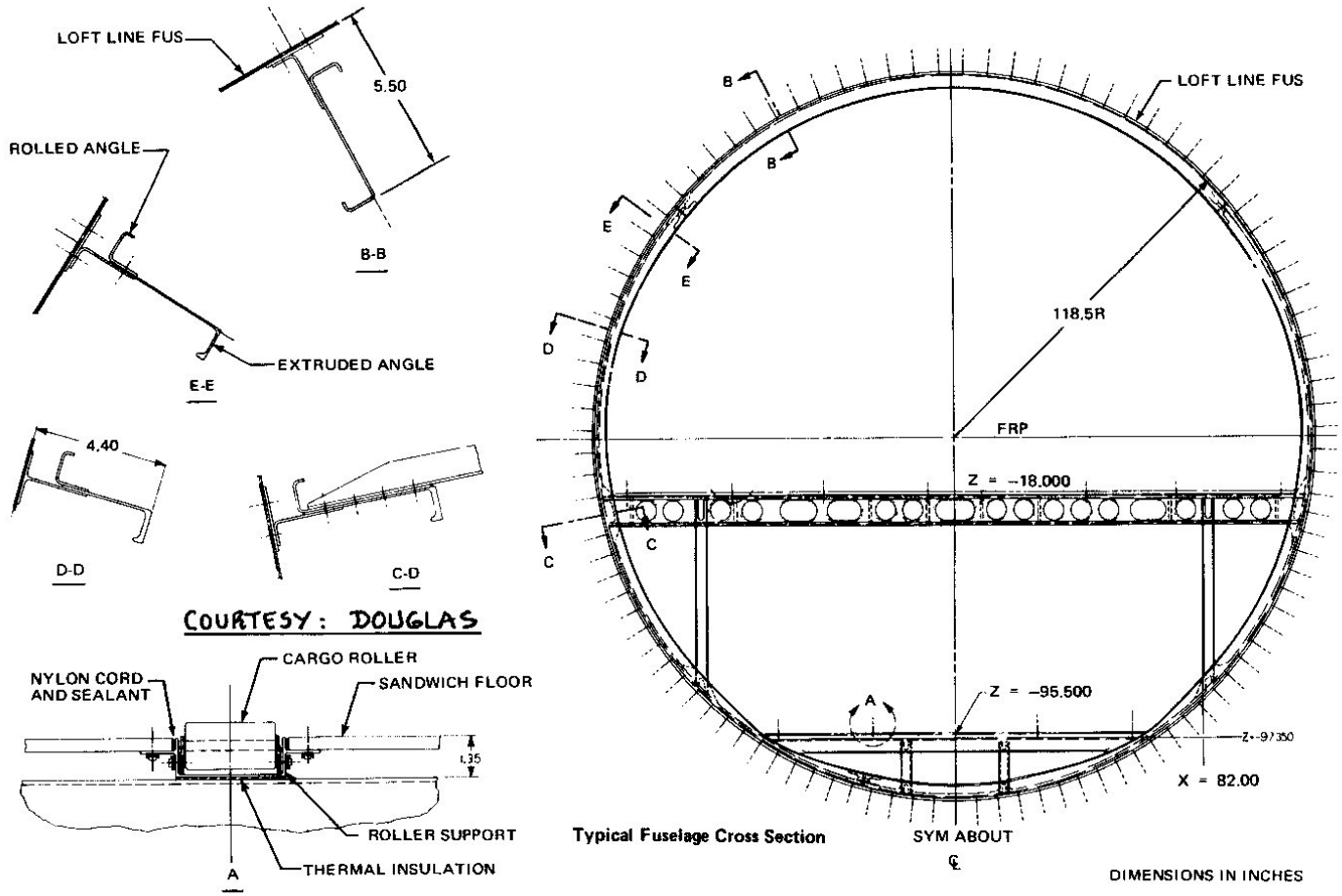


Figure 3.65 Fuselage Shell and Skin Layout for the McDonnell Douglas DC10

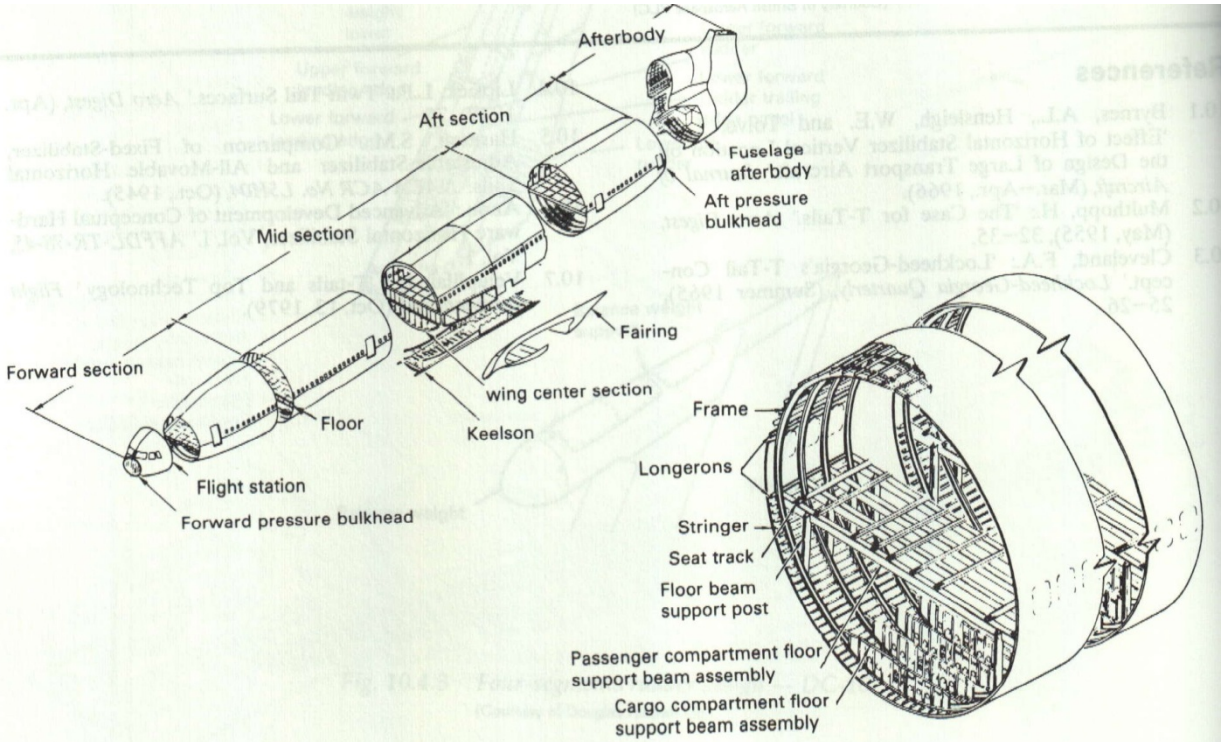


Fig. 11.1.1 Typical semi-monocoque stiffened shell — L-1011.

(Courtesy of Lockheed Aeronautical Systems Co.)

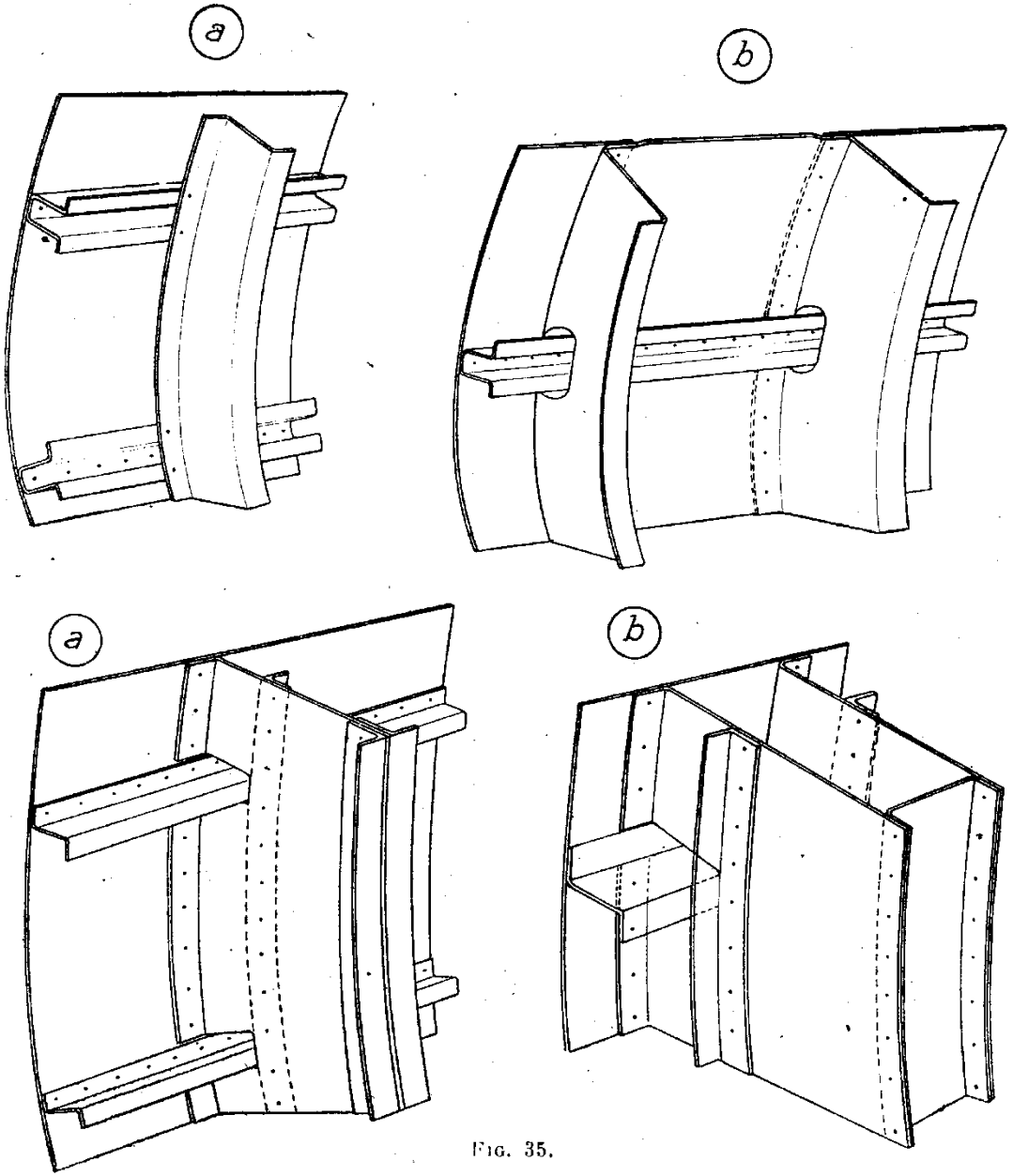


Fig. 35.

