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1. GENERAL

The flight instruments provide the pilot and copilot with pneumatically and electrically operated indications of essential flight attitude, heading, altitude, airspeed, vertical speed and comparator monitoring. The flight instrument systems consist of the pitot-static system and temperature sensing system, the attitude reference system, the heading reference system, the instrument comparator, flight instruments and standby flight instruments.

2. PITOT-STATIC SYSTEM AND TEMPERATURE SENSING SYSTEM

The pitot-static system (see Figure 1) provides the pitot and static pressures required to operate the pneumatic flight instruments, the air data computer (ADC) and the cabin pressure indicator. The system consists of the pilot's and copilot's pitot-static tubes, left and right static ports, air data sensor A.D.S. HEATER CONT. panel, pilot's and copilot's PITOT HEAT fail annunciators, pilot's and copilot's STATIC PRESSURE SELECTOR VALVES and pilot's and copilot's STALL PROTECT valves. A temperature sensing probe located on the right side of the forward fuselage provides a total-air-temperature (TAT) input to the ADC. The pitot tubes, the static ports and the temperature probe contain anti-icing heater elements which are controlled from the A.D.S. HEATER CONT. panel.

The copilot's Mach/airspeed, altimeter and vertical speed indicators are connected directly to the pitot-static system. The corresponding instruments on the pilot's side are connected to the ADC. The controls associated with the pitot-static system are the STATIC PRESSURE SELECTOR VALVES, the STALL PROTECT valves and the A.D.S. HEATER CONT. panel.

A. Static Pressure Selector Valve

The pilot's and copilot's STATIC PRESSURE SELECTOR VALVES each have two positions - STATIC TUBE and ALTERNATE SOURCE. The STATIC TUBE position is the normal (guarded) position. In normal operation, the static ports are used only to operate the cabin pressure indicator. When the pilot's STATIC PRESSURE SELECTOR VALVE is set to the ALTERNATE SOURCE position, static port pressure is also supplied to the ADC instead of static pressure from the pitot-static tubes. When the copilot's STATIC PRESSURE SELECTOR VALVE is set to ALTERNATE SOURCE, the copilot's pneumatic flight instruments receive static pressure inputs from the static ports instead of the pitot-static tubes. The setting of the STATIC PRESSURE SELECTOR VALVE does not affect the cabin pressure indicator, which always operates on static port pressure.

B. Stall Protect Valve

The pilot's and copilot's STALL PROTECT valves each have two positions; STATIC NORMAL and CLOSED. The STATIC NORMAL is the normal (guarded) position. When a valve is in the STATIC NORMAL position, the selected static source is directed to the stall transducer. When a valve is set to the CLOSED position, the selected static source to the stall transducer is shut off.
2. PITOT-STATIC SYSTEM AND TEMPERATURE SENSING SYSTEM (CONT'D)

Pitot-Static System - Components
Figure 1
2. PITOT-STATIC SYSTEM AND TEMPERATURE SENSING SYSTEM (CONT'D)

C. ADS Heater Control Panel

The A.D.S. HEATER CONT. panel contains a PWR & METER SELECT switch, a % HTR CURRENT meter and a HTR FAIL switch/light to control and monitor the air data system anti-icing.

When the PWR & METER SELECT switch is set to any position except HTRS OFF, heater element power is provided to the left and right static ports, the left and right pitot-static tubes, the left and right angle-of-attack (AOA) vanes and the total-air-temperature (TAT) probe.

The % HTR CURRENT meter monitors the current drawn by each heater, which is selected by rotating the PWR & METER SELECT switch to the individual heater position. A heater that fails to draw sufficient current can be isolated by rotating the PWR & METER SELECT switch and monitoring the % HTR CURRENT meter. The % HTR CURRENT meter pointer in the red zone (less than 40%) indicates that the selected heater is faulty.

