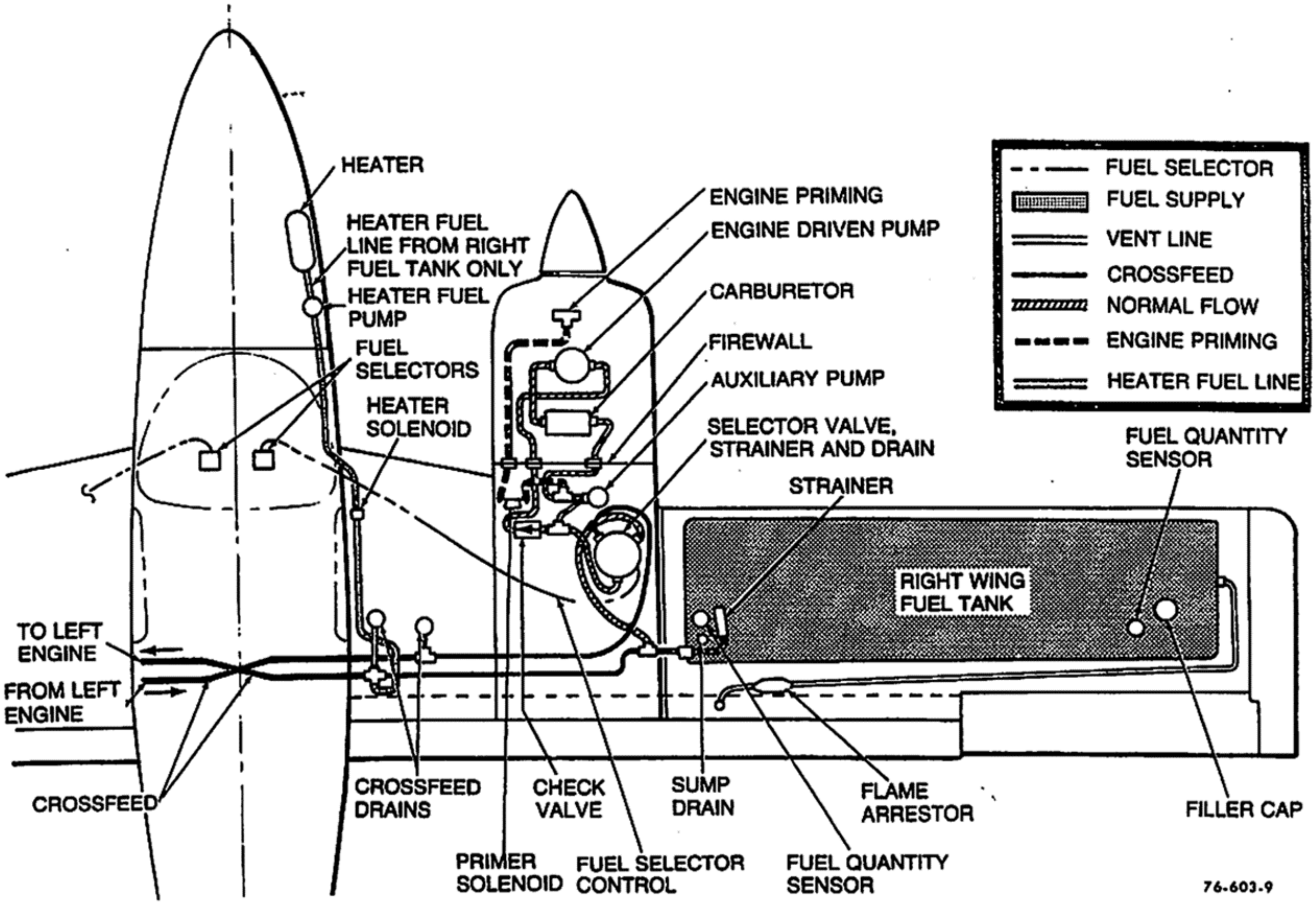
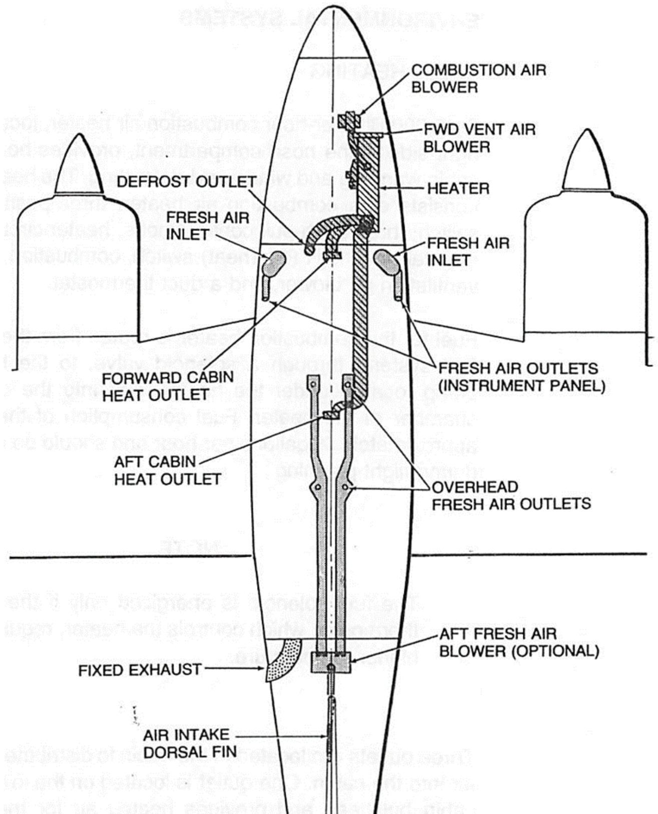
MULTI-ENGINE PRACTICAL TEST QUESTIONS

