A102 AIRCRAFT SYSTEMS

References: FAA-H-8083-25A, Pilot's Handbook of Aeronautical Knowledge, Chapters 2, 5, 6 (pgs 1-7, 10, 14-18, 25-32) and 7 (pgs 1-10, 15-20, 22-26)
DA20-C1 Flight Information Manual

WARNINGS, CAUTIONS AND NOTES.
This manual contains warnings, cautions and notes before applicable operations.

WARNING: A WARNING informs the person performing the operation that injury or death is possible if they do not follow the instructions.

CAUTION: A CAUTION informs the person performing the operation that damage to equipment is possible if they do not follow the instructions.

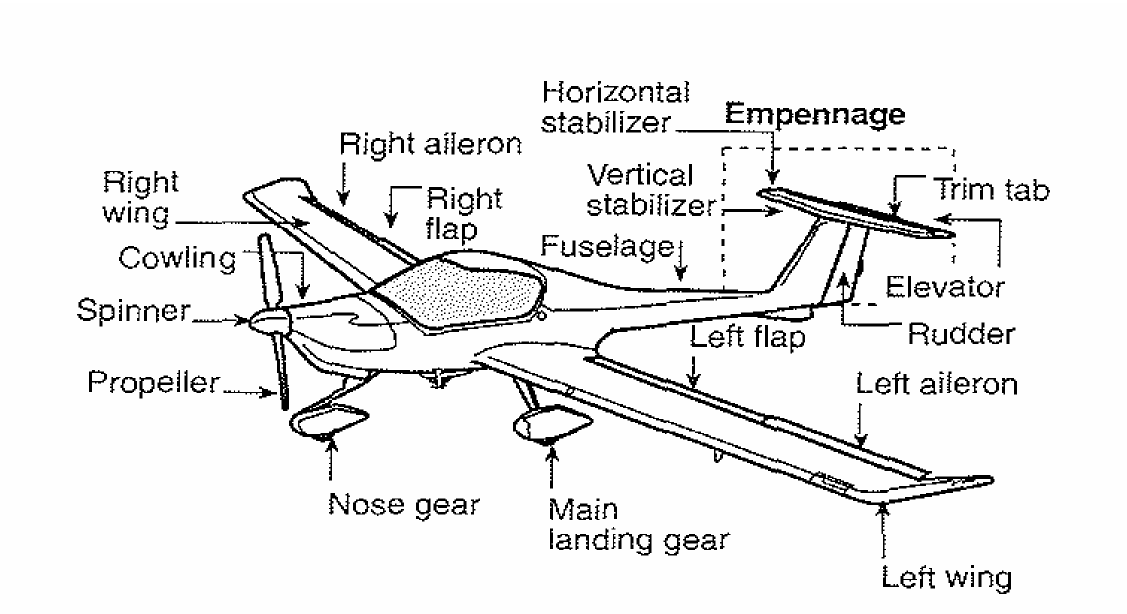
NOTE: A NOTE informs the person performing the operation how to make the task easier.

INTRODUCTION
The objective of this unit is to be able to identify and describe basic aircraft components in relation to their effect on the pilot's operation of the aircraft. Pilots do not need to be able to design and build aircraft in order to effectively employ the machine; however, a thorough knowledge of the aircraft allows the pilot to synthesize and evaluate sensory data to make good employment decisions. The student should know the location, nomenclature, and basic function of aircraft components and be able to describe the basic operation of aircraft systems.

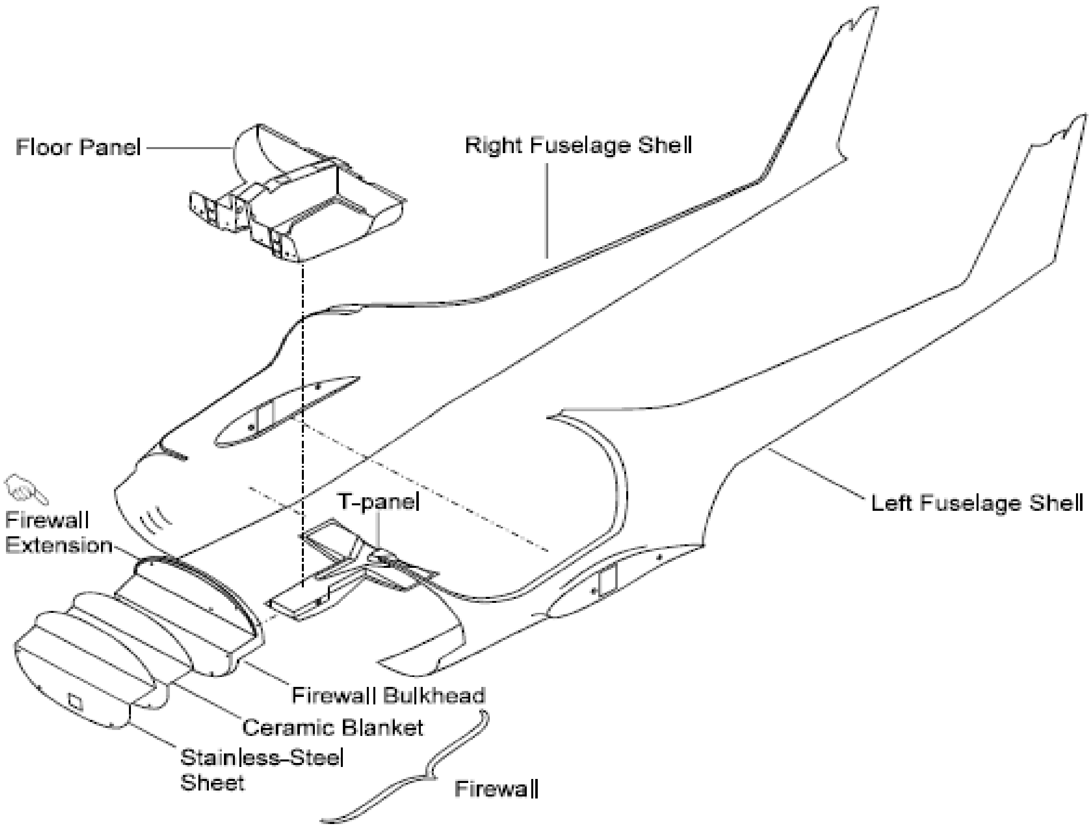
IFS is conducted in the Diamond Aircraft DA20-C1, manufactured by Diamond Aircraft in London, Ontario, Canada. The DA20-C1 is comprised of five major parts: fuselage, wings, empennage (tail), landing gear, and powerplant (engine). The framework of the airplane is called the fuselage. It is the attachment point for the other major components of the airplane. It also contains the cockpit, aircrew seating and baggage area. Within the cockpit are the flight controls and the instrument panel.

AIRFRAME

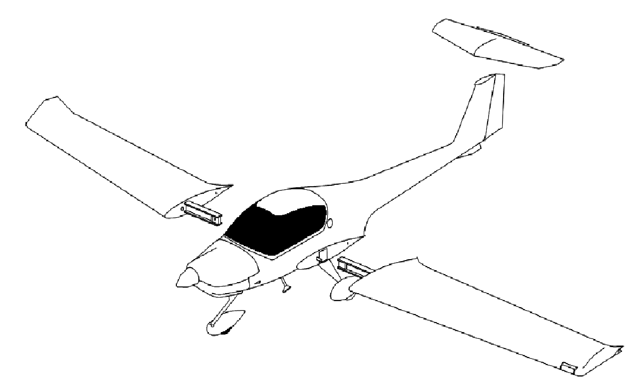
GFRP - Glass Fiber Reinforced Plastic, CFRP **-** Carbon Fiber Reinforced Plastic



FUSELAGE
The GFRP-fuselage is of semi-monocoque construction. The fire protection cover on the fire wall is made from a special fire retarding ceramic fiber that is covered by a stainless steel plate on the engine side. The main bulkhead is of CFRP/GFRP construction. The instrument panel is made of aluminum.



WINGS
The GFRP-wings are of semi-monocoque sandwich construction, and contain a CFRP-spar. The ailerons and flaps are made from CFRP and are attached to the wings using stainless steel and aluminum hinges.



STALL STRIP
A stall strip is a strip of triangular material, attached to the leading edge of a wing. It is designed to induce turbulent airflow at higher angles of attack, resulting in a stall in that particular section of the wing. It is mounted towards the outboard section of wing, so as to maintain aileron effectiveness as long as possible. It is generally a design feature which will allow the pilot to recognize a stalled condition, prior to losing aileron control, and inadvertent entry into a spin.

The DA20-C1 features a triangular strip on the leading edge of the wings towards the outboard section of wing. It looks like a stall strip, but it is actually a vortex generator. This is designed and installed to create air vortices over the wing surface. Vortices are generated at the inboard and outboard corners of these strips (although we are mostly interested in the inboard corner), so the sharpness of these corners is a critical factor in the effectiveness of these strips. The intent is not just to improve airflow over the wing and aileron, but rather to create a boundary layer fence. This "air fence" helps delay stall propagation from the inboard section of the wing, resulting in increased aileron effectiveness in a stalled or partially stalled condition. Eventually, the angle of attack will become high enough that the wing will stall completely, and the aileron control and effectiveness will be marginal.

EMPENNAGE
The DA20-C1 has two stabilizers. The vertical stabilizer is part of the fuselage. The aft part of the left and right fuselage shells make the left and right shells of the vertical stabilizer. The horizontal stabilizer has top and bottom shells. Each shell has GFRP skins with a rigid foam core. The horizontal stabilizer has a main spar which holds the attachment bracket. Center ribs fore and aft give strength to the center area. A trailing edge web holds the hinges for the elevator. The elevator has top and bottom shells. Each shell has GFRP skins with a rigid foam core. The rudder and elevator units are of semi-monocoque sandwich construction. The vertical stabilizer contains a di-pole antenna for the VHF radio equipment. The horizontal stabilizer contains an antenna for the NAV equipment (VOR).

T-TAIL
In a T-tail configuration, the elevator is above most of the effects of downwash from the propeller as well as airflow around the fuselage and/or wings during normal flight conditions. Operation of the elevator in this undisturbed air allows control movements that are consistent throughout most flight regimes. An additional benefit is reduced vibration and noise inside the aircraft.

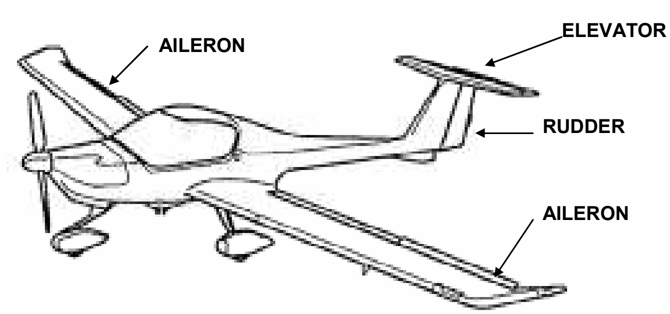
At slow speeds, the elevator on a T-tail aircraft must be moved through a larger number of degrees of travel to raise the nose a given amount than on a conventional-tail aircraft. This is because the conventional-tail aircraft has the downwash from the propeller pushing down on the tail to assist in raising the nose.

Since controls on aircraft are rigged so that increasing control forces are required for increased control travel, the forces required to raise the nose of a T-tail aircraft are greater than those for a conventional-tail aircraft. Longitudinal stability of a trimmed aircraft is the same for both types of configuration, but the pilot must be aware that the required control forces are greater at slow speeds during takeoffs, landings, or stalls than for similar size aircraft equipped with conventional tails.

T-tail airplanes also require additional design considerations to counter the problem of flutter. Since the weight of the horizontal surfaces is at the top of the vertical stabilizer, the moment arm created causes high loads on the vertical stabilizer which can result in flutter. Engineers must compensate for this by increasing the design stiffness of the vertical stabilizer, usually resulting in a weight penalty over conventional tail designs.

When flying at a very high Angle of Attack (AOA) with a low airspeed and an aft CG, the T-tail aircraft may be susceptible to a deep stall. In a deep stall, the airflow over the horizontal tail is blanketed by the disturbed airflow from the wings and fuselage. In these circumstances, elevator control could be diminished, making it difficult to recover from the stall. It should be noted that an aft CG is often a contributing factor in these incidents, since similar recovery problems are also found with conventional tail aircraft with an aft CG.

FLIGHT CONTROLS
The DA20-C1 has normal flight controls. An elevator attached to the horizontal stabilizer gives longitudinal control. Ailerons attached to the trailing edge of each wing give lateral control. The rudder attached to the vertical stabilizer gives yaw control. Flaps attached to the trailing edge of each wing give extra lift for landing and for take-off.



The ailerons and elevator are actuated via push rods. The rudder is controlled using control cables. The flaps have three positions, CRUISE, T/O (take-off), and LDG (landing) and are electrically operated. The switch is located on the instrument panel. The flap control circuit breaker can be manually ‘tripped’ to disable the flap system.

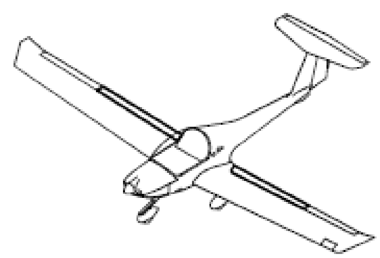
The DA20-C1 has a control stick for each pilot. The pilot can set the elevator trim with a control switch in the top of the control stick. Each pilot has a rudder pedal assembly. The assembly is attached to the cockpit floor. The pilot can adjust the position of the rudder pedals with a T-grip selector on the rudder pedal assembly. The pilot moves each primary control through a system of control rods and bellcranks. Cables operate the rudder. An electric actuator operates the flaps.

TRIM SYSTEM
The DA20-C1 has an elevator with an electrically-operated trim system. Elevator forces are balanced using the electric trim system. Control stick mounted trim switches control the elevator trim. The switches are positioned so that they can be easily operated with the thumb. Forward movement of either switch gives nose down trimming and aft movement of the switch gives nose up trim. An indicator shows the pilot the trim position. The trim switches control electrical relays that supply electrical power to the electric pitch trim motor. An electric actuator moves a spring system.

If the switches are operated in opposing directions at the same time the trim motor will not operate. Operation of the trim switches in the same direction and at the same time will cause the trim motor to operate in that direction.

A fixed trim tab attaches to the trailing edge of the left aileron and on the trailing edge of the rudder.

