SECTION 7 - SYSTEMS DESCRIPTION

PA-30 * 3600 LBS GROSS WEIGHT

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INTRODUCTION

The PA-30 Comanche is a high-performance, twin-engine, low-wing, retractable-gear monoplane of all-metal construction. It has four (optional six) place seating, 200 or 250 pound baggage capacity, and two 160 horsepower engines with full feathering propellers.

AIRFRAME

The structures of the PA-30, except for the tubular-steel engine mount, steel landing-gear struts, and other miscellaneous steel parts, are of sheet-aluminum construction, alodine treated and completely primed with zinc-chromate primer, then covered with acrylic lacquer on the exterior surfaces. The extremities (wing tips, stabilator and rudder end pieces) are constructed of fiberglass or ABS thermoplastic. The fuselage is an all-metal semi-monocoque construction composed of bulkheads, stringers, stiffeners and longitudinal beams to which the outer skin is riveted.

The laminar-flow wing is of all-metal stressed skin, full-cantilever design. The wing section is a NACA 64_2 A215 airfoil with maximum thickness approximately forty-percent aft of the leading edge. This permits the main spar to pass through the cabin under the rear seats, providing unobstructed cabin-floor space. The extruded-beam type main spar is joined with high-strength butt fittings at the center of the fuselage making in effect a continuous main spar. The spars are attached to the fuselage at the side and in the center of the structure. The wings are also attached at the rear spar and at an auxiliary front spar. The ailerons are cable and push-rod controlled and are statically and dynamically balanced. The trailing-edge wing flaps are electrically operated. Flush riveting is used over the forward part of the wing up to the main spar.

The all-metal empennage group is a full-cantilever design consisting of a vertical fin, rudder, and stabilator with an anti-servo tab. The rudder and stabilator are statically and dynamically balanced. The stabilator and vertical fin have two-channel main spars running full length. The stabilator is attached to the fuselage by a torque tube supported by bearing blocks.

ENGINE AND PROPELLER

The normally aspirated Twin Comanche is powered by two Lycoming I0-320-B series engines rated at 160 bhp each at 2700 rpm. The I0-320-B series engines are four cylinder, direct drive, wet sump, horizontally opposed, air cooled, and have 319.8 cubic inches of displacement. These engines are designed to operate on 91/96 (minimum) octane aviation-grade fuel. Major accessories furnished with the engines are geared starters, 50-ampere, 12-volt generators or 70 ampere, 12 volt alternators, dual vacuum pumps, direct-drive fuel pumps, dry automotive-type induction air filters, and dual magnetos. An external oil cooler is mounted on the left rear of each engine baffle.

Cowl flaps are manually operated by two push-pull controls located to the right of the power quadrant. The cowl flaps should be open during ground operations and in climbs. In no case should the cylinder head temperature be allowed to exceed 500 degrees Fahrenheit or the oil temperature be allowed to exceed 245 degrees Fahrenheit.

The fuel injection system is a Bendix self-purging servo regulator metering system. The system is equipped with a manual mixture control and idle cut-off mechanism. A fuel flow indicator is installed in the instrument panel to give an accurate indication of fuel flow. It is important to note that an indication of increasing or abnormally high fuel flow is a possible symptom of restricted injector lines or nozzles.

Induction air is normally directed through a filter, but the induction system includes a spring loaded door which opens automatically if the filter becomes blocked to allow air to the engine. This alternate air door can also be operated manually by a push-pull (ALT AIR) control on the instrument panel. This control should be operated if induction system icing is suspected.

The constant speed, full feathering, controllable pitch propellers are alloy forged and controlled by a governor mounted on the engine which supplies oil to the propeller at various pressures through the engine crankshaft.

The feathering mechanism is dry nitrogen operated. Feathering is accomplished by moving the propeller controls fully aft through the low rpm operating range into the feathering position. Feathering takes place in approximately three seconds. An optional propeller synchrophaser automatically matches the rpm and phase angle of both propellers. The right engine is slaved to the left, and the systems range of control is limited to 50 rpm.

ENGINE CONTROLS

Engine controls consist of dual throttle controls, mixture controls, and propeller rpm controls which are located in a power control quadrant at the lower center of the instrument panel where they are accessible to both the pilot and copilot.

FLIGHT CONTROLS

The primary flight controls of the PA-30 are of conventional design consisting of a control wheel that operates the ailerons and stabilator, and pedals that operate the rudder. Duplicate controls are provided for the copilot.

The stabilator trim is operated by an overhead crank in the cabin or an electric trim mechanism activated by a switch mounted on the control wheel. Both methods control a rotating drum in the tail section. The rudder trim is operated by a knob mounted below the right center of the instrument panel that controls a bungee mechanism that extends forward to the nose gear steering arm. Coordinated action of the rudder and ailerons is accomplished by cables that are interconnected by a cable-spring system.

Installed on the Twin Comanche are electrically operated fowler flaps which can be lowered and stopped at any position up to 27 degrees. The flap control switch is located below the right center of the instrument panel just above the rudder trim control. A flap position indicator is located in the instrument panel. It is marked to show the degree of flap travel and also shows a range of operation for takeoff. A locking mechanism holds the flap on the right side when it is in the up position so that it may be used as a step while entering or exiting the aircraft.

LANDING GEAR

The PA-30 tricycle landing-gear system is a fully retractable air-oil, oleo-strut type, and is electrically operated by a selector switch located on the instrument panel. The gear selector is in the shape of a wheel to distinguish it from the flap control which is in the shape of an airfoil. The three landing gear are mechanically connected, and move as a unit.

The nose gear is steerable with the rudder pedals through a forty-degree arc. The steering mechanism is disconnected automatically during gear retraction to reduce rudder pedal loads in flight. The nose wheel is equipped with a hydraulic shimmy damper.