1. What is required to remain current as a pilot?	*CFR §61.56 Flight Review in any rated category.*
2. Can you fail a flight review?	*No*
3. What does a flight review consist of?	*1 hr of ground and 1 hour of flight at minimum with an authorized instructor*
4. What are the requirements to carry passengers?	*3 takeoffs & landings during day. 3 takeoffs & landings to a full stop at night. Night counts for day*.
5. What are the requirements to stay current as an instrument pilot?	*CFR §61.57(c)(1) & (2) Airplane or Sim: Within 6 cal months preceding the month of the flight; 6 approaches, holding procedures, & intercepting and tracking courses through the use of nav electronic systems.*
6. If you exceed the first 6 months?	*Recurrent with safety pilot, during next 6 months.*
7. If you exceed the 6 month "grace" period?	*IPC, Instrument Proficiency Check required.*
8. What documents are to be on you when flying?	*Valid Gov photo ID, Pilot Certificate, Medical*
9. What are the required documents to be carried on the aircraft?	*ARROW - **A**irworthiness certificate, **R**egistration, **R**adio license, **O**perating limitations, **W**t & balance*
10. Does the airworthiness certificate ever expire?	*No*
11. What are the required inspections for the airworthiness certificate to remain current? (VFR and IFR)	*AV1ATE **A**nnual, **V**OR (30 days), **1**00 hours, **A**ltimeter & static system (24 months), **T**ransponder (24 months), **E**LT (12 months/1/2 listed battery life or after 1 hour of continuous use.)*
12. What is the minimum equipment for day VFR operations?	*Ref: CFR §91.205(b) A TOMATO FLAMES **A**nticollision Lights, **T**achometer, **O**il pressure, **M**anifold pressure, **A**ltimeter, **T**emperature sensor (liquid-cooled), **O**il temperature (air cooled), **F**uel gauge, **L**anding gear position, **A**irspeed indicator, **M**agnetic compass, **E**LT, **S**eat belts*
13. What is the minimum equipment for night VFR operations?	*Ref: CFR §91.205(c) FLAPS **F**uses (spares)/circuit breakers, **L**anding light (if for hire), **A**nticollision lights, **P**osition lights, **S**ource of electricity*
14. What is the minimum equipment for IFR operations?	*Ref: CFR §91.205(d)GRAB CARD **G**enerator, **R**adios, **A**ttitude indicator, **B**all, **C**lock, **A**ltimeter, **R**ate of turn indicator, **D**irectional gyro.*

Systems	
15. Weights 1. Maximum ramp weight 2. Maximum takeoff weight 3. Maximum zero fuel weight 4. Maximum Baggage weight	Maximum ramp weight: 3,916 lbs Maximum takeoff weight: 3,900 lbs Maximum zero fuel weight: 3,900 lbs Maximum Baggage weight: 200 lbs
16. Dimensions 1. Wing span 2. Wing area 3. Length 4. Height 5. Propellor diameter	Wing span: 38 ft Wing area: 181 sq. ft Length: 29 ft 5 in Height: 9 ft 6 in Propeller diameter: 76 in
17. What type of engines do we have on the Duchess?	*Lycoming O-360, normally aspirated, direct drive, air cooled, horizontally opposed, fuel injected,* *4 cylinder, 180 HP, 2700 RPMs.* *The left engine rotates clockwise and the right engine rotates counterclockwise.*
18. Fuel 1. Capacity 2. Usable 3. Bottom of the Tab 4. Center of the Tab 5. Positions	a. Capacity: 103 gal (two 51.5 gal tanks) b. Usable: 100 gal (50 usable per tank, 1.5 unusable per tank) c. Bottom of the Tab: 30 gal d. Center of the Tab: 40 gal e. Positions: On – Cross feed- off
19. Describe the fuel and cross-feed system.	*2 - 51.5 gallon tanks in each wing. 100 useable Fuel moved by engine-driven pump for each tank, with backup electric pumps. Fuel cannot be transferred from tank to tank, however, either tank may feed both engines in cross feed mode. Cross-feed lines allow fuel to be supplied to opposite engine. The fuel cross feed system is to be used during emergency conditions in level flight only.*
20. Fuel Drain locations	*8 total drains (4 per side)* • *Outboard of each nacelle* • *Fuel selector valve* • *Two on each main wheel well for cross feed lines*
21. Priming	*Priming is accomplished by push to prime on each magneto. (cylinders 1,2, and 4)*
22. Cabin Heating	• 45,000 btu-per-hour combustion air heater ○ The British thermal unit (btu) is defined as the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit • Uses fuel from the right-wing tank (approx. 2/3 gal/hr) • Overtemperature switch ill deactivate the heater at approximately 300 ° F