FLAPS
The DA20-C1 has slotted flaps for landing and take-off. A three-position toggle switch controls the flaps. The switch is in the center section of the instrument panel. The flap position indicator has marks for CRUISE, T/O and LDG positions. The flaps are driven by an electric motor. The cruise (fully retracted) and landing (fully extended) positions are equipped with position switches to prevent over-traveling. The electric flap actuator is protected by a circuit breaker (5 amp), located on the left side of the instrument panel, which can be manually tripped to disable the system.



The current flap position is indicated by three control lights beside the flap operating switch. When two lights are illuminated at the same time, the flaps are in-between positions.

CRUISE green 0°

T/O yellow 15°

LDG yellow 45°

AIRCRAFT FLIGHT INSTRUMENTS
Flight instruments enable an aircraft to be operated with maximum performance and enhanced safety. Manufacturers provide the necessary flight instruments, but to use them effectively, pilots need to understand how they operate.

1. Magnetic Compass
2. Vacuum Gauge
3. Engine Tachometer
4. Airspeed Indicator
5. Attitude Indicator
6. Altimeter

7. CDI
8. Turn Coordinator
9. Heading Indicator
10. Vertical Speed Indicator

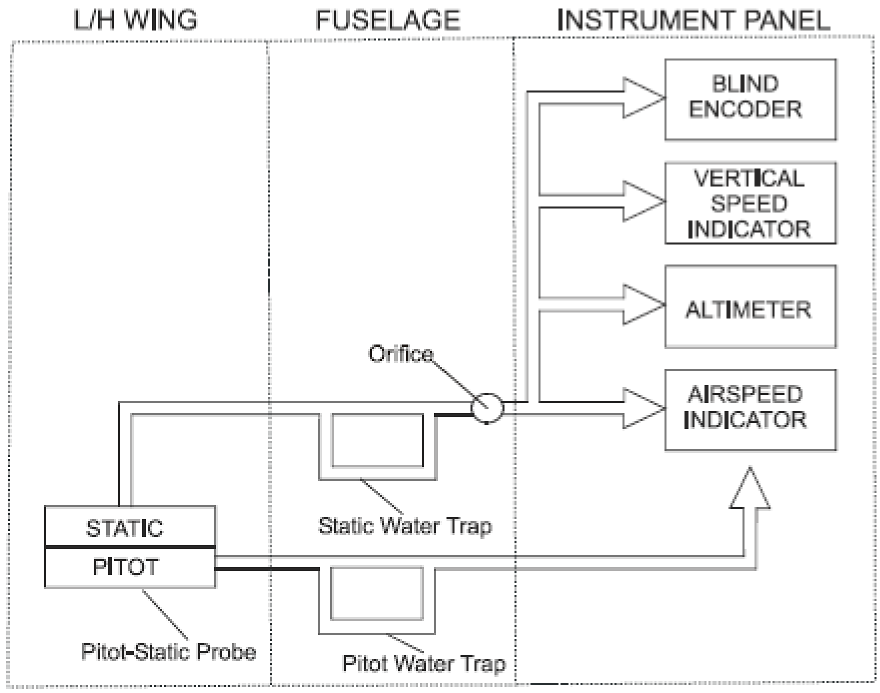
PITOT-STATIC SYSTEM
The pitot-static system has these components:

- A combined pitot-static probe below the left wing
- An airspeed indicator (ASI)
- An altimeter
- A vertical speed indicator (VSI)
- A blind altitude encoder (Mode C)

The pitot-static system supplies pitot pressure and static pressure to the air data instruments. A pitot-static probe mounted below the left wing senses pitot and static pressure. Flexible hoses connect the pitot-static probe to the air data instruments.

BLIND ALTITUDE ENCODER
The blind altitude encoder is located on the aft side of the firewall on the left. The encoder connects to the static system. The encoder supplies these outputs:

- To the transponder for Mode C operation.
- To GPS system for altitude input.



ATTITUDE AND DIRECTION
The DA20-C1 has these attitude and direction indicators:
- Attitude Indicator (vacuum powered)
- Turn Coordinator (electrically powered)
- Stall warning horn
- Magnetic compass
- Heading Indicator (vacuum powered)

VACUUM SYSTEM
The DA20-C1 vacuum system is powered by an engine-driven pump that is located on the front right side of the engine. The flow of air from this pump is used to power the Attitude Indicator and Heading Indicator. The pump is connected directly to the driveshaft and operates any time the propeller is rotating. The system includes a Vacuum Gauge that provides system pressure indications to the pilot. Air enters the vacuum system through a filter located between the firewall and the left side of the instrument panel. The vacuum necessary to operate the system is 4.5 - 5.2 in. Hg.

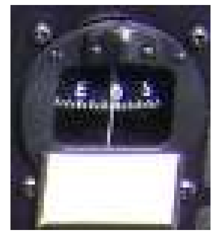
ATTITUDE INDICATOR (AI)
The attitude indicator uses a gyroscope as an attitude reference. The indicator shows pitch and roll data. The display shows blue area for the sky and brown area for the ground. A small bar shows the airplane's wings. Horizontal markings above and below the horizon show pitch up and down. Each graduation is 5°. The roll display has markings around the circumference of the instrument. The markings are at 10, 20, 30, 60 and 90 degrees of roll.

HEADING INDICATOR (HI)
The HI is vacuum powered. The HI shows the direction of the airplane in relation to a preset heading. You set the heading by pushing and turning the knob on the face of the HI. The display has a 360° compass card with 5° graduations.

TURN COORDINATOR

The turn coordinator is an electrically-powered gyroscopic instrument. It operates when the main bus is powered and the turn coordinator circuit-breaker is closed. A warning flag shows when there is no power to the unit. The warning flag goes out of view when the turn coordinator has the correct power. The turn coordinator has a slip indicator. A ball in a curved tube filled with fluid shows when the airplane is slipping or skidding. When the ball is in the center, the turn is correctly coordinated. The turn coordinator shows the rate of rotation of the airplane about the vertical axis.

MAGNETIC COMPASS

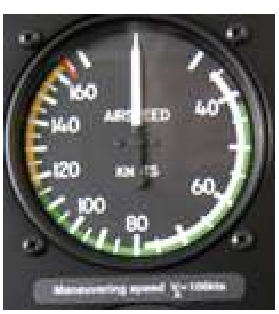


The magnetic compass aligns itself with the magnetic axis formed by the north/south magnetic field of the earth. Fluid in the compass bowl gives dampens the swinging of the compass card. Each graduation on the compass is 5°. A compass deviation card is attached to the compass. The compass light comes on when the DIM/BRIGHT switch is set to DIM.

AIRSPEED LIMITATIONS

Speed	KIAS	Remarks
V_A **Maneuvering Speed.**	106	Do not make full or abrupt control movement above this speed. Under certain conditions the airplane may be overstressed by full control movement.
V_{FE} **Maximum Flap Extended Speed.**		
V_{FE} (T/O)	100	Do not exceed this speed with flaps in take-off position.
V_{FE} (LDG)	78	Do not exceed this speed with flaps in landing position.
V_{NO} **Maximum Structural Cruising Speed.**	118	Do not exceed this speed except in smooth air, and then only with caution.
V_{NE} **Never Exceed Speed.**	164	Do not exceed this speed in any operation.

AIRSPEED INDICATOR MARKINGS



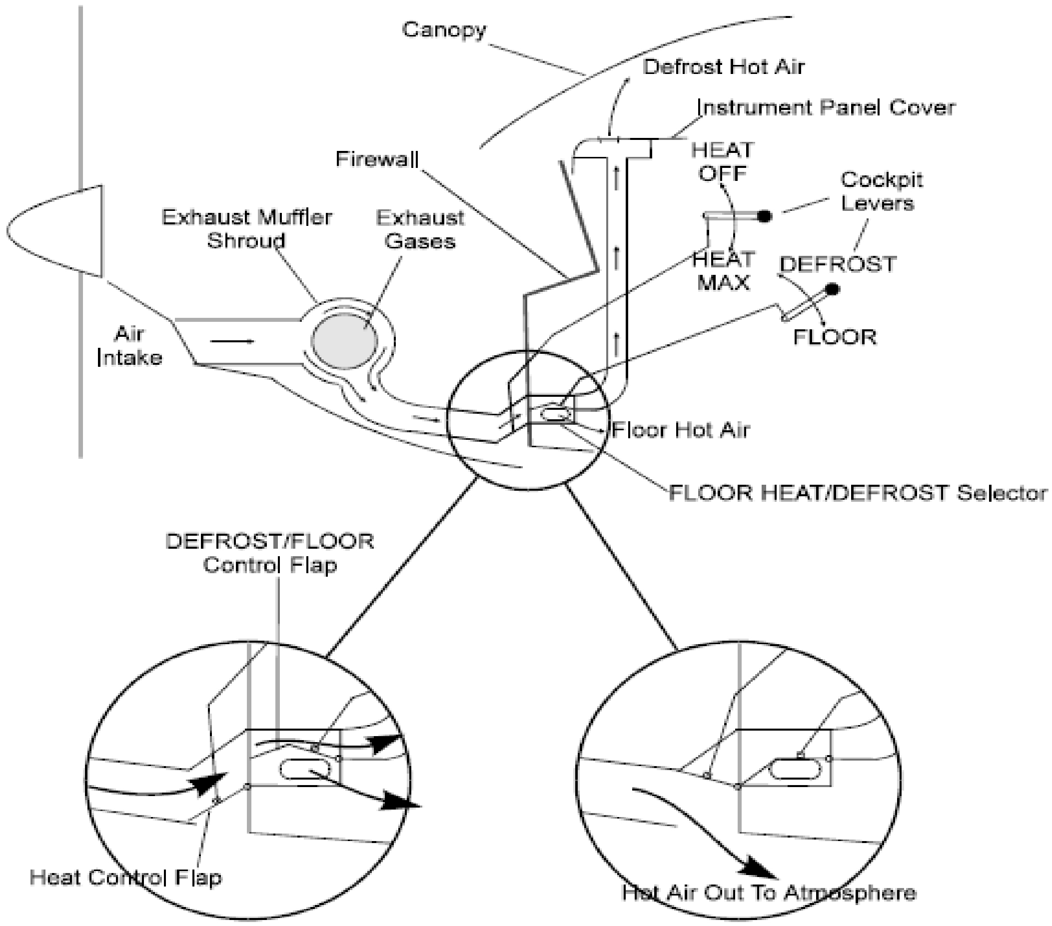
Marking	KIAS	Explanation
White Arc	34-78	Operating range with extended flaps
Green Arc	42-118	Normal operating range
Yellow Arc	118-164	Maneuvers must be conducted with caution and only in smooth air.
Red Line	164	Maximum permissible speed for all operating modes

CABIN HEAT

The cabin heat and defrost system directs ram air through the exhaust heat shroud into the cabin heat valve. The warm air is then directed to the window defrosting vents and to the cabin floor as selected by the Floor/Defrost lever. The cabin heat selector, located in the center console, is used to regulate the flow of heated air.

The CABIN HEAT control lever moves the flap in the heat control valve. In the OFF position (fully forward) no hot air can flow into the cockpit. Move the lever aft (towards the ON position) to let gradually more hot air flow into the cabin.

The DEFROST/FLOOR control lever moves the flap in the distribution box. In the DEFROST position (fully forward) the hot air flows to the windscreen. Move the lever aft (towards the FLOOR position) to let the hot air flow to the floor.



Heat ON; DEFROST/FLOOR Selector in Mid Position

Heat OFF; DEFROST/FLOOR Selector in DEFROST Position

CABIN AIR

The cabin aeration is controlled by two adjustable air-vent nozzles that receive outside air from two fuselage NACA ducts. The two sliding windows in the canopy can be opened for additional ventilation. Ram air from the right side NACA duct also cools the equipment. Warm air escapes through holes in the instrument panel cover.

OUTSIDE AIR TEMPERATURE (OAT)

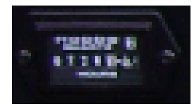
The OAT indicator is a digital instrument with a solid-state sensor. The sensor is located in the left side NACA duct.

ELECTRIC CLOCK

The DA20-C1 has an accurate electronic clock (chronometer). The clock is at the top right of the instrument panel. The clock has a digital display panel. It has GMT, local time and stopwatch functions. Two buttons control the clock.

The INST LIGHTS circuit-breaker supplies power for the clock. When the airplane power is off, an internal battery supplies the power for the clock. The internal battery cannot operate the display or control functions.

HOURS METER (HOBBS METER)



The engine-operated hours meter is at the bottom right of the instrument panel. It is an electromechanical meter. The right side of the meter shows 1/10 of an hour. The other side shows the hours. The airplane pitot-static pressure operates the meter.

SEATS AND SAFETY BELTS

The seats are made of fiberglass and are non-adjustable. Each pilot's seat has a four-point safety belt. The pilot can adjust the lap strap for correct fit. The shoulder straps are equipped with inertia reels which lock in the event high G-forces are experienced, such as turbulence, a sudden stop, etc. Tighten the belts securely. The belt is opened by pulling the lock cover.

RUDDER PEDAL ADJUSTMENT

The rudder pedals may only be adjusted on the ground. The pedals for rudder and brakes are unlocked by pulling the T-grip located in front of the rudder pedal sledge tubes. Forward adjustment: Push both pedals forward with your feet while pulling lightly on the T-grip to disengage the latch. Backward adjustment: Pull pedals backward to desired position by pulling on T-grip.

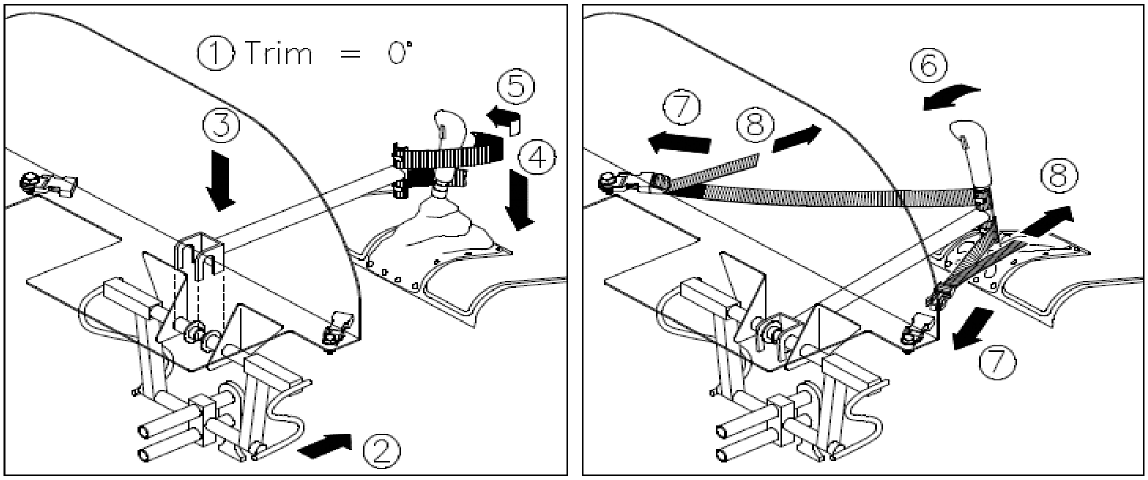
NOTE: After the T-grip is released, push the pedals forward with your feet until they lock in place.

