AEM 617

Lesson 5

Basic Systems
+
Mechanisms
+
V-n diagram

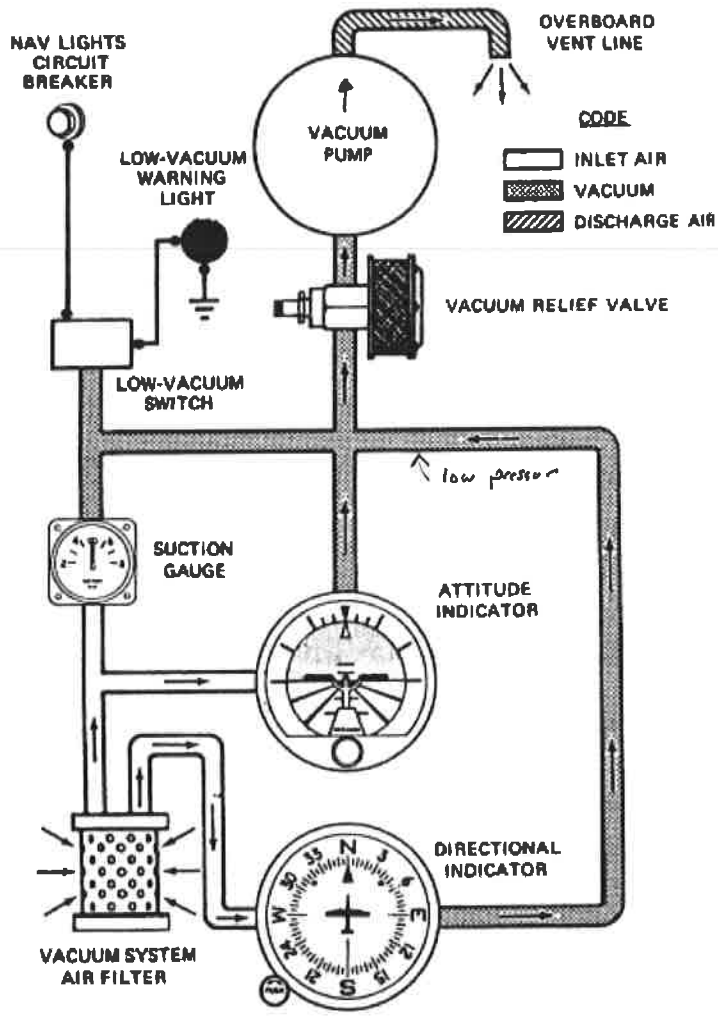
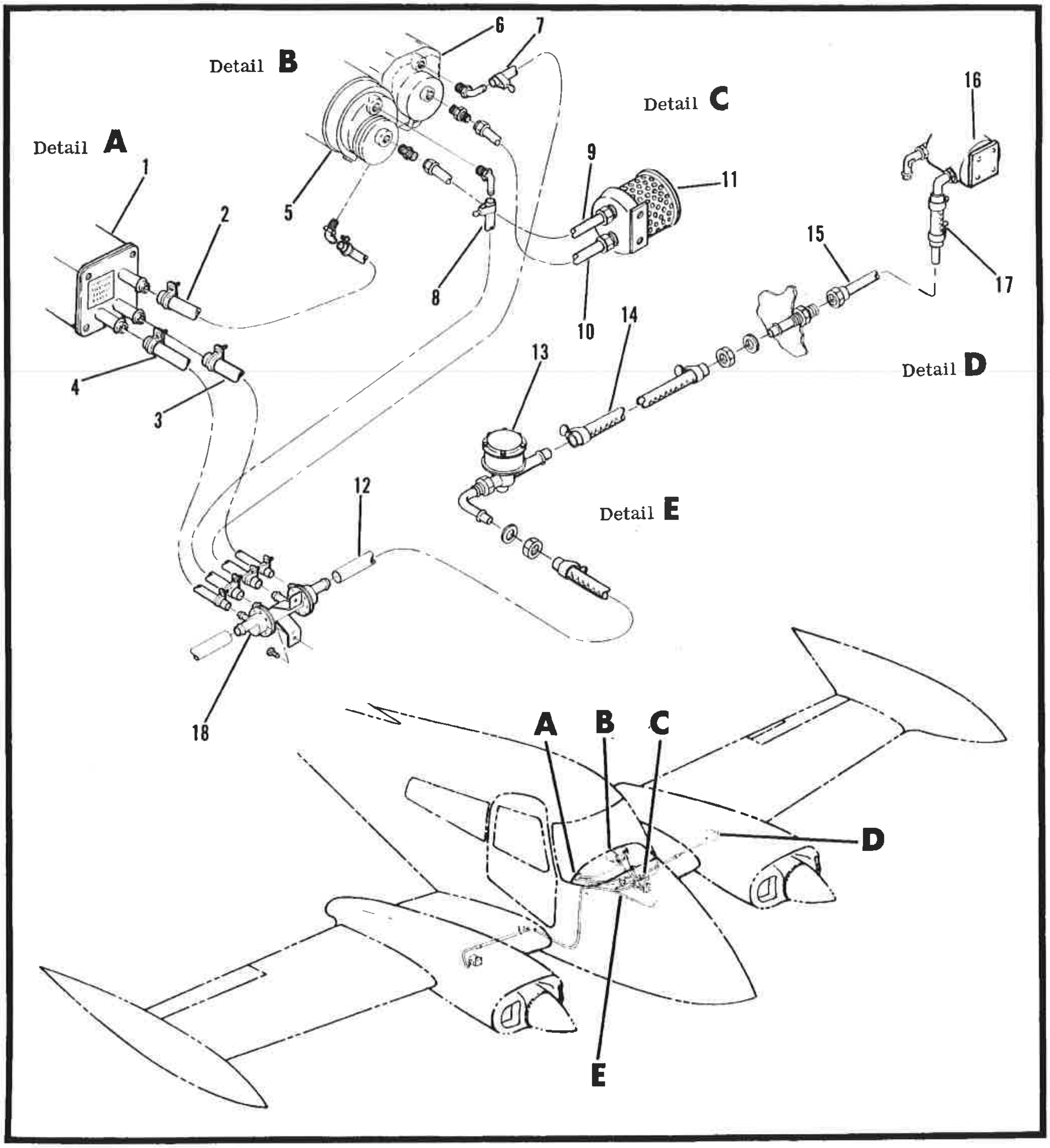


