AIRFRAME

The Cessna Skymaster 337D and 337H are twin-engine, pusher and puller propellers, with direct-drive, air-cooled, horizontally opposed, fuel-injected, six-cylinder engine with 360 cu. in. displacement. Horsepower Rating and Engine Speed: 225 rated BHP at 2800 RPM. The Skymaster T337H-SP has a turbocharged engine and the cabin can be pressurized.

The Cessna Skymaster is an innovative twin-engine civil utility aircraft built in a push-pull configuration. Instead of the engines being mounted on the wings, one is mounted on the nose and the other at the rear of the pod-style fuselage. The stabilizers are mounted on twin booms that extend from the wings. The rear engine is between the booms. With this "centerline thrust" configuration the aircraft is much easier to handle on one engine than a conventional configuration. The combination of a tractor and a pusher engine produces a unique unmistakable sound. Enthusiasts have no doubt when they hear a Skymaster fly over.

Development

The first model of the Skymaster was the 336. It had fixed landing gear and first flew in February 1961. It went into production in 1963 and 195 were produced to mid 1964.

In 1965, Cessna introduced the model 337 Super Skymaster. This aircraft was larger, had more powerful engines, retractable landing gear and a dorsal air scoop for the rear engine (the "Super" was subsequently dropped from the name). In 1967 the turbocharged T377 was introduced and in 1972 the pressurized T377G entered production. Cessna built 1,859 standard and turbocharged Skymasters and 332 T337Gs. In addition, they built 513 military O-2 versions.

Cessna production ended in 1980 but Skymaster production continued with Reims in France with the FTB337 STOL and the military FTMA Milirole. Reims produced a total of 94 Skymasters.

After a 20-year hiatus the centerline thrust, pod and twin-boom concept has been revived in the Adam A500.

Operational history

The US Army used the O-2 variant as a Forward Air Controller platform during the Vietnam War.

The California Division of Forestry uses the O-2 variant as spotter planes during firefighting operations.

In 1994, the Cuban exile group Hermanos al Rescate (Brothers to the Rescue) used Skymasters to drop life-saving supplies to rafters attempting to cross the Florida Straits to defect from Cuba. They chose Skymasters because they were eaiser to control at slow speeds than conventional twin-engine aircraft. One plane contacted the water (it is difficult to judge altitude over relatively calm water), damaging the landing gear doors and the nose propeller. Since the rear engine is mounted higher, it wasn't damaged and the aircraft was able to return to Florida to make a belly landing.

Variants

Cessna 337
337A
337B
337M - US military version, designated O-2 Skymaster in service
O-2A
O-2B
O-2T - turboprop-powered O-2
337C
337D
337E
337F
337G
337H
T337B - turbocharged engines
T337C
T337D
T337E
T337F
T337G
T337H
P337H
T337H-SP
Reims F337
F337
F337P - pressurized
FTB337G - STOL version
AVE Mizar

Flying car created by Advanced Vehicle Engineers by attaching the wings, tail, and rear engine of a Skymaster to a Ford Pinto outfitted with aircraft controls and instruments.

Summit Aviation built a militarized Skymaster as the O2-337 in 1980, and sold a few examples to the Haiti Air Corps and the Thai Air Force

Spectrum Aircraft Corporation of Van Nuys, California made an extensive conversion of a Reims FTB337G in the mid 1980s - the Spectrum SA-550. They removed the nose engine, lengthened the nose and replaced the rear engine with a turboprop. This aircraft (serial number 61) is currently registered to Basler Turbo Conversions of Oshkosh, Wisconsin.

Special Characteristics

The Skymaster has different handling characteristics than a conventional twin-engine aircraft. Foremost is that it will not yaw into the dead engine if one engine quits. Consequently, it has no tendency to depart the runway if an engine fails on the takeoff roll. The adage, "dead foot, dead engine" -- used to remind a pilot which propeller to feather when an engine quits -- is useless with the Skymaster. When a Skymaster loses power, the pilot must use the instruments to determine which engine has failed. The Skymaster is also controllable at lower airspeeds than a comparable conventional twin. There is no minimum controllable speed advisory (Vmc) on the airspeed indicator.

Nevertheless, the Skymaster requires a multi-engine-rated pilot. The pilot must be trained to manage both engines, and must also be trained to handle the special characteristics of a multiengine aircraft with centerline thrust.
One would think that with the Skymaster's superior single-engine handling it would have a lower accident rate than conventional twins. This turns out not to be true. The rear engine tends to overheat and quit while taxiing on very hot days. When this has happened, many pilots have inexplicably attempted take-off on the nose engine alone even though the single-engine take-off roll exceeded the runway length. The Skymaster also has a higher-than-average rate of accidents due to fuel mismanagement. This is puzzling since the fuel system is unremarkable.

The Skymaster produces a unique unmistakable sound. All rear-engined aircraft produce a characteristic sound as the propeller slices through turbulent air coming off the airframe. Since the Skymaster also has a nose engine, with a propeller that operates in undisturbed air, its sound is different from a pure pusher.

Ground Controller: Cessna calling ground control. Are you a Skymaster?

Pilot's reply: No Sir. I'm just a student pilot. ☺

Flight Controls

The conventional primary flight controls are operated by dual control wheels and pedals. The control wheels operate the ailerons and the elevators. The adjustable pedals operate the rudder and the nose steering. The toe brakes, which are an integral part of the pedals, operate the wheel brakes.

The pilot's and copilot's rudder pedals are individually adjustable. The control surfaces are mechanically connected to the pilot controls through systems of cables, pulleys, push-pull rods and bell-cranks. An up-down spring mechanism, linked to the stabilizer, is installed in the longitudinal control system to provide a suitable pilot stick force through the complete center of gravity range.

The yaw trim is pilot-controlled through the RUDDER TRIM switch located on the pedestal trim control panel. The switch has three positions: NOSE LEFT, OFF and NOSE RIGHT. The switch knob is split and both halves must be rotated simultaneously to initiate yaw trim motion. When the switch is released, both halves return to the center OFF position. Actuation of the rudder trim switch to NOSE LEFT or NOSE RIGHT will signal the yaw trim actuator to move the rudder trim tab in the appropriate direction.

FLIGHT CONTROLS

The airplane's flight control system consists of conventional aileron, elevator and rudder control surfaces (see figure 7-1). The control surfaces are manually operated through mechanical linkage using a control wheel for the ailerons and elevator, and rudder/brake pedals for the rudders.

TRIM SYSTEMS

Manually-operated rudder and elevator trim is provided (see figure 71). Rudder trimming is accomplished through a bungee connected to the rudder control system and a trim control wheel mounted on the control pedestal. Rudder trimming is accomplished by rotating the horizontally mounted trim control wheel either left or right to the desired trim position. Rotating the trim wheel to the right will trim nose-right; conversely, rotating it to the left will trim nose-left. Elevator trimming is accomplished through the elevator trim tab by utilizing the vertically mounted trim control wheel next to the landing gear switch. Forward rotation of the trim wheel will trim nose-down; conversely, aft rotation will trim nose-up. The elevator trim tab system is also mechanically interconnected with the wing flap system to automatically eliminate excessive nose-up trim while retracting the wing flaps. The trim control wheel can be rotated forward to the NOSE DN position or aft to the lower half of the TAKEOFF range marking. The interconnect will prevent any additional nose-up trim with the flaps retracted. Flap extension will permit additional nose-up trim until the flaps are fully extended. At this point, maximum nose-up trim can be utilized. Any time flap extension is reduced with full nose-up trim, the interconnect will automatically reduce the trim setting. Full flap retraction will return the trim setting to the lower half of the TAKEOFF range marking.

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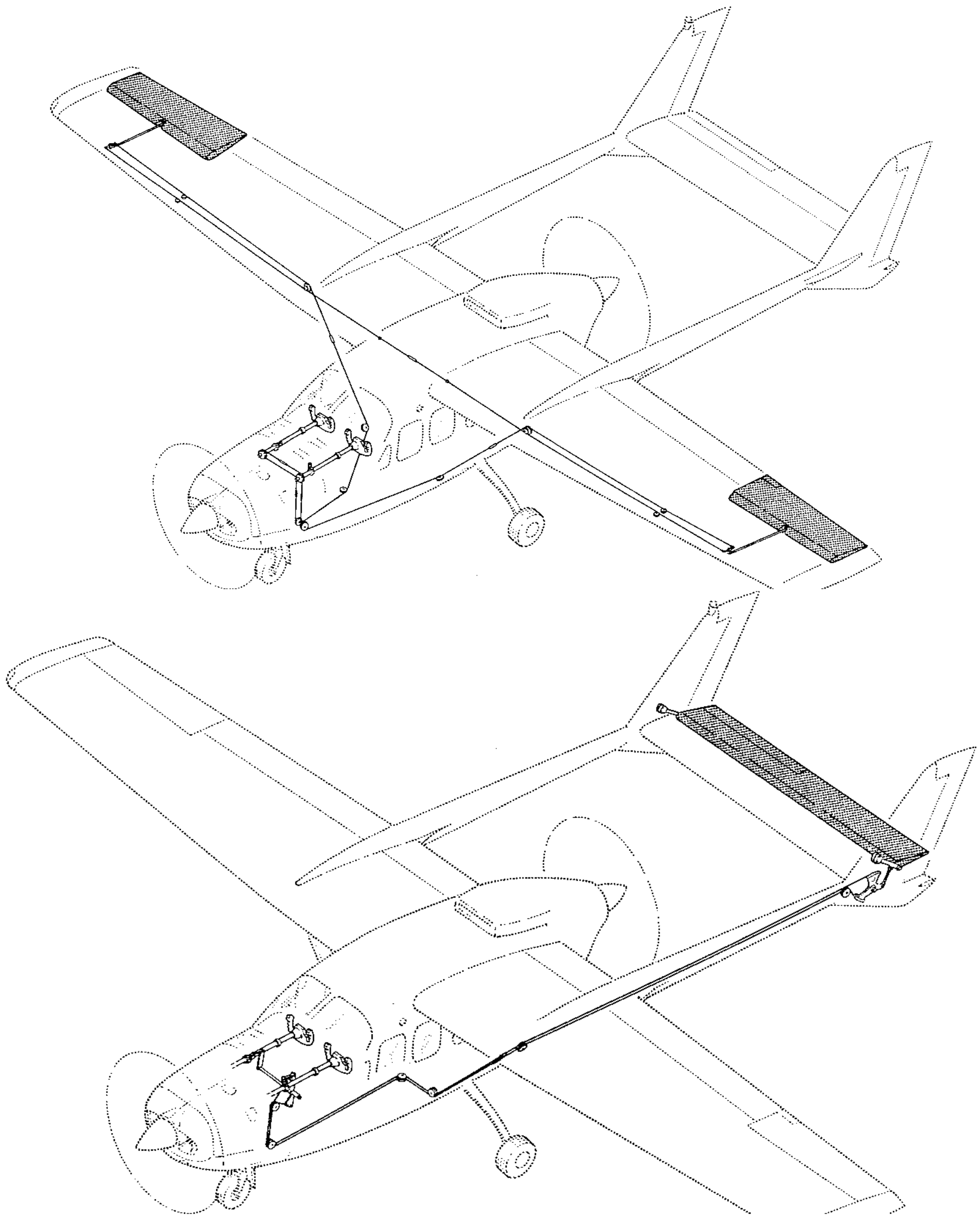