FLIGHT CONTROL LOCK

A flight control lock is provided with each aircraft and should be installed whenever the aircraft is parked.

NOTE: Failure to install the flight control lock whenever the aircraft is parked may result in control system damage, due to gusts or turbulence.

Installation and Removal of the Control Lock:



1. Trim aircraft to neutral.
2. Pull the left rudder pedals fully aft and check they are locked in position.
3. Hook the Control Lock's forks over the rudder pedal tubes as shown above.
4. Push down the Control Stick's leather boot to expose the Control Stick tube, and push the Control Stick forward against the Control Lock.
5. Loop the straps around the Control Stick as shown, and push forward on the Control Stick.
6. Clip the straps into the left and right buckle receptacles located under the instrument panel.
7. Adjust the straps as required. Straps should be tight to secure the controls properly.
8. TO REMOVE, push the Control Stick forward (to relieve strap tension). Unclip the straps and remove the Control Lock. Store in the aircraft's baggage compartment.

BAGGAGE COMPARTMENT
The baggage compartment is located behind the seat above the fuel tank. Baggage should be distributed evenly in the baggage compartment. The baggage net must be secured.

CAUTION: Ensure that baggage compartment limitations (44 lbs/20 kg max.) and aircraft weight and balance limitations are not exceeded.

CANOPY
The canopy is closed by pulling down on the forward handles on the canopy frame. Locking the canopy is accomplished by moving the two locking handles on the left and right side of the frame.

To close: Move both LH and RH locking handles forward.
To open: Move both LH and RH locking handles backward.

A canopy locking warning light, located in the upper center section of the instrument panel, indicates the status of the canopy’s locking mechanism. If the canopy locking warning light is illuminated, the canopy is not locked properly.

CAUTION: Before starting the engine, the canopy must be closed and locked.

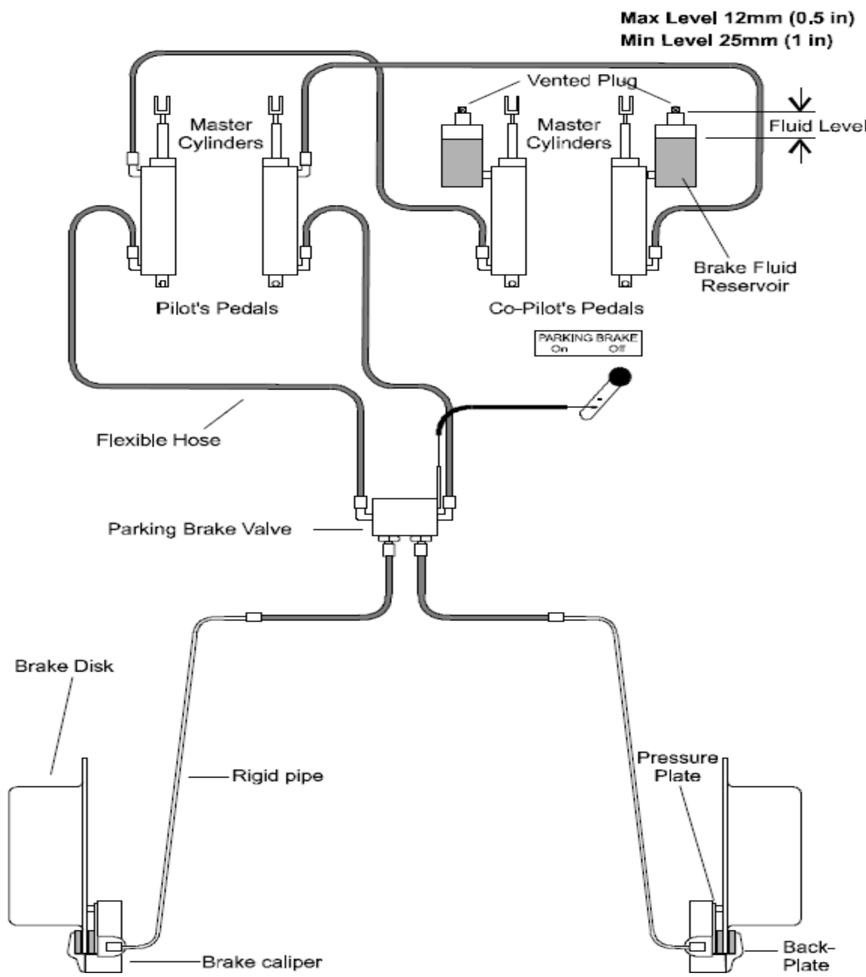
NOTE: The Master Switch must be ON for the Canopy Locking Warning Light to be operational.

LANDING GEAR SYSTEM
The landing gear system consists of the two main landing gear wheels mounted to aluminum spring struts and a 60° castering nose wheel. The suspension of the nose wheel is provided by an elastomer spring. Flat section aluminum leaf-springs make the main gear struts.

The nose gear is a tubular strut. A strong pivot attaches it to the forward fuselage. An elastomer spring pack (elastomer pack) attaches the strut to the engine mount. A pivot at the bottom of the strut has a trailing fork for the wheel. Nose and main gear have single wheels with low pressure tires, 26 psi nose, and 33 psi main.

The landing gear absorbs vertical loads (for example, landing loads). Each main gear strut is a leaf spring which deflects upwards as the load increases. The elastomer pack in the nose gear compresses as the load increases. In each case, the spring returns to the original position when the load is removed.

CAUTION: When placing the feet on the brake pedals, care should be taken to use only the toe of your shoe so you do not contact the structure above the pedals, which could prevent effective application of the brake(s).



BRAKE SYSTEM

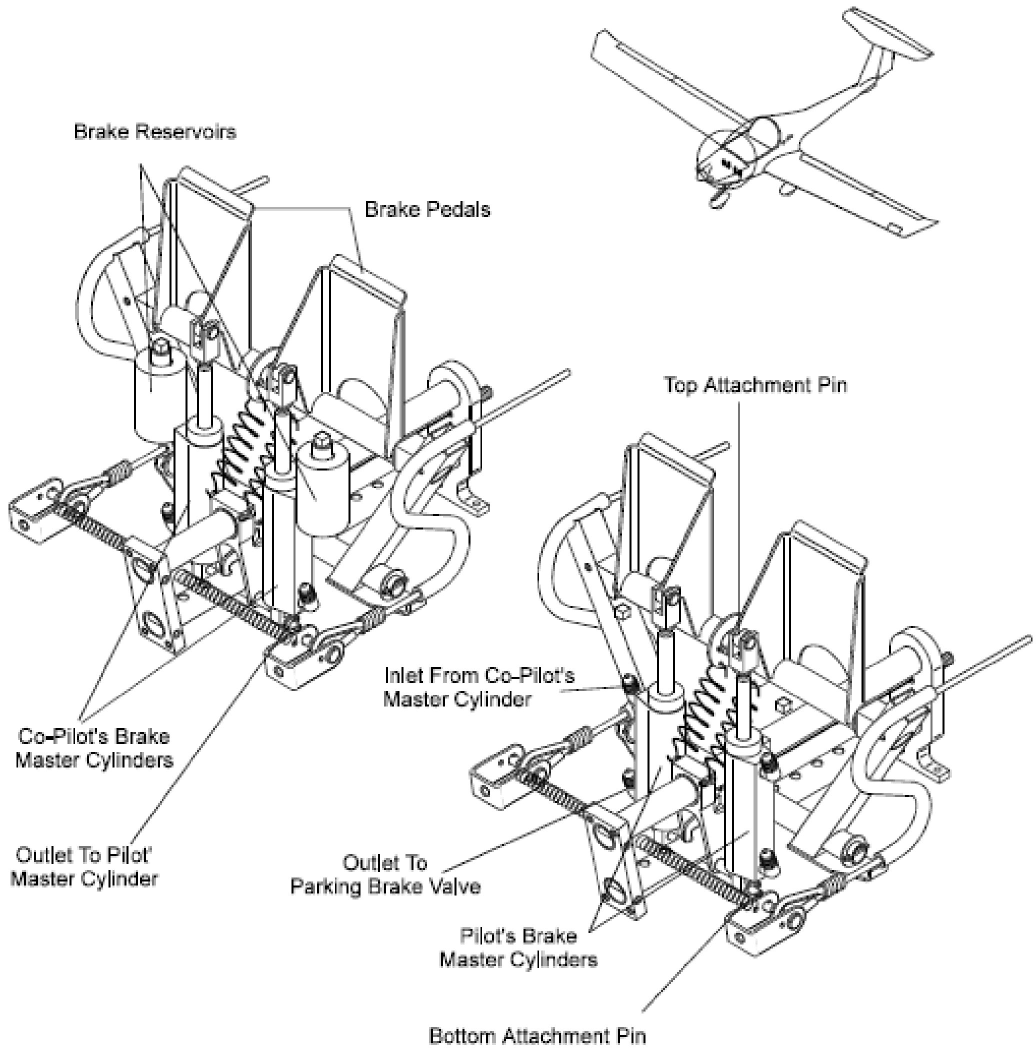
The DA20-C1 has 2 separate brake systems. The pilot’s (left side) and co-pilot’s (right side) left rudder pedals operate the left system. It supplies pressure to the left brake caliper. The right rudder pedals operate the right brake caliper. Each system has a brake fluid reservoir. The reservoir attaches to the master cylinder on the co-pilot’s rudder pedal. The outlet from the master cylinder on the co-pilot’s rudder pedal connects to the inlet of the master cylinder on the pilot’s rudder pedal. The outlet of the master cylinder on the pilot’s rudder pedals connects to the parking brake valve. And the parking brake valve connects to the brake caliper.

The parking brake valve is located below the right seat. It contains 2 valves which can seal the brake pressure into the calipers. This keeps the brakes on. The pressure will reduce in time and the brakes will release. A serviceable parking brake valve will hold the brakes on for more than one day.

When you press on the brake pedal, these things happen:

- The connection to the reservoir is cut off by the initial movement.
- Further movement pushes fluid past the piston on the pilot’s master cylinder.
- The fluid flows through the parking brake valve to the right brake caliper
- The fluid pushes the piston and the pressure plate against the brake disk.
- The reaction force on the caliper pulls the back plate against the brake disk.
- And the right brake is applied.

In the same way, when you press on the left brake pedal, the left brake is applied.



Note: If one side of the system fails, one or both pilots can loose braking on that side.

For example, a leak in the pipe between the co-pilot’s and pilot’s right master cylinders will cause a right brake failure for the co-pilot. The pilot’s right brake will operate correctly. If the leak is between the pilots right master cylinder and the right brake caliper, both pilots will have right brake failure.

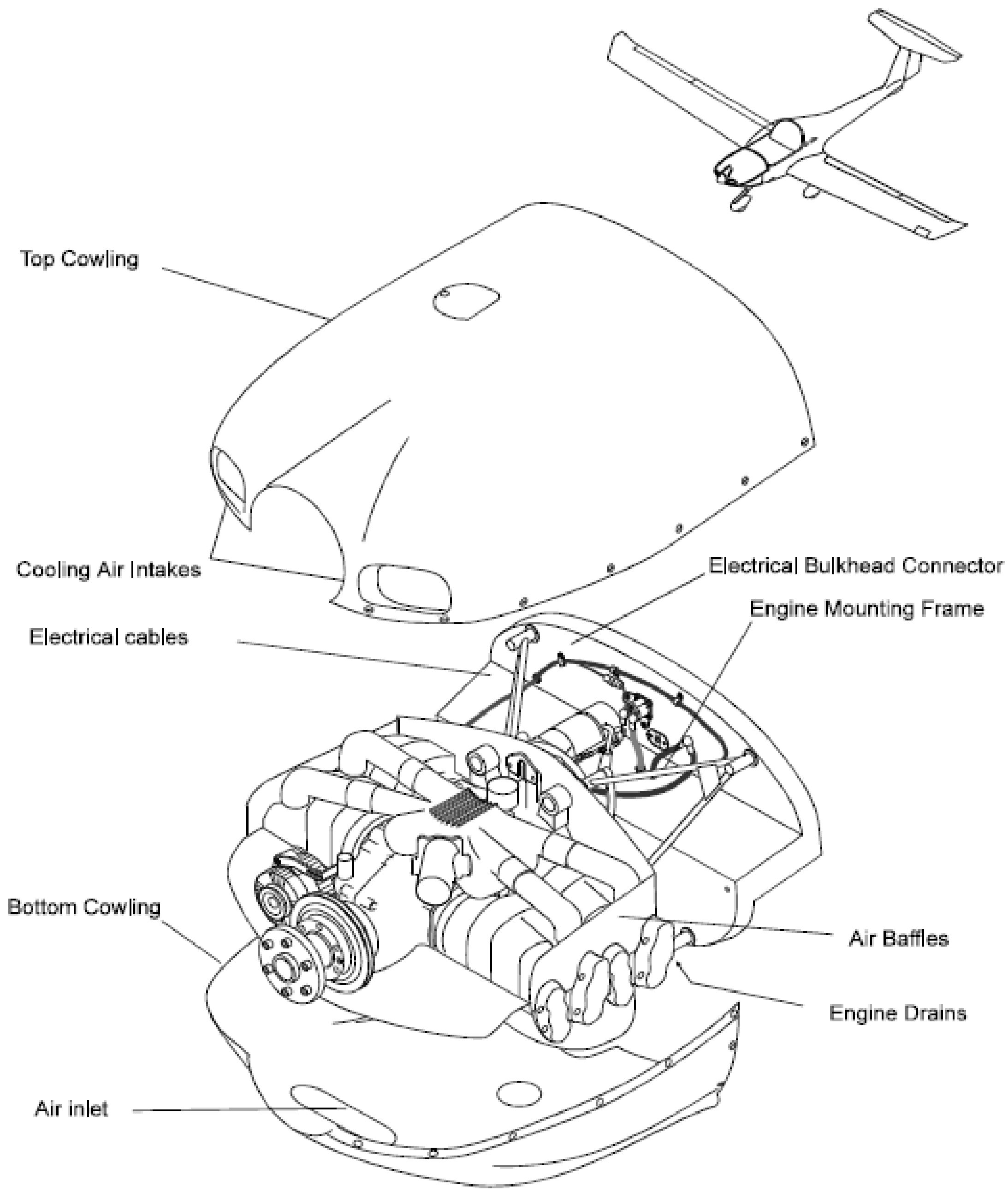
PARKING BRAKE

The Parking Brake knob is located on the center console in front of the throttle quadrant, and is pushed up when the brakes are to be released. To set the parking brake, pull the knob down to the stop. Repeated pushing of the toe-brake pedals will build up the required brake pressure, which will remain in effect until the parking brake is released. To release the parking brake, push on the toe-brake pedals before releasing the parking brake knob.

