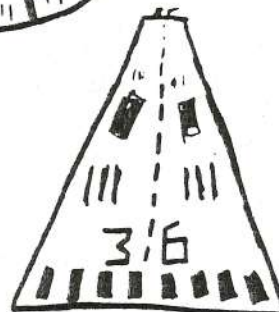
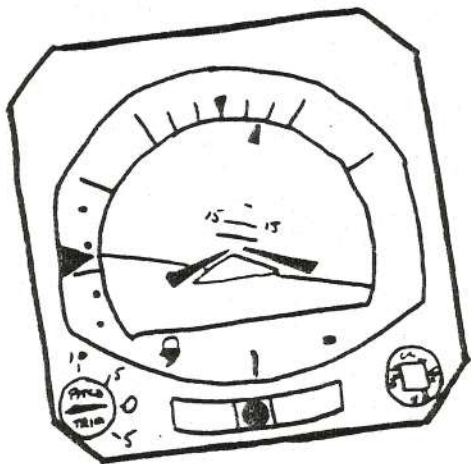
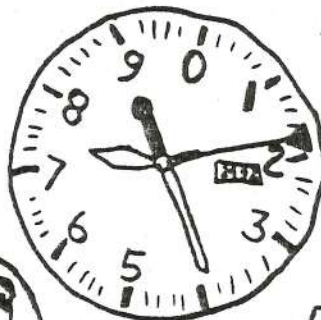
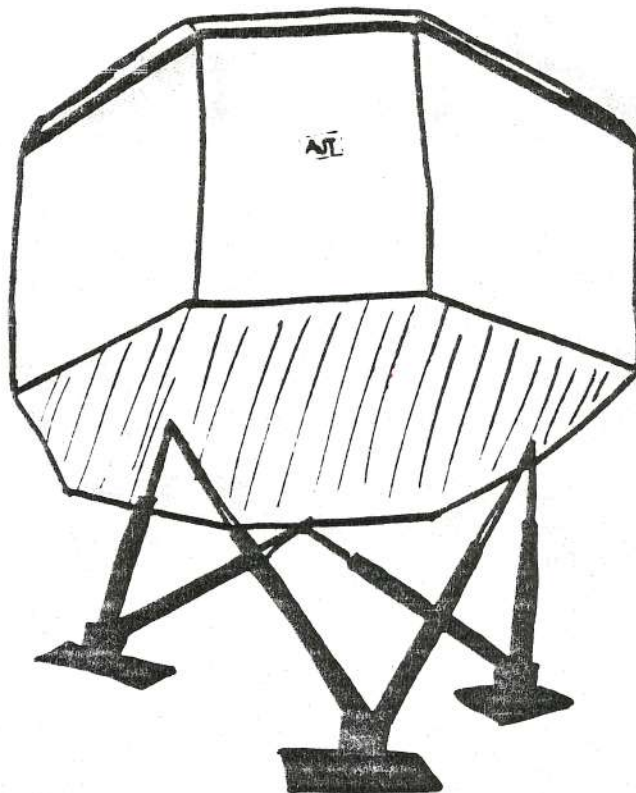


INTRODUCTION TO SIMULATION

BURGMAN

AIRCRAFT INSTRUMENTS
AND SYSTEMS



INTRODUCTION TO SIMULATION

AIRCRAFT INSTRUMENTS AND SYSTEMS

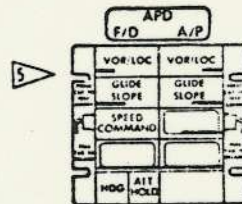
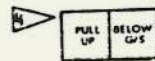
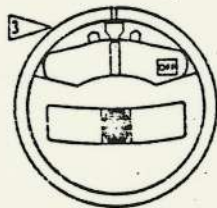
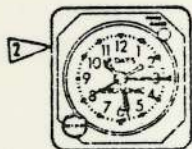
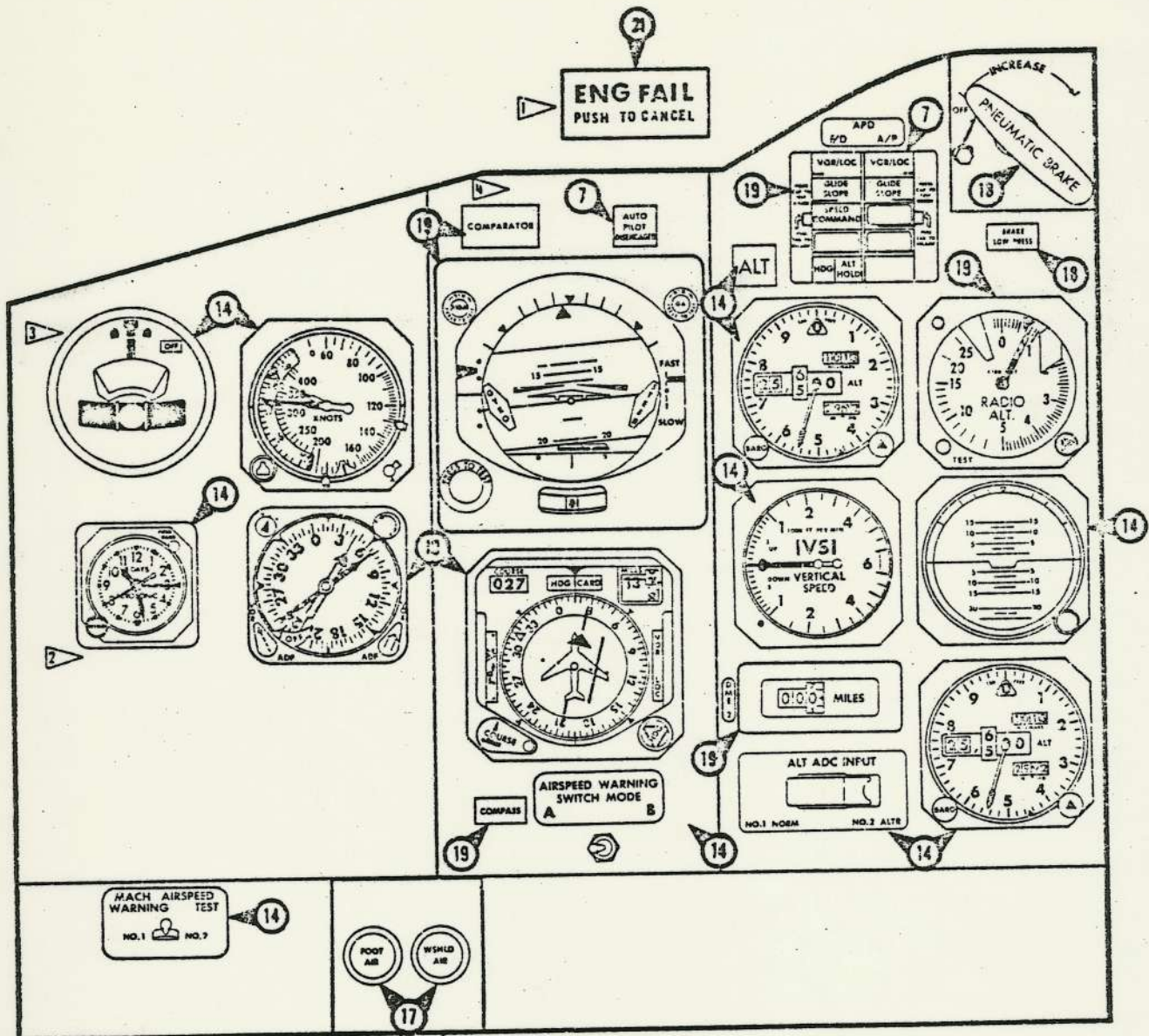
(EXCERPTS: BOEING 727 OPERATIONS MANUAL)

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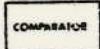
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Circled numbers refer to chapters where information on the item may be found.

The controls, panels, and indicators shown in this chapter are representative of installed units and may not exactly reflect the details of the latest configuration. Refer to the corresponding chapter under system descriptions for current information.

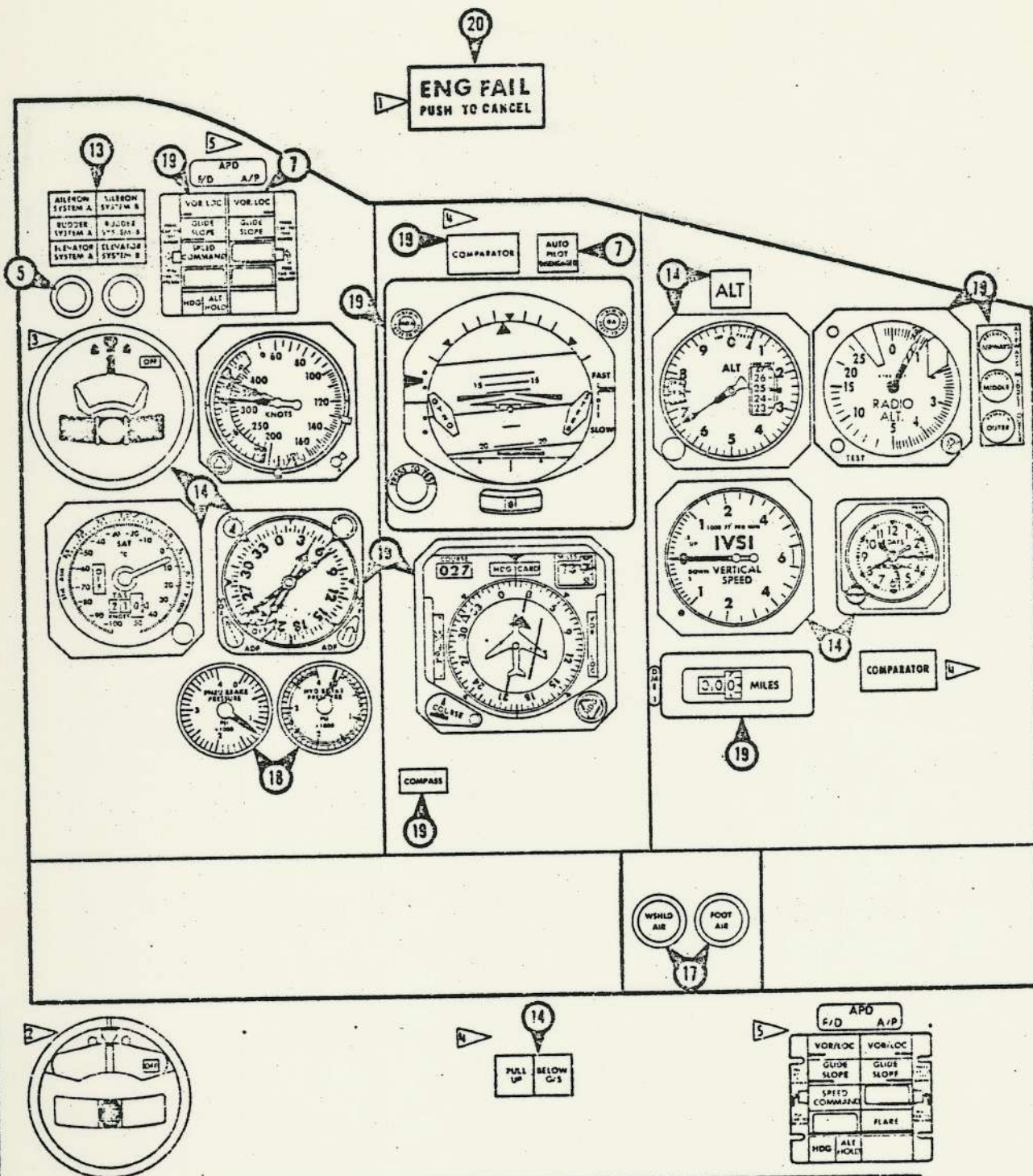


1 ▶ Located On Lightshield

2 ▶ thru 5 ▶ As Installed

AIRPLANE GENERAL
PANEL
CONFIGURATIONS

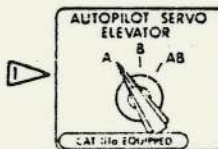
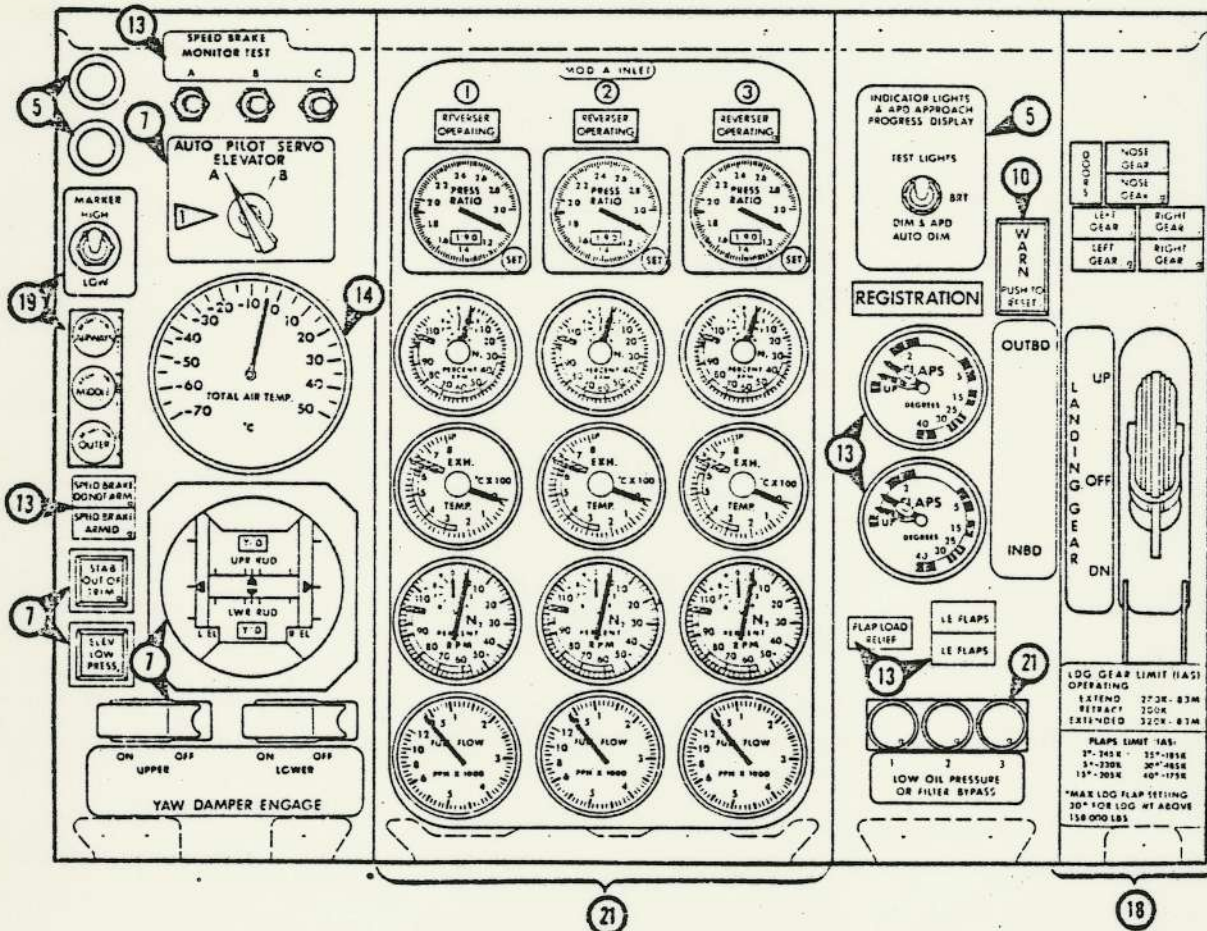
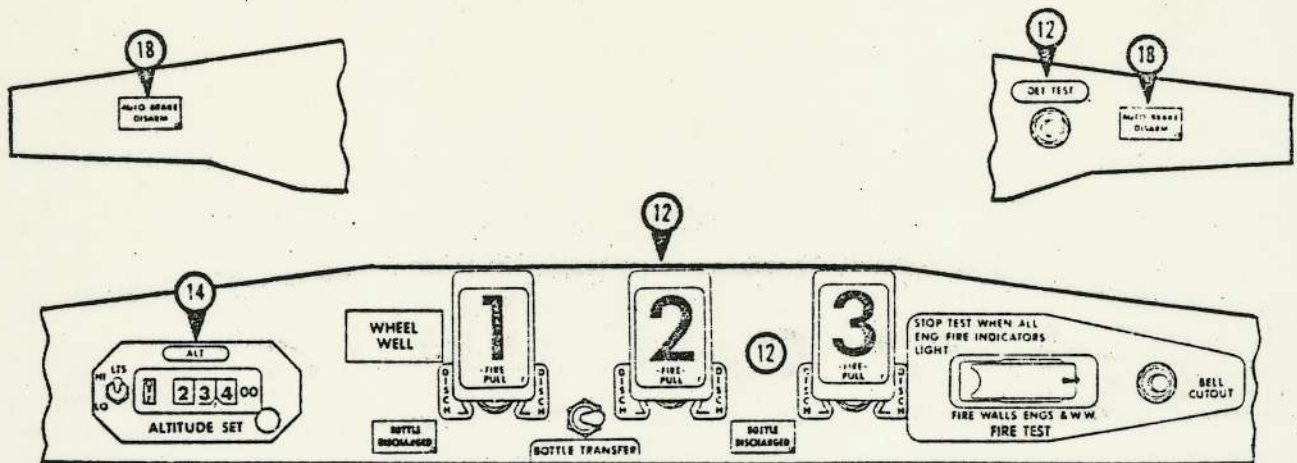
BOEING 727
OPERATIONS MANUAL



Circled numbers refer to chapters where information on the item may be found.

1 Located on Lightshield
2 thru 5 As Installed

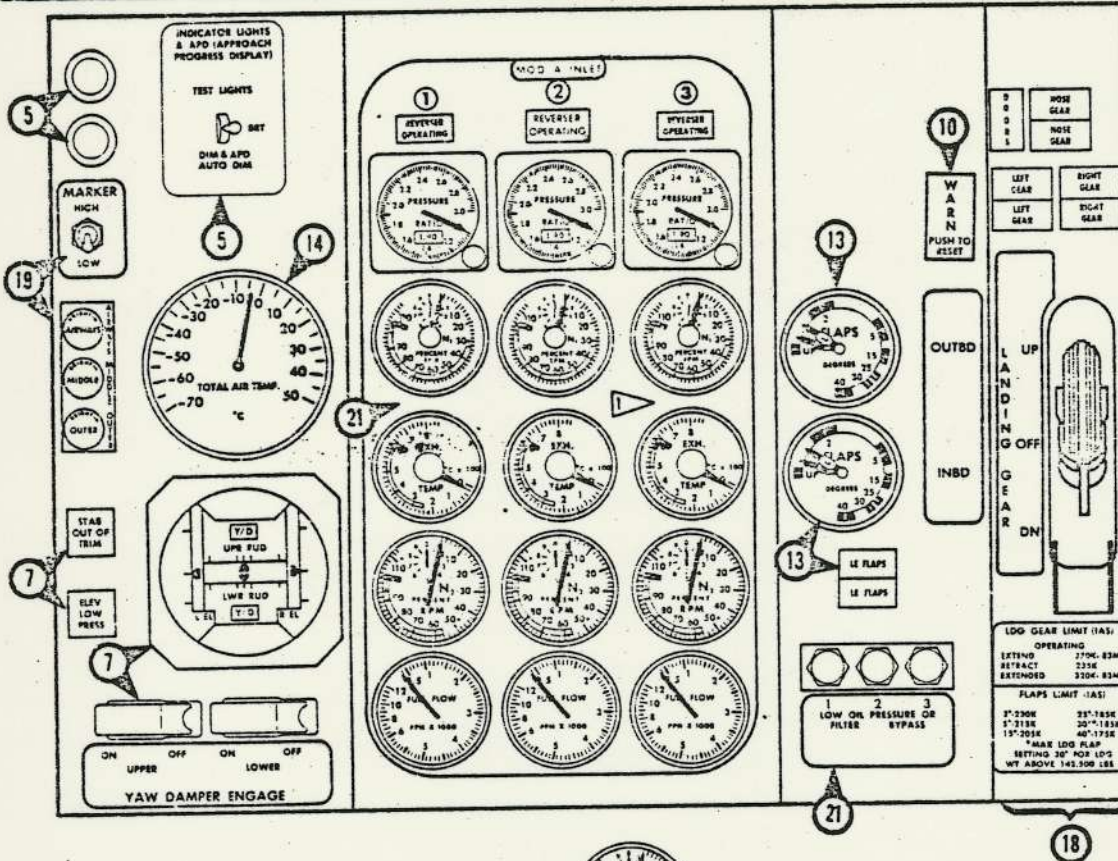
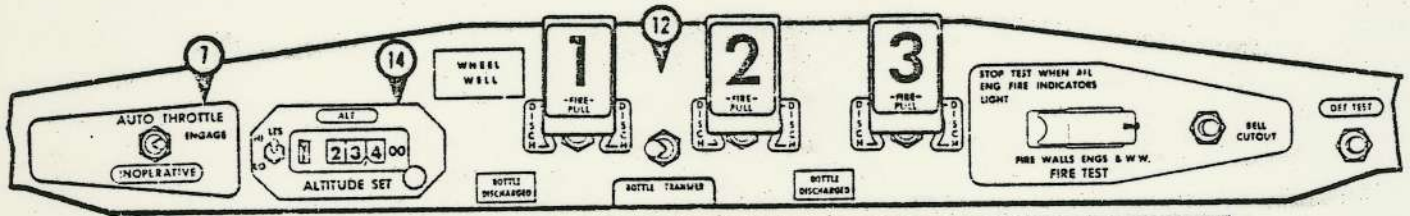
FIRST OFFICER'S PANEL



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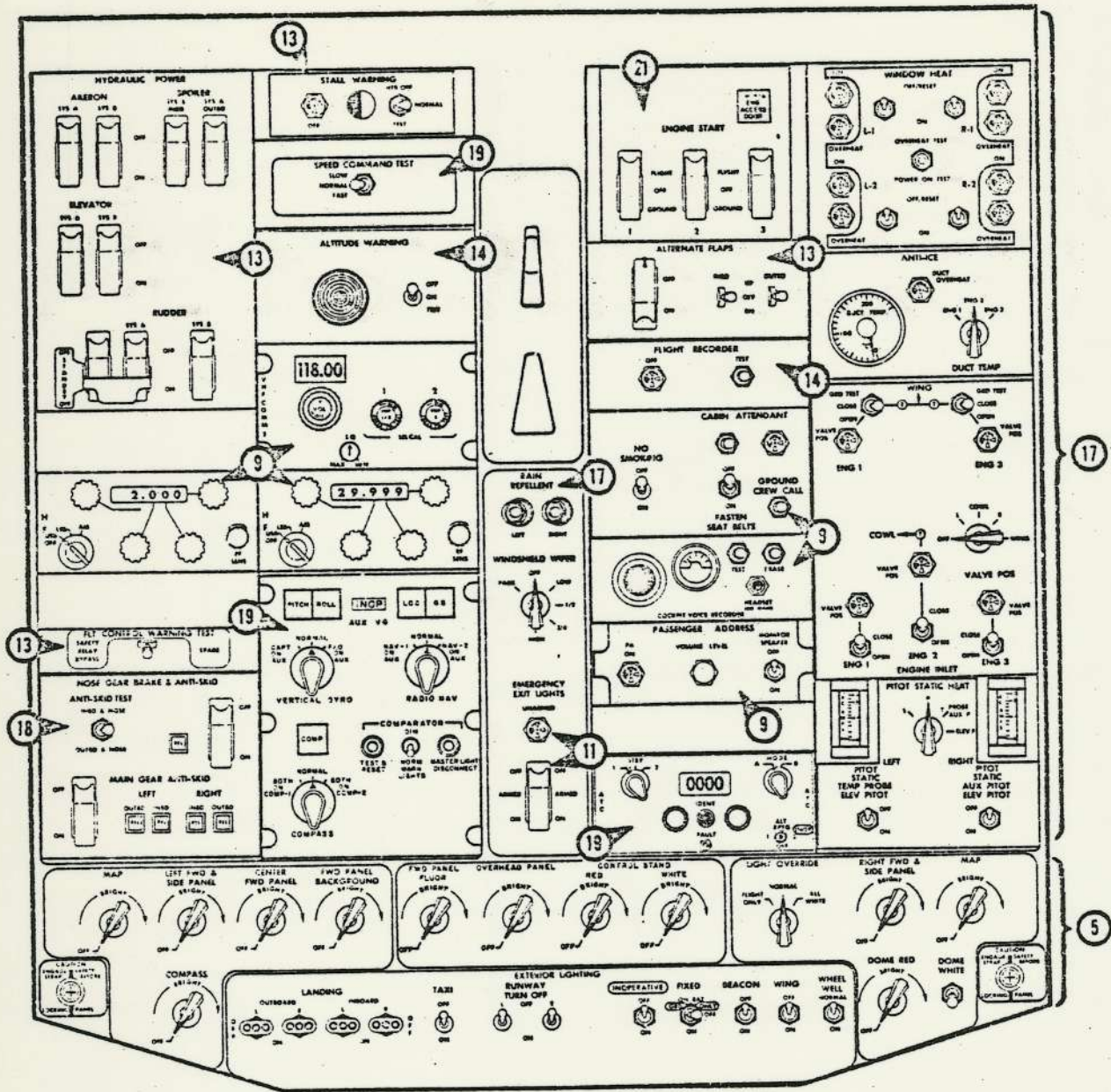
PILOT'S CENTER PANEL AND LIGHT SHIELD



Circled numbers refer to chapters where information on the item may be found.

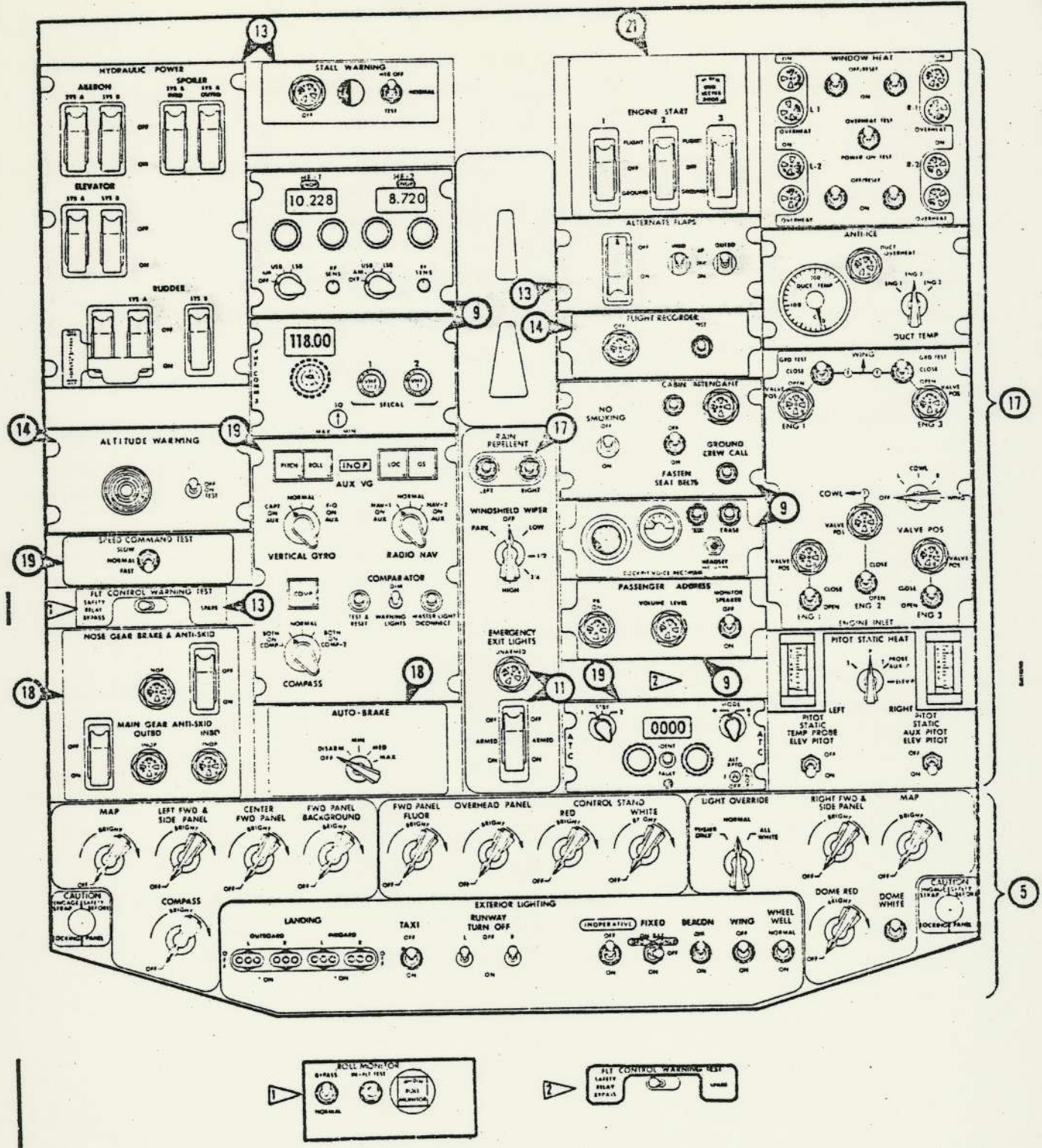
▶ As Installed

PILOT'S CENTER PANEL AND LIGHT SHIELD



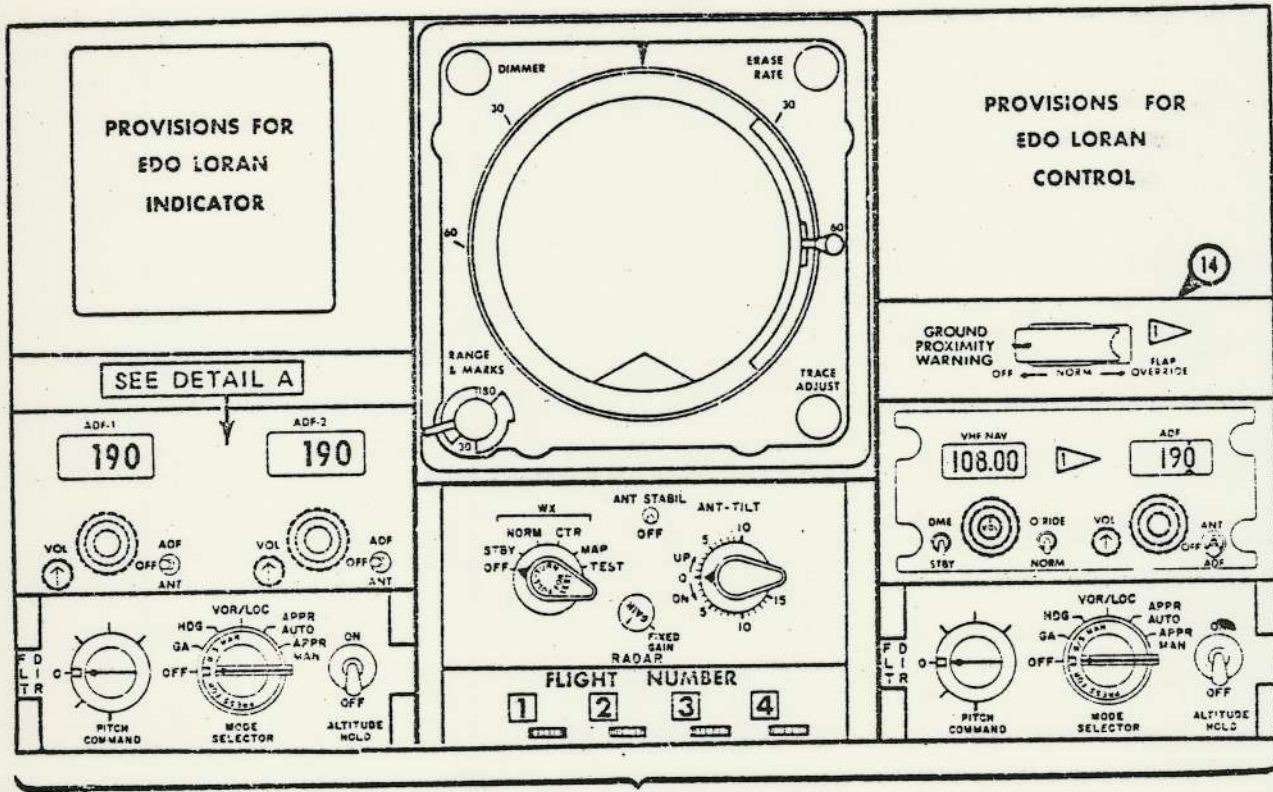
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OVERHEAD PANEL

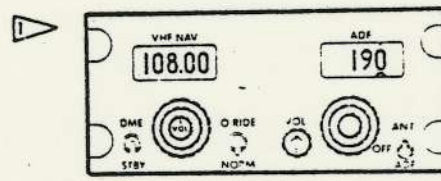


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▶ ▶ As Installed
OVERHEAD PANEL