Fig. 2-15. *Cessna TU206G Turbo Stationair single-pump engine-driven vacuum system.* (Courtesy of Cessna Aircraft Company)



1. Suction Gage
2. Suction Gage to Horizontal Gyro Hose
3. Suction Gage to LH Manifold Hose
4. Suction Gage to RH Manifold Hose
5. Horizontal Gyro
6. Directional Gyro
7. Directional Gyro to Manifold Hose
8. Horizontal Gyro to Manifold Hose
9. Filter to Horizontal Gyro Hose
10. Filter to Directional Gyro Hose
11. Vacuum Air Filter Assembly
12. Manifold to Regulator Valve Hose
13. Regulator Valve
14. Regulator Valve to Engine Nacelle Hose
15. Engine Nacelle Line Assembly
16. Vacuum Pump
17. Coupling Hose
18. Manifold

Figure 12-6. Vacuum System Installation

ILLUSTRATED PARTS CATALOG

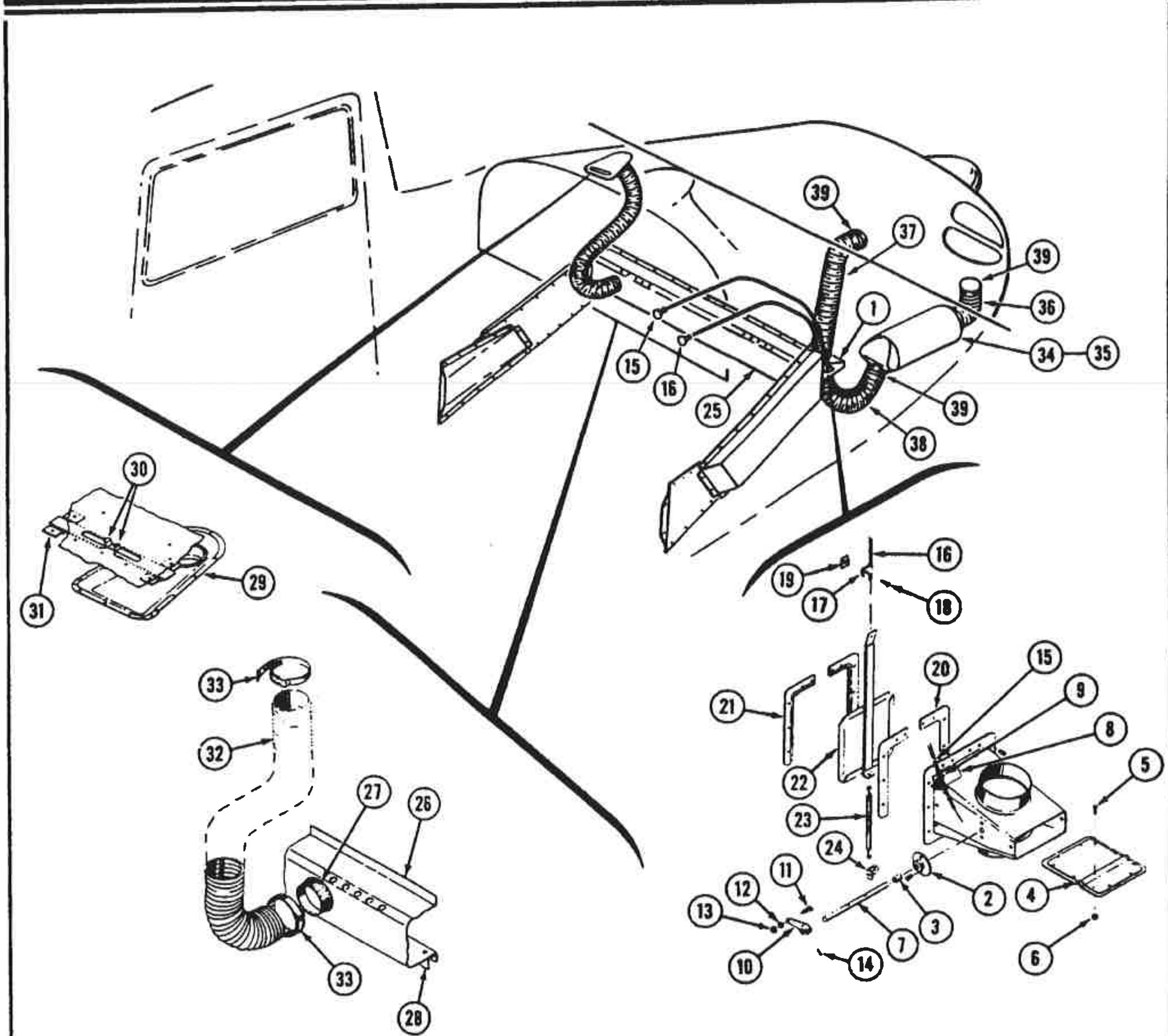
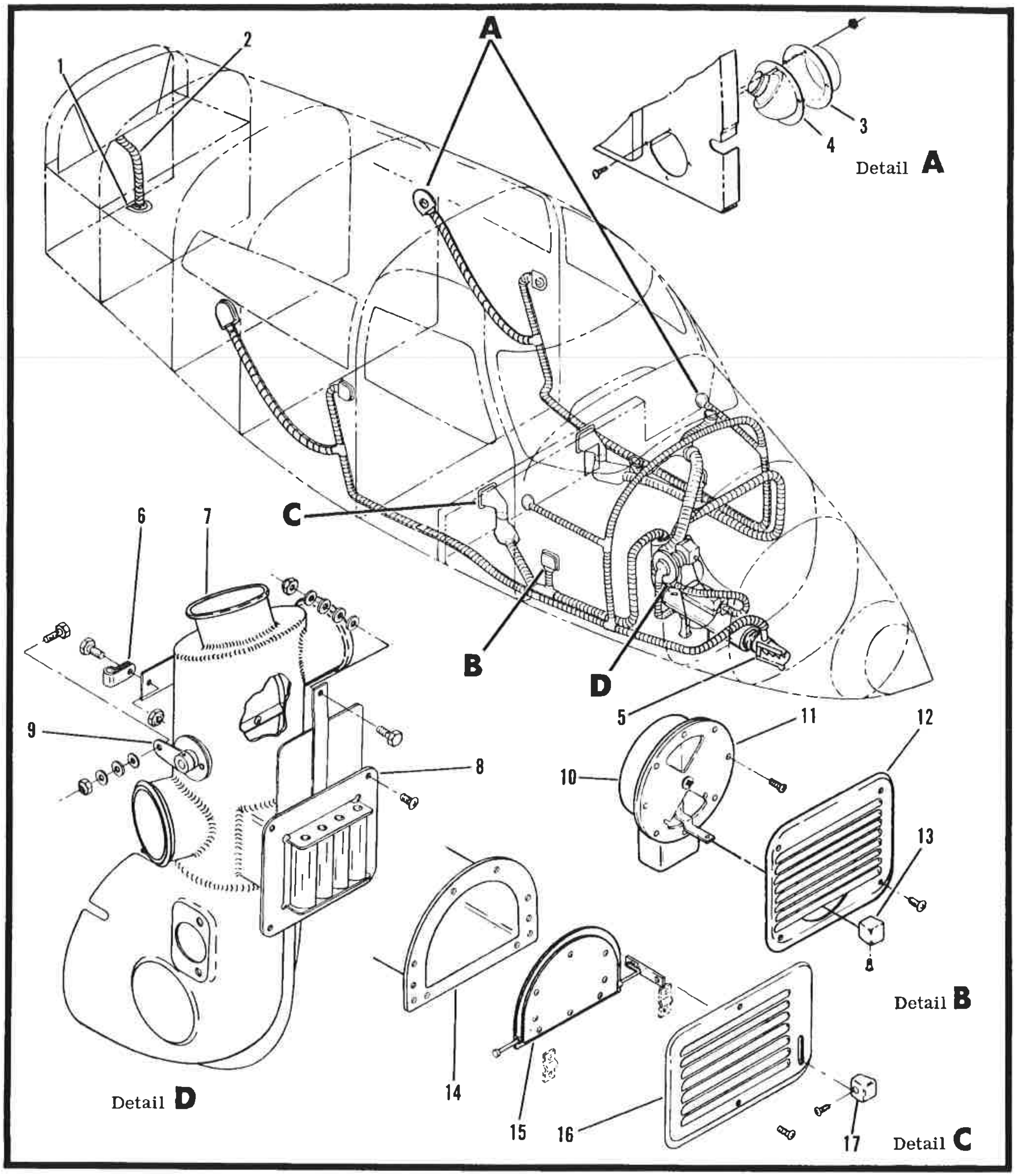