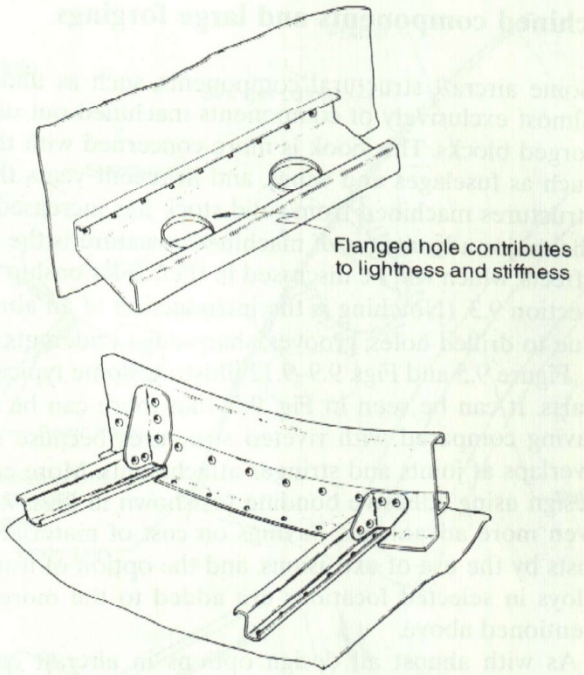


Fig. 9.2 Typical sheet-metal construction.

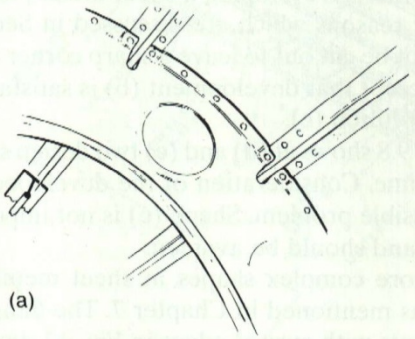


Fig. 9.3 (a) Typical constructional details (Courtesy of The de Havilland Aircraft of Canada Ltd); (b) Boeing 747 (Courtesy of The Boeing Commercial Airplane Company); (c) BAe 146 (Courtesy of British Aerospace).

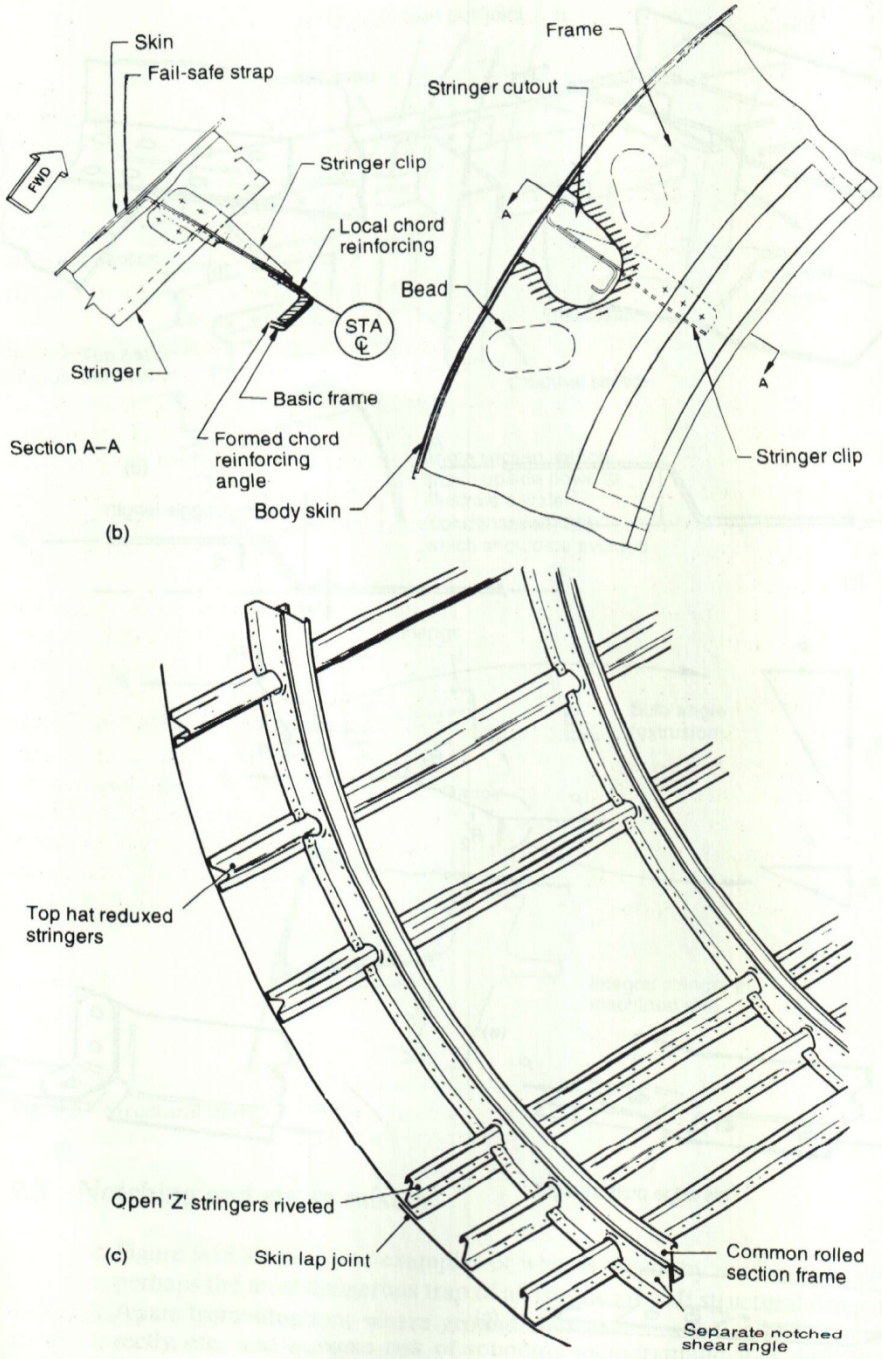

Skin
Fail-safe strap
FWD
Stringer clip
Local chord reinforcing
STA
Stringer
Basic frame
Section A–A
Formed chord reinforcing angle
Body skin
(b)
Frame
Stringer cutout
A
Bead
A
Stringer clip
Top hat reduxed stringers
Open 'Z' stringers riveted
(c)
Skin lap joint
Common rolled section frame
Separate notched shear angle