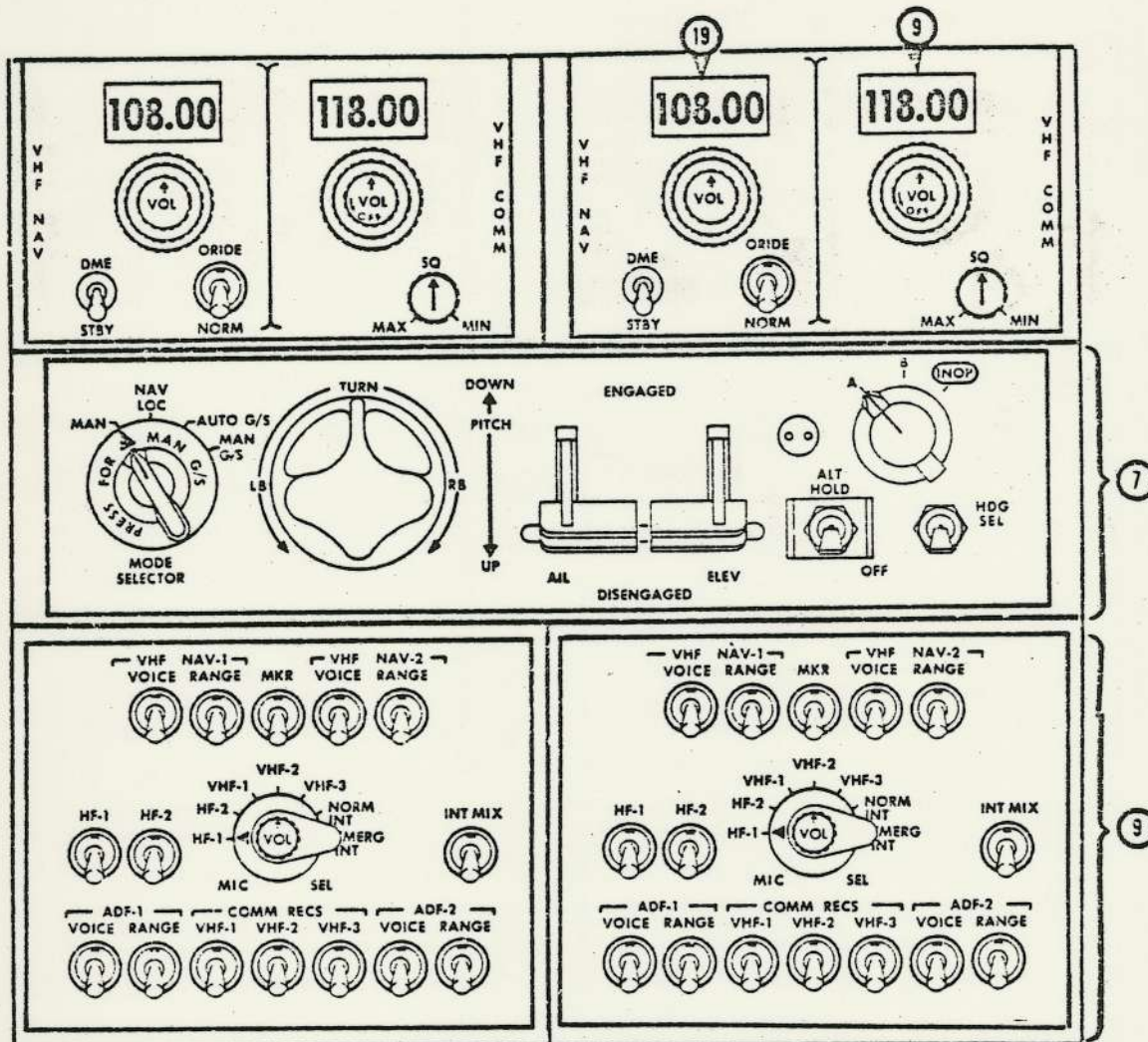
19



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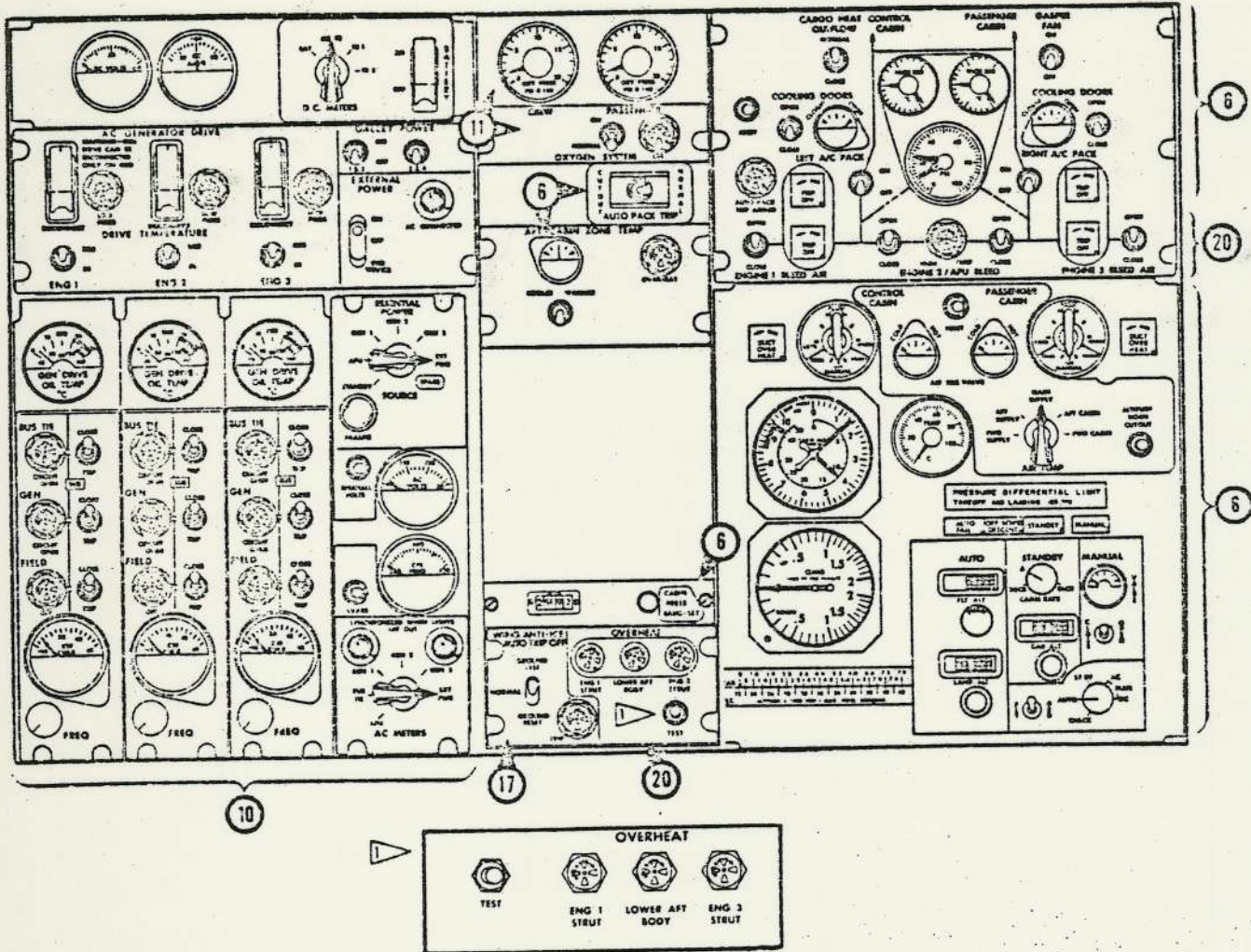
▶ As Installed

FORWARD ELECTRONIC CONTROL PANEL



Circled numbers refer to chapters where information on the item may be found.

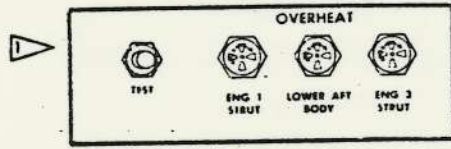
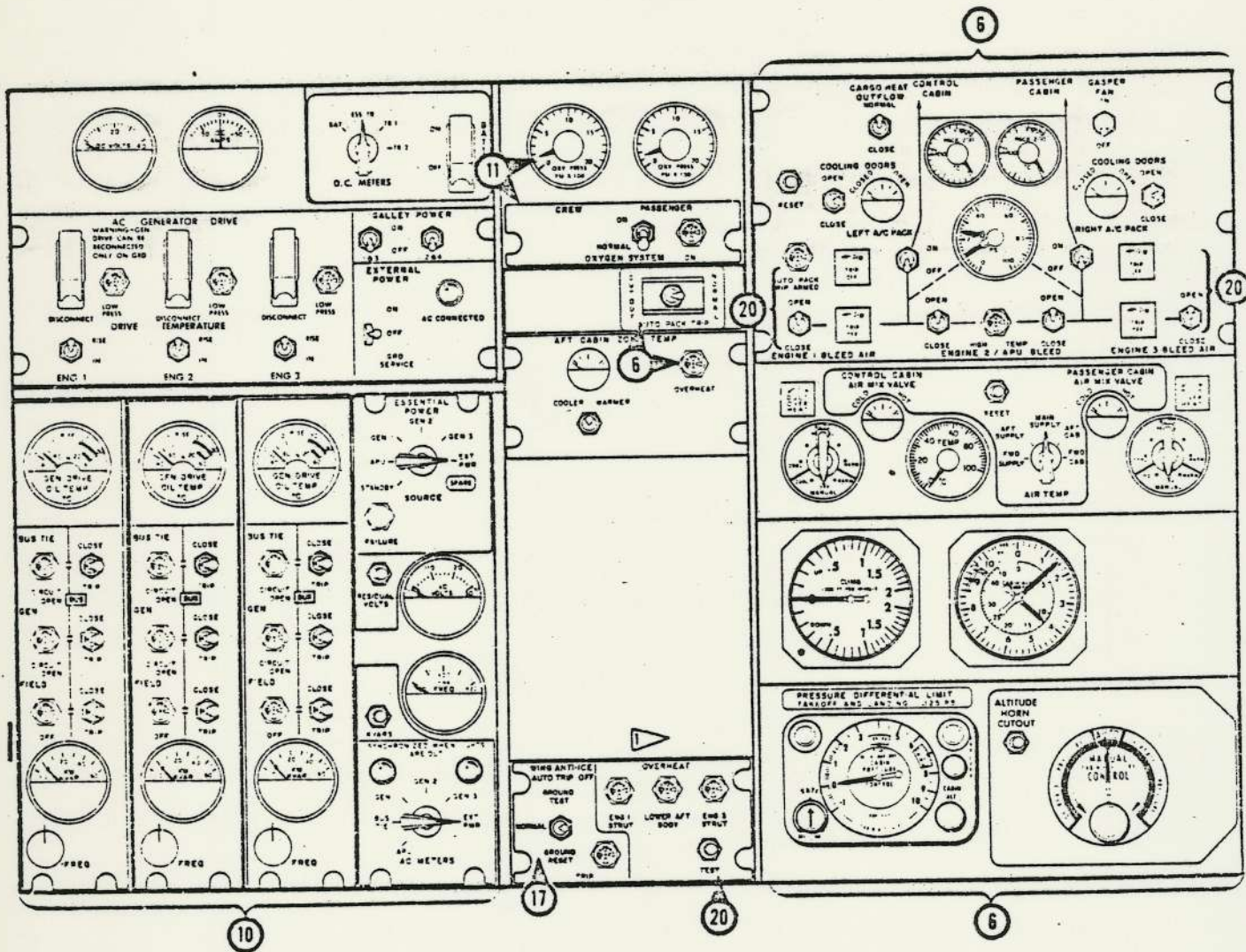
AFT ELECTRONIC CONTROL PANEL



Circled numbers refer to chapters where information on the item may be found.

As Installed

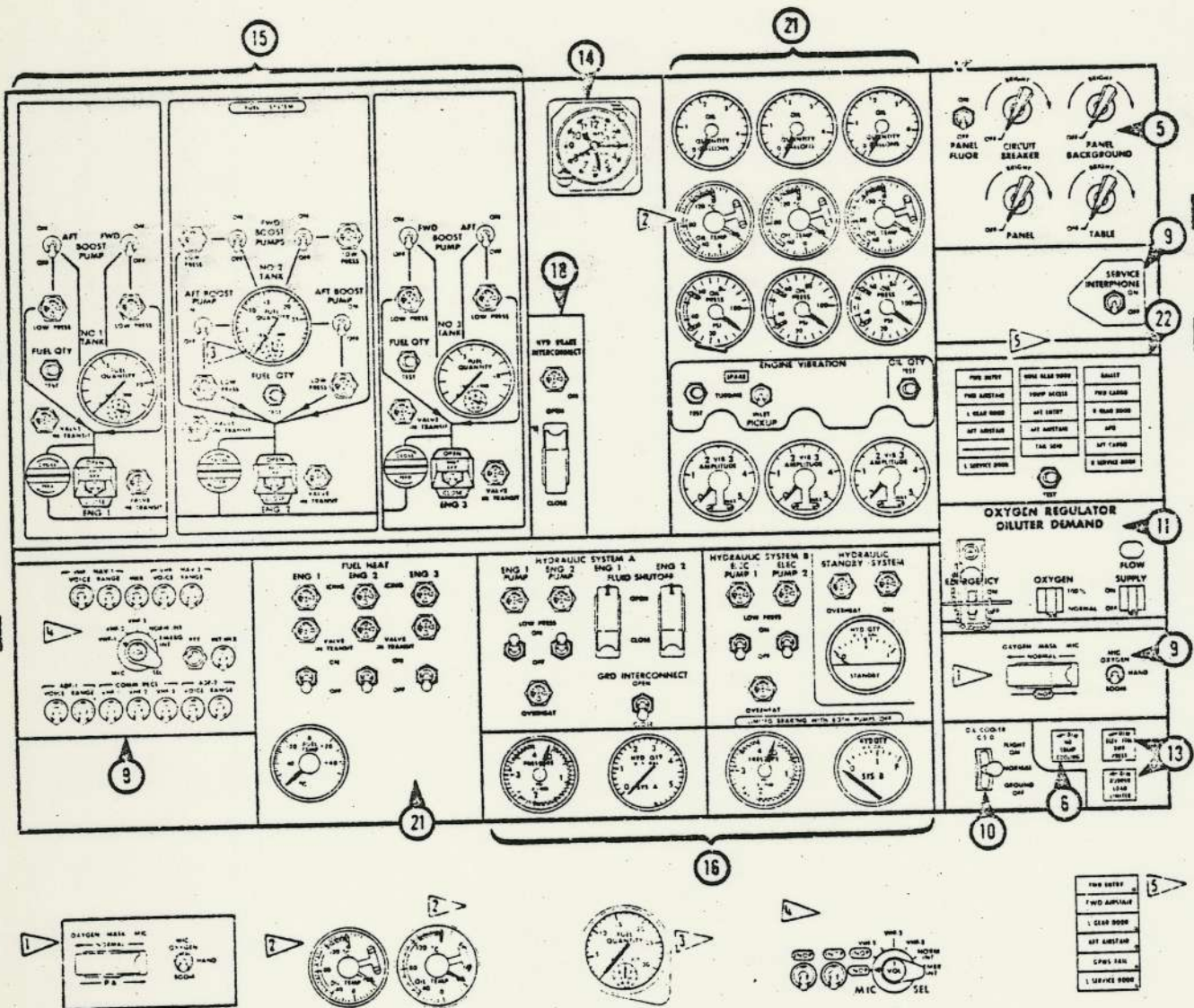
FLIGHT ENGINEER'S UPPER PANEL



Circled numbers refer to chapters where information on the item may be found.

▶ As Installed

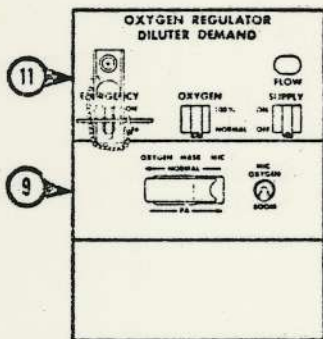
FLIGHT ENGINEER'S UPPER PANEL



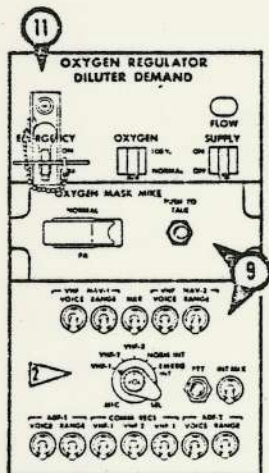
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1 thru 5 As Installed

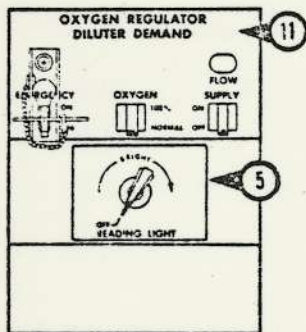
FLIGHT ENGINEER'S LOWER PANEL



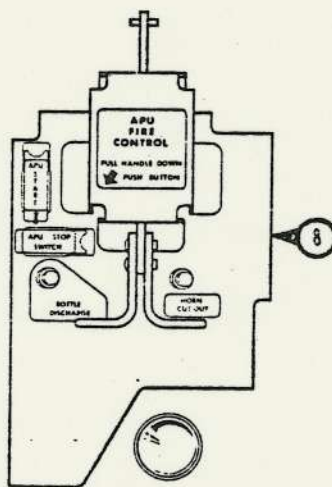
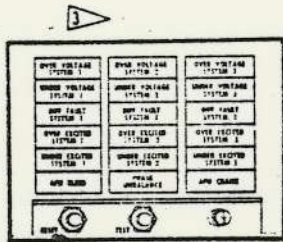
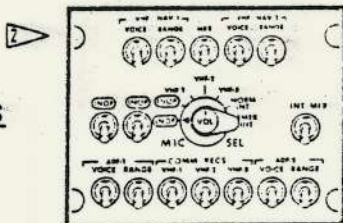
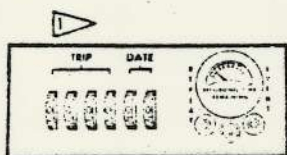
**CAPTAIN'S AND FIRST OFFICER'S
AUXILIARY PANEL**



**FIRST OBSERVER'S
AUXILIARY PANEL**

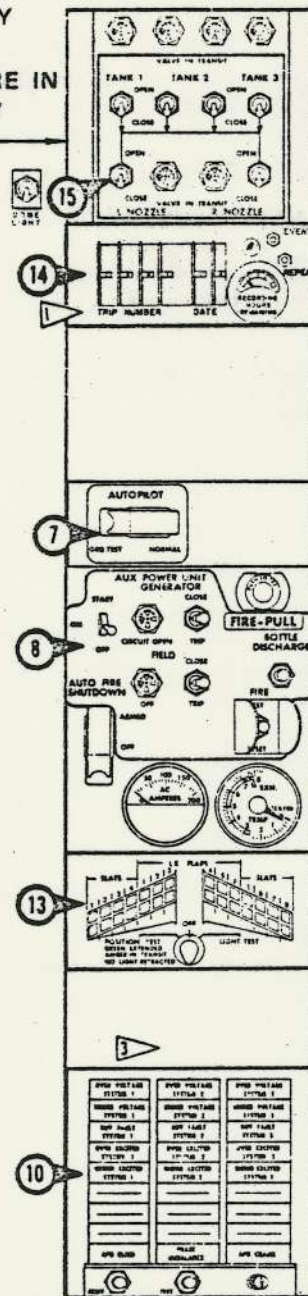


**SECOND OBSERVER'S
AUXILIARY PANEL**



**APU GROUND CONTROL
PANEL
(LEFT WHEEL WELL)**

DOOR OVER
THIS FUEL DUMP
MODULE CAN BE
CLOSED ONLY
WHEN THE
SWITCHES ARE IN
THE "CLOSE"
POSITION

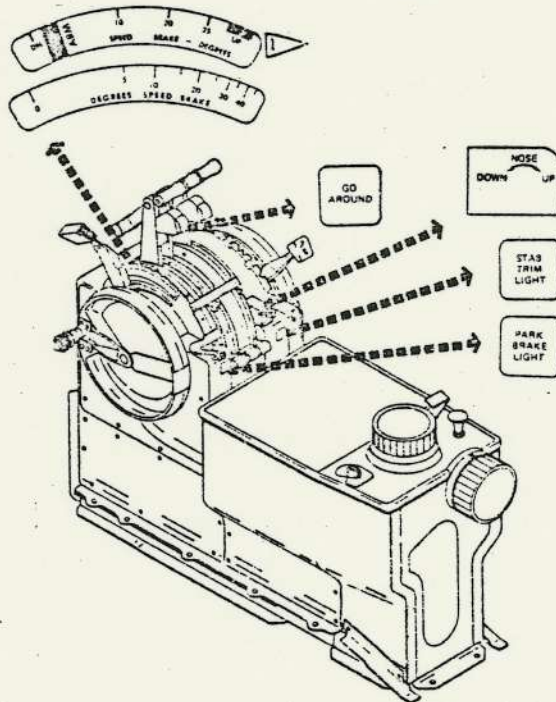
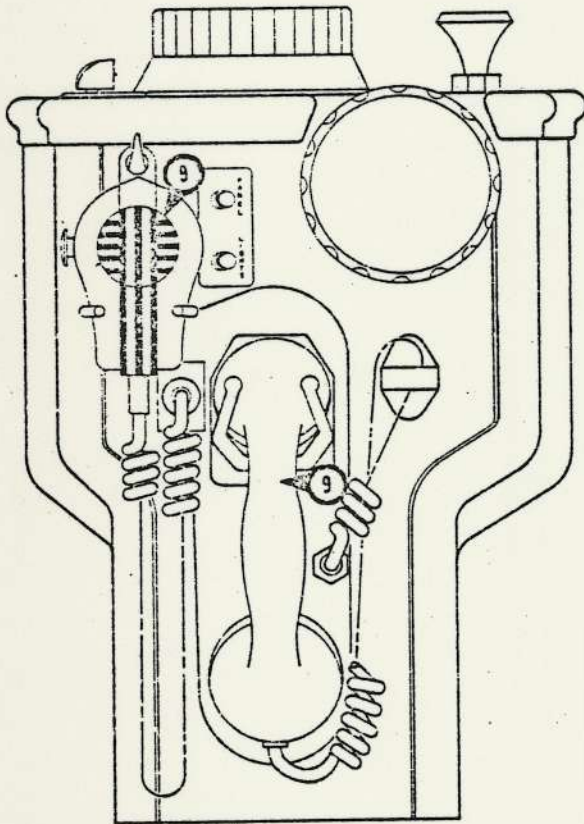
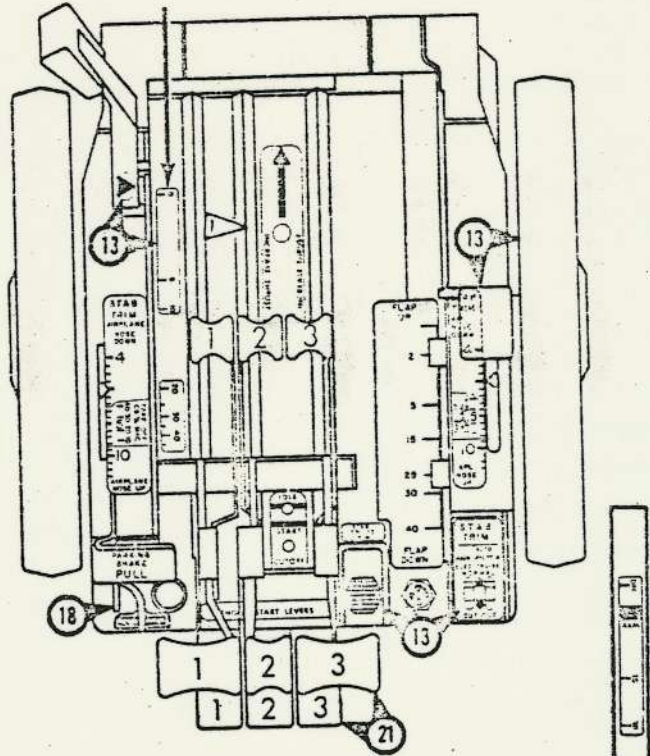
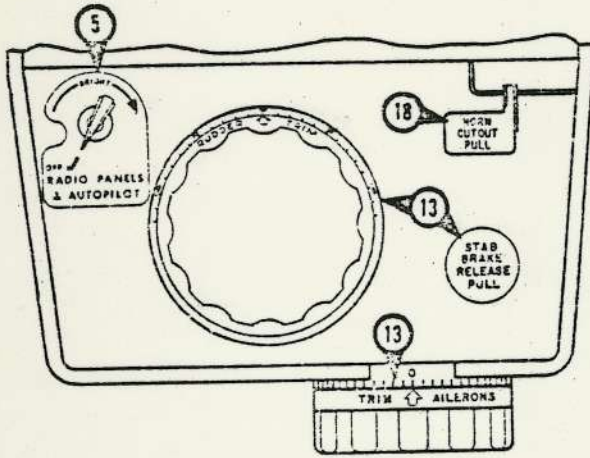


**FLIGHT ENGINEER'S
AUXILIARY PANEL**


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1 thru 3 As Installed

AUXILIARY PANELS



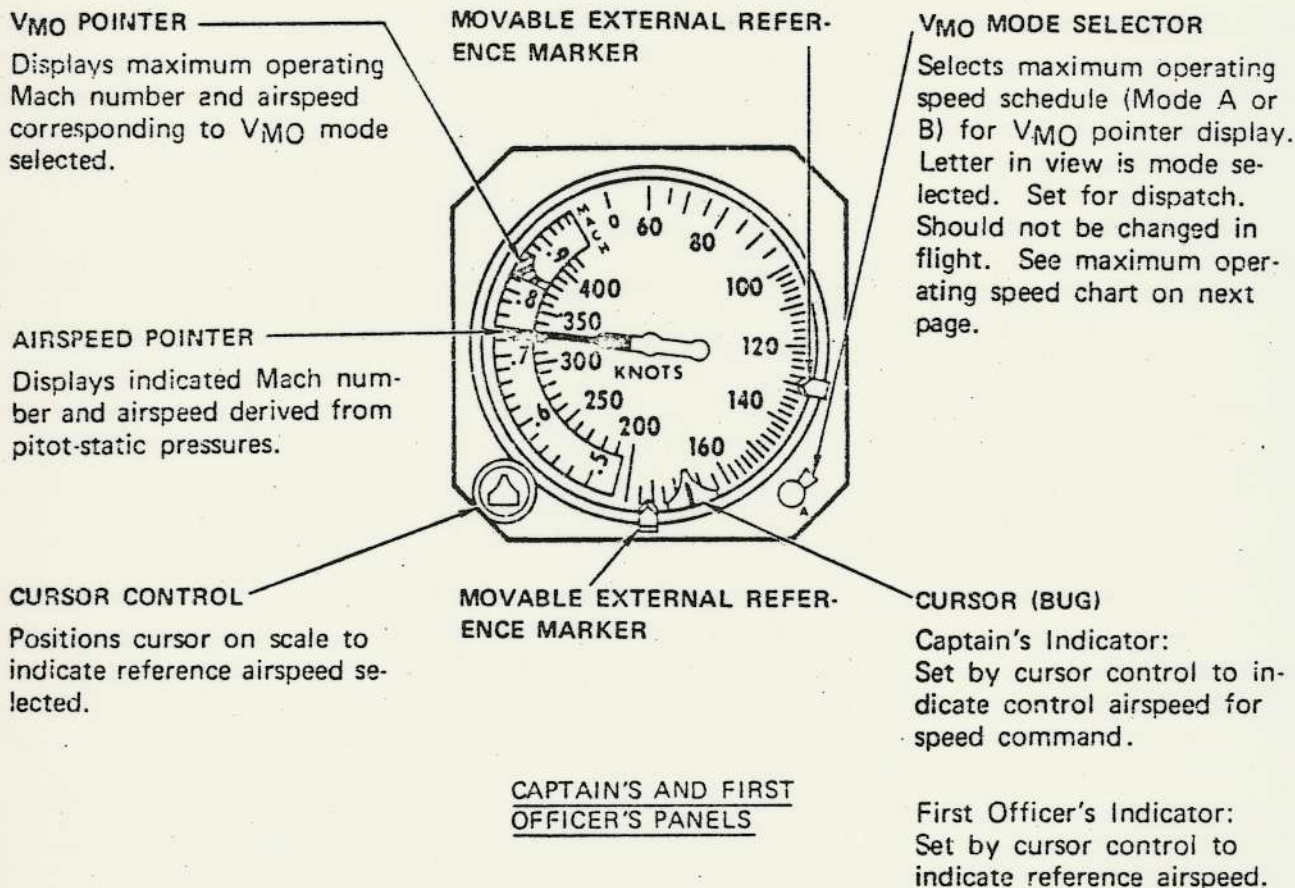
Circled numbers refer to chapters where information on the item may be found.

 As Installed
 CONTROL STAND

MACH/AIRSPEED INDICATOR

and indicated airspeed, as derived from the pitot-static system.

A Mach/airspeed indicator is located on each pilot's panel. The instruments display indicated Mach number



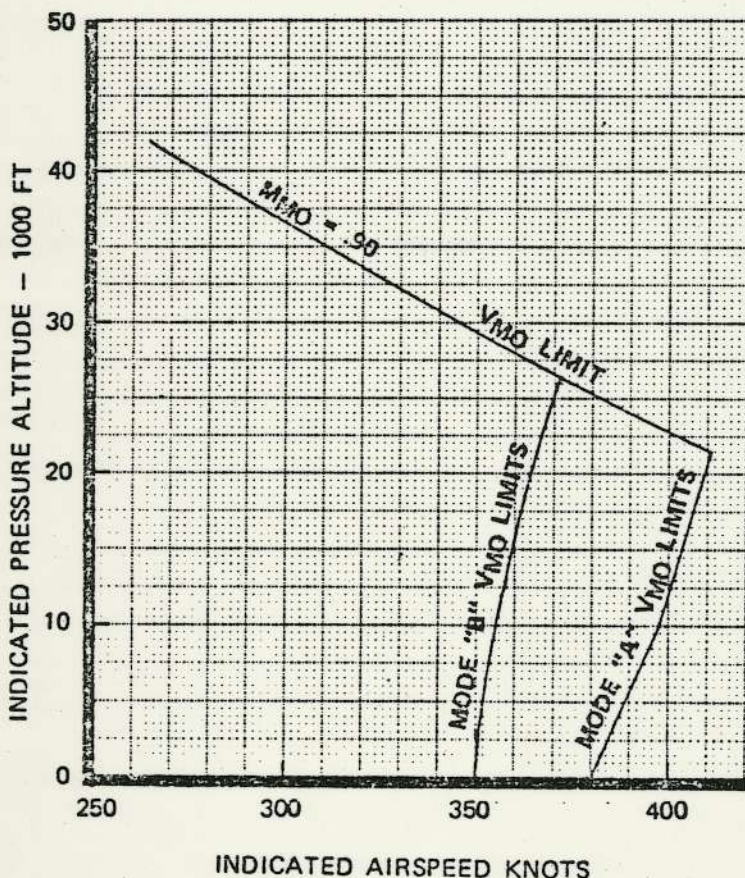
MACH/AIRSPEED INDICATOR

MACH/AIRSPEED WARNING

Two maximum operating speed (VMO) schedules are provided. Mode A or mode B must be selected in accordance with airplane flight manual limitations.

The indicated VMO airspeeds shown are based on the maximum operating airspeeds in the FAA Approved Airplane Flight Manual.

Warning is provided by two clackers. No cutout is provided for this warning which will sound until airspeed is reduced below the VMO of the mode selected by the airspeed warning mode switch. The VMO mode selector and the airspeed warning mode switch should always be in like positions.



CAPTAIN'S PANEL

AIRSPEED WARNING MODE SWITCH

Selects maximum operating speed schedule for aural warning. Set for dispatch. Should not be changed in flight.

- A - Selects Mode A VMO limits. Utilizes No. 1A pressure switch.
- B - Selects Mode B VMO limits. Utilizes No. 1B pressure switch.

Pressure switch No. 2 is active at all times and provides warning whenever Mode A VMO limits are exceeded.



CAPTAIN'S PANEL

MACH AIRSPEED WARNING TEST SWITCH

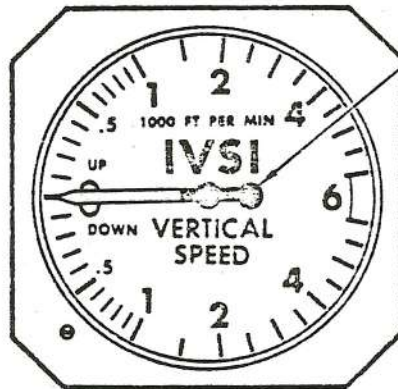
Used in conjunction with airspeed warning mode switch to test aural warnings.
NO. 1 - Tests clacker connected to auxiliary pitot-static system.
NO. 2 - Tests clacker connected to F/O's pitot-static system.

VERTICAL SPEED INDICATOR

An instantaneous vertical speed indicator is located on each pilot's panel.

Either pilot may connect his vertical speed indicator to the auxiliary static system by positioning his static source selector to ALTERNATE.

CAPTAIN'S AND
FIRST OFFICER'S
PANELS



VERTICAL SPEED INDICATOR
POINTER

Depicts rate of climb or descent from 0 to 6000 feet per minute. The instruments are marked in 100-foot increments from 0 to 1000 feet per minute and in 500-foot increments from 1000 to 6000 feet per minute.

ALTITUDE ALERTING SYSTEM

An altitude alerting system provides aural and visual indication to the flight crew upon approaching (acquisition mode) or departing (deviation mode) from a pre-selected altitude.