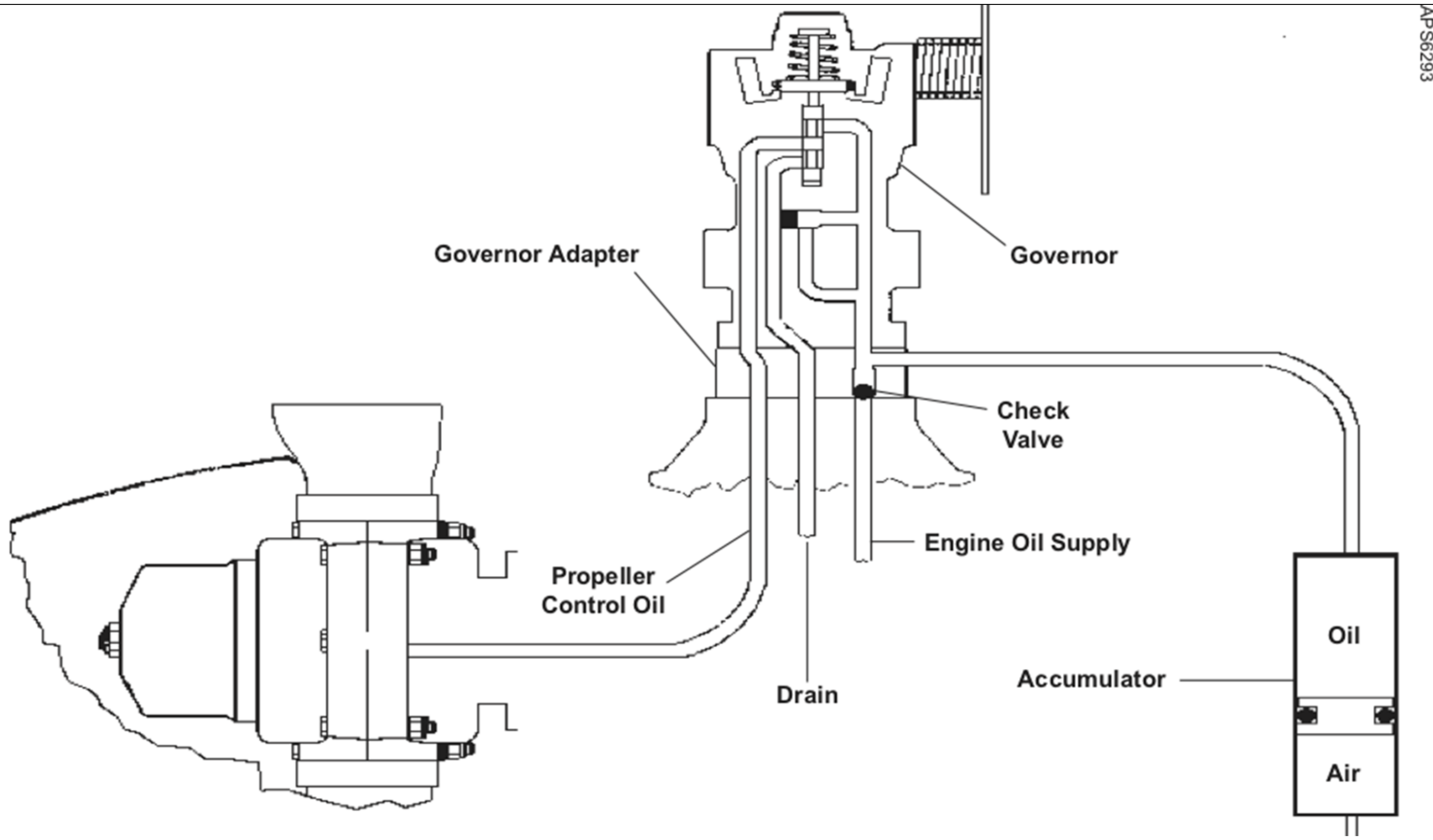


Above: Fuel System Schematic

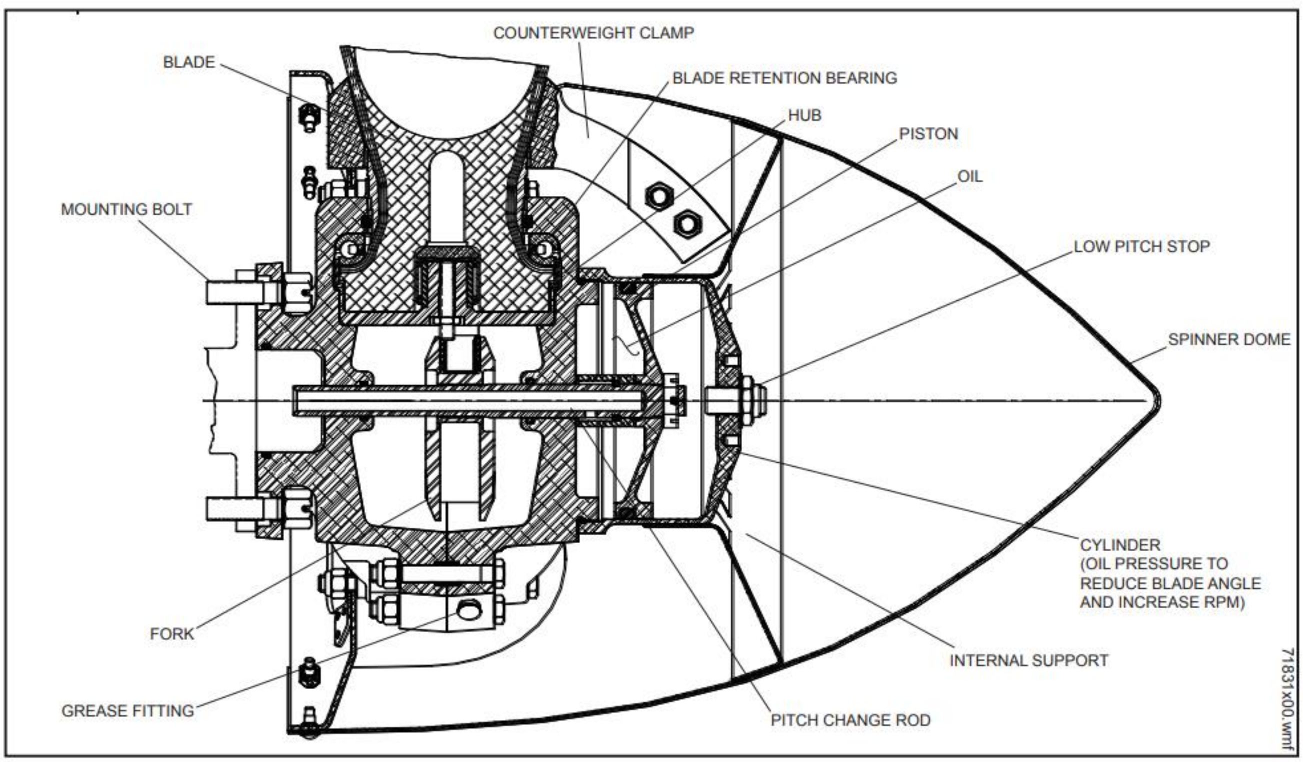


Above: Heater Schematic

Systems: Propeller	
23. Describe the propeller system.	*Counter-rotating, constant speed, full feathering Hartzell 2-blade operation.* • *Engine oil under governer boosted pressure maintains high RPM or unfeather position.* • *Springs and dome air (Nitrogen pressure), aided by counterweights, move the pitch into a low RPM or feathered position.* *The system fails in the most favorable position (Feathered: high pitch, low rpm)*
1. Governor	*Engine RPM sensing device. Supplies oil through the propeller shaft at various pressures to maintain constant RPM.*
2. Function of the feathering pin/lock	• *Prevents feathering during shutdown.* • *This pin inhibits feathering below 800 RPM by centrifugal force.*
3. Speed conditions i. On Speed ii. Overspeed iii. Underspeed	*i. On Speed: Engine rpm = propellor rpm. Pilot valve blocks oil from entering or exiting the hub* *ii. Overspeed: Engine rpm > propellor rpm. Tension is released on the speeder spring. Centrifugal force moves the flyweights outward. The pilot valve moves upward. Oil flows from the hub to the sump to maintain constant speed.* *iii. Underspeed: Engine rpm < propellor rpm. Tension is increased on the speeder spring. Centrifugal force moves the flyweights inward. The pilot valve moves downward. Oil flows from the sump to the hub to maintain constant speed.*
4. Counterweights	*Mounted on the blades. Centrifugal force moves oil to high RPM. Oil pressure on the piston opposes the twisting of the blade.*
5. Unfeathering accumulator	*Unfeathering accumulators store oil from the engine to use for forcing the propellers out of the feather position. This builds pressure by means of the engine oil pumps. If the are use and the blades do not unfeather, then the pressure won't build again till the engine has been restarted (this means using the accumulator is a one-shot deal). Therefore, the only remaining way to unfeather is to use the starter.*