Fig. 9.3 *Cont.*

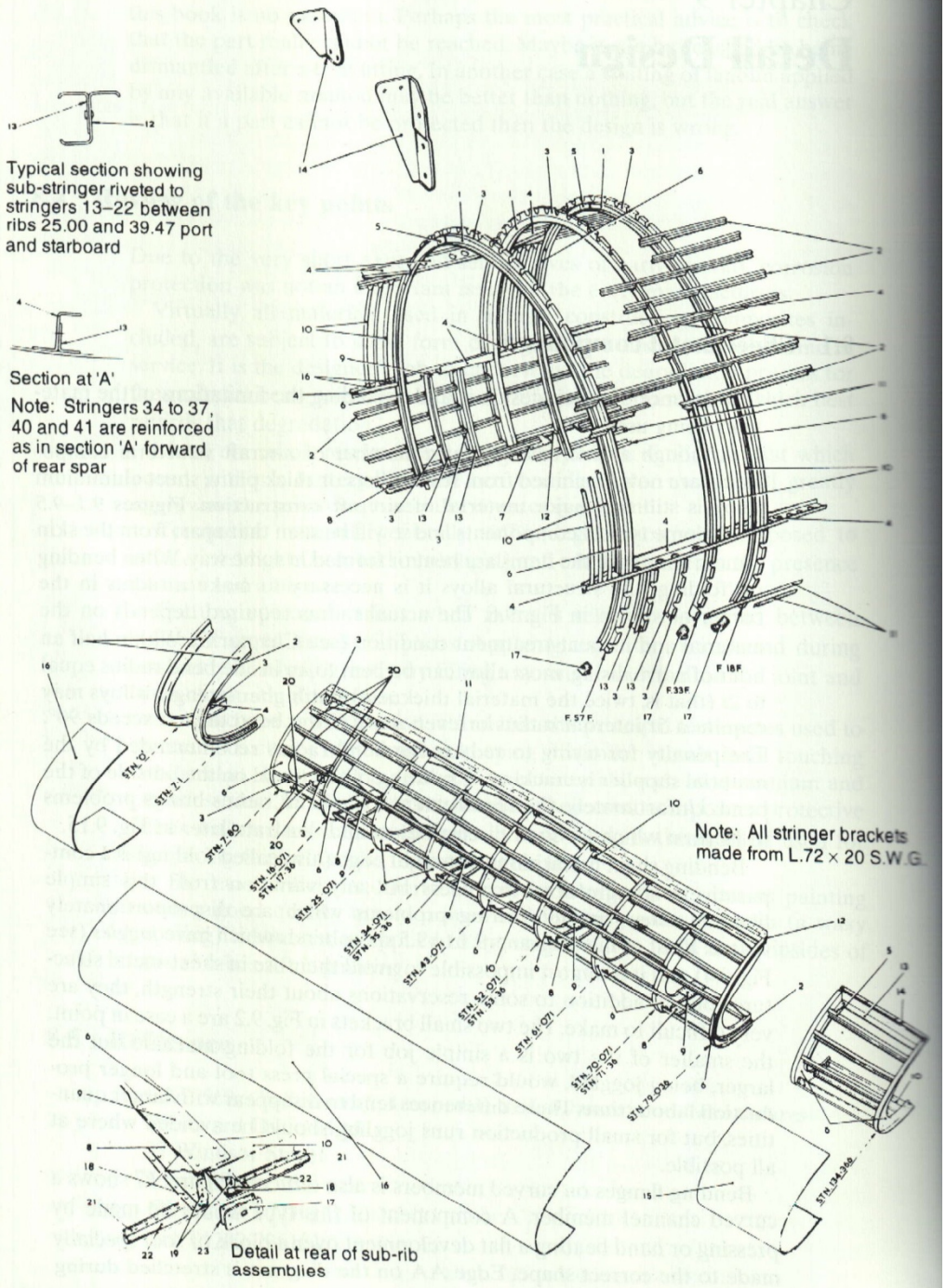


Fig. 9.1 Examples of detail design, BAe 748. (Courtesy of British Aerospace.)

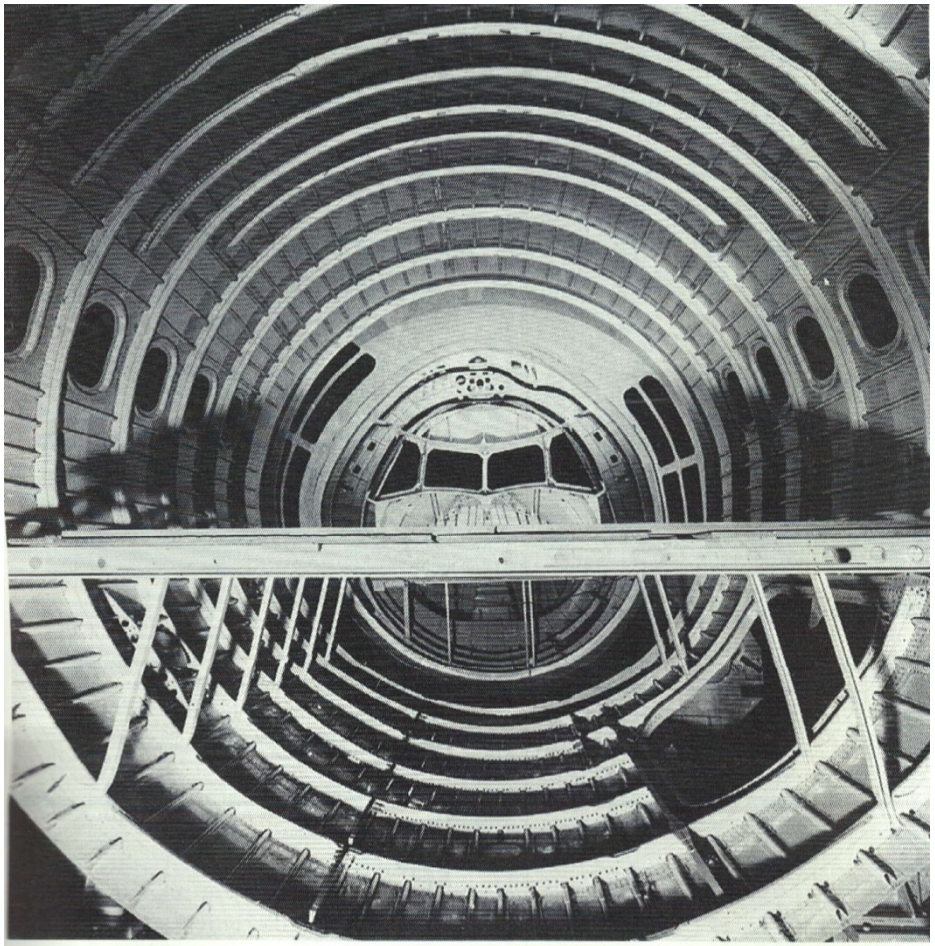


Fig. 5.2(b) Conventional stressed skin construction – British Aerospace 146. (Courtesy British Aerospace.)

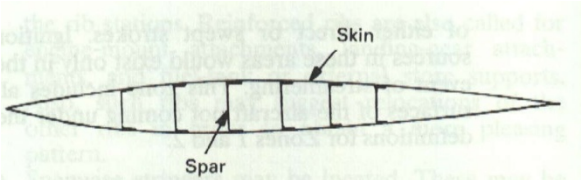


Fig. 8.3.2 Multi-spar skin bending material.

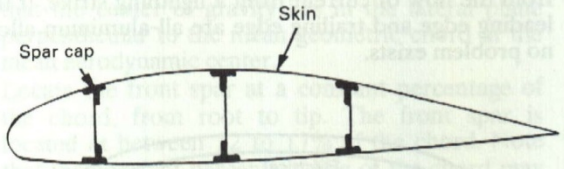


Fig. 8.3.1 Three spar wing — all bending materials concentrated at the spar caps.

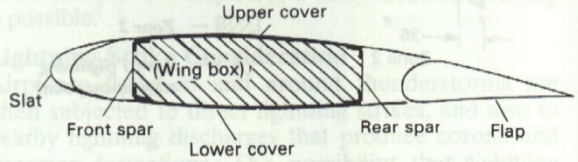


Fig. 8.3.3 Typical wing torque box enclosed area.

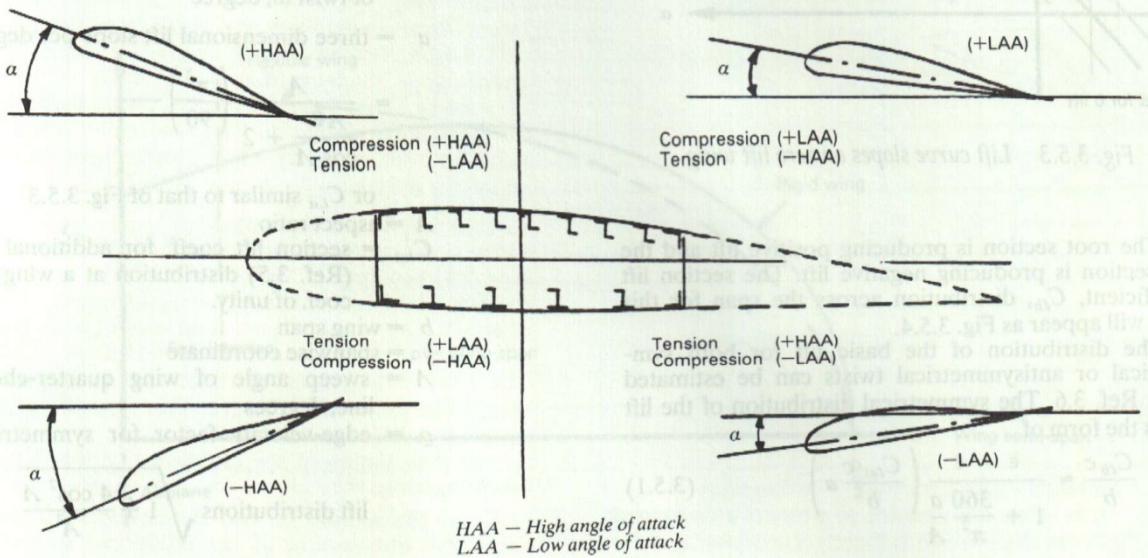


Fig. 3.5.6 Critical conditions for wing box structure.

