

# SECTION VII.

## AIRPLANE & SYSTEMS DESCRIPTION

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## INTRODUCTION

Acquiring a working knowledge of the aircraft's controls and equipment is one of your important first steps in developing a fully efficient operating technique. This airplane and Systems section describes location, function, and operation of systems controls and equipment. It is advisable for you, the pilot, to familiarize yourself with all controls and systems while sitting in the pilot's seat and rehearsing the systems operations and flight procedures portions of this manual.

## AIRFRAME

The airframe has a welded, tubular-steel cabin structure enclosed in sheet-aluminum skins. Stressed skins rivet to main and auxiliary spars in the wing, stabilizer, and vertical fin. The laminar-flow wing has full wrap-around skins with flush riveting over the forward top and bottom two thirds of the wing area.

For pitch trim control, the empennage pivots on the aft fuselage. A torque-tube-driven jack screw, bolted to the rear tailcone bulkhead, sets the stabilizer angle.

The forward-opening cabin door provides access to both front and rear seats. The baggage compartment door is located above the right wing trailing edge to permit baggage loading from the ground.

The tricycle landing gear allows maximum taxi vision and ground maneuvering. Hydraulic disc brakes and a steerable nose wheel aid in positive directional control during taxiing and crosswind landings.

The landing gear is electrically retracted and extended. A gear warning horn, a gear position indicator on the floorboard and a green "gear down" light help prevent inadvertent gear-up landings. A manual emergency gear extension system is provided for use in the event of an electrical failure.

## POWER PLANT

### ENGINE CONTROLS

The engine controls are centrally located, between the pilot and co-pilot, at the top of center console panel. The throttle knob regulates manifold pressure. Pushing the knob forward increases the setting; pulling the knob aft decreases the setting.

The propeller control, with its crowned blue or black knob, controls engine RPM through the propeller governor. Pushing the knob forward increases engine RPM; pulling the knob aft decreases the setting.

The mixture control, with its red fluted knob, establishes the fuel-air ratio (mixture). Pushing the knob full forward sets the mixture to full-rich, pulling the knob aft leans the mixture, and pulling the knob to its maximum aft travel position closes the idle cutoff valve, shutting down the engine. Precise mixture settings can be established by observing the EGT gage (if installed) on the pilot's right hand instrument panel while adjusting the mixture control.

The ram air control located directly below the throttle control, allows the selection of filtered induction air or unfiltered direct ram air.

Using ram air will increase the manifold pressure by allowing engine induction air to partially bypass the induction air filter. The use of ram air must be limited to clean, dust-free air. The engine will operate on direct unfiltered air when the ram air control is pulled on. When ram air is on allowing unfiltered air to enter the engine, the ram air annunciator light located above the center radio panel will illuminate when the landing gear is down. Should the induction air filter clog, a spring-loaded door in the induction system will open by induction vacuum to allow alternate air to enter the engine.

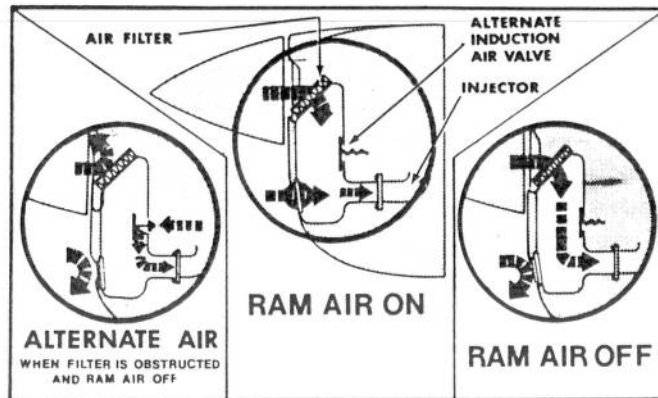


FIGURE 7-1 ENGINE AIR INDUCTION SYSTEM

Cylinder head temperature, oil pressure, fuel pressure and oil temperature gages are located above the flight instruments. EGT, tachometer, and manifold pressure are located to the right of the radio panel. Color arcs on instrument faces mark operating ranges. Proper interpretation of engine instrument readings is essential for selecting optimum control settings and for maintaining maximum cruise fuel economy.