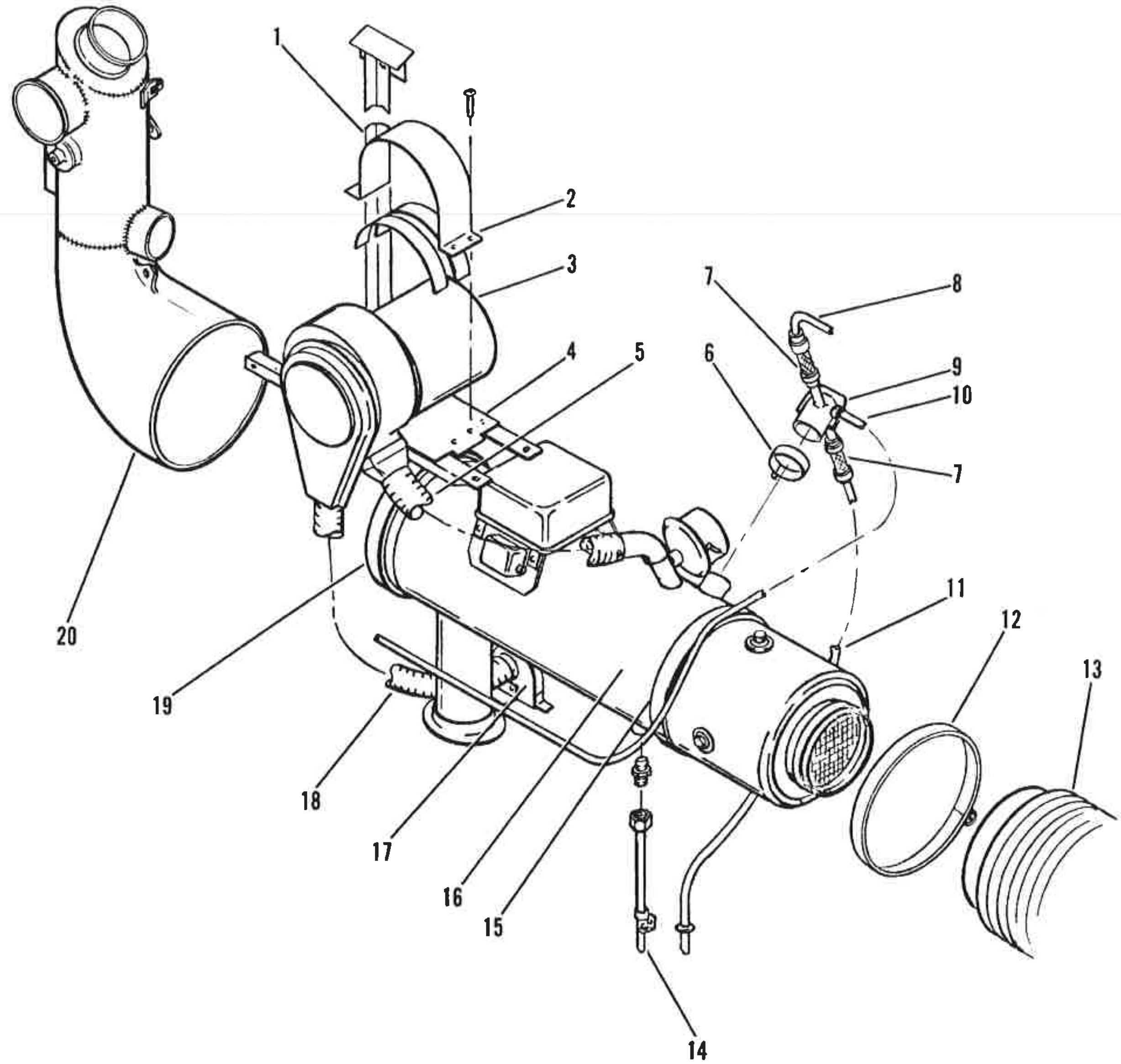
FIGURE 55. MANIFOLD TYPE CABIN HEATER INSTALLATION (SERIALS 25373 AND ON)