Retraction of the landing gear is accomplished by an electric motor and transmission assembly located under the floorboard, activating push-pull cables to each of the main gear, and a push-pull tube to the nose gear. Limit switches are installed in the system to cut off the gear motor when the gear is fully extended or retracted.

To guard against inadvertent movement of the landing-gear selector switch while on the ground, a mechanical guard is positioned just below the switch. The switch handle must also be pulled aft before being placed in the "GEAR UP" position. A warning horn will sound if the selector switch is placed in the "GEAR UP" position while the weight of the airplane is resting on the landing gear.

To prevent inadvertent retraction of the landing gear while the airplane is on the ground, a safety "squat" switch is installed on the left main gear to open the electric circuit to the landing-gear motor until the strut is fully extended.

If manifold pressure on both engines is reduced below approximately 12-inches, and the landing gear is not down and locked, a warning horn will sound to alert the pilot to the possibility of a gear-up landing. The landing-gear warning horn emits a continuous sound.

A green light on the instrument panel is the primary indication that the landing gear is down and locked. When the gear is fully extended, the series circuit that lights this lamp is completed through a switch located on each of the three gear. All three gear must be down and locked for the indicator to light. An amber light above the landing-gear selector switch indicates the gear is up. This lamp will flash if the landing gear is up and manifold pressure of one engine is reduced below approximately 12 inches. A third white light (installed on later models) will indicate that the landing gear is in transit. It is important to note that the landing-gear indication lights are automatically dimmed when the navigation lights are turned on.

A removable emergency handle is used to manually extend the landing gear in the event of a malfunction of the electrical system.

BRAKE SYSTEM

The brakes are activated by toe pedals mounted above the pilot (optional copilot) rudder pedals, or by a hand lever located below the left center of the instrument panel. The hydraulic brake system is a self-adjusting, single-disk, double-piston assembly. Each rudder pedal has its own master cylinder, but both share a common reservoir.

The parking brake is connected mechanically to the master cylinders and may be set by applying the toe brakes or hand lever and pulling out the parking brake "T" handle. To prevent inadvertent application of the parking brake in flight, a safety lock is incorporated to eliminate the possibility of pulling out the "T" handle until pressure is applied by use of the toe brakes or hand lever. To release the parking brake, apply the brakes and push in on the parking brake "T" handle.

FUEL SYSTEM

The fuel cells on the Twin Comanche consist of rayon-neoprene bladders which are contained in cavities in the forward sections of the wing. The inboard main cells hold a capacity of 30 gallons (27 usable) each and the outboard auxiliary cells have a capacity of 15 gallons each. Optional wingtip tanks (if installed) also have a capacity of 15 gallons each. It is important to note that due to several factors including aircraft attitude while refueling, many fuel cells do not hold their full rated capacity.

Fuel cells should be kept full when the aircraft is not in use to prevent accumulation of moisture through condensation and to keep the rubber from deteriorating by drying out.

Fuel cells are vented individually by NACA anti-icing vent tubes located beneath the wing. Fuel from each cell passes through a selector-shutoff valve to a sediment bowl in the lowest part of the fuel system where it is filtered, and any water or foreign particles are trapped. From there the fuel is drawn to the fuel injection system by an engine driven pump. In the event of failure of the engine driven pump, an electric auxiliary fuel pump is provided. In addition to the back-up function, this pump is normally operated when switching fuel tanks and during starting, takeoff and landing.

The fuel strainer units are located under the floorboard between the pilot and copilot seats just aft of the fuel selector valves. Daily draining of the sediment bowls is accomplished by opening the hinged access door and operating the quick drain valve for approximately five seconds with the fuel selector valve on one cell. Change the fuel selector to the next cell and repeat the process until all cells are checked. Allow enough fuel to flow to clear each of the lines as well as the sediment bowl strainer. Positive fuel flow shutoff can be observed by means of the clear plastic tube which carries the fuel overboard.

Fuel quantity is indicated by two electric gauges located in the engine instrument cluster. The fuel quantity gauges will indicate the amount of fuel in the cells that are selected by the selector-shutoff valves.

A crossfeed is provided for emergency single engine operation. To use fuel from the side opposite of the operating engine, place the fuel selector for the inoperative engine in the "MAIN" or "AUXILIARY" position (solenoid switch in the "AUX" or "TIP" position if wingtip fuel tanks are installed) and place the fuel selector for the operating engine in the "CROSSFEED" position.

Never place both fuel selectors in the crossfeed position at the same time, and the fuel system should be taken off crossfeed before executing a single engine landing.

ELECTRICAL SYSTEM

Electrical power for the Twin Comanche is supplied by a 12-volt, direct-current, negative-ground system. The primary electrical power source on the A and B models is a 12-volt, 50-ampere generator (dual generators optional) controlled by a voltage and current regulator. The C model is equipped with dual 12-volt, 70-ampere alternators protected by an overvoltage relay. Secondary power is provided by a 12-volt, 35 ampere-hour battery which supplies power for starting, and is a reserve power source in the event of generator or alternator failure.

The battery is mounted in a stainless-steel box either immediately aft of the baggage compartment or in the nose section. The voltage regulator and overvoltage relay is mounted on the aft bulkhead of the nose section. The ammeter, located on the instrument panel near the engine gauge cluster, indicates battery discharge.

Electrical switches are located on the lower left side of the instrument panel. The master switch is positioned on the far left of these switches. Circuit breakers on the A and B models are mounted in the floorboard below the power quadrant. Circuit breakers on the C model are mounted on the lower right of the instrument panel.

Standard lighting on the Twin Comanche includes navigation lights, landing lights, cabin and instrument lights. Optional equipment includes a rotating beacon and strobe lights. A combination on-off rheostat switch controls the instrument and radio lights.

