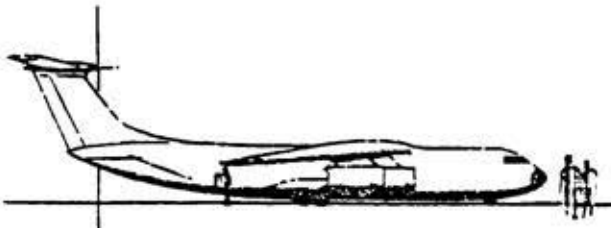


NAVIGATIONAL COMPUTER SET

GENERAL

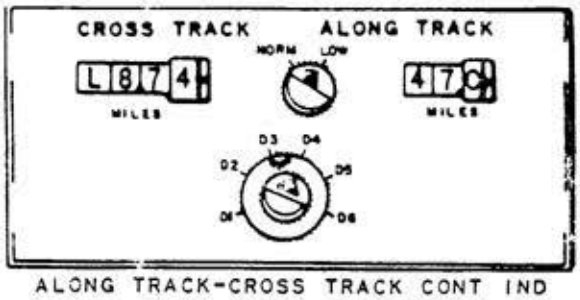
The ASN-24 is a general purpose, airborne, serial digital computer used to provide automatic solutions to aircraft navigation problems. Inputs inserted manually and from associated navigational sensors (TACAN, LORAN, etc.) are used to provide a continuous present position indication. Great circle range and bearing to a primary destination or to any of five intermediate or alternate destinations are available for readout by the navigator and for autopilot command. Control indicators provide for readouts of wind, ground speed, track, cross track, and along track distance, true heading and celestial parameters.

Track angle error, cross track deviation and distance to go are also provided as outputs for pilot's displays and autopilot guidance. Distance-to-go information is also supplied to the vertical navigation systems.

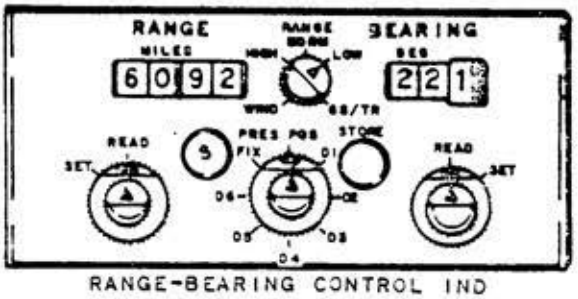
AIRCRAFT INSTALLATION

Eleven components of the ASN-24 navigational computer are installed as follows:

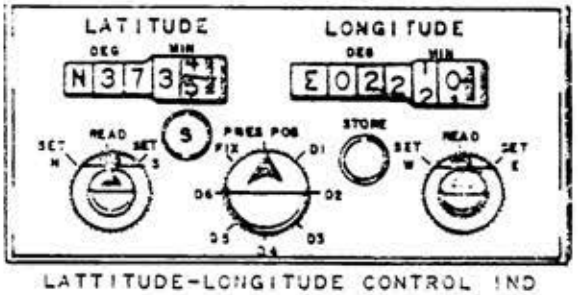
Part No.	Name	Installation
CP-641, ASN-24	Computer	Left Hand Avionics Rack
PP-3214/ASN-24	Power Supply	Left Hand Avionics Rack
C-3961	Control Indicator	Navigator's Inst. Panel
C-3962	Control Indicator	Navigator's Inst. Panel
C-3963	Control Indicator	Navigator's Inst. Panel
C-3964	Control Indicator	Navigator's Inst. Panel
C-3965	Control Indicator	Navigator's Inst. Panel
C-6214	Control Indicator	Navigator's Inst. Panel
C-6213	Control Indicator	Navigator's Inst. Panel
	Switch, Ground Test	Navigator's Inst. Panel
	Control Input Selec.	Navigator's Inst. Panel