Parking Brake Operation
To apply the parking brake:
− Press on both pedals.
− Pull the parking brake knob fully aft.
− Release your foot pressure on the pedals.
− If necessary, pump the brake pedals.
To release the parking brake, select control to OFF.

NOTE: When parking the aircraft for longer than 12 hours, place wheel chocks in front of and behind the main landing gear wheels. Tie down ropes should also be used if you are uncertain of favorable climatic conditions for the duration of the park.

POWERPLANT
DA20-C1 aircraft are equipped with the Continental IO-240-B engine. The IO-240-B is a fuel injected, 4-cylinder, 4-stroke engine with horizontally opposed, air cooled cylinders and heads. The propeller drive is direct from the crankshaft. The propeller turns in a clockwise direction, when you look from the cockpit. Displacement: 239.8 cu.in. (3.9 liters).

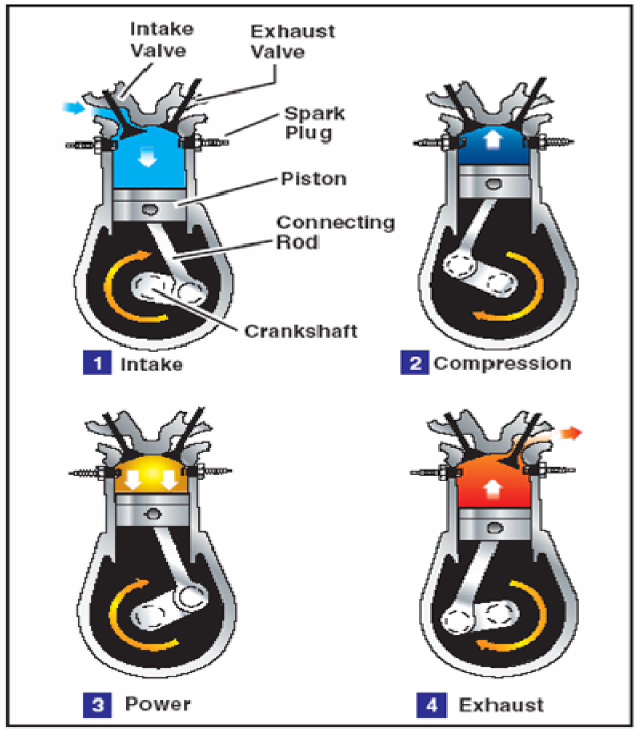


Engine Operating Limitations:
Max. Permissible RPM: 2800 RPM
Max. Continuous Power: 125 HP / 93.25 kW at 2800 RPM

Cylinder Head Temperature (CHT):
Maximum: 460°F (238°C)
Minimum: 240°F (115°C) takeoff and descent

FOUR-CYCLE ENGINE OPERATION

The basic principle for reciprocating engines involves the conversion of chemical energy, in the form of fuel, into mechanical energy. This occurs within the cylinders of the engine through a process known as the four-stroke operating cycle. These strokes are called intake, compression, power, and exhaust.



1. The intake stroke begins as the piston starts its downward travel. When this happens, the intake valve opens and the fuel/air mixture is drawn into the cylinder.

2. The compression stroke begins when the intake valve closes and the piston starts moving back to the top of the cylinder. This phase of the cycle is used to obtain a much greater power output from the fuel/air mixture once it is ignited.

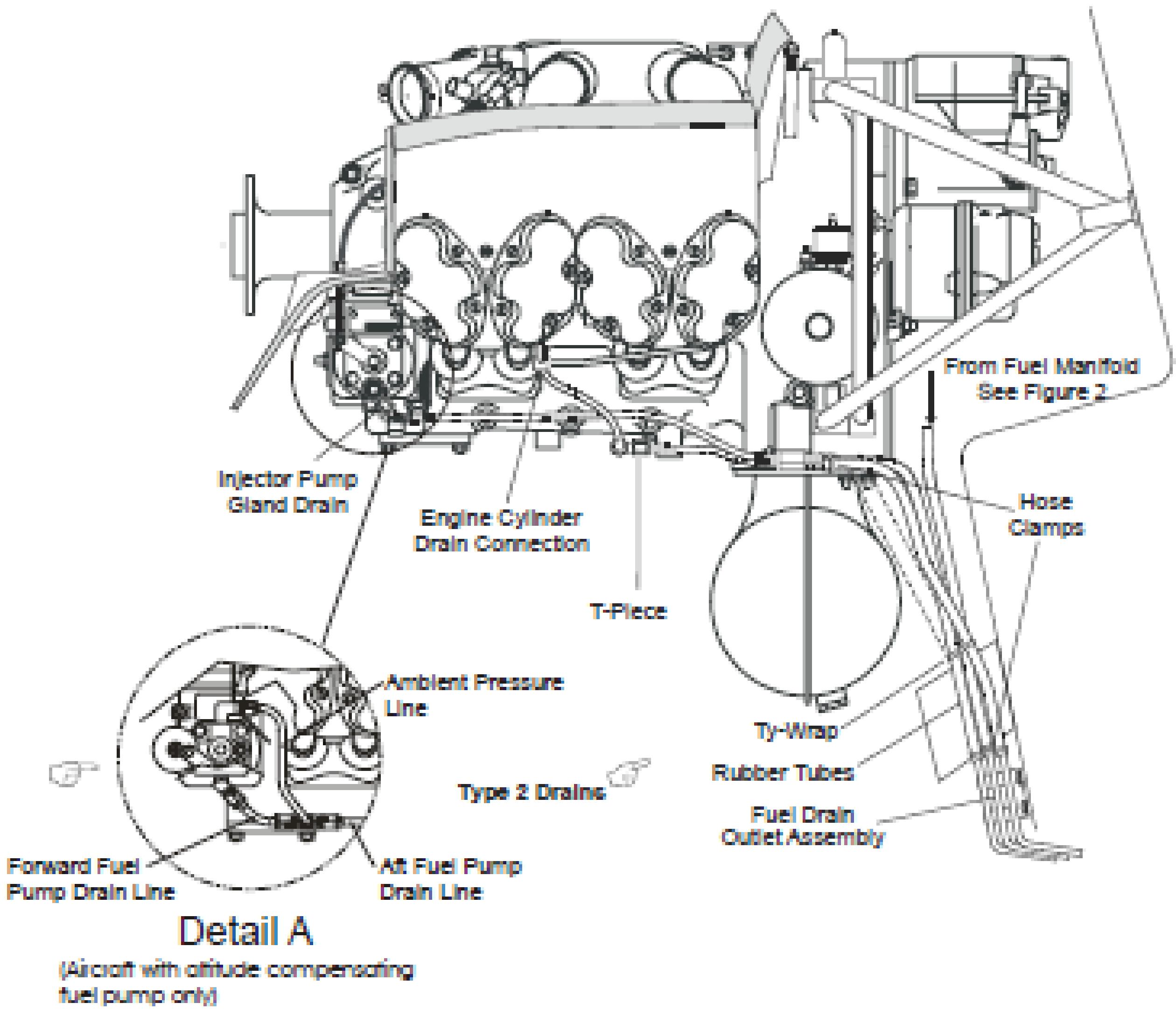
3. The power stroke begins when the fuel/air mixture is ignited. This causes a tremendous pressure increase in the cylinder, and forces the piston downward away from the cylinder head, creating the power that turns the crankshaft.

4. The exhaust stroke is used to purge the cylinder of burned gases. It begins when the exhaust valve opens and the piston starts to move toward the top of the cylinder.

COWLING
The powerplant has a top and a bottom engine cowling. The two halves attach to the airframe with camlock fasteners. The top cowling has a left and a right air intake. The bottom cowling has one large air intake.

AIR INTAKES
The GFRP air intake attaches below the front of the engine. Two flexible hoses from the air intake go to the exhaust muffler and the induction manifold.

ENGINE DRAIN PIPES
Each cylinder inlet port has a drain pipe. The drain pipe connects from the cylinder head to a “T” piece connector. From the “T” piece connector the drain pipes connect to a single pipe. The pipe has a check valve installed. An aluminum drain pipe attached to the mixture control valve gives drainage for the fuel pump.



ENGINE CONTROLS
The Mixture, Throttle and Alternate Air Control levers are grouped together in the center console. The tension/friction for the controls can be adjusted using the friction knob located on the right side of the center console.

Mixture: right lever with red cylindrical handle and integral lock out lever. The mixture control lever features a safety lock which prevents inadvertent leaning of the mixture. To release, squeeze the safety lock lever and the control knob together.

Lever full forward = Full Rich
Lever full aft = Idle Cutoff

Throttle: center lever with "T" handle

Lever full forward = FULL throttle
Lever full aft = IDLE

Alternate Air: left lever with square handle. The alternate air control selects a second induction air intake in case of restriction of the primary air intake (filter).

Lever full forward = Primary air intake
Lever full aft = Alternate air intake

MIXTURE CONTROL

(a) Cruise
The mixture control allows leaning of the fuel mixture to maximize fuel economy during cruise conditions. Teledyne Continental Motors specifies that above 75% of maximum rated power, the mixture must be set at FULL RICH. It should be noted that even with the throttle set at the full power position, actual power may be less than 75% of maximum rated power and then leaning is required (reference Section 5.3.2, Cruise performance).

(b) Reduced Throttle Settings
When operating at reduced throttle settings, other than steady state cruise, the mixture should always be set to FULL RICH. This applies to maneuvers (e.g.: stalls, spins, slow flight), descents, landing approaches, after landing and while taxiing. The only exception to this is for operating at very high altitudes, where the low air density may require leaning to maintain satisfactory engine operation.

(c) Full Throttle
When operating at full throttle, the mixture must be set at FULL RICH. This applies to take-off, balked landings and climb. The only exception is for operating below 75% of maximum rated power, as may be the case in an extended climb (reference Section 5.3.2, Cruise performance).

NOTE: All adjustment of the mixture control should be done in small increments.

POWERPLANT INSTRUMENT MARKINGS

Instrument	Red Line = Lower Limit	Green Arc = Normal Operating Range	Yellow Arc = Caution Range	Red Line = Upper Limit
Tachometer	-	700 - 2800 RPM	-	2801 RPM
Oil Temperature Indicator	75º F	170 - 220º F	75-170º F 220 -240º F	240º F
Cylinder Head Temperature Indicator	-	360-420º F	240-360º F 420-460º F	460º F
Oil Pressure Indicator	10 psi	30-60 psi	10-30 psi 60-100 psi	100 psi
Fuel Pressure Indicator	3.5 psi	-	-	16.5 psi
	3.5 psi	-	-	32.5 psi *

Oil Temperature Indicator	75º F	170 - 220º F	-	240° F
Cylinder Head Temperature Indicator	-	300-420º F	420-460º F	460° F
Oil Pressure Indicator	10 psi	30-60 psi	-	100 psi

Instrument	Red Arc = Lower Limit	Green Arc = Normal Operating Range	Yellow Arc = Caution Range	Red Line = Upper Limit
Voltmeter	8-11 Volts	12.5 - 16 Volts	11 - 12.5 Volts	16.1 Volts

OIL SYSTEM
The engine oil system performs several important functions, including:
• Lubrication of the engine's moving parts.
• Cooling of the engine by reducing friction.
• Removing heat from the cylinders.
• Providing a seal between the cylinder walls and pistons.
• Carrying away contaminants.

Reciprocating engines use either a wet-sump or dry-sump oil system. In a dry-sump system, the oil is contained in a separate tank, and circulated through the engine by pumps. In a wet-sump system, the oil is located in a sump, which is an integral part of the engine. The main component of a wet-sump system is the oil pump, which draws oil from the sump and routes it to the engine. After the oil passes through the engine, it returns to the sump. In the DA20-C1 engine, additional lubrication is supplied by the rotating crankshaft which splashes oil onto portions of the engine.

The oil filler cap and dipstick (for measuring the oil quantity) are accessible through a panel in the engine cowling. If the quantity does not meet the manufacturer's recommended operating levels, oil should be added. The AFM, POH, or placards near the access panel provide information about the correct oil type and weight, as well as the minimum and maximum oil quantity.

The DA20-C1 engine has a high pressure, wet sump lubrication system. The oil is pumped by a mechanical, engine driven pump. An oil dipstick indicates the level of oil in the tank. The dipstick is marked for US quarts. Never operate the engine with the oil filler cap removed.

Observe normal procedures and limitations while running the engine. With the engine stopped, check the oil level on the dipstick. The oil level must be between the 6 US quarts and 4 US quarts level as indicated by the markings on the dip stick.

The engine oil supply is contained in the engine sump. The engine oil pump supplies oil to the oil cooler adaptor (supplied by the airplane manufacturer). The oil cooler adaptor holds the oil filter. The oil filter is a full-flow canister. The oil flows through the oil filter to a thermostatic relief-valve (Vernatherm). It also flows to the outlet of the oil cooler.