Figure 7.1

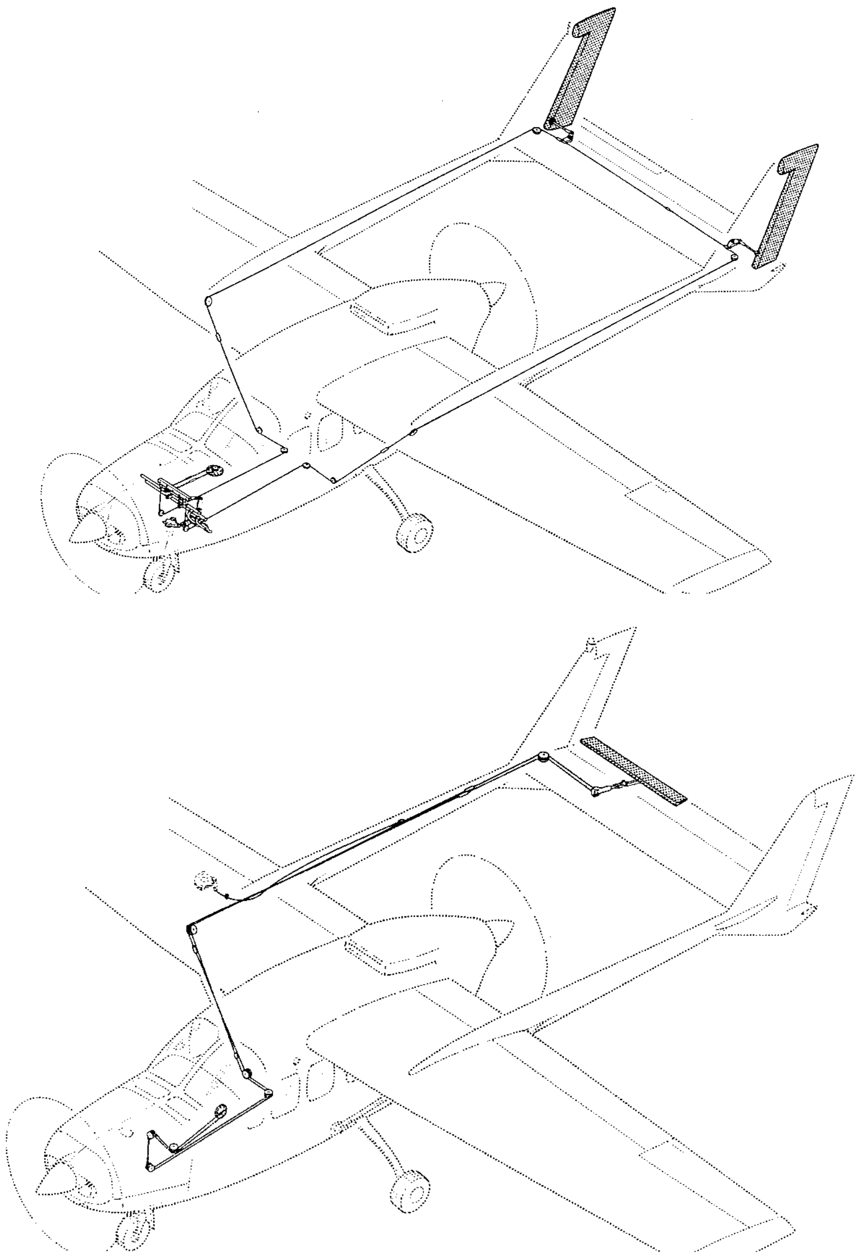


Figure 7.2

Wing Flap System

The wing flaps are of the large span, single-slot type (see figure 7-3), and are extended or retracted by positioning the wing flap switch lever on the instrument panel to the desired flap deflection position. The switch lever is moved up or down in a slotted panel that provides mechanical stops at the 1/3 and 2/3 positions. For flap settings greater than 1/3, move the switch lever to the right to clear the stop and position it as desired. A scale and pointer on the left side of the switch lever indicates the position of the flaps. The wing flap system is mechanically interconnected with the elevator trim tab system to automatically eliminate excessive nose-up trim during wing flap retraction. A 10-ampere circuit breaker labeled WING FLAPS, on the left sidewall circuit breaker panel, protects the wing flap system.

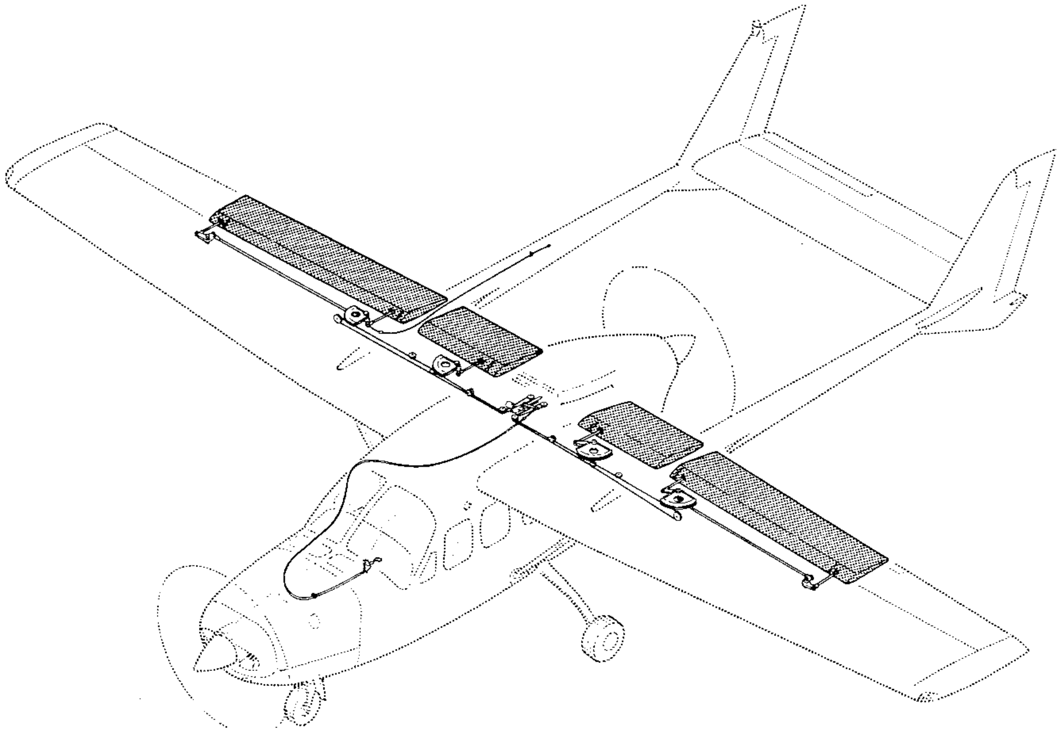


Figure 7.3

Instrument Panel

The instrument panel is designed around the basic "T" configuration. The gyros are located immediately in front of the pilot, and arranged vertically. The airspeed indicator and altimeter are to the left and right of the gyros respectively. The remainder of the flight instruments are located around the basic "T". Avionics equipment is placed vertically, approximately on the center line of the panel. Two adjustable ventilator outlets are installed at the lower edge of the glare shield above the avionics equipment. The right side of the panel contains the dual indicating tachometer, manifold pressure, and fuel flow indicators adjacent to the avionics equipment. Also located on the right side is the engine instrument cluster, ammeter, and space for additional instruments and avionics. Near the lower edge of the left side of the instrument panel is a switch and control panel containing most of the switches and controls necessary to operate the airplane systems. The left end of the panel contains the ignition, battery, alternator, and auxiliary fuel pump switches. Across the top of the panel are the electrical switches, and below them are the electrical system warning lights and high voltage test switch. An alternator restart switch, cowl flap controls, and cowl flap position lights are also on the lower portion of the panel. The pressurization instruments and controls (H Model) are located below the switch and control panel. The landing gear switch, landing gear position lights, and the elevator trim control wheel and indicator are located on a panel on the right side of the switch and control panel. The lower right side of the instrument panel contains the wing flap control/ cabin comfort control panel, a cigar lighter, and a map compartment. A control pedestal, extending from the center of the instrument panel to the floor, contains synchrophaser controls, engine controls, rudder trim control wheel, engine primers, and weather radar (if installed). Mounted on the right side of the control pedestal is a switch which controls the front and rear pressurized air dump valves. The parking brake lever and a panel containing the avionics power switch (in the VC – lower panel on the 2D) are located on the left cabin sidewall.