FIGURE AND INDEX NO.	PARTS NUMBER	DESCRIPTION	UNITS PER ASS'Y
55-	No Number	Cabin Heater Installation - (Serial 25373 & on)(0513030 Ref.)(see figure 1 for NHA)	Ref
-1	0713019-20	. Valve Assembly - Cabin heater	1
-2	0713019-41	. . Bushing Assembly - Cabin heater valve	2
-3	A367-1	. . . Bearing - Cabin heater valve (Oilite)	1
-4	0713019-85	. . Plate Assembly - Cabin heater valve	1
-5	AN526-632R9	. . Screw - (Attach gate)	2
-6	AN365-632C	. . Nut - (Attach gate)	2
-7	0713019-16	. . Shaft - Cabin heater valve	1
-8	0450286	. . Angle - Cabin heater valve	1
-9	0713019-16	. . Clip - Cabin heater valve	1
-10	0713019-24	. . Arm Assembly - Cabin heater valve	1
-11	0450311-5	. . Clamp - (Attach cabin heat control)	1
-12	AN960-10L	. . Washer - (Attach cabin heat control)	1
-13	AN364-1032	. . Nut - (Attach cabin heat control)	1
-14	52-018-078-05625	. . Roll Pin - Esna	1



1. Clamp
2. Cabin Air Spill Tube
3. Adapter
4. Wemac Valve
5. Nose Inlet Adapter
6. Clamp
7. Heat Control Assembly
8. Outlet
9. Arm Assembly
10. Adapter
11. Valve
12. Grill
13. Knob
14. Heat Outlet
15. Valve and Rod Assembly
16. Grill
17. Knob

Figure 13-3. Heating, Ventilating and Defrosting System Installation



1. Support
2. Strap Assembly
3. Combustion Air Blower and Motor Assembly
4. Support Assembly
5. Blower Outlet Tube
6. Clamp
7. Hose
8. Vent Air Inlet Line
9. Fuel Inlet Shroud
10. Fuel Line Assembly
11. Fuel Drain Line
12. Clamp
13. Ram Air Inlet Hose
14. Drain Line
15. Strap
16. Heater Assembly
17. Inlet Assembly
18. Blower Inlet Tube
19. Clamps
20. Heater Control Assembly