INSTRUMENT PANEL

The instrument panel is designed to accommodate the customary advanced flight instruments, the normally required engine instruments, and avionics for VFR and IFR flight. Flight instruments on the C model are arranged in the "T" configuration. The artificial horizon and directional gyro are vacuum operated. The turn-indicator or turn coordinator gyro is electrically operated and serves as a standby for the vacuum gyros in the event of a vacuum system failure.

Radios are located in the center section of the instrument panel. The avionics master switch (if installed) is typically located with the other electrical switches to the right of the master switch.

VACUUM SYSTEM

The vacuum system provides the suction necessary to operate the attitude indicator and the directional gyro. The engine-driven system consists of two vacuum pumps, each of which has its own vacuum relief valve with filter, a system inlet-air filter, and a suction gauge. If suction is lost from one of the vacuum pumps, a check valve closes and adequate suction is supplied by the remaining pump. A mechanical warning indicator located in the suction gauge will indicate which pump has failed.

The vacuum pumps are dry-type pumps. A shear drive in the pump assembly protects the engine from damage. Caution should be exercised to insure that the propeller is never pulled through backward, as doing so will damage the rotary vanes in the vacuum pump and potentially render the gyros inoperative.

The vacuum regulator is adjustable to a normal reading of 5.0 inch Hg plus .1 or minus .2 inch Hg. Proper adjustment is important because higher settings will damage the gyros, and the instruments will be unreliable with a low setting.

PITOT-STATIC SYSTEM

The pitot-static system provides ram air pressure to the airspeed indicator and static pressure to the airspeed indicator, vertical speed indicator, and altimeter. The system is composed of a heated (optional) pitot tube mounted on the lower surface of the left wing, a pair of static ports located on either side of the fuselage aft of the baggage compartment, and the associated piping necessary to connect the instruments to the sources.

An alternate static source is available as an option. Airspeed and altitude readings can be expected to be higher than normal when operating from the alternate air source.

The following table shows corrections to use when operating on the alternate static system.

	Standard Static System	Alternate Static System	
Indicated Airspeed (mph)	CAS (mph)	CAS (mph)	
80	82	81	
88	90	91	
120	121	113	Gear and Flaps Retracted
160	160	148	
200	197	185	
220	216	204	
80	80	81	
91	90	91	Gear and Flaps Extended
100	98	97	
120	117	113	

HEATING AND VENTILATING SYSTEM

There are four individual controls located on the lower right side of the instrument panel which regulate the flow of heating, defrosting and ventilating air.

Heat for the cabin interior is provided by a gasoline heater installed in the nose section. Heated air for the defroster system is provided by the same heater, but has an individual control. Caution should be used when operating the defroster on the ground as prolonged application of heat may cause damage to the Plexiglas windshield.

The cabin heater consumes approximately one gallon of gasoline an hour when operating, and its source is the right engine fuel supply. If the cabin heater is used, this factor should be computed when figuring fuel consumption.

Fresh air is supplied to the cabin by air inlets located in the fuselage nose. Two adjustable ventilators are located near the floor forward of the front seats. In addition, there is a fresh air scoop located in the dorsal fin which provides air to the rear seating positions.

The early model Twin Comanche (SN 30-1 through 30-401) is equipped with a cabin heater manufactured by Southwind. Later models (SN 30-402 and above) are equipped with a Janitol heater. Controls are provided to direct the airflow to both the front and rear cabin. The heater uses gasoline supplied from the right engine fuel system. If the right fuel selector is off, the heater is inoperative. A temperature limit switch will override heater operation if a malfunction occurs resulting in excessive temperatures.

To operate the Southwind heater, first turn on the fuel valve, then move the heater switch to "LOW" or "HIGH" position. If the heater does not start, move the switch to the "PRIME" position for 15 seconds and then to "HIGH". If all controls are in the closed position, heated air is exhausted overboard. high heat is normally used only in flight as ground operation may result in excessive exhaust smoke from the heater.

When the heater is turned off, combustion stops but the fan continues to operate for a few minutes to cool the heater and purge it of fumes. It is recommended that the heater be turned off as soon as practical after landing to insure that it has cycled before shutting off the master switch.

To operate the Janitol heater, the manual fuel valve must be "ON" and the three position switch on "HEAT". No priming is required. Heat is regulated by a thermostat and no excess hot air is exhausted overboard.

When the Janitol heater is turned off, and the manual fuel valve is closed, combustion stops and no purge time is required.

CABIN FEATURES

The front seats adjust fore and aft for ease of entry and exit to the cabin, and occupant comfort. All seats are easily removed and all seat positions are equipped with seat belts.

The early model PA-30 has a single rear seat. The back of the seat is adjustable to various fore and aft positions by use of latches located at the upper outboard corners. The B and C models are equipped with two individually adjustable rear seats.

A large baggage area is located aft of the rear seat. On the early model, it is accessible through a 20 x 20 inch outside baggage door on the right side of the fuselage. Maximum capacity is 200 pounds, and tie down straps are provided. On the B and C models, the baggage compartment is accessible either from the cabin or through a 19 x 21 inch outside baggage door on the left side of the fuselage. Maximum capacity is 250 pounds, and optional 5th and 6th seats are available.

The baggage door on the later models may be used as an emergency exit. It is opened from inside the aircraft by holding the door knob up while turning the latch clockwise.

Each aircraft is equipped with a tow bar. It is stowed either in the baggage compartment or next to the main spar under the flap covering.

STALL WARNING

An approaching stall is indicated by a stall-warning light (and optional horn) which is activated between five and ten knots above stall speed. The stall warning horn emits an interrupted sound to distinguish it from the landing gear warning horn. Mild to moderate airframe buffeting and gentle pitching may precede the stall. The stall-warning lamp is activated by a lift detector installed in the leading edge of the left wing. The stall-warning system is inoperative with the master switch off.