Skymaster 337H

Skymaster 337D

Ground Control

Effective ground control while taxiing is accomplished through nose wheel steering by using the rudder pedals; left rudder pedal to steer left and right rudder pedal to steer right. When a rudder pedal is depressed, a spring-loaded steering bun gee (which is connected to the nose gear and to the rudder bars) will turn the nose wheel through an arc of approximately 15° each side of center. By applying either left or right brake, the degree of turn may be increased up to 39° each side of center. The minimum turning radius of the airplane, using differential braking and nose wheel steering during taxi, is approximately 27 feet.

Moving the airplane by hand is most easily accomplished by attaching a tow bar to the nose gear strut. If a tow bar is not available, or pushing is required, utilize the wing struts 'as push points. Do not push on the vertical or horizontal leading or trailing edges. If the airplane is to be towed by vehicle, never turn the nose wheel more than 39° either side of center or structural damage to the nose gear could result.

Landing Gear Systems

The landing gear is a retractable, tricycle type with a steerable nose wheel and two main wheels. Shock absorption is provided by the leaf type spring-steel main landing gear struts and the air / oil nose gear shock strut. Each main wheel is equipped with a hydraulically actuated disc-type brake on the inboard side of the wheel.

Landing gear extension and retraction, wheel well door operation, and up and down lock operation is accomplished by hydraulic actuators powered by an electrically-driven hydraulic power pack. The power pack assembly is housed within the control pedestal. Hydraulic system fluid level may be checked by utilizing the dipstick/filler cap, on the power pack, behind a snap-out cover panel on the face of the control pedestal (lower right side if weather radar is installed). The system should be checked at 25-hour intervals. lithe fluid level is at or below the ADD line on the dipstick, hydraulic fluid (MIL-H-5606) should be added to bring the level to the top of the dipstick/filler cap opening.

Power pack operation is initiated by a landing gear switch, and is turned off by a pressure switch. Two position indicator lights are provided to show landing gear position. The landing gear system is also equipped with a nose gear safety switch, an emergency extension hand pump, and a gear-up warning system.

Landing Gear Switch
The landing gear switch, mounted to the left of the elevator trim control wheel, has two positions (RETRACT and EXTEND) which give a mechanical indication of the gear position selected. Positioning the switch in the RETRACT or EXTEND position will start the electrically-driven hydraulic power pack and select the direction of gear travel. Operation of the landing gear system will not begin until repositioning of the switch is completed.

Landing Gear Position Indicator Lights
Two position indicator lights, mounted above and below the landing gear switch, indicate that the gear is either up or down and locked. The lights are the press-to-test type. The gear-down (lower) indicator light (green) has two positions; with the light pushed in half way (either throttle retarded and battery switch on) the gear warning system should be heard intermittently on the airplane speaker, and with the light pushed full in, it should illuminate. The gear-up (upper) indicator light (amber) has only one test position; with the light pushed full in, it should illuminate. The indicator lights contain dimming shutters for night operation.

Landing Gear Operation
To retract or extend the landing gear, pull out on the gear switch and move it to the desired position. After the switch is positioned, the electrically-driven hydraulic power pack will create pressure in the system and the landing gear will be actuated to the selected position.

CAUTION
If for any reason the hydraulic pump continues to run after gear cycle completion (up or down), the 30-amp circuit breaker switch labeled LG MTR should be pulled out. This will shut off the hydraulic pump motor and prevent damage to the pump and motor. Refer to Section 3 for complete emergency procedures.

During a normal cycle, the gear locks up or down and the position indicator light (amber for up and green for down) comes on. When the light illuminates, hydraulic pressure is switched from the gear actuators to the door actuators to close the gear doors. When the doors are closed, pressure will continue to build until a pressure switch in the door closing system turns off the hydraulic pump. The gear doors are held in the closed position by hydraulic pressure.

A landing gear safety switch, actuated by the nose gear strut, electrically prevents inadvertent retraction whenever the nose gear strut is compressed by the weight of the airplane. The switch type circuit breaker, labeled LG MTR, should be used for safety during maintenance. With the switch pulled out, landing gear operation cannot occur. After maintenance is completed, and prior to flight, the switch should be pushed back in.

For inspection purposes, the landing gear doors may be opened and closed while the airplane is on the ground with the engines stopped.

Operate the doors with the landing gear switch in the EXTEND position. To open the doors, turn off the battery switch, pull out the LG MTR circuit breaker switch, and operate the hand pump until the doors open. To close the doors, check that the landing gear switch is in the EXTEND position, push the LG MTR circuit breaker switch in, and turn on the battery switch.

" WARNING"

In accordance with safety placards installed on each wheel well door, do not perform maintenance in the wheel well areas unless the LG MTR circuit breaker switch is pulled out.

NOTE

The position of the battery switch for gear door operation is easily remembered by the following rule: OPEN circuit = OPEN doors CLOSED circuit = CLOSED doors

Emergency Hand Pump

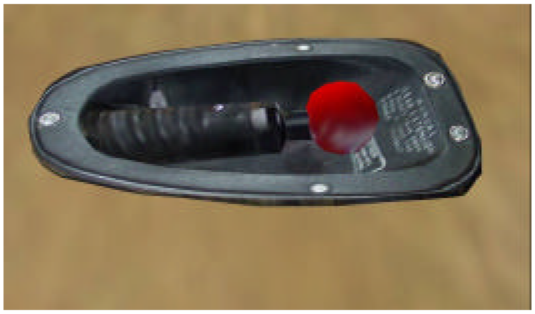
A hand-operated hydraulic pump, located between the two front seats, is provided for extension of the landing gear in the event of an electrical or power pack pump failure. To utilize the pump, extend the handle forward and pump vertically. For complete emergency procedures.

For practice manual gear extensions, pull out the LG MTR circuit breaker switch before placing the landing gear switch in the EXTEND position. After the practice manual extension is completed, push the circuit breaker in to restore normal gear operation.

(**Important note**)

MSFS does not allows us to duplicate the actual pump movements
Electric failure or turning off internal electricity most occur to activate Landing Gear Pump.

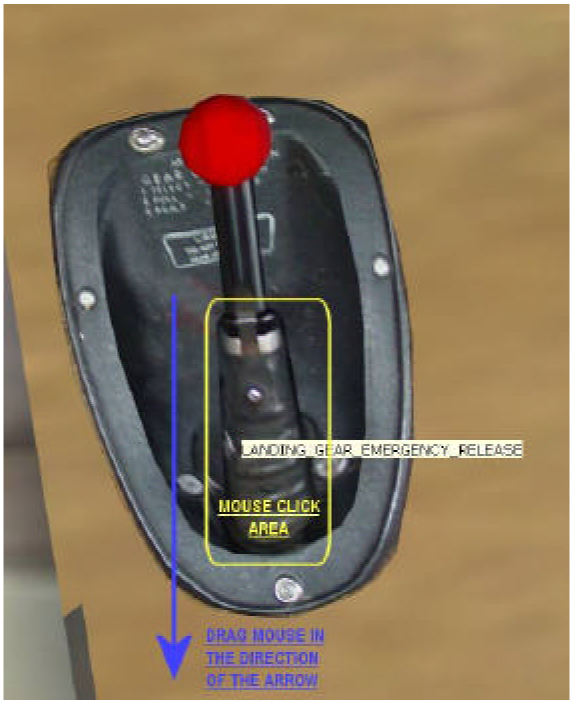
How do you activate the Manual Gear Pump with in the Virtual Cockpit?
When the electric system is intact and working, the Manual Gear Pump lever's position will look as follows:



When electric failure has occurred or the electric system has been turned off, the Manual Gear Pump Lever will now look as follows:

When the Manual Gear Pump Lever is in the up position because of a generalized electric failure and your intention is to lower the landing gears, it is important that you pull/lower the main landing gear lever to the extend landing gear position. This will allow for the correct positioning of the gear valves (if you do not take this step you will not be able to manually lower the landing gears).

Once you have carried out the previously described steps, now you are ready to lower the landing gears. Please look closely at the following picture, the yellow box is the MOUSE CLICK AREA, the BLUE ARROW represents the direction you will have to drag your mouse while holding down the left mouse key. The landing gears will not descend automatically. Youl have to drag the mouse over the click area several times, as you do this you will notice that the Manual Gear Pump Lever will begin to slowly rise, just keep up the effort until the Manual Gear Pump Lever stops moving at that point your landing gears should be down and in locked position.



Landing Gear Warning System

The airplane is equipped with a landing gear warning system designed to help prevent the pilot from inadvertently making a wheels-up landing. The system consists of throttle actuated switches which are electrically connected to a dual warning unit. The warning unit is connected to the airplane speaker.

When either throttle is retarded, below approximately 15 inches of manifold pressure (battery switch on), the throttle linkage will actuate a switch which is electrically connected to the gear warning portion of a dual warning unit. If the landing gear is retracted (or not down and locked), an intermittent tone will be heard on the airplane speaker. The system may be checked for correct operation before flight by retarding either throttle to idle and depressing the green gear-down position indicator light half way in. With the indicator light depressed as described, an intermittent tone should be heard on the airplane speaker.