The components of the system are functionally connected in the schematic below.

ACQUISITION MODE

Alert light illuminated
- At 750 feet from set ALT.

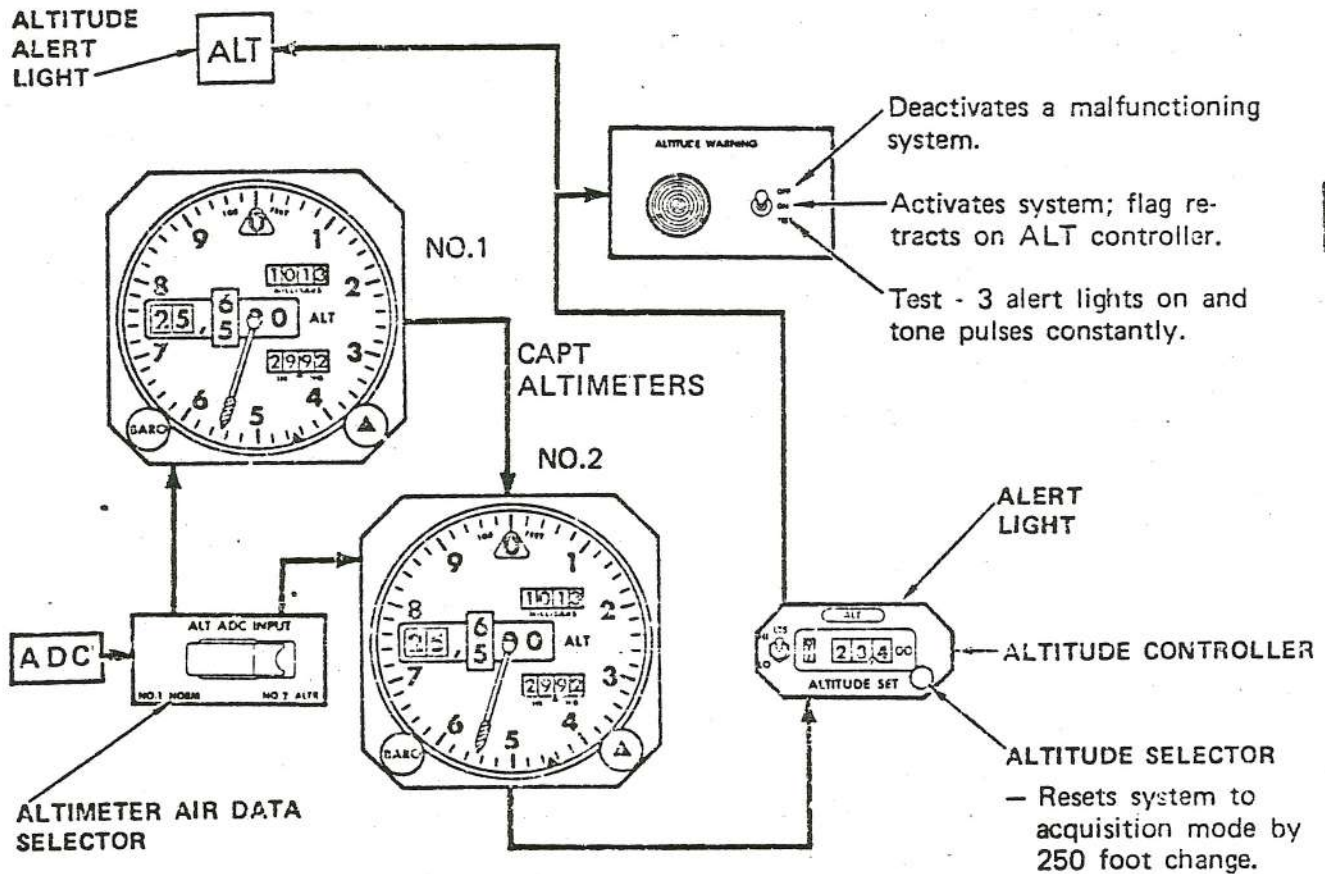
Alert light extinguished.
Short tone.
- At 250 feet from set ALT.

DEVIATION MODE

Short tone.
Alert light flashes.
- 250 feet above or below set altitude.
- Less than 2300 feet above ground tone sounds but lights do not illuminate.

ON DESCENT

2 short tones
2300 feet above ground.

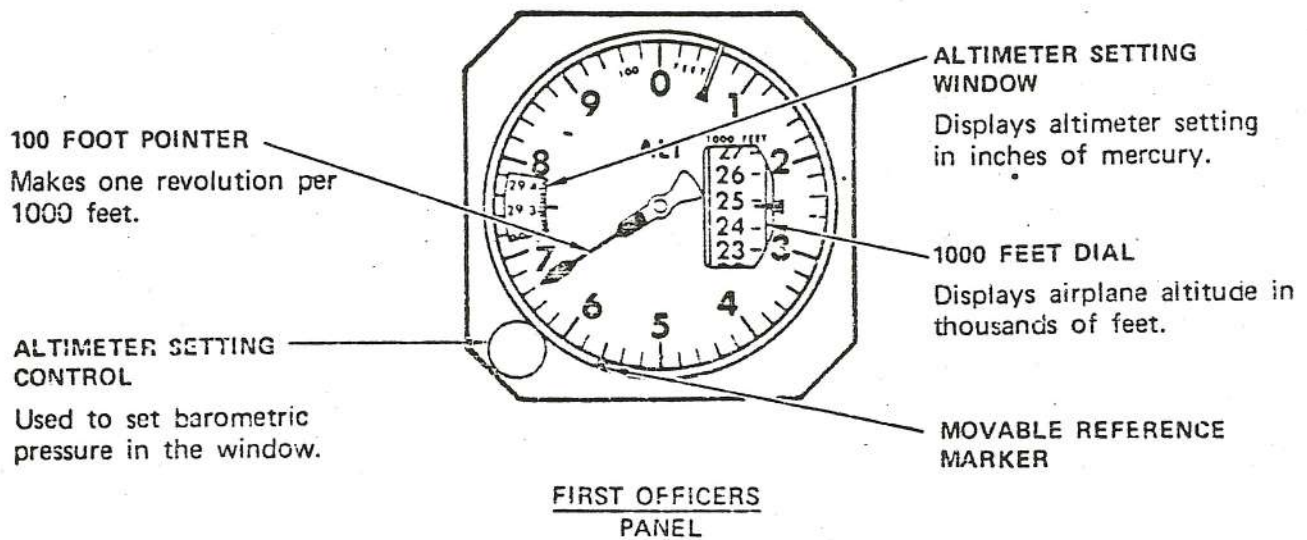
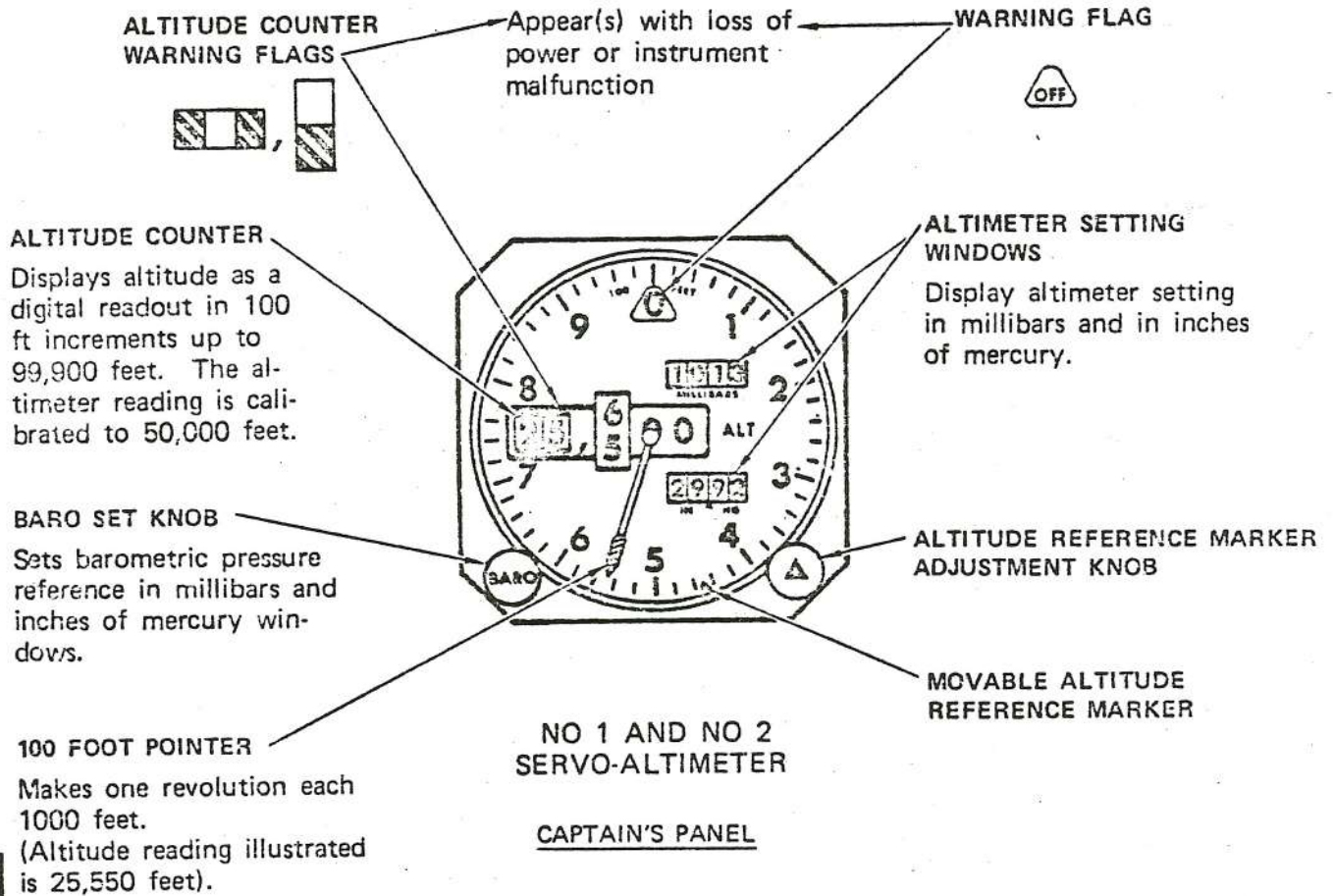


ALTITUDE ALERTING SYSTEM

ALTIMETERS

The Captain's altimeters are electrically operated from the number one air data computer.

The First Officer's altimeter is pneumatic and operates from his static source. This altimeter has an integral vibrator to prevent error caused by mechanical friction.

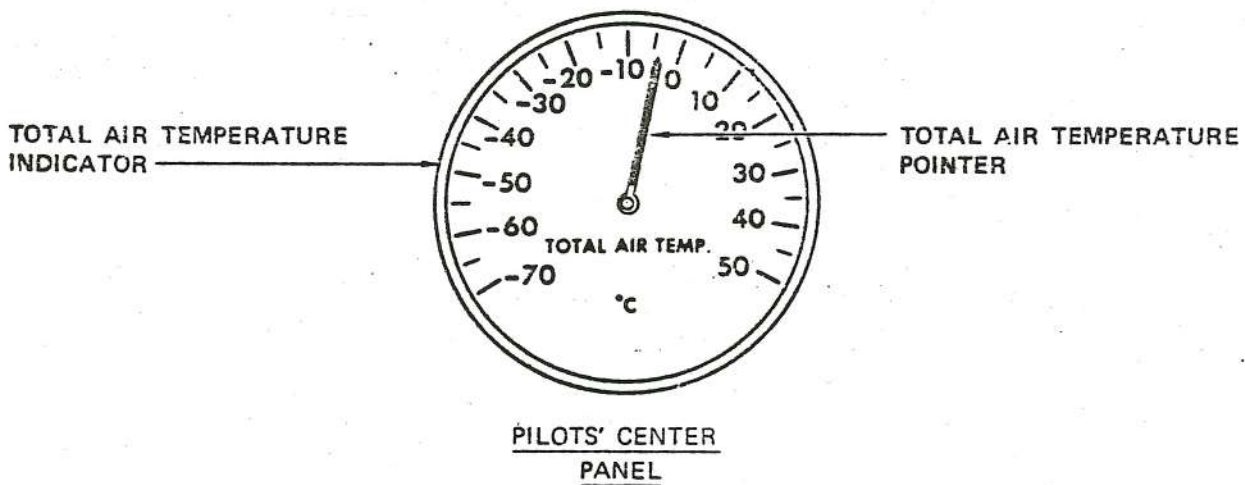


ALTIMETERS

TOTAL AIR TEMPERATURE INDICATOR

A total air temperature indicator receives input from a sensing probe on the left forward fuselage. The probe is anti-iced by the left pitot-static anti-ice circuit.

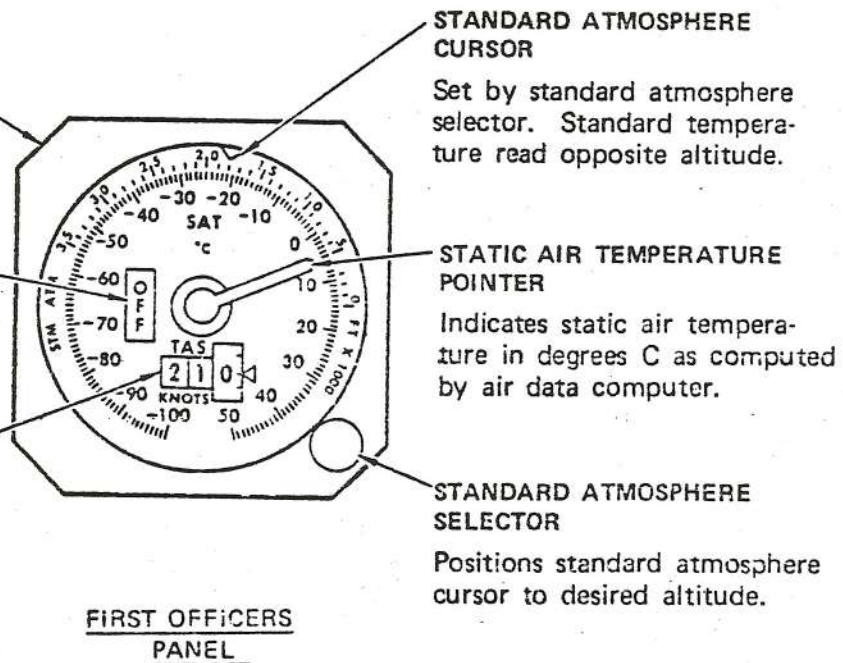
The TAT indication is comprised of outside air temperature (OAT) plus all of the ram rise. TAT indication on the ground will approximate OAT; however, will be erroneously high if the left pitot-static heat switch is ON.



**STATIC AIR TEMPERATURE/
TRUE AIRSPEED INDICATOR**

OFF FLAG
In view when air data computer or instrument electrical power fails.

TRUE AIRSPEED INDICATOR
Displays true airspeed in knots as computed by air data computer. TAS less than 200K is unreliable and first digit will be masked.



TEMPERATURE/TRUE AIRSPEED INDICATORS

GMT HOURS SET CONTROL
Pull and rotate to set GMT hours display.

POWER FAIL FLAG
In view indicates electrical power to the clock has failed.

GMT MINUTES SET CONTROL
Pull and rotate to set GMT minutes display.

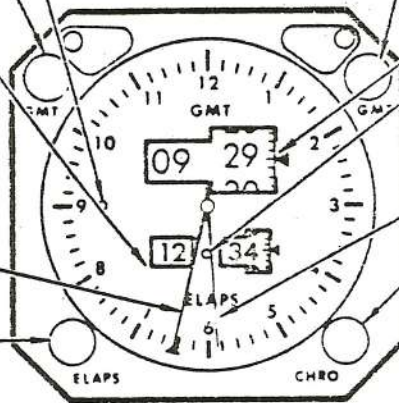
ELAPSED TIME DISPLAY
Displays elapsed time in numerical form up to 99 hours 59 minutes. Controlled by elapsed time switch.

GMT DISPLAY
Displays Greenwich Mean Time in numerical form on 24-hour scale.

MINUTE HAND

ELAPSE TIME FLAG
In view indicates elapsed time is operating.

ELAPSE SWITCH
With elapsed time indicating zero:
- Press once to start elapsed time
- Pressing a second time stops the elapsed time. After a short delay, elapsed time automatically returns to zero.



SECOND HAND

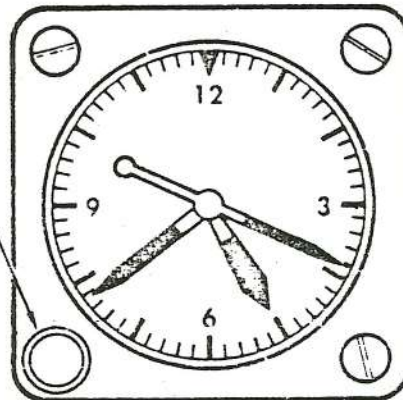
CHRO SWITCH
With minute and second hand at the 12 o'clock position:
- Press once to start hands moving
- Pressing a second time stops the minute and second hands. After a short delay, the hands automatically reset to the 12 o'clock position

PILOT'S PANELS

Remote switches labelled **CLOCK** on the pilots' glareshield provide the same function.

WINDING AND SETTING CONTROL

A complete winding powers clock for eight days. Pull control out and rotate to set hour and minute hands.

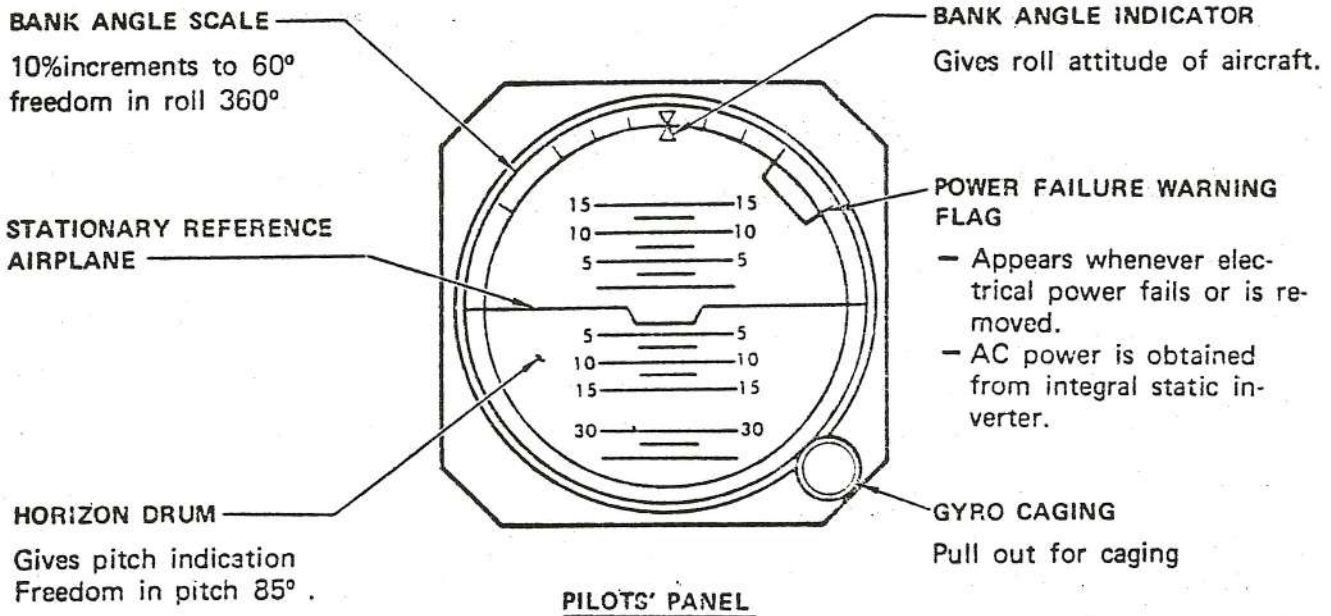


FLIGHT
ENGINEER'S PANEL

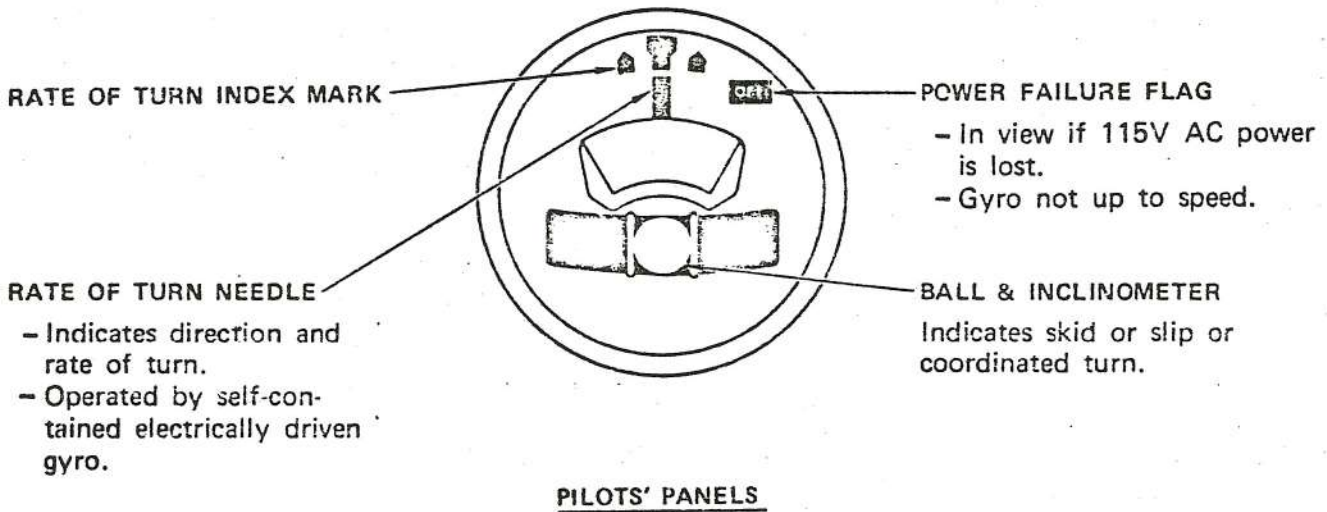
STANDBY HORIZON INDICATOR

The standby horizon indicator provides a visual indication of airplane atti-

tude at all times during flight. The instrument operates independent of other airplane systems.



TURN AND BANK INDICATOR



STANDBY HORIZON/TB INDICATOR

FLIGHT RECORDER SYSTEM

A flight recorder, located on the right side of the aft stairs, receives and transcribes flight data on metallic tape. Inputs to the system include heading, altitude, air-

speed, vertical acceleration, trip and date code, VHF/HF microphone keying and event mark recording.

The recorder operates automatically whenever airplane electrical power is available.

FLIGHT RECORDER LIGHT ILLUMINATED

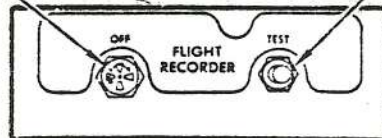
- Recorder is not operating due to power failure.
- Recording tape is not moving at proper speed.

EXTINGUISHED

- Recorder is operating, either automatically or during test.

FLIGHT RECORDER TEST SWITCH

Operates flight recorder on APU or external power.



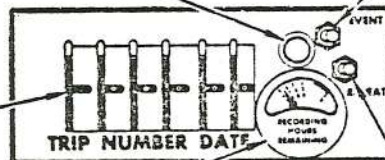
OVERHEAD PANEL

TRIP AND DATE ENCODER LIGHT (Amber) ILLUMINATED

- Trip and date information are being recorded.

TRIP AND DATE ENCODERS

Enters trip number and date.



EVENT SWITCH

Records a mark on the tape indicating the time of an event.

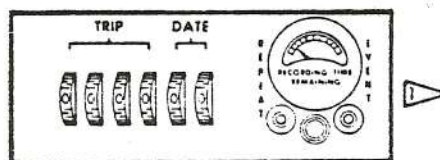
Hold at least 5 seconds. Do not use during or within 5 minutes of trip/date recording.

RECORDING TIME REMAINING INDICATOR

Indicates number of recording hours remaining on tape.

REPEAT SWITCH

Records trip and date information.



FLIGHT ENGINEER'S
AUXILIARY PANEL

▷ Airplane serial no. 20522 and on

FLIGHT RECORDER SYSTEM

PITOT-STATIC SYSTEM

The pitot-static system provides total and static pressure inputs for pressure sensing instruments, Mach/airspeed, altitude, and vertical speed indicators, and systems which have functions that vary with altitude and airspeed. Three systems are referred to as Captain's, First Officer's, and auxiliary.

All pitot probes and static ports are equipped with heaters for anti-ice protection.

AIR DATA SYSTEM

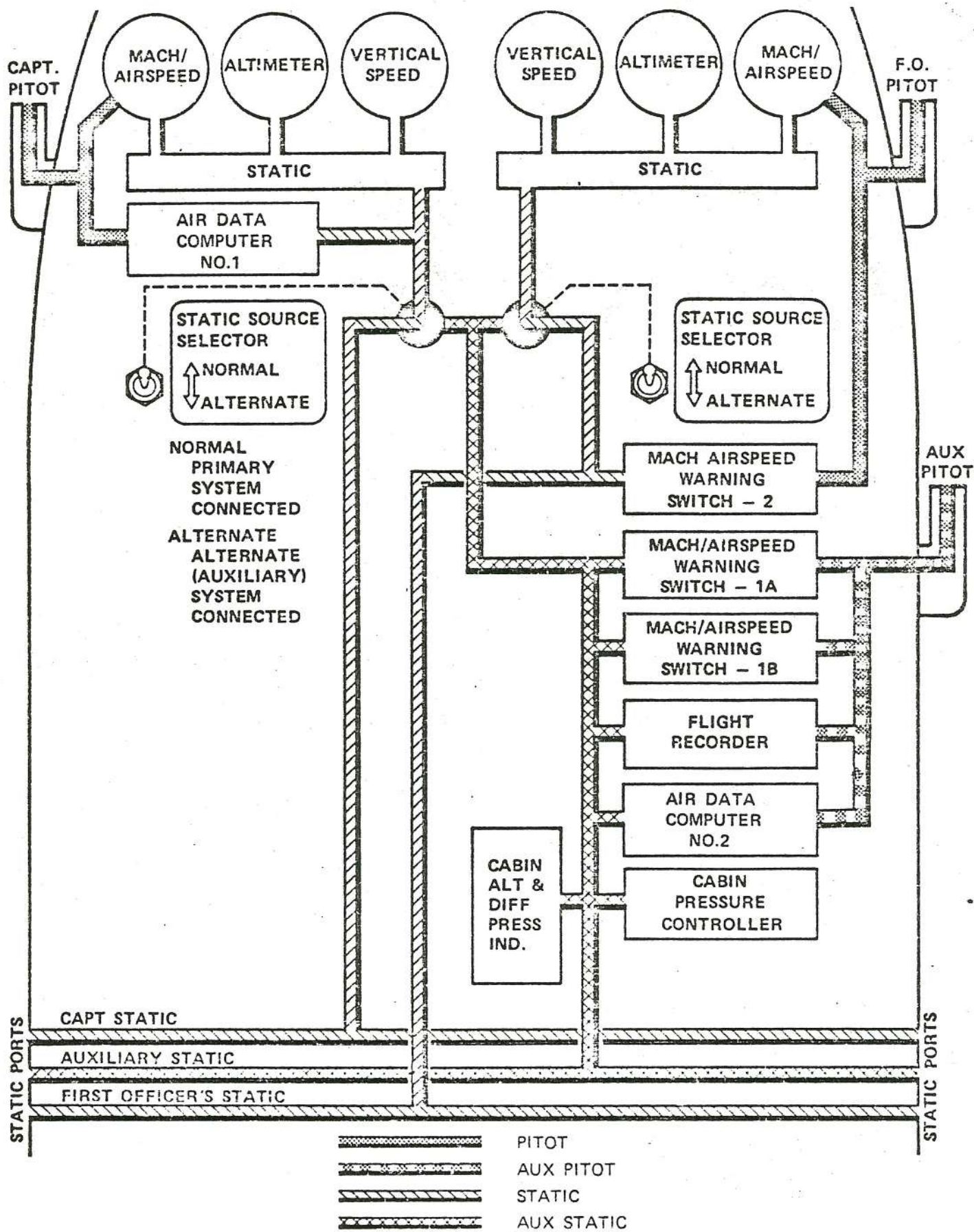
Two air data computers (ADC) provide altitude, Mach and airspeed data.

They are powered whenever power is on the airplane.

Failure of the IAS computer module will be indicated by the speed command warning flag on each pilot's ADI and retraction of the pitch command bar on each ADI if in SC mode.

Failure of the altitude module will cause retraction of the pitch command bar on the ADI if in altitude hold.

Inputs to the computers are shown on the pitot static schematic plus total temperature from the probe.



PITOT-STATIC SYSTEM

**GROUND PROXIMITY WARNING
SYSTEM (GPWS)**

CAUTION: THE GPWS MAY NOT BE DEACTIVATED (BY PULLING THE CIRCUIT BREAKER OR USE OF THE FLAP INHIBIT SWITCH) EXCEPT FOR APPROVED PROCEDURES WHERE USE OF FLAPS AT LESS THAN NORMAL LANDING FLAP POSITION OR LANDING GEAR UP IS SPECIFIED.

Mode 1 through Mode 4 aural warnings have priority over Mode 5 aural alerting. The visual warning and alerting may occur at the same time. The warning and/or alert will continue until the condition(s) are corrected.

The system is armed when all required inputs are valid and the airplane is flown into one or more of the five warning/alerting areas.

The Ground Proximity Warning System alerts the flight crew when one or more of five thresholds is exceeded.

- Mode 1 - Excessive descent rate
- Mode 2 - Excessive terrain closure rate
- Mode 3 - Altitude loss after takeoff or go-around
- Mode 4 - Unsafe terrain clearance while not in the landing configuration
- Mode 5 - Below glide slope deviation alert

NOTE: The GPWS will not provide a warning if an airplane is flying directly towards a vertical cliff.

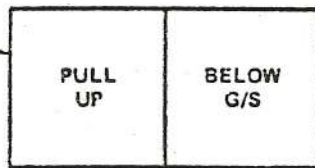
Inputs to the ground proximity computer are radio altitude, barometric altitude rate, glide slope deviation signals from the VHF navigation unit used by the Captain, and landing gear and flap position.

Warning for modes 1 through 4 consists of steady red PULL UP lights and an aural warning WHOOP-WHOOP-PULL-UP. Alerting for mode 5 consists of steady amber BELOW G/S lights and an aural alert which is either soft or loud, as a function of radio altitude and below glide slope deviation. The rate at which GLIDE SLOPE is repeated increases as the airplane deviates farther from the glide slope, or flies closer to the ground.

PULL UP WARNING LIGHT
(Red)

ILLUMINATED

- Excessive descent rate.
- Excessive closure rate.
- Altitude loss after takeoff or go-around.
- Non landing configuration descent.



PILOTS' INSTRUMENT PANEL

BELOW G/S ALERT LIGHT
(Amber)

ILLUMINATED - Airplane more than 1.3 dots below the glide slope.

Both lights have a common light cap. Pressing either pilot's light cap:

- inhibits or cancels glide slope alerting if pressed when radio altitude is between 50 and 1,000 feet and prior to entering loud alerting area.
- performs system test if pressed when radio altitude is not between 50 and 1,000 feet. Test illuminates PULL UP, BELOW GLIDE SLOPE and GPWS FAIL Lights and causes "pull up" and "below glide slope" aural warning and alert to sound.

GPWS FAIL

FLIGHT ENGINEER'S
LOWER PANEL

*(Door warning
annunciator panel)*

GROUND PROXIMITY WARNING SYSTEM FAIL LIGHT

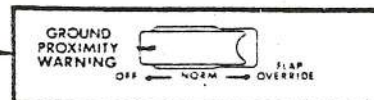
ILLUMINATED - Ground proximity warning computer power lost or invalid inputs received from the navigation unit, CADC, or radio altimeter.

GROUND PROXIMITY WARNING SWITCH

OFF - Deactivates Ground Proximity Warning System.

NORMAL - Flap position logic is provided for Mode 2, Mode 3 and Mode 4.

FLAP OVERRIDE - Inhibits or cancels warnings caused by flaps not in landing configuration.



