# SECTION IX

## SYSTEMS

### TABLE OF CONTENTS

## TABLE OF CONTENTS (Continued)

**AIRFRAME**

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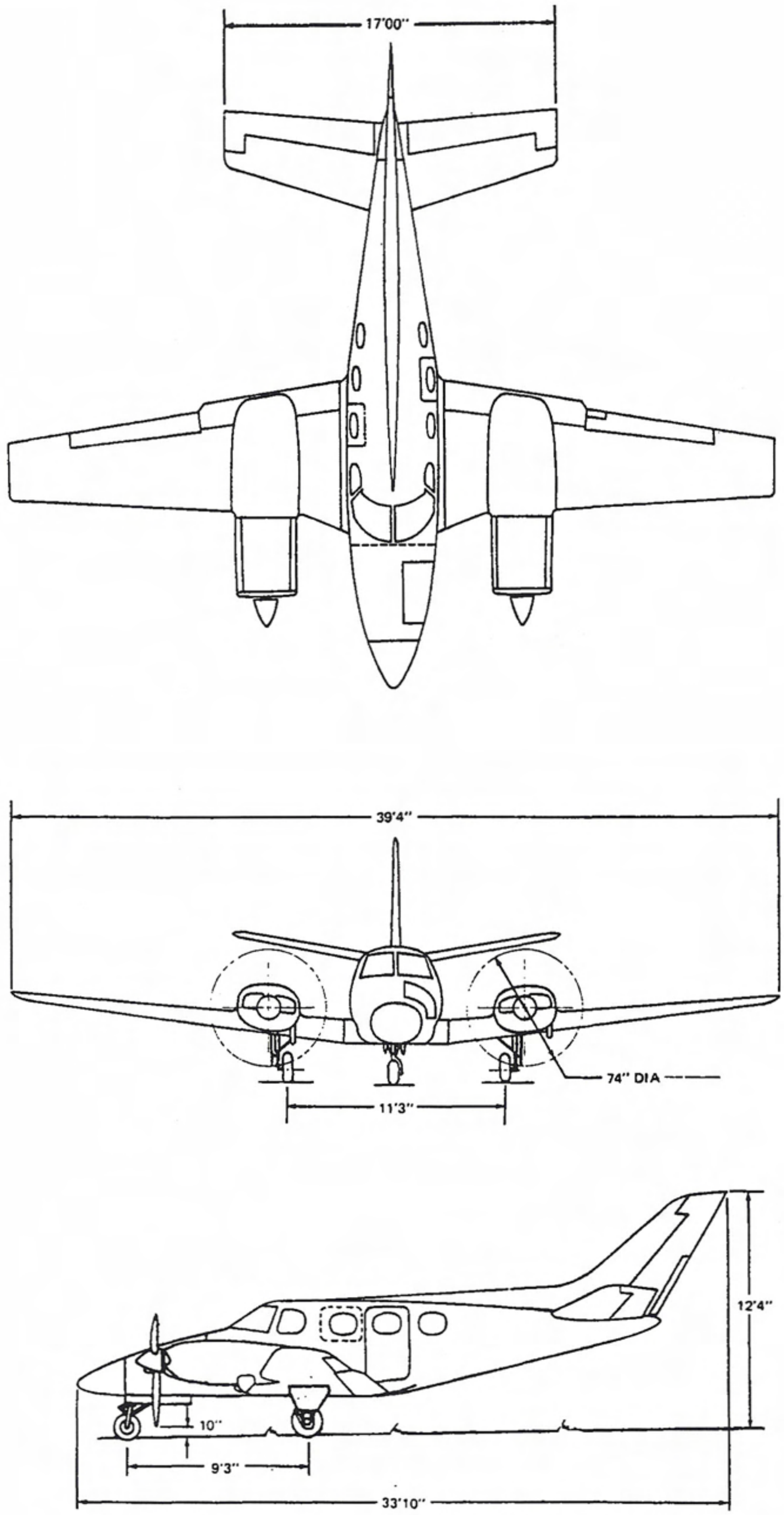


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THREE VIEW

# GENERAL SPECIFICATIONS

## *WEIGHTS*

| | |
|---|---|
| Maximum take-off and landing | 6775 lbs |
| Useful load (Standard Equipment) | 2675 lbs |
| Maximum ramp weight | 6819 lbs |

## *WING AREA AND LOADING*

| | |
|---|---|
| Wing Area | 212.9 sq ft |
| Wing Loading at 6775 lbs | 31.8 lbs/sq ft |
| Power Loading at 6775 lbs | 8.91 lbs/hp |

## *DIMENSIONS*

| | |
|---|---|
| Wing Span | 39 ft 4 in. |
| Length | 33 ft 10 in. |
| Height to top of fin | 12 ft 4 in. |

## *CABIN DIMENSIONS*

| | |
|---|---|
| Length | 142 in. |
| Height | 52 in. |
| Width | 50 in. |
| Entrance Door | 47-1/2 in. x 26-1/2 in. |

## *FUEL*

100/130 (Green) Aviation Gasoline. If not available 115/145 (Purple) Aviation Gasoline.

| | |
|---|---|
| With baffled fuel cells in both wings | 202 gals usable |
| With unbaffled fuel cells in one or both wings | 192 gals usable |

## *OIL*

| | |
|---|---|
| Oil capacity per engine | 13 qts |

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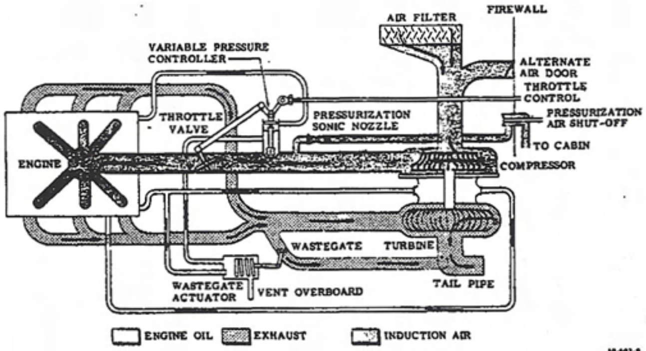
## PROPULSION SYSTEM

### ENGINES

The BEECHCRAFT Duke is equipped with Lycoming TIO-541-E1A4 and/or TIO-541-E1C4 engines. They are rated at 380 horsepower at 2900 rpm and 41.5 in. Hg , and are turbocharged for high performance at altitudes to 30,000 feet. The engines drive three-bladed, 74 in. diameter, constant speed, full feathering, hydraulically controlled propellers.

### TURBOCHARGER

The turbocharger consists of two separate components; a compressor and a turbine connected by a common shaft.




The compressor supplies pressurized air to the engines for high altitude operation, and to the cabin for pressurization. The compressor and its housing are located between the ambient air intake and the induction air manifold. The turbine and its housing are part of the exhaust system and utilize the flow of exhaust gases to drive the compressor.

### *WASTE GATE AND EXHAUST BYPASS*

The waste gate actuator, operated by engine oil pressure, activates a waste gate valve located in the exhaust bypass. Oil pressure closes the waste gate and all the exhaust gas is routed into the turbine side of the turbocharger, giving maximum compression to induction air. When the actuator opens the waste gate a minimum of exhaust gas drives the turbocharger. The balance of the exhaust is dumped directly overboard. Thus, the waste gate position regulates the supercharger air available to the engine.

The following steps illustrate the operation of the system:

1. Induction air is taken in through the air filter and ducted to the compressor.
2. The induction air is then compressed and ducted to the engine.
3. A portion of the compressed air is bled off for cabin pressurization.
4. As the waste gate opens, some of the exhaust gases are routed around the turbine, through the exhaust bypass and overboard.
5. When the waste gate is closed, all of the exhaust gases pass through and drive the turbine, which, in turn, drives the compressor.
6. The exhaust gases are dumped overboard.

### *VARIABLE ABSOLUTE PRESSURE CONTROLLER*

The control center of the turbocharger system is the variable absolute pressure controller. This device simplifies turbocharging to one control - the throttle. Once the pilot has set the desired manifold pressure, virtually no throttle adjustment is required with changes in altitude. The controller senses manifold pressure requirements for various altitudes and regulates the oil pressure to adjust the waste gate. Thus, the turbocharger maintains only the manifold pressure called for by the throttle setting (except for operation above the "critical altitude" or that altitude where the waste gate reaches the fully closed position. For example, at 2900 rpm, the critical altitude is that altitude above which 41.5 in. Hg manifold pressure cannot be obtained at full throttle.