Cabin Windows

The windshield is of one-piece construction and has a center strip. A vent window is located on each side of the airplane immediately aft of the windshield. The windows are spring-loaded to the open position, hinged at the top, and are held in the closed position by an overcenter latch opposite the hinge. To open either window, rotate the latch forward and allow the window to swing inboard and up. Both windows must be closed and securely latched prior to pressurized flight. The airplane also has eight fixed two-layer side windows, two of which are in the cabin door.

Control Locks

A control lock is provided to lock the ailerons and elevator control surfaces in a neutral position and prevent damage to these systems by wind buffeting while the airplane is parked. The lock consists of a shaped steel rod with a red metal flag attached to it. The flag is labeled CONTROL LOCK, REMOVE BEFORE STARTING ENGINES. To install the control lock, align the hole on the top of the pilot's control wheel shaft with the hole in the top of the shaft collar on the instrument panel and insert the rod into

the aligned holes. Proper installation of the lock will place the red flag over the ignition switches. In areas where high or gusty winds occur, a control surface lock should be installed over the vertical stabilizers and rudders. The control lock and any other type of locking device should be removed prior to starting the engines.

Engines

The H model is powered by two specially equipped horizontally opposed, six-cylinder, overhead-valve, turbocharged, air-cooled, fuel injection engines with wet sump oil systems. The D model utilizes a normally aspirated intake system. The engines (H model) are Continental Model TSIO-360-Cs and are rated at 225 horsepower at 2800 RPM continuous. Major accessories attached to each engine include a propeller governor on the front (propeller end) of the engine and dual magnetos, starter, gear-driven alternator, and full flow oil filter on the rear of each engine. Each engine is equipped with a turbocharger and associated components, and pressurization components. Provisions are also made for vacuum pumps.

ENGINE CONTROLS

Engine manifold pressure is controlled by two throttles located at the top of the control pedestal on the left side. The throttles operate in a conventional manner; in the full forward position, the throttles are open, and in the full aft position they are closed. Friction on the throttles is controlled by a knurled control knob, on the right side of the pedestal, which increases friction when rotated clockwise. The linkage to both throttles is designed to mechanically actuate micro switches electrically connected to the landing gear warning system. The switches will cause a warning tone to sound anytime either throttle is retarded with the landing gear retracted, with less than approximately 15 inches of manifold pressure.

The mixture control levers, at the top of the control pedestal on the right side, have red knobs with raised points around the circumference and operate in a conventional manner. The rich position is with the levers full forward, and full aft is the idle cut-off position. Friction on the mixture control levers is also controlled by the knurled control knob on the right side of the pedestal.

ENGINE INSTRUMENTS

Engine operation is monitored by the following instruments: two oil pressure gauges, two oil temperature gauges, two cylinder head temperature gauges, dual-indicating tachometer, dual-indicating manifold pressure gauge, and dual-indicating fuel flow indicator. A dual-indicating economy mixture (EGT) indicator is also available.

The oil pressure gauges, on the right side of the instrument panel, are operated by oil pressure. A direct pressure oil line from the front and rear engine delivers oil at engine operating pressure to the respective oil pressure gauge. Gauge markings indicate that minimum idling pressure is 10 PSI (red line), the normal operating range is30to 60PSI (green arc), and maximum pressure is 100 PSI (red line).

Oil temperature is indicated by two gauges below the oil pressure gauges.

The gauges are operated by electrical-resistance type temperature sensors which receive power from the airplane electrical system. Oil temperature limitations are the normal operating range (green arc) which is 24°C (75°F) to 116°C (240°F), and the maximum (red line) which is 116°C (240°F).

The cylinder head temperature gauges, under the fuel quantity indicators, are operated by an electrical-resistance type temperature sensor on each engine which receives power from the airplane electrical system. Temperature limitations are the normal operating range (green arc) which is 93°C (200°F) to 238°C (460°F) and the maximum (red line) which is 238°C (460°F).

The electrically-operated, dual-indicating tachometer is located on the right side of the instrument panel. The instrument is calibrated in increments of 100 RPM and indicates both engine and propeller speed. The left half of the tachometer indicates front engine RPM, and the right half indicates rear engine RPM. Instrument markings include an operating range of 2200 to 2600 RPM (stepped green arc) with a step at the 2450 RPM indicator mark. The normal operating range is 2200 to 2450 RPM (outer green arc). The range from 2200 to 2600 RPM (inner green arc) is for use during hot day conditions above 10,000 feet, and the maximum at any altitude is 2800 RPM (red line).

The dual-indicating manifold pressure gauge is located above the tachometer on the right side of the instrument panel. The gauge is direct reading and indicates induction air manifold pressure in each engine in inches of mercury. The left half of the gauge indicates front engine manifold pressure, and the right half shows rear engine manifold pressure. Instrument markings show a normal operating range (green arc) of 17 to 33 inches of mercury, and a maximum of 37 inches (red line) for the H model and 12-25 mmHg (green arc) and 25 mmHg (redline) for the D model.

The dual-indicating fuel flow indicator is mounted below the tachometer on the right side of the instrument panel. The indicator is a fuel pressure gauge calibrated to indicate the approximate pounds per hour of fuel being metered to each engine. The left half of the indicator shows fuel flow to the front engine, and the right half shows fuel flow to the rear engine. The normal operating range (green arc) is from 30 to 90 pounds per hour, the normal climb range (white arc) is 90 to 140 pounds per hour, the minimum (red line) is 3.0 PSI, and the maximum (red line) is 142.5 pounds per hour (18.5 PSI).

A dual-indicating economy mixture (EGT) indicator is available for the airplane and is located adjacent to the fuel flow indicator. A thermocouple probe, mounted in an exhaust collector on each engine, measures exhaust gas temperature and transmits it to the indicator. The indicator serves as a visual aid to the pilot in adjusting cruise mixture. Exhaust gas temperature varies with fuel-to-air ratio, power, and RPM. However, the difference between the peak EGT and the EGT at the cruise mixture setting is essentially constant and this provides a useful leaning aid. The indicator is equipped with manually positioned reference pointers.

NEW ENGINE BREAK-IN AND OPERATION

The engines underwent a run-in at the factory and are ready for the full range of use. It is suggested however, that cruising be accomplished at 65% to 75% power until a total of 50 hours has accumulated or oil consumption has stabilized. This will ensure proper seating of the rings.

The airplane is delivered from the factory with corrosion preventive oil in the engines. If, during the first 25 hours, oil must be added, use only aviation grade straight mineral oil conforming to Specification No. MILL-6082.

ENGINE OIL SYSTEM

The oil system for both engines is identical, and is fully described in the following paragraphs. For the purpose of clarity, all future references to the sides or ends of either engine will be as viewed from the pilot's seat.

Oil for engine lubrication, propeller governor operation, and turbocharger system control is supplied from a sump on the bottom of the engine. The capacity of the engine sump is eight quarts (one additional quart is contained in the engine oil filter). Oil is drawn from the sump through a filter screen on the end of a pick-up tube to the engine-driven oil pump. Oil from the pump passes through a pressure relief valve and full flow oil filter to the turbocharger system controls and a thermostatically controlled oil cooler. Oil from the cooler is then circulated to the oil galleries and propeller governor. The engine parts and turbocharger are then lubricated by oil from the galleries. After lubricating the engine, the oil returns to the sump by gravity, and oil from the turbocharger is returned to the sump by a scavenger pump. The oil filter is equipped with a bypass valve which will cause lubricating oil to bypass the filter in the event the filter becomes plugged, or the oil temperature is extremely cold.

The oil dipstick for each engine is located near the firewall on the left side of the front engine, and the right side of the rear engine. Each engine is equipped with an oil filler tube on top of the crankcase near the firewall. Access doors are provided for each dipstick and oil filler. The engines should not be operated on less than six quarts. To minimize loss of oil through the breather, fill to seven quart level for normal flights of less than three hours. For extended flight, fill to eight quarts (dipstick indication only). For engine oil grade and specifications, refer to Section 8 of this handbook.

IGNITION STARTER SYSTEM

Ignition for each engine is provided by two engine-driven magnetos and two spark plugs in each cylinder. The right (horizontally mounted) magneto fires the lower left and upper right spark plugs, and the left (vertically mounted) magneto fires the lower right and upper left spark plugs. Normal operation is conducted with both magnetos due to the more complete burning of the fuel-air mixture with dual ignition.

Ignition and starter operation is controlled by two rotary type switches located on the left switch and control panel. Each switch is labeled clockwise, OFF, R, L, BOTH, and START. The engines should be operated on both magnetos (BOTH position) except for magneto checks. The Rand L positions are for checking purposes and emergency use only. When either the FRONT or REAR switch is rotated to the spring-loaded START position, (with the battery switch in the ON position), the respective starter contactor is energized and the starter will crank the engine. When the switch is released, it will automatically return to the BOTH position.

AIR INDUCTION SYSTEM

Ram air for the front engine enters a duct in the right intake in the front of the engine cowling, and is drawn downward through a filter and into an induction airbox containing an alternate air door. If the induction air filter becomes blocked, suction created by the engine will open the door, drawing unfiltered air from inside the cowling. An open alternate air door will result in a decrease of up to 10 inches Hg manifold pressure from a cruise power setting. Maximum allowable manifold pressure (37 inches Hg) can be maintained up to approximately 18,000 feet with the alternate air door open and the filter fully blocked. After passing through the airbox, induction air is ducted to the compressor section of the turbocharger. At this point, induction air is compressed. The pressurized air is then ducted to the cabin pressurization system and also through a fuel/ air control unit, into the induction manifold which delivers it to the cylinders.