FORWARD ELECTRONIC
CONTROL PANEL

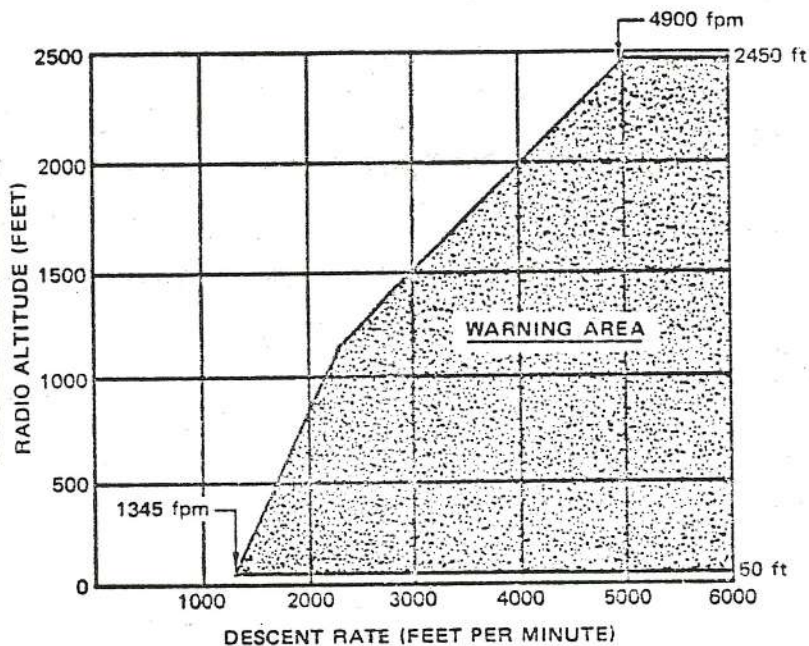
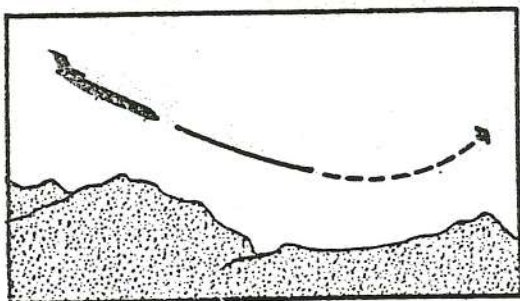
MODE 1 – EXCESSIVE DESCENT RATE

FLIGHT PATH PROFILE-----EXCESSIVE DESCENT RATE ENVELOPE

AURAL – “WHOOOP WHOOP

PULL UP”

VISUAL – **PULL UP**



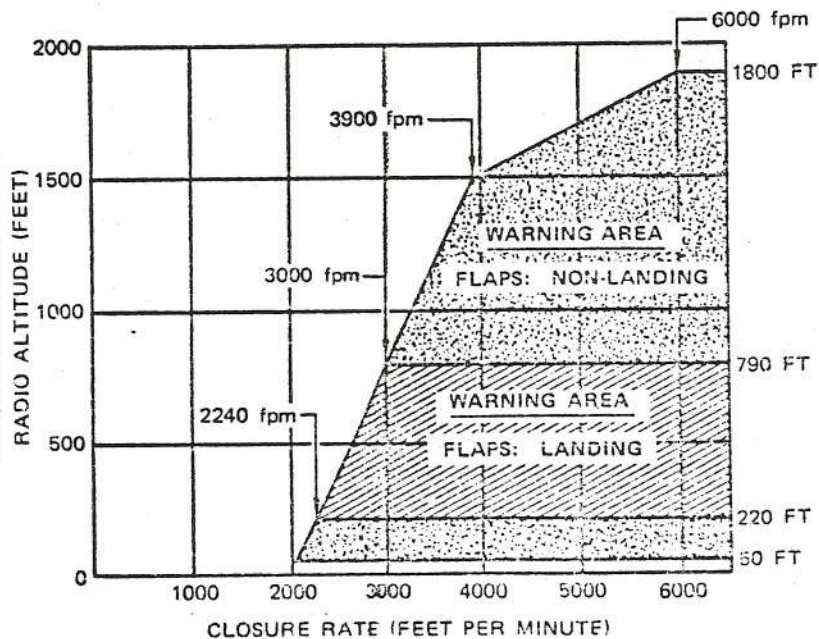
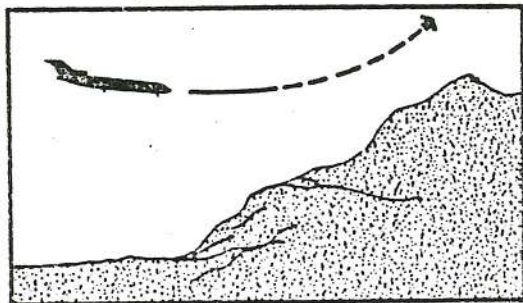
MODE 2 – EXCESSIVE TERRAIN CLOSURE RATE

FLIGHT PATH PROFILE-----EXCESSIVE TERRAIN CLOSURE RATE ENVELOPE

AURAL – “WHOOOP WHOOP

PULL UP”

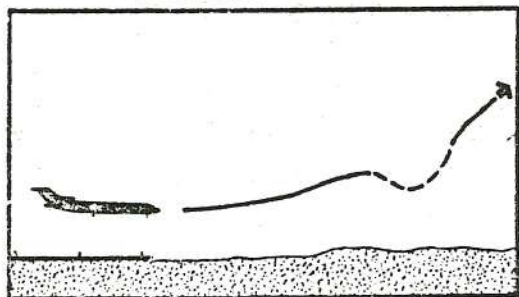
VISUAL – **PULL UP**



MODE 3 – ALTITUDE LOSS AFTER TAKEOFF OR GO-AROUND

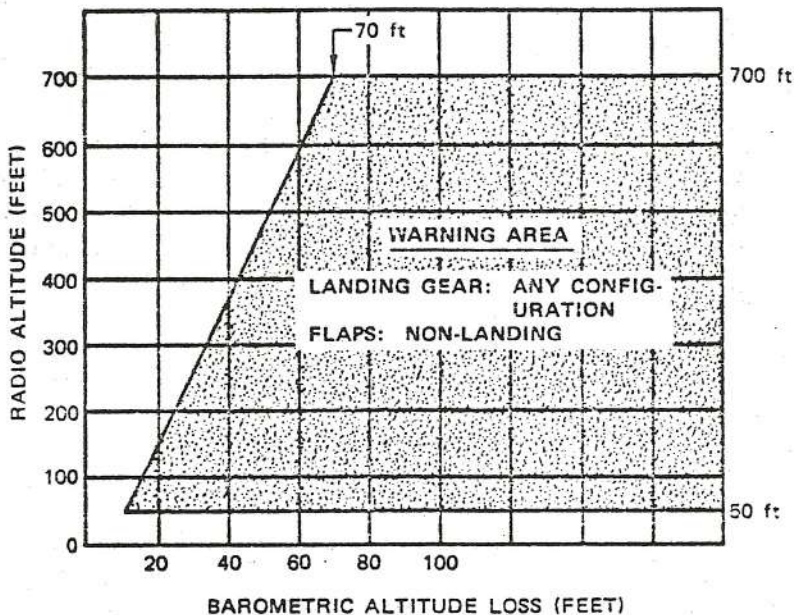
FLIGHT PATH PROFILE----- EXCESSIVE ALTITUDE LOSS AFTER TAKEOFF OR GO-AROUND ENVELOPE

AURAL – "WHOOP WHOOP
PULL UP"
VISUAL – **PULL UP**



NOTE

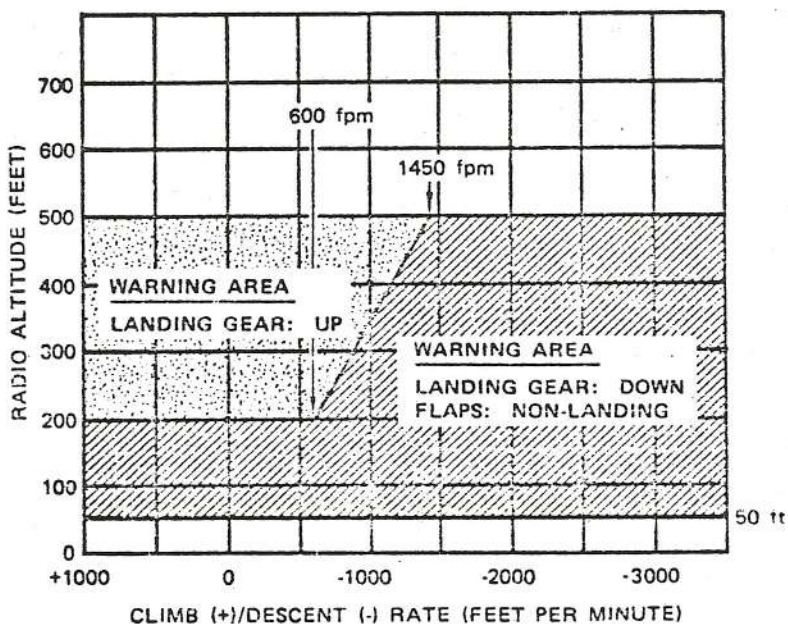
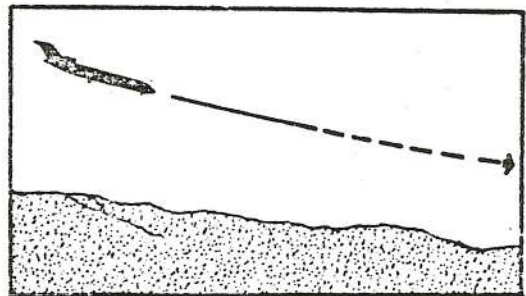
Mode 3 arms when the airplane descends below 200 ft. in landing configuration.



MODE 4 – UNSAFE TERRAIN CLEARANCE WHILE NOT IN THE LANDING CONFIGURATION

FLIGHT PATH PROFILE----- UNSAFE TERRAIN CLEARANCE ENVELOPE

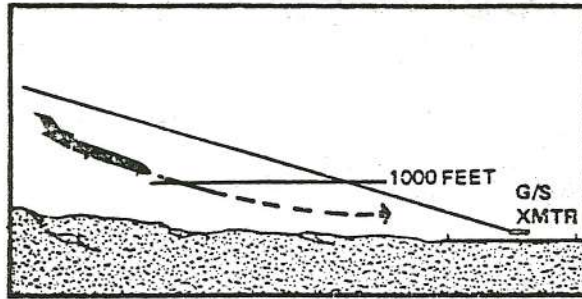
AURAL – "WHOOP WHOOP
PULL UP"
VISUAL – **PULL UP**



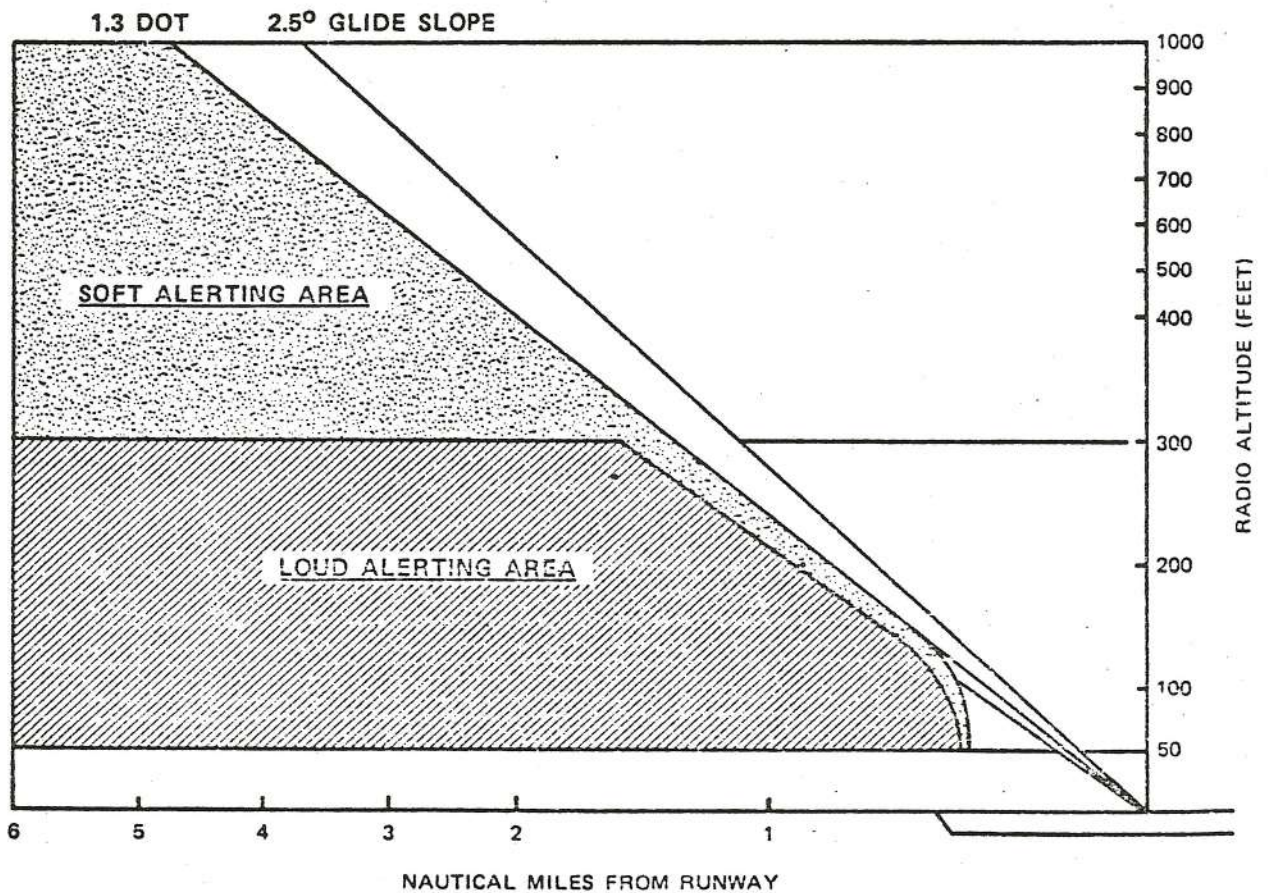
MODE 5 - BELOW GLIDE SLOPE DEVIATION ALERT

FLIGHT PATH PROFILE

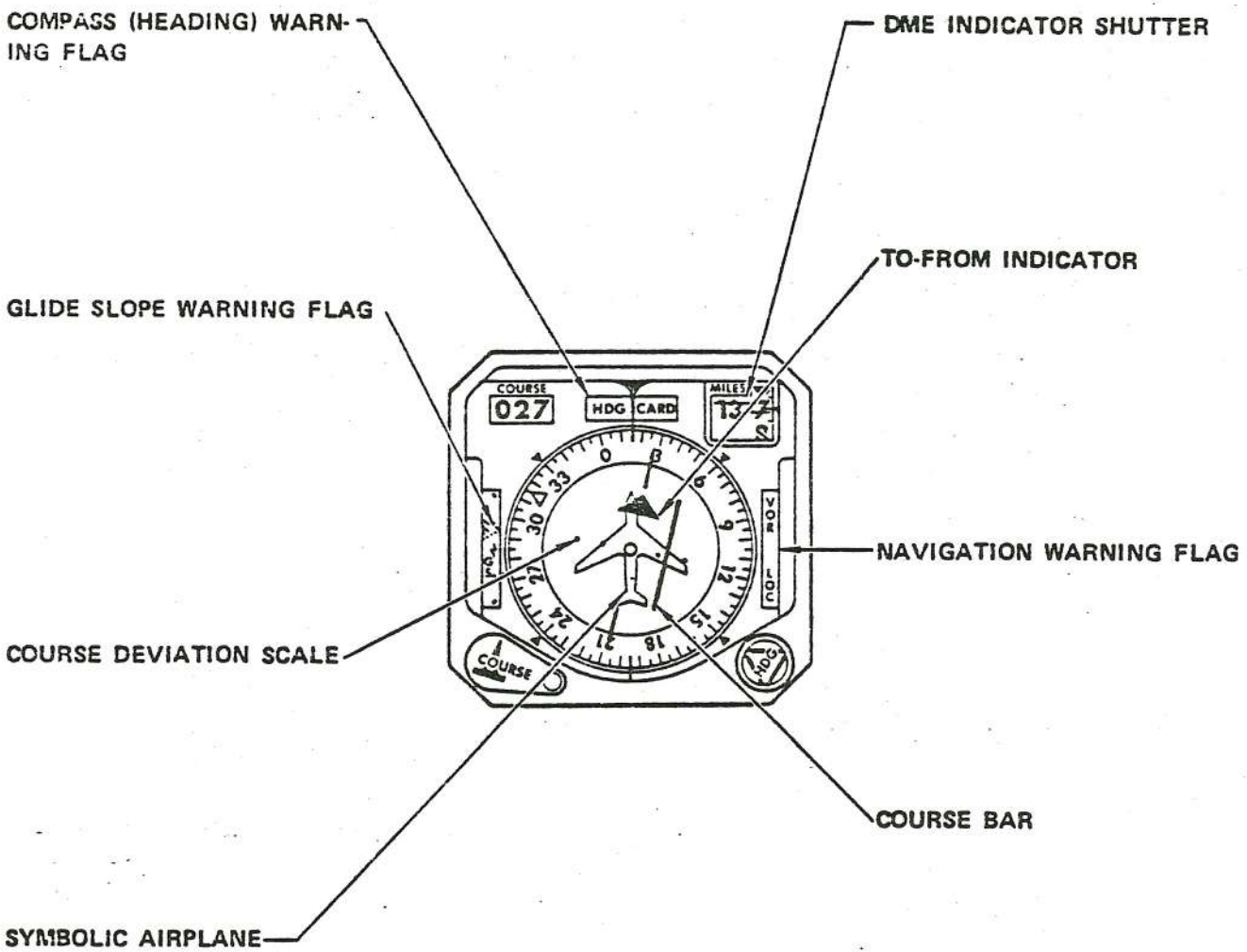
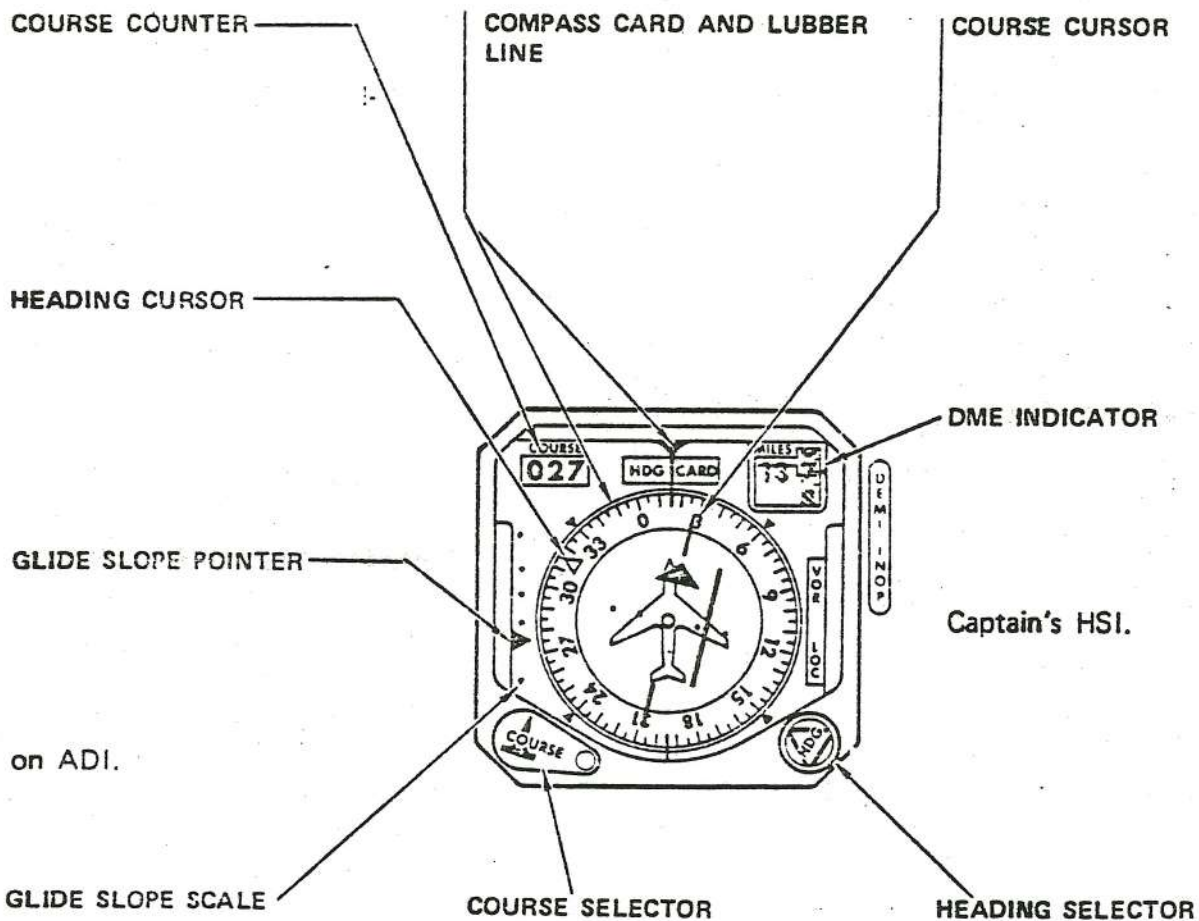
AURAL - GLIDE SLOPE
VISUAL - **BELOW G/S**



BELOW GLIDE SLOPE DEVIATION ENVELOPES



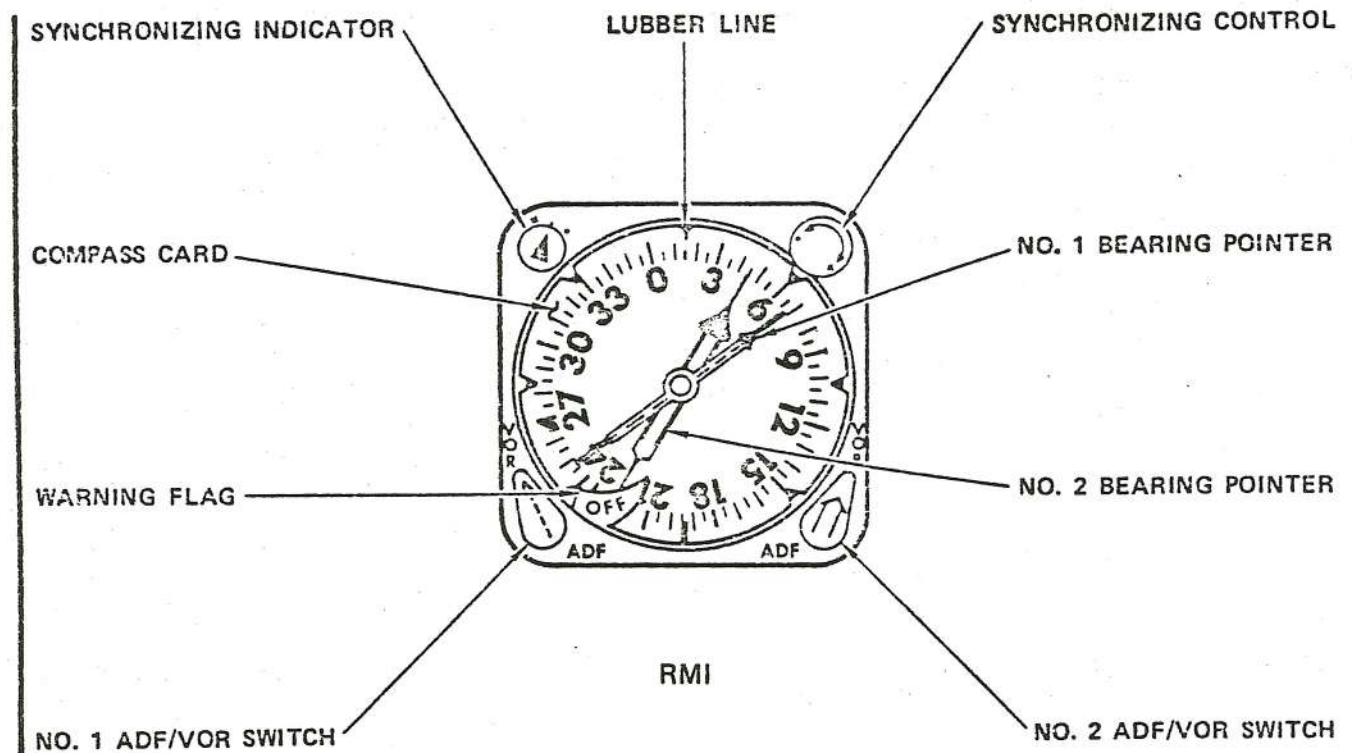
GROUND PROXIMITY WARNING SYSTEM



RADIO MAGNETIC INDICATOR

A radio magnetic indicator (RMI) on each pilot's panel displays magnetic heading from the compass system.
(See COMPASS SYSTEM this chapter.)

Magnetic and relative bearings to selected radio facilities (VOR/ADF) are displayed by the bearing pointers.



PILOTS' PANELS

RADIO MAGNETIC INDICATOR

HORIZONTAL SITUATION INDICATOR

A horizontal situation indicator (HSI) on each pilot's panel displays a plan view of the navigation situation.

COURSE COUNTER
One for each integrated flight system. Digital read-out displays course as set by course selector.

HEADING CURSOR
Indicates desired heading for flight director and/or autopilot operation.

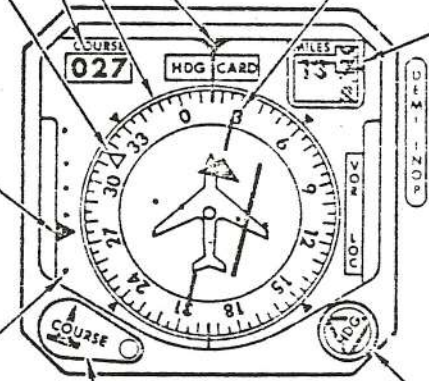
GLIDE SLOPE POINTER
Indicates glide slope location relative to airplane position. In view when localizer frequency is selected. In parallel with glide slope pointer on ADI.

GLIDE SLOPE SCALE
Reference for measuring displacement from glide slope (glide slope pointer). One dot deviation represents approximately 1/3 of a degree.

COMPASS CARD AND LUBBER LINE
Rotating card driven by compass system, indicates airplane magnetic heading under lubber line.

COURSE CURSOR
Indicates selected course corresponding to digital readout on course counter. Rotates with compass card.

DME INDICATOR
Indicates slant range in nautical miles to station tuned on corresponding VHF NAV radio. Shown with shutter in view. Inoperative on Captain's HSI.



COURSE SELECTOR
One for each integrated flight system. Rotation adjusts associated course counter, and course cursor to desired course for VOR or localizer navigation.

HEADING SELECTOR
Rotation of selector adjusts heading cursor on Captain's and First Officer's HSI's. Selects heading for computed steering commands. Selected heading transmitted to autopilot and flight director

COMPASS (HEADING) WARNING FLAG

- Compass system power fails
- Signal is unreliable
- Compass display is in error.

GLIDE SLOPE WARNING FLAG

IN VIEW over glide slope scale and pointer after localizer frequency is tuned when

- Glide slope power fails
- Signal is unreliable.
- In parallel with glide slope warning flag on ADI.

COURSE DEVIATION SCALE

Reference for measuring displacement from selected course (course bar). One dot deviation of course bar represents approximately 5 degrees on VOR and 1¼ degrees on localizer.

SYMBOLIC AIRPLANE

Represents airplane position relative to the selected course (course bar).



DME INDICATOR SHUTTER

Covers DME digital readout when signal unreliable, during search, or when power is off.

TO-FROM INDICATOR

Indicates direction of VOR station along selected course. **OUT OF VIEW** in localizer operation. Shown in **TO** position.

NAVIGATION WARNING FLAG
IN VIEW

- VHF NAV radio power fails
- Signal is unreliable.

COURSE BAR

Moveable center portion of course cursor represents segment of VOR radial or localizer beam. Relationship of bar to course deviation scale shows airplane position with respect to selected course.

The ADI presents a pictorial rear view of the pitch and bank attitude of the airplane. Computed steering commands are presented on the ADI by command

bars which are read with respect to a delta-shaped fixed symbolic airplane in the center of the ADI.

MINIMUM DECISION ALTITUDE (MDA) ANNUNCIATOR

Operated by radio altimeter. Light illuminates when airplane descends to altitude selected on radio altimeter.

BANK ANGLE SCALE AND POINTER

Displays roll attitude relative to symbolic airplane. A full 360 degree roll presentation is possible. Scale increments - 10, 20, 30, 45 and 60 degrees. Pointer and horizon receive signals from vertical gyro.

HORIZON AND PITCH SCALE

Displays pitch attitude by the vertical position of the movable pitch tape relative to the fixed symbolic airplane. Scale above horizon - 5, 10, 15, 20, 40, 60, 90 degrees; below horizon - 10, 20, 40, 60, 90 degrees.

GLIDE SLOPE POINTER

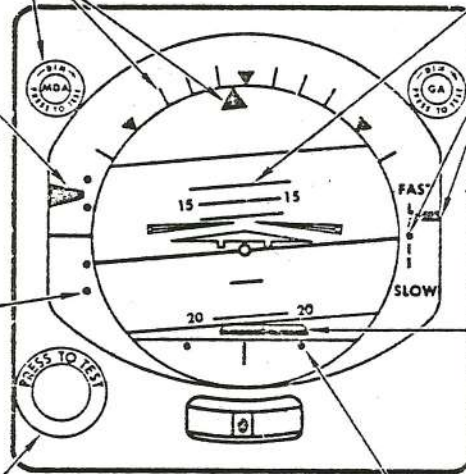
Displays vertical position relative to GS; out of view until localizer frequency selected; in parallel with pointer on HSI. If pointer is above center scale mark, airplane is below the glide slope.

GLIDE SLOPE SCALE

Fixed scale measures airplane displacement above or below glide slope beam. Each dot equals approximately .35 degree.

FLIGHT DIRECTOR TEST SWITCH

Activates self-test circuits. Attitude tape should indicate climbing right turn. GYRO and STEER flags will appear and command bars will be driven from view.



SPEED COMMAND POINTER AND SCALE

Displays fast-slow "state of condition" of airplane air-speed versus selected or programmed airspeed. See system description.

RUNWAY/LOCALIZER SYMBOL

Displays localizer deviation and relative altitude above the terrain. In view when corresponding VHF NAV receiver is tuned to a localizer frequency. Lateral movement across deviation scale represents airplane displacement left or right of localizer beam center line. The runway symbol will move up toward the fixed symbolic airplane to show radio altitude while on final ILS approach.

LOCALIZER DEVIATION SCALE

Displays expanded center portion of the Course Deviation Scale on the HSI. Outside marks represent 1/4 degrees displacement from localizer beam center line (same as one dot deviation on HSI).

SYMBOLIC AIRPLANE

Fixed symbol — rear view of airplane. Reference for airplane attitude when related to bank angle and horizon scales. Reference for flight commands when related to command bars.

GYRO WARNING FLAG

IN VIEW

- Vertical gyro power is lost
- Gyro in fast erection cycle
- Instrument amplifier power is lost

Requires power to retract. Command bars driven from view. Computer warning flag appears with gyro flag. Radio and heading displays are still correct if the corresponding flags are not shown.

GLIDE SLOPE WARNING FLAG

OUT OF VIEW

- Localizer frequency selected and GS signal is reliable.

IN VIEW

- Glide slope power fails
- Signal is unreliable
- Glide slope receiver malfunctions.

In parallel with glide slope warning flag on HSI.

NOTE

Generally, if a flag is displayed and the information from the source affected by the particular flag is being used to compute V-bar commands, the V-bars will be driven from view. One notable exception is the RUNWAY flag.

GO AROUND (GA) ANNUNCIATOR

Illuminates when system is in GA mode.

COMPUTER WARNING FLAG

IN VIEW

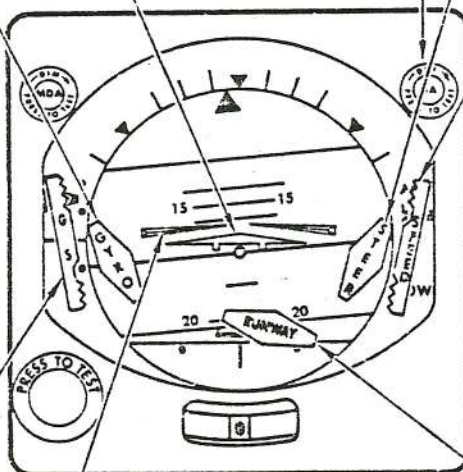
- GYRO flag is in view
 - Power fails
 - Steering computer fails
 - Flight director computer information not valid
- Will also appear with Speed-Attitude Command flag if pitch commands are being supplied by SACS computer.

SPEED ATTITUDE COMMAND WARNING FLAG

IN VIEW

- SACS power fails
- SACS computer malfunctions

STEER flag will appear with SPEED flag if pitch commands are being supplied by SACS computer



COMMAND BARS

Displays computed pitch and roll attitudes which the airplane must assume to make good the desired course and altitude or glide path. When in the GA mode for take-off or go-around, the command bars call for pitch attitudes computed by the speed-attitude command system computer. Airplane is maneuvered to fly the symbolic airplane into the vee formed by the command bars.

RUNWAY WARNING FLAGS

Monitors Navigation Warning Flag (VOR/LOC on HSI), displays servos, power and radio altimeter. Flag circuits operate when corresponding VHF NAV receiver tuned to a LOCALIZER frequency.

IN VIEW

- LOC frequency weak or unreliable
 - Receiver failed, or display servos system failed
 - If in view with NAV (VOR/LOC) flag, command bars will be driven from view
- Any time Runway flag is in view, radio altimeter/localizer deviation information is unreliable.

Three VHF navigation units, each consisting of VOR, localizer, and glide slope components provide signals to the ADI, the HSI and the FMI. Frequency selector controls for the

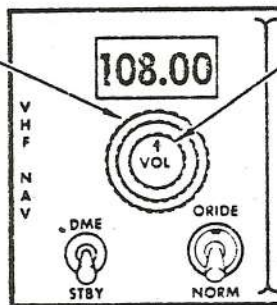
system are accessible to both pilots on the aft electronic control panel. The third (auxiliary) radio is available to either pilot through the navigation radio switch.

FREQUENCY SELECTOR

Used to select VOR or ILS frequencies in the range of 108.0 to 117.95 megacycles.