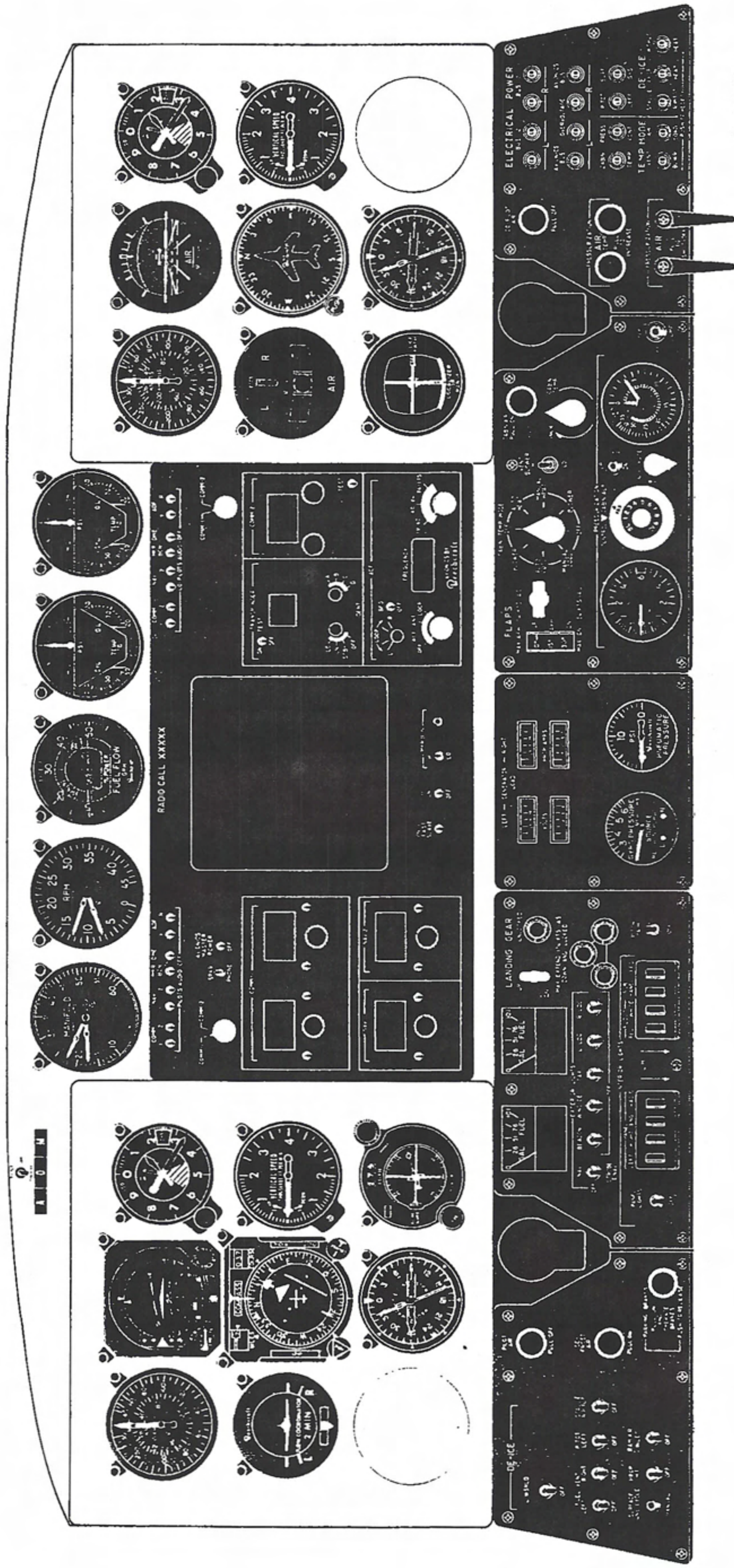
### *OPERATIONAL CHARACTERISTICS*

Aside from the absence of manifold pressure variation with altitude, there is little difference between the turbocharged and the unturbocharged engine when operated below the critical altitude.

Above critical altitude, certain operational characteristics must be understood to fully realize the advantages and capabilities of this turbocharger engine combination. These are as follows:

### *RPM EFFECT ON MANIFOLD PRESSURE*

Above the critical altitude, any change in rpm will result in a change in manifold pressure. A decrease in rpm will produce an increase in manifold pressure.



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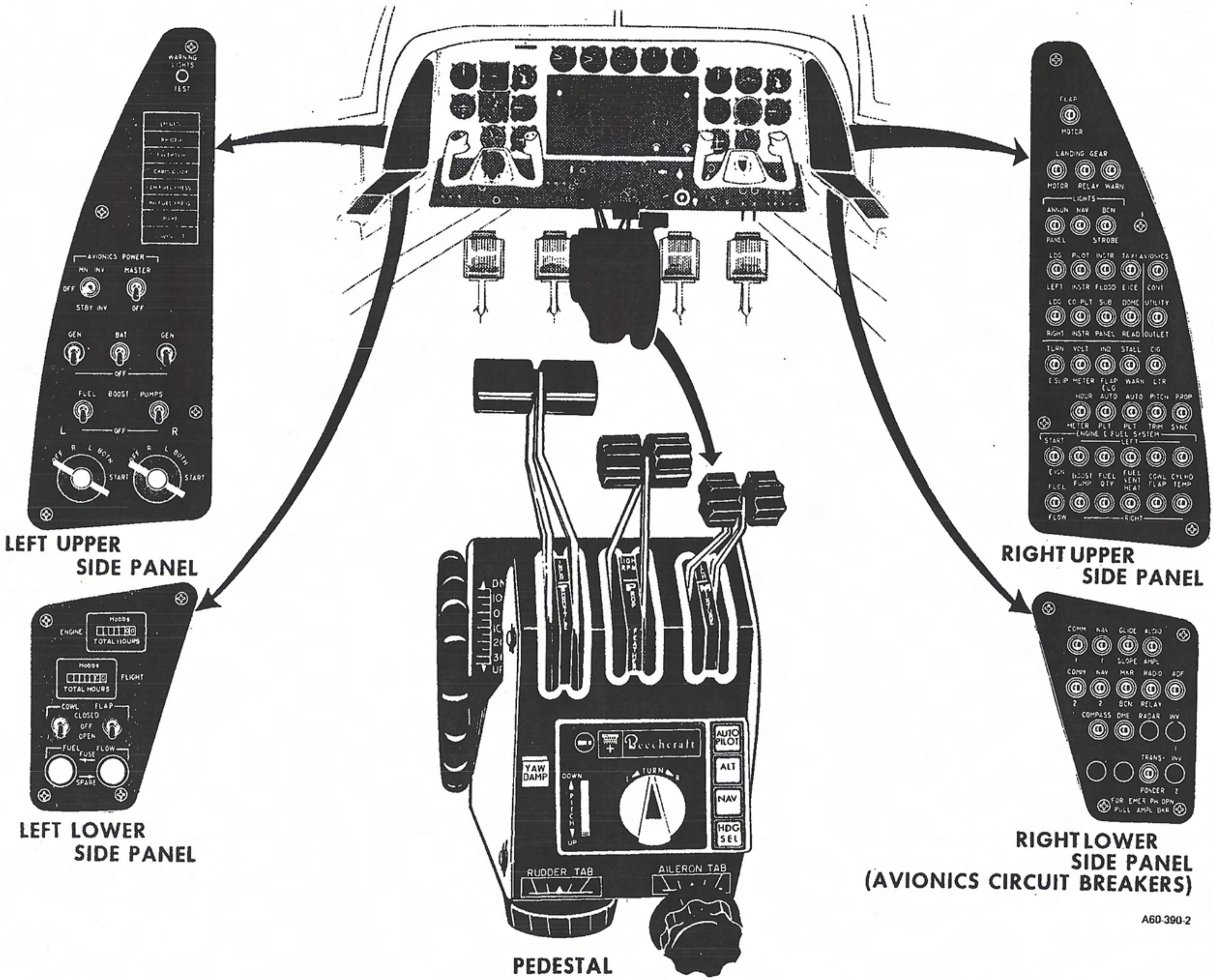
TYPICAL INSTRUMENT PANEL


WARNING LIGHTS
TEST
AVIONICS POWER
MN INV
MASTER
OFF
STBY INV
OFF
GEN
BAT
GEN
OFF
FUEL BOOST PUMPS
L
OFF
R
START
START
LEFT UPPER
SIDE PANEL
ENGINE
TOTAL HOURS
FLIGHT
TOTAL HOURS
COWL FLAP
CLOSED
OFF
OPEN
FUEL FLOW
FUSE
SPARE
LEFT LOWER
SIDE PANEL
FLAP
MOTOR
LANDING GEAR
MOTOR RELAY WARN
LIGHTS
RIGHT UPPER
SIDE PANEL
COMM NAV GLIDE ALSO
SLOPE AMPL
COMM NAV MKR RADIO ADF
BCN RELAY
COMPASS DME RADAR INV
TRANS- INV
PONDER
RIGHT LOWER
SIDE PANEL
(AVIONICS CIRCUIT BREAKERS)
A60-390-2
YAW DAMP
Beechcraft
AUTO PILOT
ALT
NAV
HDG SEL
DOWN
PITCH
UP
TURN
RUDDER TAB
AILERON TAB
PEDESTAL

## *FUEL FLOW EFFECT ON MANIFOLD PRESSURE*

Above the critical altitude, with rpm and manifold pressure established for cruise, leaning will cause a slight increase in manifold pressure. When the mixture reaches the recommended fuel flow, a slight reduction in manifold pressure may be necessary.

## *AIRSPEED EFFECT ON MANIFOLD PRESSURE*

Above the critical altitude, an increase in airspeed will result in a corresponding increase in manifold pressure. This is true because the increase in ram air pressure from an increase in airspeed is magnified by the compressor resulting in an increase in manifold pressure. The increase in manifold pressure creates a higher mass flow through the engine, causing higher turbine speeds and thus increasing manifold pressure. This characteristic may be used to best advantage by allowing the aircraft to accelerate to cruise speed after leveling off and prior to reducing power.

## *ENGINE RESPONSE AT HIGH ALTITUDE*

Large, sudden power reductions at altitude with rich mixtures can cause loss of engine power. These power reductions or increases should be made slowly with necessary mixture adjustments in a series of two or three steps.

*CAUTION*

The engine manufacturer limits the manifold pressure to 41.5 in. Hg. To avoid exceeding this limitation, the last 1-1/2 inches of throttle travel should be applied slowly while monitoring manifold pressure. In cold weather a momentary manifold pressure overshoot of up to 2 in. Hg will have no detrimental effect on the engine.

## POWER PLANT CONTROLS

## *THROTTLE, PROPELLER AND MIXTURE*

The throttle, propeller and mixture control levers are arranged in a conventional manner along the top of the pedestal. Throttle levers are on the left, propeller levers in the center, and mixture levers on the right. An adjustable friction wheel on the upper right side of the console may be turned clockwise to increase friction of the levers to prevent creeping.

## *INDUCTION AIR*

Induction air is available from two sources, filtered ram air or automatic alternate air. Filtered ram air enters from a flush inlet air scoop on the right side of each cowl. Should the filter become obstructed, a spring-loaded door on the firewall will open automatically and the induction system will operate on alternate air taken from a louvered opening on the right side of the nacelle. Above critical altitude, on alternate air, a drop of approximately 8 to 10 in. Hg of manifold pressure will be noted. Below critical altitude, no change of manifold pressure will be indicated. If the manifold pressure drops, it may be regained by advancing the throttles. The mixture should be readjusted after resetting the power.

## *COWL FLAP*

The cowl flap of each engine is controlled by separate switches on the lower left side panel. Each switch has three positions, placarded: CLOSED - OFF - OPEN. The switch allows the cowl flap to be stopped in any position so that the cylinder head temperature can be regulated.