#### IGNITION SYSTEM

The magneto ignition system features two electrically independent ignition circuits in one housing. The right magneto fires the lower right and upper left spark plugs, and the left magneto fires the lower left and upper right spark plugs. The magneto/starter switch has five positions: OFF, R (right), L (left), BOTH, and START. In the OFF position both magnetos are grounded. At the R position the left magneto grounds. At the L position the right magneto grounds. At the BOTH position both magnetos are HOT and the ignition system is on. For safety, the ignition switch must be OFF and key removed when the engine is not running. Turning the ignition switch to start and pushing in closes the starter solenoid, engages the starter and allows the impulse coupling to automatically retard the magneto until the engine is at its retard firing position. The spring action of the impulse is then released to spin the rotating magnet and produce the spark.

to fire the engine. After the engine starts, the impulse coupling flyweights do not engage due to centrifugal action. The coupling then acts as a straight drive and the magneto fires at the normal firing position of the engine. The magneto/starter switch is spring loaded to return from START to the BOTH position when released.

### **CAUTION**

Do not operate the starter in excess of 30 seconds or re-engage the starter without allowing it time to cool.

### **WARNING**

Do not turn the propeller when the magnetos are NOT grounded. Ground the magneto points before removing switch wires or electrical plugs. All spark plug leads can be removed as an alternate safety measure.

## **FUEL SYSTEM**

Fuel is carried in two integral sealed sections of the forward inboard area of the wings. Total usable fuel capacity is 64 gallons (242.4 liters) (53.3 Imp. Gal.). Both tanks have fuel level indicators visible through the filler ports. These indicators show the 25-gallon (94.7 liters) (20.8 Imp. Gals.) level in each tank. There are sump drains at the lowest point in each tank for taking fuel samples to check for sediment contamination and condensed water accumulation.

The recessed three-position fuel selector handle aft of the console on the floor allows the pilot to set the selector valve to LEFT tank, RIGHT tank, or OFF position. The gascolator, located to the left of the selector valve in the floorboard, is for draining condensed water and sediment from the lowest point in the fuel lines before the first flight of the day and after each refueling.

Fuel feeds from one tank at a time to the selector valve and through the electric fuel pump (boost pump) enroute to the engine-driven pump and the fuel injector unit. The electric fuel pump is capable of supplying sufficient pressure and fuel flow for maximum engine performance should the engine driven pump fail.

Electric fuel-level transmitters in the tanks operate the fuel gages. The master switch actuates the fuel quan-