VOLUME CONTROL

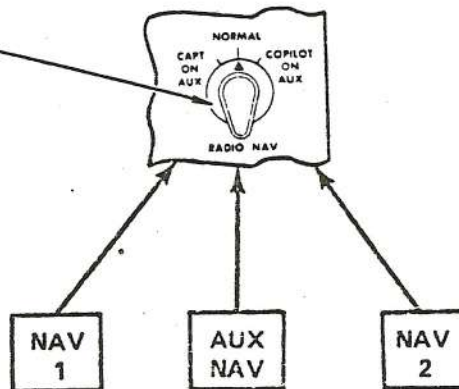
Clockwise rotation increases volume.



AFT ELECTRONICS
CONTROL PANEL

NAVIGATION RADIO SWITCH

Selects navigation radio, VOR-ILS, input to controls (See instrument transfer switching, this section). DME is not switched.



OVERHEAD PANEL

VHF NAVIGATION SYSTEM

DISTANCE MEASURING EQUIPMENT

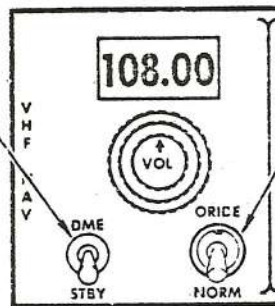
Dual distance measuring equipment (DME) systems provide slant range in nautical miles to stations tuned.

Both pilots have displays as shown below. A shutter will cover the respective display if the equipment is not operating or if the signal is unreliable.

DME SWITCH

STBY (standby) – The DME set is warmed up and ready for use.

DME – The interrogator will search up to 200 miles if operating on a VOR facility and up to 50 miles if operating on a terminal VOR (TVOR) facility (with override switch in NORMAL).



DME OVERRIDE SWITCH

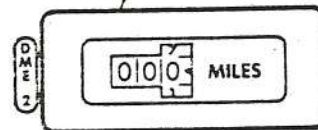
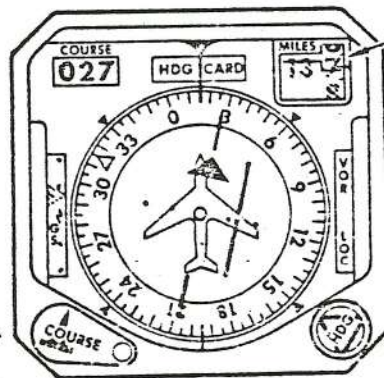
NORM – Normal operating position. Interrogator searches as described under DME switch for DME position.

O'RIDE – The interrogator will search beyond the normal 50-mile range when operating on a terminal VOR facility.

AFT ELECTRONICS
CONTROL PANEL

DME INDICATORS

Each pilot has 2 indicators showing slant range mileages to stations selected on NAV-1 and NAV-2 radios.

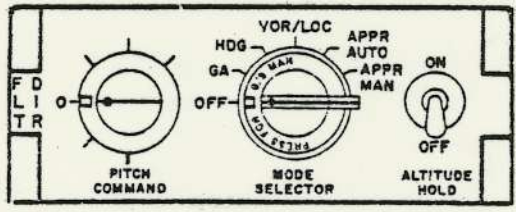


DISTANCE MEASURING EQUIPMENT

FLIGHT DIRECTOR CONTROLS

A flight director control panel is provided for each integrated flight

system. Each pilot is provided with a means of selecting a mode in which his individual flight director system will operate. Pitch command and altitude hold are also available.



FLIGHT DIRECTOR MODE SELECTOR

OFF – Command bars driven out of view. The ADI then displays attitude information only.

GA (Go Around) – Selected by rotating the mode selector to GA or when the Mode Selector is in APPR AUTO or APPR MAN, Go Around is instantly available by actuating the palm-operated go around switches on the thrust levers. The Mode Selector then rotates automatically to GA. In either case, the GA annunciator illuminates and the command bars will call for a WINGS-LEVEL pitch angle to maintain optimum climb-out speed. The Mode Selector must be rotated to another position to disengage the go-around circuits.

HDG (Heading) – The flight director computer receives heading information as set by the heading selector on the HSI. The command bars on the ADI indicate how the airplane must be maneuvered to maintain the selected heading.

VOR/LOC (VOR-Localizer) – The flight director computer receives deviation signals from the associated VHF navigation radio. The radio must be tuned to a VOR or ILS localizer frequency and the desired course (radial) must be set in the HSI. Lateral deviation from the radio is shown by the course bar on the HSI. The command bars on the ADI will indicate how the airplane must be maneuvered to intercept and track the desired course.

To capture a radial from a selected intercept heading, the heading cursor on the HSI must be set and the mode selector rotated directly from HDG to VOR/LOC.

To capture a radial from a fixed intercept angle (approx 46°), the mode selector must be rotated to APPR MAN and then directly to VOR/LOC mode for the capture. The course cursor is set for the radial to be captured. The system will follow the heading cursor until the airplane is approximately 5 degrees from the radial.

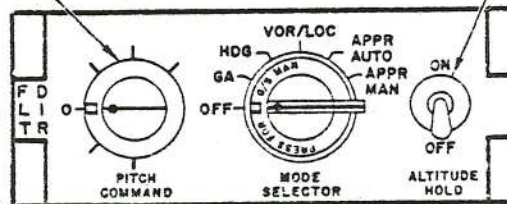
The computer will then switch to VOR operation and proceed to capture the radial set on the course cursor. The command bars will call for a maneuver to roll out and track the course while compensating for crosswind.

APPR AUTO (glide slope automatic) – Tuning and course selection is the same as in VOR/LOC except that only ILS (localizer) frequencies are usable. The glide slope frequency is automatically tuned with localizer frequency selection. The command bars as well as the glide slope pointer and the runway symbol will indicate how the airplane must be maneuvered to stay on the localizer course and on the glide slope. The same information is displayed on the HSI by the course bar and the glide slope pointer. The approach must be made from below the glide slope to insure automatic "capture" of the glide slope.

APPR MAN (glide slope manual) – Tuning and course selection is the same as in APPR AUTO. The command bars provide commands for a fixed angle intercept of the selected localizer course and an immediate "fly to" command to the associated glide slope. Localizer intercept is at a fixed 45-degree angle; glide slope capture can be from above or below.

PITCH COMMAND CONTROL

Permits manual selection of a pitch-up or pitch-down angle. The command bars will call for a pitch-up or pitch-down attitude to agree with the selected angle. The control is calibrated in 5-degree increments from +15 through -10 degrees. Not effective with altitude hold switch ON, or after glide slope capture in APPR AUTO mode.



FORWARD ELECTRONIC CONTROL PANEL

ALTITUDE HOLD SWITCH

ON – The command bars will call for pitch commands to maintain a constant pressure altitude in HDG and VOR/LOC modes, and in the APPR AUTO mode prior to glide slope capture. The command bars call for climb or descent necessary to maintain the barometric altitude indicated on the altimeter at the time the altitude hold switch is engaged.

OFF – Switch automatically returns to OFF position after glide slope capture or when mode selector is set to APPR MAN.

NOTE

The system should be placed in HDG mode whenever a new frequency or course is selected which will result in a significant displacement of the course bar HSI and should remain in HDG until any false rate signals have been eliminated. This may take several minutes depending on the magnitude of the change.

NOTE

For additional functions pertaining to the Speed Attitude Command System, see system description, this chart.

INTEGRATED FLIGHT SYSTEM

An integrated flight system for each pilot provides a display of airplane position, attitude and the commands necessary to intercept and hold a desired flight path and altitude. This flight information is displayed by the attitude director indicator (ADI) and the horizontal situation indicator (HSI) and augmented by the radio magnetic indicator (RMI). The flight director controller enables the manual selection of operating modes, pitch angle commands, altitude hold, heading, course and VHF NAV radio outputs.

Each integrated flight system consists of a complex inter-relationship between raw data inputs and displays and computed data displays.

Raw (non-computed) data is distributed for each pilot as follows:

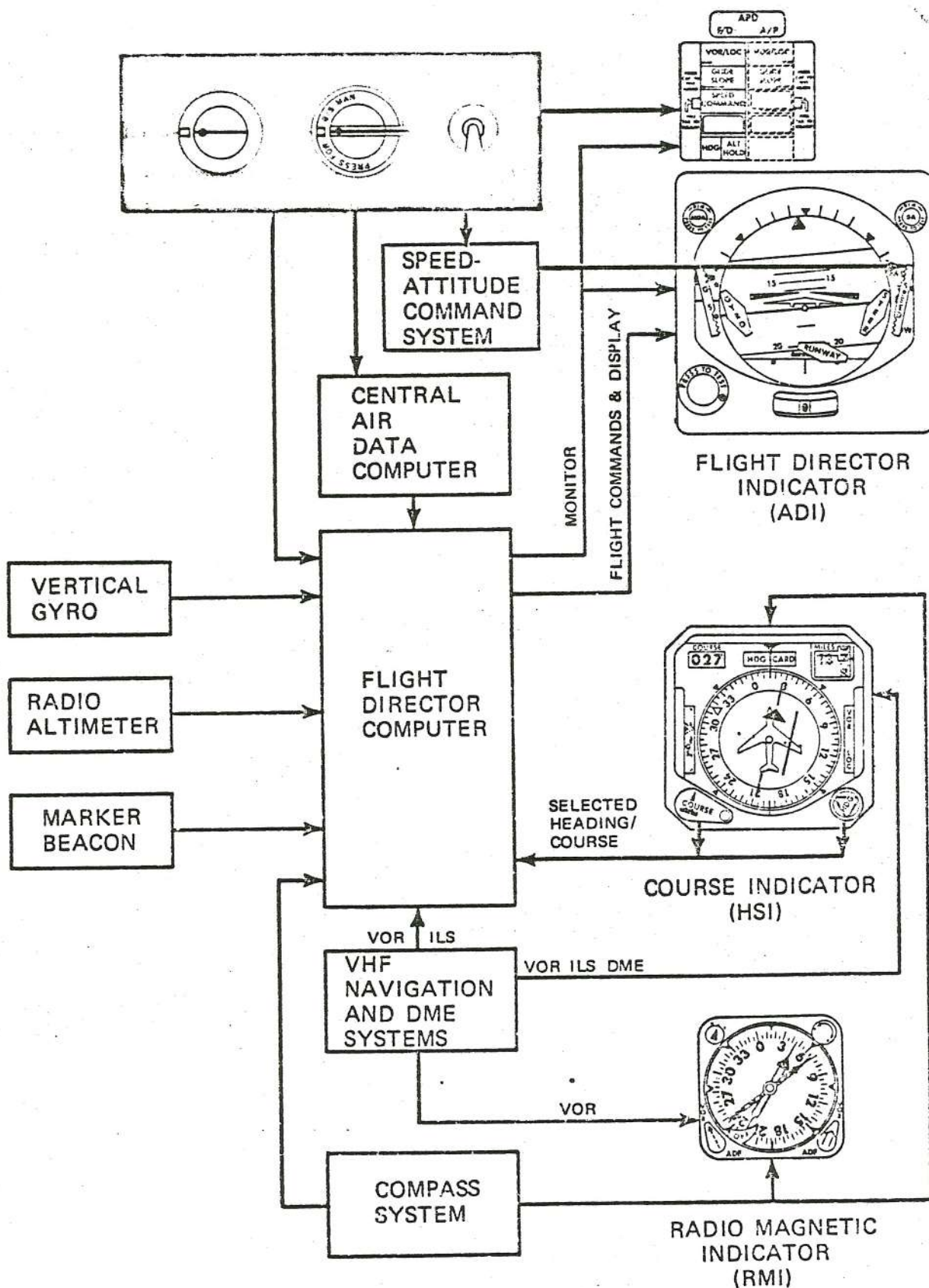
- Vertical gyro provides pitch and roll sensing to the ADI horizon.
- VHF NAV provides radio bearing to the RMI pointers.
- VHF NAV provides VOR/localizer and glide slope deviation signals to the HSI and ADI.

- Speed command computer provides speed deviation for display on ADI.
- Compass provides magnetic heading to VHF NAV and to the compass cards on the HSI and RMI.
- Warning flag retraction power is provided by each system to its respective indicator(s).

Raw data is also provided to each flight director computer as shown on the accompanying chart. The computed data output is distributed and displayed as follows:

- Illuminates appropriate annunciator(s) on the F/D approach progress display (APD).
- Drives the command bars on the ADI. |

With altitude hold selected, an input is made from the controller to the air data computer. The air data computer provides altitude error enabling steering commands to a selected altitude.



**INTEGRATED FLIGHT SYSTEM
(TYPICAL FOR EITHER PILOT)**

COMPASS SYSTEM

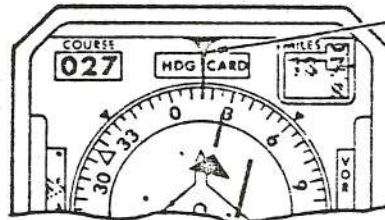
Two gyro compass systems provide the directional references for the pilots' RMI's, the integrated flight systems, the autopilot, and the flight recorder. The compass systems operate as slaved magnetic compasses, thereby performing as directional gyros with magnetic sense.

A standby magnetic compass is mounted on a hinged support above the center of the pilots' windshield. When not in use, the compass may be folded upward. The compass is calibrated in the inflight cruise condition.

When switching compass to a non-normal position, resync switched RMI to good RMI.

COMPASS TRANSFER ANNUCIATOR

ILLUMINATED - Compass switch is in either transfer position.



COMPASS WARNING FLAG

Operates with OFF flag on RMI.

HSI

COMPASS

LUBBER LINE

Stationary reference mark. Indicates compass heading.

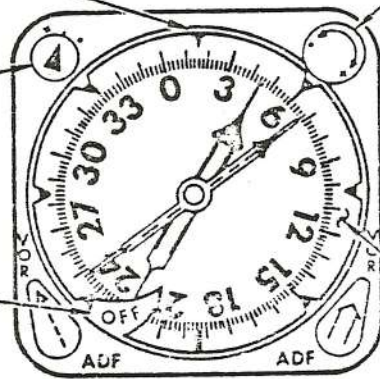
SYNCHRONIZING INDICATOR

Points to either cross or dot when RMI is not synchronized with compass system.

COMPASS WARNING FLAG

Appears:

- Heading power lost, or
- Monitor voltage lost, or
- Excessive error in system.
- Compass Warning Flag on HSI also appears.



RMI

SYNCHRONIZING CONTROL

Synchronizes RMI compass card to compass system when required by indicator (cross or dot indicates out-of-sync condition). Rotate control toward symbol displayed by indicator.

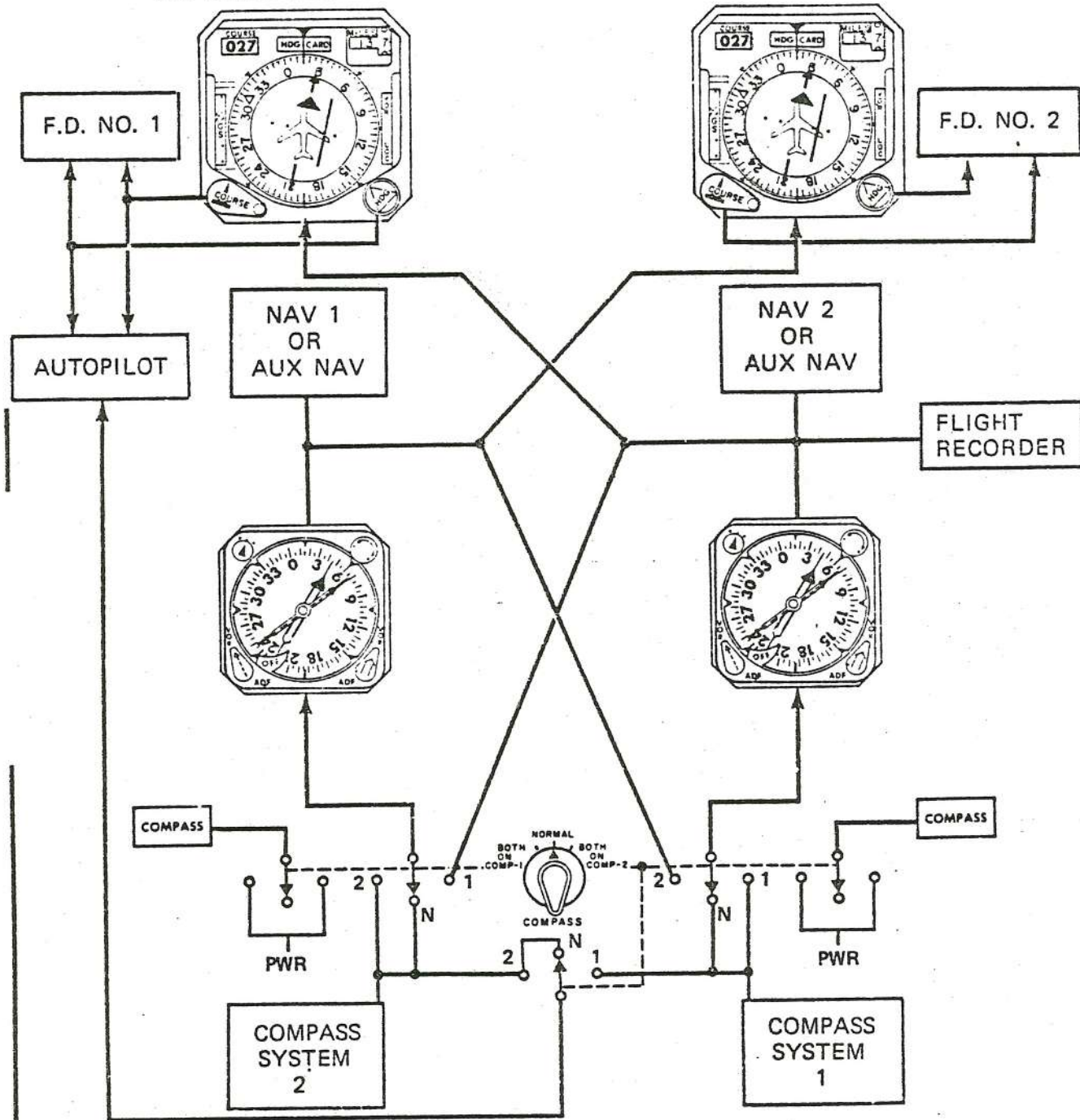
COMPASS CARD

Rotating 360 degrees scale. Compass cards are driven by the compass systems selected on the compass transfer switch.

PILOTS' PANELS

CAPTAIN'S INSTRUMENTS

FIRST OFFICER'S INSTRUMENTS



COMPASS SWITCH

SWITCH POSITION	EQUIPMENT INPUT					
	CAPT RMI	F/O HSI	AUTO PILOT		F/O RMI	CAPT HSI
			TURN KNOB	CAPT HSI COURSE & HEADING		
NORMAL		COMP 2		COMP 1		
BOTH ON 1		COMP 1		COMP 1		
BOTH ON 2		COMP 2		COMP 2		

COMPASS SYSTEM

ATTITUDE SYSTEM

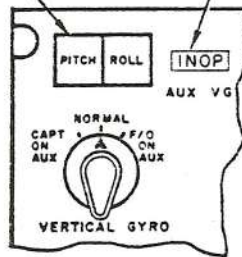
The Vertical Gyro Transfer switch permits either pilot to select the Auxiliary Vertical Gyro to replace his nor-

mal system. The Gyro and STEER (Computer) Warning Flags both appear when the selected gyro input fails.

COMPARATOR LIGHTS

AUXILIARY VERTICAL GYRO ANNUNCIATOR

BLANK – AUX VG operating normally.
INOP – AUX VG failure.



OVERHEAD
PANEL

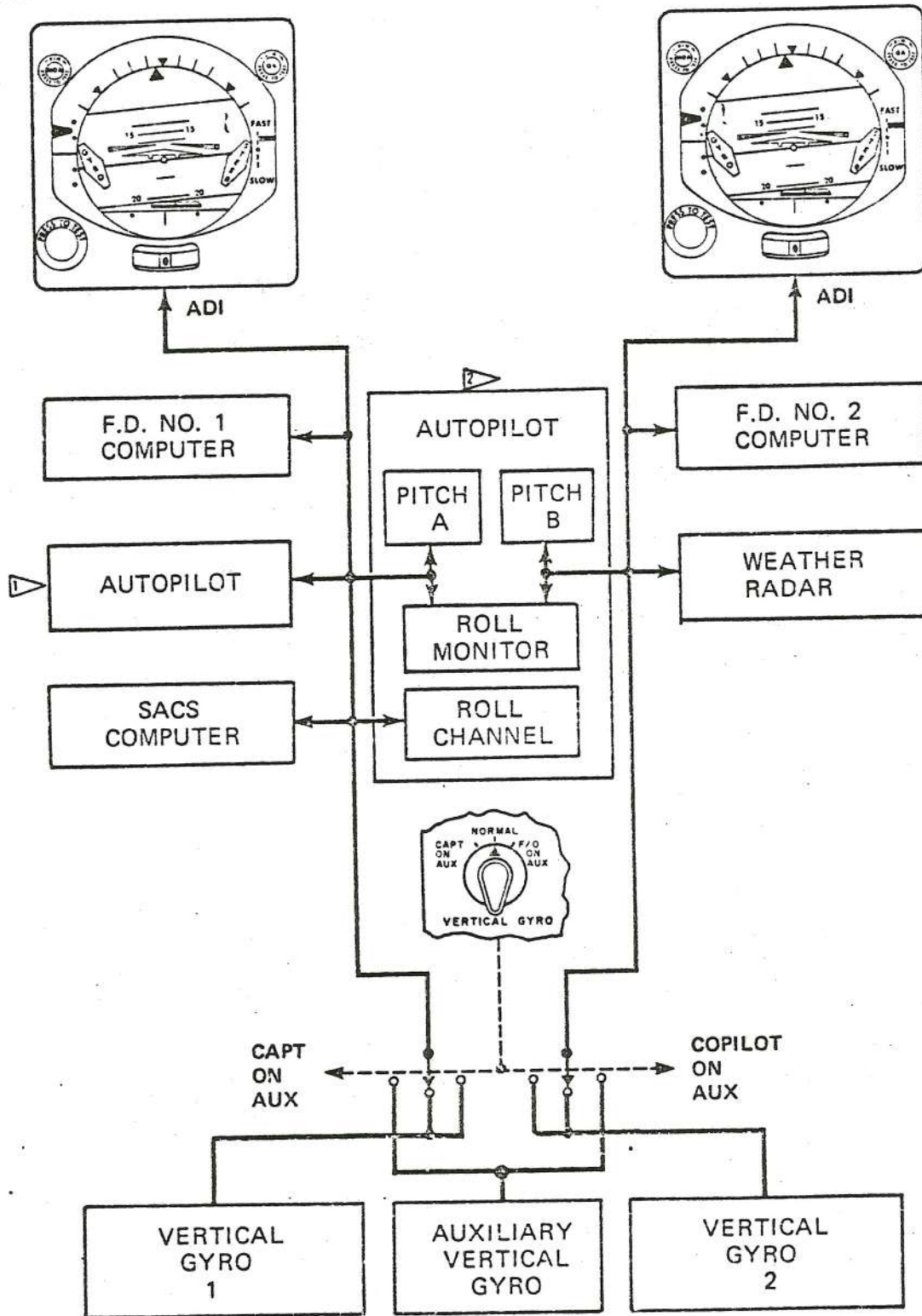
VERTICAL GYRO SWITCH

SWITCH POSITION	EQUIPMENT / GYRO INPUT						
	CAPT ADI	FD COMP NO. 1	*AUTO-PILOT	SACS COMP.	WEATHER RADAR	F/O ADI	FD COMP. NO. 2
NORMAL	VG-1				VG-2		
CAPT ON AUX	AUX VG				VG-2		
F/O ON AUX	VG-1				AUX VG		

*See opposite page

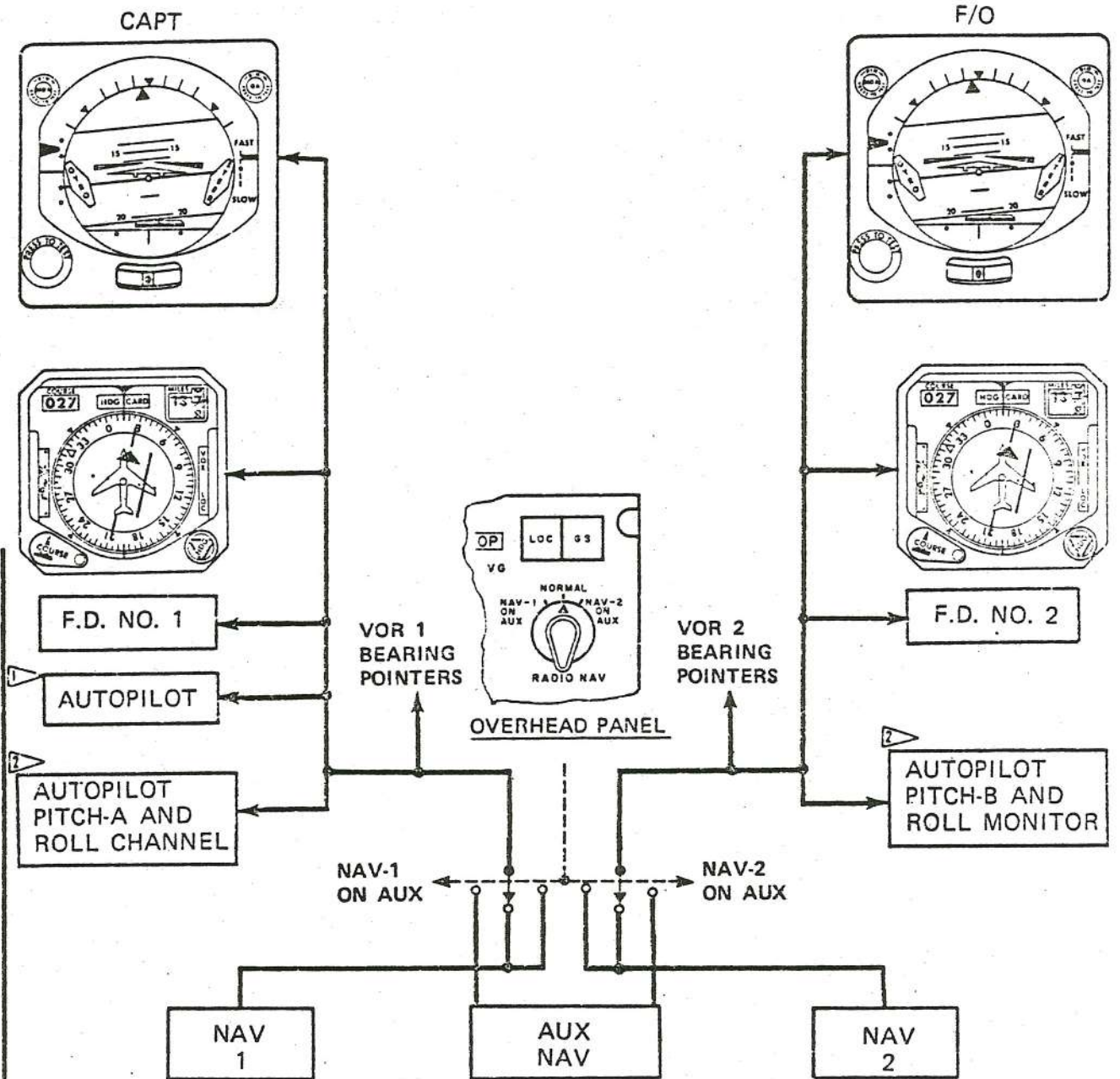
CAPTAIN'S INSTRUMENTS

FIRST OFFICER'S INSTRUMENTS



1 *Apl. S/N 20144, Reg. No. N8825E and like configuration.*
 2 *Apl. S/N 21449, Reg. No. N8876Z and like configuration.*

ATTITUDE SYSTEM



VHF NAV TRANSFER SWITCH POSITION	EQUIPMENT/NAVIGATION SYSTEM INPUT							
	CAPT ADI	AUTO PILOT	CAPT HSI	RMI'S	AUTO PILOT	F/O ADI	F/O HSI	RMI'S
NORMAL								
NAV-1 ON AUX								
NAV-2 ON AUX								

NOTE: DME not switched.

- 1 Apl. S/N 20144, Reg. No. N8825E and like configuration.
- 2 Apl. S/N 21449, Reg. No. N8876Z and like configuration.

VHF NAVIGATION SYSTEM

APPROACH PROGRESS DISPLAY

Pressing the F/D (left side of the APD) will illuminate all amber lights

on the display for test. Pressing the A/P (right) side of the APD will illuminate all green lights.

VOR/LOC

AMBER

— System armed in VOR LOC or APPR AUTO modes prior to intercept of VOR radial or localizer beam.

GREEN

— Capture of radial or localizer beam in VOR/LOC or APPR AUTO modes. Green when APPR MAN selected.

GLIDE SLOPE

AMBER

— System armed in APPR AUTO mode — prior to intercept of glide slope.

GREEN

— Capture of glide slope beam in APPR AUTO mode. Green when APPR MAN selected.

NOTE

Both VOR;LOC (Green) and Glide Slope (Green) will illuminate in APPR MAN to indicate automatic feature has been by-passed.

SPEED COMMAND

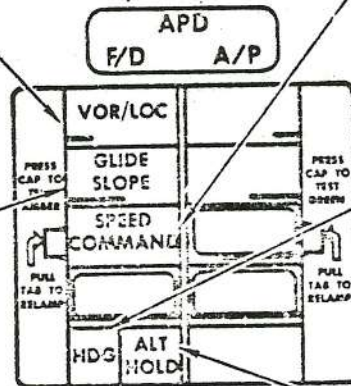
GREEN — Illuminates when Flight Director Mode Selector is in the GA position.

HEADING

GREEN — Illuminates when Flight Director Mode Selector is in the HDG position.

ALTITUDE HOLD

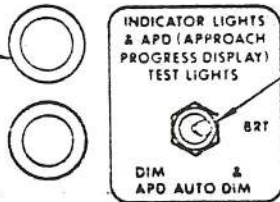
GREEN — Illuminates when altitude hold function is selected on the Flight Director Controller.



APD
(APPROACH PROGRESS DISPLAY)

PHOTOELECTRIC CELLS

(One set with each APD)



PILOTS' CENTER PANEL

INTENSITY SWITCH

TEST

— Has no effect on APD

BRIGHT

— All steady bright when on.

DIM & APD AUTO DIM

— APD light intensity controlled automatically by 2 photoelectric cells.

APD LIGHT INTENSITY CONTROLS

APPROACH PROGRESS DISPLAY

The Speed Attitude Command System (SACS) provides supplemental speed/attitude information, through the Attitude Director Indicator (ADI), to aid the pilot in acquiring and maintaining computed attitudes and airspeeds. The system may be used for climb after takeoff, approach, rotation for go-around and go-around. With the mode selector in the GA position, speed command information is presented on the Command Bars and Slow/Fast Indicator; in all other modes only the Slow/Fast Indicator presents SACS information. SACS may be used in conjunction with, and always as a supplement to, the primary airspeed and attitude indicators.

MODE SELECTOR

GA (Go Around Mode)

- GA light on ADI illuminates when selector is manually rotated to GA or when go around switches are used to trip the selector to GA.
- Used for climb after takeoff or for go around.
- Command bars call for wings-level pitch attitudes required for computed climb airspeeds. (20° pitch limit)
- Slow/Fast indicator shows deviations from airspeeds based on computer-programmed angles of attack and flap positions.

HDG (Heading Mode)

- Slow/Fast indicator only displays SACS information.
- Switching to HDG after GA will cause the command bars to direct flight on the heading set on the HSI; pitch commands will relate to the setting on the Pitch Command Control.

VOR/LOC AND APPROACH MODES

- Command bars do not display SACS information in these modes.
- Slow/Fast indicator is effective for computed approach speeds (V_{Ref}) or for higher speeds as selected with the SACS Speed Control (0-25° flaps). The angle of attack references are determined by the flap position.
- In turbulent air a gust bias circuit will automatically increase the reference speeds (up to 13 knots) for final approach flap settings, 30 and 40 degrees.

This system incorporates a single SACS computer which provides pitch command and speed deviation information to each of the pilot's Flight Director Systems. Each pilot can independently select the desired speed command display for this ADI, irrespective of the position of the other pilot's mode selector.