## CONTROL LOCK

If it is necessary to park the airplane outside for extended periods, install the control locks and tie down the airplane. Installing control locks may be done as follows:

1. Insert the spring end of the rudder control locking pin into the hole at the top of the pilot's left rudder pedal arm.
2. Neutralize the pedals with the locking pin spring compressed and insert the opposite end of the locking pin into the right pedal arm. The rudder pedals locking pin is placarded RUDDER PEDALS LOCKED.
3. Position the throttle control lock, placarded THROTTLE CONTROLS STOP, forward of the throttle levers in the closed position and secure it to the console with the Dzus fastener.
4. The aileron control locking device, placarded AILERON AND ELEVATOR CONTROLS LOCKED, is installed by inserting the pin through a hole in a flange protruding from the subpanel, and through a matching hole in the lower side of the control column tube.

To lessen the possibility of taxi or take-off with the control locks installed, remove the locking components in the following order: rudder, aileron/elevator and throttle.

## ENGINE INSTRUMENTATION

Most of the engine instruments are located in the upper center of the instrument panel above the avionics controls. The standard grouping is the dual manifold pressure, dual tachometer, a dual fuel flow indicator, and a left and right multiple readout indicator for oil pressure, oil temperature, and cylinder head temperature. The left and right loadmeter with the volt meter and propeller ammeter directly below are located in the center subpanel. The fuel quantity indicators are located on the pilot's subpanel and the turbine inlet temperature, TIT, indicator is located on the right floating panel.

## ENGINE LUBRICATION

The engines are equipped with a wet sump, pressure type oil system. Each engine sump has a capacity of 13 quarts. The oil system may be checked through access doors in the engine cowling. A calibrated dip stick attached to the filler cap indicates the oil level. Due to the canted position of the engines, the dip sticks are calibrated for either right or left engines and are not interchangeable.

The oil grades listed in the Approved Oil are general recommendations only, and will vary with individual circumstances. The determining factor for choosing the correct grade of oil is the oil inlet temperature observed during flight; however, inlet temperatures consistently near the maximum allowable indicate a heavier oil is needed. Lycoming recommends use of the lighest weight oil that will give adequate cooling.

NOTE

The turbocharged engines are to be operated with ashless dispersant oil conforming to MIL-L-22851 or a Lycoming approved synthetic oil.

## PROPELLERS

The engines are equipped with 74 inch Hartzell, three-blade, full feathering, constant speed, air dome propellers. Centrifugal force from the propeller counterweights, assisted by air pressure in the propeller dome, moves the blades to high pitch. Engine oil under governor-boosted pressure moves the blades to low pitch. Propeller dome air pressure settings are listed in the Servicing Section.

The propellers should be cycled occasionally during high altitude flight and during cold weather operation. This will help maintain warm oil in the propeller hubs so that the oil will not congeal.

### *PROPELLER SYNCHRONIZER*

The propeller synchronizer automatically matches the left "slave" propeller rpm to that of the right "master" propeller. To prevent the left propeller from losing excessive rpm if the right propeller is feathered while the synchronizer is on, the synchronizer operation is limited to approximately ± 30 rpm from the manual governor setting. Normal governor operation is unchanged but the synchronizer will continuously monitor propeller rpm and reset the governor as required.

A magnetic pickup mounted in each propeller governor transmits electric pulses to a transistorized control box installed behind the pedestal. The control box converts any pulse rate differences into correction commands, which are transmitted to a stepping type actuator motor mounted on the left engine compressor mounting bracket. The motor then trims the left propeller governor through a flexible shaft and trimmer assembly to exactly match the right propeller rpm. The trimmer, installed between the governor control arm and the control cable, screws in or out to adjust the governor while leaving the control lever setting constant.

A toggle switch installed on the pedestal turns the system on. With the switch off, the actuator automatically runs to the center of its range of travel before stopping to assure that when next turned on, the control will function normally.

To operate the system, synchronize the propellers in the normal manner and turn the synchronizer on. The left propeller rpm will automatically be adjusted to correspond with the right. To change rpm, adjust both propeller controls at the same time. This will keep the left governor setting within the limiting range of the right propeller. If the synchronizer is on but is unable to adjust the left propeller rpm to match the right, the actuator has reached the end of its travel. Turn the synchronizer switch off (allowing the actuator to run to the center of its range and the left propeller to be governed by the propeller lever), synchronize the propellers manually, and turn the synchronizer switch on.

### *PROPELLER SYNCHROSCOPE*

A propeller synchroscope, located in the tachometer case, operates to give an indication of synchronization of propellers. If the right propeller is operating at a higher rpm than the left, the face of the synchroscope, a black and white cross pattern, spins in a clockwise rotation. Left or counterclockwise, rotation indicates a higher rpm of the left propeller. This instrument aids the pilot in obtaining complete manual synchronization of the propellers.

## ENGINE ICE PROTECTION

Engine ice protection consist of electrothermal fuel vent heaters controlled by a switch on the left side panel, and an automatic alternate air inducation system.

The possibility of induction system icing is reduced by the non-icing characteristics of fuel injection engines and the Duke's automatic alternate air source. The only possible ice accumulation is impact ice at the ram air scoop and filter.

Should the ram air scoop of filter become clogged with ice, a spring-loaded door on the firewall will open automatically, and the induction system will operate on alternate air. When operating on alternate air above the critical altitude, approximately 8 to 10 inches of manifold pressure will be lost.

## ANNUNCIATOR SYSTEM

The annunciator warning lights system consists of several single channel circuits which are divided into fault warning and indicating channels. When a fault warning signal is sent to an annunciator circuit, it is used to illuminate its respective readout in the annunciator panel, located in the upper left side panel. Illumination of an annunciator light indicates a fault in its respective system. A dimming circuit for the annunciator lights is connected to the navigation light switch. Should an annunciator light illuminate with the NAV light switch in the ON position, the diming circuit prevents a distracting glare. All warning lights in the annunciator panel can be tested for illumination by pressing the WARNING LIGHTS TEST switch on the annunciator panel above the warning lights.

## FUEL SYSTEM

The fuel system is a simple ON-OFF-CROSSFEED arrangement.

### *FUEL CELLS*

The fuel system installation consists of an inboard main fuel cell and an outboard cell in the leading edge, a nacelle tank, and a wing panel fuel cell in each wing. All of the fuel cells in each wing are interconnected in order to make all of the usable fuel in each wing available to its engine when the fuel selector valve is turned ON. The interconnecting fuel cells are serviced through a single filler on each wing.

### *FUEL QUANTITY INDICATORS*

Fuel quantity is measured by float type transmitter units which transmit the common level indication to a single indicator for each respective wing.

### *FUEL FLOW INDICATOR*

The dual fuel flow indicator on the instrument panel is calibrated in pounds per hour, the green arc indicating fuel flow for normal operating limits.

In the cruise power range the green sectors cover power settings of 55%, 65%, 75% and take-off. The lower edge of each sector is the cruise-lean setting and the upper edge is the best-power setting for that particular power range.

### *FUEL CROSSFEED*

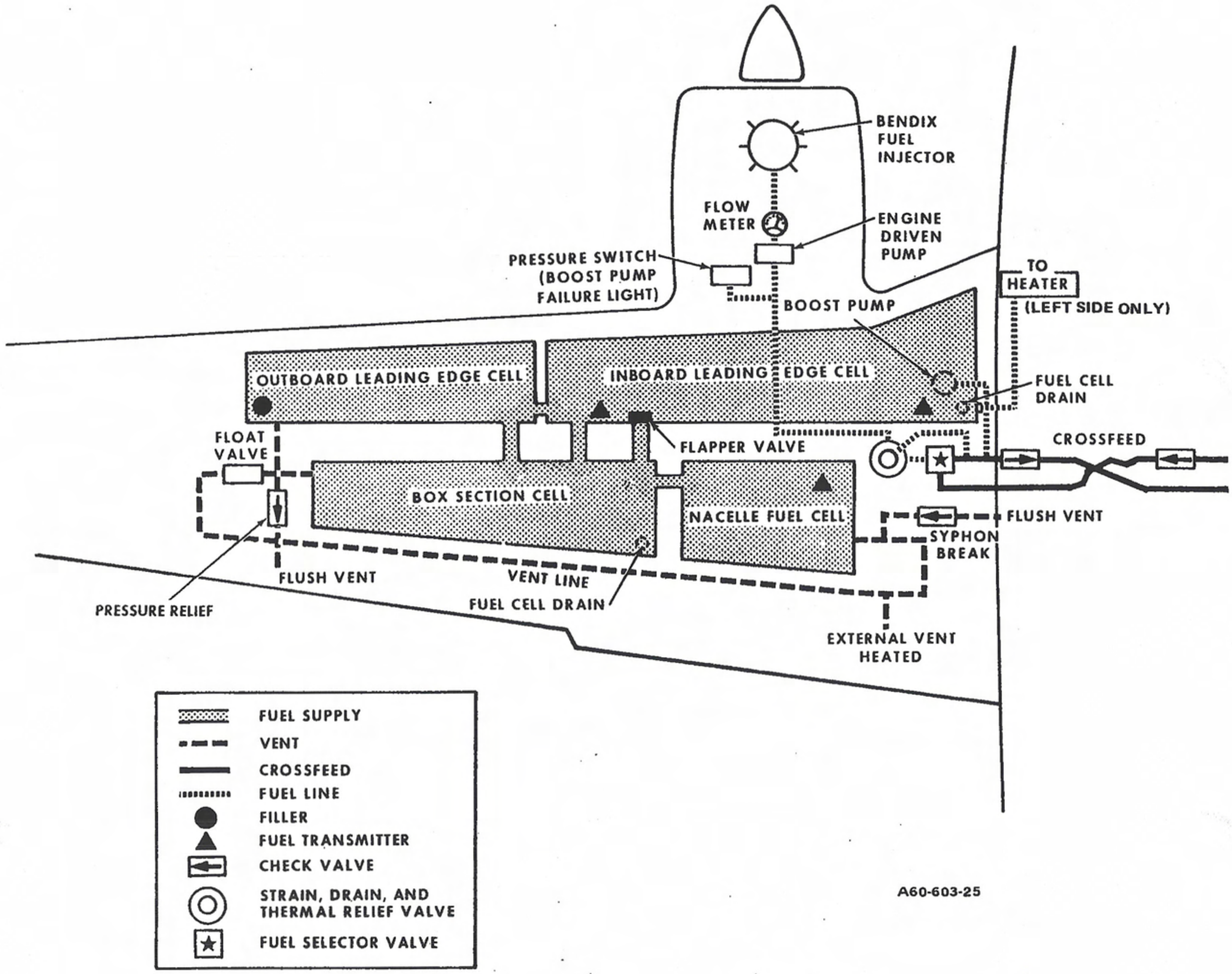
The separate identical fuel supplies for each engine are interconnected by crossfeed lines. During normal operation, each engine uses its own fuel pumps to draw fuel from its respective fuel tank arrangement. However, on crossfeed operations, the entire usable fuel supply of both wings can be consumed by either engine. The procedure for using the crossfeed system is described in the Normal Procedures Section.