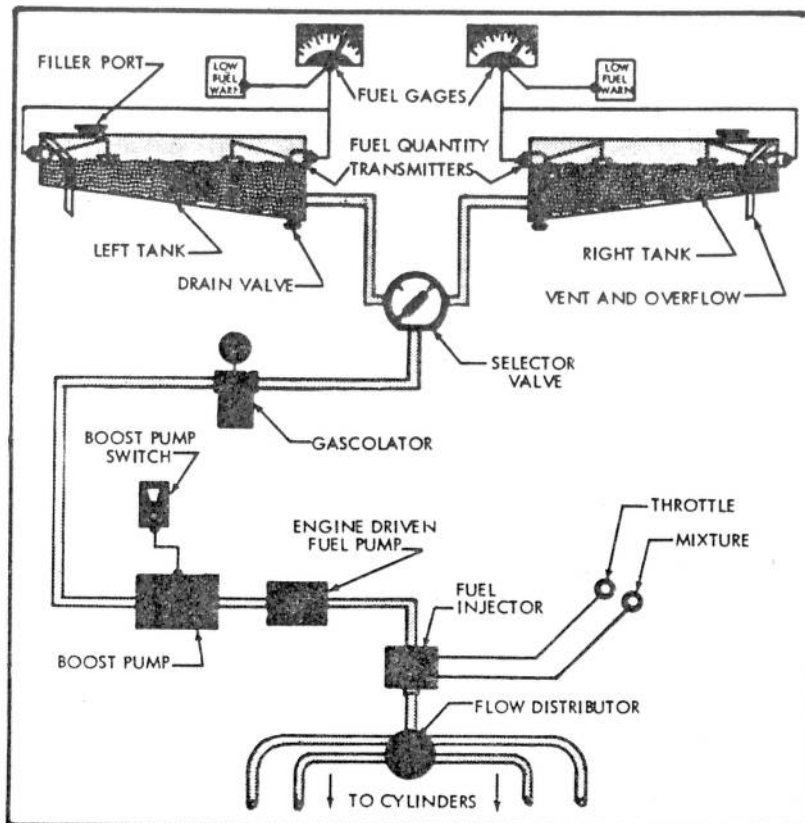


FIGURE 7-2 FUEL SYSTEM SCHEMATIC

tity indicator system to maintain an indication of fuel remaining in each tank. The fuel pressure gage registers fuel pressure in the line to the injector. Vents in each fuel tank allow for overflow and ventilation.

The optional, visual fuel quantity indicators located on top of each wing tank are to be used for partial fuel loading only and not for preflight inspection purposes.

## OIL SYSTEM

The engine has a full-pressure wet-sump oil system with an 8-quart (7.6 liters) capacity. An automatic bypass control valve routes oil flow around the oil cooler when operating temperatures are below normal or when the cooling radiator is blocked.

## ENGINE COOLING

The down-draft engine cooling system provides ground and inflight power plant cooling. Engine baffling directs air over and around the cylinders and out the cowl flap openings. Opening the cowl flap doors allows proper air flow on the ground and during low-speed high-power climbs. Pulling the cowl flap control full aft opens the cowl flaps. The cowl flaps should be partially opened, (control pulled aft approximately two to three inches), if necessary to maintain the oil and cylinder head temperature within the normal operating range.

## VACUUM SYSTEM

An engine-driven vacuum pump supplies suction for the vacuum-operated gyroscopic flight instruments. Air entering the vacuum-powered instruments is filtered; hence, sluggish or erratic operation of vacuum-driven instruments may indicate that a clogged vacuum filter element is preventing adequate air intake. A vacuum annunciator light is provided to monitor system operation.

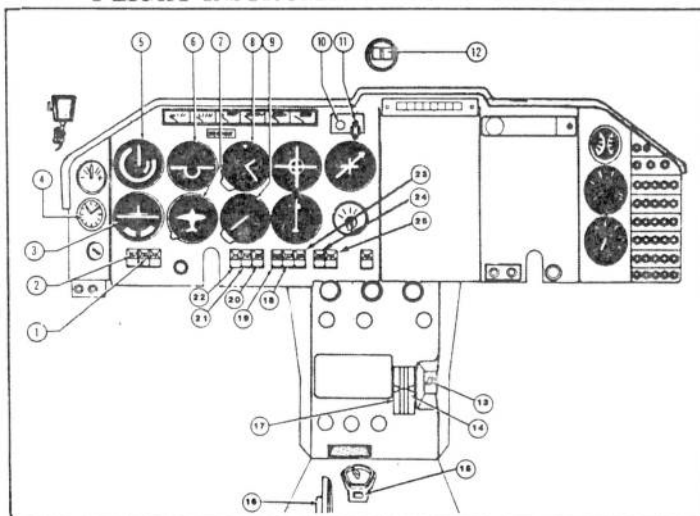
## PROPELLER

The propeller, of the constant speed type, is a single-acting unit in which hydraulic pressure opposes the natural, centrifugal twisting moment of the rotating blades, and the force of a spring, to obtain the correct pitch for the engine load. Engine lubricating oil is supplied to the power piston in the propeller hub through the propeller shaft. The amount and pressure of the oil supplied is controlled by an engine-driven governor. Increasing engine speed will cause oil to be admitted to the piston, thereby increasing the pitch. Conversely, decreasing engine speed will result in oil leaving the piston, thus decreasing the pitch.