The Vernatherm makes a by-pass between the outlet from the oil filter and the inlet to the engine system. The Vernatherm has two functions:

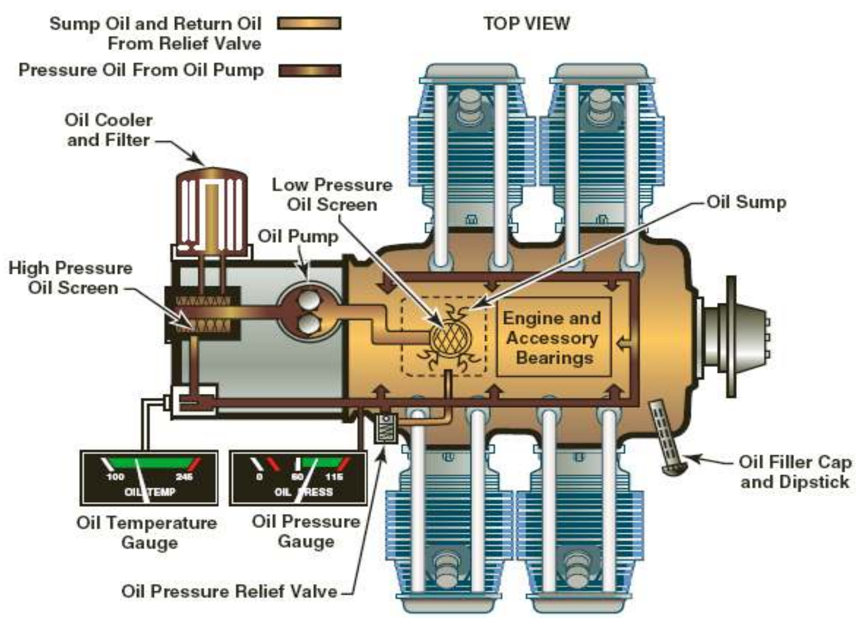
- It senses oil temperature. At less than 110°F (43°C) the valve is open and the oil flows through the valve directly to the engine. Between 110°F and 170°F (43°C and 77°C) the valve gradually closes. The hot oil must flow through the oil cooler.
- It senses the differential oil pressure across the oil cooler. If the oil cooler becomes blocked, the valve opens to allow oil to by-pass the cooler. As the hot oil flows through the oil cooler matrix, ram air from above the engine flows into the air hose at the aft baffle. The air then flows down the hose and over the oil cooler matrix to cool the oil. There are no adjustments to the oil distribution and cooling system.

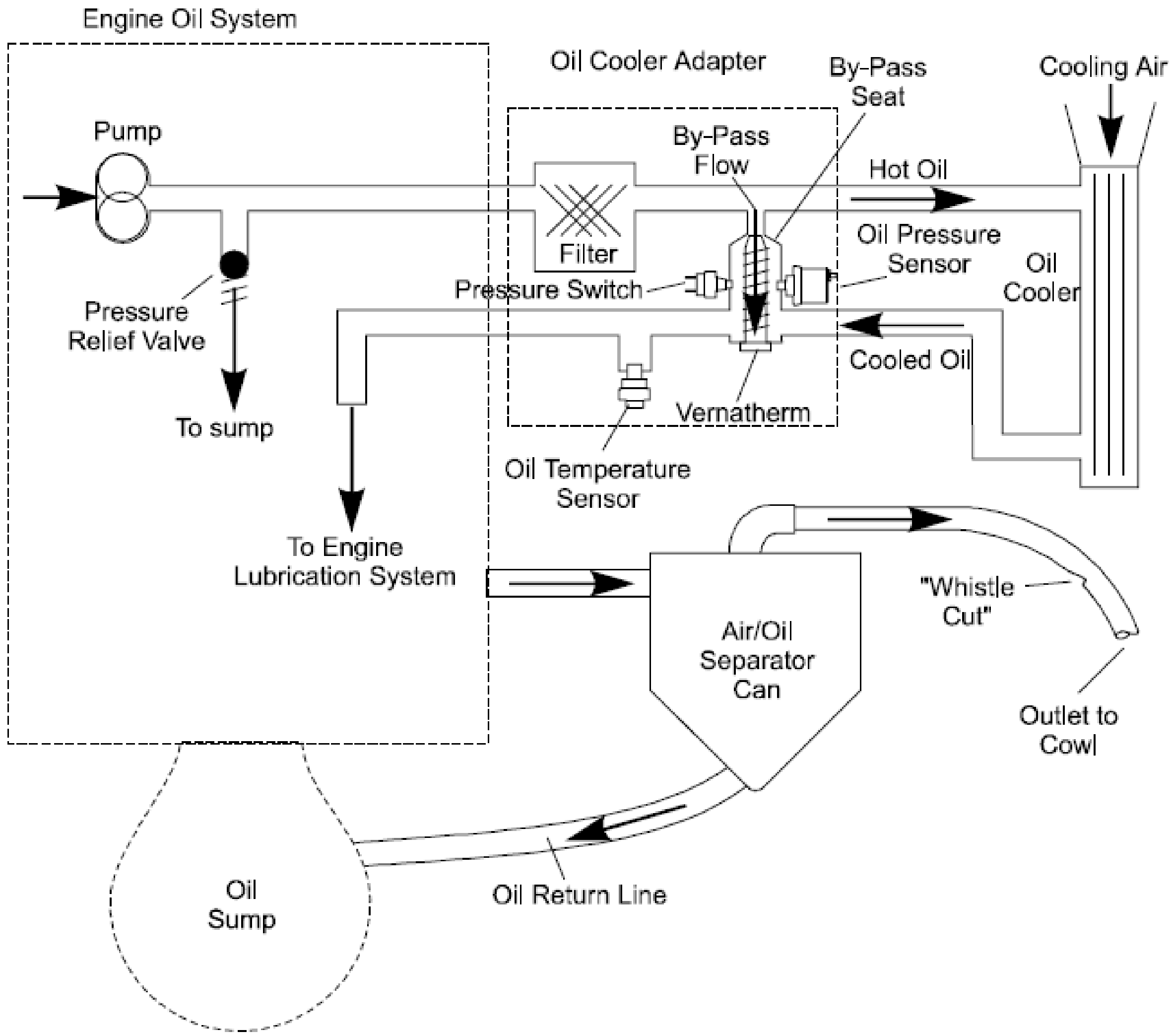
The engine has an oil breather system. A hose connected to an external connector on the crankcase lets the oil/air mixture flow from the crankcase to the oil/air separator that attaches to the outside of the engine. The oil flows from the oil/air separator back to the sump through a hose. And the air gets ejected through the separator vent pipe out through the bottom of the engine cowling.

Oil Pressure:
Minimum: 10 psi; Maximum: 100 psi
Ambient temperature below 32ºF (0ºC), Full power operation oil pressure 70 psi max
Normal Operating: 30 psi (2.1 bar) to 60 psi (4.1 bar)

Oil Temperature:
Minimum: 75°F (24°C)
Full power operation, oil pressure normal 100ºF (38ºC)
Maximum: 240ºF (115°C)

CAUTION: Never operate the engine with the oil filler cap removed. Observe normal procedures and limitations while running engine. With the engine stopped, check the oil level on the dipstick. The oil level must be between the 6 US quarts and 4 US quarts level as indicated by the markings on the dip stick.





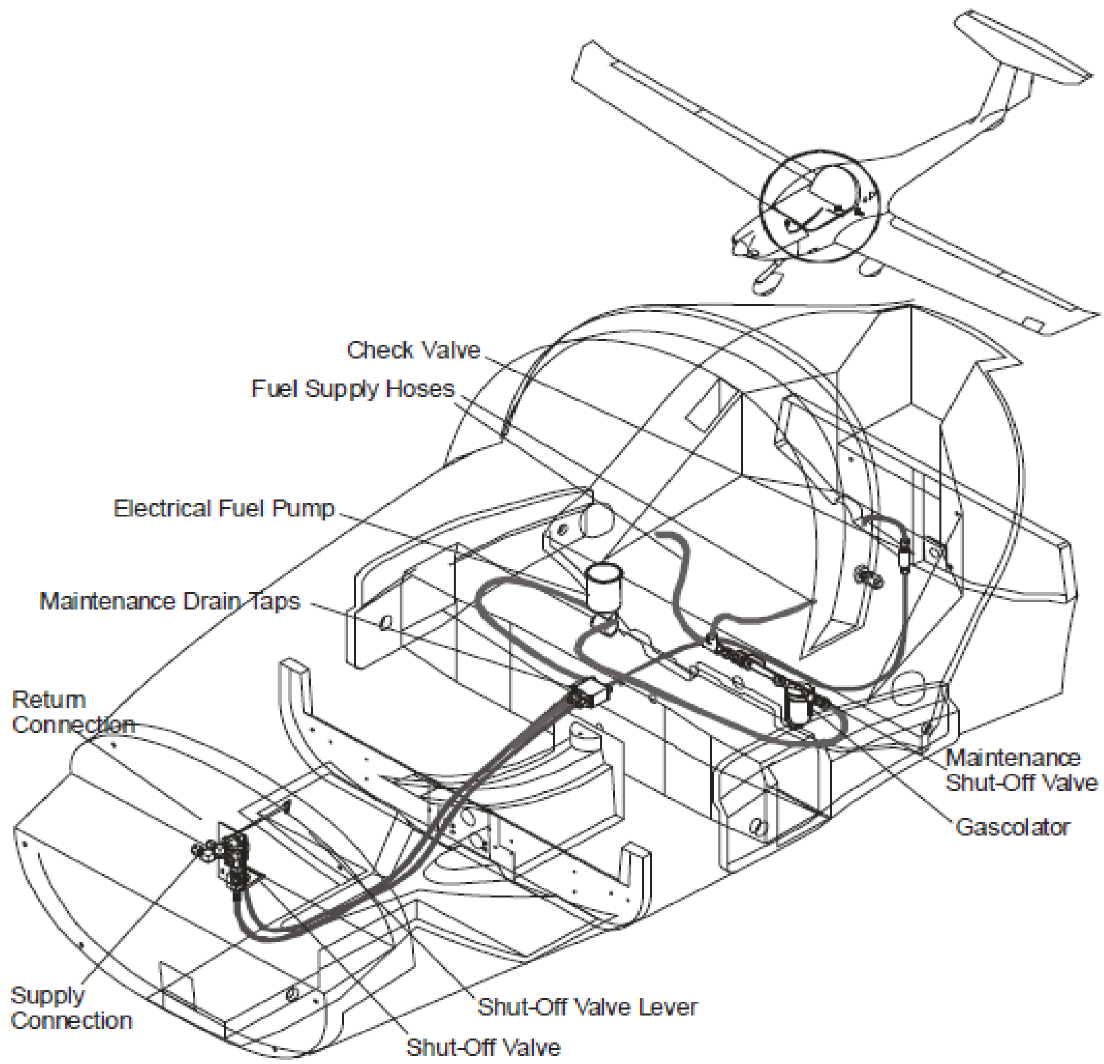
FUEL SYSTEM
The aluminum tank is located behind the seats, below the baggage compartment.

Fuel Capacity:
Total Fuel Quantity: 24.5 US gal. (93.0 liters)
Usable Fuel: 24.0 US gal. (91.0 liters)
Unusable Fuel: 0.5 US gal. (2.0 liters)
Unusable Fuel: The amount of fuel remaining in the tank, which cannot be safely used in flight.
Fuel Specifications: Approved fuel grades: AVGAS 100LL or 100
Fuel weighs approximately 6 pounds per gallon. DA20-C1 fuel burn is approximately 6 gallons per hour.

Mandatory preflight idle mixture rise: 50 RPM minimum. See Normal Procedures-Before Takeoff.
NOTE: Less than 50 RPM rise indicates an excessively lean idle mixture that can result in engine stoppage at idle.

Minimum Ground Idle Speed: 975 RPM Minimum
NOTE: Recommended minimum flight idle speed 1400 RPM, during idle power flight conditions and maneuvers.

The tank filler on the left side of the fuselage behind the canopy is connected to the tank with a rubber hose. A grounding stud is located on the underside of the fuselage near the trailing edge of the left hand wing. The aircraft must be grounded prior to any fueling operation. The tank vent line runs from the filler neck through the fuselage bottom skin to the exterior of the airplane. The vent line is the translucent plastic hose adjacent to the left wing root. The vent line must be clear for proper fuel system operation. The tank has an integral sump which must be drained prior to each flight, by pushing up on the brass tube which protrudes through the underside of the fuselage, forward of the trailing edge of the left hand wing.



Two outlets with finger filters, one left and one right, are installed at the bottom of the tank. Fuel is gravity fed from these outlets to a filter bowl (gascolator) and then to the electric fuel pump. The filter bowl must be drained prior to each flight, by pushing up on the black rubber tube that protrudes through the underside of the fuselage, adjacent to the fuel tank drain.

The electric fuel pump primes the engine for engine starting (Prime ON) and is used for low throttle operations (Fuel Pump ON). When the pump is OFF, fuel flows through the pump's internal bypass. From the electric pump, fuel is delivered to the engine's mechanical fuel pump by the fuel supply line.

The DA20-C1 is equipped with a DUKES constant flow, vane type, two speed, electric fuel pump. This pump emits an audible whine when it is switched on. The pump's high speed setting is used for priming the engine prior to engine start. The prime setting is selected by turning the FUEL PRIME switch ON. An amber annunciator indicates that FUEL PRIME ON is selected.