The fuel crossfeed system cannot be employed to transfer fuel from one wing to another during flight.

## ANNUNCIATOR PANEL

| *NOMENCLATURE* | *COLOR* | *PROBABLE CAUSE FOR ILLUMINATION* |
|---|---|---|
| L.H. GEN | RED | Left generator failure |
| R.H. GEN | RED | Right generator failure |
| INVERTER | RED | Loss of Avionics AC Power |
| CABIN DOOR | RED | Cabin door not fully secure |
| L.H. FUEL PRESS | RED | Left Fuel Boost Pump failure |
| R.H. FUEL PRESS | RED | Right Fuel Boost Pump failure |
| SPARE | RED | |
| CABIN ALT | YELLOW | Cabin is above 10,000 ft. |

# FUEL SYSTEM SCHEMATIC



## *FUEL BOOST PUMPS*

Submerged, tank-mounted fuel boost pumps are provided for each engine and are located in the inboard leading edge tanks. They are controlled by separate ON-OFF toggle switches located on the pilot's subpanel and should be used for starting, take-off, landing, and any other time fuel-flow fluctuations are noted. The fuel boost pumps provide for near maximum engine performance should the engine-driven pump fail. Fuel boost pump failure is indicated by illumination of a FUEL PRESS light on the panel.

## *FUEL MANAGEMENT*

The fuel selector panel, located between the front seats, contains the fuel selector valve for each engine and a schematic diagram of fuel flow. During normal operation, fuel is consumed from the tanks as indicated by the fuel selector valves. Fuel may be used as desired during flight.

## *FUEL REQUIRED FOR FLIGHT*

Flight planning and fuel loading is facilitated by the use of fuel quantity indicators that have been coordinated with the fuel supply. It is the pilot's responsibility to ascertain that the fuel quantity indicators are functioning and maintaining a reasonable degree of accuracy, and be certain of ample fuel for a flight. Take-off is prohibited if the fuel quantity indicators do not indicate above the yellow arc. An inaccurate gage could give an erroneous indication of fuel quantity, therefore, a minimum of 25 gallons of fuel is required in each wing system before take-off. If you as the pilot are not sure that at least twenty-five gallons are in each tank, add necessary fuel so that the amount of fuel will not be less than twenty-five gallons per tank at take-off. Plan for an ample margin of fuel for any flight.

# ELECTRICAL SYSTEM

The direct current, 28-volt, electrical power circuit is energized by a 13 ampere-hour nickel-cadmium battery mounted in the top center of the left nacelle. The aircraft is equipped with two 125 ampere generators mounted on the lower left side of the engine and are belt driven. An air duct from the upper portion of the nacelle directs a supply of ram air to the generator for cooling. If a generator failure indication appears on the annunciator panel, turn the affected generator switch OFF then ON. If the condition persists turn the affected generator off and reduce electrical power consumption as necessary.

## *A.C. POWER*

Since the major portion of the airplane instrumentation functions on DC power, the AC power requirements are confined to only the fuel flow indicator, windshield heat, and some avionics. The inverter for the fuel flow indicator is a small unit designed to supply power only to this instrument. An inverter is installed for the operation of the left windshield heat and is activated by a switch on the pilot's subpanel marked L. WSHLD - OFF. This inverter is also used as a standby for the avionics inverter.

Avioncis power is obtained by two switches mounted on the upper switch panel. One is marked MASTER - OFF and activates power to the avionics equipment. For that equipment requiring AC, current, a three position switch marked MN INV - OFF - STBY INV must be placed in the MN INV position. Should a failure occur in the main inverter, the switch can be placed in the STBY INV position. This opens a relay to direct the current from the windshield heat inverter to the avionics provided the L. WSHLD switch is on. Because the STBY INV switch position is designed only to direct the current flow, no power can be supplied to the avionics with the L. WSHLD switch in the OFF position. Power for the operation of both systems cannot be supplied by this inverter at the same time.

*CAUTION*

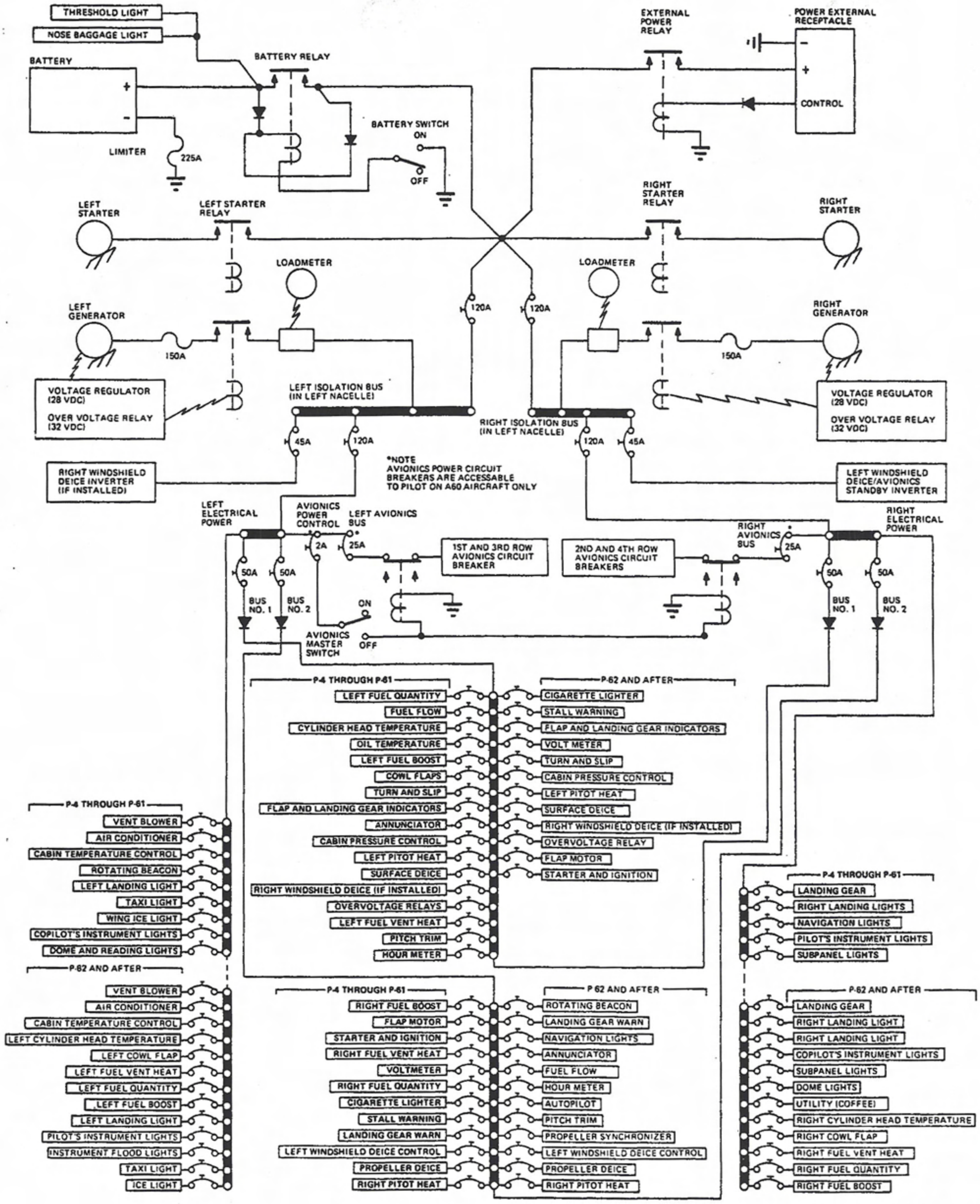
Ground use of windshield heat is limited to 10 minutes.

## *LOADMETERS*

Two loadmeters on the subpanel above the console indicate the bus loads of their respective generators. A full needle deflection on a reading of 1.0 on the instrument is an indication of 100% normal amperage output of the generator. A voltmeter, located just below the loadmeters, is provided to monitor voltage increase or decrease from a common bus.

## *AUDIO AMPLIFIER*

In the event of a malfunction in the audio amplifier system, audio capabilities may be restored by pulling the audio amplifier circuit breaker located on the lower right side panel. All avionics audio is then simultaneously feed to the headphones. Each avionic unit must be adjusted separately for the desired audio volume level.

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## TYPICAL POWER DISTRIBUTION SCHEMATIC

## *EXTERNAL POWER*

The external power receptacle is located in the outboard side of the left nacelle and accepts a standard AN type plug. The power unit should be capable of delivering at least 300 amperes for starting. Before connecting an external power unit, turn the electrical systems and avionics off to avoid damage due to electrical surges. If the unit does not have a standard AN type plug, check the polarity (negative ground) and connect the positive lead from the external power unit to the center and aft posts of the aircraft receptacle. The negative lead connects to the front post. When external power is connected, the battery switch should be turned on.

NOTE

If polarity is reversed, the reverse polarity protection relay will not close, thus preventing current from flowing.

# AIRFRAME

## CABIN APPOINTMENTS

### *SEATING*

To adjust the seats forward or aft, pull up the release bar below the left corner of the seat and slide the seat to the desired position. The seat backs of the copilot's seat and the third and fourth seats may be moved from the vertical to the reclined position by actuating a release lever on the inboard side of the seat. The back of the pilot's seat and the optional 5th and 6th seats may be placed in four positions by using the same release lever.