The rear engine induction system draws its air from ram air entering the scoop on top of the fuselage. Air is drawn through an induction air filter, aft of the firewall and below the scoop, into an airbox equipped with an alternate air door. If the air filter becomes blocked, suction created by the engine will open the door, drawing unfiltered air from inside the cowling. Due to the location of the alternate air door, an open door will result in negligible variations in manifold pressure and power. After passing through the air box, induction air is ducted to the compressor section of the turbocharger. The compressor pressurizes induction air and delivers it to the cabin pressurization system and also through the fuel! air control unit, into the induction manifold which delivers it to the cylinders.

EXHAUST SYSTEM

Exhaust gas from each cylinder of the front engine passes through riser assemblies into an exhaust manifold which discharges the gas into the turbine section of the turbocharger. After the exhaust gas has passed through the turbine, it is vented overboard through a tailpipe. A waste gate is incorporated in the exhaust manifold, and controls the amount of exhaust gas to the turbine by venting excess gas to the tailpipe through a bypass.
Rear engine exhaust gas passes from each cylinder, through riser assemblies to an exhaust collector on each side of the engine. Each collector ducts exhaust gas to the turbine section ofthe turbocharger. After the exhaust gas has passed through the turbine, it is vented overboard through a tailpipe. A waste gate is incorporated in the ducting, between the exhaust collectors and turbine, and controls the amount of exhaust gas into the turbine by venting excess gas to the tailpipe through a bypass.

FUEL INJECTION SYSTEM (H MODEL)

Both engines are equipped with identical fuel injection systems. Each system is comprised of an engine-driven fuel pump, fuel/ air control unit, fuel distributor manifold, fuel flow indicator and air-bleed type injector nozzles.

Fuel is delivered by the engine-driven fuel pump to the fuel/ air control unit on the engine. The fuel/ air control unit correctly proportions the fuel flow to the induction air flow. After passing through the control unit, induction air is delivered to the cylinders through intake manifold tubes, and metered fuel is delivered to a fuel distributor manifold. The fuel manifold, through spring tension on a diaphragm and valve, evenly distributes the fuel to an air-bleed type injector nozzle in the intake valve chamber of each cylinder. A pressure line is also attached to the fuel manifold, and is connected to one side of the dual-indicating fuel flow indicator on the instrument panel.

COOLING SYSTEM

Ram air for front engine cooling enters through two intake openings in the front of the engine cowling; ram air entering a scoop on top of the aft fuselage section cools the rear engine. The cooling air is directed around the cylinders and other areas of the engine by baffling, and is then exhausted through cowl flaps on the lower aft edge of the front engine cowling, and cowl flaps on the sides of the rear engine cowling.
Both front and rear engine cowl flaps are electrically operated, and are controlled by two three-position toggle switches on the left switch and control panel. The switches are labeled COWL FLAPS, FRONT and REAR, and their positions are labeled OPEN (up) and CLOSE (down). Two blue indicator lights, one located beside each switch, illuminate when the cowl flaps have reached either the full open or full closed position and remain lighted until the switches are placed in the off (center) position. The indicator lights also incorporate dimming shutters for night operation.

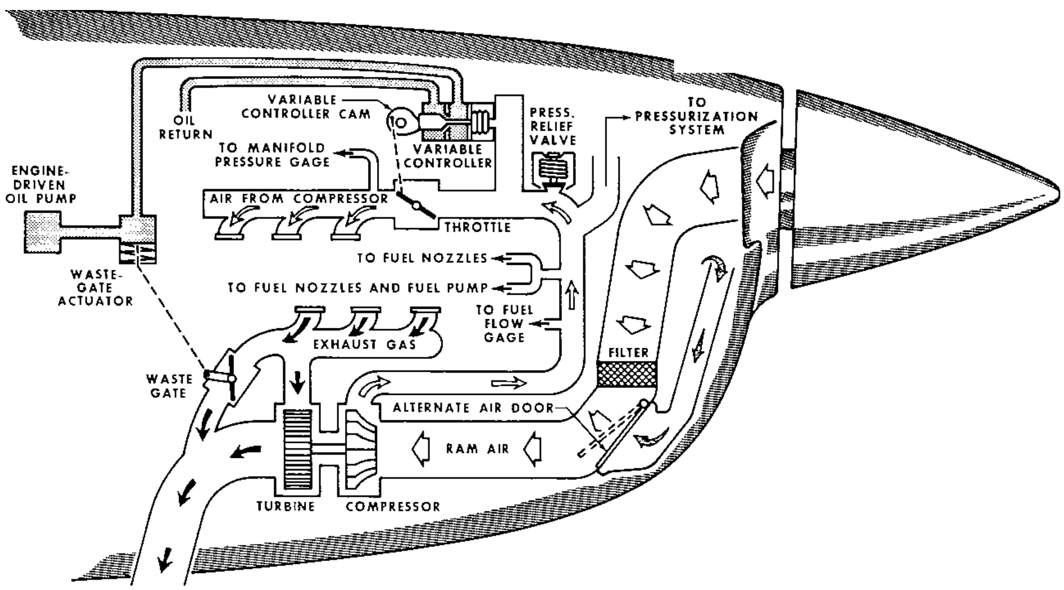
To fully open or close the cowl flaps, place the cowl flap switches in either the OPEN or CLOSE position. When the opening or closing operation is completed, the blue indicator lights will illuminate. If intermediate positioning of the cowl flaps is required, for example half open, actuate the switches for approximately one second and return them to the off position. Other settings can be approximated in a similar manner. Proper cowl flap settings should be determined by monitoring the cylinder head temperature gauges. While in cruise flight, cylinder head temperatures should be maintained at approximately two-thirds of the normal operating range (green arc). During extended let-downs, the cowl flaps should normally be closed.

TURBOCHARGING SYSTEM

The airplane is equipped with turbocharged engines which make it possible to maintain 75% power for cruise up to 20,000 feet.

Identical, the following information describes both systems and points out some of the items that are affected by turbocharging. Section 4 contains the normal operating procedures for the turbocharged engines.

The following steps, when combined with the turbocharger system schematic (following figure), provide a better understanding of how the turbocharger system works. The steps follow the induction air as it enters and passes through the engine until it is expelled as exhaust gases.



2.

1. Because the engines are turbocharged, some of their characteristics differ from normally aspirated engines. Since the front and rear systems are functionally Engine induction air is taken from the engine air inlet, ducted through a filter and into the compressor where, after compression, it is ducted to the throttle body.
2. The pressurized induction air then passes through the throttle body and induction manifold into the cylinders.
3. The air and fuel are burned and exhausted to the turbine portion of the turbocharger.
4. The exhaust gases drive the turbine which, in turn, drives the compressor, thus completing the cycle.
5. From studying steps 1 through 4 and the schematic shown in figure 7 -5, it is obvious that the 4-step study of the induction air flow through the engine is quite simplified. In actuality, controls are needed to cause the engine to function in a controllable manner. To accomplish this, a variable controller, a waste gate, a waste gate actuator and a pressure relief valve, properly interconnected, are added.
6. The heart of the system control is the variable controller which senses compressor discharge pressure at the throttle valve inlet. This mechanism is further designed so that the controller setting varies proportionately to the amount of power selected by the throttle. This is accomplished by a direct linkage to the throttle arm.

The speed or output of the compressor is directly related to the speed of the exhaust turbine. Therefore, the amount of compressor discharge pressure is controlled by controlling the speed of the exhaust turbine. This is accomplished by bleeding or dumping exhaust gases as needed by the incorporation of a waste gate valve.

Since the variable controller is sensing compressor discharge pressure, it is used to control the waste gate valve positions through a separate waste gate actuator. The interconnection between the variable controller and the waste gate actuator is accomplished with the use of appropriate plumbing and engine oil, the pressure of which correspondingly positions the actuator piston and subsequently the waste gate valve through connecting linkage.

When the throttle is advanced, the compressor discharge pressure is decreased as the air enters the engine. As the pressure decreases, the variable controller senses the decrease and increases the oil pressure to the waste gate actuator which then assumes a different position and in moving repositions the waste gate valve to a closed position. This sends more exhaust through the exhaust turbine, increasing the compressor speed until the compressor discharge pressure balances with the manifold pressure and throttle setting selected.

Some environmental and engine operating conditions result in the turbine having enough speed to cause the compressor discharge pressure to exceed the rated. 37 inches of Hg. To limit the amount of overboost and reduce the possibility of damage to the engine, a manifold pressure relief valve is installed.

MANIFOLD PRESSURE VARIATION WITH ENGINE RPM

When the waste gate is open, a turbocharged engine (H model) will react the same as a normally aspirated engine (D model) when the engine RPM is varied. That is, when the RPM is increased, the manifold pressure will decrease slightly. When the engine RPM is decreased, the manifold pressure will increase slightly.

However, when the waste gate is closed, manifold pressure variation with engine RPM is just the opposite of the normally aspirated engine. An increase in engine RPM will result in an increase in manifold pressure, and a decrease in engine RPM will result in a decrease in manifold pressure.

High altitude operation (above 10,000 feet) at low engine speeds is the only time you should be aware of closed waste-gate type of operation. Should manifold pressure decrease as engine speed is reduced for cruise, select a slightly higher cruise RPM where the turbocharger and controller maintains a stable manifold pressure.

FUEL FLOW VARIATIONS WITH CHANGES IN MANIFOLD PRESSURE

Engine-driven fuel pump output is regulated by engine speed and compressor discharge pressure. Engine fuel flow is regulated by fuel pump output and the metering effects of the throttle and mixture controls. When the waste gate is open, fuel flow will vary directly with manifold pressure, engine speed, mixture, or throttle control position. In this case, manifold pressure is controlled by throttle position and the waste gate actuator, while fuel flow varies with throttle movement and manifold pressure.