The HTR FAIL switch/light comes on for heater failures in the static ports, AOA vanes and/or the TAT probe. When a static port, AOA vane and/or TAT probe heater failure is identified, pressing the HTR FAIL switch/light resets the monitor and the HTR FAIL light goes out. If another heater fails, the HTR FAIL switch/light comes on again.

If a left or right pitot-static tube heater fails, the PITOT HEAT light on the associated pilot's or copilot's instrument panel comes on. While a pitot-static tube heater failure is monitored on the A.D.S HEATER CONT. panel, the failure cannot be cancelled or reset by the HTR FAIL switch/light.

D. Pitot Heat Failure Indicator

The pilot's and copilot's instrument panels each contain an amber PITOT HEAT warning light. If the heater element in the pilot's or copilot's pitot-static tube becomes defective, the associated PITOT HEAT warning light comes on. The pitot-static tube warning circuits cannot be reset. The PITOT HEAT warning lights also come on when the PWR & METER SELECT switch on the A.D.S. HEATER CONT. panel is set to HTRS OFF.
3. ATTITUDE REFERENCE SYSTEM

Primary attitude reference is provided by two, electrically-driven vertical gyros. Gyro VG-1 supplies pitch and roll attitude data to the pilot's ADI and flight director computer. VG-2 supplies pitch and roll attitude data to the copilot's ADI and flight director computer. Each vertical gyro also produces a validity signal which, if lost, causes the red ATT flag to come into view on the associated ADI.

A. Gyro Fast Erect

The pilot and copilot each have a GYRO FAST ERECT switch/light for use when a gyro is suspected of toppling or drifting. When the switch/light is pressed, and the aircraft is within 6 degrees of level flight, the gyro erects in 3 minutes (see Figure 2).

B. Flight Director Switching Panel

The flight director switching panel has a CAPT FLT DIR switch with two positions - NORM and NAV 2 (see Figure 2):

(1) NORM Position

Navigational information for the pilot's flight director is supplied from the NAV 1 receiver.

(2) NAV 2 Position

Navigational information for the pilot's flight director is supplied from the NAV 2 receiver.
3. ATTITUDE REFERENCE SYSTEM (CONT'D)

PILOT'S SWITCH/LIGHT
When pressed, erects gyro within 3 minutes, if aircraft is within 6-degree level flight.

COPilot'S SWITCH/LIGHT
When pressed, erects gyro within 3 minutes, if aircraft is within 6-degree level flight.

CAPT FLT DIR SWITCH
NORMAL - navigation information received from NAV 1.
NAV 2 - navigation information received from NAV 2.

Flight Director Switching Panel
Figure 2
4. **HEADING REFERENCE SYSTEM**

The compass system provides primary heading data to the horizontal situation indicators (HSIs), the radio magnetic indicators (RMIs), and the automatic flight control system (AFCS). The data is provided by two flux valve/directional gyro systems, corrected for the aircraft magnetic fields. The output of gyro DG–1 supplies the pilot's HSI and the copilot's RMI, and gyro DG–2 supplies the pilot's RMI and the copilot's HSI. This arrangement ensures that both pilots receive heading information, even if one gyro system is inoperative.

**A. Compass Controls Panels**

Two compass control panels are provided, one for each system. Each panel contains a mode switch and a sync switch (see Figure 3).

(1) **Mode Switch**

The mode switch has two positions – DG and SLAVED. In the SLAVED position, the flux valve determines the magnetic heading and the gyro is slaved to follow. The compass is normally operated in the SLAVED mode in non-polar regions.

In the DG position, the heading data is provided by the gyro alone. Operation in this mode applies in polar regions, where the earth's magnetic field is too concentrated for the flux valves to resolve accurate directional readings.

(2) **Sync Switch**

The sync switch is used to slew the gyro in either direction until it is synchronized with its flux valve. This is indicated by a cross-dot alignment on the HSI compass sync annunciator.
4. HEADING REFERENCE SYSTEM (CONT'D)

MODE SWITCH
Controls mode of operation of the system.
DG - Directional gyro in free mode.
SLAVED - Directional gyro controlled by flux valve.