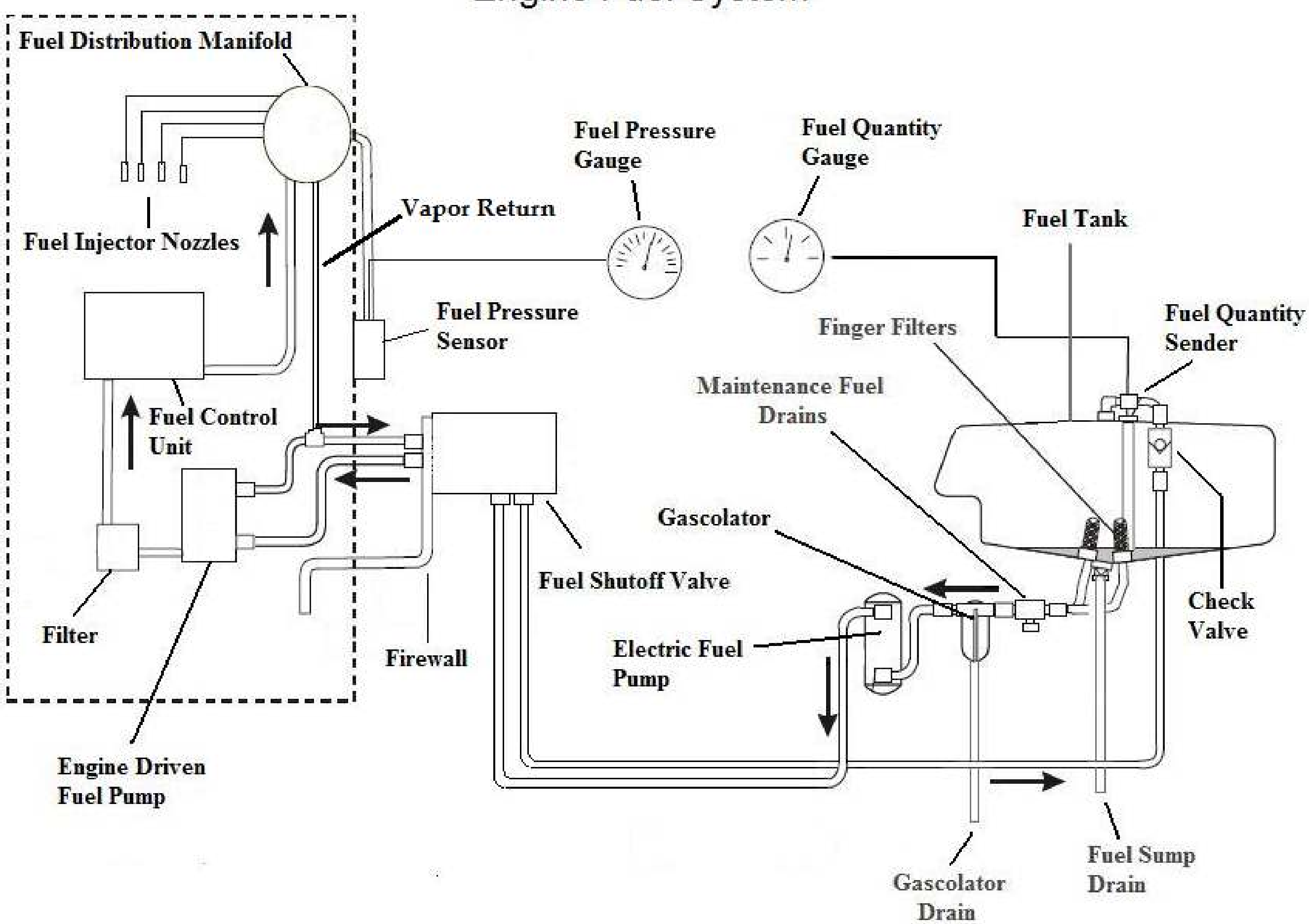
The pump's low speed setting is required for maintaining positive fuel supply system pressures at low throttle settings. This setting is selected by turning the FUEL PUMP switch ON. This setting should be selected for any low throttle operations, including taxiing and any flight operations when engine speed may fall below 1000 RPM (e.g. stalls, spins, descents, landings, etc.). The FUEL PUMP may also be selected ON to suppress suspected vapor formation in the fuel supply system. Smooth engine operation at high ambient temperatures with heat soaked fuel and up to and exceeding the service ceiling has been demonstrated without use of the electric pump.

NOTE: Turning the priming pump on while the engine is running, will enrichen the mixture considerably. Although the effect is less noticeable at high power settings when the fuel flow rate is high, the effect at low and idle throttle settings is an overrich mixture, which may cause rough engine operation or engine stoppage. It is therefore recommended that for normal operations, the FUEL PRIME be turned OFF.

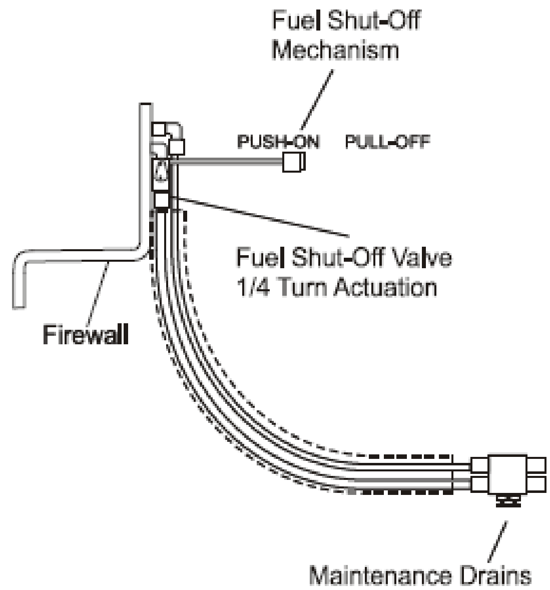
Fuel is metered by the fuel control unit and flows via the fuel distribution manifold to the injector nozzles. Closing the fuel shut-off valve, located either on the aft side of the firewall or at the maintenance drain manifold, will cause the engine to stop within a few seconds.

A return line from the mechanical pump's fuel vapor separator returns vapor and excess fuel to the tank. Fuel pressure is measured at the fuel distribution manifold and displayed on the fuel pressure indicator, which is calibrated in PSI. The DA20-C1 also has a fuel vapor separator in the distribution manifold. This aircraft has a second vapor return line from the distribution manifold to the firewall.

Engine Fuel System



FUEL-SHUTOFF VALVE
The fuel shut-off valve is located on the cabin side of the firewall and is controlled by a handle on the right side center pedestal. To activate the fuel shutoff valve, lift the handle release lock and pull the handle out. In the open position the knob is in. In the closed position the knob is out.



Instrument Panel
Mounted Fuel Shut Of

WARNING: The fuel shut-off valve should only be closed for emergencies or fuel system maintenance.

TANK DRAIN
To drain the tank sump, activate the spring loaded drain by pushing the brass tube in with a drain container. The brass tube protrudes approx. 1 1/6 in (30 mm) from the fuselage contour and is located on the left side of the fuselage, approximately at the same station as the fuel filler cap.

FUEL FILTER BOWL
The fuel filter bowl or gascolator is between the tank and the fuel pump. The bowl acts as a trap for sediment and water that has entered the fuel line from the tank. The filter bowl drain is next to the fuel tank drain. It operates in the same manner as the fuel tank drain.

FUEL QUANTITY
The DA20-C1 has a fuel quantity indicating system. The fuel quantity indicating system has a resistance-wire sensor. The gauge on the instrument panel measures the current flowing through the sensor. The gauge is marked 0, 1/4, 1/2, 3/4 and 1/1. A fuel dipstick is supplied with the aircraft to permit direct measurement of fuel level during the preflight check.

To check the fuel level:
1. Insert the graduated end of the fuel dipstick into the tank through the fuel filler opening until the dipstick touches the bottom.
2. Withdraw the dipstick from the fuel tank.
3. Read fuel quantity. The dipstick is calibrated in increments of ¼ of useable fuel capacity.
NOTE: Electric fuel gauges may malfunction. Check fuel quantity with fuel dipstick before each flight.

ENGINE INDUCTION AIR
The Teledyne Continental Motors IO-240-B engines are fuel injected with a down draft induction system. The intake manifold supplies air to the air distribution system. The air distribution system mounts above the engine cylinders. It sends induction air to the cylinder intake ports. The cylinder intake ports are cast into the cylinder head assembly. The air mixes with fuel from the injector nozzles where it enters the cylinders as a combustible mixture.

The DA20-C1 has a GFRP air intake that attaches below the front of the engine. A stainless-steel mesh screen bonds into the left opening. The screen holds the air filter. Two flexible hoses from the air intake go to the exhaust muffler and the engine intake manifold. An opening at the rear of the air intake supplies alternate air to the engine intake manifold. The GFRP air intake attaches to the bottom of the engine at the front.
The air intake has three openings. The left opening (primary intake) supplies air through a filter assembly and large flexible hose to the engine intake manifold. The right opening supplies unfiltered air through a duct and large flexible hose to the heat-exchanger on the muffler. The rear opening (alternate air intake) has a door

assembly. A Bowden cable controls the door position from the cockpit. If the filter in the left opening becomes blocked, you can select the alternate air supply. The alternate air control opens a by-pass for the engine air filter if it becomes blocked with debris or ice.

The alternate air lever attaches to the control quadrant in the center console. The alternate air lever is the left hand lever in the control quadrant. A Bowden cable connects between the alternate air lever in the cockpit and the lever at the airbox. The Bowden cable goes from the center console, up behind the instrument panel and through the firewall to the engine bay. From the firewall the Bowden cable goes below the engine on the left side. The outer sheath of the Bowden cable then attaches to the support bracket at the air intake.

ENGINE FUEL INJECTION
The fuel injection system uses a low-pressure system to inject fuel into the intake-valve port in the cylinder head.

The four basic parts to the fuel injection system are: fuel pump, fuel metering unit, fuel manifold valve and fuel nozzles. Fuel flows from the fuel pump to the fuel metering unit. The fuel then flows from the metering unit to the fuel manifold valve. From the fuel manifold valve the fuel then flows to the four injector nozzles.

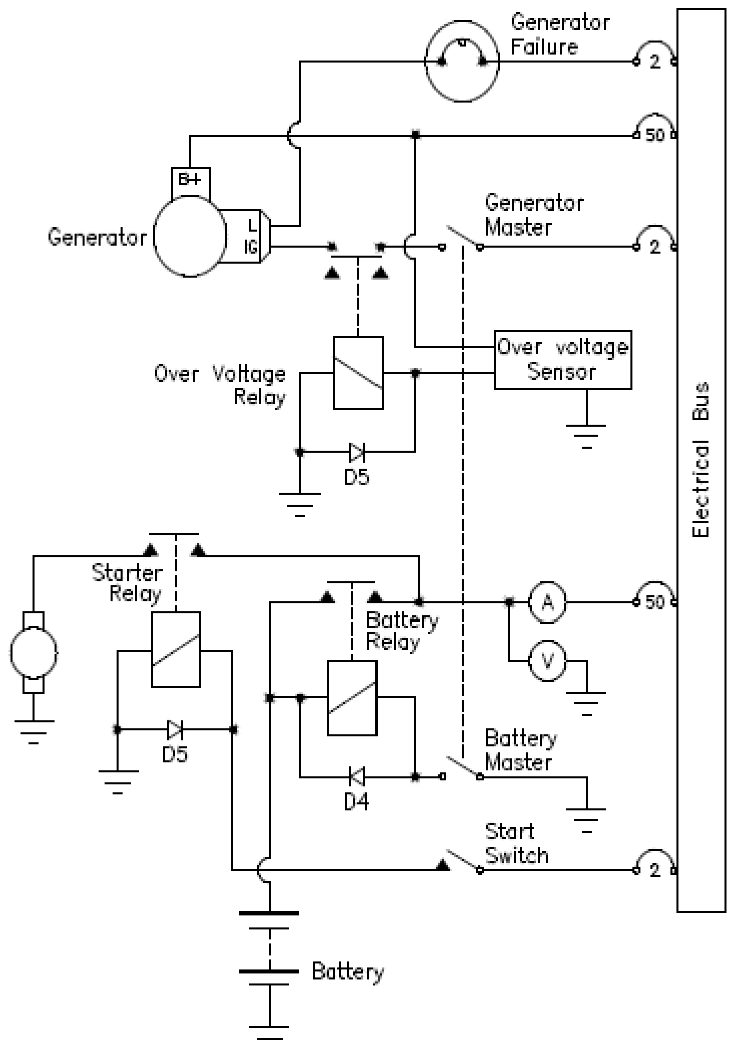
The ram air supplied to the intake manifold goes through a filter assembly. The filter assembly attaches to the engine air intake at the left side. Polyurethane foam makes the filter element. A stainless steel screen at the front and the rear of the filter element makes the filter assembly.

The DA20-C1 has a fuel pressure indicating system. The fuel pressure indication system has 2 components: a fuel pressure sensor and a fuel pressure indicator. The fuel pressure sensor is located on the upper left side of the engine mount. It senses pressure at the outlet of the fuel manifold on the engine, which is the pressure of the fuel going to the injection nozzles. A hose and a restricting orifice connect the manifold to the sensor. The fuel pressure indicator is located on the left side of the instrument panel. It uses the pressure signal from the pressure sensor to set the pointer. The markings are in pounds/square inch. If the fuel pressure in the manifold increases, the flow to the engine injection nozzles increases. The fuel pressure sensor measures the pressure. If the pressure increases, the indicator shows a higher pressure.

ELECTRICAL SYSTEM
The DA20-C1 has 2 sources of electrical power. It has a 14 volt generator and it has a 12 volt battery. In normal operation the generator supplies the power for the system.

The DA20-C1 has a 14 volt direct current (DC) electrical system. The generator attaches to the front of the engine. A flexible belt turns the generator. The generator has a built-in rectifier and voltage regulator. The 40 amp generator is attached to the engine near the propeller hub. The generator feeds the main bus via the generator circuit breaker (50 amps). Both circuit breakers can be triggered manually. The generator warning light is activated by an internal voltage regulator monitoring circuit and illuminates when a generator fault occurs.

The DA20-C1 has a 12 volt, 20 ampere hour battery. The battery supplies DC to the electrical system when the generator is not operating. It also supplies power for engine starting. The battery can also supply power when the load is more than the generator can supply. The battery supplies heavy current for starting through the battery relay and the starter relay. The circuit has no protection. A 12 V battery is connected to the master bus via the battery circuit breaker (50 amps). The battery position is located on the front left hand side of the firewall.



An over-voltage sensor protects the electrical system from too high a generator voltage. The over-voltage sensor controls a relay which isolates the generator from the system. If the over-voltage sensor senses more than 16.1 volts at its input the output voltage goes to zero. The over-voltage relay de-energizes. This removes the excitation voltage for the generator and the generator goes off-line. If you cycle the GEN/BAT switch OFF and ON after the over-voltage has cleared, the generator will come back on line.

Circuit-breakers or fuses protect all other circuits. Circuit-breakers protect the wiring in each circuit from too much current. The circuit-breakers are located on the left side of the instrument panel. You can open and close all of the circuit breakers manually. If too much current flows in a circuit, the related circuit-breaker opens automatically. The GEN/BAT switch controls all electrical power sources in the system.

A main bus and an avionics bus distribute power to the consumer systems. The battery relay attaches to the rear of the battery compartment, or the battery relay can be located on the front left hand side of the firewall. The individual consumers (e.g. Radio, Fuel Pump, Position Lights, etc.) are connected in series with their respective circuit breakers.