For more cabin area, the 5th and 6th seats may be stored by folding the backs forward and sliding the seats aft on the tracks until they are against the aft bulkhead. Ashtrays and cigarette lighters are located in the outboard armrest consoles that are built into both cabin sidewalls.

### *CABIN DOOR*

The Duke is equipped with a fail safe cabin door latching mechanism. When the door latch bolts are in position, a spring-loaded secondary locking device maintains a safety locked condition. In addition, a pressure lock prevents inadvertent movement of either the secondary system or the door handle itself when pressurized. When the door is closed, the outside cabin door handle is spring loaded to fit into a recess in the door to create a flat, aerodynamically clean surface. The door may be locked with a key.

To open the door from the outside, press inward on the forward end of the handle to raise the aft end enough to grasp it. On serials P-123, P-127 and after push the safety release button and lift the handle from its recess and turn it counterclockwise until the door opens. The door will swing out and forward over the center wing section. The door may be closed from the outside by rotating the handle clockwise. The three door latching bolts activate three switches mounted on the bulkhead behind the fuselage door frame. A fourth switch mounted on the door (serials P-4 through P-122 and P-124 through P-126) is activated by the door handle latch mechanism. A cabin door warning light on the annunciator panel illuminates when the cabin door is not secure. All door switches must be activated to turn off the annunciator light.

To close the door from the inside, pull the door shut firmly with the handle in the forward position. Rotate the door handle aft in a counterclockwise manner until the safety lock bolt handle moves aft or the safety lock button pops outward. When the door handle has been rotated completely aft, (serials P-4 through P-126 except P-123) the safety lock bolt handle will snap forward to its original position.

At this point, the door is securely locked and cannot be open except by moving the safety lock bolt full aft; or on serials P-123, P-127 and after, pressing the safety lock button in. If there is residual pressure remaining in the cabin, the red "T" handle, located forward of the cabin door handle, must be pulled to override the pressure locking mechanism before the safety lock bolt or safety lock button will move. Once the safety lock bolt has been pulled aft, or the safety lock button pressed in, the door handle may be rotated forward to open the door.

### *EMERGENCY EXIT*

The emergency exit door is a pressure sealed plug type door that opens into the cabin. It is located on the right side at the forward cabin window. The release is in a covered recess behind the window curtain. To open the door, lift the cover, release the catch and pull the handle down fully. There is no provision made for opening the door from outside the airplane.

### *CABIN SHELF RACK AND BAGGAGE AREA*

Immediately ahead of the aft cabin bulkhead on serials P-4 through P-126 except P-123, is a combination baggage area and shelf rack. If more space is needed for bulky items, the shelf rack, hinged in the middle may be folded back flat against the aft bulkhead. A webbing may be attached to two chrome lugs overhead, two on the side walls, and two on the floor, to secure the baggage during flight. The backs of both optional rear seats fold forward for accessibility to the storage area. The shelf is placarded for a maximum weight of 135 pounds. The shelf and floor combined are placarded for a total of 315 pounds.

## *NOSE BAGGAGE COMPARTMENT*

The forward baggage compartment is easily accessible through a large door on the left side of the nose. The door, hinged at the top, swings upward, clear of the loading area. This compartment affords accessibility to some of the aircraft avionics as well as storage space for the larger, heavier items, but loading within this area will fall within the limitations according to the WEIGHT AND BALANCE SECTION. The nose baggage compartment incorporates the full width of the fuselage as usable space.

## FLIGHT CONTROLS

### *CONTROLS AND SURFACES*

The Duke is equipped with conventional dual controls. Primary flight surfaces are operated through push-pull rods and conventional cable systems, terminating at bell cranks.

Control of the rudder and nose wheel steering is provided by rudder pedals. To adjust the rudder pedals, press the spring-loaded lever on the side of each pedal and move the pedal to its forward or aft position. The adjustment lever can also be used to place the right set of rudder pedals against the floor when not in use.

### *ELEVATOR TRIM TAB*

An elevator trim tab control wheel on the left side of the console, operates in the conventional manner. An indicator placarded DN and UP, is calibrated in 10° increments. Nose-down trimming of the aircraft from 0° to 10° may be effected by rotating the top of the wheel forward. Nose-up trimming, from 0° to 30°, requires the top of the wheel to be moved aft. Make necessary compensations for loading conditions before take-off.

### *RUDDER TRIM TAB*

A wheel, placarded RUDDER TAB, positioned horizontally on the lower aft side of the console, trims the aircraft with the rudder tab. Vertical reference marks to the left and right of the center mark indicate the amount of rudder tab being used. To move the nose of the aircraft to the right, move the protruding edge of the wheel to the right.

### *AILERON TRIM TAB*

To the right of the rudder trim wheel is the aileron trim tab control. It is a vertically mounted knob that may be turned clockwise to lower the right wing and counterclockwise to lower the left wing. The indicator above the knob, placarded AILERON TAB, is identical to that used on the rudder tab installation.

### *ELECTRICAL ELEVATOR TRIM*

A switch on the control wheel actuates the electric elevator trim control. The switch is moved forward for nose down, aft for nose up. When released, the switch centers in the OFF position. When the system is not being electrically actuated, the manual trim control wheel may be used. An ON-OFF switch is located on the left subpanel.

### *WING FLAPS*

The wing flaps are controlled by a three-position switch located to the right of the control console on the subpanel. The flaps have three positions, 0° (full up), 15° (approach), and 30° (full down), with no intermediate positions. To move the flaps from 0° to 15°, move the switch to the middle detent position. From 15° to 30°, the switch must be pulled out of the detent and moved downward to the last position.

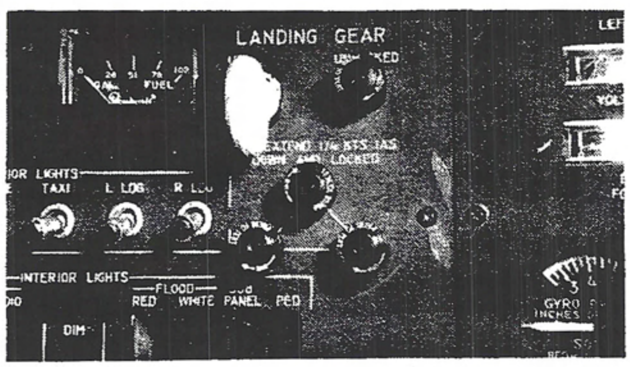
## LANDING GEAR SYSTEM

### *CONTROL SWITCH*

A two-position switch on the subpanel to the left of the console controls the landing gear. The switch is operated by moving it upward to retract and downward to extend the gear. From one position to the other, the switch handle must be lifted across a center detent.

### *POSITION INDICATORS*

Landing gear position lights are located on the subpanel adjacent to the control switch. To the right of the switch is a single red light placarded UNLOCKED. This light indicates that the gear is in transit, neither full up or full down. Below the switch are three green lights arranged in a triangle. Each light represents a landing gear, and, when illuminated, indicates that the gear is locked in the extended position. These are placarded DOWN AND LOCKED.




**Position Indicator**

### *SAFETY SWITCH*

A safety switch incorporated in the left main gear strut prevents inadvertent retraction of the landing gear. When the strut is compressed, the control circuit is open and the gear cannot retract. However, maneuvering over rough ground may allow the gear strut to extend momentarily, closing the circuit long enough to begin retraction. NEVER RELY ON THE SAFETY SWITCH TO KEEP THE GEAR DOWN DURING GROUND MANEUVERING. CHECK TO SEE THAT THE LANDING GEAR SWITCH IS DOWN.

### *WARNING HORN*

A gear-up warning horn is located behind the panel. Any time either or both throttles are retarded to approximately 12 in. Hg, the horn will sound intermittently if the landing gear is in the retracted position. During single-engine operation, the horn can be silenced by advancing the throttle of the inoperative engine until the throttle warning horn switch opens the circuit.

### *MANUAL EXTENSION*

The landing gear can be manually extended, but not retracted, by operating a handcrank on the rear of the pilot's seat. This procedure is described in FAA APPROVED EMERGENCY PROCEDURES Section.

### *BRAKES*

A toe brake is incorporated in each rudder pedal. Either set of pedals will actuate the brakes. The parking brake system, operated from the pilot's controls only, utilizes a parking brake valve to allow buildup of pressure in the landing gear cylinders. To operate, pull out the parking brake knob, placarded PARKING BRAKES, on the subpanel below the pilot's control column and pump the toe pedals. Apply pressure to the pedals then push the control in to release the brakes. This will allow the pressure in the brake system to gradually bleed back into the reservoir.

### *NOSE GEAR STEERING*

Nose gear steering allows a 15° angle of turn by movement of the rudder pedals. Friction of the nose wheel against the ground while the aircraft is standing still inhibits turning movement. Proper turning may be accomplished smoothly by allowing the aircraft to roll while depressing the appropriate rudder. Sharper turns require light brake pedal on the depressed rudder.

### *LANDING GEAR SAFETY SYSTEM*

The landing gear safety system is designed to prevent "gear-up" landings and premature or inadvertent operation of the landing gear mechanism. The system is to be used as a safety backup device only; normal usage of the landing gear position switch is mandatory.