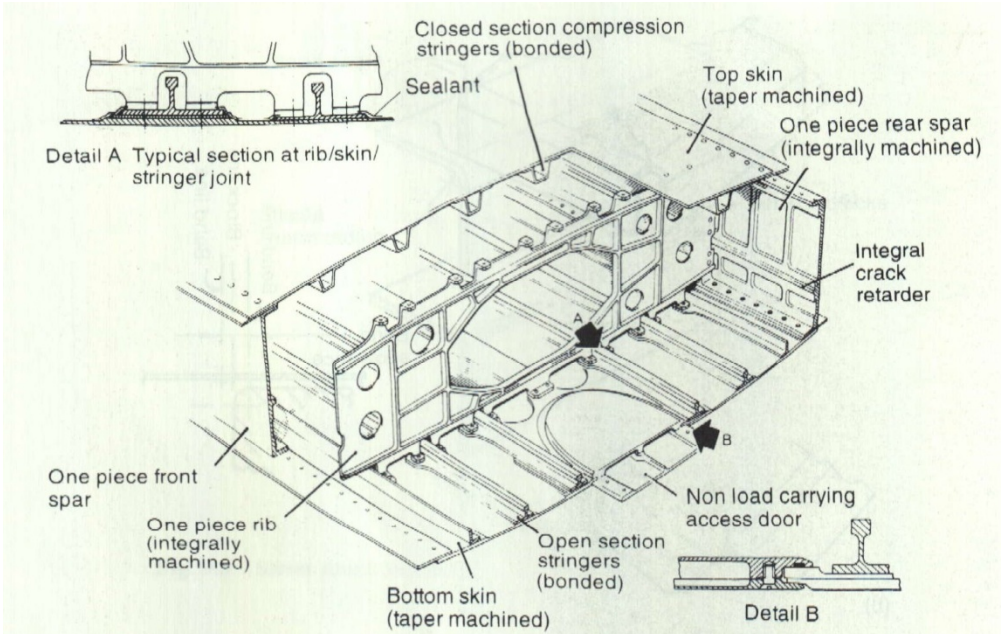
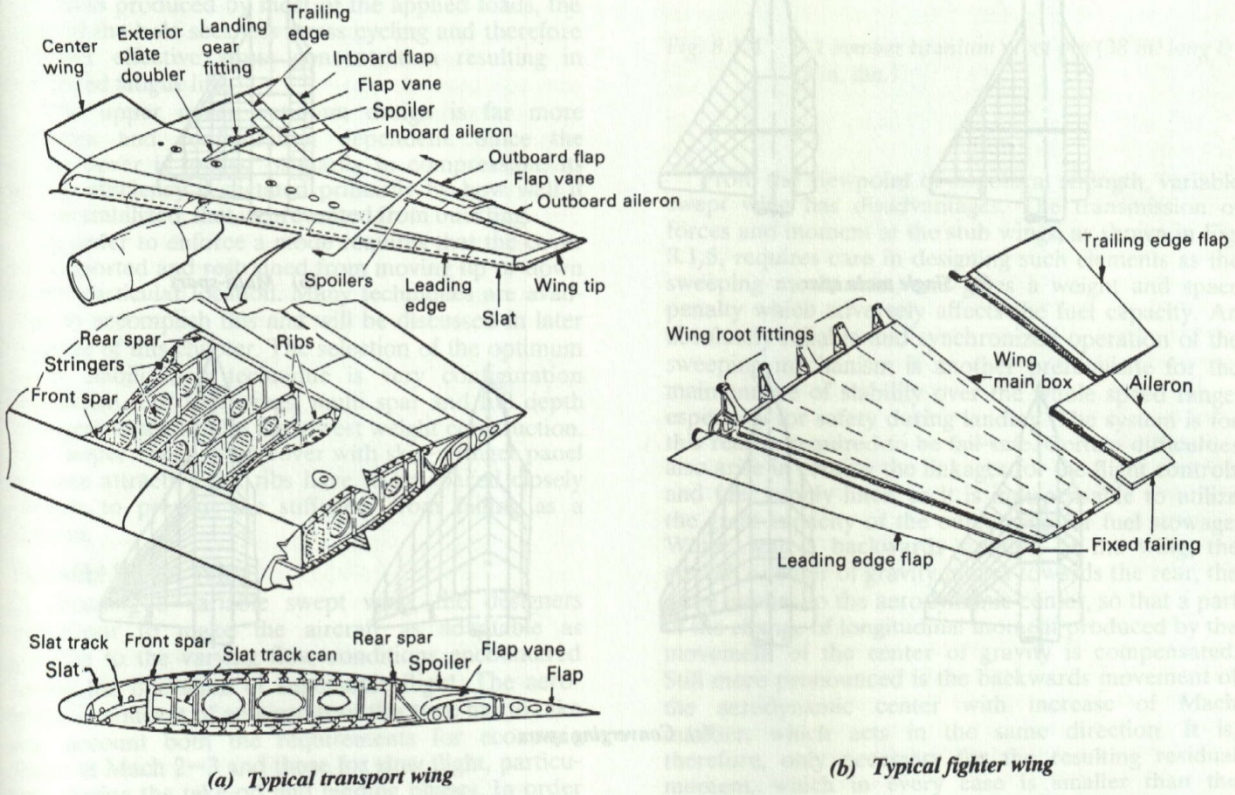


Fig. 9.9 Machined structural details. (Courtesy of British Aerospace.)



(a) Typical transport wing

(b) Typical fighter wing

Fig. 8.1.1 Typical transport and fighter wing.

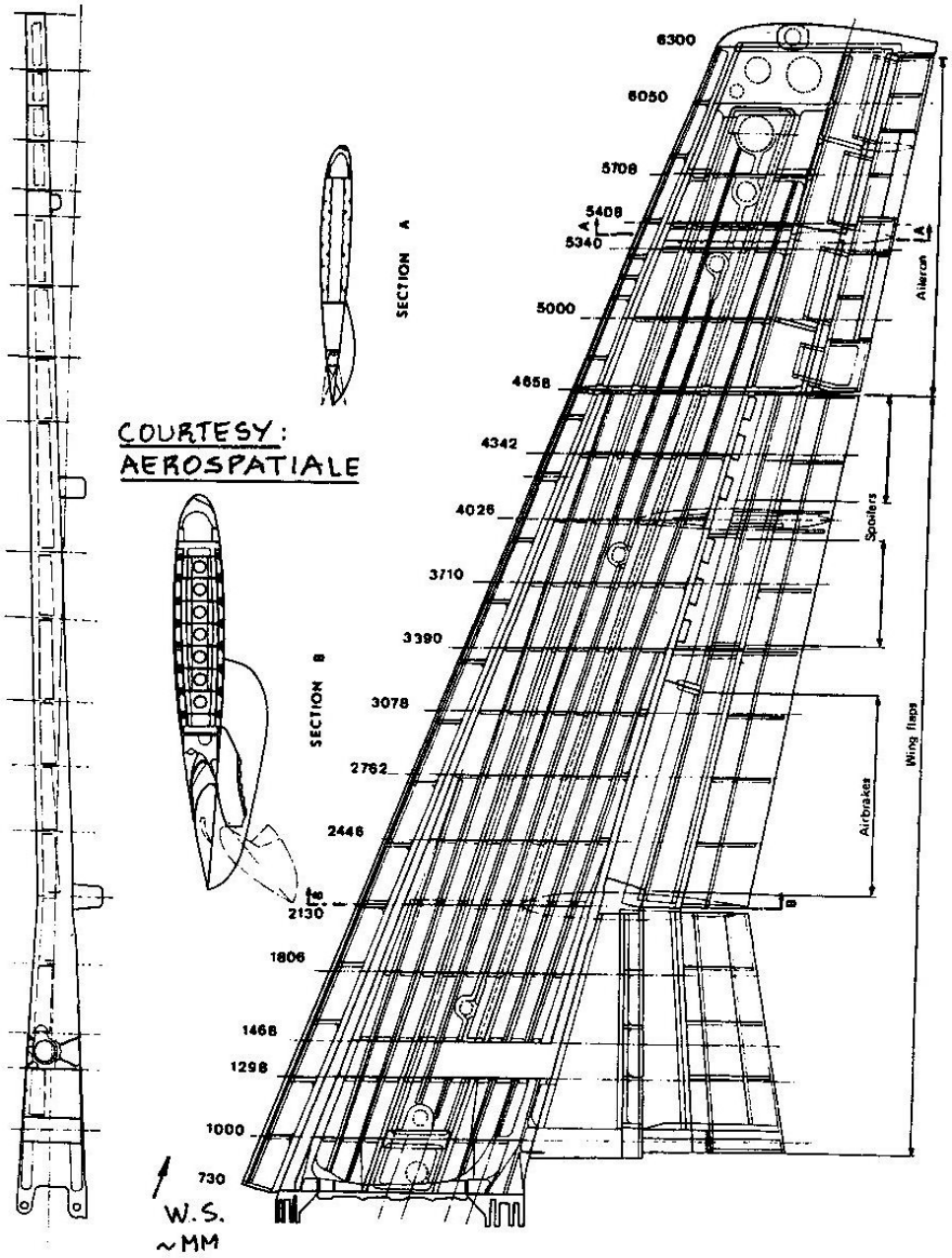


Figure 4.56 Wing Structural Arrangement Aerospatiale Corvette


MACHINE No.
MCC 20
SERIAL No.
00303

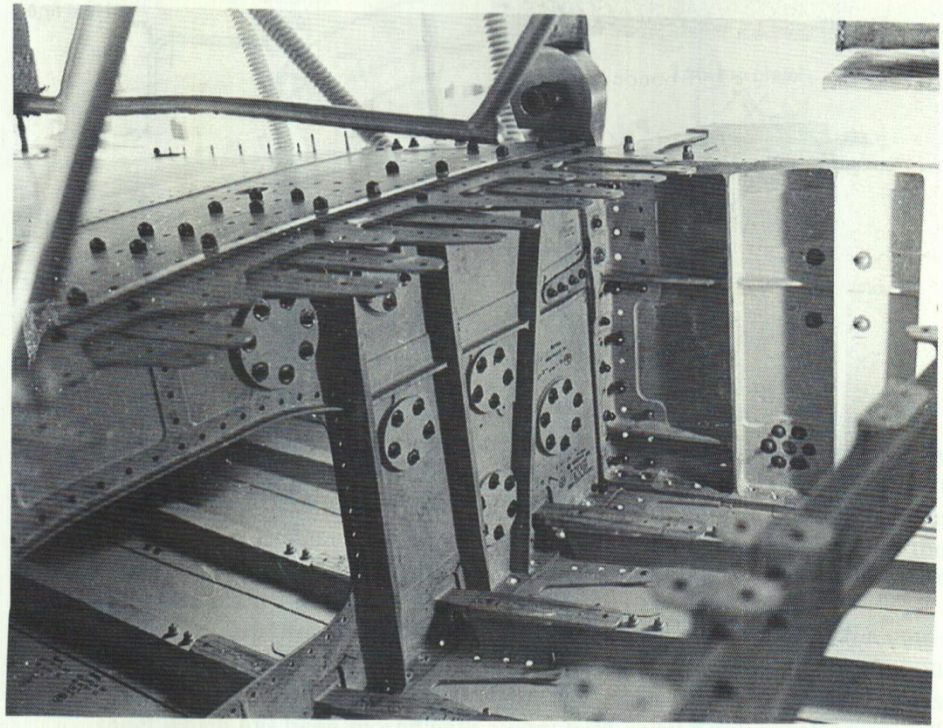


Fig. 9.10 Constructional details with machined components. (Courtesy of British Aerospace.)