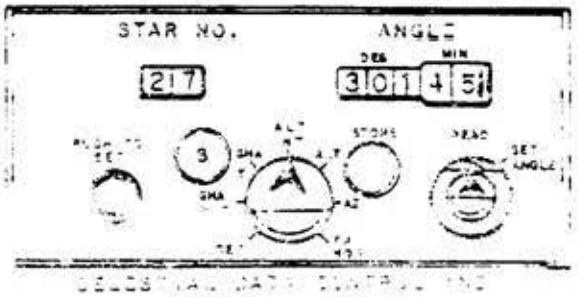
ALONG TRACK-CROSS TRACK CONT IND



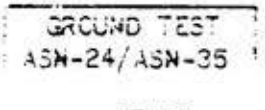
RANGE-BEARING CONTROL IND

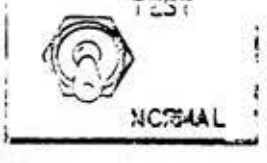


LATTITUDE-LONGITUDE CONTROL IND

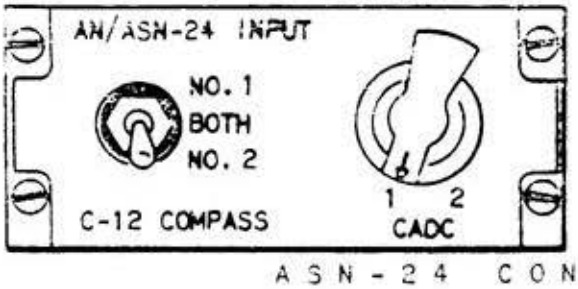


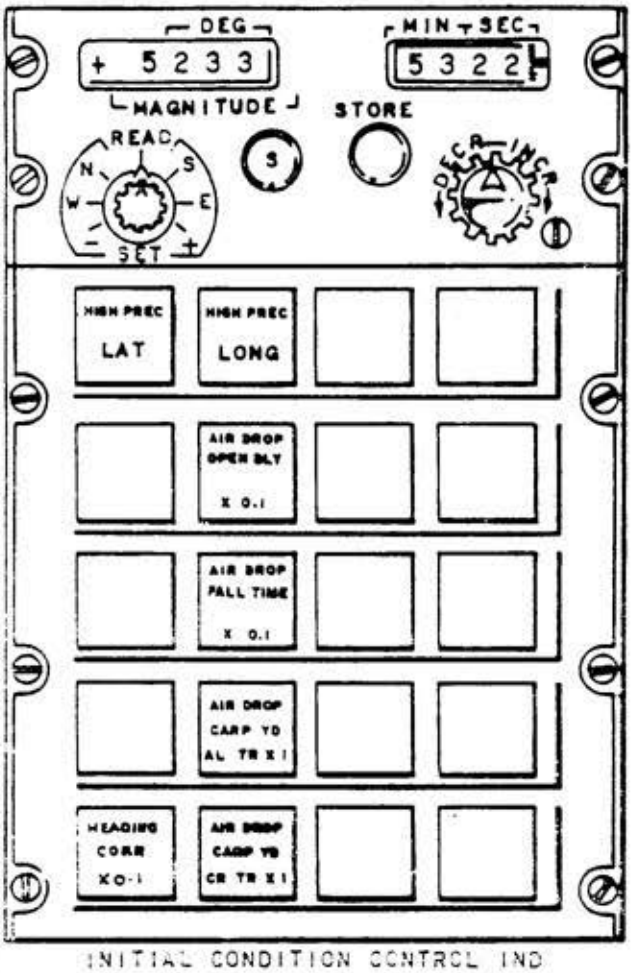
SELECTIVE DATA CONTROL IND



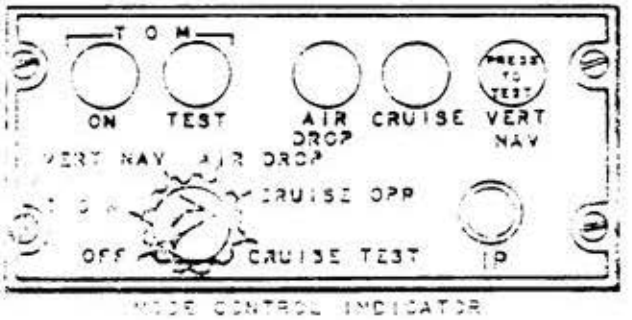


CONTROL INPUT SELECTOR

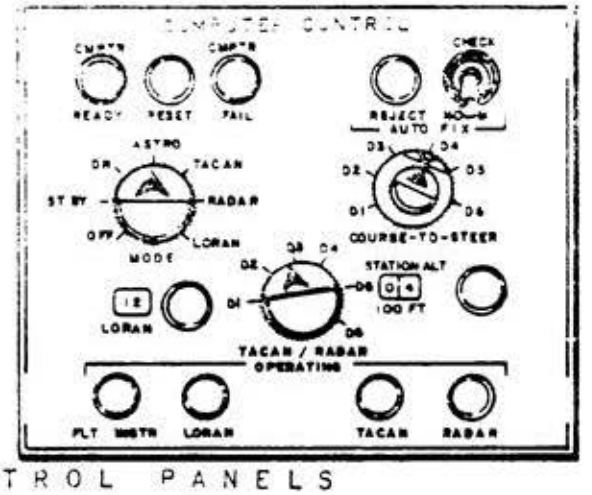




INITIAL CONDITION CONTROL IND

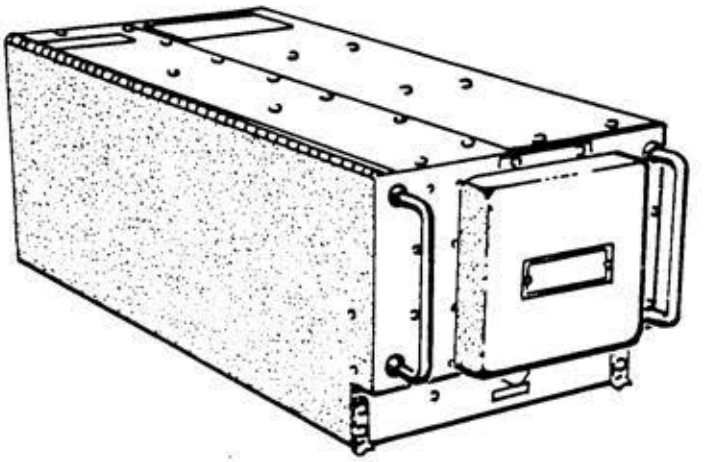