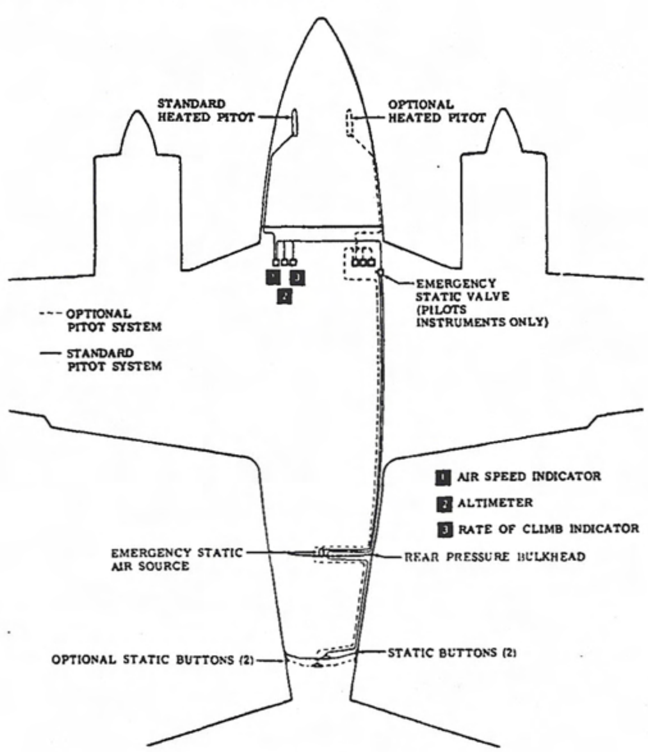
With the landing gear safety system ON-OFF-TEST switch in the ON position, the landing gear will be automatically extended when: (1) the airspeed is below approximately 120 mph/104 kts and (2) both engines are operating at a throttle position corresponding to approximately 17 inches or less of manifold pressure.

With the landing gear safety system ON-OFF-TEST switch in the ON position, the landing gear will not retract unless: (1) the landing gear position switch is in the UP position (2) the airspeed is above approximately 70 mph/61 kts and (3) one engine is operating at a throttle position corresponding to approximately 19 inches or more of manifold pressure.

NOTE

> If landing gear retraction is desired before the indicated airspeed reaches approximately 70 mph/61 kts, the landing gear safety system must be deactivated by placing the ON-OFF-TEST switch in the OFF position, preferably before placing the landing gear position switch in the UP position.

## PITOT - STATIC SYSTEM



### *HEATED PITOT*

A standard pitot tube for the pilot's flight instruments is located immediately to the right of the nose gear doors. The optional pitot tube for the copilot's instruments is located to the left of the nose gear doors. Left and right pitot heat switches, supplying heat to the left and right pitot masts respectively, are located on the pilot's left subpanel.

### *STATIC AIR*

Static buttons mounted on the aft fuselage sides furnish static air for the flight instruments. An emergency static air valve is located in the right sidewall adjacent to the copilot's seat. Open the valve by turning it counterclockwise. Emergency static air is taken from the tail section just aft of the pressure bulkhead. Airspeed Calibrations and Altimeter Corrections are provided in the FAA PERFORMANCE Section.

### *STATIC DRAIN*

The pitot system needs no drain because of the location of the components. Static air plumbing is drained by removing the side panel, placarded STATIC AIR LINE DRAIN, on the lower right cockpit wall forward of the copilot's seat and opening the valves provided.

## FLIGHT INSTRUMENTS

The flight instruments are arranged on the floating instrument panel in a standard "T" grouping. Complete pilot and copilot flight instrumentation is standard, including one electric and one vacuum directional indicator, horizon, and turn and slip indicator. Dual navigation systems are available.

## INSTRUMENT PRESSURE SYSTEM

Pressure for the pressure-operated flight instruments is supplied by two engine-driven, dry, pressure pumps, interconnected to form a single system. If either pump fails, check valves automatically close. The remaining pump will continue to operate the gyro instruments. With both engines operating at a minimum of 2200 rpm, the pressure gage on the instrument panel should indicate between 3.5 and 5.5 in. Hg. A pressure pump failure is indicated by the protrusion of a red button on the pressure gage placarded "L" or "R", adjacent to each button indicating which pump has failed.

Aircraft with serials P-186 and after may be equipped with dual regulators installed in the instrument pressure system. A regulator is located in each pressure line ahead of the pilot's and co-pilot's instruments to facilitate a check of the pressure to either of the instrument systems. A two-position switch, placarded PILOT - COPILOT, located adjacent to the Gyro Pressure gage on the center subpanel, gives a constant reading of the pressure of the instrument system selected with the switch. An abnormal reading is an indication of probable malfunction of one regulator. Select the other regulator and check the system pressure. If it is normal, operate with the instrument system that is functioning from that regulator.

## STALL WARNING INDICATOR

The stall warning system consists of a stall warning horn mounted forward of instrument panel, a lift transducer on the leading edge of the left wing, a lift transducer vane heater element, a face plate heater element, a landing gear switch, a circuit breaker, and a switch located on the pilot's subpanel marked STALL & R PITOT.

When aerodynamic pressure on the lift transducer vane indicates that a stall is imminent, the transistor switch is actuated to complete the circuit to the stall warning horn. The lift transducer senses the angle of attack and is triggered by reverse air flow.

*CAUTION*

The heater element protects the lift transducer from ice, however, a buildup of ice on the wing may disrupt the airflow and prevent the system from accurately indicating an incipient stall.

## LIGHTING

### *INTERIOR LIGHTING*

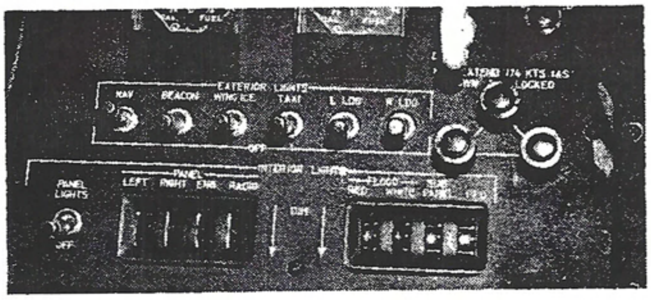
The cockpit dome light is operated by a push button switch, adjacent to the light. The switches for the individual reading lights above the rear seats are located adjacent to the lights. All other interior lights are controlled from the interior light switch group on the pilot's right subpanel. A master PANEL LIGHTS switch activates the group and the individual lights are regulated by thumb wheel switches.

A courtesy light to the left of the cabin door illuminates the doorway and will be turned off by closing the door. If the door is to remain open for extended periods, the light may be turned off with a pushbutton switch inside the cabin just forward of the light.

A baggage compartment light and light switch are located just inside at the top of the nose compartment door for illumination of baggage and avionics space. The courtesy light and the baggage compartment light receive power directly from the battery.

## *EXTERIOR LIGHTING*

The switches for the navigation lights, landing lights and rotating beacon, which are standard equipment, plus the switches for the nose taxi light and wing ice lights, are



**Light Switches**

grouped on the left subpanel. The landing lights in the leading edge of each wing tip are operated by separate switches. For longer battery and lamp service life, use the landing lights only when necessary. Avoid prolonged operation during ground maneuvering to prevent overheating.

## ENVIRONMENTAL SYSTEM

An environmental control section on the right subpanel provides for automatic or manual control of the system. This section, just to the right of the flap control lever contains all the major controls of the environmental function; the mode selector switch for selecting manual or automatic heating or cooling, a vent blower control switch, and a cabin temperature level control. Directly below these controls are the pressurization controls. To the right of the copilot's control column, are the pressurization Air Temp controls and pressurization Air Shut-Off controls.

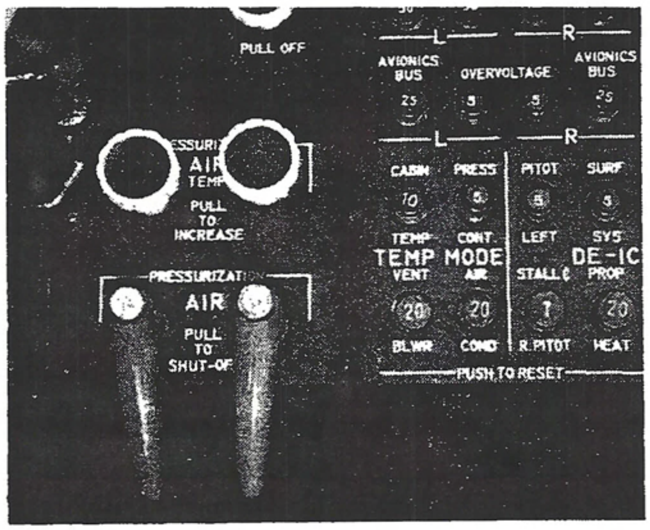
## *PRESSURIZATION*

### DESCRIPTION

Pressurized air for the cabin is taken from the turbocharger compressor of each engine and reduced to a usable flow by a restrictor in the line called a sonic nozzle. The air then passes through a firewall shutoff valve, through an intercooler and into the cabin beneath the pilot and copilot floorboards. The intercooler reduces the heat acquired by the air during pressurization with a flow of ram air from a scoop at the leading edge of each wing root. After entering the pressure vessel, the air is drawn into the conditioning plenums where it is either heated or cooled, according to the selected mode, and distributed evenly throughout the cabin. Located on the aft cabin bulkhead are two valves; the isobaric control valve and the safety/dump valve. The pressurization controller on the right subpanel pneumatically regulates the isobaric control valve to maintain the selected cabin altitude. The safety/dump valve is connected to the pressure dump switch, and to the landing gear safety switch. If either of these switches is closed, the safety/dump valve will open to atmosphere and the cabin will depressurize.

### CONTROLS

The pressurization system components consists of a cabin climb indicator, the cabin altitude controller, a PRESS-TO-TEST switch, a PRESSURE-DUMP switch and the cabin differential pressure gage. Pressurization from the

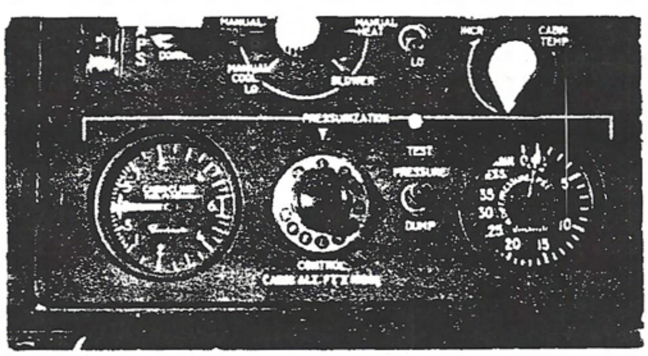



**Pressurization Controls**

engines may be shut off by pulling the pressurization air controls (red "L" - shaped handles) located outboard of the copilot's control wheel and is placarded PRESSURIZATION AIR - PULL TO SHUT OFF. This closes the firewall shutoff valve and dumps the pressurized air into the engine compartment.