When the waste gate is closed and manifold pressure changes are directly related to turbocharger output, as discussed previously, fuel flow will follow manifold pressure even though the throttle position is unchanged. This minimizes fuel flow adjustments to (1) small initial adjustments on takeoff or climb-out for the proper rich climb setting, (2) lean-out in cruise, and (3) return to full rich position for approach and landing.

MOMENTARY OVERSHOOT OF MANIFOLD PRESSURE

Under some circumstances (such as rapid throttle movement, especially with cold oil) it is possible that the engine can be overboosted above the maximum allowable manifold pressure of 37 inches. This would most likely be experienced during the takeoff roll or during a change to full throttle operation in flight. The induction air pressure relief valve will normally limit the overboost to 2 or 3 inches.

Slight overboosting is not considered detrimental to the engine as long as it is momentary. No corrective action is required when momentary overboost corrects itself and is followed by normal engine operation. However, if overboosting of this nature persists when oil temperature is normal or if the amount of overboost tends to exceed 3 inches or more, the throttle should be retarded to eliminate the overboost and the controller system, including the waste gate and relief valve, should be checked for adjustment or replacement of components at the first opportunity.

ALTITUDE OPERATION

Because a turbocharged airplane will climb faster than a normally aspirated airplane, fuel vaporization may be encountered. If fuel flow is slightly less than that desired, or if variations of ±5 lbs./hr or more are observed (as a "nervous" fuel flow needle) on either or both engines, placing the appropriate auxiliary fuel pump switch or switches in either the HI or LO position, as required, will control vapor. Refer to Auxiliary Fuel Pump Switches in this section for details concerning the use of the auxiliary fuel pumps during climbs or cruise at high altitudes. If either or both pumps are used, be sure to adjust the mixture controls for the desired fuel flow. If the pumps are used during cruise, they should be turned off and the mixtures reset prior to descent and landing.

Propellers

The airplane is equipped with tractor and pusher type all-metal, twobladed, constant-speed, governor-regulated, full feathering propellers. The constant speed/feathering function of both propellers is identical. A setting introduced into the governor with the propeller control establishes the propeller speed, and thus the engine speed to be maintained. The governor then controls flow of engine oil, boosted to high pressure by the governing pump, to or from a piston in the propeller hub. Oil pressure acting on the piston twists the blades toward low pitch (high RPM). When oil pressure to the piston in the propeller hub is relieved, centrifugal force, assisted by external counterweights and internal springs, twists the blades toward high pitch (low RPM). If the propeller control is placed in the feathering position, the counterweights and spring tension will continue to twist the propeller blades from high pitch into the streamlined or feathered position. Latch mechanisms within the propeller hub, operated by centrifugal force, prevent feathering of the propeller during normal engine shut down.
The propeller and engine RPM of both engines is controlled by two levers on top of the control pedestal between the throttle and mixture controls. The levers are labeled RPM, FRONT, REAR, and INCREASE. When the levers are pushed forward, blade pitch will decrease, giving a higher RPM. As the levers are pulled aft, blade pitch increases, thereby decreasing RPM. The levers can be pulled aft until they reach a detent which is marked by a white line and a double headed arrow. If it should become necessary to feather either or both propellers, lift up on the levers to override the detent and pull them full aft. Refer to Section 3 for the procedures for feathering and unfeathering the propellers.

PROPELLER UNFEATHERING SYSTEM

A propeller unfeathering system is available, and if installed, one is provided for each engine. The system consists of a special propeller governor, hose assembly, nitrogen charged accumulator and a placard on the instrument panel. The governor contains a spring-loaded check valve which is open while the propeller control lever is in any position except the feathering position, maintaining oil under pressure in the hose and accumulator. When the propeller control is placed in the feathering position, the check valve closes and traps the oil in the hose and accumulator. If the propeller control lever is pushed out of the feathering position, the valve in the governor will open and the charged accumulator will force the oil through the governor to the propeller, returning it to the high pitch (low RPM) .position. The accumulators are pre-charged with nitrogen to 90 PSI, and should be maintained at 90 PSI for proper operation.

PROPELLER SYNCHROPHASER

The airplane is equipped with a propeller synchrophaser system to automatically synchronize both the engine speed and relative blade positions between the front and rear propellers. In addition, the phase relationship between the front and rear propeller blades can be selected by the pilot for minimum noise and vibration in the cabin.

This system consists of the control, electronic phase computer, magnetic RPM sensors in each governor, and an actuator motor attached to the rear governor.

The rear engine governor acts as a slave to the engine speed of the front engine over a ±50 RPM range. This limited range prevents the slaved engine from losing more than a nominal amount of .propeller RPM in case the master engine is feathered with the synchrophaser engauged.

The controls consist of a function switch labeled PHASE-OFF. During climb, descent, or in turbulent air, after the airplane is trimmed and the desired manifold pressure is set, manually synchronize the propellers as closely as possible and tighten the quadrant friction lock securely. The synchroscope will aid in this process. Then engauge the synchrophaser by setting the function switch to the PHASE position.

NOTE

During a climb, the RPM of the two engines may tend to drift apart if small power adjustments are made. If the climb is long or power adjustments are large, an unsynchronized condition may result. In the event this occurs, turn the synchrophaser off and then re-engauge it as described in the preceding paragraph.

During cruise flight in smooth air, place the synchrophaser in the PHASE mode as described above. The switch should be in the OFF position for large changes in power, single-engine operation, or during takeoffs and landings. Placing the switch in the OFF position will automatically cycle the unit to the center of its range before stopping, thus ensuring that the control is positioned properly when next turned on.

For best operation, it is important to guard against propeller control creeping by setting the quadrant friction lock tightly. On long flights, where the slaved governor may eventually be operating near either extremity of its operating range, it may be necessary to periodically switch to the OFF position, reset the propeller control levers, and re-engauge the synchrophaser.

Fuel System

The fuel system for this airplane (see figure 7-7), utilizes four vented, interconnected tanks in each wing. In the following paragraphs and diagram, these tanks will be designated and referred to as a single tank in either the left or right wing. Refer to figure 7-6 for total and usable fuel quantities. The system contains the tanks, two fuel line manifolds, two fuel selector valves, two auxiliary fuel pumps, two fuel strainers, and an engine-driven fuel pump, fuel/air control unit, fuel distributor manifold, and fuel injection nozzles on each engine.

Fuel flows by gravity from the fuel tanks to two fuel line manifolds, and from the manifolds to two three-position selector valves. The selector valves are controlled by handles in the overhead console. Handle positions are labeled LEFT, FUEL OFF, and RIGHT. With the FRONT ENGINE fuel selector handle in the LEFT position and the REAR ENGINE fuel selector handle in the RIGHT position, fuel from the selector valves is routed through a bypass in each auxiliary fuel pump (when it is not in operation),

Fuel quantity data (u.s. Gallons)			
Tanks	**Total** USABLE FUEL ALL FLIGHT CONDITIONS	**Total** UNUSABLE FUEL	**Total** FUEL VOLUME
Standard	148	2.6	150.6
(75.3 gal. Each wing)			

Fuel Quantity Data

and through fuel strainers to the engine-driven fuel pumps. The enginedriven fuel pumps deliver the fuel to fuel/air control units where it is metered and routed to a distributor manifold on each engine which distributes it to the cylinders. Vapor and excess fuel from the engine driven pumps are returned to the appropriate fuel line manifolds.

The normal fuel routing is from the left tank and front selector valve to the front engine, and from the right tank and rear selector valve to the rear engine. However, for the purpose of maintaining or re-establishing lateral trim, it is permissible to operate both engines from a single tank in level cruising flight under certain conditions. If single-tank operation is initiated with nearly full tanks, it must be remembered that vapor and excess fuel from each engine-driven fuel pump is being returned to its normal tank system, and the tank not being used is continuously refilling. To prevent the tank from overflowing, switch back to normal fuel management procedures when the fuel quantity in the unused tank indicates 50 pounds below full. If single-tank operation is being used when fuel levels are low, the fuel quantity in the tank in use should not be allowed to drop below 50 pounds prior to re-establishing normal single-engine per tank operation; this will aviod the possibility of dual engine stoppage due to fuel starvation.

NOTE

The fuel selector valve handles must be turned to LEFT for the front engine and RIGHT for the rear engine for takeoff, landing, and all normal operations. Cross-feeding is limited to level flight only.

The amount of unusable fuel is relatively small due to the specially designed tanks. The maximum unusable fuel quantity, as determined from the most critical flight condition, is about 8 pounds per tank. This quantity was not exceeded by any other reasonable flight condition, including prolonged 30 second full-rudder sideslips in the landing configuration.

During single-engine operation, fuel can be used from either tank through the use of the normal (green sector) and cross-feed (yellow sector) positions of the fuel selector valve handles. Again, the normal (unused) tank should not be allowed to continue refilling when it is 50 pounds below full during cross-feeding, to prevent fuel tank overflow due to vapor and excess fuel return flow. Use of fuel from the right and left tanks alternately will maintain lateral trim. Remember that single-engine landings must be accomplished with the fuel selector for the operating engine turned to the normal tank position (green selector of the fuel selector valve).

In single-engine cruise flight when cross-feeding has been done to use all the fuel in the opposite tank, a continuation of fuel flow must be assured as the new tank is being selected. Therefore, when switching from the dry tank to the tank containing fuel, place the appropriate auxiliary fuel pump switch momentarily in the HI position (up to 10 seconds) until normal fuel flow has been restored.