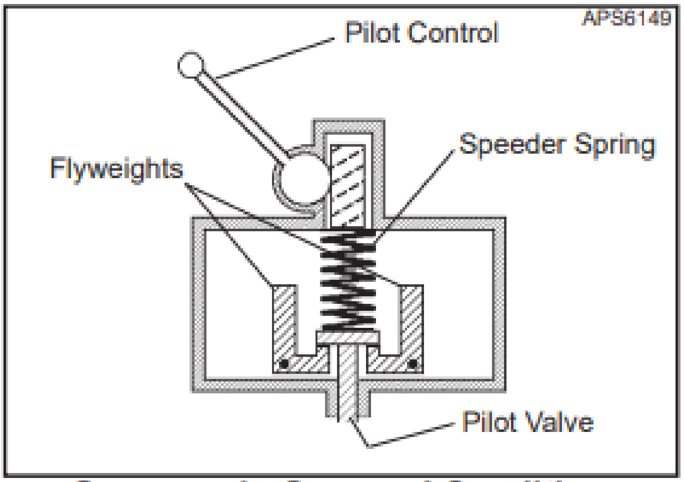


Above: Propeller Schematic

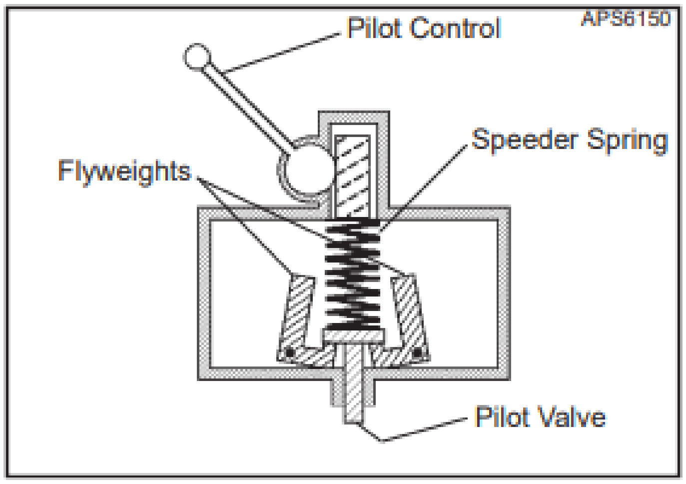


Cutaway of -4 Series Constant Speed, Counterweighted Propeller
Figure 2-5

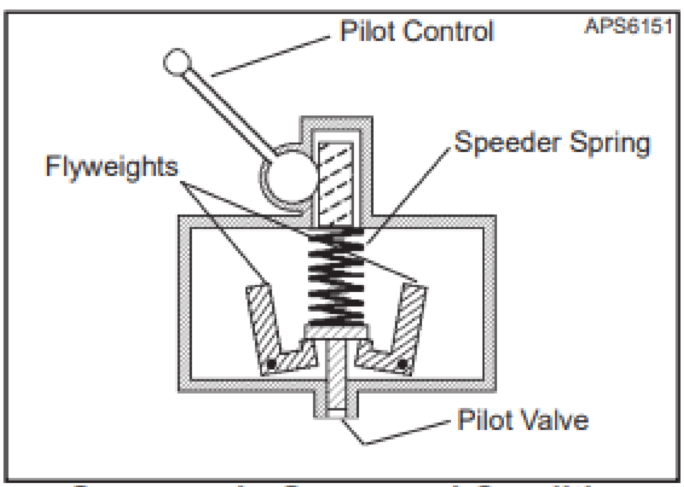
Above: schematic from Hartzell Manual



Governor in Onspeed Condition
Figure 2-6

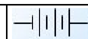
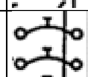
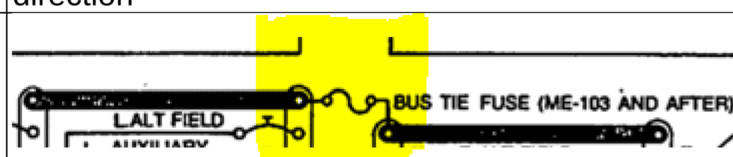


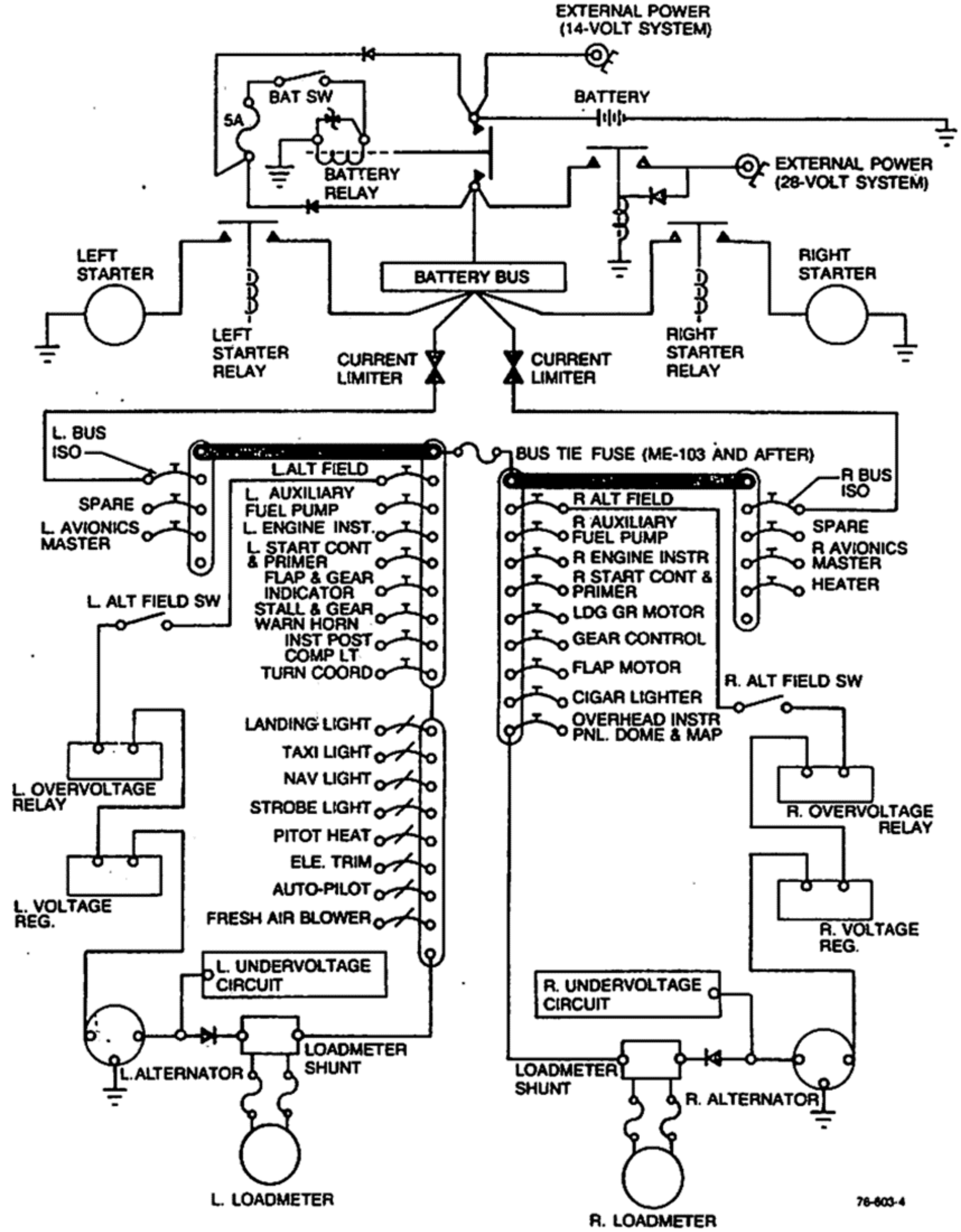
Governor in Underspeed Condition
Figure 2-7