### CABIN ALTITUDE CONTROLLER (MANUAL)

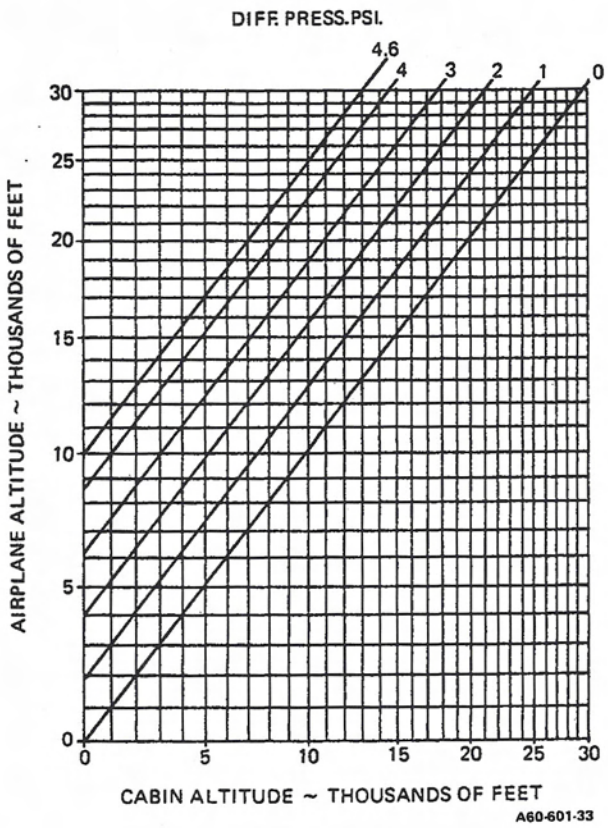
The cabin altitude controller is located on the right subpanel between the cabin climb indicator and the cabin differential pressure gage. The cabin altitude is maintained with the control anywhere from zero pressure to the maximum differential pressure of 4.6 psi.



Altitude Selector

The controller is rotated until the desired cabin altitude for flight is at the 12 o'clock position under the index mark. Any selected cabin altitude will be maintained during the flight provided the cabin pressure is at or below the maximum differential pressure. If the cabin reaches the maximum differential of 4.6 psi and the aircraft is still climbing, the cabin altitude will climb with the aircraft.

The following graph is provided to allow the pilot to determine the relationship between cruise altitude, cabin altitude and differential pressure. The zero differential pressure line indicates that the cruise altitude and the cabin altitude are identical (unpressurized). The 4.6 psi line indicates the maximum differential pressure obtainable in the cabin. To determine the lowest cabin altitude which can be maintained for a given cruise altitude: enter the graph at the desired cruise altitude and read right to the 4.6 psi differential pressure line. Then read down the graph to the altitude which can be maintained in the cabin.




If a cabin altitude change is required in flight it can be accomplished with a minimum of abrupt cabin pressure change by turning the selector dial very slowly and monitoring the rate of change on the cabin pressure indicator. A time lapse of approximately two minutes for each thousand-foot increment change on the dial will effect a comfortable change of pressure. Rapid cabin pressure changes will be experienced if the altitude selector is moved quickly before reaching the maximum differential pressure of 4.6 psi.

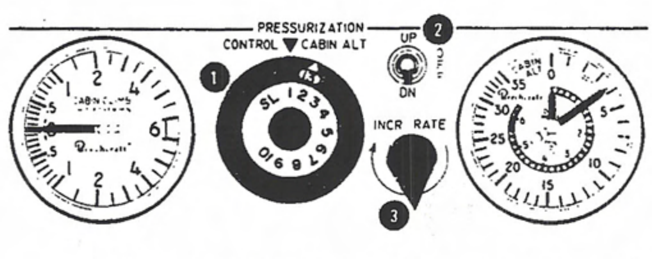
## CABIN ALTITUDE CONTROLLER (MOTORIZED)

The motorized controller is similar to the standard controller except in the method of changing cabin altitude up or down. The unit is best described as an adjustable isobaric controller incorporating a variable speed drive motor with automatic shut off. The additional controls for the unit are the Red Altitude Selector Ring, the Motor Rate Rheostat and the Directional Toggle Switch. The inner cabin altitude selector is normally operated with the directional toggle switch. The control can be moved to override the motor drive but under normal operation all movement should be made with the toggle switch. The inner scale shows the cabin altitude when read at the index mark (12 o'clock position). The outer scale under the window shows the selected aircraft altitude. The inner scale adjacent to the window shows what the cabin altitude will be when maximum differential pressure (4.6 psi) is reached.

To ready the unit for operation, place the rate rheostat knob in the midrange and insure that the directional toggle switch is in the off position. Manually set the cabin altitude controller (inner scale) to approximately 1000 feet above the take-off field elevation. (The red altitude selector ring will turn with the inner scale when this adjustment is made). Now set the window on the red altitude selector ring to 1000 feet above the planned aircraft cruise altitude. This will avoid reaching maximum differential pressure in the cabin prior to achieving cruise altitude.

After take-off and during the climb when the cabin rate of climb has returned to zero, move the directional toggle switch to the up position. This gradually climbs the cabin to the altitude which is opposite the altitude in the window on the red selector ring. The controller should be driven at a rate to arrive at the cabin altitude shortly before the aircraft arrives at the cruise altitude. This can be accomplished by increasing or decreasing the rate rheostat knob. A few seconds lag time must be allowed for the pressurization controls to respond and stabilize before

1. Red Altitude Selector Ring
2. Directional Toggle Switch.
3. Drive Motor Rate Rheostat.




**Motorized Cabin Altitude Controller**

reading the cabin altitude rate of climb indicator. The controller will automatically turn off when the window in the red selector ring reaches the 12 O'Clock position. However, the directional switch should be placed in the OFF position.

NOTE

> In the event the Directional Toggle Switch is positioned improperly, the controller will drive to the end of the scale and damage to the slip clutch may result.

For normal descent turn the red selector ring until the window is opposite the altitude which is 1000 feet above the landing altitude. After departing the original altitude, place the directional toggle switch in the down position. In the event that a rapid descent rate is required, set the rate rheostat for an increased rate of descent so as to maintain a higher aircraft altitude than cabin altitude throughout the descent.

If the cruise altitude selected is less than 11,000 feet or corresponding cabin altitude (below the window) is less than the take-off field elevation, then the controller need not be moved. However, if the landing altitude is less than the take-off field elevation then the controller can be driven down to the selected cruise altitude.

## *AIR CONDITIONING SYSTEM*

### DESCRIPTION

A 45,000 BTU combustion heater and a 14,000 BTU, refrigerative air cooler work through a cabin temperature control system to maintain cabin comfort. The air conditioning mode is selected on the TEMP MODE selector on the right subpanel. Fresh air is taken into the system at the nose ram air vent opening for unpressurized flight, and from the pressurization air inlets beneath the cockpit floor for pressurized flight. From either source, the air is collected in a plenum ahead of the cockpit, heated or cooled according to the selected mode, and forced through ducts for distribution throughout the cabin. Air is ducted to individual overhead outlets above the seats. These outlets can be swiveled in any direction and the volume of air may be regulated by rotating the fitting.

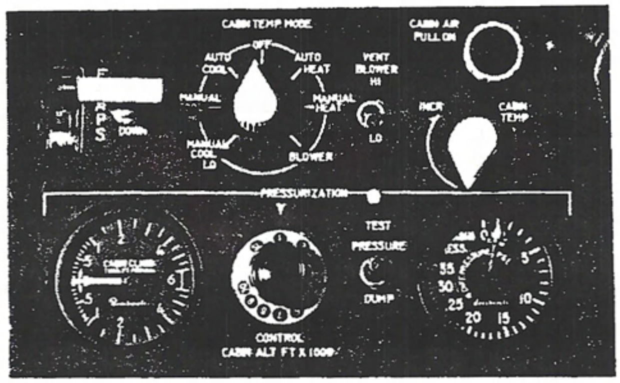
Conditioned air (or ventilation air) is ducted into an armrest console along each wall of the cabin. Small holes in the console direct the air out into the cabin.

Other air outlets are: defroster outlets above the glare shield, individual pilot and copilot air outlets, and on the Duke 60 only a vent air distribution bypass outlet that dumps directly from the plenum into the forward portion of the cockpit for accelerated cooling on the ground.

Exchanging the cabin air is accomplished by exhausting a controlled amount of air through the isobaric control valve on the aft pressure bulkhead.

### VENT BLOWER

Velocity of the air from the cabin air outlets may be controlled by the VENT BLOWER switch, located on the right subpanel. Either the HI or LO position may be selected.