The fuel system supplying each engine is equipped with its own venting system, which is essential to fuel system operation. Blockage of either venting system will result in a decreasing fuel flow from the respective fuel tank, and eventual stoppage of the respective engine and/ or collapse of the fuel tank. Venting is accomplished by check valve equipped vent lines attached to the left and right fuel tanks which terminate at each wing tip trailing edge. The fuel filler caps are equipped with a vacuum operated vent which will open, allowing air into the tanks, should the fuel tank vent lines become blocked.

Fuel quantity is measured by four electrically-operated capacitance type fuel quantity transmitters (two in each wing tank) and indicated by two electrically-operated fuel quantity indicators on the right side of the instrument panel. The fuel quantity indicators are calibrated in pounds (bottom scale) and will indicate the weight of fuel contained in the tanks. Since fuel density varies with temperature, a full tank will weigh more on a cold day than on a warm day. This will be reflected by the weight shown on the indicators. A gallons scale (top) is provided in blue on the indicators for convenience in allowing the pilot to determine the approximate volume of fuel on board. A red line indicates an empty tank. When an indicator shows an empty tank, approximately 1.3 gallons remain in the tank as unusable fuel. The indicators cannot be relied upon for accurate readings during skids, slips, or unusual attitudes. If both indicator pointers should rapidly move to a zero reading, check the cylinder head temperature and oil temperature gauges for operation. If these gauges are not indicating, an electrical malfunction has occurred.

auxiliary fuel pumps are controlled by two split-rocker switches located on the left switch and control panel. The switches are labeled AUX PUMPS and F ENGINE R. One side of each switch is red and is labeled HI; the other side is yellow and is labeled LO. The LO side of either switch is used for vapor purging and may also be used for engine starting. The HI side of either switch operates the respective auxiliary fuel pump at high speed, supplying sufficient fuel flow to maintain adequate power in the event of an engine-driven fuel pump failure. In addition, the HI side may be used for normal engine starts, vapor elimination, and in-flight engine starts.

When the engine-driven fuel pump is functioning and the auxiliary fuel pump switch is placed in the HI position, an excessively rich fuel/ air ratio is produced unless the mixture is leaned. Therefore, these switches must be turned off during takeoff or landing, and during all other normal flight conditions. With the engine stopped and the battery switch on, the cylinder intake ports can be flooded if the HI or LO side of the auxiliary fuel pump switch is accidentally turned on.
Under hot day-high altitude conditions, or conditions during a climb that are conducive to fuel vapor formation, it may be necessary to utilize the auxiliary fuel pumps to attain or stabilize the fuel flow required for the type of climb being performed. Select either the HI or LO position of the switches as required, and adjust the mixtures to the desired fuel flow. If fluctuating fuel flow (greater than 5 lbs./ hr.) is observed during cruise at high altitudes on hot days, place the appropriate auxiliary fuel pump switch in the HI or LO position as required for approximately 15 minutes to clear the fuel system of vapor. This will usually be adequate corrective action; however, if fluctuation persists, use the auxiliary fuel pump as required to stabilize fuel flow indication. The auxiliary fuel pump may be operated continuously in cruise, if necessary, but should be turned off prior to descent. Each time the fuel pump switches are turned on or off, the mixtures should be readjusted.

Brake System

The airplane has a single-disc, hydraulically-actuated brake on each main landing gear wheel. Each brake is connected, by a hydraulic line, to a master cylinder attached to each of the pilot's rudder pedals. The brakes are operated by applying pressure to the top of either the left (pilot's) or right (copilot's) set of rudder pedals, which are interconnected. When the airplane is parked, both main wheel brakes may be set by utilizing the parking brake which is operated by a lever on the left cabin sidewall. Actuate the toe brakes and move the lever down to set the brakes.

For maximum brake life, keep the brake system properly maintained, and minimize brake usage during taxi operations and landings.

Some of the symptoms of impending brake failure are: gradual decrease in braking action after brake application, noisy or dragging brakes, soft or spongy pedals, and excessive travel and weak braking action. If any of these symptoms appear, the brake system is in need of immediate attention. If, during taxi or landing roll, braking action decreases, let up on the pedals and then re-apply the brakes with heavy pressure. If the brakes become spongy or pedal travel increases, pumping the pedals should build braking pressure. If one brake becomes weak or fails, use the other brake sparingly while using opposite rudder, as required, to offset the good brake.

Electrical System

Electrical energy is supplied by a 28-volt, direct current system powered by two engine-driven, 38-amp alternators. A 24volt, 14-amp hour battery (or 17-amp hour battery, if installed) is located in the lower left portion of the front engine compartment. Power is supplied to most general electrical and all avionics circuits through the lighting, general de-ice/ anti-ice, and avionics bus bars. The lighting bus and avionics bus are interconnected by a switch labeled AVIONICS MASTER. The lighting, general, and de-ice/ anti-ice bus bars are on anytime the battery switch is turned on, and are not affected by starter or external power usage. All bus bars are on anytime the battery and avionics power switches are turned on.

CAUTION
Prior to starting the engines or applying an external power source, the avionics power switch, labeled AVIONICS MASTER, should be turned off to prevent any harmful transient voltage from damaging the avionics equipment.

BATTERY SWITCH
The rocker-type battery switch provides a means of isolating the electrical system bus bars from the power supply system by controlling the battery contactor. When using an external power source for lengthy maintenance checks on the electrical system, the battery switch should be turned on. To check or use avionics equipment or radios while on the ground, the avionics power switch must also be turned on.

AVIONICS MASTER SWITCH
Electrical power from the airplane lighting, general, and de-ice/ anti-ice bus to the avionics bus is controlled by a rocker-type circuit switch labeled AVIONICS MASTER. The switch is located on the lower panel and is ON in the forward position and OFF in the aft position. With the switch in the OFF position, no electrical power will be applied to the avionics equipment, regardless of the position of the battery switch or the individual equipment switches. The avionics power switch also functions as a circuit breaker. If an electrical malfunction should occur and cause the circuit breaker to open, electrical power to the avionics equipment will be interrupted and the switch will automatically move to the OFF position. If this occurs, allow the circuit breaker approximately two minutes to cool before placing the switch in the ON position again. If the circuit breaker opens again, do not reset it. The avionics power switch should be placed in the OFF position prior to starting the engines or applying an external power source, and may be utilized in place of the individual avionics equipment switches.

ALTERNATOR SWITCHES
Both alternator switches are combined in a split rocker-type switch labeled F ALT R. The alternator switch controls both front and rear engine alternators and permits switching the front or rear alternator off in the event of an alternator, alternator circuit, or engine failure. If an alternator is turned off, operation should be continued on the functioning alternator, using only necessary electrical equipment.

ALTERNATOR WARNING LIGHTS
Two rectangular amber lights labeled ALT NOT CHARGING, FRONT, REAR indicate failure of the alternators to supply current to the electrical system. If the front or rear alternator fails, the corresponding FRONT or REAR light will come on. In the event both lights illuminate, both alternators have stopped functioning. The lights can be checked by turning on the battery switch before the engines are started, or by turning the alternator switches off while the engines are running. If a light comes on during flight, the faulty alternator should be turned off. The ALT NOT CHARGING light or lights will remain on until the flight is terminated. An ambient light sensor in the cabin automatically controls the brilliance of the ALT NOT CHARGING lights.

The ALT NOT CHARGING lights will normally stay out during idling and taxi operations. Occasionally a light may come on when electrical loads are at a minimum and one engine is operating at a much lower RPM than the other. If one light constantly comes on during idle or taxi with equal engine RPM, or during cruise, the voltage differential between the voltage regulators is too great and the regulators should be adjusted.

OVER-VOLTAGE WARNING LIGHT

A rectangular red warning light, labeled VOLTS HIGH is illuminated by an over-voltage sensor any time electrical system voltage exceeds 32 volts. If the output voltage of an alternator (or alternators) becomes excessive, the over-voltage sensor will automatically shut off the alternator (or alternators) experiencing the over-voltage condition, causing the ALT NOT CHARGING lights to come on simultaneously with the red VOLTS HIGH light. The over-volt sensor can be reset and the VOLTS HIGH light turned off by turning off the alternator switch (or switches) and battery switch (in that order). After the switches are turned off, delay attempts to re-cycle the system for approximately five seconds so that residual power from electrical components will have diminished and the sensor can be reset. Turn the battery switch back on and then turn the alternator switch (or switches) on separately to identify the faulty system. If the condition was temporary, the VOLTS HIGH light will remain off after the alternator switches are turned back on.

LIGHTING SYSTEMS

EXTERIOR LIGHTING

Exterior lighting consists of navigation lights on the wing tips and lower tip of the right vertical fin, a flashing beacon on top of the right vertical fin, and landing and taxi lights mounted in the nose cs,p. Additional lighting includes a strobe light on each wing tip, and one on the lower tip of the right vertical fin. All exterior lights are controlled by rocker type switches on the left switch and control panel. The switches are ON in the up position and off in the down position.

The flashing beacon should not be used when flying through clouds or overcast; the flashing light reflected from water droplets or particles in the atmosphere, particularly at night, can produce vertigo and loss of orientation.
The high intensity strobe lights will enhance anti-collision protection.
However, the lights should be turned off when taxiing in the vicinity of other airplanes, or during night flight through clouds, fog or haze.

INTERIOR LIGHTING

Instrument and control panel lighting is provided by electroluminescent, flood, and integral lighting, with post lighting also available. The instrument panel floodlights are operated by the switch labeled FLOOD ON/OFF and the panel gauge backlighting/post lighting is controlled by the switch labeled PANEL ON/OFF. These switches can be found on the lower left side of the instrument panel.