Compass Control Panel
Figure 3
5. INSTRUMENT COMPARATOR

The INSTRUMENT COMPARATOR monitors the dual instrument system for correct pitch and roll. It also monitors the difference in localizer signals between NAV–1 and NAV–2, after capture. If a predetermined difference between the pilot and copilot systems is exceeded, the appropriate ROLL, PITCH, HDG, GS or LOC amber warning light comes on (see Figure 4).

The TEST/RESET switch/light is provided to test the comparator circuits and the warning lights. All lights should come on when the TEST/RESET switch/light is pressed. The TEST/RESET switch/light also resets any previously disabled channel.

The MNTR light monitors the unit power supply, and comes on if the output voltage drops below a predetermined level.

The WARN DISABLE switch/light is used to disable a warning light until the fault is corrected or the circuit reset.

If a power supply fault develops, the MNTR light cannot be disabled by the WARN DISABLE switch/light. The fault must be cleared before the MNTR light can be reset.
5. INSTRUMENT COMPARATOR (CONT'D)

- **PITCH LIGHT**
  Comes on when a difference exists between the dual pitch channels.

- **ROLL LIGHT**
  Comes on when a difference exists between the dual roll channels.

- **LOCALIZER LIGHT**
  Comes on when a difference exists between the two localizer signals.

- **TEST/RESET SWITCH**
  Tests the internal electronics and annunciator lights. Resets any prior disabled channel.

- **VOLTAGE MONITOR LIGHT**
  Comes on when the internal power supply voltage drops below a predetermined level.

- **WARN/DISABLE SWITCH/LIGHT**
  Amber light comes on when one or more chirp signals from the above six functions produce a master warning drive signal. Pressing the button disables all monitoring functions except the voltage monitor.

- **GUIDE SLOPE LIGHT**
  Comes on when a difference exists between the two glide slope signals.

- **HEADING LIGHT**
  Comes on when a difference exists between the two heading signals.

---

**Instrument Comparator**
Figure 4
6. PRIMARY FLIGHT INSTRUMENTS

The primary flight instruments consist of the pilot's and copilot's electrically operated flight instruments and the copilot's pneumatically operated flight instruments.

A. Electrically Operated Flight Instruments

The electrically operated flight instruments are:

- Pilot's Mach/Airspeed Indicator
- Pilot's Altimeter
- Pilot's Vertical Speed Indicator
- Pilot's and Copilot's Horizontal Situation Indicators
- Pilot's and copilot's Attitude Director Indicators.

The Mach/airspeed indicator, altimeter, and vertical speed indicator are driven from the air data system and the horizontal situation indicator and attitude director indicator operate with the flight director system.

1. **Pilot's Mach/Airspeed Indicator**

The Mach/airspeed indicator provides a counter display of Mach and servo-driven displays of airspeed and maximum operating airspeed (Vmo) (see Figure 5).

2. **Pilot's Altimeter**

The altimeter provides a servo-driven counter-drum-pointer display of barometrically corrected pressure altitude (see Figure 6). The barometric pressure is set manually with the BARO knob and displayed in units of inches of mercury and millibars. A light on the bezel is provided for altitude alert warning.

3. **Pilot's Vertical Speed Indicator**

The vertical speed indicator provides a servo-driven display of vertical speed rates from 0 to ±6,000 feet per minute (see Figure 7).

4. **Horizontal Situation Indicator**

The integrated horizontal situation indicator displays heading, course deviation, vertical deviation, ADF or NAV bearing, selected heading, selected course with digital readout, DME distance, waypoint alert light and appropriate annunciators and flags. The indicator also provides heading and course error signals to the flight director computer (see Figure 8).