## FLIGHT PANEL & CONTROLS FAMILIARIZATION

### FLIGHT INSTRUMENTS AND CONTROLS



- ① **RADIO MASTER**  
The Radio Master Switch/Circuit Breaker operates a relay supplying power to the radiobus bars. Since the relay is energized to cut the power to the radio bus, failure of the relay coil will still allow power to the radio bus. Energizing the starter automatically energizes the relay and disconnects the radios from the bus.
- ② **MASTER SWITCH**  
The master switch operates the battery relay which controls battery power to the main ship bus bar. This switch also cuts the alternator field power - from main bus to the alternator. This cuts off all ship power except the cabin light and electric clock.
- ③ **TURN COORDINATOR (if installed)**  
The turn coordinator takes the place of a turn and bank indicator and operates from an electric power source. The turn coordinator is independent of the flight reference gyros. The turn coordinator displays variations in roll and yaw to the pilot by means of a damped miniature aircraft silhouette display - this provides the pilot with the essential information to execute a "proper turn".

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④ CLOCK (if installed)

The electric clock with a sweep second hand, may be set by the pilot by pulling the knob and turning either left or right.

⑤ AIRSPEED INDICATOR

The airspeed indicator registers airspeed in knots. The air pressure difference between the pitot tube and the static ports on each side of the tailcone operates the airspeed indicator.

⑥ ATTITUDE INDICATOR (If Installed)

The vacuum-powered attitude indicator indicates aircraft attitude relative to straight-and-level flight. Bank attitude is presented by a pointer at the top of the indicator relative to the bank scale which is marked in increments of 10°, 20°, 30°, 45°, 60° and 90° either side of the center mark. Pitch attitude is presented by an airplane silhouette in relation to the horizon bar. The knob at the bottom of the instrument is provided for adjustment of the silhouette to the horizon bar for a more accurate flight attitude indication. Vacuum pressure for satisfactory operation is  $4.25 \pm .25$  to  $5.50 \pm .2$  IN Hg.

⑦ GYROSCOPIC HEADING INDICATOR (Directional Gyro) (If Installed)

The directional gyro 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. Vacuum pressure for satisfactory operation is the same as the artificial horizon/attitude indicator.

⑧ ALTIMETER

The altimeter operates by absolute pressure, and converts barometric pressure to altitude reading in feet above mean sea level. The altimeter has a fixed dial with three pointers to indicate hundreds, thousands, and tens-of-thousands of feet. Barometric pressure is sensed through the static ports. A knob adjusts a movable dial, behind a small window in the face of the main dial, to indicate local barometric pressure and to correct the altimeter reading for prevailing conditions.

⑨ VERTICAL SPEED INDICATOR

The vertical speed indicator converts barometric pressure changes in the static lines to aircraft ascent or descent rate readings in feet per minute. This indicator has a single needle and two adjoining scales that read from 0 to 2000 feet per minute. The recessed, slotted screw at the lower left of the instrument case is used to "zero" the indicator when the aircraft is on the ground.

⑩ GEAR SAFETY OVERRIDE SWITCH

The gear safety override switch is a manual means of electrically bypassing the airspeed safety switch. In the event the gear control switch is inadvertently placed in the gear-up position, the gear airspeed safety switch prevents the gear being retracted before approximately 65+4 KTS airspeed is reached. Should it be necessary to retract at lower airspeed the gear safety override switch may be pressed allowing the gear to retract.

**CAUTION**

The activation of the gear safety override switch overrides the safety features of the airspeed switch and can cause the gear to start retracting while on the ground.

⑪ GEAR SWITCH

The electric gear switch, identifiable by its wheel shaped knob, is a two-position switch. Pulling aft and lowering the knob lowers the landing gear while pulling aft and raising the knob raises the gear.