Instrument panel flood lighting consists of four lights mounted in the glare shield above the instrument panel. These lights operate independently of the gauge backlight or post lighting.

PRESSURIZATION SYSTEM (H Model)

The airplane is equipped with a cabin pressurization system (see figure 7-10) to permit flight at high altitude without the need for oxygen masks, and to increase passenger comfort. Pressurization is provided by two independent sources: the front and rear-engine turbocharger systems, The following paragraphs describe, in brief detail, the flow of pressurization air from its front and rear engine sources to the cabin.

FRONT ENGINE SYSTEM

Pressurized air from the compressor section of the front-engine turbocharger flows to the engine air induction system and also through a sonic venturi (flow limiter) to an air selector valve. If cool pressurized air is desired, the selector valve is positioned to route pressurized air through the heat exchanger and directly to the dump valve on the engine side of the firewall. If warm or heated air is desired, the selector valve is positioned to bypass the heat exchanger and duct pressurized air, where it is mixed with air from the air recirculation blower (if operating), to the combustion heater. From the combustion heater, air flow is ducted to the dump valve. Opening the dump valve will discharge pressurized airflow overboard. If the dump valve is opened, or the engine fails to provide sufficient pressurized airflow, a cabin pressure check valve on the cabin side of the firewall will automatically close.

An airflow plenum, mounted over the cabin pressure check valve, directs pressurized air into the cabin through ducts to outlets under the pilot's and front passenger's seats, and an outlet on the right side of the control pedestal. A closeable outlet in the plenum, near the pilot's rudder pedals, also allows pressurized airflow into the cabin. Airflow for the defroster system is provided by a valve in the plenum. Refer to the Pressurization/ECS System documentation for more detailed information.

CABIN ALTITUDE V5. AIRPLANE ALTITUDE WITH 3.35 PSI DIFFERENTIAL	
AIRPLANE ALTITUDE IN FEET	CABIN ALTITUDE IN FEET
7000	Sea Level
8000	800
10,000	2400
12,000	4000
14,000	5500
16,000	7000
18,000	8500
20,000	10,000

Cabin Altitude Vs. Airplane Altitude

Pressurization or re-pressurization of the airplane during flight should be accomplished with care to avoid passenger discomfort. If the airplane is at or below 10,000 feet, set the cabin altitude selector to 10,000 feet on the outer scale. After setting the selector, push both pressurized air dump valve controls full in and place the cabin pressurization switch in the ON position. Once the system is set up for pressurization, VERY SLOWLY turn the cabin altitude selector to the desired cabin altitude. By turning the selector slowly, no passenger discomfort is likely as the cabin pressure increases to the desired level.

If the airplane is above 10,000 feet, set the cabin altitude selector to 10,000 feet on the outer scale and check that both pressurized air dump valve controls are pulled full out. Place the pressurization switch in the ON position and VERY SLOWLY push the REAR pressurized air dump valve control full in. Slow movement will prevent any sudden pressure change in the cabin. After the cabin rate-of-climb indicator has stabilized at zero, push the front pressurized air dump valve control full in and VERY SLOWL Y adjust the cabin altitude selector to the desired cabin altitude.

As the pilot approaches his destination, or if he is required to descend to a lower altitude enroute, care must be taken to maintain proper pressurization system operation. Descents should be made with a minimum of 40% power to maintain cabin pressure. Prior to landing, the differential pressure indicator should be checked to assure the airplane is depressurized. The airplane is not approved for landing while pressurized.

After completing a trip, it is good practice to leave the pressurization switch in the ON position, and the pressurized air dump valve controls pushed in. This will save time and help prevent inadvertent unpressurized flight on subsequent trips.

Windshield Defrost

Windshield defrosting and defogging air flows from outlets spaced along the lower edge of the windshield. Airflow to the outlets is controlled by a lever labeled DEFROST, which operates a valve in the airflow plenum in front of the pilot's feet on the firewall. To defrost or defog the windshield, move the DEFROST lever from the OFF position downward to the ON position for maximum airflow. Airflow may be increased further by checking that the FRONT PRESS AIR TEMP lever is in the WARM position, and placing the FWD PASS AUX AIR switch in the HIGH position. The temperature of defrost airflow is dependent upon the position of the FRONT PRESS AIR TEMP lever, and if the combustion heater is in use. If the airplane is equipped with windshield anti-ice, the anti-ice and windshield defrost may be used simultaneously.

Pitot-Static System And Instruments

The pitot-static system supplies ram air pressure to the airspeed indicator and static pressure to the airspeed indicator, rate-of-climb indicator, altimeter, and autopilot system (if installed). The system is composed of a dual ported pitot (both ports act as pitot sources while the lower port also serves as a drain port on the ground) mounted in the leading edge of the left wing strut, two flush external static ports, one on each side of the fuselage aft of the front engine cowling, and the associated plumbing necessary to connect the instruments to the sources.

The airplane is also equipped with a pitot heat system. The system consists of a heating element between the pitot and the strut leading edge skin, a rocker-type switch labeled ANTI-ICE HEAT, PITOT on the lower left side of the instrument panel, a 10-amp circuit breaker on the left sidewall circuit breaker panel, and associated wiring. When the pitot heat switch is turned on, the strut leading edge skin is heated to maintain proper operation in possible icing conditions. Pitot heat should be used only as required.

A static pressure alternate source valve is installed on the left side of the control pedestal, and is used if the external static source is malfunctioning. This valve supplies static pressure from inside the left wing instead of the external static ports.

If erroneous instrument readings are suspected due to water or ice in the pressure lines going to the standard external static pressure source, the alternate static source valve should be pulled on. Refer to Section 5 for the effect of the alternate static source on indicated airspeeds. Also, refer to Section 9, Supplements, for the effect of alternate static source usage while operating the autopilot (if installed).

Airspeed Indicator
The airspeed indicator is calibrated in knots and miles per hour.

Limitation and range markings include the white arc (60 to 110 knots), green arc (65 to 169 knots), blue line (89 knots), yellow arc (169 to 205 knots), and a red line (205 knots).

If a true airspeed indicator is installed, it is equipped with a rotatable ring which works in conjunction with the airspeed indicator dial in a manner similar to the operation of a flight computer. To operate the indicator, first rotate the ring until pressure altitude is aligned with outside air temperature in degrees Fahrenheit. Pressure altitude should not be confused with indicated altitude. To obtain pressure altitude, momentarily set the barometric scale on the altimeter to 29.92 and read pressure altitude on the altimeter. Be sure to return the altimeter barometric scale to the original barometric setting after pressure altitude has been obtained. Having set the ring to correct for altitude and temperature, read the true airspeed shown on the rotatable ring by the indicator pointer.

Rate-Of-Climb Indicator
The rate-of-climb indicator depicts airplane rate of climb or descent in feet per minute. The pointer is actuated by atmospheric pressure changes resulting from changes of altitude as supplied by the static source.

Airplane altitude is depicted by a barometric type altimeter. A knob near the lower left portion of the indicator provides adjustment of the instrument's barometric scale to the current altimeter setting.

Vacuum System And Instruments
An engine-driven vacuum system is available and provides the suction necessary to operate the attitude indicator and directional indicator. The system consists of a vacuum pump on each engine, two vacuum relief valves, a check valve manifold, a vacuum system air filter in the wing, vacuum operated instruments on the left side of the instrument panel, and a suction gauge, equipped with dual warning indicators labeled F and R, on the right side of the panel.

Attitude Indicator
An attitude indicator is available and gives a visual indication of flight attitude. Bank attitude is presented by a pointer at the top of the indicator relative to the bank scale which has index marks at 10°,20°,30°,60°, and 90° either side of the center mark. Pitch and roll attitudes are presented by a miniature airplane in relation to the horizon bar. A knob at the bottom of the instrument is provided for

in-flight adjustment of the miniature airplane to the horizon bar for a more accurate flight attitude indication.

Directional Indicator

A directional indicator is available and displays airplane heading on a compass card in relation to a fixed simulated airplane image and index. The directional indicator will precess slightly over a period of time. Therefore, the compass card should be set in accordance with the magnetic compass just prior to takeoff, and occasionally re-adjusted on extended flights. A knob on the lower left edge of the instrument is used to adjust the compass card to correct for any precession.

Suction Gauge

A suction gauge is located on the upper right side of the instrument panel when the airplane is equipped with a vacuum system. Suction available for operation of the attitude indicator and directional indicator is shown by this gauge, which is calibrated in inches of mercury. The desired suction range is 4.6 to 5.4 inches of mercury. A suction reading below this range may indicate a system malfunction or improper adjustment, and in this case, the indicators should not be considered reliable. The gauge is equipped with two red warning buttons marked F and R, on the lower part of the gauge face, which will extend if either or both vacuum sources fail. Either vacuum source is capable of supplying adequate vacuum to the gyro instruments in the event one source fails.

Stall Warning System

The airplane is equipped with a vane-type stall warning unit in the leading edge of the left wing. The unit is electrically connected to a warning unit located in the fuselage. The vane in the wing unit senses the change in airflow over the wing and operates the warning unit, which produces a continuous tone over the airplane speaker between 5 and 10 knots above the stall in all configurations.

If the airplane has a heated stall warning system, the vane-type unit in the wing is equipped with a heating element. Both the heated stall warning system and the pitot heat system are operated by the PITOT heat switch, and are protected by the same circuit breaker.

The stall warning light is located on the upper-center of the pilot's instrument panel. The system should be checked during the preflight inspection by momentarily turning on the battery switch and actuating the vane in the wing. The system is operational if a continuous tone is heard on the airplane speaker as the vane is pushed upward.