**Vent Control**

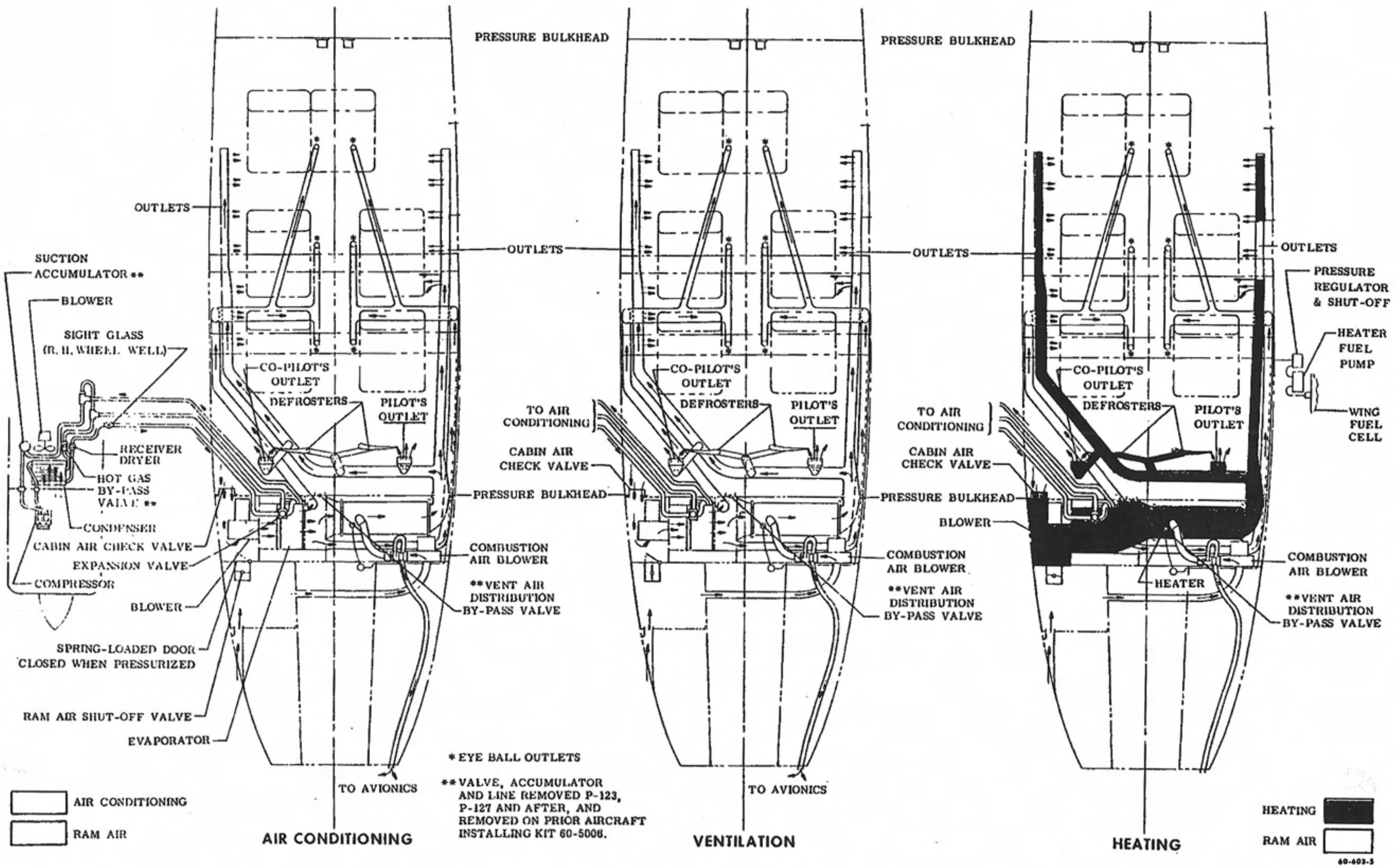
## *HEATING MODE*

### PRESSURIZED OPERATION

Heating may be accomplished in either the manual or automatic position. For manual heating, select MANUAL HEAT using the CABIN TEMP MODE selector on the right subpanel. The heater will then operate continuously. For faster heating at the pilot and copilot positions, place the vent controls (placarded PILOT AIR - PULL OFF and COPILOT AIR - PULL OFF) in the "on" position by pushing them in. For maximum windshield defrosting (in addition to the electrically heated windshield) the individual vents for the pilot and copilot may be turned off and the heater blower placed in the HI position to provide a greater flow of warm air through the defroster ducts.

Automatic heating is achieved in the same manner as manual heating except the selector is set on AUTO HEAT and the CABIN TEMP knob is adjusted for a comfortable temperature. A temperature controller located on the forward side of the pedestal between the pilot's and copilot's rudder pedals, makes possible the regulation of the cabin temperature by monitoring temperature variations at the temperature sensing units. These sensing units are located: (1) In the ram air inlet, (2) forward of the two pressure control valves on the rear pressure bulkhead, and (3) in the heater outlet duct.

# ENVIRONMENTAL SCHEMATIC



Ambient air, from the ram air inlets at the leading edges of the wing roots, normally passes over the intercoolers to cool the turbocharged air from the engines before it enters the cabin. If normal heating is insufficient, an even greater heating capacity may be attained by turning off the intercoolers. This is done by pulling out the controls on the right subpanel, placarded PRESSURIZATION AIR TEMP - PULL TO INCREASE.

### *COOLING MODE*

For the cooling mode, the Duke is equipped with a refrigerant-type cooling system. The compressor is located in the right nacelle just aft of the engine, and the evaporator just ahead of the forward pressure bulkhead adjacent to the heater unit. The air is circulated through the same ductwork as for heating. Cold air coming through the evaporator enters the duct system, goes to the armrest console outlets, to the individual overhead outlets and (on serials P-4 through P-126 except P-123) is also available through the distribution bypass valve for faster cooling of the area around the pilot and copilot seats.

When the selector is placed in the AUTO COOL position, the temperature is automatically controlled through the thermostat. The temperature sensing units monitor the cabin temperature variations, as in the heating mode. Regulate the temperature with the CABIN TEMP adjustment knob. Automatic cooling may be over-ridden by placing the selector in MANUAL COOL - HI or MANUAL COOL - LO (serials P-4 through P-126 except P-123) or MANUAL COOL (serials P-123, P-127 and after). In either of these positions the system will continue to cool regardless of the cabin temperature.

While operating in the heating mode, the intercoolers may be turned off to allow warm, pressurized air to enter the vessel, but the opposite is true for the cooling mode; the intercoolers may be turned on by pushing in the intercooler controls so the incoming air will be as cool as possible before reaching the evaporator.

For cabin ventilation, a portion of the air is automatically exhausted through the isobaric control valve on the aft pressure bulkhead, just as in the heating mode.

### *VENTILATION MODE*

With the aircraft unpressurized, open the ram air vent inlet (CABIN AIR) and move the mode selector to BLOWER. Choose HI or LO as desired on the vent blower switch. In this mode the isobaric and safety dump valves are open (with the pressurization switch in DUMP position), to exhaust the cabin air. If the ambient air is cool and no vent blower is desired, move the temperature mode selector to OFF.

## OXYGEN SYSTEM

**WARNING**

Proper safety measures must be employed while using oxygen, or a serious fire hazard will be created. NO SMOKING PERMITTED.

### *DESCRIPTION*

Oxygen masks provided with the oxygen system are of the Scott 283 continuous-flow type. They are easily adjusted to fit the average person comfortably with a minimum leakage of oxygen, and are considered adequate for continuous use up to 30,000 feet.

The oxygen cylinder is located under the nose baggage compartment or in the aft fuselage. An oxygen console on the pilot's sidewall regulates flow to the six cabin wall outlets. When use of the oxygen is discontinued, it is absolutely necessary that the system be turned off by closing the control valve on the console. An oxygen pressure gage on the console indicates the supply of oxygen available. 1850 psi is normal pressure for a full supply in the bottle. The pressure gage does not indicate whether the system is on or off.

## ICE PROTECTION

### *EQUIPMENT*

For standard ice protection equipment, the Duke has heated pitot, stall warning and fuel vents. Optional icing equipment includes: Pneumatically operated surface deice boots, and electrically heated propellers, windshield and ventilation ram air inlet scoop. In addition, an alternate static air source backs up the fuselage mounted static air source buttons.

### *SURFACE DEICE SYSTEM*

Deice boots on the wing and empennage leading edges are inflated by the two engine-driven pressure pumps. A venturi, operated from the pressure pumps, supplies vacuum for boot hold down at all times except during the inflation mode. Through an electric timer, solenoid-operated control valves cause all the boots to be inflated simultaneously. The timer is controlled by a three-position switch: SURFACE ONE CYCLE, and MANUAL with off position centered. This switch is located on the left subpanel. ONE CYCLE and MANUAL switch positions are momentary. A gage is provided to indicate system pressure. Momentary engagement of the ONE CYCLE position will cause the boots to inflate for five to eight seconds, then deflate to the vacuum hold-down condition. The MANUAL position will inflate the boots only as long as the switch is held in engagement; when the switch is released, the boots deflate. Leave the deicing system off until 1/2 to 1 inch of ice is accumulated. During inflation, the deice system pressure gage should register approximately 15 to 18 psi. Sufficient pressure for proper operation of the system is available with one engine inoperative.

When the surface deice system is operated with the cabin pressure switch in the "dump" position, cabin pressure oscillations will occur. This is caused by a momentary loss of vacuum to the outflow valve while the boots are pressurizing. This vacuum loss allows the outflow valve to close and create a small residual cabin pressure. After a small increase, this pressure is then dumped by the safety valve.

The cabin pressurization shut off controls should be pulled during this mode to divert cabin pressurizing air overboard and prevent excessive cabin pressure oscillations. Cabin ventilation may be obtained by pulling out the cabin air control. In this mode pressure oscillations will be small.

For night operation, a wing ice light is provided on the outboard side of the left nacelle. The switch, placarded WING ICE, is on the left subpanel.

### *PROPELLER ELECTROTHERMAL DEICE*

Electrothermal deice boots, cemented to the propeller blades, remove ice from the propellers. Each boot, consisting of one outboard and one inboard heating element, receives its electrical power through a deice timer. The timer directs current to the propeller boots alternately, in a 30-second cycle. The PROP HT switch is located on the left subpanei. The propeller deice ammeter (prop amp) will indicate 14 to 18 amperes with minor fluctuations about every 30 seconds during normal operation. For deviations from the normal indications, and the procedures to be followed, see the Surface Deice Supplement in the FAA FLIGHT MANUAL SUPPLEMENTS Section.

### *WINDSHIELD ANTI-ICE*

The pilot's electrically-heated windshield is controlled by a switch, placarded WSHLD HT, located on the left subpanel. Windshield heat, designed for continuous use, should be applied prior to, or upon first encountering, icing conditions. This system is also beneficial as an aid in preventing frost and fogging due to rapid descents from higher altitudes into warm, moist air.

Operation of the windshield heat will cause the standby compass to become erratic; therefore, windshield heat should be turned off for a period of 15 seconds to allow a stable reading of the standby compass.

*CAUTION*

Ground use of windshield heat is limited to 10 minutes.

### *ADDITIONAL ICE PROTECTION*

The right pitot heat element (and the left pitot heat element if installed) is turned on by moving the respective PITOT HEAT switch to the ON position. Stall warning heat is installed in conjunction with right pitot heat, and is controlled by the STALL & R. PITOT HEAT switch. Fuel vent heat is controlled by two switches, placarded FUEL VENT - LEFT - RIGHT. The ram air inlet electrothermal lip boot is activated by a separate switch, placarded RAM AIR INLET-OFF.