VOLTMETER

The voltmeter indicates the status of the electrical bus. It consists of a dial that is marked numerically from 8 - 16 volts in divisions of 2. The scale is divided into three colored arcs to indicate the seriousness of the bus condition. These arcs are:

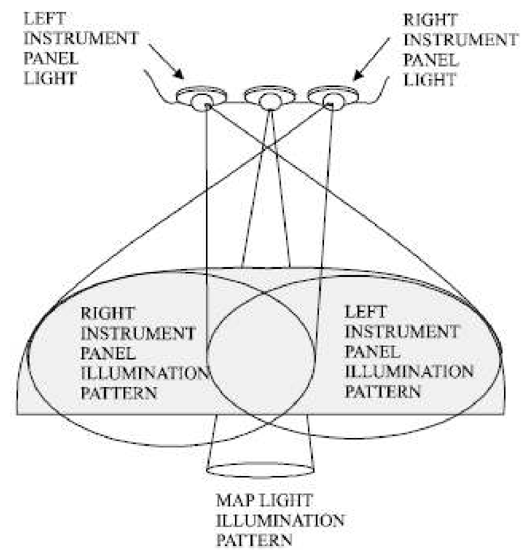
Red for 8.0 - 11.0 volts,
Yellow for 11.0 - 12.5 volts,
Green for 12.5 - 16.0 volts,
Redline at 16.1 volts.

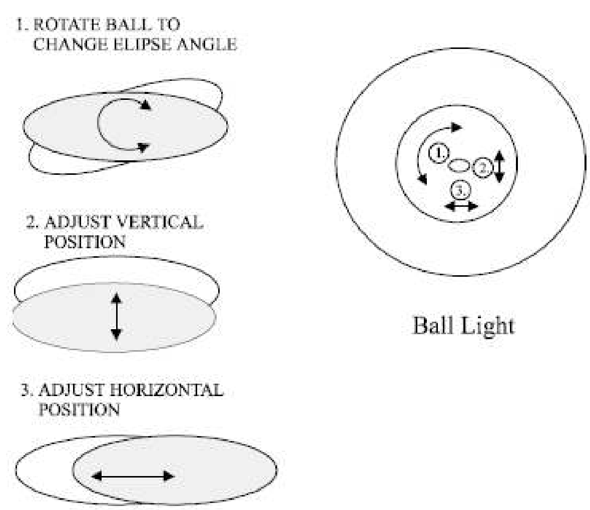
AMMETER
The ammeter indicates the charging (+) and discharging (-) of the battery. It consists of a dial, which is marked numerically from -60 to 60 amps.

LIGHTS
The internal lighting of the DA 20-C1 is provided by a lighting module located aft of the Pilot's head and on the centerline of the aircraft. Included in this module are two panel illumination lights and one map light. The switches for the lights are located on the instrument panel. There is a dimming control located on the left side of the instrument panel for adjusting the intensity of the lighting. There is a toggle switch located beside the dimming control that controls the intensity of the Wing Flap and Trim Annunciator.

Care must be taken when adjusting the lights to maintain proper illumination. The Illumination Pattern and Adjustment shows how the lights are aimed in order to provide proper panel illumination.

Illumination Pattern and Adjustment





The DA20-C1 has these cockpit lights:

- General instrument panel lighting from 2 lights on the bottom face of the roll bar.
- A map light on the bottom face of the roll bar.
- Internal lighting for the magnetic compass.

Some avionics equipment has internal lighting. The control for the interior lights is on the instrument panel.

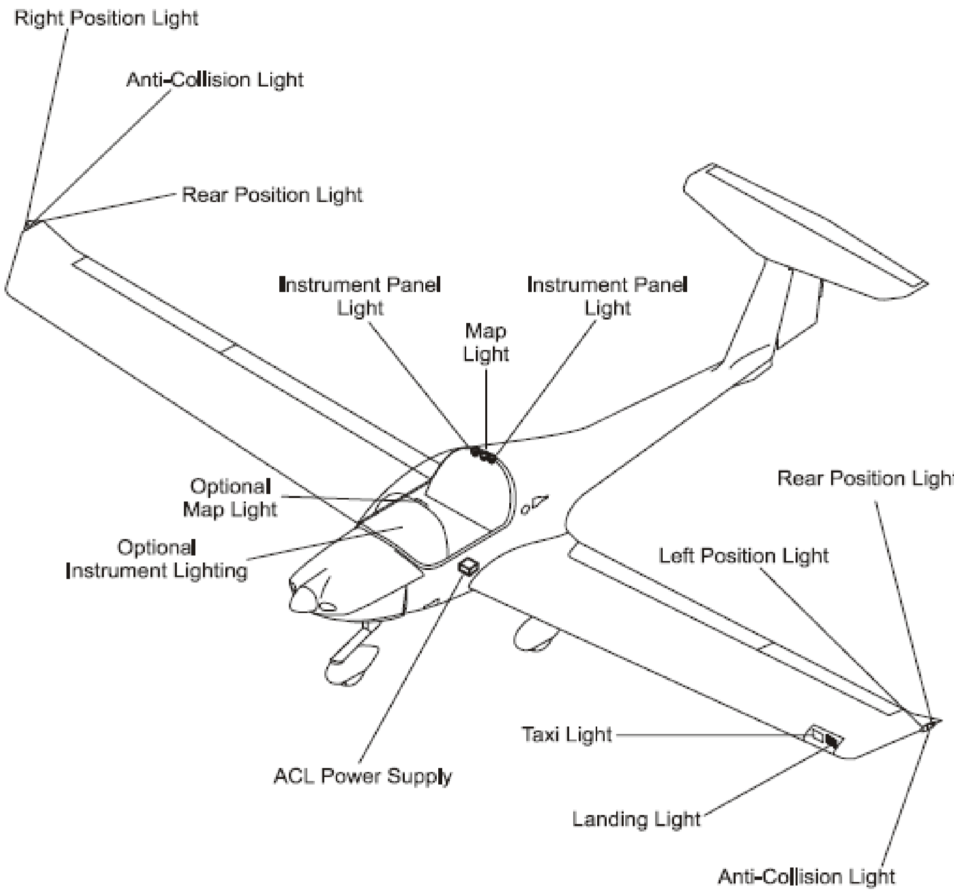
The DA20-C1 has these exterior lights in one light-unit at each wing-tip:

- Left and right position lights. The front part of the light-unit has a red (left) or green (right) lens. The light can be seen from the front and the side.
- Rear position lights. The aft part of each light-unit has a clear lens. The lights can be seen from the rear only.
- Anti-collision lights or Strobes. The middle part of each light-unit has a clear lens. The filament gives a high-intensity flash. The lights can be seen from all directions. The power unit for the Strobe lights is located under the left seat.

The DA20-C1 has these exterior lights in one housing in the leading edge of the left wing:

- Landing light. The landing light has a clear lens and a 100 watt bulb. It is located inboard in the housing.
- Taxi light. The taxi light has an optic lens and a 100 watt bulb. It is located outboard in the housing.

The switches for the exterior lights are located together on the left instrument panel.



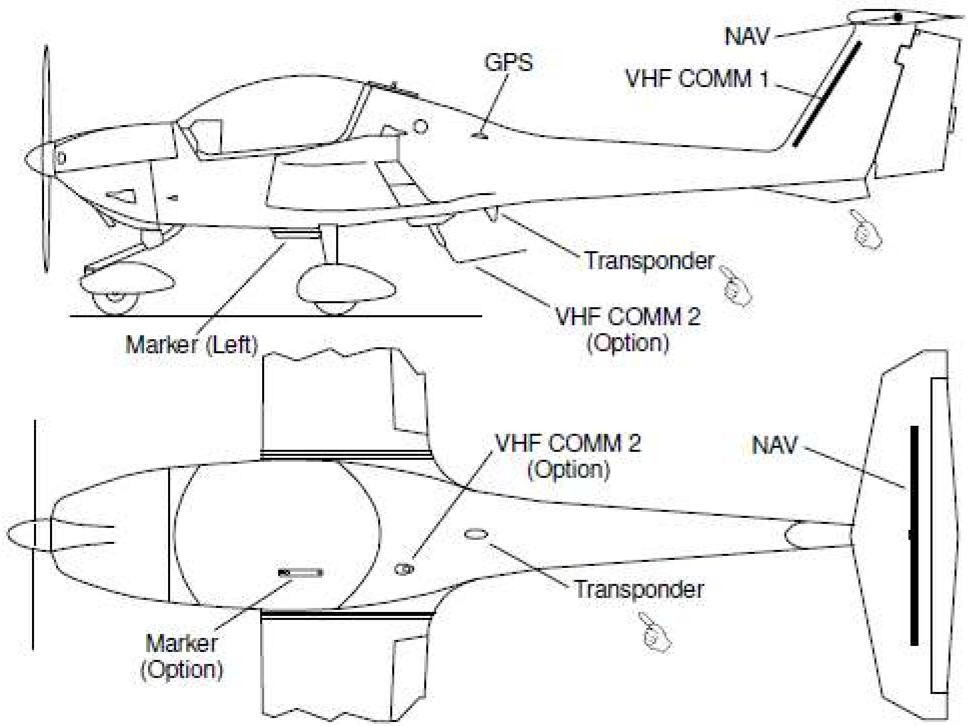
AVIONICS

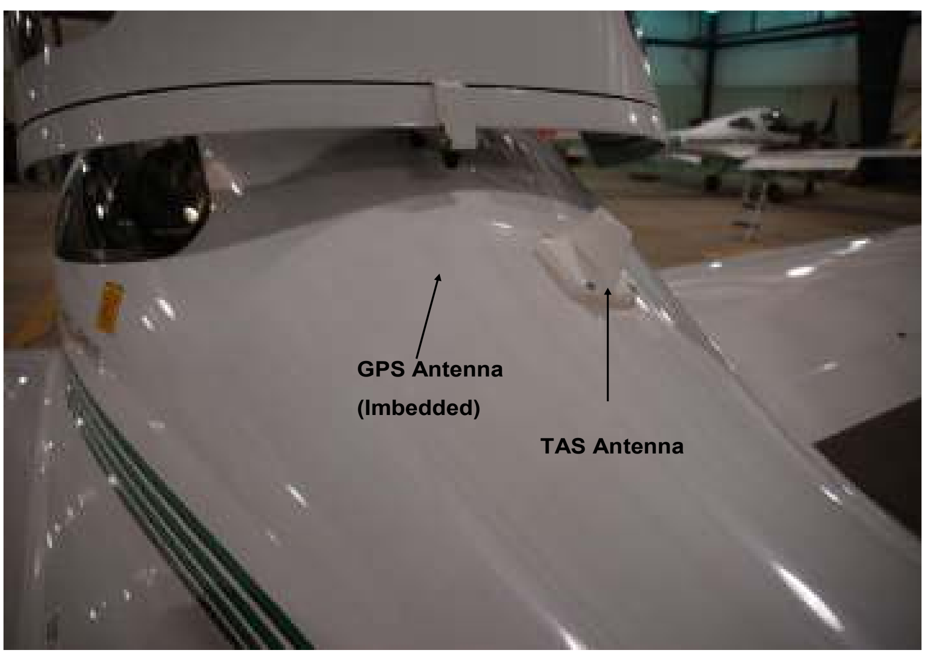
The center of the instrument panel contains the radio and navigation equipment. The microphone key for the radio is installed in the control stick. There are two connectors for headsets on the backrest of the seat. Operating instructions for individual avionics equipment should be taken from the manuals of the respective manufacturers.

The DA20-C1 has a Garmin GNS-430 NAV/COMM and a SL-40 COMM for radios. An audio panel with speaker amplifier operates the cabin speaker.

ANTENNA LOCATIONS

The #1 VHF COMM antenna is a dipole. It is installed in the leading edge of the vertical stabilizer. The #2 VHF COMM antenna is a 1/4 wave whip. It is installed below the bottom skin of the fuselage. The antenna ground plane is copper adhesive tape. The ground plane connects to the airplane static bonding system.


NAV
GPS
VHF COMM 1
Transponder
VHF COMM 2
(Option)
Marker (Left)
VHF COMM 2
(Option)
NAV
Transponder
Marker
(Option)


GPS Antenna
(Imbedded)
TAS Antenna

IGNITION SYSTEM
The engine is provided with two independent ignition systems. The two magnetos are independent from the power supply system, and are in operation as soon as the propeller is turning and the ignition switch is not off. This ensures safe engine operation even in case of an electrical power failure.

The ignition system has these components:
- Ignition Switch.
- Ignition cables
- Two Magnetos
- Starting vibrator “Shower of Sparks” system.
- Ignition Harness (Spark-plug leads).
- Spark Plugs.

The ignition switch is in the lower center of the instrument panel. You operate the ignition switch with a key. The ignition switch has these five positions:
- OFF - Both magnetos grounded.
- R - Right magneto live, left grounded.
- L - Left magneto live, right grounded.
- BOTH - Both magnetos live.
- START – Retarded points of left magneto live, Right magneto grounded, starting vibrator energized and starter relay energized.

WARNING: If the ignition key is turned to L, R or BOTH, the respective magneto is "HOT". If the propeller is moved during this time the engine may start and cause serious or fatal injury to personnel. The possibility of a ‘HOT’ magneto may exist due to a faulty switch or aircraft wiring. Use EXTREME CARE and RESPECT when in the vicinity of a propeller!

Two Slick magnetos supply the high voltage electrical pulses to the spark plugs. An ignition switch in the cockpit controls the magnetos. Shielded leads connect the magnetos to the spark plugs. Two spark plugs in each cylinder give ignition to the engine.

Each cylinder has two spark plugs. The left magneto connects to the top spark plugs and the right magneto connects to the bottom spark plugs.

A Teledyne Continental Motors electrically operated starter-motor attaches to the Teledyne Continental Motors IO-240-B series engine. The starter motor attaches to the rear of the accessory drive case.

The starter has a DC motor. During starting, the motor turns the engine through a reduction gear and a clutch. A solenoid attaches to the bottom of the motor. The solenoid moves the pinion gear of the starter to engage with the engine crankshaft gear. It also operates contacts to supply power to the motor. The starter electrical circuit has 2 parts. It has a control circuit and a heavy current circuit.

The main bus supplies power for the starter control circuit through a circuit-breaker. The control circuit has the usual key-operated ignition switch. The ignition switch is located near the bottom center of the instrument panel. The fully clockwise START position of the ignition switch gives a positive supply to the starting vibrator which switches power to the starter relay. In all other switch positions, there is no supply to the starter relay.

Heavy cables from the output side of the battery relay supply the electrical power to the starter relay. A heavy cable connects the output of the starter relay to the starter.

When you set the ignition switch to START battery power energizes the starter motor. The starter solenoid that attaches to the starter motor pushes a pinion gear forwards to engage the crankshaft gear. At this point the starter motor turns the pinion gear through a pair of reduction gears that turn the crankshaft. When the engine starts and the ignition switch is released, the pinion gear retracts from the crankshaft gear. A start annunciator light comes on when the starter relay closes.