Figure 13-2. Heater Installation

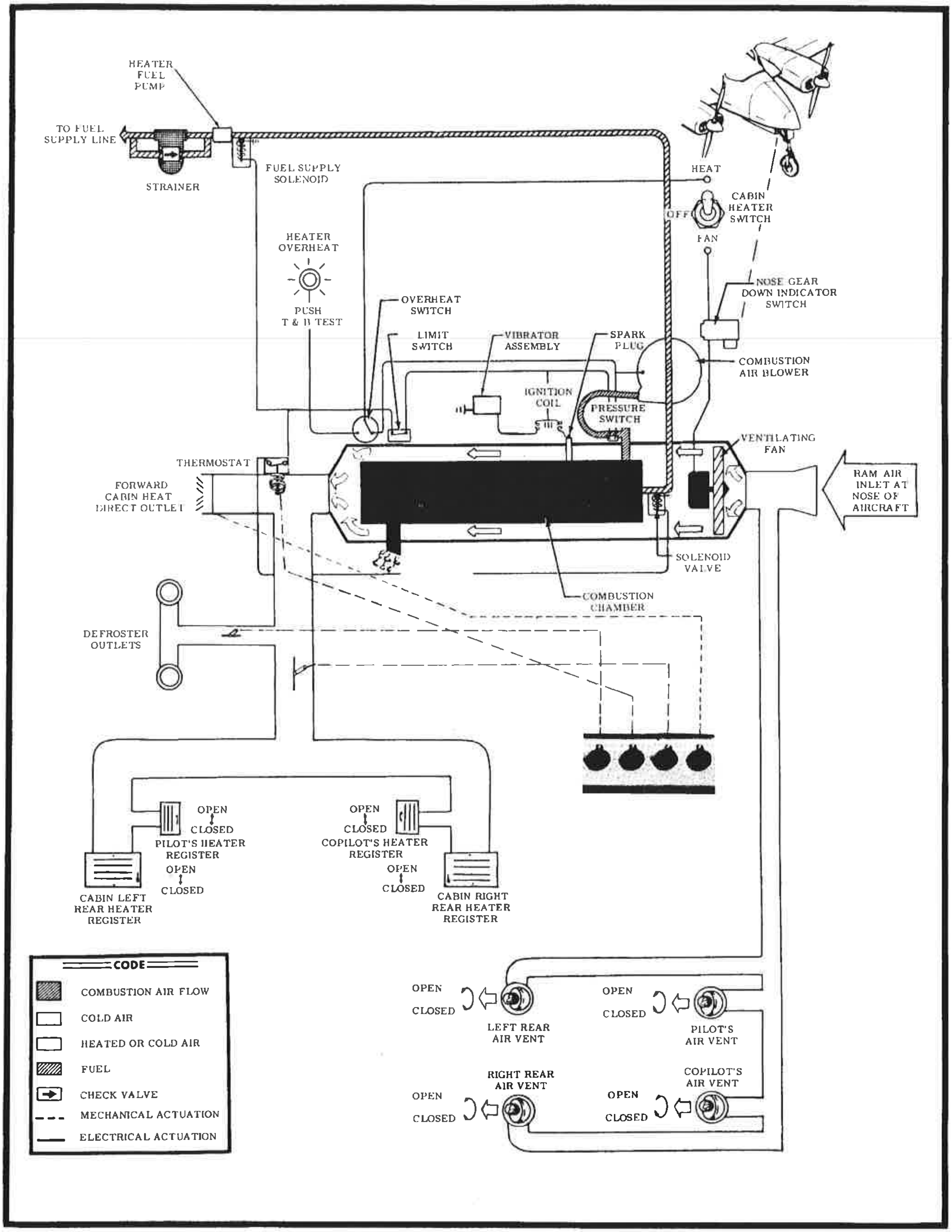


Figure 13-1. Heating, Ventilating and Defrosting Schematic

Simple
Fuel
Systems

ILLUSTRATED PARTS CATALOG

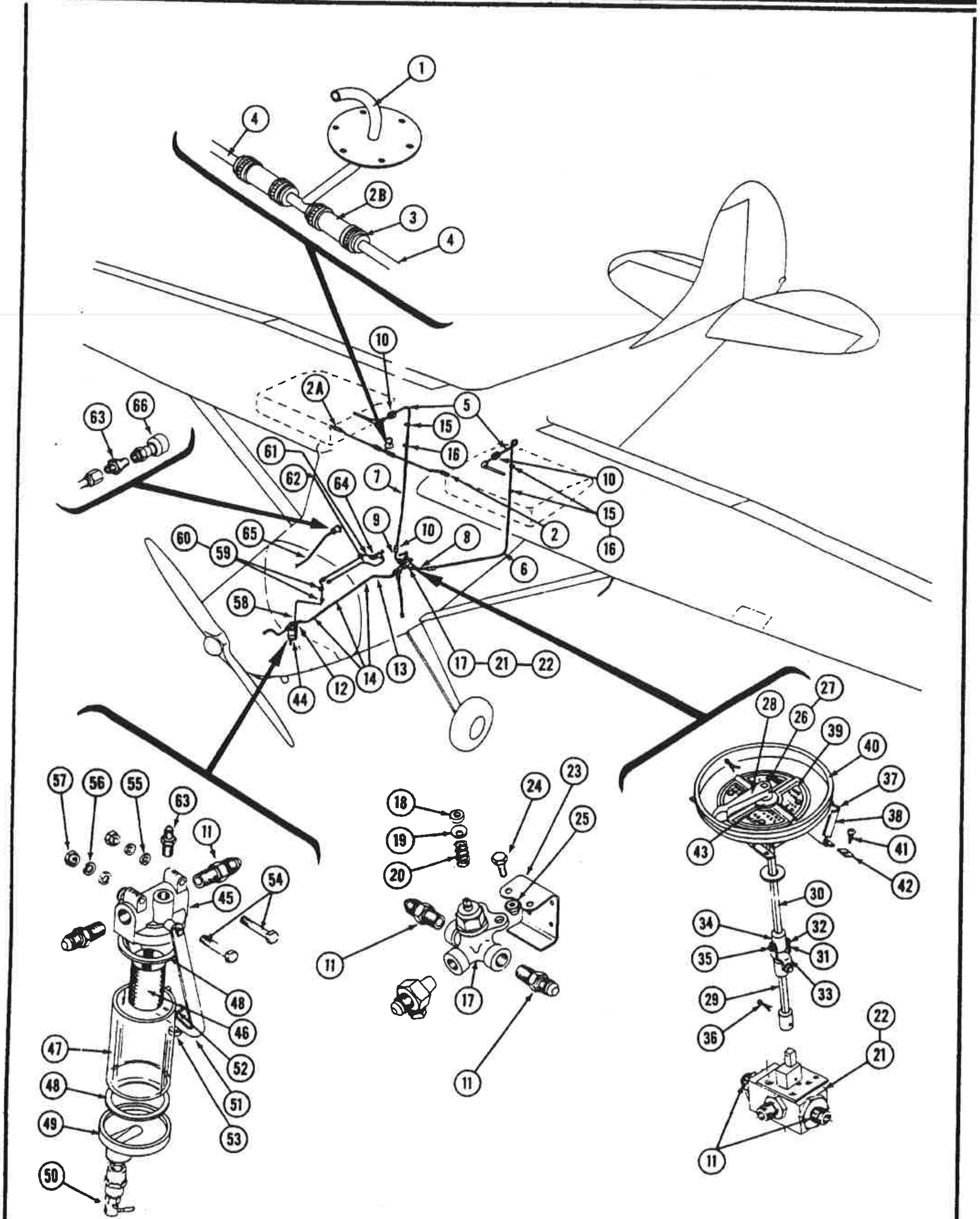
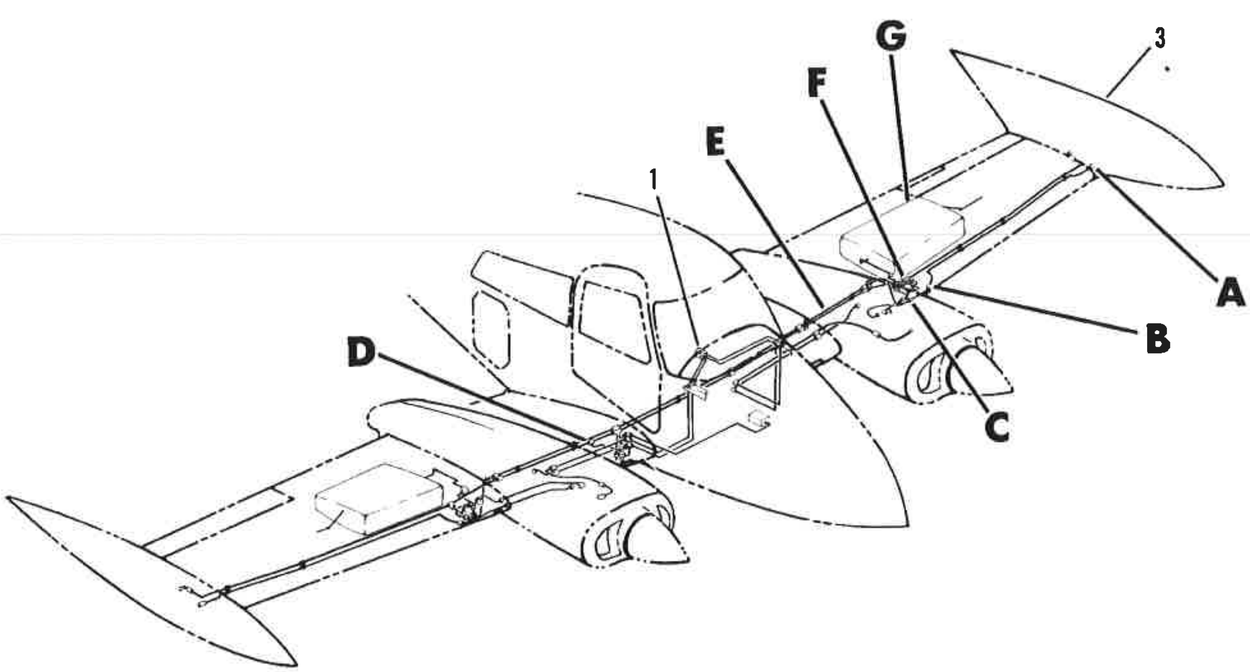