**NOTE**

Failure to "Pull" knob out prior to movement may result in a broken switch.

⑫ MAGNETIC COMPASS

The magnetic compass is liquid-filled, with expansion provisions to compensate for temperature changes. It is equipped with compensating magnets adjustable from the front of the case. Access to the compass light and the compensating magnets is provided by pivoted

covers. No maintenance is required on the compass except an occasional check on a compass rose with adjustment of the compensation card, if necessary, and replacement of the lamp.

⑬ FLAP SWITCH

The flap switch, in a recess on the right of the console operates the electrically-actuated wide span wing flaps. Holding the spring-loaded switch in the down position lowers the flaps to the desired angle of deflection. A pointer in the center console indicates flap position. Simply releasing downward pressure on the switch allows it to return to the OFF position stopping the flaps at any desired intermediate position during extension. When flap-up position is selected, flaps will retract to full up position unless the switch is returned to the neutral position for a desired intermediate setting. Pushing the switch to the UP position retracts the flaps completely.

⑭ FLAP POSITION INDICATOR

Wing flap position is mechanically indicated thru a cable mounted directly to the flap jackshaft. A pointer in the flap position indicator indicates flap position. The intermediate mark in the pointer range is the flap TAKEOFF setting ( $15^{\circ}$ ).

⑮ GEAR POSITION INDICATOR

The illuminated gear-down position indicator at the back of the fuel selector trim pan aft of the center console has two marks that align when the gear is down and illuminates when the green gear down light is on.

⑯ TRIM CONTROL WHEEL

Rotating the trim control wheel forward lowers the nose while rearward rotation raises the nose of the aircraft.

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①7 TRIM POSITION INDICATOR

Stabilizer trim position is mechanically indicated thru a cable attached to the trim wheel mechanism. Position indications are shown on the console.

①8 PITOT HEAT SWITCH/CIRCUIT BREAKER

Pushing ON the pitot heat combination rocker switch/circuit breaker turns on the heating elements within the pitot tube. Should a short occur the combination switch/circuit breaker will automatically trip to the OFF position.

LANDING LIGHT SWITCH/CIRCUIT BREAKER

- ①9 Pushing ON the landing light combination rocker switch/circuit breaker turns ON the landing light. Should a short occur the combination switch/circuit breaker will automatically trip to the OFF position. The landing light should not be operated when the engine is not running to preclude overheating of the lamp.

②0 NAVIGATION LIGHT SWITCH/CIRCUIT BREAKER

Pushing ON the navigation light combination rocker switch/circuit breaker turns ON the wing tip and tail navigation lights. Should a short occur the combination switch/circuit breaker will automatically trip to the OFF position.

②1 STROBE LIGHT SWITCH/CIRCUIT BREAKER

Pushing ON the strobe light combination switch/circuit breaker turns ON the wing tip and tail strobe lights. Should a short occur the combination switch/circuit breaker will automatically trip to the OFF position.

②2 ROTATING BEACON SWITCH/CIRCUIT BREAKER  
(if installed)

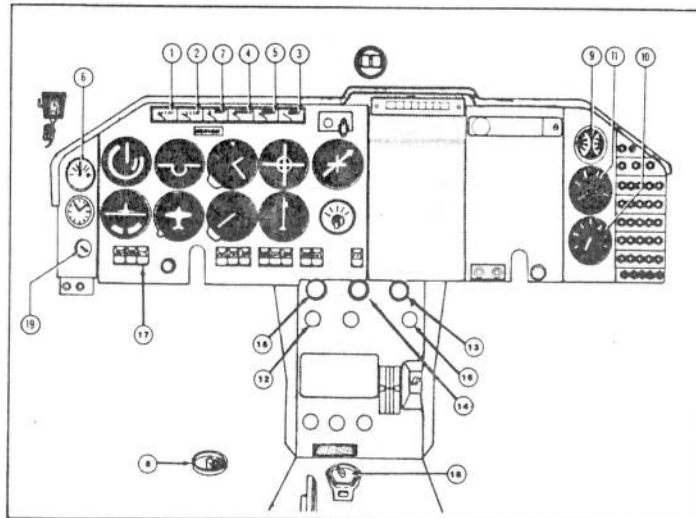
Pushing ON the rotating beacon combination switch/circuit breaker turns ON the rotating beacon. Should a short occur the combination switch/circuit breaker will automatically trip to the OFF position.