When you turn the ignition switch to the START position with the GEN/BAT switch ON, these things happen:

- The main bus supplies power to the ignition switch.
- The ignition switch gives a positive supply to the starter relay.
- The starter relay energizes. The relay contacts close.
- The start light comes on.
- The starter solenoid energizes. This moves the starter pinion to engage the crankshaft gear.
- The contacts in the solenoid close to complete the power circuit to the starter motor.
- The motor turns the engine.

Note: Inadvertent starter engagements can cause significant damage to the starter pinion gear and cluster gear. This damage causes unnecessary maintenance delays and substantial financial costs to repair the damage. Students receive training in inadvertent starter engagement prevention and are expected to use good judgment and professionalism in the operation of the aircraft. All inadvertent starter engagements must be immediately reported to maintenance and will result in a cancelled sortie, grounding of the student, and an UNSAT grade. Additionally, the student will require a mandatory counseling session with the Chief Pilot or Designated Representative/MTO prior to the next flight.

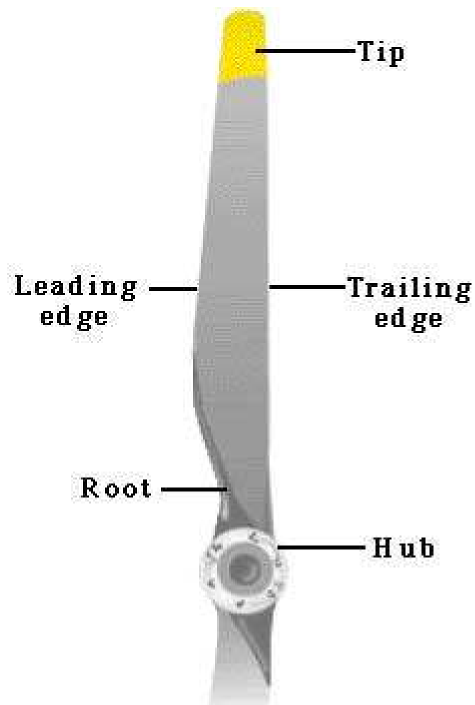
PROPELLER

The DA20-C1 propeller is a Sensenich two-bladed, fixed pitch, wood propeller, Model W69EK7-63, 5ft 9 in. The propeller has a metal spinner to streamline the aerodynamic flow of air to the front of the propeller. The propeller attaches directly to the engine crankshaft with bolts. A plastic laminate coating protects the leading edge of the propeller from debris.

The "W" denotes this as a wood propeller.
The "69" always denotes the propeller diameter in inches.
The “E” designates blade design.
The “K” Designates hub configuration "K" - for installation on SAE No. 1 (Ref AS 127) flanged shaft or spool spacer. “K7” – for installation on SAE No. 1 flanged shaft or spool spacer with 7/16” attaching bolts.
The "63" denotes propeller pitch in inches at the 75% radius

The function of the propeller is to convert brake horsepower from the engine into thrust. To do this there are two types of propellers in use: fixed pitch (or ground adjustable, which remains a fixed pitch during flight) and the constant speed propeller with some variations possible.

Looking at a propeller, its blade angle varies from the root to the tip. This is because angular speed of the blade is at its highest at the tip (reaching the speed of sound) and lowest at the root. If the blade angle would be constant then the angle of attack (and thrust) of the relative airflow (result of forward speed and RPM) would vary across the propeller disc, and the blade would probably be stalled. To make sure that the generated thrust is equal from root to tip, the blade angle is high at the root (low angular speed) and low at the tip (high angular speed).



During propeller rotation the airflow past the propeller blade produces an aerodynamic reaction which can be resolved into thrust and propeller torque (called lift with wings). To rotate the propeller, the engine needs to create a torque. The resistance to this rotation is called propeller torque and when these two forces are in balance or stabilized, engine/propeller RPM is constant. Thus, power created by the engine is absorbed by the propeller and as a result thrust is generated.

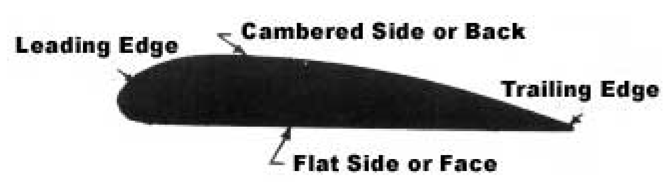
With this propeller, the blade angle is fixed. It can be seen that there is also one RPM / airspeed combination where the propeller is operating at its optimum angle of attack and produces its maximum thrust. On all other airspeeds (or conditions of flight) there is less thrust available from the propeller. In other words, its effective angle of attack depends on RPM and airspeed.

To compensate, manufacturers sometimes have a climb and a cruise propeller available for the same model or type. Although convenient and simple to operate, a fixed pitch propeller will always be a compromise between a number of factors as RPM, airspeed, relative airflow, angle of attack, two or three blades, blade chord and length, emitted sound level etc.

Thrust is the force that moves the aircraft through the air. Thrust is generated by the propulsion system of the aircraft. The different types of propulsion systems develop thrust in different ways, although it usually is generated through some application of Newton's Third Law. Propeller is one of the propulsion systems. The purpose of the propeller is to move the aircraft through the air. The propeller consists of two or more blades connected together by a hub. The hub serves to attach the blades to the engine shaft.

The blades are made in the shape of an airfoil like the wing of an aircraft. When the engine rotates the propeller blades, the blades produce lift. This lift is called thrust and moves the aircraft forward. Most aircraft have propellers that pull the aircraft through the air. These are called tractor propellers. Some aircraft have propellers that push the aircraft. These are called pusher propellers.

The leading edge of the airfoil is the cutting edge that slices into the air. As the leading edge cuts the air, air flows over the blade face and the camber side.



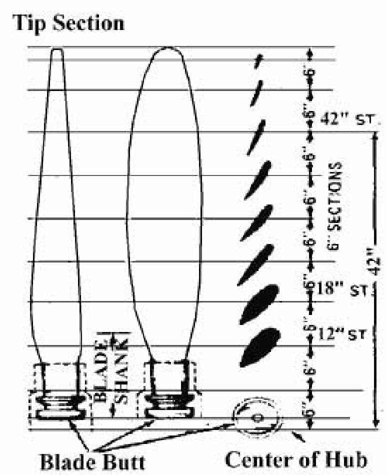
Cross section of a propeller blade.

Blade Face is the surface of the propeller blade that corresponds to the lower surface of an airfoil or flat side.

Blade Back / Thrust Face is the curved surface of the airfoil.
Blade Shank (Root) is the section of the blade nearest the hub.

Blade Tip is the outer end of the blade farthest from the hub.
Plane of Rotation is an imaginary plane perpendicular to the shaft. It is the plane that contains the circle in which the blades rotate.

Blade Angle is formed between the face of an element and the plane of rotation. The blade angle throughout the length of the blade is not the same. The reason for placing the blade element sections at different angles is because the various sections of the blade travel at different speeds. Each element must be designed as part of the blade to operate at its own best angle of attack to create thrust when revolving at its best design speed.



Blade Elements are the airfoil sections joined side by side to form the blade airfoil. These elements are placed at different angles in rotation of the plane of rotation. The reason for placing the blade element sections at different angles is because the various sections of the blade travel at different speeds. The inner part of the blade section travels slower than the outer part near the tip of the blade. If all the elements along a blade are at the same blade angle, the relative wind will not strike the elements at the same angle of attack. This is because of the difference in velocity of the blade element due to distance from the center of rotation.

The blade has a small twist (due to different angle in each section) in it for a very important reason. When the propeller is spinning around, each section of the blade travels at a different speed. The twist in the propeller blade means that each section advances forward at the same rate to stop the propeller from bending.

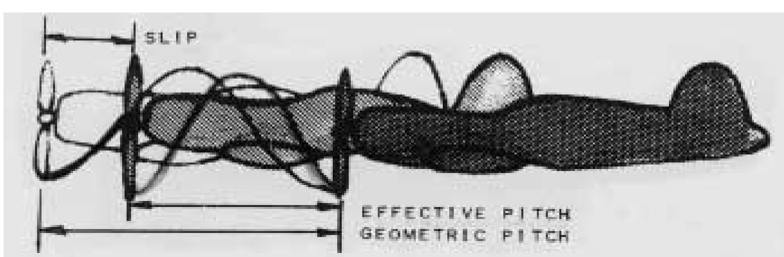
Thrust is produced by the propeller attached to the engine driveshaft. While the propeller is rotating in flight, each section of the blade has a motion that combines the forward motion of the aircraft with circular movement of the propeller. The slower the speed, the steeper the angle of attack must be to generate lift. Therefore, the shape of the propeller's airfoil (cross section) must change from the center to the tips. The changing shape of the airfoil (cross section) across the blade results in the twisting shape of the propeller.

Relative Wind is the air that strikes and passes over the airfoil as the airfoil is driven through the air.

Angle of Attack is the angle between the chord of the element and the relative wind. The best efficiency of the propeller is obtained at an angle of attack around 2 to 4 degrees.

Blade Path is the path of the direction that the blade element moves.

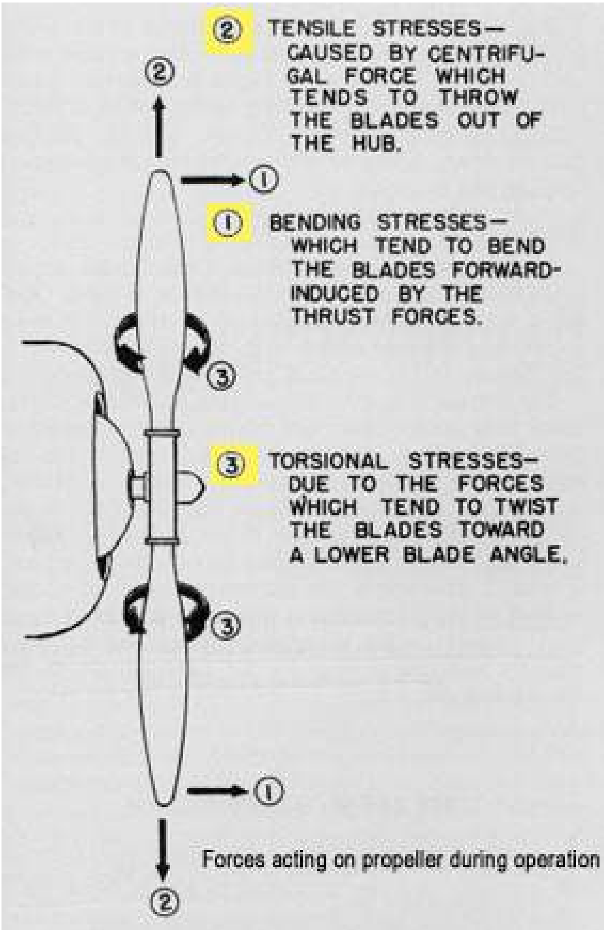
Pitch refers to the distance a spiral threaded object moves forward in one revolution. As a wood screw moves forward when turned in wood, the same occurs with the propeller as it moves forward when turned in the air.



Geometric and Effective Pitch

Geometric Pitch is the theoretical distance a propeller would advance in one revolution.

Effective Pitch is the actual distance a propeller advances in one revolution in the air. The effective pitch is always shorter than geometric pitch due to the air being a fluid and there will always be slip.



Forces and stresses acting on a propeller in flight
The forces acting on a propeller in flight are:

1. Thrust is the air force on the propeller which is parallel to the direction of advance and induces bending stress in the propeller.

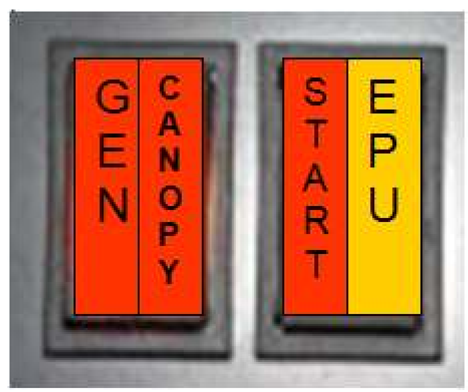
2. Centrifugal force is caused by rotation of the propeller and tends to throw the blade out from the center.

3. Torsion or twisting forces in the blade itself, caused by the resultant of air forces which tend to twist the blades toward a lower blade angle.

The stresses acting on a propeller in flight are:

1. Bending stresses are induced by the thrust forces. These stresses tend to bend the blade forward as the airplane is moved through the air by the propeller.
2. Tensile stresses are caused by centrifugal force.
3. Torsion stresses are produced in rotating propeller blades by two twisting moments. One of these stresses is caused by the air reaction on the blades and is called the aerodynamic twisting moment. The other stress is caused by centrifugal force and is called the centrifugal twisting moment.

WARNING SYSTEMS



The DA20-C1 has 3 standard warnings. It has a CANOPY warning, a GEN warning and a START warning. An EPU status is also installed.

The warnings are in two annunciator units at the top of the instrument panel. The left unit has the GEN (Red) and the CANOPY (Red) warnings. The right unit has the START (Red) and EPU (Amber) warnings.

Each warning unit has a test switch. Press the front of the unit to operate the test switch. (The BAT/GEN switch must be ON).

The FUEL PRESS/OIL PRESS circuit-breaker supplies power for the press-to-test function of the GEN, CANOPY and START warnings.

The starter side of the starter relay supplies power for the START warning. An in-line fuse protects the circuit. The external power bus supplies the EPU warning.

STALL WARNING SYSTEM

A stall warning horn is located on the right side of the instrument panel. Air pressure operates the horn. A hole in the leading edge of the left wing connects to the horn. When the angle of attack is just less than the stall angle, the airflow through the hole operates the horn. When the airspeed drops below 1.1 times the stall speed, a horn sounds in the left instrument panel. The horn grows louder as the speed approaches the stall speed. The horn is activated by air from a suction hose that connects to a hole in the leading edge of the left wing. The hole has a red circle around it. The stall warning hole should be plugged whenever the aircraft is parked to prevent contamination and subsequent malfunction of the stall warning system.

TEMPERATURE LIMITS CAUTION
Temperature limit of the structure for the operation of the airplane:
Maximum T/O Temperature: 131°F (55°C)

DEMONSTRATED CROSSWIND COMPONENT
The maximum demonstrated crosswind component is 20 knots. (37 km/h).