MODE CONTROL INDICATOR

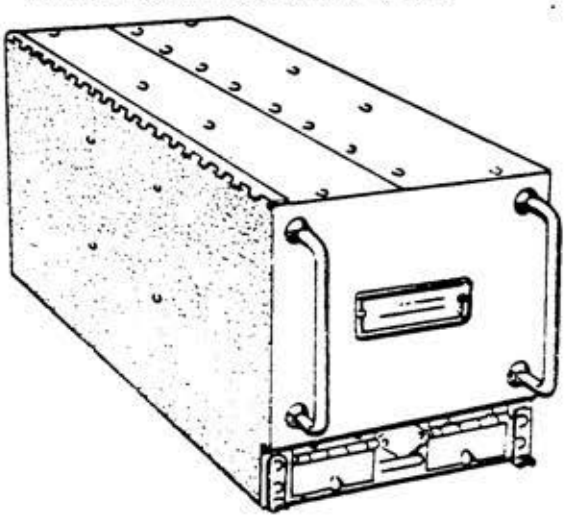


A S N - 2 4 C O N T R O L P A N E L S

CONVERTER CHASSIS - POWER SUPPLY PP3214



NAVIGATIONAL COMPUTER CP641



ASN-24 COMPUTER AND POWER SUPPLY

Power required for system operation is supplied from the main avionics bus No. 1 (115 volts, AC, 400 Hz), navigation bus No. 1 (26 volts, AC, 400 Hz), and the main avionics bus No. 1 (28 volts, DC). Circuit breakers for the system are on the avionics circuit breaker panel at the navigator's station.