Governor in Overspeed Condition
Figure 2-8

Above: Speed Conditions

Electrical System	
24. Describe the electrical system.	• *2-70 amp,28V engine-driven alternators, voltage regulators, ammeters, circuit breakers, various switches, relays & 2 12V batteries* • *The Battery powers the starter solenoids and the main bus bar* • *Battery Fumes are vented outside through two vents in the lower fuselage below the battery box* • *Output of each alternator is controlled by a separate voltage regulator* • *The Alternator systems are completely separate, except for the bus tie fuse, the mutual tie to the battery bus through two bus isolation circuit breakers, and the paralleling circuit between the regulators*
Symbol Identification	
1. Battery	
2. Ground	
3. Fuse	
4. Combination circuit breaker switches	
5. Circuit breakers that can be manually pulled	
6. Diode	 A device that conducts electricity only in one direction
7. Bus Isolation breaker	 Provides a means of disconnecting the alternator from te battery, so that in the event of an alternator failure the battery will not discharge through it.
Terminology	
8. Loadmeter Shunt	Part of the instrument on the panel which displays how much current the alternator is supplying. Relies on Ohms law for operation.
9. Bus tie fuse	Connects the system together allowing an alternator to provide power to the other devices in case of an alternator failure. It additionally serves as a fuse to isolate in the event of overvoltage from one alternator.
10. Voltage regulator	Controls the alternator output by controlling the field current. The overvoltage and undervoltage devices warn the pilot of those conditions through lights on the panel



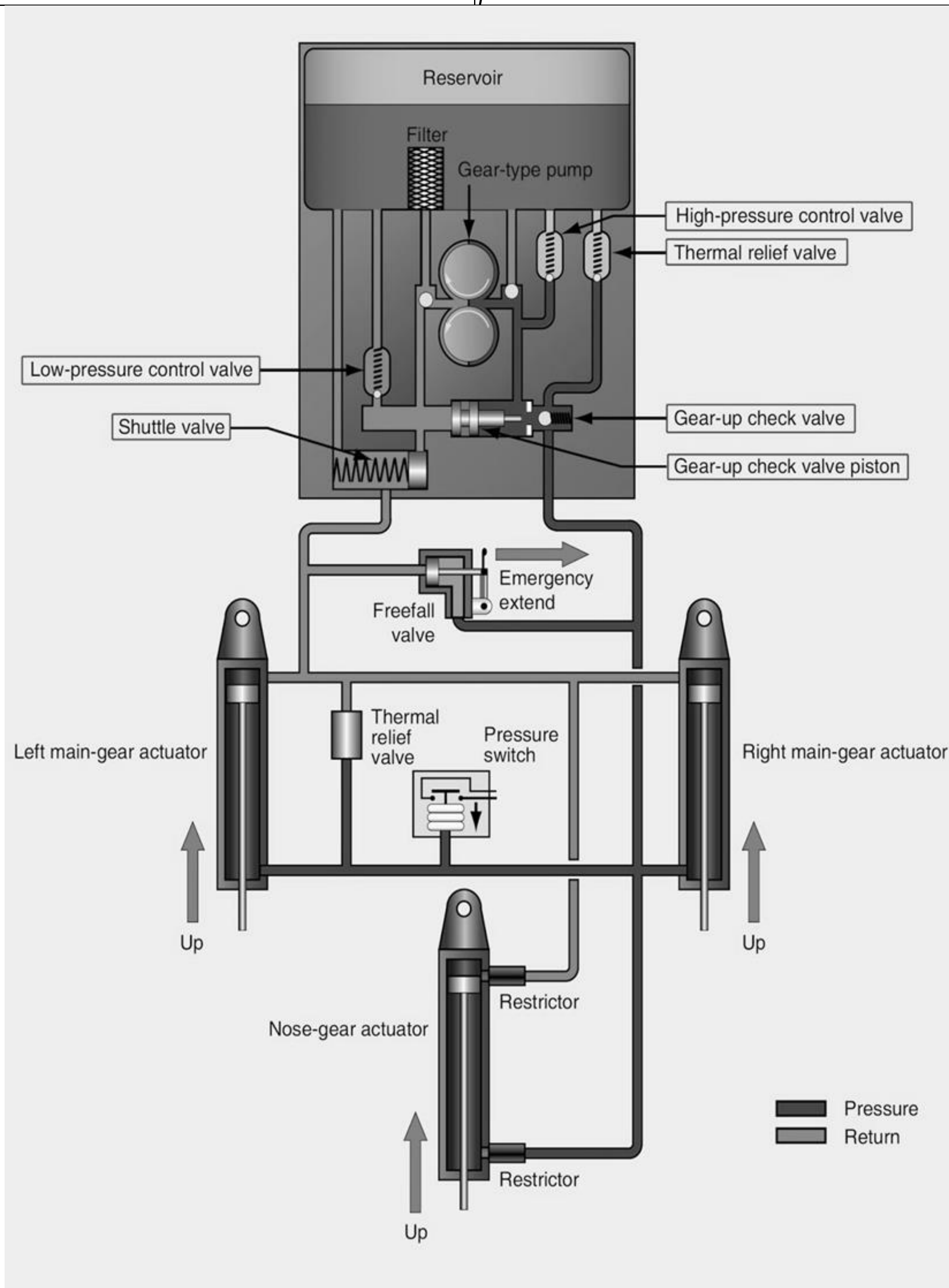
Above: electrical schematic from POH

<table>
<tr><th colspan="2">Landing Gear</th></tr>
<tr><td>25. Describe the landing gear system.</td><td>The retractable tricycle landing gear is fabricated from magnesium castings and aluminum forgings.