The airspeeds computer are based on the Flight Manual takeoff speeds (V_2) and final approach speeds (V_{REF}) for the operating flap settings, CG, gross weight and applied thrust. A speed control enables the selection of airspeeds higher than the computed airspeed program. Additional Flight Director Control functions are as follows:

GO AROUND SWITCHES

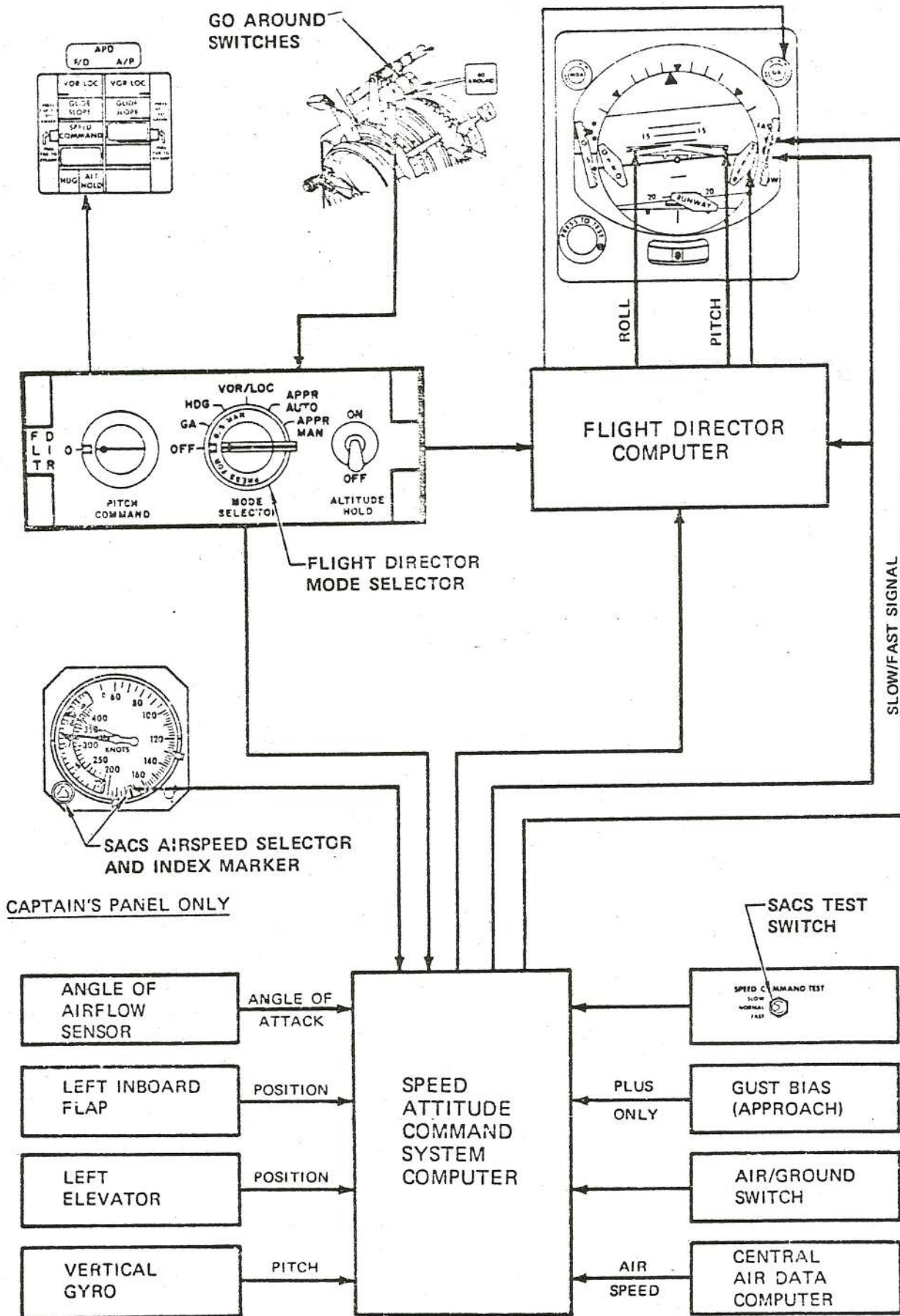
- Palm-operated switches on throttles.
- When pressed in APPR AUTO or APPR MAN modes, selector will rotate automatically to GA, initiating SACS go-around information on the command bars and slow/fast indicator.

SACS TEST SWITCH

- Used in conjunction with the stall warning switch to perform self-test of SACS. See CHAP 04.19.

SACS AIRSPEED SELECTOR AND INDEX MARKER

- Selector on the Captain's Mach Airspeed Indicator provides airspeed inputs to SACS computer; the function of the First Officer's Selector is unchanged.
- Provides for setting airspeeds higher than the SACS computed airspeed program. Speed selections below programmed speed are not accepted by the computer.
- With approach modes selected, speed selector is operable throughout the 0° -25° flap range.
- Speed selector will not affect SACS airspeeds when flaps are in the 30° -40° landing position.



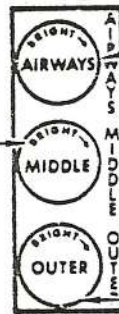
SPEED ATTITUDE COMMAND SYSTEM
(Sheet 2 of 2)

MARKER BEACON SYSTEM

The marker beacon system consists of a single receiver and two sets of indicator lights. The system provides visual and aural indication of airplane position over airways and approach beacons that transmit on 75 MHz.

Marker beacon audio is heard through the cockpit speakers or the individual headsets with the marker receive audio switch on the audio selector panel ON.

MIDDLE MARKER LIGHT
(Amber)
Illuminates flashing when over ILS middle marker beacon. (1300 Hz signal.)



AIRWAYS LIGHT (Clear)
Illuminates steady when over airways beacon or flashing when over airway fan marker beacon. (3000 Hz signal.)

OUTER MARKER LIGHT (Blue)
Illuminates flashing when over ILS outer marker beacon. (400 Hz signal.)

CENTER AND
FIRST OFFICERS
PANELS

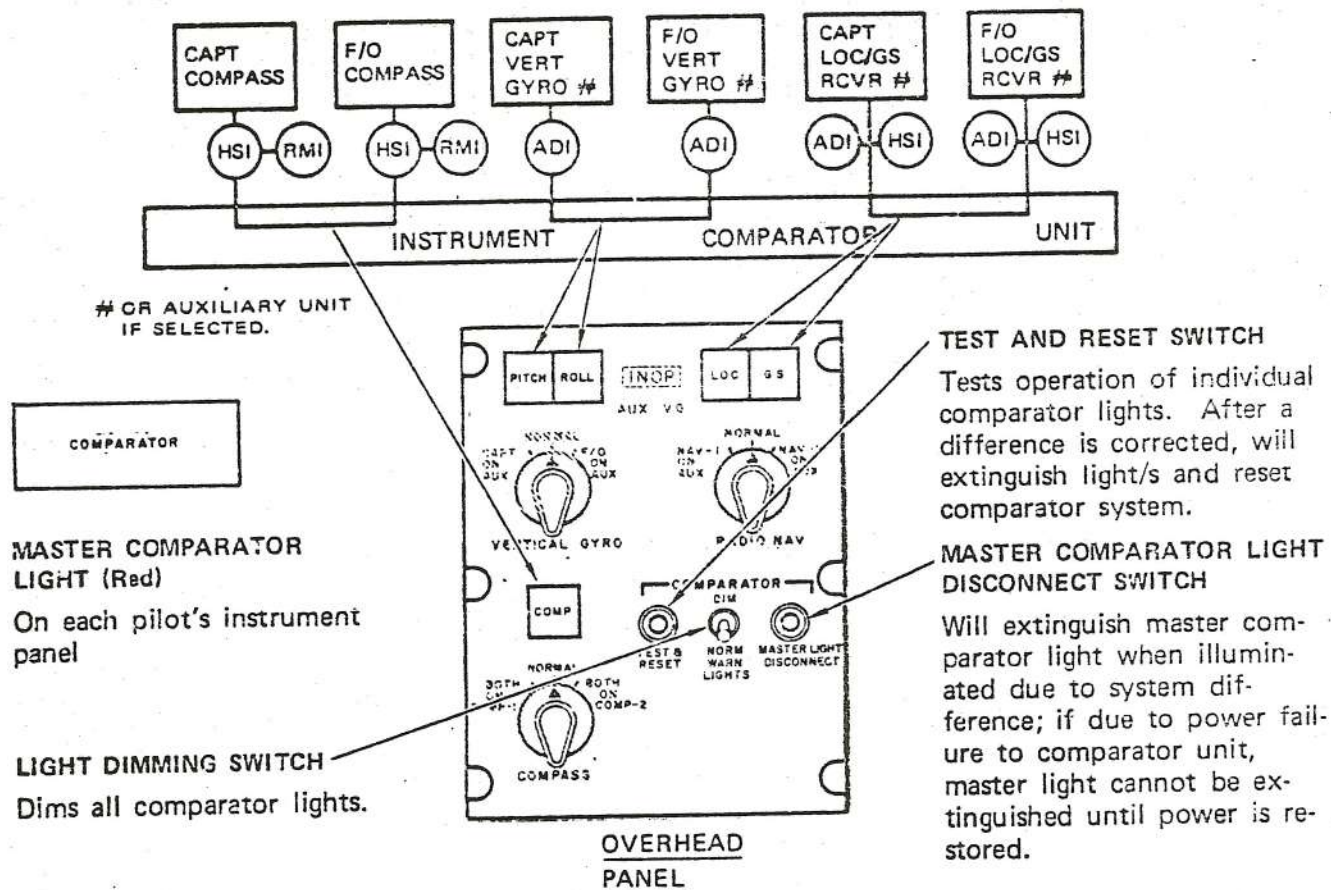


MARKER BEACON SENSITIVITY SWITCH
Normally, at high altitudes HIGH position is used and at low altitudes LOW position is best.

CENTER
PANEL

The instrument comparator/warning system provides visual light signals at any time a predetermined difference in signals between two units (primary or

auxiliary) of a system is being exceeded. Any time the power source to the comparator fails, the red master comparator light illuminates.



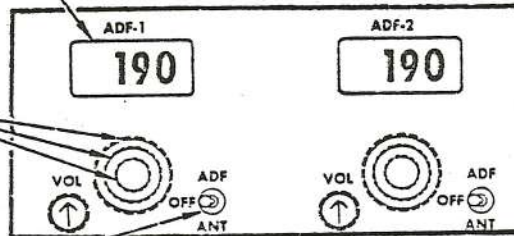
LIGHT	LIGHT ILLUMINATES WHEN:		REMARKS
	DIFFERENCE BETWEEN:	EQUALS OR EXCEEDS APPROX:	
COMPASS	HSI HEADINGS	6° LEVEL FLIGHT 10° TURNS 4° IN GS CAPTURE	RMI OUT-OF-SYNC MAY ILLUMINATE HDG. LIGHT
PITCH	ADI PITCH ATTITUDES	4° OR 3° IN GS CAPTURE	FOR LEVEL FLT. CLIMB, DESCENT
ROLL	ADI ROLL ATTITUDES	4° OR 3° IN GS CAPTURE	TOLERANCE IS GREATER IN TURNS
LOCALIZER*	COURSE BARS ON HSI'S	¾ DOT DEFLECTION	*INOP. WITH VOR FREQ. SELECTED
GLIDE SLOPE*	GS POINTERS ADI'S & HSI'S	1 DOT DEFLECTION	
MASTER COMPARATOR	POWER TO COMPARATOR UNIT FAILS; ANY LIGHT(S) ABOVE ILLUMINATE.		

Two complete ADF systems provide for automatic and manual determination of magnetic bearing to a selected facility for homing and position fixing, and for range navigation and broadcast monitoring. Controls for function se-

lection and tuning are accessible to both pilots on the forward electronic control panel. Selected radio information is displayed on the RMI's. Audio signals can be received through the crew members' headsets or speakers.

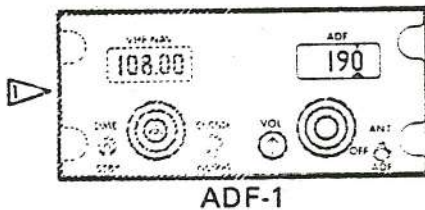
FREQUENCY INDICATOR
- Displays frequency in KHz.
- Both indicators apply to same ADF receiver.

FREQUENCY SELECTOR (3)
Used to tune desired frequency, 190 to 1749.5 KHz.

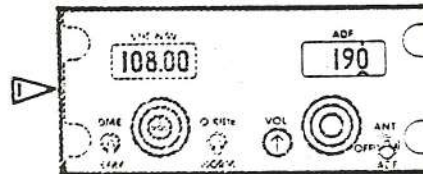


FORWARD
ELECTRONICS
PANEL

FUNCTION SELECTOR
ADF - Continuously indicates magnetic bearing to station on RMI. Simultaneously provides aural reception of audio transmissions from the station.
ANT - Receives voice and CW transmissions.

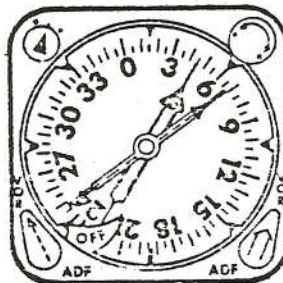


ADF-1



ADF-2

ADF/VOR
SWITCHES
NO. 1
NO. 2



PILOTS' PANELS

ADF BEARING POINTERS
Indicate magnetic and relative bearings to LF/MF stations tuned to No. 1 and No. 2 ADF radios.

NO. 1 ADF/VOR POINTER

NO. 2 ADF/VOR POINTER

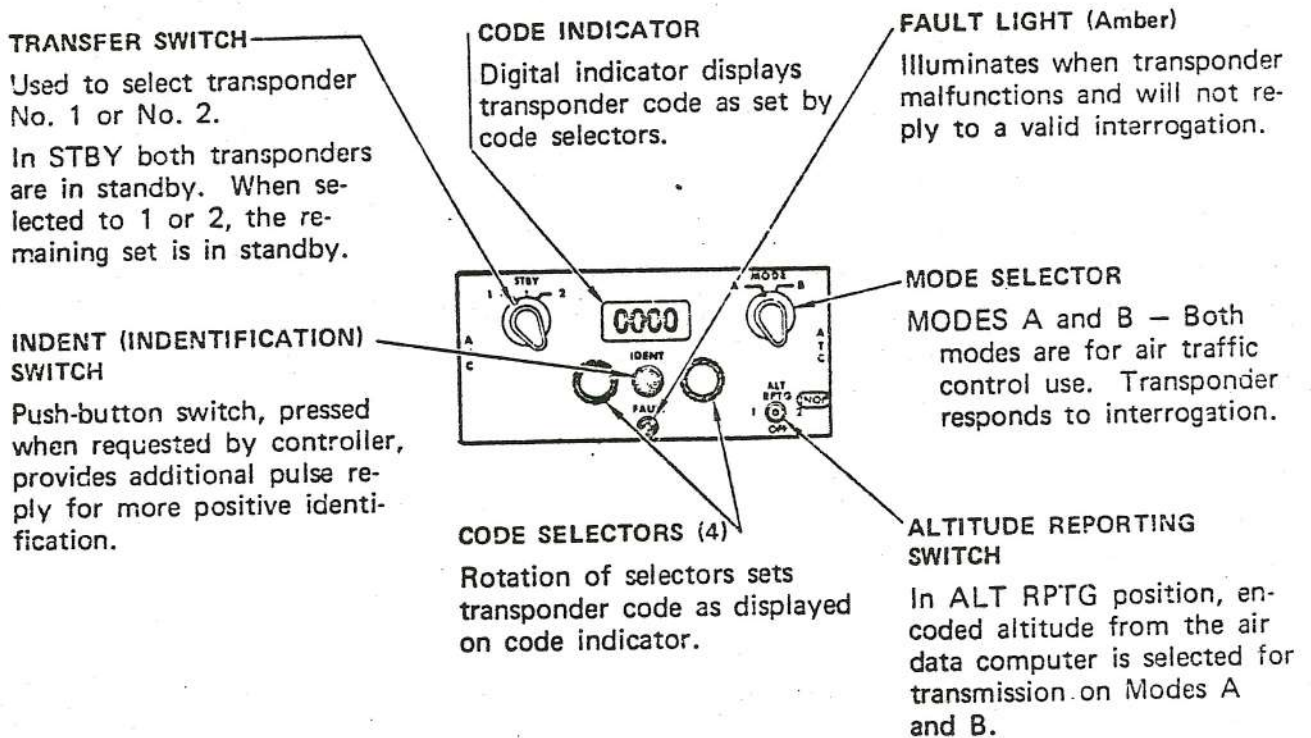
▷ Apl. S/N 21288, Reg. No. N8370Z and like configuration

AUTOMATIC DIRECTION FINDING SYSTEM

ATC TRANSPONDER SYSTEM

Two air traffic control (ATC) transponders are installed. Selection of either enables a ground station to positively identify a single airplane. The ground radar initiates interroga-

tion pulses which are received and automatically responded to by the airplane transponder. The reply from the transponder is displayed as a coded return on the ground radar controller's radar scope.



WEATHER RADAR SYSTEM

The weather radar system provides the pilots with a radar display of

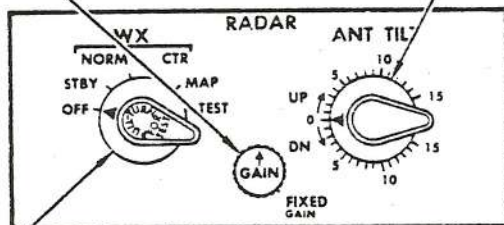
areas of storms, precipitation, and prominent terrain features. The weather radar antenna is gyro stabilized.

GAIN CONTROL

Controls signal gain in receiver. In **FIXED GAIN**, automatic gain control at a preset level is maintained.

ANTENNA TILT CONTROL

Tilts antenna 15 degrees UP or 15 degrees DOWN. On earlier airplanes the antenna tilts 10 degrees UP.



FORWARD ELECTRONIC
CONTROL PANEL

MODE SELECTOR

OFF – No power is applied and no signals are received. When switching from OFF to an operating position there is an automatic three-minute delay.

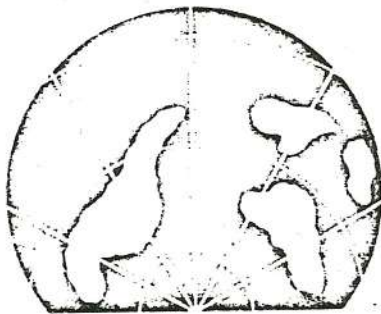
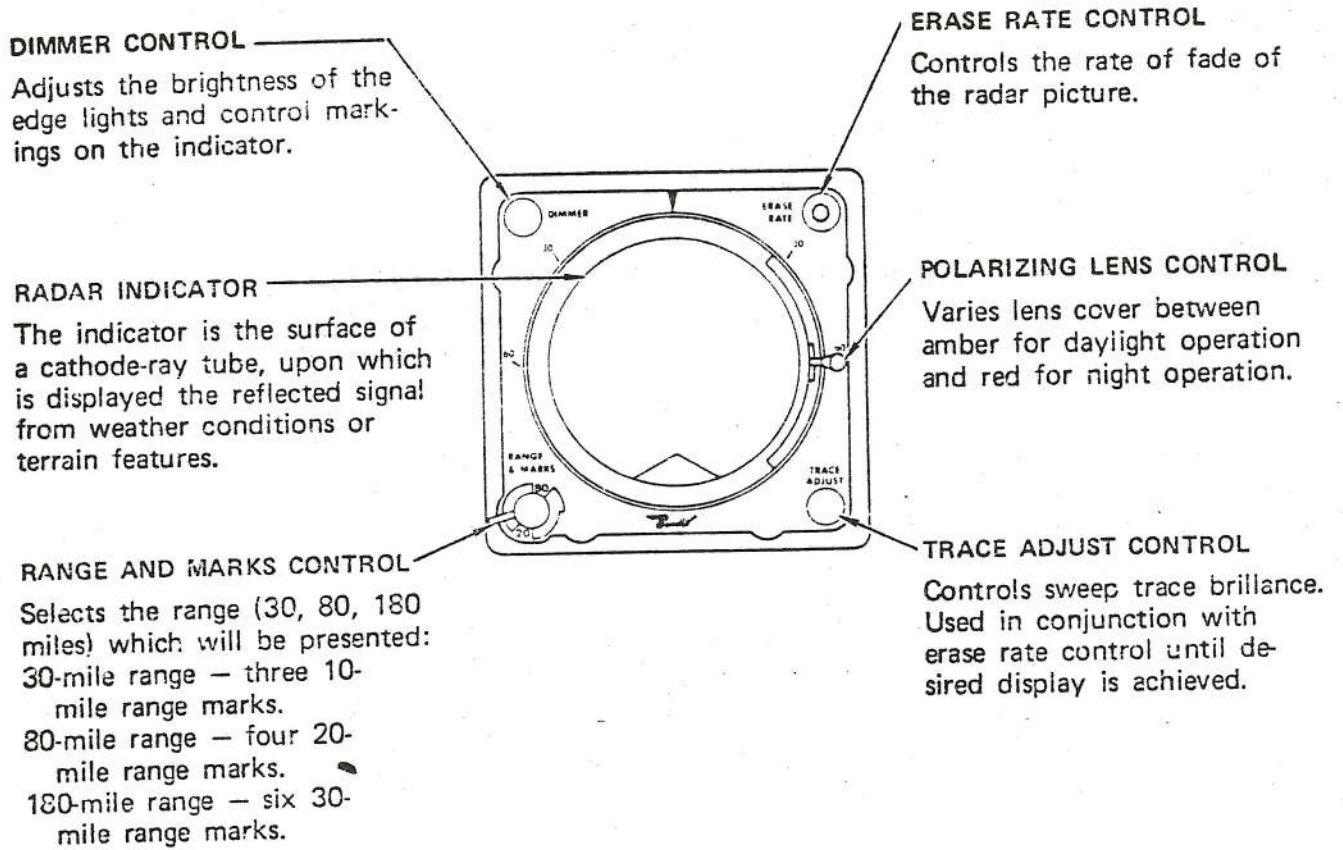
STBY – Used for warm-up.

NORM – A narrow pencil-like beam is radiated for sharp target definition. Used for long range weather detection. See illustration.

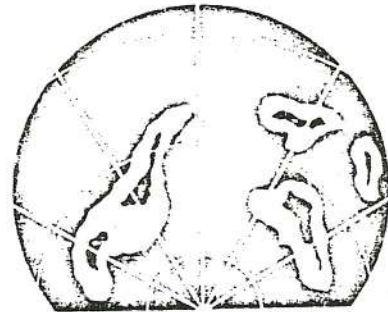
CTR – Heavy storm returns are contrasted (contoured) so that heaviest concentration appears dark rather than light. See illustration.

MAP – A wide beam, suitable for ground mapping, is radiated.

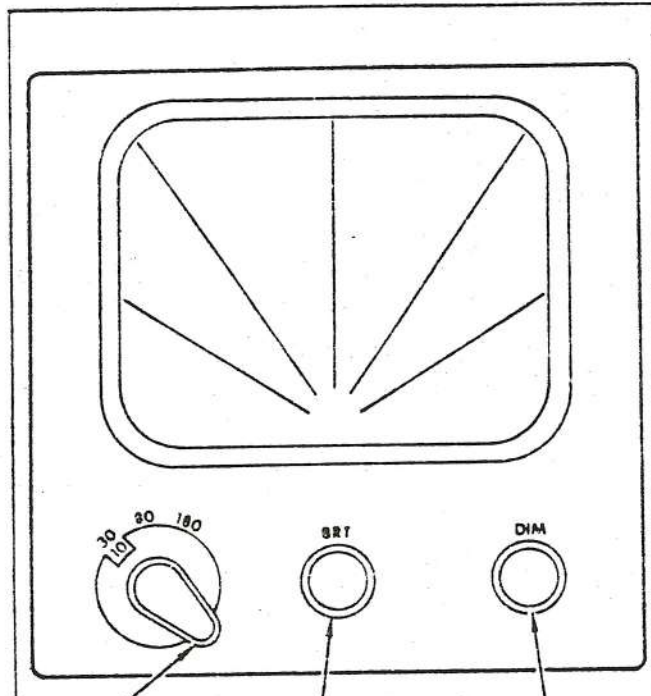
TEST – Transmitter de-energized. With 180-mile range selected, contrasting test signals are imposed on the indicator, signifying proper circuit functions. (See WEATHER RADAR TEST, Chapter 04.19.



CLOUDS IN NORM (NORMAL) MODE



CLOUDS IN CONT (CONTOUR) MODE



RANGE AND MARKS CONTROL

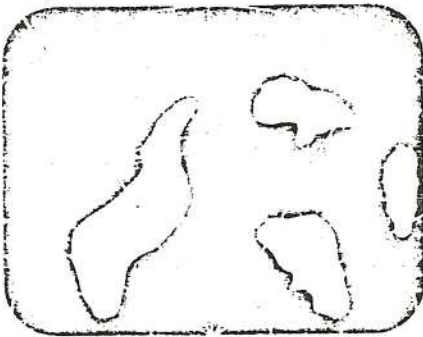
Selects the range (30, 80, 180 miles) which will be presented:
30-mile range — three 10-mile range marks.
80-mile range — four 20-mile range marks
180-mile range — six 30-mile range marks.

DIMMER CONTROL

Adjust the brightness of the edge lights and control markings on the indicator.

BRIGHTNESS CONTROL

Adjusts brightness of display.



NORMAL



CONTOUR

Two low range radio altimeter systems each provide a display of actual airplane height above the ground while the airplane is on approach. A reference altitude, MDA (minimum decision altitude), can be set, at or below which reminder lights will illuminate. One system displays information on the Captain's instrument. A second low range altimeter system displays on the

First Officer's panel. Radio altimeter information is also used to operate the runway/localizer symbol on the related ADI. This will display radio altitude of the airplane above the terrain while on final approach. Power is applied any time the radio master switches are ON and power is on the airplane.

MDA (MINIMUM DECISION ALTITUDE) LIGHTS

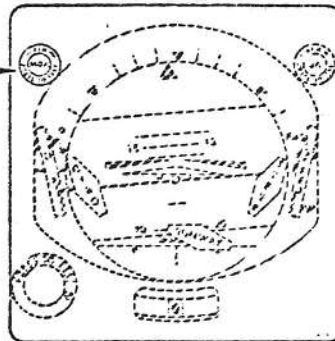
Illuminate when Altitude Pointer descends to or below MDA Cursor

MASK FOR ALTITUDE POINTER

LOW RANGE RADIO ALTIMETER TEST SWITCH

TEST - Altitude pointer drives to 100 feet. Warning flag appears. MDA light will illuminate if minimum decision altitude cursor is above 100 feet.

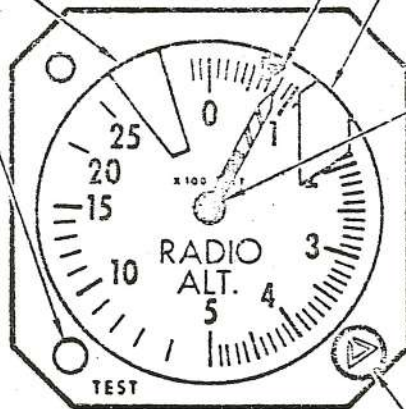
Tolerance:
 From 20 to 500 feet:
 the greater of ± 2 ft or $\pm 2\%$
 From 500 to 2500 feet:
 $\pm 5\%$



MDA CURSOR
0-500' scale.

WARNING FLAG

Appears:
 Power failure.
 Loss of return signal below 2500'.
 System test.



ALTIMETER SCALES & ALTITUDE POINTER

ON THE GROUND - Altitude pointer reads "0" ± 3 ft.

IN FLIGHT - Altitude pointer reads true altitude above ground up to 2500 feet. Above 2500 feet, the pointer is masked.

PILOTS' PANELS

MDA CURSOR CONTROL
Sets MDA Cursor

NOTE

The radio altimeter provides an altitude trip signal to the speed-altitude command system for the GA/TAKEOFF mode and provides altitude signals to the (rising) runway symbol on the ADI when used for ILS approaches.

LOW RANGE RADIO ALTIMETER

ENGINE FAIL LIGHT (Amber)
ILLUMINATED – Indicates thrust decrease on any engine provided the auto. pack trip system is armed.

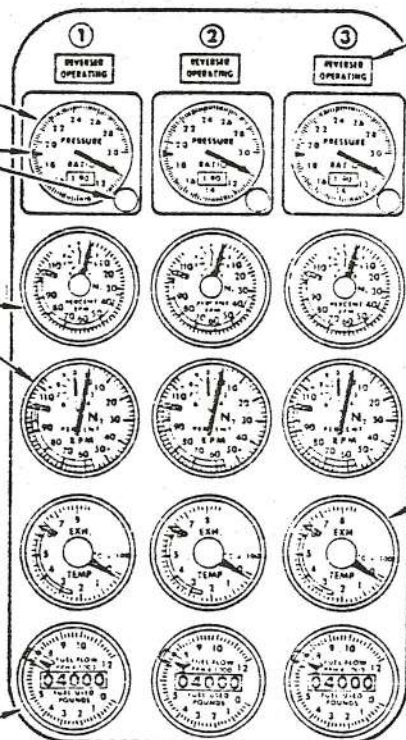


GLARE SHIELD
ABOVE CAPTAIN'S
AND FIRST OF-
FICER'S PANELS

ENGINE PRESSURE RATIO INDICATORS (EPR)
Indicates engine thrust EPR, CURSOR AND SETTING CONTROL

N₁ & N₂ PERCENT RPM INDICATORS (TACHOMETERS)
Indicates respective rotor speeds. Tachometers are independently powered
Green Band - Normal Operating range
Yellow Band - Approaching Overspeed
Red Radial - Maximum Operating RPM

ENGINE FUEL FLOW INDICATORS
Indicate fuel consumption rate and total fuel used by each engine.



THRUST REVERSER OPERATING LIGHT (Amber)
ILLUMINATED – Indicates respective reverser deflector door is unlocked.

EXHAUST GAS TEMPERATURE INDICATORS (EGT)
Indicators are independently powered.
Green Band - Normal Operating range
Yellow Band – Approaching Overtemperature
Red Radial – Max Takeoff/ In-Flight temperature

PILOTS' CENTER PANEL

FLIGHT ENGINEER'S
LOWER PANEL



FUEL FLOW RESET SWITCH
Returns the fuel used digital readout to zero.

ENGINE INDICATORS

**POWER PLANT
CONTROLS AND
INDICATORS**

**BOEING 727
OPERATIONS MANUAL**

ENGINE OIL QUANTITY INDICATORS

Indicate quantity of usable oil in the oil tank.

OIL PRESSURE INDICATORS

UPPER RED RADIAL – Max operating pressure.
GREEN BAND – Normal operating pressure.
YELLOW BAND – Min pressure required for flight at reduced thrust.
LOWER RED RADIAL – Below operating pressure.

ENGINE VIBRATION PICKUP SWITCH

INLET – Senses vibration at inlet section of all engines simultaneously.
TURBINE – Senses vibration at turbine section of all engines simultaneously.

ENGINE VIBRATION TEST SWITCH

Tests system for proper operation.

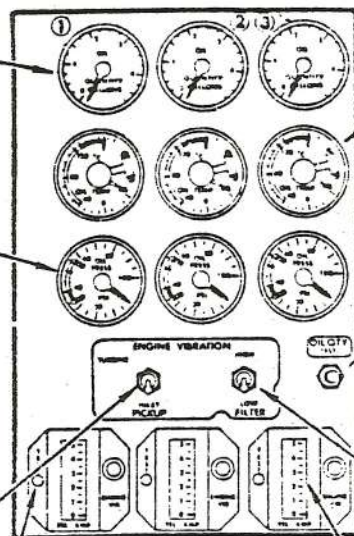
LOW OIL PRESSURE AND FILTER BYPASS WARNING LIGHTS

Low Oil Pressure Warning light ON (Amber)
Indicates engine oil pressure below 36 psi.
Oil Filter Bypass Warning Light ON (Amber)
Filter clogged, unfiltered oil circulating through engine.

FUEL HEAT SWITCH

ON – Engine bleed air furnished to fuel heater.

NO. 1 TANK FUEL TEMPERATURE INDICATOR



**FLIGHT ENGINEER'S
LOWER PANEL**

ENGINE OIL TEMPERATURE INDICATORS

Indicates the temperature of the oil entering the engine. (Degrees centigrade).

ENGINE OIL QUANTITY INDICATORS TEST SWITCH

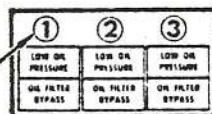
When the switch is pressed, the oil quantity indicator needles are driven slowly toward zero. When released, the indicator needle should return to the original readings.

ENGINE VIBRATION FILTER SWITCH

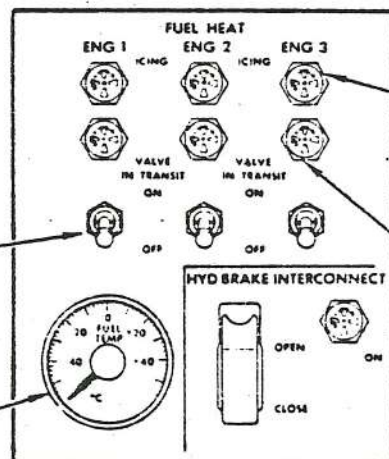
HIGH – Indicates vibrations originating in N2 section.
LOW – Indicates vibrations originating in N1 section.

ENGINE VIBRATION INDICATOR AMPLIFIERS

Displays engine vibration, indicating a trend in engine performance.



**PILOTS' CENTER
PANEL**



**FLIGHT ENGINEER'S
LOWER PANEL**

FUEL ICING WARNING LIGHT (Amber)

ILLUMINATED – Indicates clogged fuel filter.

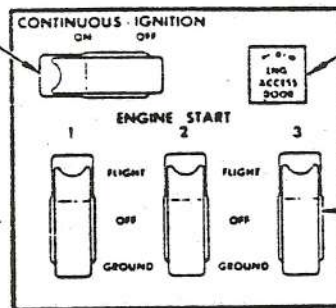
FUEL HEAT VALVE IN-TRANSIT LIGHT (Blue)

ILLUMINATED – During valve transit.

OIL/ENGINE VIBRATION INDICATORS/FUEL HEAT

CONTINUOUS IGNITION SWITCH

ON — Energizes the low energy ignition system when the engine start lever is 10° or more out of the CUTOFF detent and the engine start switch is OFF (guarded).