OXYGEN SYSTEM

The oxygen system for the PA-30 consists of an oxygen cylinder and regulator, filter valve, pressure gauge, outlets for masks and an on-off control mounted on the instrument panel. The cylinder has a 63 cubic foot capacity at a working pressure of 1800 pounds per square inch. Each outlet has a spring-loaded valve that prevents the flow of oxygen until a mask hose is engaged into the outlet.

**** WARNING ****

The utmost care should be taken to insure that no combustion source exists in the cabin while operating on oxygen. Smoking is prohibited while oxygen is in use.

When recharging the oxygen supply, be certain to use only aircraft quality aviator's breathing oxygen. Do not use hospital or industrial oxygen because the moisture contained in these products may freeze at altitude and disable the oxygen system.

EMERGENCY LOCATOR TRANSMITTER

Federal Aviation Regulations require (with certain exceptions) that all civil aircraft registered in the United States must be equipped with an ELT which meets the applicable requirements of TSO-C91 or TSO-C91-A.

The ELT battery must be replaced if the transmitter has been used in an emergency, or after one hour of accumulated testing time, or if the unit has been inadvertently activated for an undetermined period of time, or after half of the useful life has expired. The battery expiration date is marked on the outside of the ELT case.

The ELT should be checked after each flight to make certain that the unit has not been accidentally activated. Check by tuning a radio receiver to 121.5 and listening for an oscillating sound. If the ELT has been activated, it should be turned off immediately.

**** NOTE ****

Testing of the ELT should be conducted only in the first five minutes of the hour, and limited to three audio sweeps.