Retraction and extension of the gear is accomplished by use of an electrically driven hydraulically operated by fully reversible pump and hydraulic system terminating in a hydraulic actuator assembly mounted in each wheel well. Pressure holds the gear up, no up locks.</td></tr>
<tr><td>1. Identify the functions of the pressure switch, high and low pressure.</td><td>Electric limit switches stop electricity to motor of pump at a certain pressure when gear retracted or extended</td></tr>
<tr><td>2. How does the landing gear retract?</td><td>• Pump begins to turn, fluid flows towards the gear up check valve
• The gear up check valve moves and fluid flows toward the high-pressure distribution manifold
• From the distribution manifold, fluid flows to the base of the actuating cylinder and fills it, retracting the gear
• The fluid on the down side of the cylinder moves to the low-pressure distribution manifold
• From there it moves up to the shuttle valve
• The shuttle valve moves and the fluid is free to flow to the pump/reservoir
• Vlr :112
Note: On the high-pressure retraction side there is an orifice to slow the flow of fluid from the nose wheel. This is so that the nose does not slam in while retracting due to the help of aerodynamic forces</td></tr>
<tr><td>3. How does the landing gear extend?</td><td>• Gear pump turns, fluid flows down against the shuttle valve.
• The shuttle valve moves
• The fluid is then free to flow to the low-pressure distribution manifold
• Once reaching the manifold, it fills actuating cylinders on the extension side
• Fluid that was on the retraction side, flows back up through to the high-pressure distribution manifold. That fluid then flows up to the gear up check valve
• The gear up check valve moves, allowing the fluid to flow back to the pump and reservoir
• Vle/Vlo: 140</td></tr>
<tr><td>4. How does the emergency gear extension work?</td><td>Pilot uses the lever to rotate the hydraulic pressure bypass valve 90° counterclockwise.

Turning the valve releases hydraulic pressure and gravity pulls the gear down to the extended position.</td></tr>
<tr><td>5. High pressure control</td><td>Protects system when pressure is too high.</td></tr>
<tr><td>6. Low pressure control</td><td>Send fluid to reservoir when need less pressure.</td></tr>
<tr><td>7. Shuttle valve</td><td>Allows displaced fluid to return to the reservoir.</td></tr>
<tr><td>8. Time delay relay</td><td>Retraction operation is protected by a time-delay relay which will disengage electrical power to the hydraulic pump motor after 30 seconds of continuous pump operation. Can be reset by moving the gear handle to the down position</td></tr>
<tr><td>9. Safety retraction switch</td><td>To prevent inadvertent retraction of the landing gear on the ground, a safety pressure switch is installed in the pitot system to deactivate the hydraulic pressure pump</td></tr>
</table>

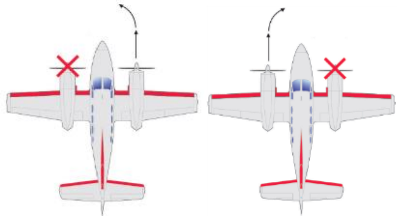
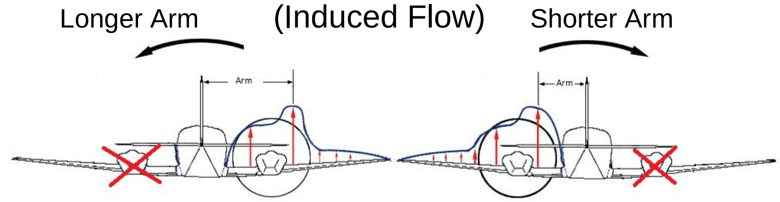
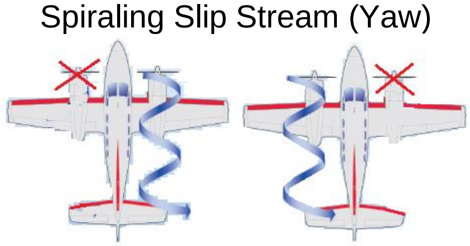
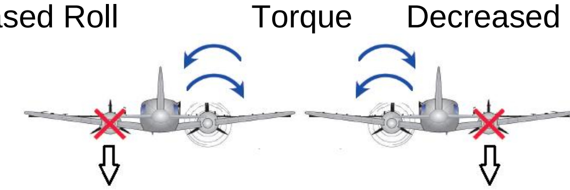
	circuit when the impact air pressure is below 59-63 knots.
10. Warning horn	1. *If either throttle levers are retarded below an engine setting sufficient to sustain flight (Maintenance set) and the gear is retracted the horn will sound.* 2. *If the flaps are extended beyond approximately 16 degrees with gear retracted the horn will sound*
11. Circuit breakers	*Gear motor and gear control breakers for system protection*



Above: Landing Gear Schematic

Systems	
Flaps	• Wing flaps are operated by an electric motor located under the right rear passenger seat and connected via torque tubes which operate worm gears to extend or retract the flaps. • They are operated by a three-position switch located to the right of the throttle quadrant with an Up, down, and off position • The switch must be pulled out of the detent to raise or lower the flaps • There is an indicator gauge with up, 10°, 20°, and down (35 °)
Stall Warning Tabs	• Left wing sounds warning when flaps are approximately 16° and below • Right wing sounds warning when flaps are above 16°
V speeds	
Vso	60
Vmc	65
Vs	70
Vr	71 DCT Practice: Vr at 75 for a safer margin above stall speed
Vx	71
Vsse	Safe, intentional OEI Speed- originally known as safe single engine speed, now defined as the minimum speed to intentionally render the critical engine inoperative. 71
Vy	85
Vxse	Best angle of climb speed with one engine inoperative (blue line on most airspeed indicators) 85
Vyse	Best rate of climb speed with one engine inoperative (blue line on most airspeed indicators) 85
Vso	60
Va range	116 (3,000 lbs) – 132 (Max Weight)
Vno	154
Vne	194
Vlr	112
Vle/Vlo	140
Vfe (20°)	120
Vfe (Full)	110
Best Glide (3,000)	82
Best Glide (Max)	95
Maximum Crosswind limitation	25 kts