FIGURE 63. FUEL AND OIL SYSTEM



1. Fuel Flow Gage
2. Auxiliary Fuel Tank
3. Main Fuel Tank
4. Elbow
5. Line Assembly (Main tank)
6. Vapor Return Line (Outboard)
7. Reducer
8. Vapor Return Line (Center)
9. Check Valve
10. Vapor Return Line (Inboard)
11. Tee
12. Line (Engine supply)
13. Line (Strainer to nacelle tee)
14. Line Assembly (Selector valve to union)
15. Reducer
16. Selector Valve
17. Tee
18. Line Assembly (Tee to wing root)
19. Union
20. RH Crossover line
21. LH Crossover line
22. Heater fuel line
23. Line Assembly (Selector valve to tee)
24. Line Assembly (Selector valve to union)
25. Drain Fittings
26. Drain Valves
27. Heater Fuel Supply Tee
28. Elbow
29. Line Assembly (Auxiliary fuel cell to elbow)
30. Union
31. Auxiliary Fuel Cell Strainer
32. Clamp
33. Line Assembly (Fuel vent, auxiliary fuel cell)
34. Hose (Interconnecting)
35. Vent Line (Main fuel tank)
36. Line Assembly (Fuel selector valve to elbow)
37. Elbow
38. Front Wing Spar
39. Nut

Figure 11-4. Fuel System Plumbing (Sheet 1 of 2)

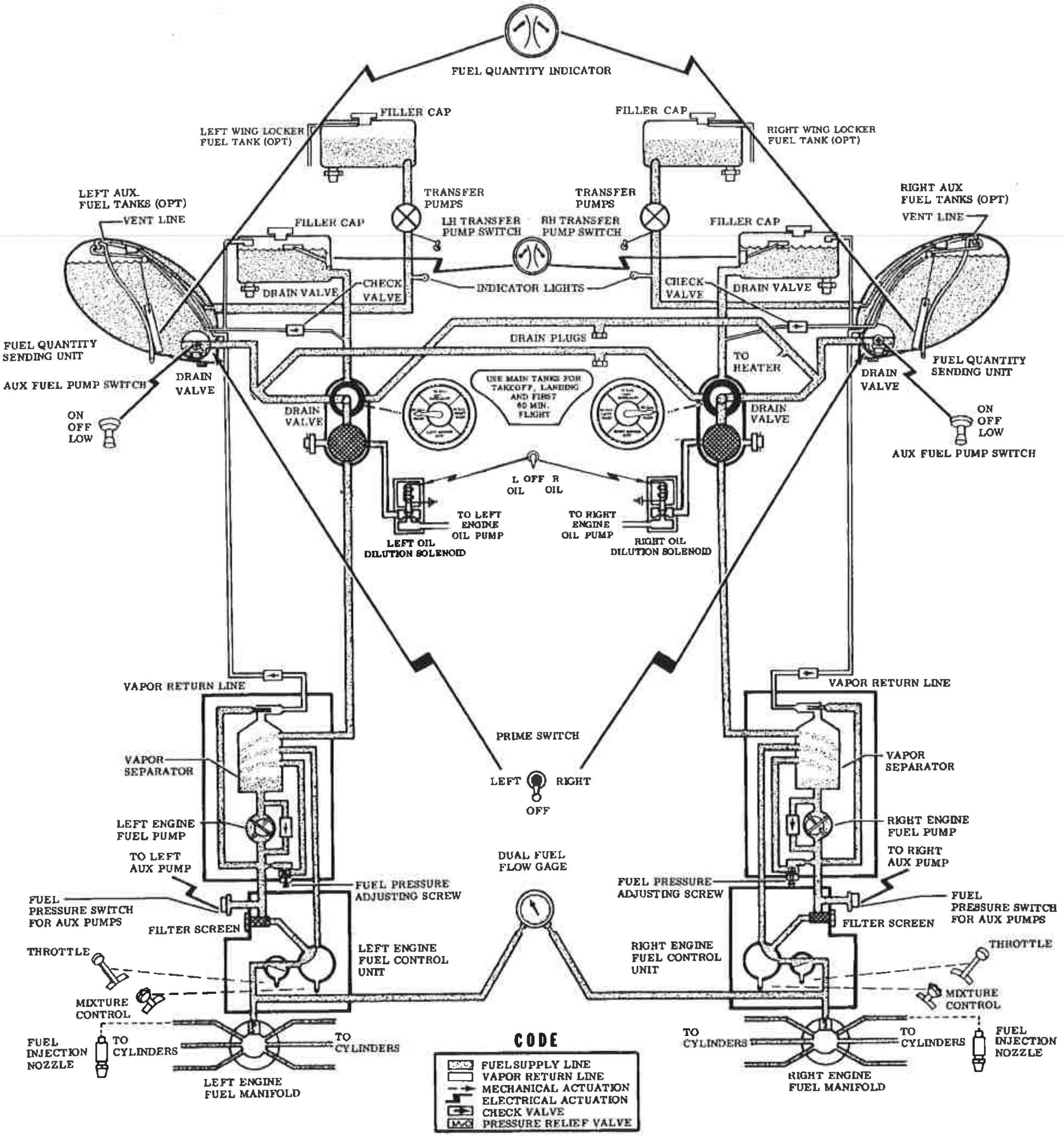
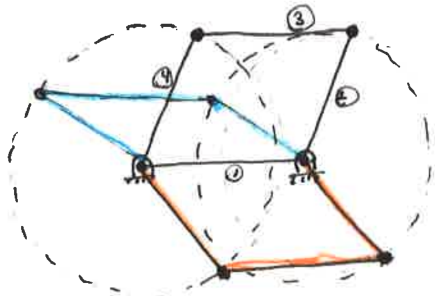