SYSTEM OPERATION

The navigational computer operates in five different modes and controls the air-drop operation. The mode selected is dependent upon navigational requirements, operators settings, and operational status of associated equipment. Inputs to the computer system include:

SENSOR	INFORMATION
TACAN No. 1	Bearing and range of TACAN stations. TACAN validity.
LORAN C	Time delay of Slave A and B. LORAN validity.
Search Radar	Ground range and azimuth of selected Radar target: Radar transfer information.
Central Air Data Computer	True airspeed, mach number and pressure altitude.
Gyro Compass	Heading (gyro or magnetic) and heading validity.
Doppler Radar	Ground speed and drift angle. Validity and system mode (land, sea, or smooth sea) operation.

Outputs from the computer include the visual readouts on navigator's and pilot's navigational indicators, autopilot steering signals and distance-to-go to the vertical navigation computer.

DEAD-RECKONING MODE

In dead-reckoning (DR) the computer set utilizes the best available combinations of magnetic and directional gyro inputs. A true heading is derived from the magnetic-heading input by applying corrections for magnetic variation. True heading is also obtained from the directional-gyro input corrected by an offset angle and continuously corrected for the earth's rate and the earth's transport-precession effects. Wind information is computed from the Doppler Radar input. In the event of invalid Doppler Radar information, DR continues using the CADC true airspeed and the last remembered wind or manually inserted wind.

TACAN MODE

The TACAN (Tactical air navigation) mode provides an automatic computation of present position using TACAN range and bearing data. The resulting positions fix is used to correct the present position determined by dead-reckoning. The TACAN bearing received by the computer set is corrected for magnetic variations. The TACAN slant range is converted to ground range using aircraft altitude and TACAN station altitude. TACAN station altitude is manually set in by the operator. TACAN computations are automatically interrupted if the aircraft enters the cone of confusion. When "TACAN" information is selected to update dead-reckoning information, a credibility test is applied to validate it. If the credibility test is passed, a weighing factor is applied and the present position is automatically corrected.

RADAR MODE

The geographical coordinates of a selected radar target are set into the computer when operating in the "RADAR" mode. The distance and azimuth of the target are selected by converging crosshair-type markers upon the target in the APN-59B search radar presentation. The exact geographical coordinates of the target are set into the computer prior to insertions of the radar fix. A credibility test is applied to the fix information from the APN-59 and if it is valid the fix information is used to update the dead-reckoning position.