②3 Prop De-Ice Switch/Circuit Breaker (If Installed).

②4 Weather Scout Radar Switch/Circuit Breaker  
(If Installed).

②5 Electric Trim Switch (If Installed).

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ENGINE INSTRUMENTS AND CONTROLS



①. and ②. FUEL QUANTITY INDICATORS

The fuel quantity indicators are used in conjunction with float-operated variable-resistance transmitters in each fuel tank. The tank-full position of the transmitter float produces a maximum resistance through the transmitter, permitting minimum current flow through fuel quantity indicator and maximum pointer deflection. The instrument is calibrated in pounds of fuel.

③. CYLINDER HEAD TEMPERATURE (CHT)

The cylinder head temperature indications are controlled by an electrical resistance type temperature probe installed in the number three cylinder, and receives power from the aircraft electrical system. The instrument is calibrated in  $^{\circ}\text{F}$ .

④. OIL PRESSURE GAGE

The electric oil pressure gage uses a transducer, which varies resistance with pressure, as reference.

⑤. OIL TEMPERATURE GAGE

The oil temperature gage is an electric instrument connected electrically to a temperature bulb in the

engine. Temperature changes of the engine oil change the electrical resistance in the bulb thereby allowing more or less current to flow through the indicating gage. The instrument is calibrated in °F.

6. AMMETER

The ammeter indicates current flow, in amperes, from the alternator to the battery, or from the battery to the electrical system. With the engine operating, and master switch "ON", the ammeter indicates the rate of charge being applied to the battery. In the event of an alternator malfunction, or if the electrical load demand exceeds the alternator output, the ammeter will indicate the discharge rate of the battery.

7. FUEL PRESSURE GAGE

The fuel pressure gage is of the electric type, using a transducer as reference, and is calibrated in pounds per square inch and indicates the pressure to the fuel injector.

8. GASCOLATOR

The gascolator, located to the left of the console on the floorboard, allows the pilot to drain condensed water and any sediment from the lowest point in the fuel line. To activate the gascolator pull the ring upward, to stop drainage release the ring.

9. EGT/OAT GAGE

The EGT/OAT gage is located to the right of the radio panels and above the engine tachometer. A thermocouple probe in the number 3 exhaust pipe transmits temperature variations to the indicator mounted in the instrument panel. The indicator serves as a visual aid to the pilot when adjusting mixture. Exhaust gas temperature varies with fuel-to-air ratio, power and RPM. The OAT, gage provides the pilot with the free stream outside air temperature in degrees centigrade.

⑩ TACHOMETER

The tachometer is a mechanical indicator driven at half crankshaft speed by a flexible shaft. Most tachometer difficulties will be found in the driveshaft. To function properly, the shaft housing must be free of kinks, dents and sharp bends.

⑪ MANIFOLD PRESSURE

The manifold pressure gage is of the direct reading type and is mounted above the engine tachometer. The gage is calibrated in inches of mercury and indicates the pressure in the induction air manifold.

⑫ RAM AIR CONTROL

Pulling the ram air control allows the use of unfiltered air. The use of ram air must be limited to clean dust-free air and must not be used during any ground operations.

⑬ MIXTURE CONTROL

The mixture control allows the pilot to adjust the fuel-air ratio (mixture) of the engine. Pushing the control forward richens the mixture. Pulling the control aft leans the mixture and pulling the control full aft closes the idle cutoff valve shutting down the engine. The control is of the vernier type and fine adjustments of the mixture can be obtained by turning the knob, clockwise richens the mixture, counterclockwise leans.