OVERHEAD PANEL

ENGINE NO. 2 DUCT ACCESS DOOR LIGHT (Amber)

ILLUMINATED — Indicates the engine No. 2 duct access door is not locked.

ENGINE START SWITCH

GROUND (Momentary contact, switch must be held) — Start valve opens, high energy ignition system energized when the start lever is approximately 10° out of the CUTOFF detent. Engaged engine starter.

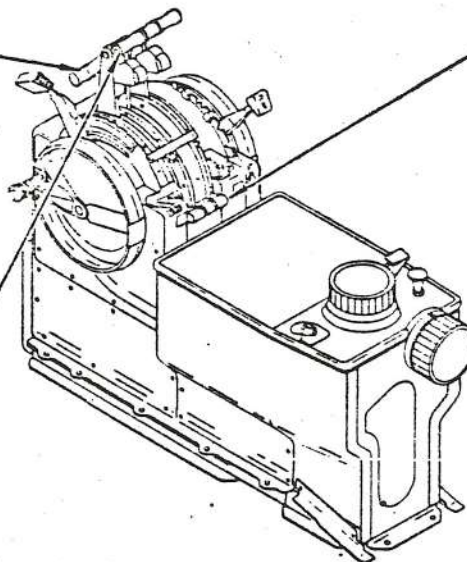
FLIGHT — High energy ignition system energized with the start levers 10° or more out of the CUTOFF detent. Does NOT engage engine starter.

REVERSE THRUST LEVER

Selects power for reverse thrust. Cannot be actuated unless forward thrust levers are in the idle position. Interlock prevents application of reverse thrust until doors are in reverse position.

FORWARD THRUST LEVER

Selects power. Cannot be advanced unless engine reversers are in the forward thrust configuration.



CONTROL STAND

ENGINE START LEVERS

IDLE — Fuel on; with engine start switch in GROUND or FLIGHT position 20-joule ignition system is energized. With continuous ignition switch in ON position and engine start switch OFF — 4-joule ignition system is energized.

CUTOFF — Fuel shutoff; both ignition systems are de-energized.

GENERAL

The Pratt & Whitney JT8D turbo-fan engines have two rotors in series, called N1 & N2. The two rotors, each consisting of a compressor and turbine are mechanically independent but related by airflow. The first two stages of N1, called fan stages, are considerably larger in diameter than the remaining stages. Engine airflow is in two separate streams, called primary and fan flow. The inner primary stream travels through the engine while the fan flow travels through the full length fan duct providing additional thrust.

FUEL SYSTEM

The fuel control unit meters fuel to the burner section. The fuel flow is governed by the thrust lever position, and is modified by the computing system which senses and combines engine pressures, temperatures and rpm to control the output of the metering system.

FUEL HEAT

When fuel temperature is below 0°C, ice crystals may form and collect on the surface of the filter element causing a pressure drop across the filter. Upon reaching a predetermined pressure differential across the filter the differential pressure switch activates a fuel icing warning light. A fuel heater is located between the first and second stages of the engine driven fuel pump. When the fuel heat is used, hot bleed air passes through the heater thus warming the fuel. The resulting warm fuel will melt any ice formation within the filter causing the fuel icing light to go out as the pressure drop across the filter is decreased.

In the event the filter becomes clogged with a solid contaminant, the fuel icing light will illuminate and stay on.

OIL SYSTEM

The oil system lubricates and cools the engine bearings and accessory drives. The oil pump delivers oil from the tank through the oil filter and the fuel-cooled oil cooler to the engine bearings. Fuel flow and fuel tank temperature variations will affect oil temperature. Oil is then scavenged from the engine bearings and accessory drives and pumped back to the tank.

OIL FILTER

If the engine oil filter becomes clogged, a bypass allows unfiltered oil to flow through the engine. An impending

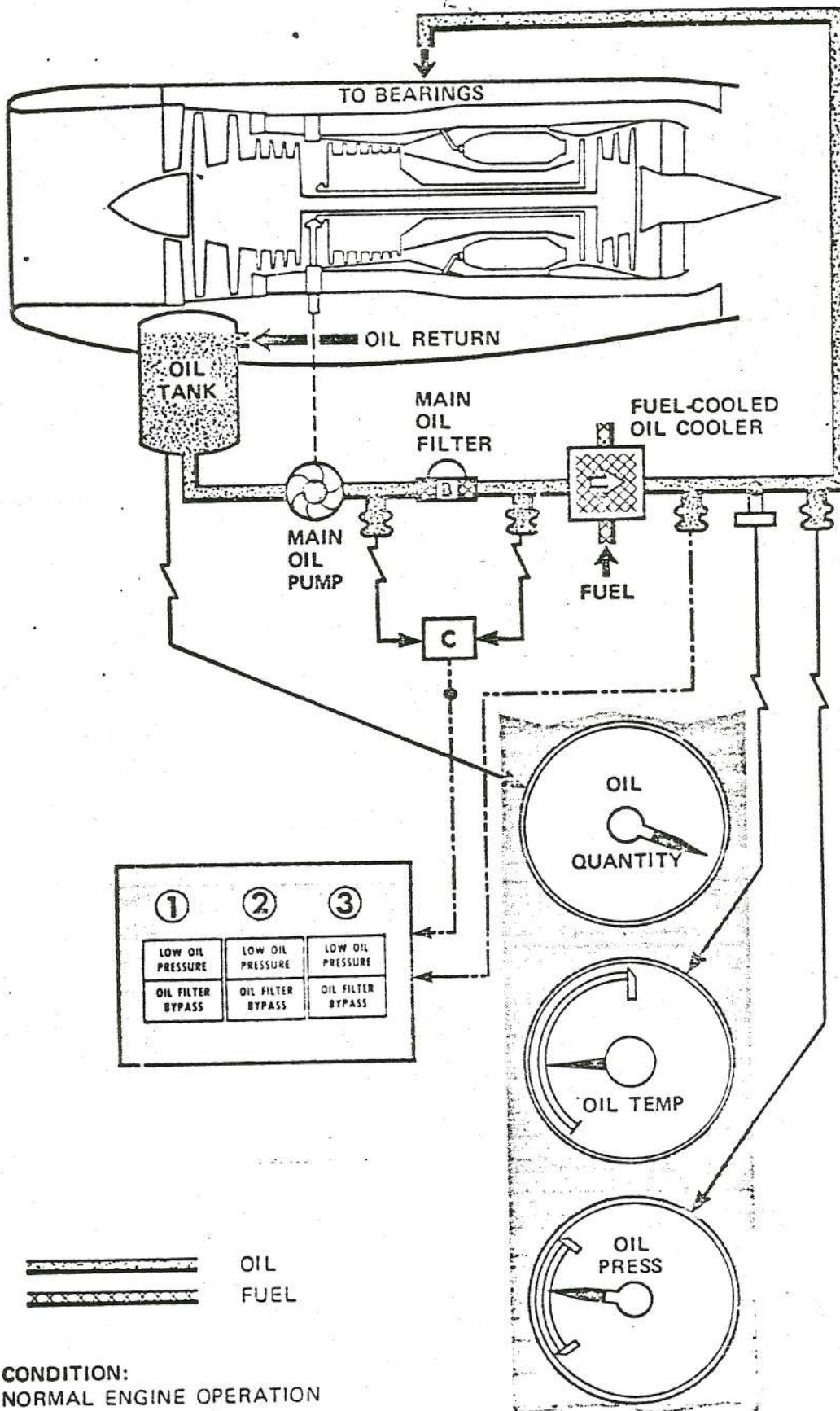
filter bypass condition will illuminate the filter bypass light on the pilots' center panel.

LOW OIL PRESSURE WARNING LIGHT

Light illuminates at 35 ± 1 PSI when pressure is decreasing and extinguishes at 36.5 ± 1.5 PSI when pressure is increasing.

OIL TANK

The engine oil tank capacity is approximately 5.2 gallons of which approximately 4 gallons are usable. The remaining space accommodates any foaming and expansion.



CONDITION:
NORMAL ENGINE OPERATION

ENGINE START SYSTEM

Engine starting requires electrical and pneumatic power. These may be supplied by the APU, external power, or from an operating engine.

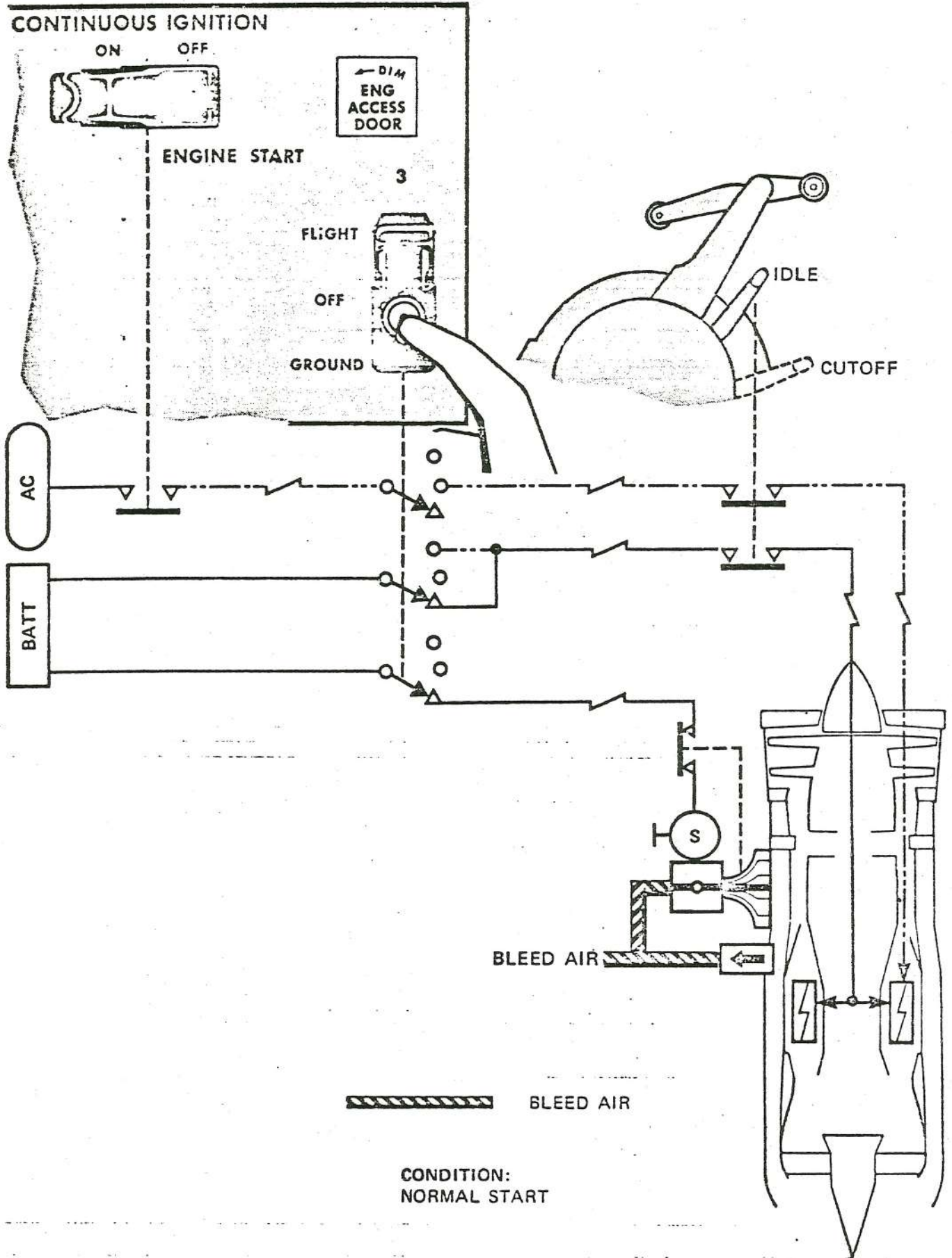
Air to the pneumatic engine starter is regulated by a solenoid-operated valve. When the engine start switch is positioned to Ground, the start valve opens and the starter rotates the engine. Should the start switch fail to operate the valve, a manual override on the engine may be used to open the valve.

As the engine, driven by the starter, accelerates, the start lever is advanced out of the Cutoff position, metered fuel flow commences and ignition

is initiated. The engine then starts and continues to accelerate. At 35-40% N2, a starter cutout switch activates, interrupting ignition and power to the starter valve. The start valve closes. The engine continues to accelerate to idle and the start is completed.

Positioning the start lever to CUTOFF will override the open position of the engine fuel shutoff switch and close the respective engine fuel shutoff valve. Provided the engine fire switch is in the normal position and engine fuel shutoff switch is positioned to OPEN, positioning start lever to IDLE will open the valve.

NOTE: With the installation of fast response EGT probes on the JT8D-15 engine, a rapid rise of EGT is normal.



START SYSTEM

REVERSE THRUST SYSTEM

The thrust reversers are attached at the turbine outlet case of each engine. The clamshell-door type thrust reversers block the engine exhaust and fan air cases and deflect the gases forward through openings made by the repositioned deflector doors. The center engine gases are deflected out of the sides of the aft fuselage, while strut mounted engine gases are deflected above and below the engine.

The reversers are controlled by reverse thrust levers and operated by

engine bleed air. When not in use, the reversers are held in the locked position by bleed air and a mechanical lock. Aft movement of the lever increases reverse thrust. The reverser levers are locked down (forward thrust) whenever the forward thrust levers are out of the (idle) position.

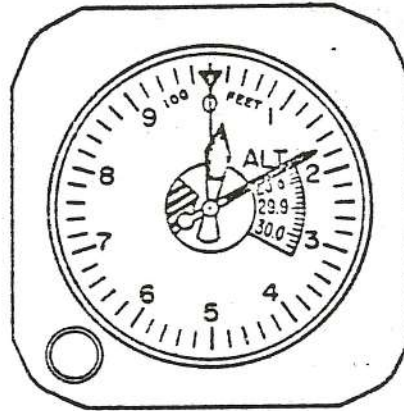
"Feel" is built into the reverse system by spring loads which increase as additional reverse thrust is applied.

PRESSURE ALTIMETERS

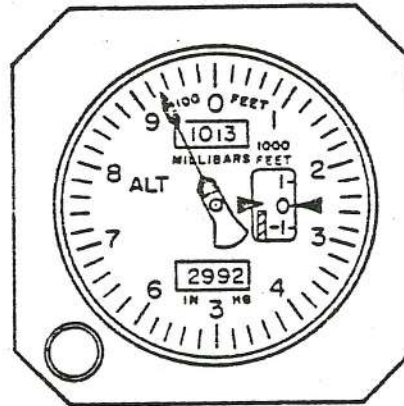
Dial-Pointer Arrangements

Some of the many types of dial and pointer arrangements used for pressure altimeters are shown in the following illustrations.

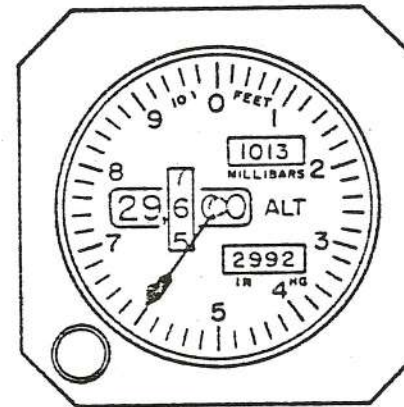
Three-pointer: The long pointer makes one turn per thousand feet. The short pointer makes one turn per ten thousand feet. The triangular mark makes one turn per hundred thousand feet. The altimeter setting scale is not quite uniformly spaced. This is the simplest and least expensive display.

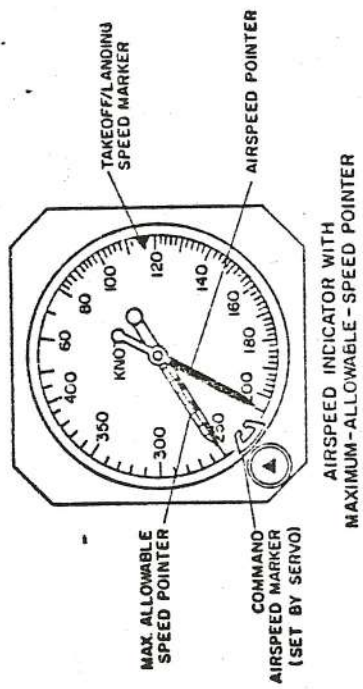


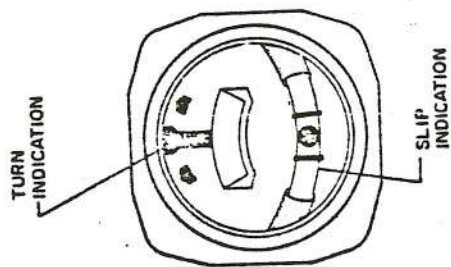
Drum pointer: The pointer makes one turn per thousand feet. The drum reads in thousands of feet. It moves smoothly. The altimeter setting number (inches of Hg and millibars) is on digital counters. This display is easier to read than the three-pointer design.



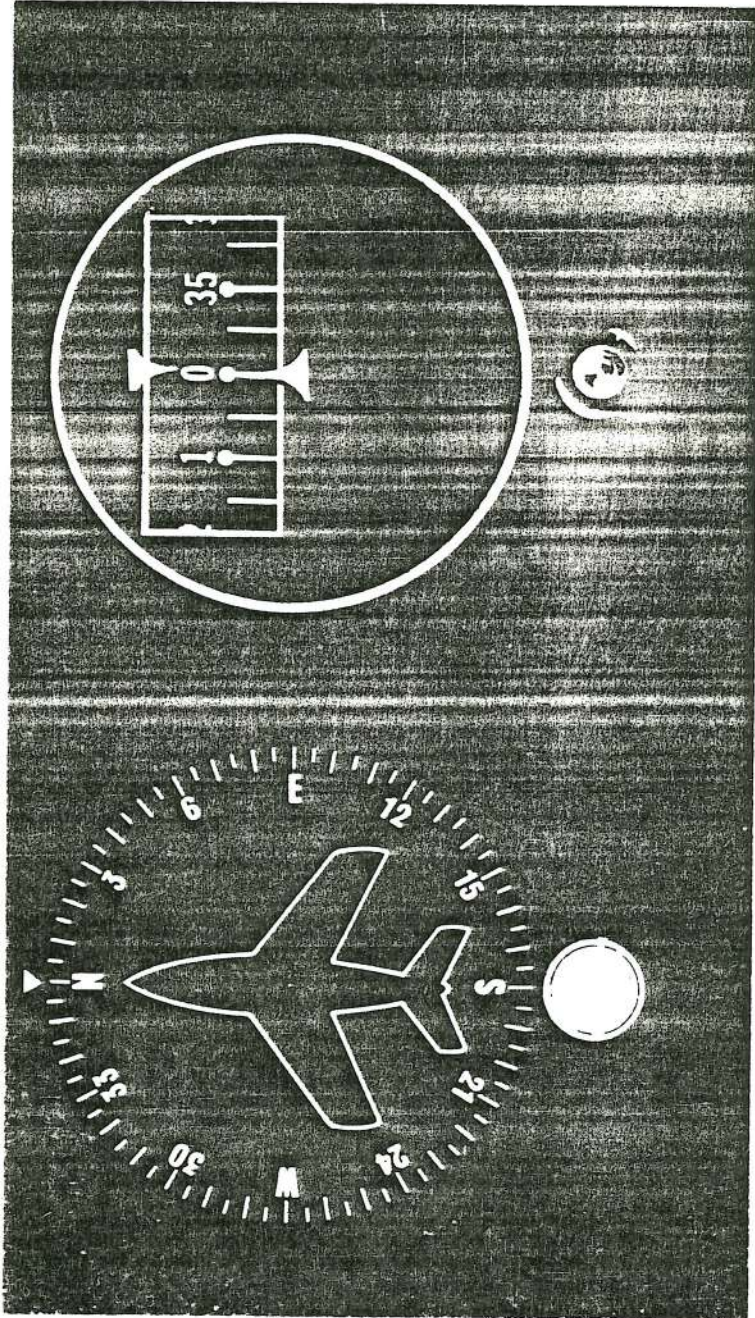
Counter-pointer: The pointer makes one turn per thousand feet. The counter reads in hundreds of feet. The altimeter setting (inches of Hg and millibars) is on digital counters. This display is also used for servo-driven altimeters where the inherent drawbacks of counter friction and inertia are of less concern.



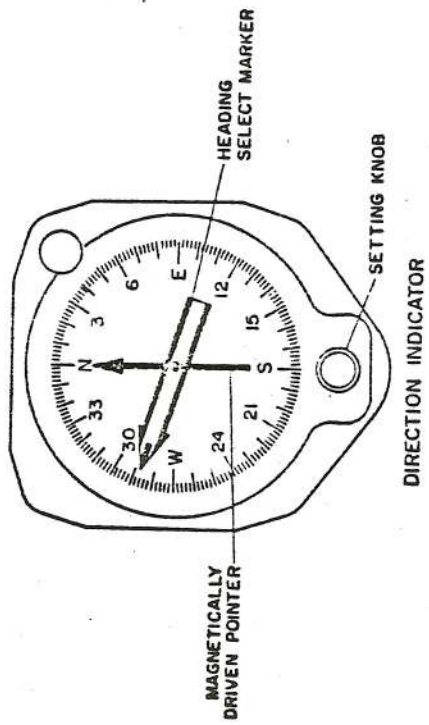


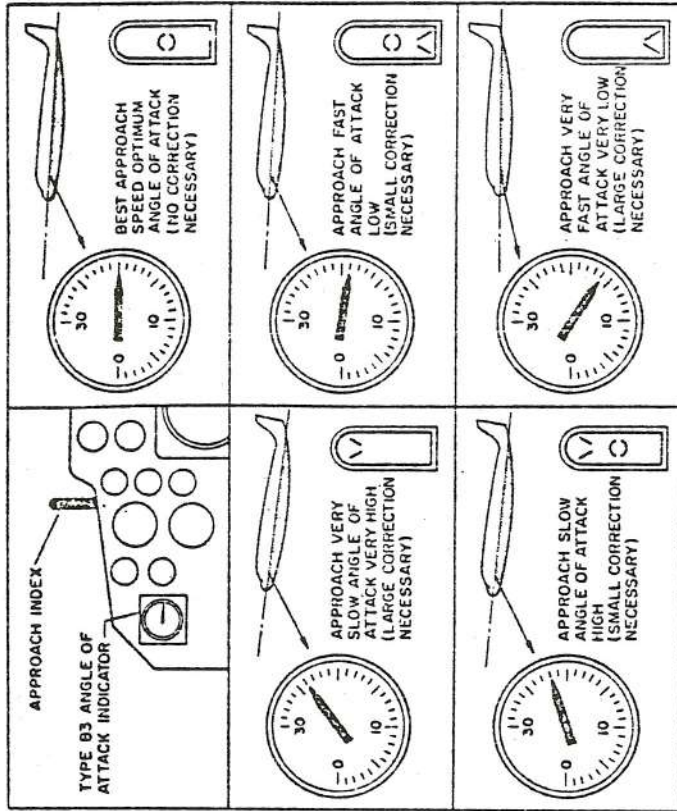


TURN-AND-SLIP
INDICATOR

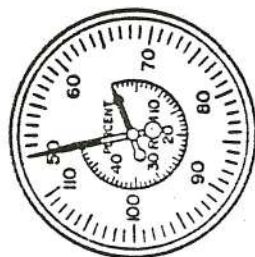


Heading Indicator Types

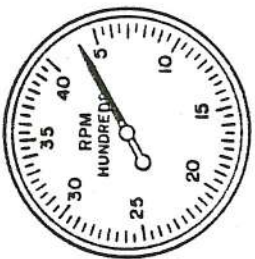
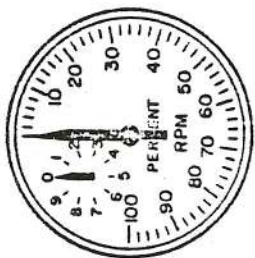




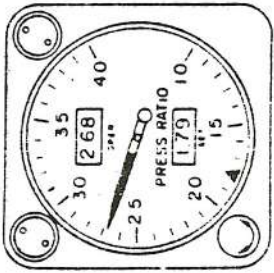
ANGLE OF ATTACK INDICATOR



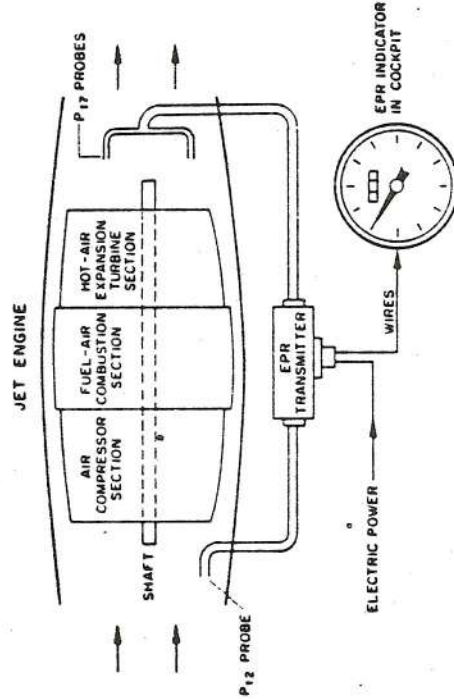
TACHOMETER INDICATORS
(PERCENT)



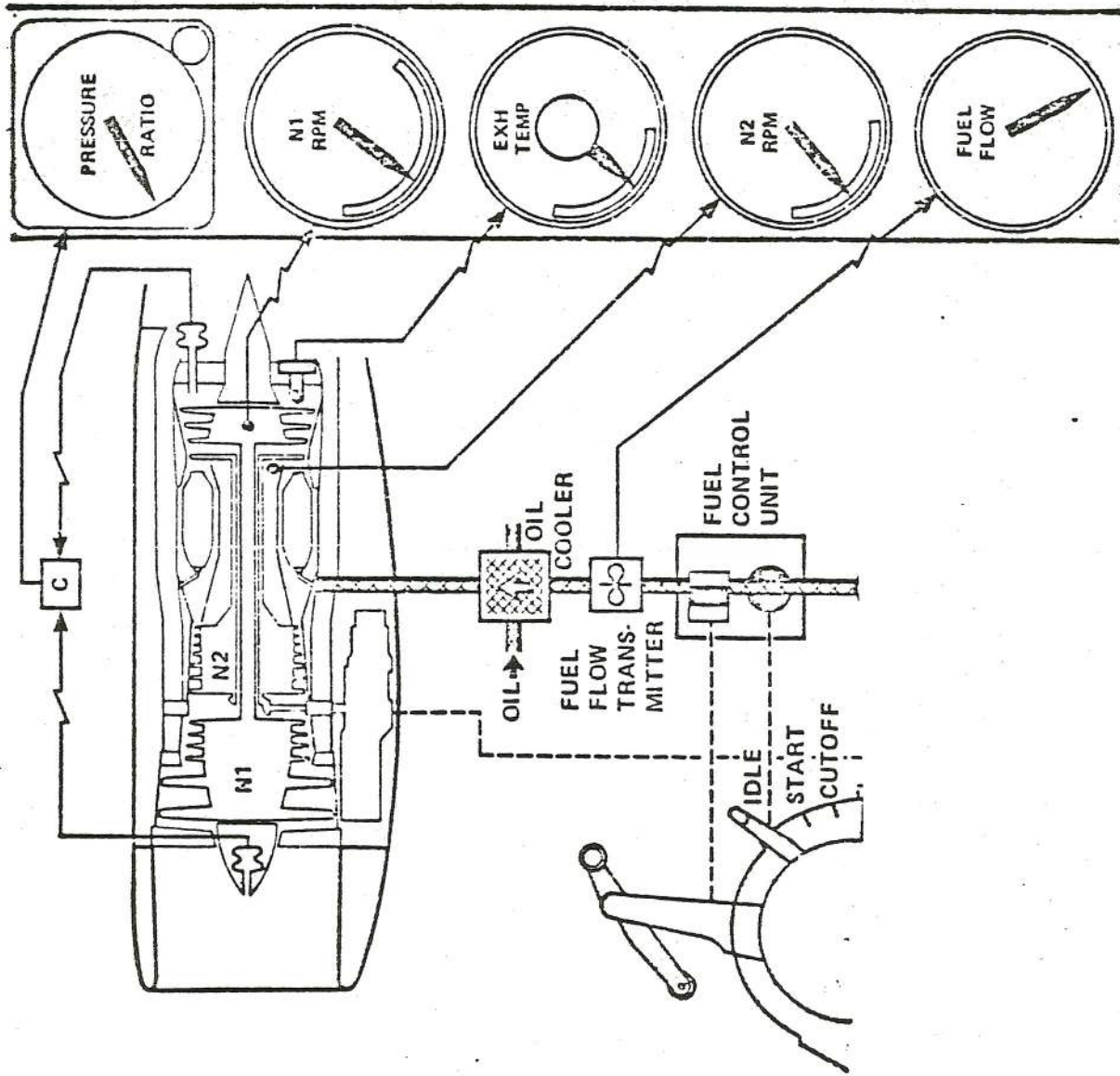
TACHOMETER INDICATOR
(NONSENSITIVE)

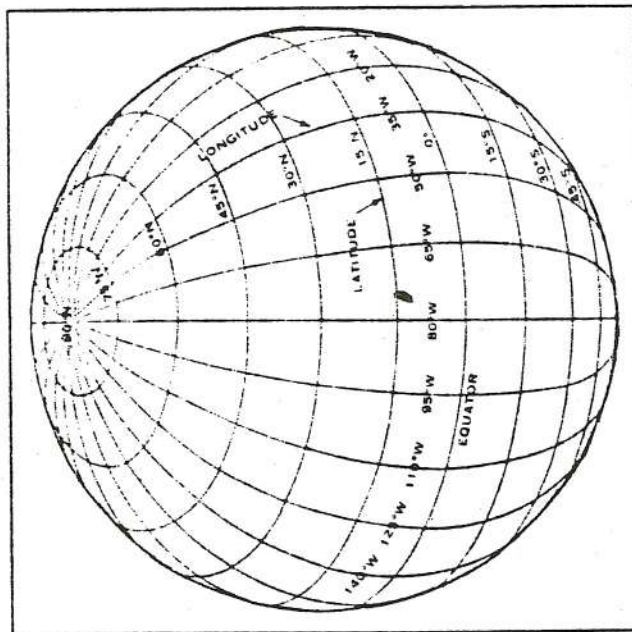


ENGINE PRESSURE RATIO INDICATOR

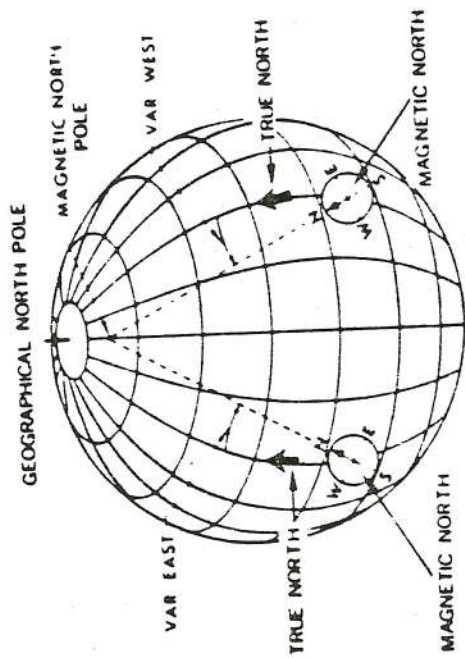


$$EPR = P_{17}/P_{12}$$

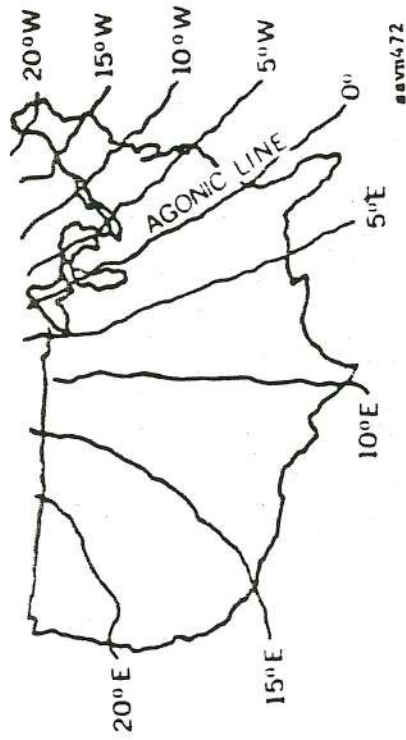




Parallels and Meridians (Latitude and Longitude)

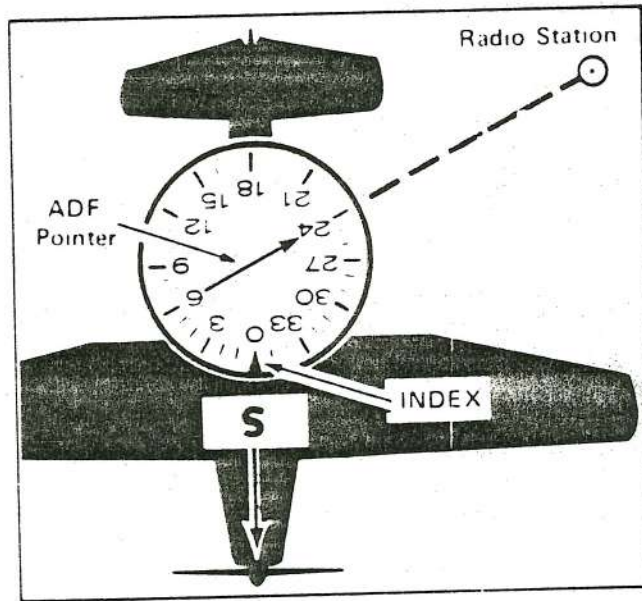


Magnetic variation.