Figure 11-1. Fuel System Schematic

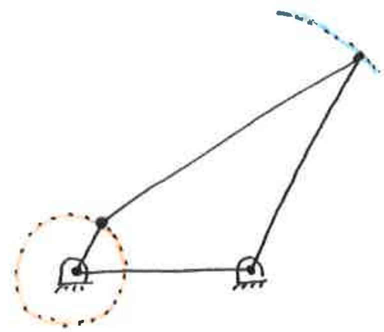
Simple
Heater
Systems

Mechanisms

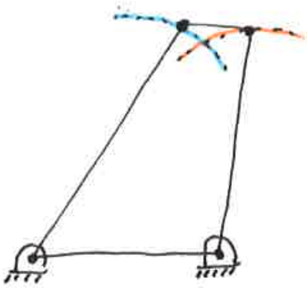
4 bar linkage



Drag Link

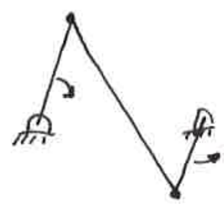


Crank Rocker



Double Rocker

The rotation direction is not always the same, for a drag link.

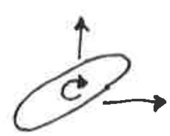


Anti-parallel

parallel

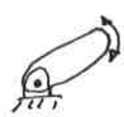
Gruebler's Equation (2D)

- Each link has 3 Degrees of freedom (DOF)



2 translate
1 rotate

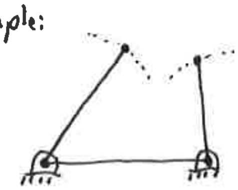
- Each pivot subtracts 2 DOF



The total system DOF = $3(N-1) - 2P$

(N ↑ links, P ↑ pivot)

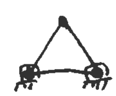
Example:



How many DOF?
3 links → $N=3$
2 pivots → $p=2$

$$DOF = 3(N-1) - 2P$$
$$= 3(3-1) - 2 \cdot 2$$
$$6 - 4 = \underline{\underline{2}}$$

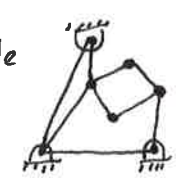
Example



3 Links
3 pivots ⇒ $3(3-1) - 2 \cdot 3 = \underline{0}$

triangles are stable

Example

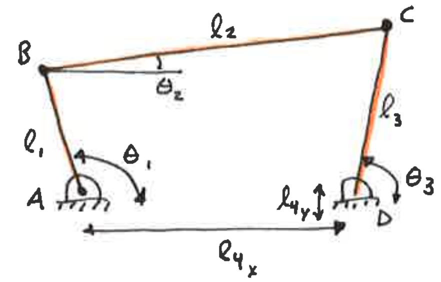


9 links
7 pivots ⇒ $3(9-1) - 2 \cdot 7 = 10$

How many DOF?

Overconstrained!

General 4 bar



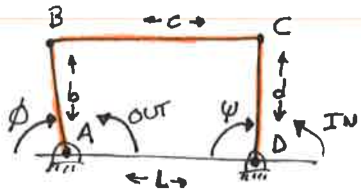
Assume system is connected

X direction: $l_1 \cos\theta_1 + l_2 \cos\theta_2 + l_3 \cos\theta_3 - l_{4x} = 0$

Y direction: $l_1 \sin\theta_1 + l_2 \sin\theta_2 + l_3 \sin\theta_3 - l_{4y} = 0$

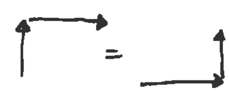
These are constraints but they dont give us information on $\theta_1 = f(\theta_3)$

Freudenstein Equation (notice the angle convention!)



Consider the term AB as the vector from A to B

AB =  CD =  DC = 

From continuity, $AB + BC = AD + DC$ 

Solve for $BC = AD + DC - AB = -(DA + CD + AB)$

Freudenstein's insight was to take the dot product of BC with BC.

$$BC \cdot BC = -(DA + CD + AB) \cdot -(DA + CD + AB)$$

Find terms for location of B,C (assuming mechanism is aligned with x axis at A and D)

$$B = [-b\cos\phi,\ b\sin\phi] \qquad C = [-d\cos\psi,\ d\sin\psi]$$

Simplify $BC \cdot BC = c^2$!! Such that

$$c^2 = [l + b\cos\phi - d\cos\psi,\ -b\sin\phi + d\sin\psi] \cdot [\text{ditto}]$$

After some simplification

$$R_1 \cos\phi - R_2 \cos\psi + R_3 = \cos(\phi - \psi)$$

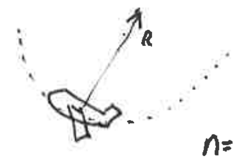
$$R_1 = L/d \qquad R_2 = L/b \qquad R_3 = \frac{L^2 + b^2 - c^2 + d^2}{2bd}$$

4 unknowns

4 equations → You need to specify 4 positions.