FUEL SYSTEM SCHEMATIC

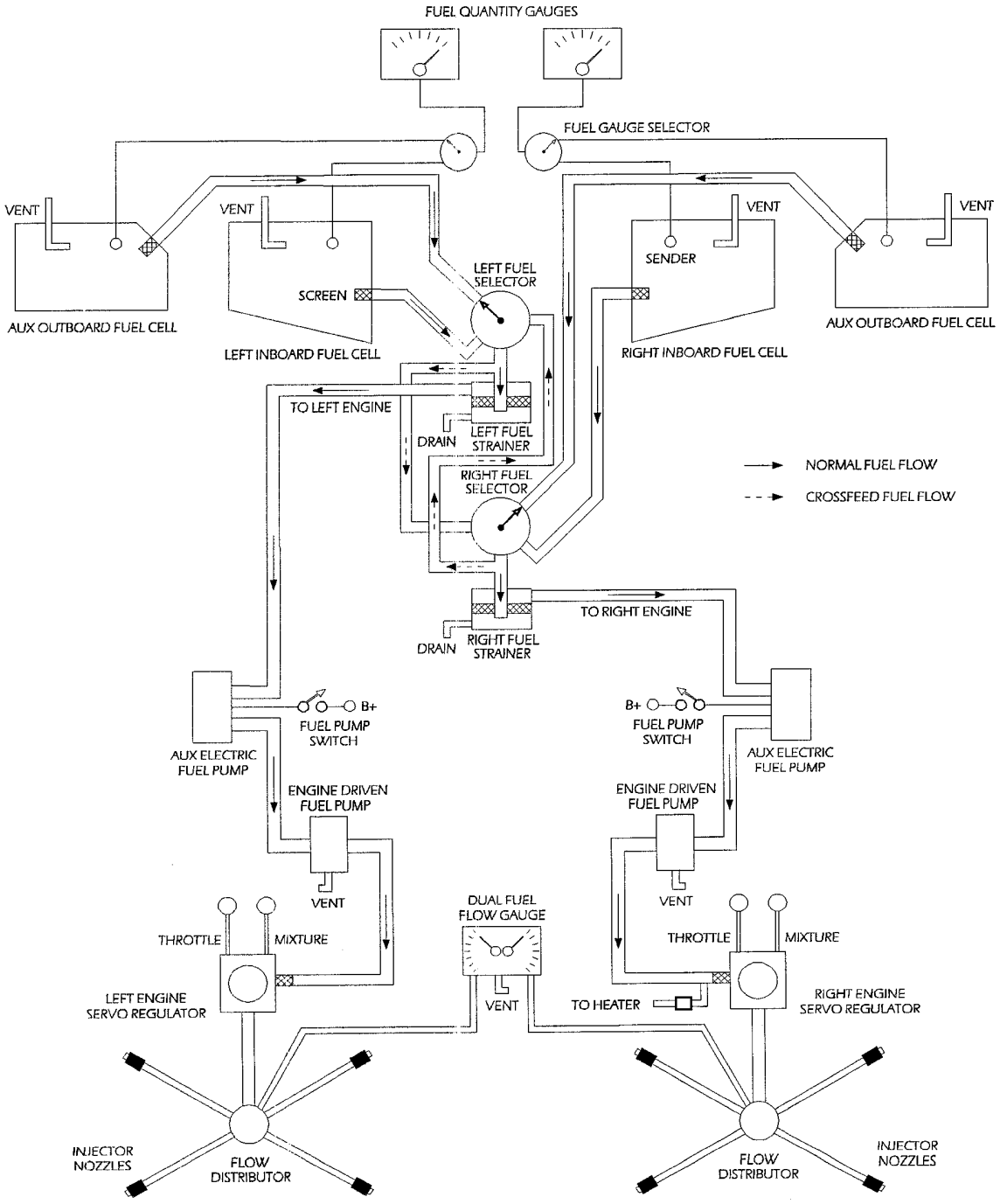

FIGURE 7-01

GENERATOR AND STARTER SYSTEM SCHEMATIC

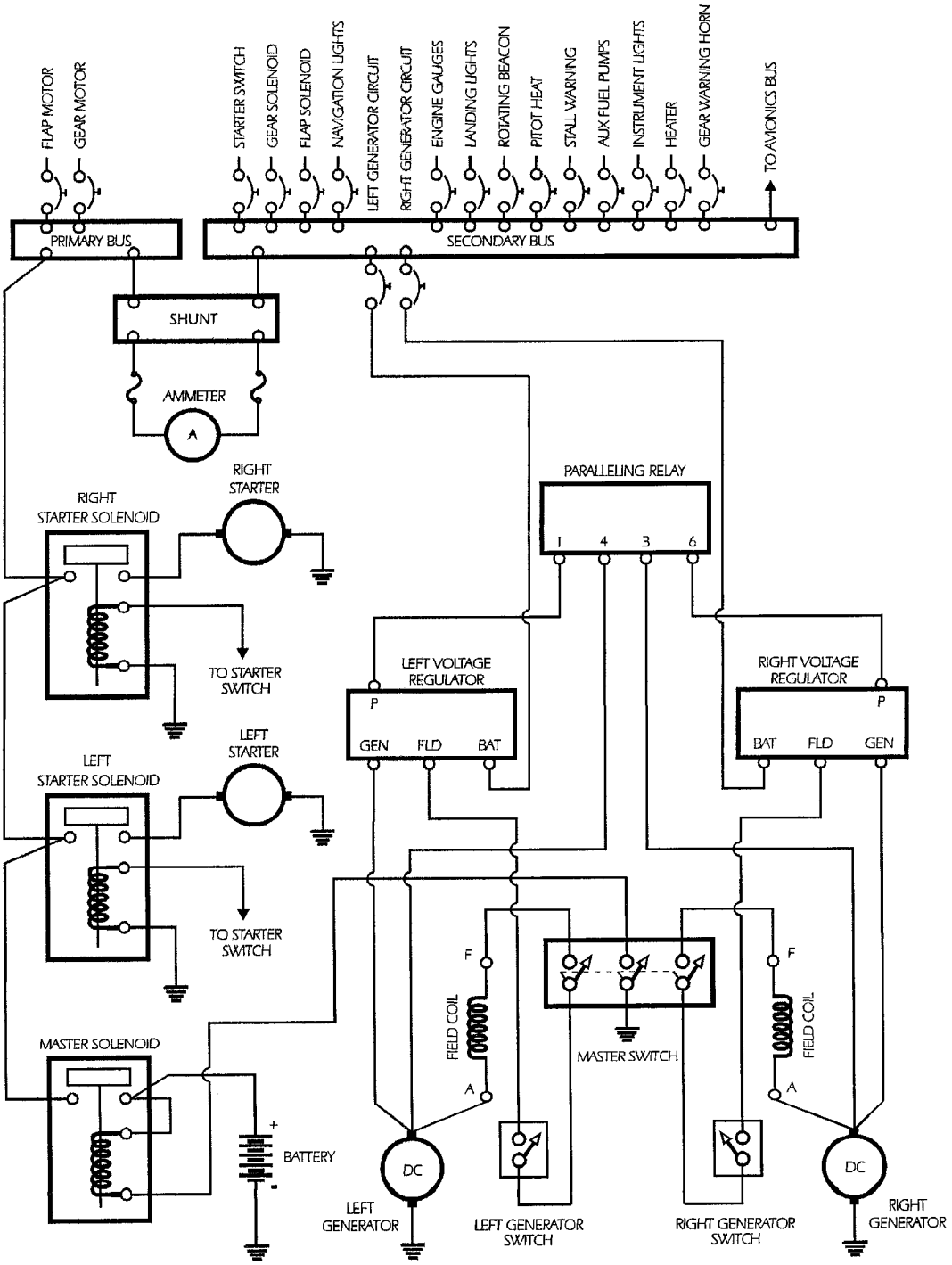

FIGURE 7-02

ALTERNATOR AND STARTER SYSTEM SCHEMATIC

(Non-Paralleling System)