⑭ PROPELLER CONTROL

Pushing the propeller control forward increases engine RPM; pulling the control aft decreases the engine RPM. The control is of the vernier type and fine adjustments of RPM's can be obtained by turning the knob: clockwise increases RPM's, counterclockwise decreases RPM's.

⑮ THROTTLE CONTROL

Pushing the throttle control forward increases the manifold pressure thereby increasing the engine power.



Pulling the control aft decreases the manifold pressure thereby decreasing the engine power. A friction lock is provided to prevent creeping at cruise settings.

**①6 COWL FLAP CONTROL**

Pulling the cowl flap control full aft opens the cowl flap doors allowing additional airflow to properly cool the engine on the ground and during low speed high power climbs. During cruise the cowl flaps may be partially opened, (control pulled aft approximately three inches) if necessary, to maintain oil and cylinder head temperatures within the normal operating range.

**①7 FUEL BOOST PUMP SWITCH/CIRCUIT BREAKER**

Pushing ON the fuel boost pump combination rocker switch/circuit breaker turns on the fuel boost pump. Use of the fuel boost pump should be limited to starting, takeoff, switching fuel tanks, landing, and emergency situations.

The fuel boost pump is capable of supplying fuel to the engine at the rated quantities and pressures to permit the engine to develop maximum rated power.

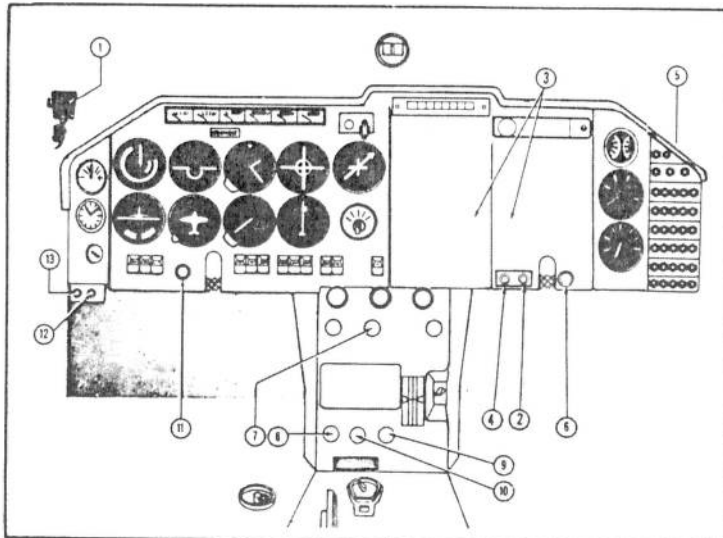
**①8 FUEL SELECTOR VALVE**

The fuel selector valve located on the floorboard is a three-position valve which allows the pilot to select either the left or right fuel tank. Turning the valve to OFF shuts off all fuel to the engine. At full throttle the engine will stop from fuel starvation in 2 to 3 seconds.

**①9 MAGNETO/STARTER SWITCH**

The magneto/starter switch combines both ignition and starting functions. Turning the ignition key clockwise through R, L, and BOTH to the START MAG position and then pushing forward on the key and receptacle engages the starter. Releasing the key when the engine starts allows the switch to return by spring action to the BOTH position.

# MISCELLANEOUS INSTRUMENTS, CONTROLS AND INDICATORS



- ① RADIO MICROPHONE (If Installed)
- ② RADIO LIGHT SWITCH AND DIMMER  
Turning the radio light switch knob clockwise turns ON the radio and indicator lights. Continued turning clockwise increases light intensity.
- ③ RADIO PANELS  
Adequate space is provided for installation of optional avionics.
- ④ PANEL LIGHT SWITCH AND DIMMER  
Turning the panel light switch knob clockwise turns on the instrument lights located in the glareshield. Continued turning clockwise increases the lighting intensity.
- ⑤ CIRCUIT BREAKER PANEL  
Push-to-reset and push-pull circuit breakers automatically break the electrical current flow if a system receives an overload.