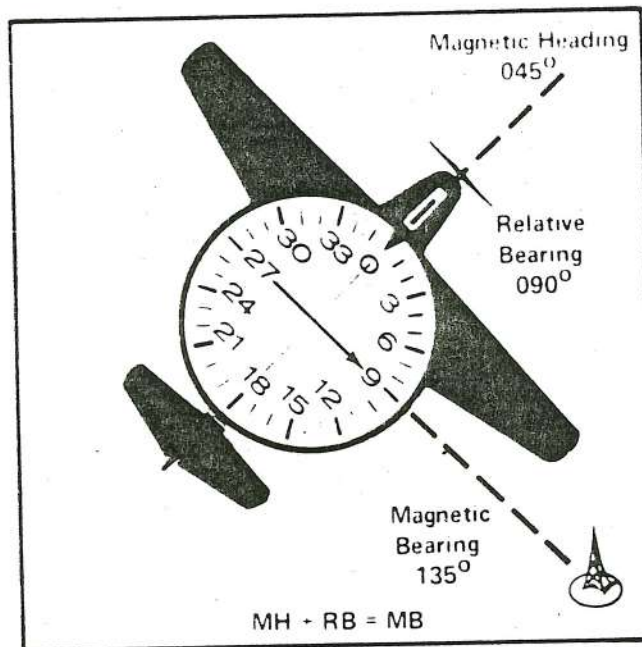


8876472

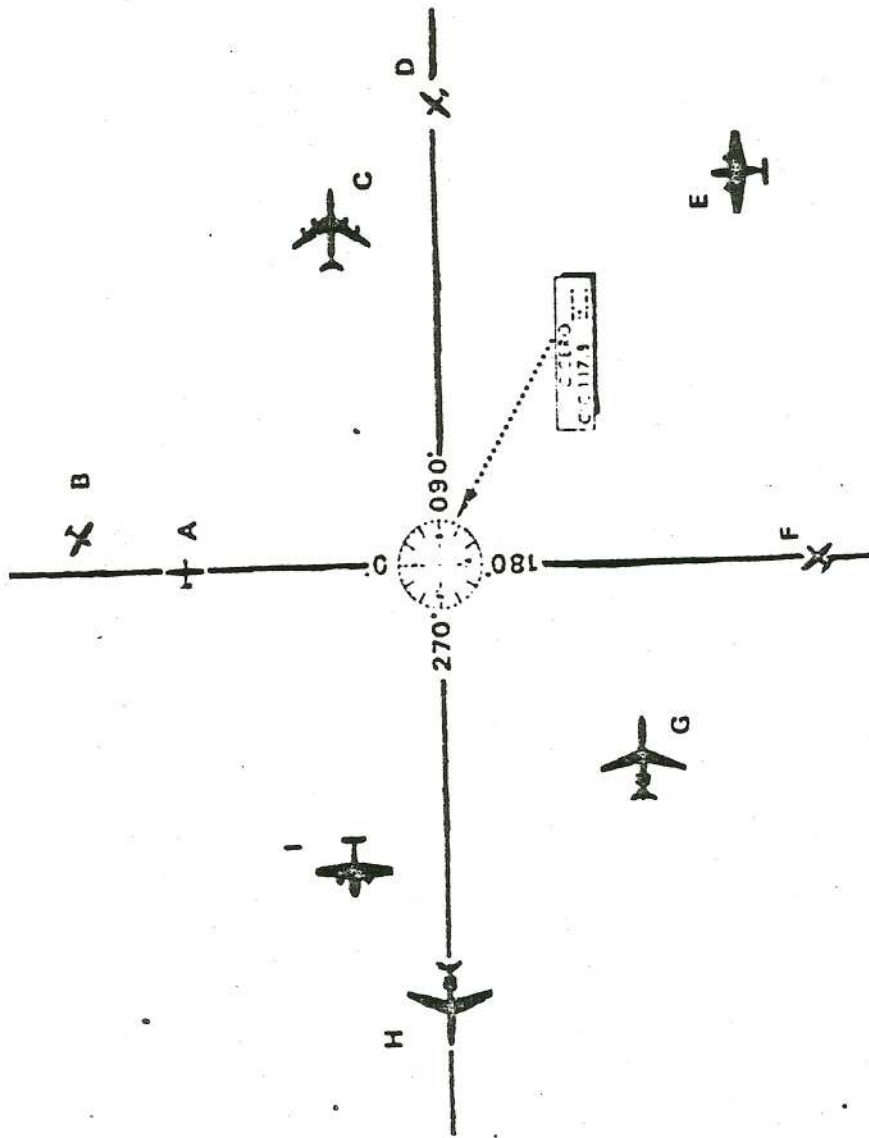
Magnetic variation in the United States



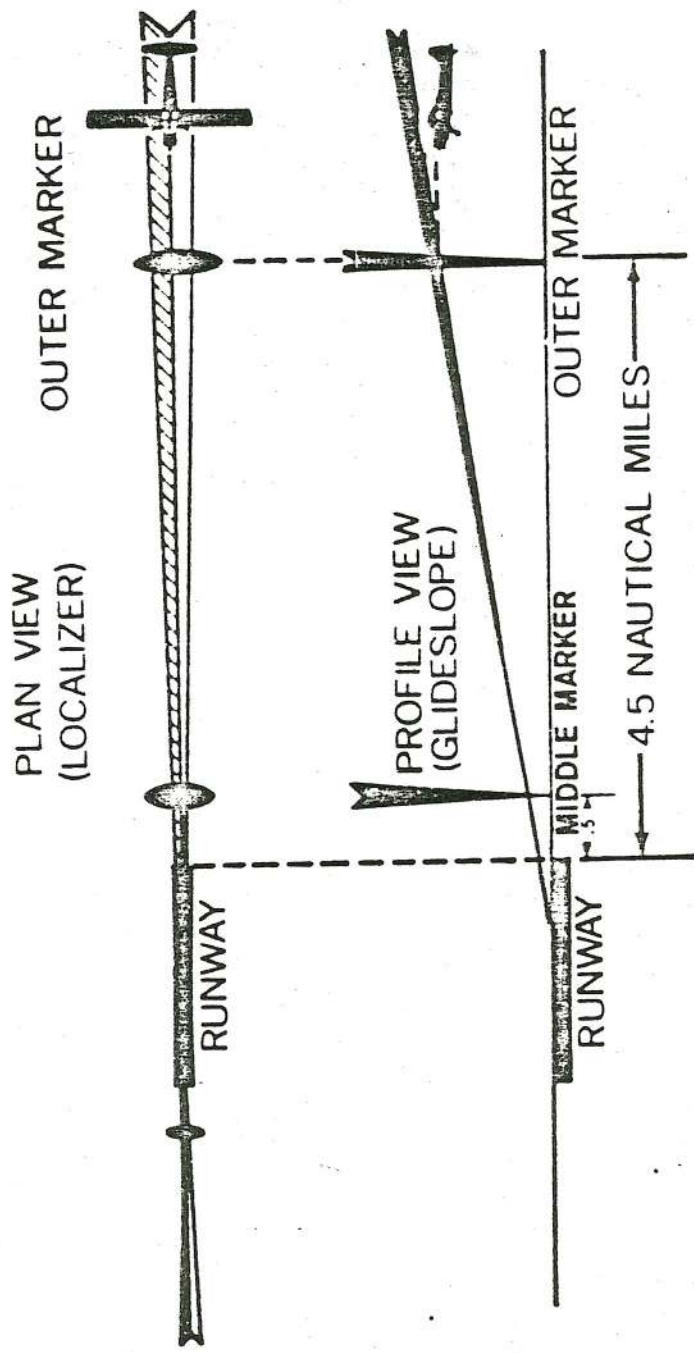
ADF Indicator



The Bearing Formula



Airplane	A	B	C	D	E	F	G	H	I
Heading	090°	210°	090°	310°	0°	045°	090°	270°	270°
Course Selector	0°	180°	270°	270°	130°	180°	180°	270°	270°
CDI	FR	TO	TO	TO	FR	FR	FR	FR	FR
To-From	FR	TO	TO	TO	FR	FR	FR	FR	FR



ILS

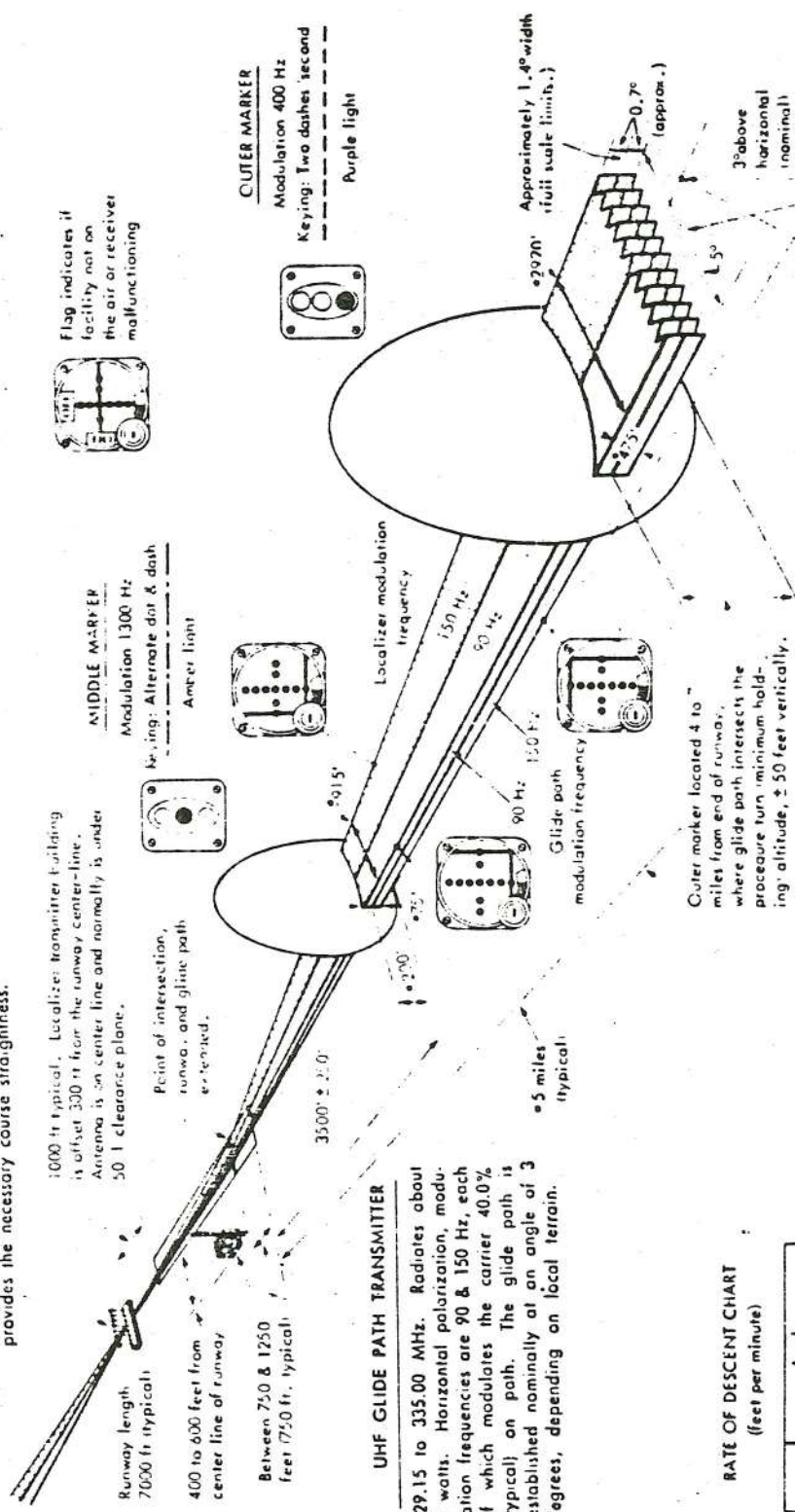
[FAA INSTRUMENT LANDING SYSTEM]

STANDARD CHARACTERISTICS AND TERMINOLOGY

VHF LOCALIZER
 108.10 to 111.95 MHz. Radiates about 100 watts. Horizontal polarization. Modulation frequencies 90 and 150 Hz. Modulation depth on course 20% for each frequency. Code identification (1020 Hz, 5%) and voice communication (modulated 50%) provided on same channel. At some localizers, where terrain (siting) difficulties are encountered, an additional antenna (slotted waveguide type) provides the necessary course straightness.

1000 ft typical. Localizer transmitter building is offset 300 ft from the runway center-line. Antenna is on center line and normally is under 50 ft clearance plane.

Point of intersection, runway, and glide path established.



UHF GLIDE PATH TRANSMITTER
 329.15 to 335.00 MHz. Radiates about 5 watts. Horizontal polarization, modulation frequencies are 90 & 150 Hz, each of which modulates the carrier 40.0% (typical) on path. The glide path is established nominally at an angle of 3 degrees, depending on local terrain.

RATE OF DESCENT CHART
(feet per minute)

Speed (Knots)	Angle			
	2 1/2°	2 3/4°	3°	3°
90	400	440	475	585
110	485	535	585	690
130	575	630	690	795
150	665	730	795	849
160	707	778	849	

NOTE:
 Compass locators, rated at 25 watts output. 200 to 415 kHz, are installed at most outer and middle markers. A 1020 Hz tone, modulating the carrier about 95%, is keyed with the first two letters of the ILS identification on the outer locator and the last two letters on the middle locator. At some localizers, simultaneous voice transmissions from the control tower are provided, with appropriate reduction in identification percentage.

• Figures marked with asterisk are typical. Actual figures vary with deviations in distances to markers, glide angles and locator widths.

All marker transmitters approximately 2 watts of 75 MHz modulated about 95%

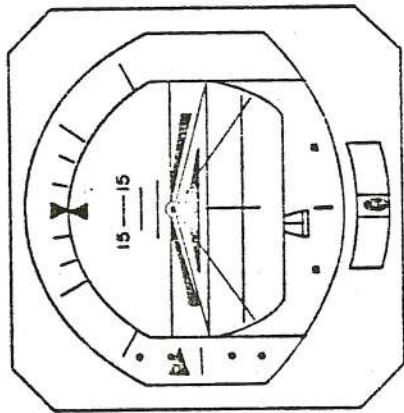
Outer marker located 4 to 7 miles from end of runway, where glide path intersects the procedure turn minimum holding altitude, ± 50 feet vertically.

Course width varies; 5% at most locations (full scale limits)

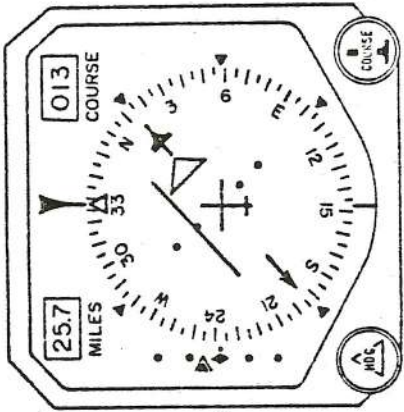
OUTER MARKER
 Modulation 400 Hz
 Keying: Two dashes second
 Purple light

Flag indicates if facility not on the air or receiver malfunctioning

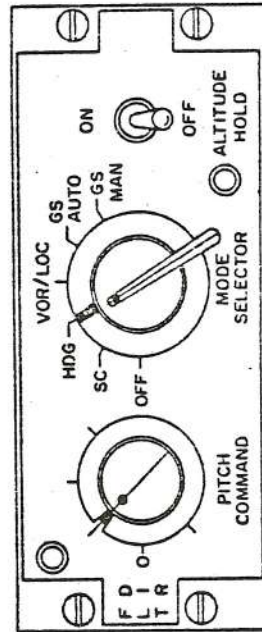
MIDDLE MARKER
 Modulation 1300 Hz
 Keying: Alternate dot & dash
 Amber light



FLIGHT DIRECTOR INDICATOR

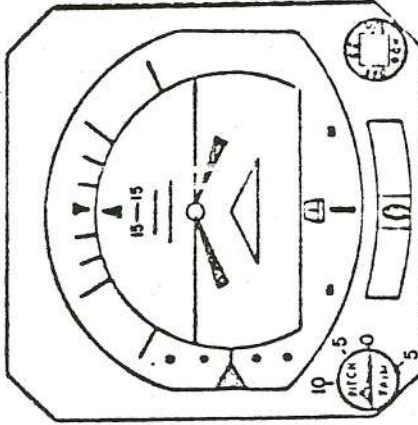


COURSE INDICATOR

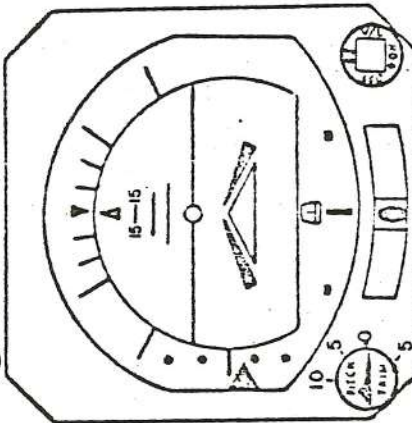


FLIGHT DIRECTOR CONTROL

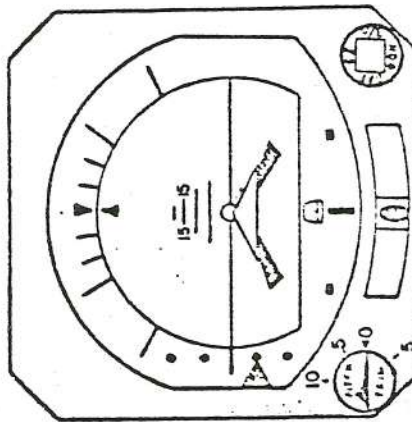
(B) PITCH COMMAND



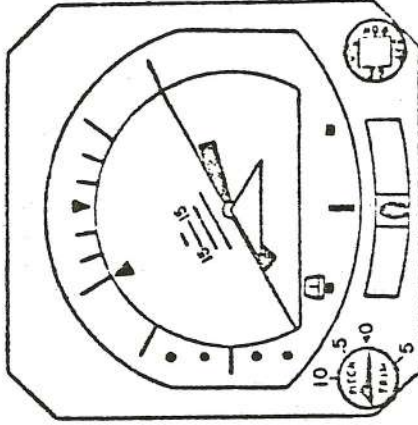
5° NOSE UP COMMAND
AIRCRAFT 5° NOSE DOWN



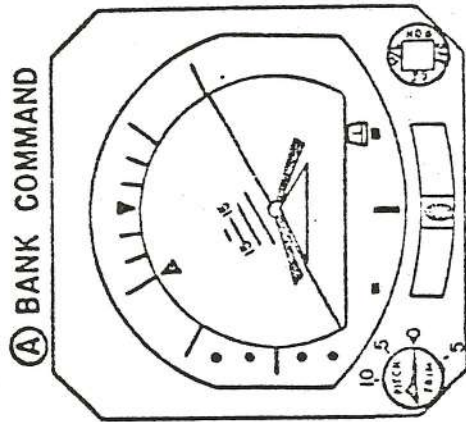
NO COMMAND
AIRCRAFT 5° NOSE DOWN



5° NOSE DOWN COMMAND
AIRCRAFT NOSE LEVEL

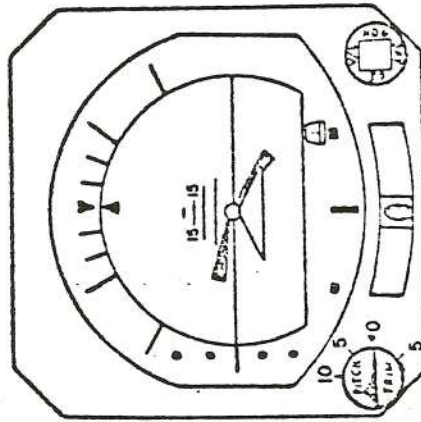


30° LEFT BANK (WINGS LEVEL)
COMMAND
AIRCRAFT 30° RIGHT BANK.

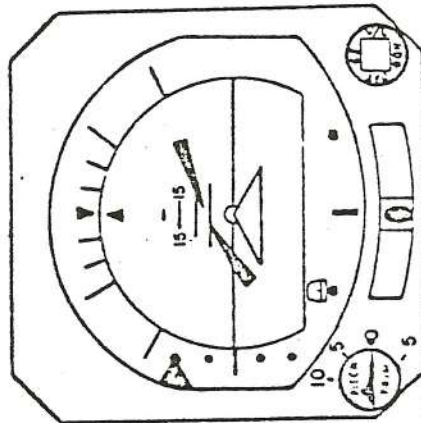


Ⓐ BANK COMMAND

NO COMMAND
AIRCRAFT 30° BANK

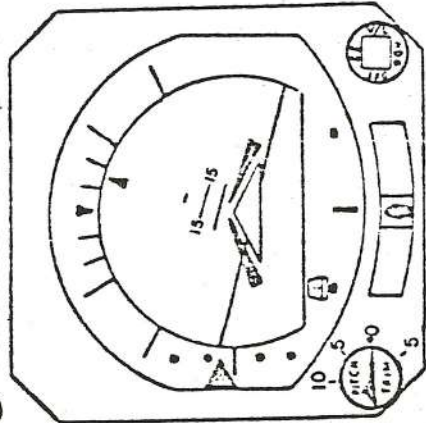


30° RIGHT BANK COMMAND
AIRCRAFT WINGS LEVEL

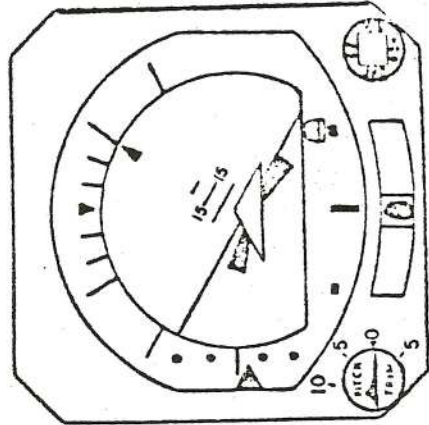


CLIMBING, LEFT TURN COMMAND
AIRCRAFT WINGS & NOSE LEVEL

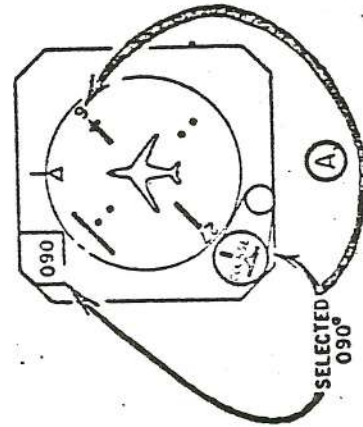
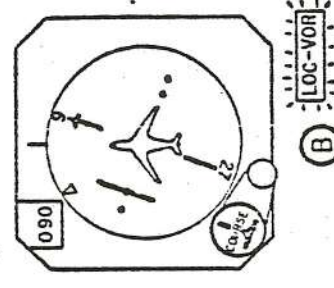
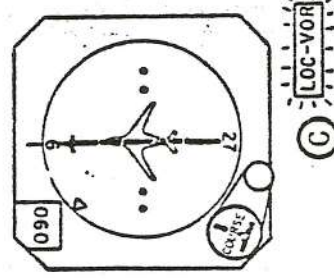
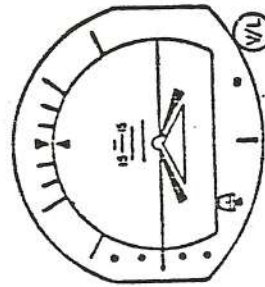
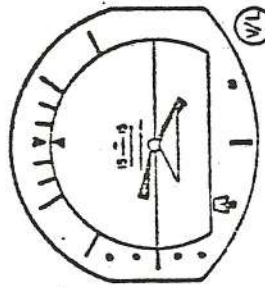
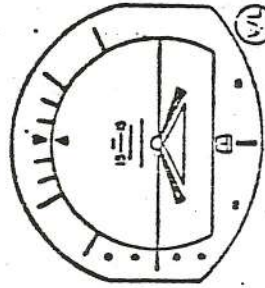
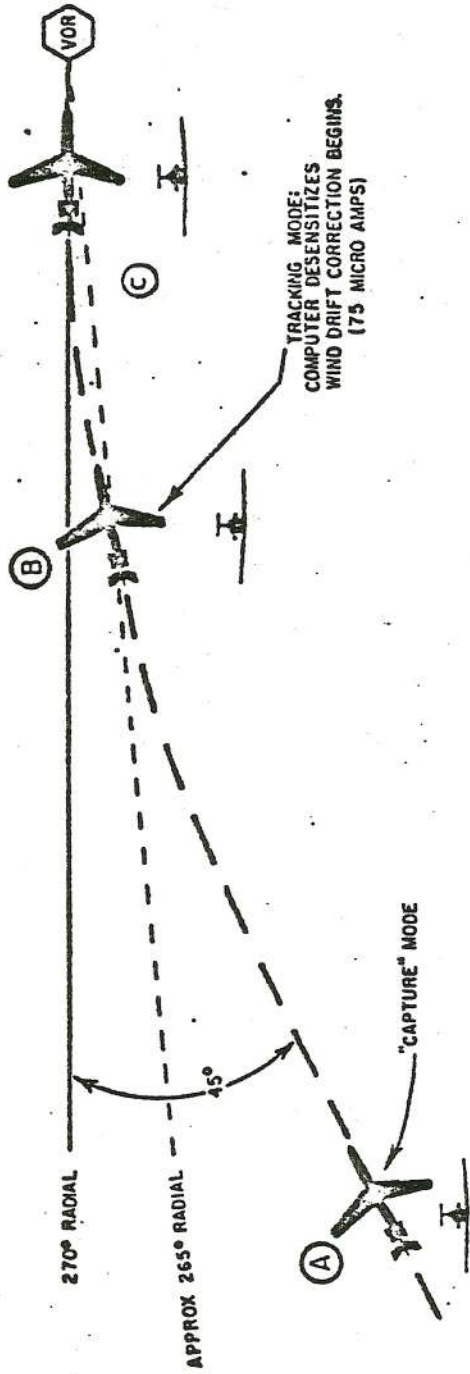
© COMBINED INDICATION

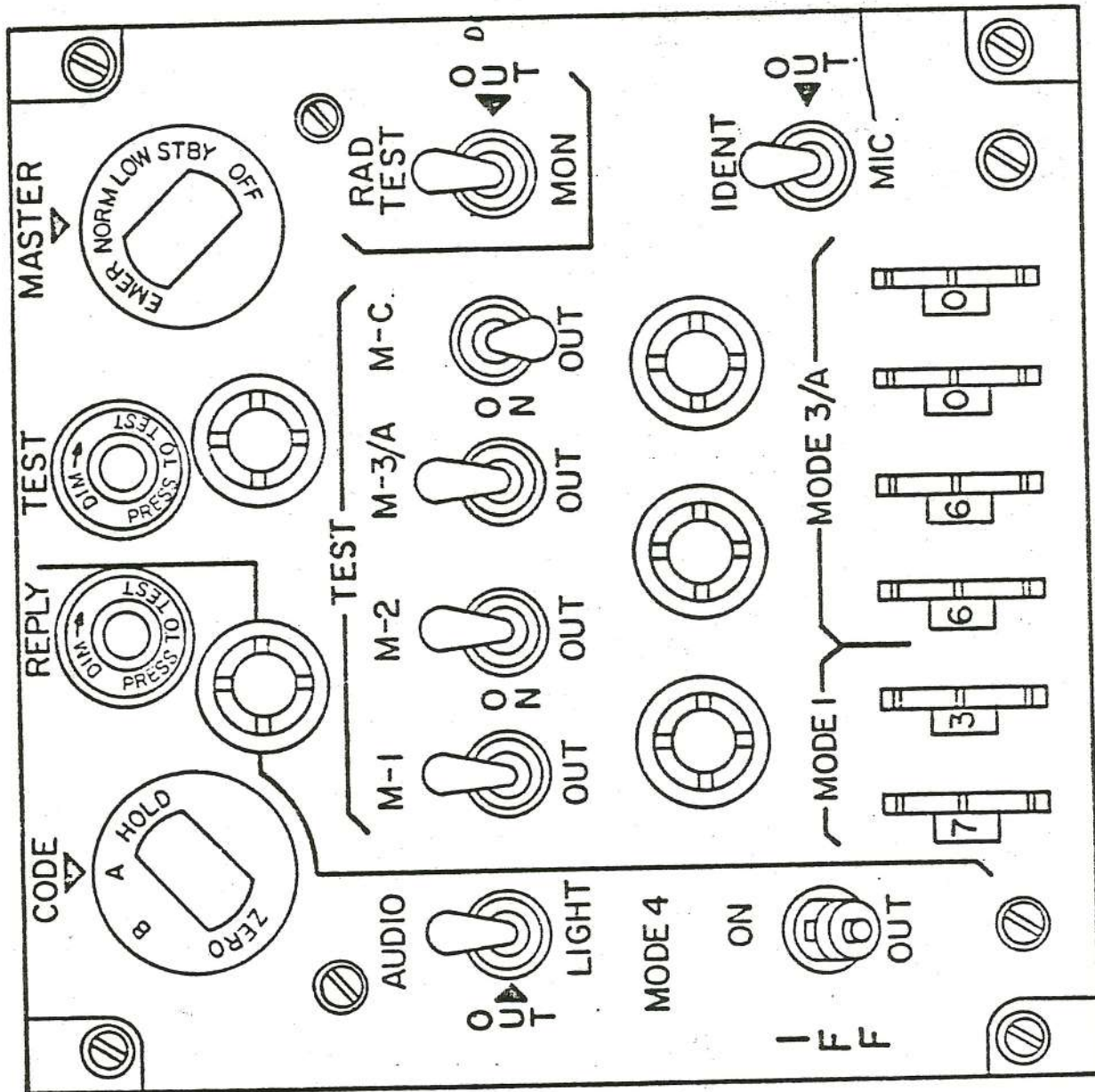


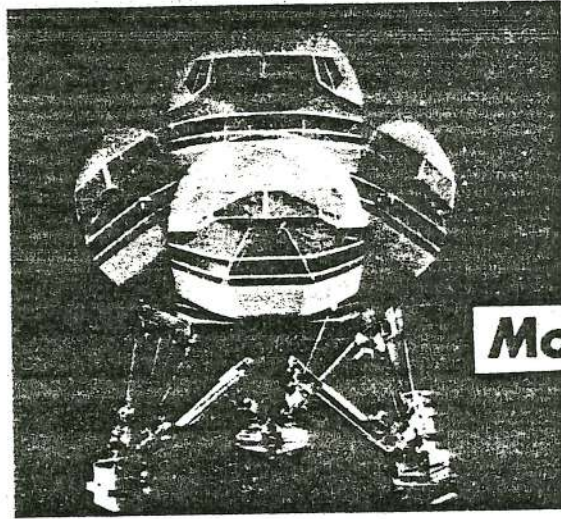
NO COMMAND
AIRCRAFT 5° CLIMB—15° LEFT BANK



NOSE DOWN, RIGHT BANK (WINGS
LEVEL) COMMAND
AIRCRAFT 5° CLIMB, 30° LEFT
BANK







Motion Systems...

SYSTEM	TYPE	SYSTEM DESCRIPTION	ASSOCIATED PROGRAM(S)
Two-Point System	Hydraulic - electronically controlled	Two-point suspension yielding roll and pitch motion. Acceleration cues provided by displacement with washout and return to level accomplished through slow, imperceptible movement. Rough air buffet introduced through separate servo system.	ME-1 Basic Jet Instrument Trainer, F-4 Weapon System Trainers
Cradle System	Electric - amplidyne powered, mechanically coupled	Provides simulation of helicopter pitch/roll about rotor axis - simulates hovering maneuver. Consists of two semi-circular cradles mounted at right angles. Control signals provided through computer linkage.	Link Helicopter Trainer
Three-Point System	Hydraulic - electronically (computer) controlled	Three-point suspension using four-way hydraulic servo valve for each of the three actuators. Position and rate feedback employed for absolute damping action. Provides: <ul style="list-style-type: none"> • Vertical translation • Pitch motion • Roll motion • Initial roll acceleration • Vertical acceleration • Initial pitch acceleration 	B-38, C-130, 707, 727, DC-8 and DC-9 Flight Simulators
Five-Degree-of-Freedom System	Hydraulic - electronically (computer) controlled	Three vertical cylinders impart pitch, roll and vertical translation to the cockpit platform, upon which is mounted the additional cylinders and associated raceways for yaw and lateral motion. In this system, all cylinders are capable of full displacement in either direction. The actuator arrangement provides for completely independent translatory motions without coincident angular changes.	F-111 Mission Simulators
Six-Degree-of-Freedom System	Hydraulic - electronically (computer) controlled	Provides pitch, roll, and yaw movement, as well as lateral, longitudinal, and vertical movement. New design concept based on triangular bipod actuator arrangement that generates stability and response. Incorporates latest Link designed pressure compensation circuits and hydraulic components. This system designed to meet the state-of-the-art requirements associated with the 747 simulator training.	747 Transport Aircraft Simulator Complex