V-n Diagram

Steady level flight
1g = "one gee"

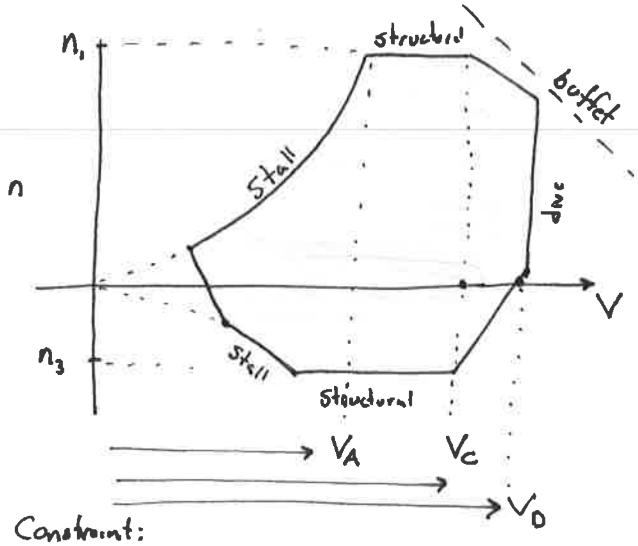


$a = \frac{V^2}{R}$

$n = 1 + \frac{V^2}{R}$

Accelerated Flight

A V-n diagram represents the aircraft design limits in terms of <u>V</u>elocity and g-loading <u>n</u>.



Stall Constraint:

$L_{max} = C_{L_{max}} \cdot q \cdot S$ and $W = n g m \Rightarrow n = \frac{W}{gm} = \frac{C_{L_{max}} \cdot q \cdot S}{g \cdot m}$

$$n = \frac{C_{L_{max}} \cdot \frac{1}{2} \cdot \rho \cdot V^2 \cdot S}{\underbrace{g \cdot m}_{\text{1-g weight}}} = \frac{1}{2}\rho V^2 C_{L_{max}} \cdot \frac{1}{\text{Wing Loading}}$$

- n depends on V^2
- $C_{L_{max}}$ with $\alpha > 0$ may be larger than $C_{L_{max}}$ when $\alpha < 0$

Load limits

Inertial loads limit the positive g-load and the negative g-load.

Dive

Dynamic pressure limit

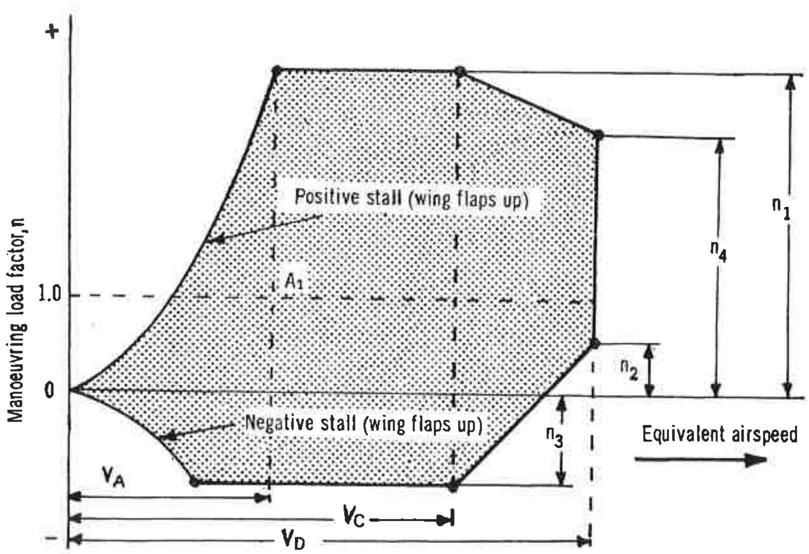
Flutter limit, etc

V_D

Load Factors FAR 23

Load factor (i.e. inertia) force)*	Category		
	Normal	Semi-aerobatic	Aerobatic
n_1	$2.1 + \dfrac{24000}{W_0 + 10\,000}$ but n_1 need not be greater than 3·5 and not less than 2·5	4·5	6·0
n_2	0	0	0
n_3	1·0	1·8	3·0
n_4	0·75 n_1 but not less than 2·0 2·5	3·5	4·5

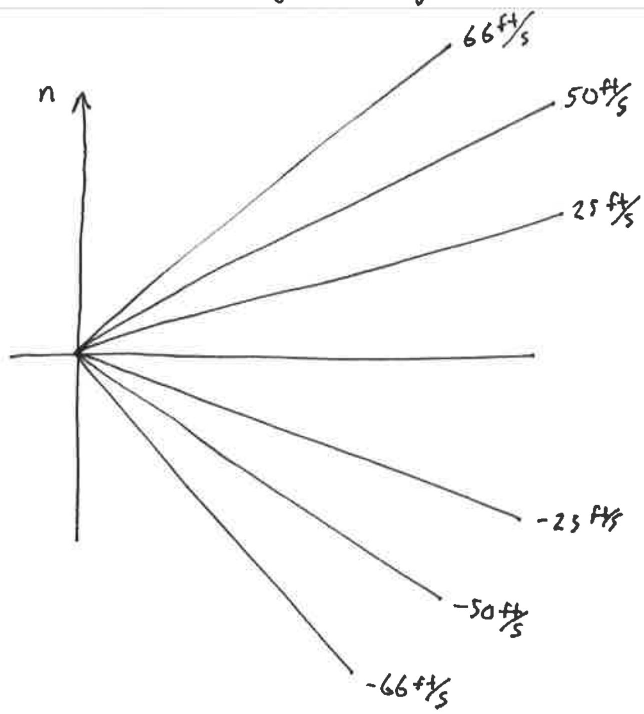
W_0 . . . lb . . . is design all-up weight.
*See Fig. 4.4(a).



Gust

$$\Delta\alpha = \tan^{-1}\left(\frac{V_g}{V}\right) \approx \frac{V_g}{V}$$

FAR 23 gives gust requirements



- 50 ft/s at V_C up to 20000 ft
- 25 ft/s at V_D up to 20000 ft
- 66 ft/s at V_B up to 20000 ft for commuter aircraft
- linear reduction above 20 kft to 50 kft