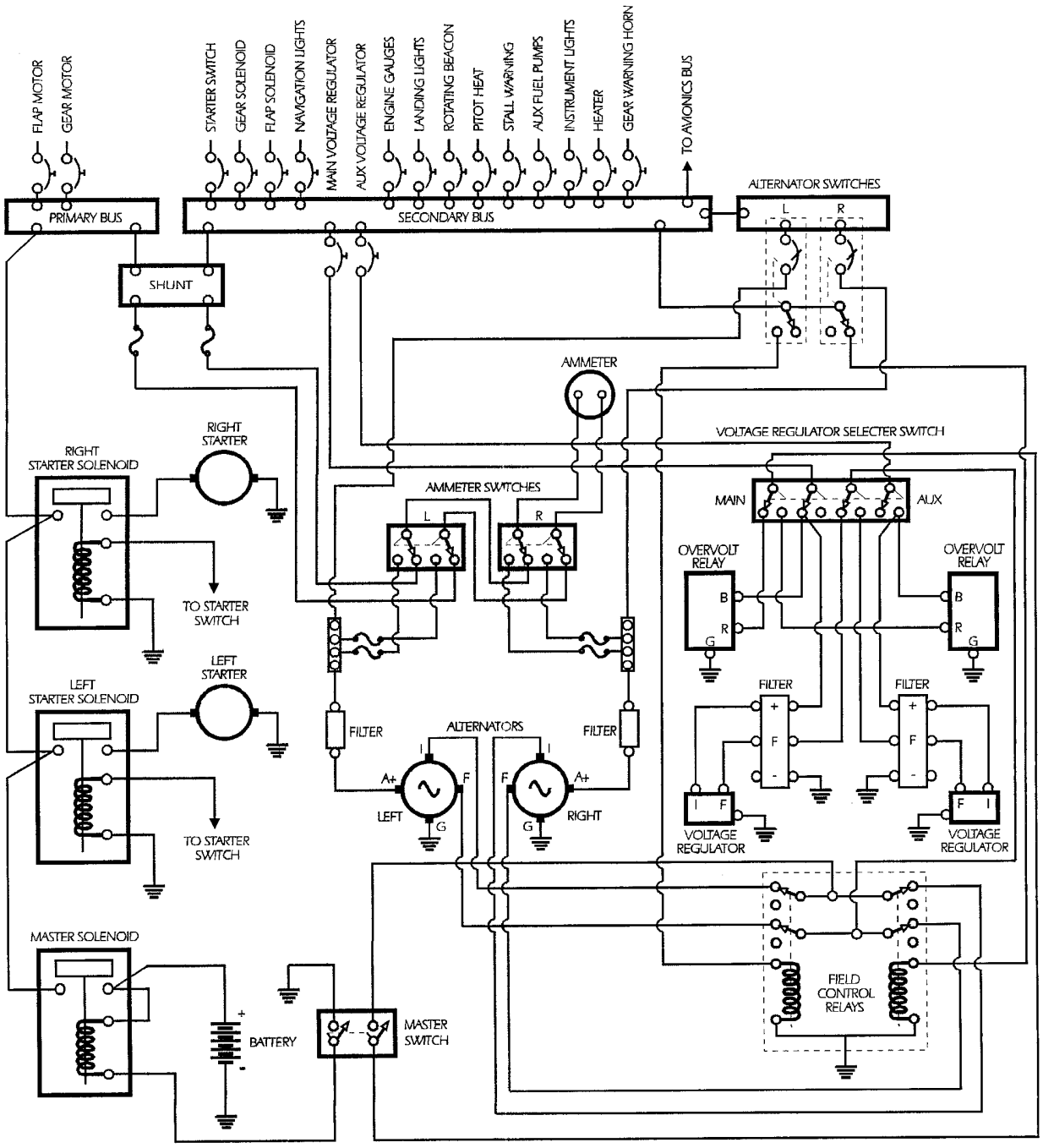

FIGURE 7-03

TYPICAL INSTRUMENT PANEL

(A & B MODELS)

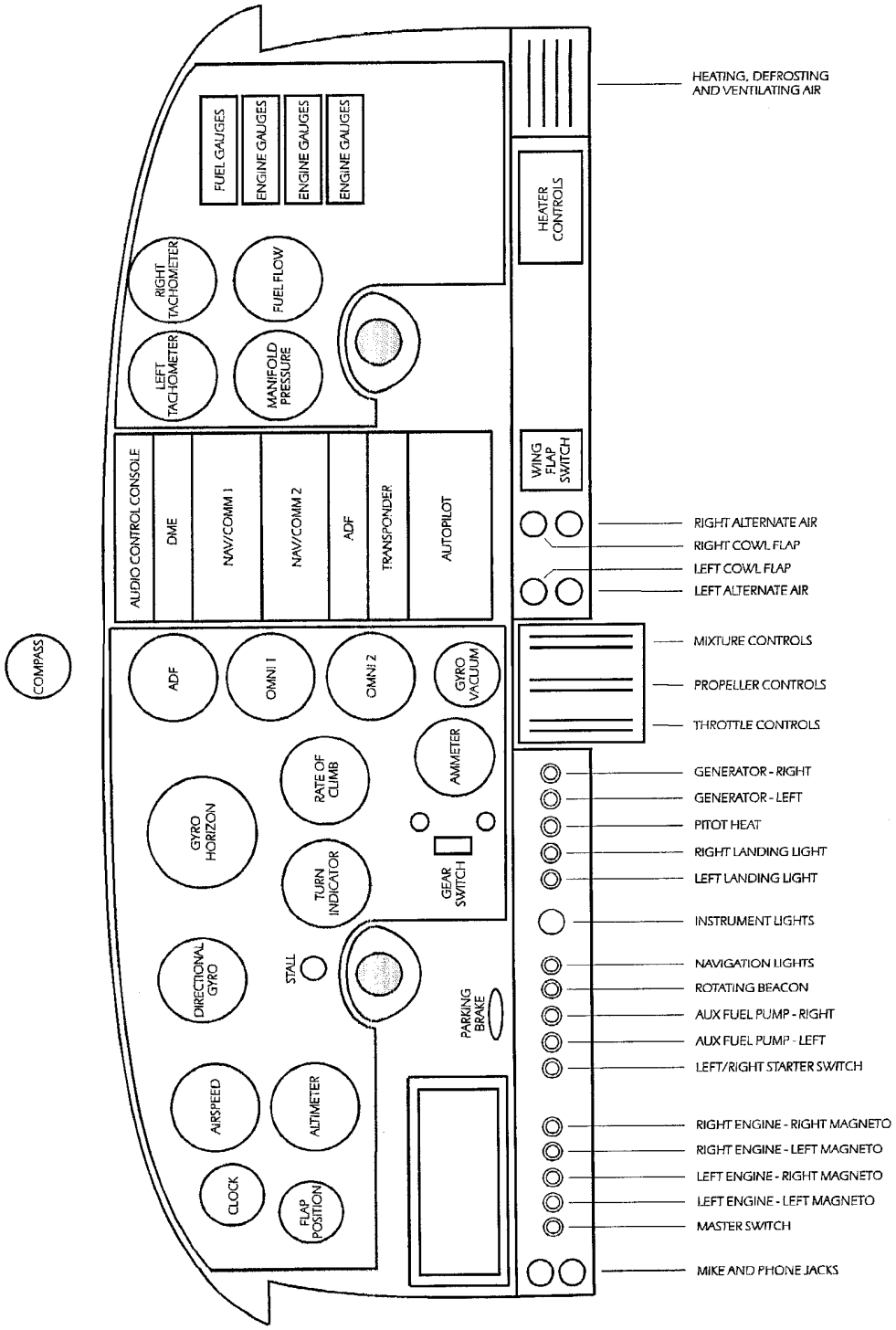

FIGURE 7-04

TYPICAL INSTRUMENT PANEL

(C MODEL)