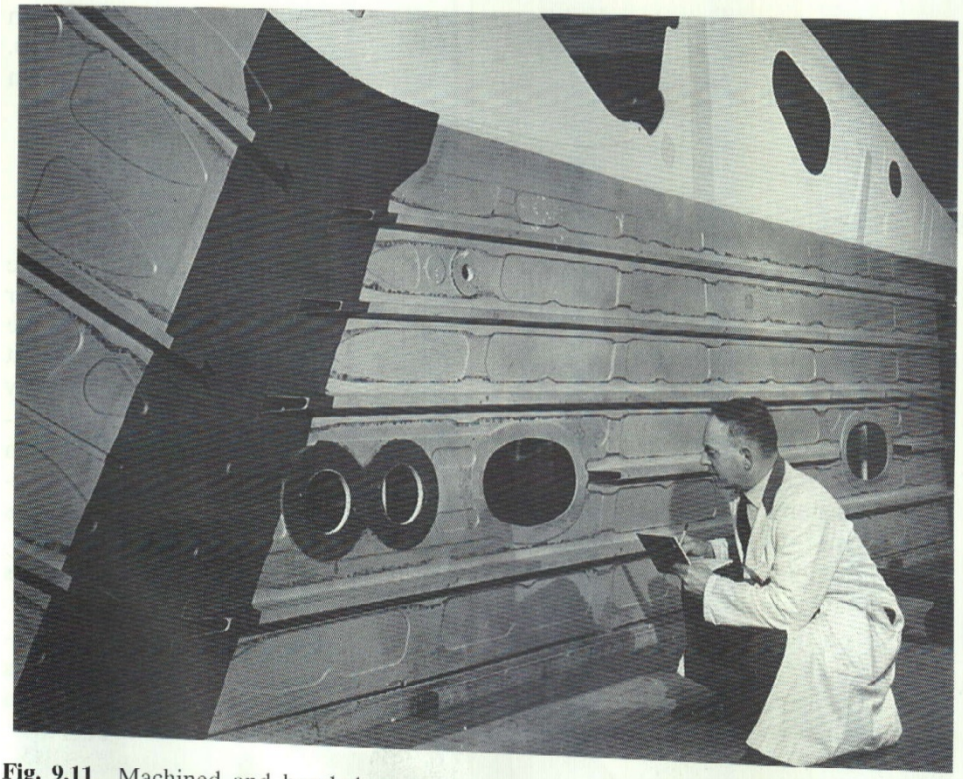


Fig. 9.11 Machined and bonded structure. (Courtesy of Ciba-Geigy, Bonded Structures Division, Cambridge.)

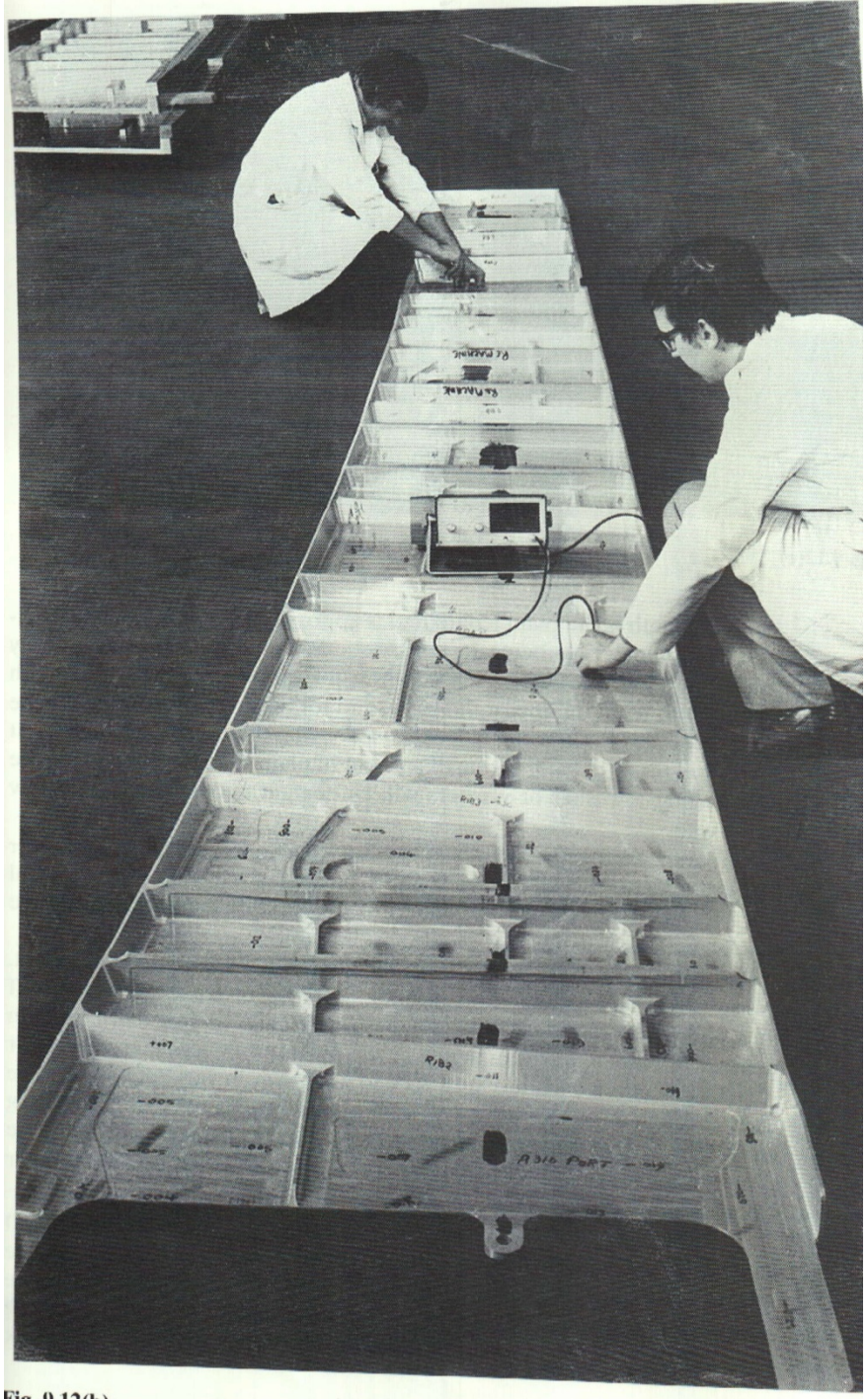
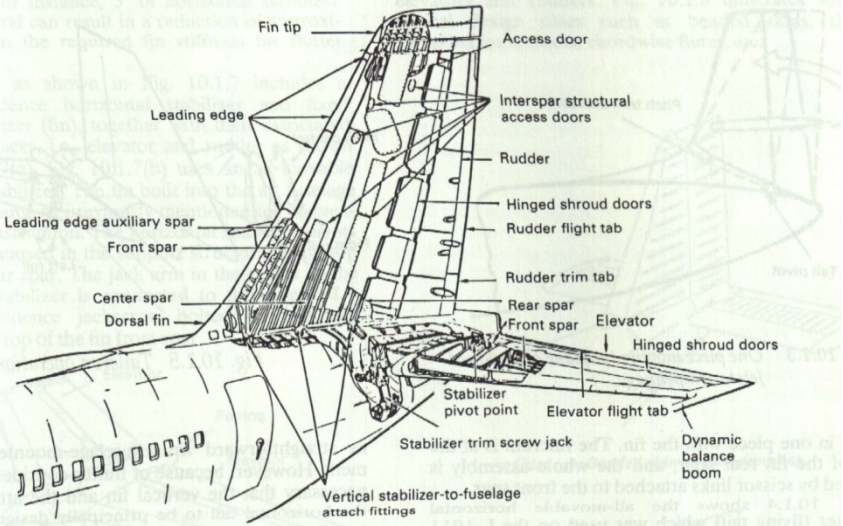
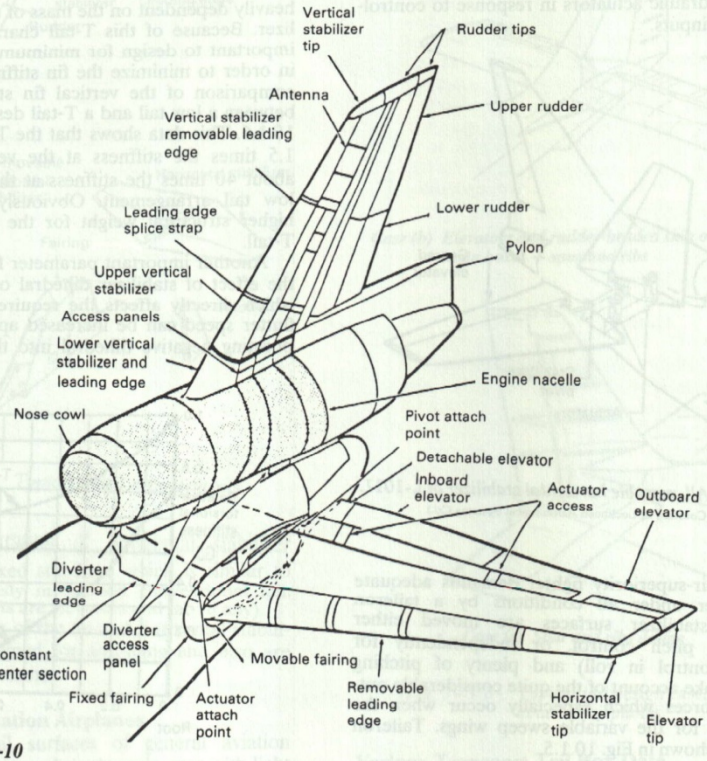


Fig. 9.12(b)



(a) Convair 880

(Courtesy of General Dynamics Corp. – Convair.)