5. **Attitude Director Indicator**

The integrated attitude director indicator displays pitch and roll attitude, flight director commands, glideslope deviation, localizer deviation, radio altitude, rate-of-turn, speed command and appropriate flags. The indicator also provides an inclinometer, attitude self-test switch and mode annunciation (see Figure 9).
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

Pilot's Mach/Airspeed Indicator
Figure 5
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

Pilot's Altimeter
Figure 6
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

Pilot's Vertical Speed Indicator
Figure 7
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

Horizontal Situation Indicator
Figure 8
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

![Diagram of Primary Flight Instruments]

- **AIRCRAFT SYMBOL**
- **GLIDE SLOPE WARNING FLAG**
- **GLIDE SLOPE POINTER**
- **DECISION HEIGHT DISPLAY**
- **RADIO ALTITUDE TEST SWITCH**
- **ATTITUDE TEST SWITCH**
- **INCLINOMETER**
- **RATE OF TURN WARNING FLAG**
- **EXPANDED LOCALIZER POINTER**
- **RATE OF TURN POINTER**
- **LOCALIZER WARNING FLAG**

**Attitude Director Indicator**

Figure 9

SECTION 11
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6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

B. Pneumatically Operated Flight Instruments

The pneumatically operated flight instruments are:
- Copilot's Mach/Airspeed Indicator
- Copilot's Altimeter
- Copilot's Vertical Speed Indicator.

The copilot's pneumatic flight instruments operate directly from the pitot-static system.

(1) Copilot's Mach/Airspeed Indicator

The copilot's Mach/airspeed indicator is an integrally lit instrument that displays Mach number (MACH), indicated airspeed (IAS) and maximum allowable airspeed (Vmo) (see Figure 10).

(2) Copilot's Altimeter

The copilot's barometric altimeter is an integrally lit instrument that provides altitude displays, barometric settings and an optical encoder output (see Figure 11). The instrument is internally vibrated to minimize mechanism friction error.

(3) Copilot's Vertical Speed Indicator

The copilot's vertical speed indicator is a pneumatic inertial lead, integrally lit instrument that displays vertical speed on a pointer that moves over a dial with major markings at 0.5, 1, 2, 4 and 6 times 1,000 ft/min. Vertical speed indications are displayed in ascending (UP) and descending (DOWN) values over the range 6,000 ft/min (see Figure 12).
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

MACH NUMBER
OFF flag displayed if no power

Copilot's Mach/Airspeed Indicator
Figure 10
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

Copilot's Altimeter
Figure 11
6. PRIMARY FLIGHT INSTRUMENTS (CONT'D)

VERTICAL SPEED POINTER

1000 FT PER MIN

IVSI

UP

DOWN VERTICAL SPEED

Copilot's Vertical Speed Indicator

Figure 12
7. STANDBY FLIGHT INSTRUMENTS

An artificial horizon and a magnetic compass, both self-contained and completely independent of other systems, are provided as standby instruments.

A. Artificial Horizon

The artificial horizon indicator displays pitch and roll aircraft attitude information (see Figure 13). Vertical attitude is maintained by a mechanical erection system. The indicator continues to provide attitude information for a minimum of 9 minutes after loss of power.

The dual-function PULL TO CAGE knob is pulled to cage the indicator, and rotated to adjust the miniature airplane for varying pitch attitudes.

The OFF flag is normally out of view, but comes into view to indicate a caged condition, an open internal motor winding, or loss of power.

B. Standby Magnetic Compass

The standby magnetic compass is aligned with the aircraft longitudinal axis and is the self-contained, dry type. A miniature aircraft pointer displays the heading against a rotating vertical compass card (see Figure 14).
7. STANDBY FLIGHT INSTRUMENTS (CONT'D)

Standby Artificial Horizon
Figure 13
7. STANDBY FLIGHT INSTRUMENTS (CONT'D)

Standby Magnetic Compass
Figure 14