VMC	
26. What is the definition of V_{MC} ?	*Minimum control speed with the critical engine inoperative and windmilling, and the operative engine developing maximum power available. Min speed that directional control can be maintained. 65 KTS*
27. What is the critical engine?	*The engine whose failure most adversely affects the performance or handling characteristics of the aircraft.*
28. Which is the critical engine on a conventional twin?	*The engine whose failure would most adversely affect the performance and/or handling qualities of an aircraft.* *For most twins, with both engines rotating clockwise, thi critical engine is the left*
29. What regulation is used to determine V_{MC}?	*14 CFR §23.2135(c) Replaced §23.149 08-30-17* *"(c) VMC is the calibrated airspeed at which, following the sudden critical loss of thrust, it is possible to maintain control of the airplane. For multiengine airplanes, the applicant must determine VMC, if applicable, for the most critical configurations used in takeoff and landing operations."*
30. What conditions did manufacturers use to determine Vmc under former CFR §23.149?	*MMMM CC TGOF* • ***M**ax available power on operating engine @ sea level, standard day;* • ***M**ax gross weight;* • ***M**ost unfavorable CG;* • ***M**ax 5° bank into operating engine;* • ***C**ritical engine windmilling;* • ***C**owl flaps set to takeoff;* • ***T**rims set for takeoff;* • ***G**ear up;* • ***O**ut of ground effect;* • ***F**laps set for takeoff.*
31. What factors determines the critical engine?	*PAST: **P**-Factor (Yaw), **A**ccelerated Slip Stream (Roll), Spiraling Slip Stream (Yaw), **T**orque (Roll)*

<table>
<tr>
<td>P-Factor (Yaw)
Downward right blade, higher AOA, more thrust.
</td>
<td>Accelerated Slip Stream (Roll)
Longer Arm (Induced Flow) Shorter Arm

</td>
</tr>
<tr>
<td>Spiraling Slip Stream (Yaw)

More Rudder Control
when slipstream hits the rudder from the left engine</td>
<td>Increased Roll Torque Decreased Roll

Newton's 3rd Law: For every action, there is an equal and opposite reaction.</td>
</tr>
</table>

Performance	

32. Zero Sideslip	• Method for maintaining aircraft heading and reducing drag
	• Aircraft is banked (2 – 5 degrees)
	  ○ Wing dihedral creates a horizontal component of lift
	  ○ This horizontal component of lift minimizes the amount of rudder deflection needed to align the aircraft with the relative wind
	• The pilot must also apply enough rudder towards the operating engine as required to “split” the ball as indicated on the inclinometer

33. Accelerate-Stop Distance *Use performance chart*	The distance required to accelerate an airplane to a specified speed and, assuming failure of an engine at that to bring the airplane to a stop *Use performance chart*
34. Accelerate- Go Distance *Use performance chart*	The distance required to accelerate an airplane to a specified speed and, assuming failure of an engine at that speed, feather inoperative propeller and continue takeoff on the remaining engine to a height of 50 feet *Use performance chart*
35. Single engine service ceiling	The highest altitude at which the airplane can maintain a steady rate of climb of 50 fpm with one engine operating at full power and one engine’s propeller feathered
36. Single engine absolute ceiling	The altitude where climb is no longer possible with one engine operating at full power and one engine’s propeller is feathered
37. What is climb gradient?	Climb gradient is the altitude gained per 100 feet of horizontal travel, expressed as a %. An altitude gain of 1.5’/100’ of horizontal travel is a climb gradient of 1.5%.
38. Calculate distance to climb to 1,000’.	$\frac{(Altitude)}{(Single\ Engine\ Climb)}\ x\ \frac{(Ground\ Speed)}{60} = \mathbf{Distance\ to\ Climb\ To\ Altitude}$ 1000′/300 x 80/60=3.33 $minutes\ x$ 1.33 $nm\ per\ min$=$\mathbf{4.4\ nm\ to\ Climb\ to\ 1000'}$
39. Why is it that we lose 80% of our performance when we lose an engine?	$Total\ HP - Straight\ \&\ Level\ HP = \mathbf{Excess\ Thrust\ HP}$ $Excess\ Thrust - Engine\ Lost\ HP = \mathbf{Remaing\ Excess\ Thrust\ HP}$ $\frac{Remaining\ Excess\ Thrust\ HP}{Total\ HP} = \%\mathbf{Power\ Remaining\ for\ Climb}$ $100 - \%Power\ Remaining = \%\mathbf{Power\ Loss\ for\ Climb}$

40. Climb performance single engine	$\frac{100\%}{(Multi\ Engine\ Climb)}\ x\ (Single\ Engine\ Climb) = \%\boldsymbol{Power\ Left}$ $100\% - \%Power\ Left = \%\boldsymbol{Power\ Loss\ in\ Climb}$
41. How to calculate maneuvering speed	$Va@Max\ Gross\ x\sqrt{\frac{Your\ Weight}{Max\ Gross}} = Va$