(b) DC-10

(Courtesy of Douglas Aircraft Co.)

Fig. 10.1.2 Structural arrangement of transport tails.

Introdução às Estruturas Aeronáuticas

ESTRUTURAS AERONÁUTICAS & MATERIAIS

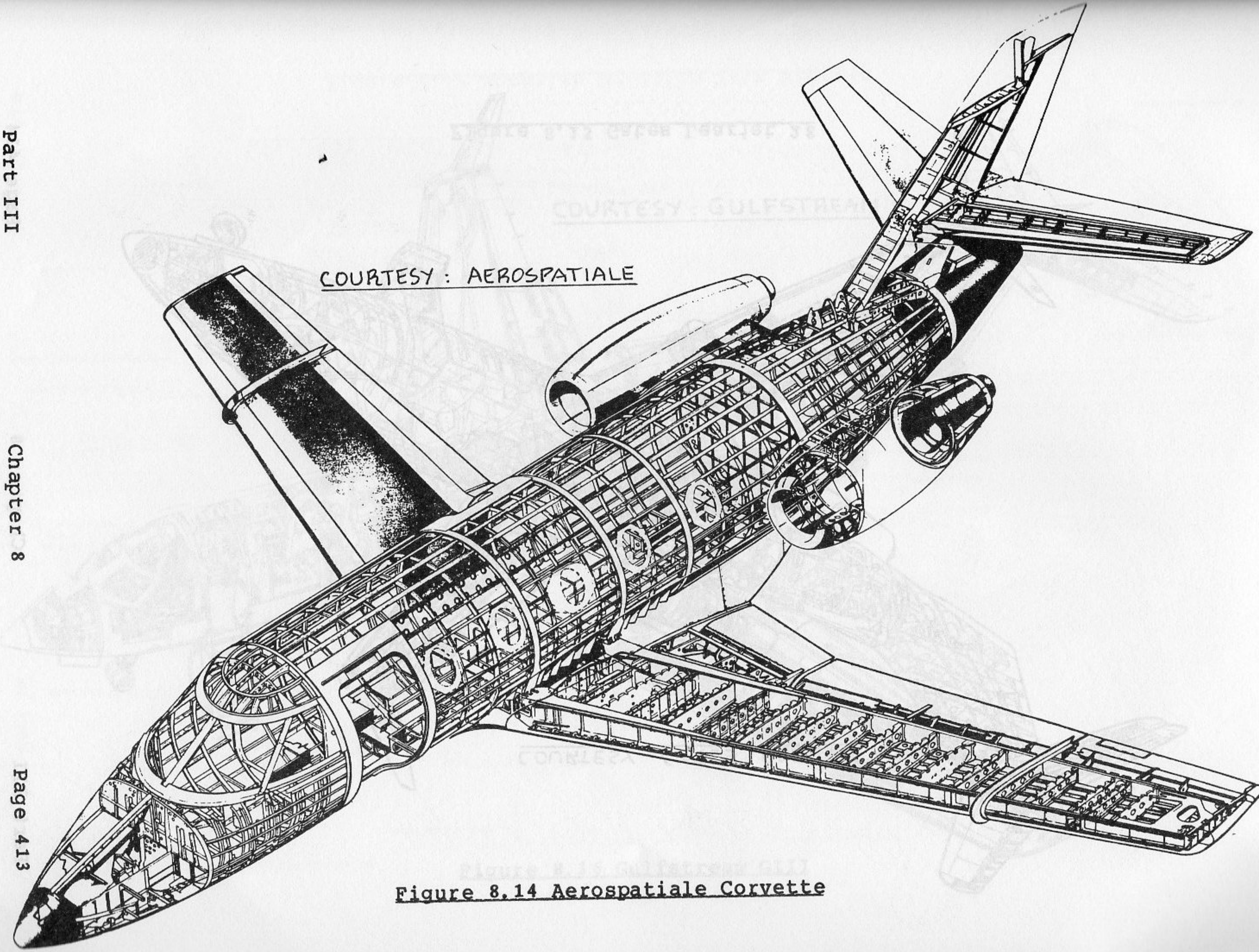


Figure 8.14 Aerospatiale Corvette

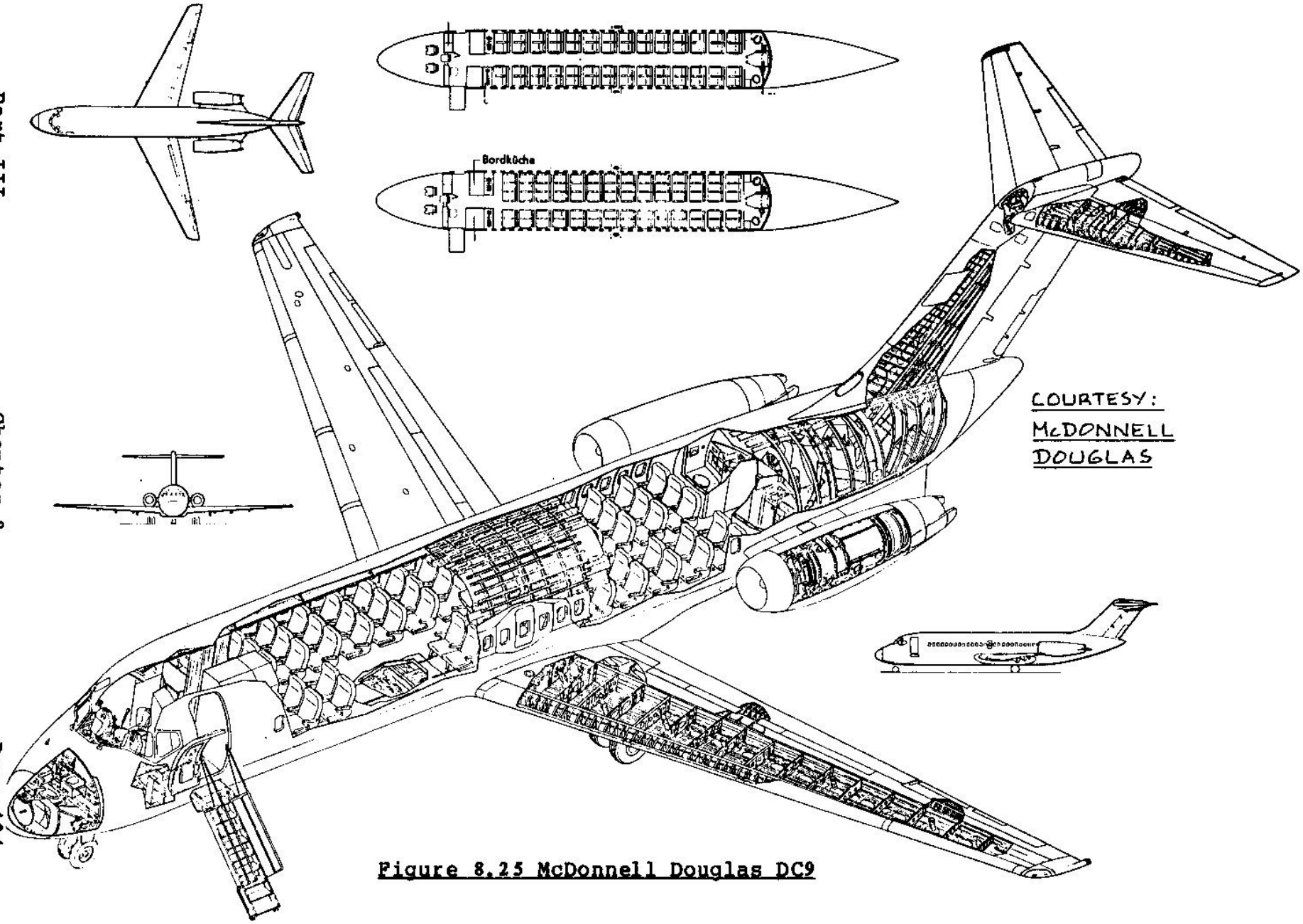


Figure 8.25 McDonnell Douglas DC9

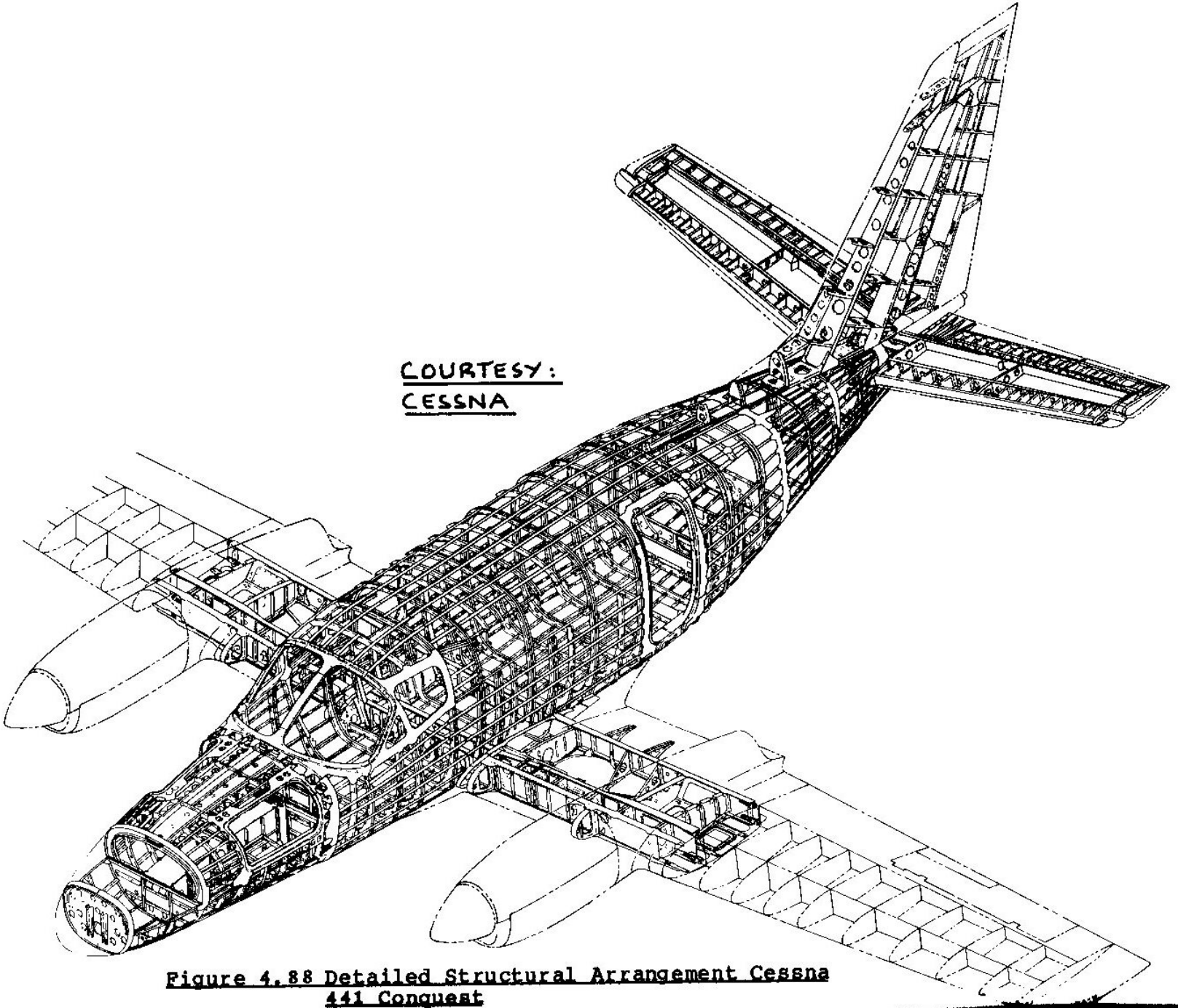
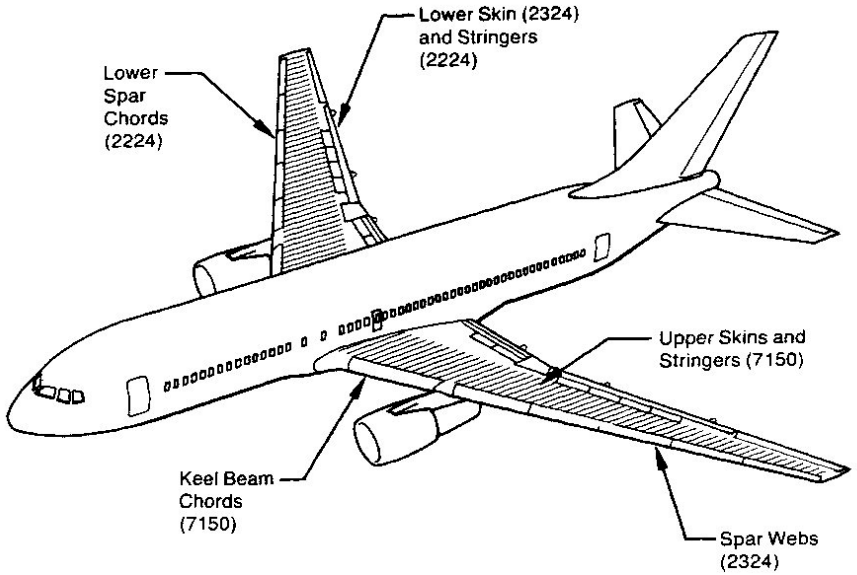
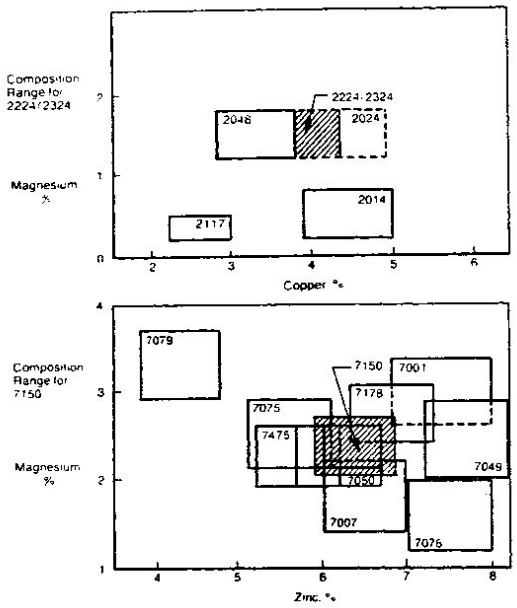


Figure 4.88 Detailed Structural Arrangement Cessna 441 Conquest



COURTESY: BOEING



- Alloy designations 2224/2324 and 7150
- Similarity to conventional alloys (2024 and 7075)
  - Narrower composition ranges
  - Modified milling procedures
- Improved strength
  - 2224/2324 ..... 5 to 8%
  - 7150 ..... 11 to 13%
- Equivalent fatigue, toughness, and corrosion resistance

Figure 7.3a Aluminum Usage: Boeing 767-200

Material	Application
Graphite/Epoxy	Inboard Aileron Outboard Aileron Inboard and Outboard Spoilers Rudder Elevator
Hybrid (Kevlar/Graphite)	Fixed Panels-Wing T.E. Cowls-Thrust Reverser, Inlet and Fan Fairing-T.E. Flap Linkage Cove Panels-Inbd T.E. Flap Wing/Body Fairing Landing Gear Doors-Body Fixed T.E. Panels, Tip-Empennage Seal Plates-Stabilizer
Hybrid (Fiber-Glass/Graphite	Nose Landing Gear Doors (Graphite Weight Only)
Kevlar	ECS Ducts Cargo Liner Outboard Stowage Bins & Center Stowage Supports Emergency Escape System Lavs, Closets, & Partitions Fairings-Engine Pylon Outboard Flap-L.E. and T.E. Inboard Flap-Debris Protection Fairing-Thrust Reverser