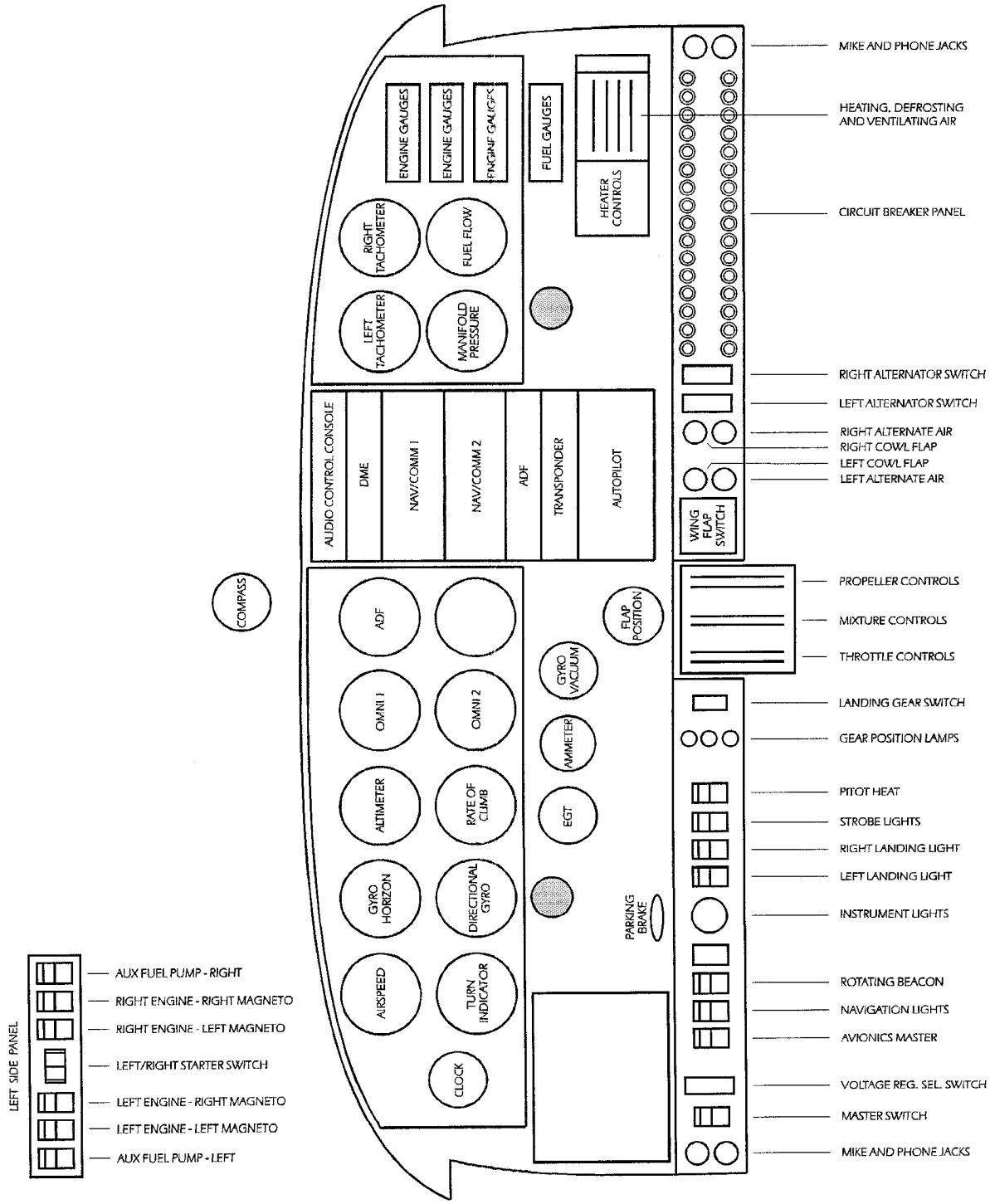

FIGURE 7-05

HEATING AND VENTILATING SYSTEM

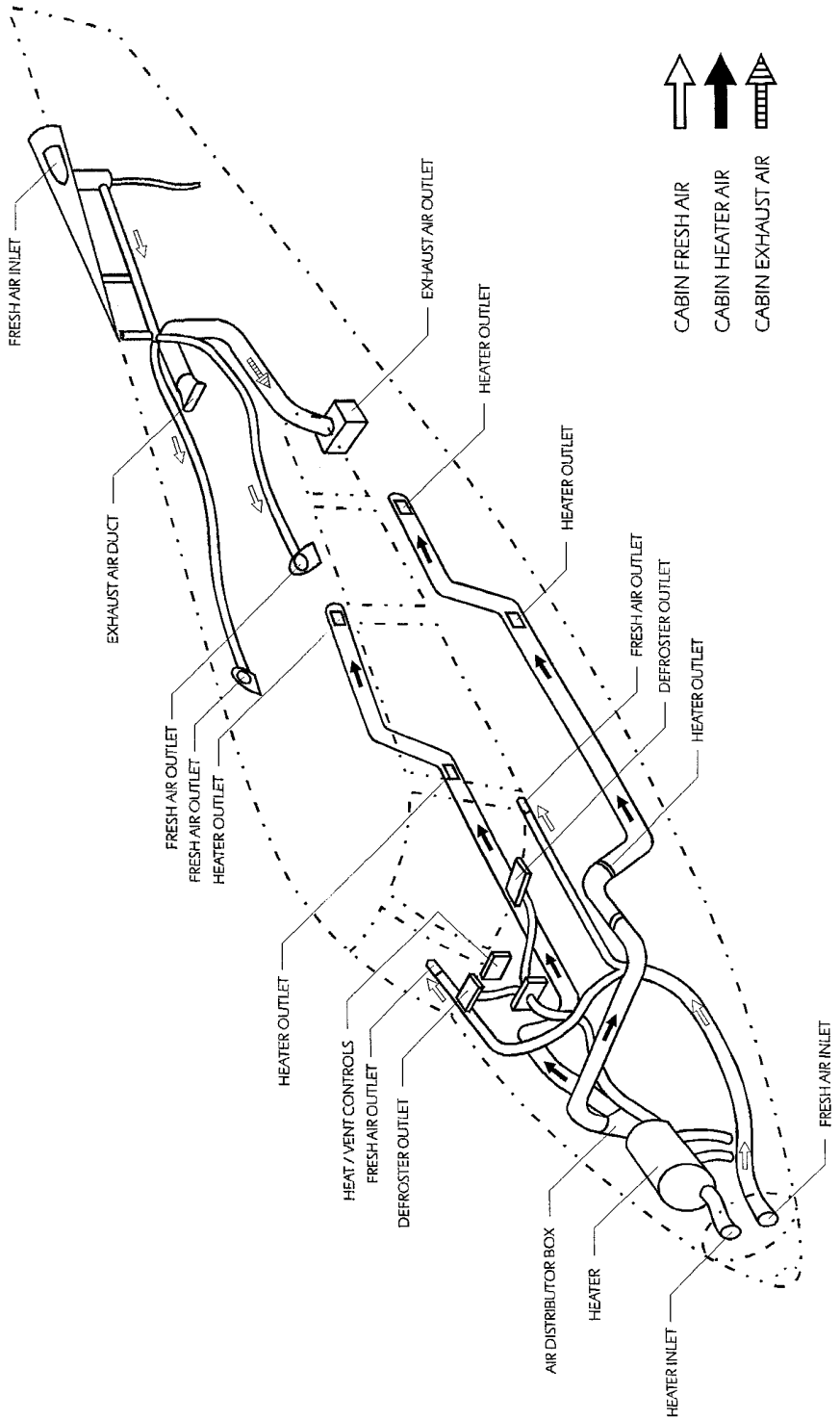

FIGURE 7-06

VACUUM SYSTEM SCHEMATIC

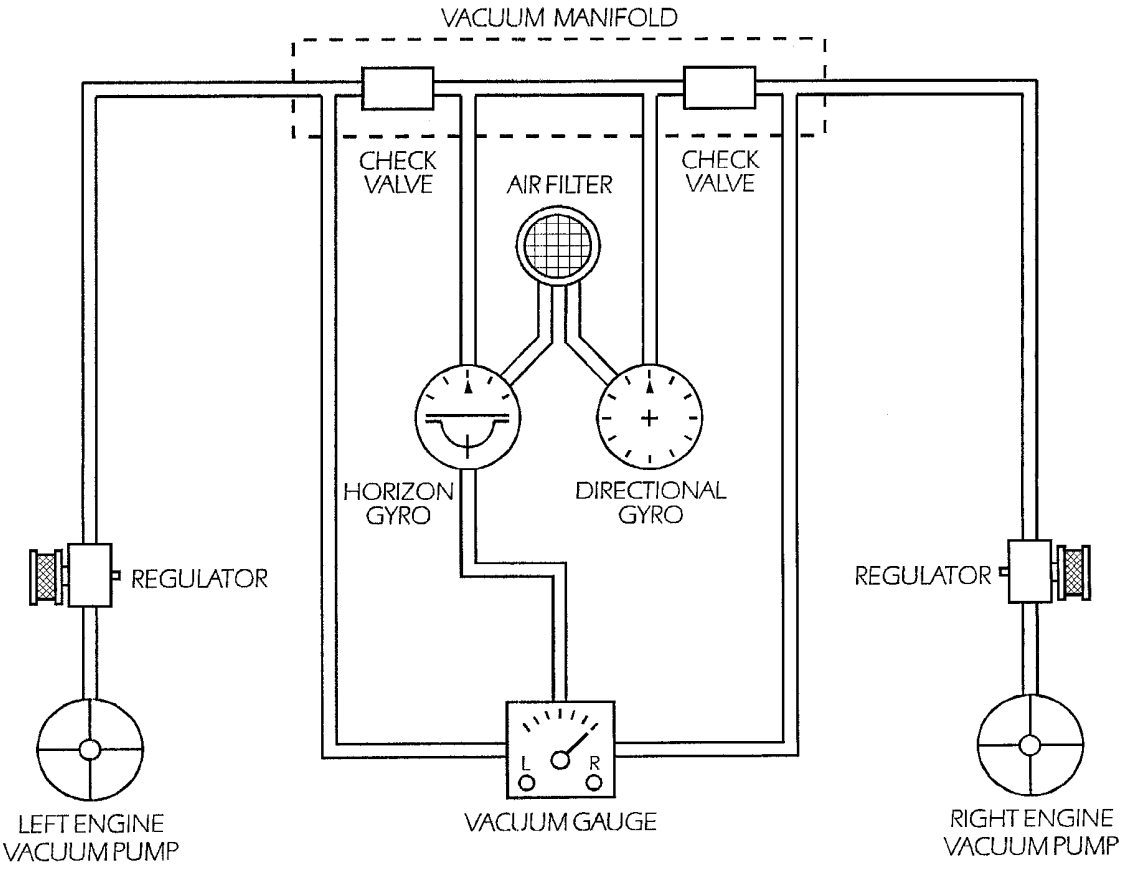

FIGURE 7-07