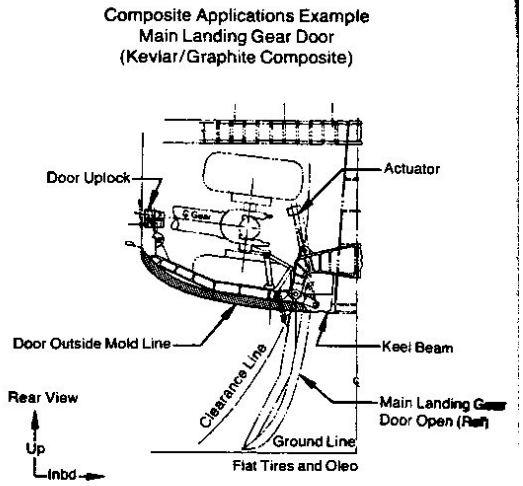


Figure 7.3c Composites Applications: Boeing 767-200

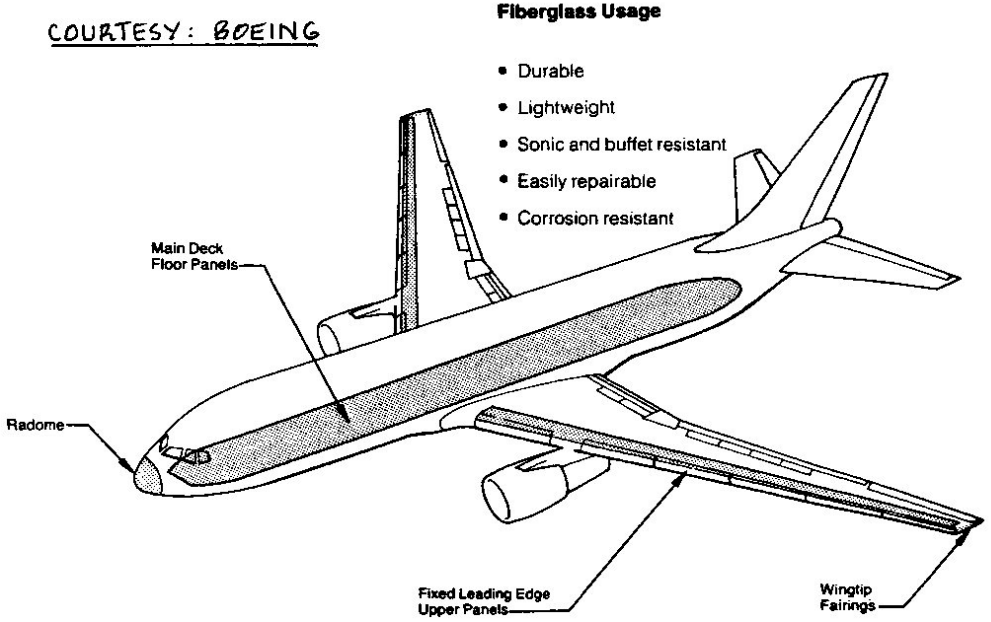
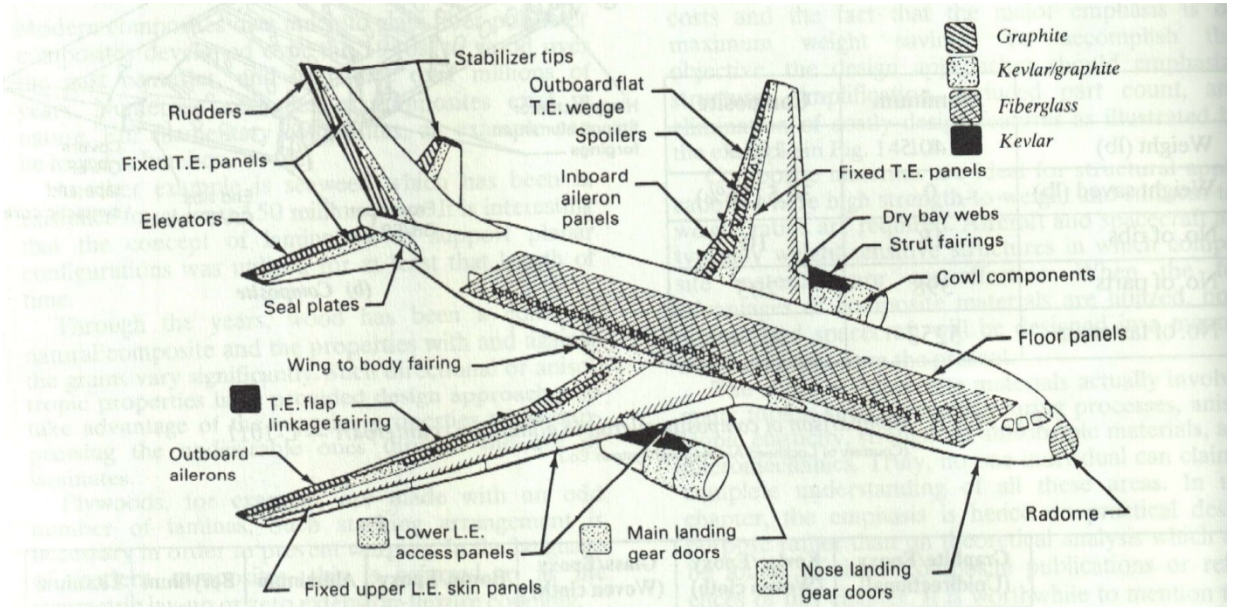
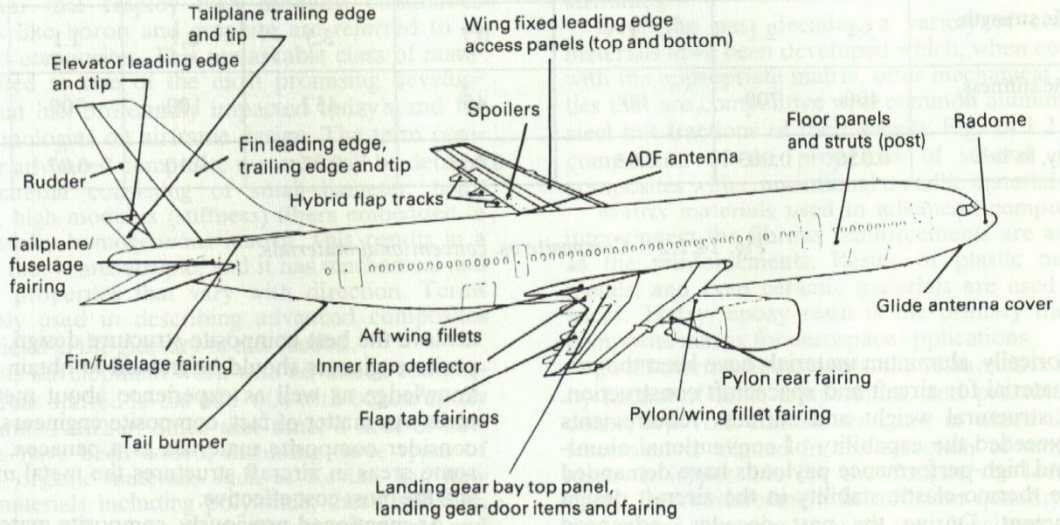


Figure 7.3d Fiberglass Usage: Boeing 767-200



(a) Boeing B767



(b) Airbus A300/A310

Fig. 14.1.3 Composite materials applications on commercial airplanes.

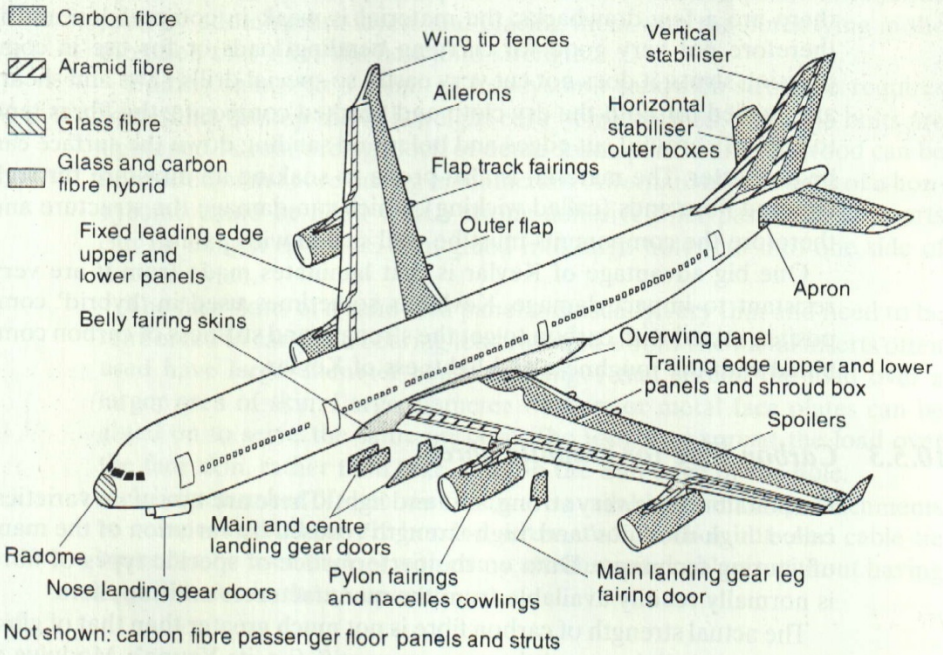


Fig. 10.3 Application of composite materials to the A340.

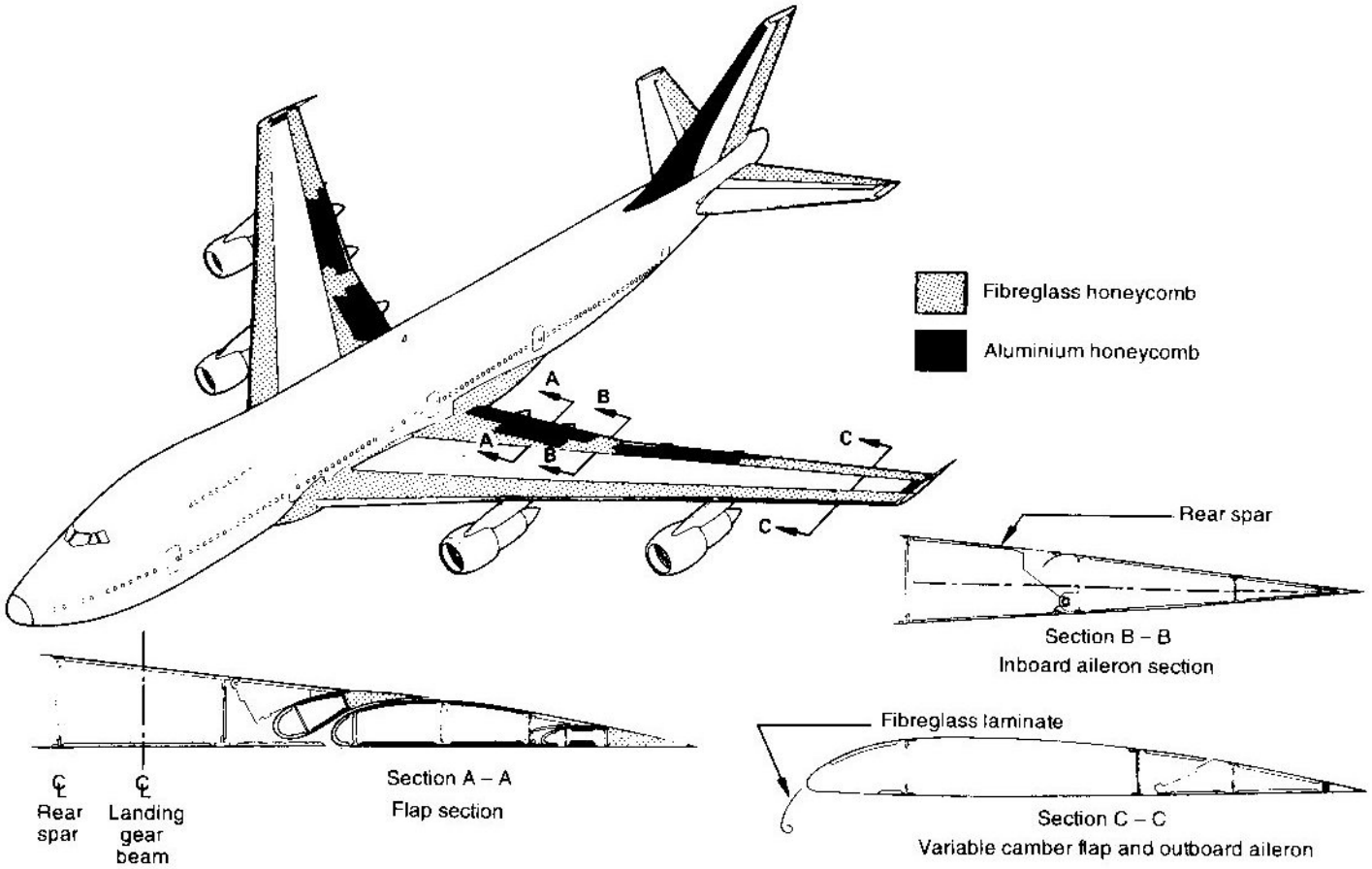


Fig. 2.14(c) Typical use of sandwich structure. (Courtesy of the Boeing Commercial Airplane Company.)