LORAN MODE

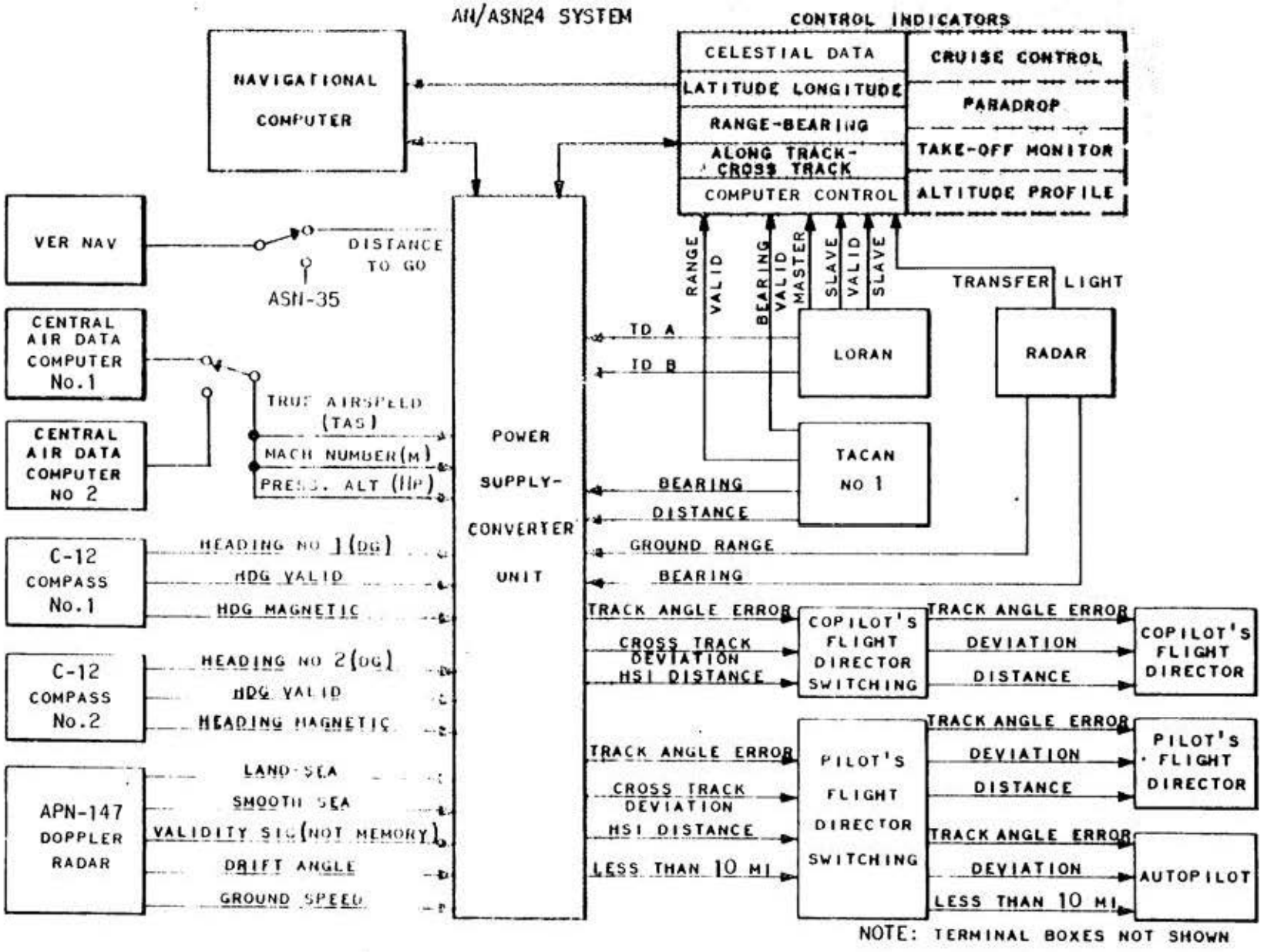
The computation of a navigational fix, using the LORAN receiver, is accomplished in the "LORAN" mode of operation. Geographical positions for the LORAN C master ground station and slave A and B are manually inserted by the operator. The LORAN position is computed and compared with the dead-reckoning position. If the LORAN fix is within the credibility limits, then a series of corrections are made to the dead-reckoning computations. Radio propagation and earth's spheroidal shape correction values are applied to the computed great circle range of each LORAN transmitter.

ASTRO MODE

Provisions are made in the computer to control and accept star data from an external Astro-Tracker. Celestial data may also be manually inserted into the computer. Presently the Astro-Tracker is not installed in the StarLifter.

AIRDROP FUNCTION

In the airdrop submode the computer provides a high-precision, continually updated, Computed Air Release Point (CARP) and steering information for guiding the aircraft to that CARP. Information stored by the navigator include the



AN/ASN-24 DATA FLOW DIAGRAM

geographical coordinates of the Initial Point (IP), parachute ballistics and coordinates of the drop zone.

COMPUTER SET INPUTS

Inputs and outputs of the navigational computer set are shown in the simplified Data Flow Diagram. Inputs to the set are as follows:

- Central Air Data Computers No's. 1 and 2
- Gyro-Magnetic Compasses No's. 1 and 2
- APN-147 Doppler Radar System
- APN-157 LORAN
- APN-59 Search Radar
- ARN-21C TACAN No. 1

In addition to the navigational sensor inputs listed, many parameters may be inserted manually. Manual inputs will be discussed with the appropriate control indicator.

Outputs of the computer are displayed on the control indicators. In addition to these indications the following signals are furnished for pilot's indicators, autopilot guidance, and the vertical navigation system:

- Track Angle Error
- Cross Track Deviation
- HSI Distance
- Distance-to-go to the Vertical Navigation Computer

CONTROL INDICATORS OPERATION

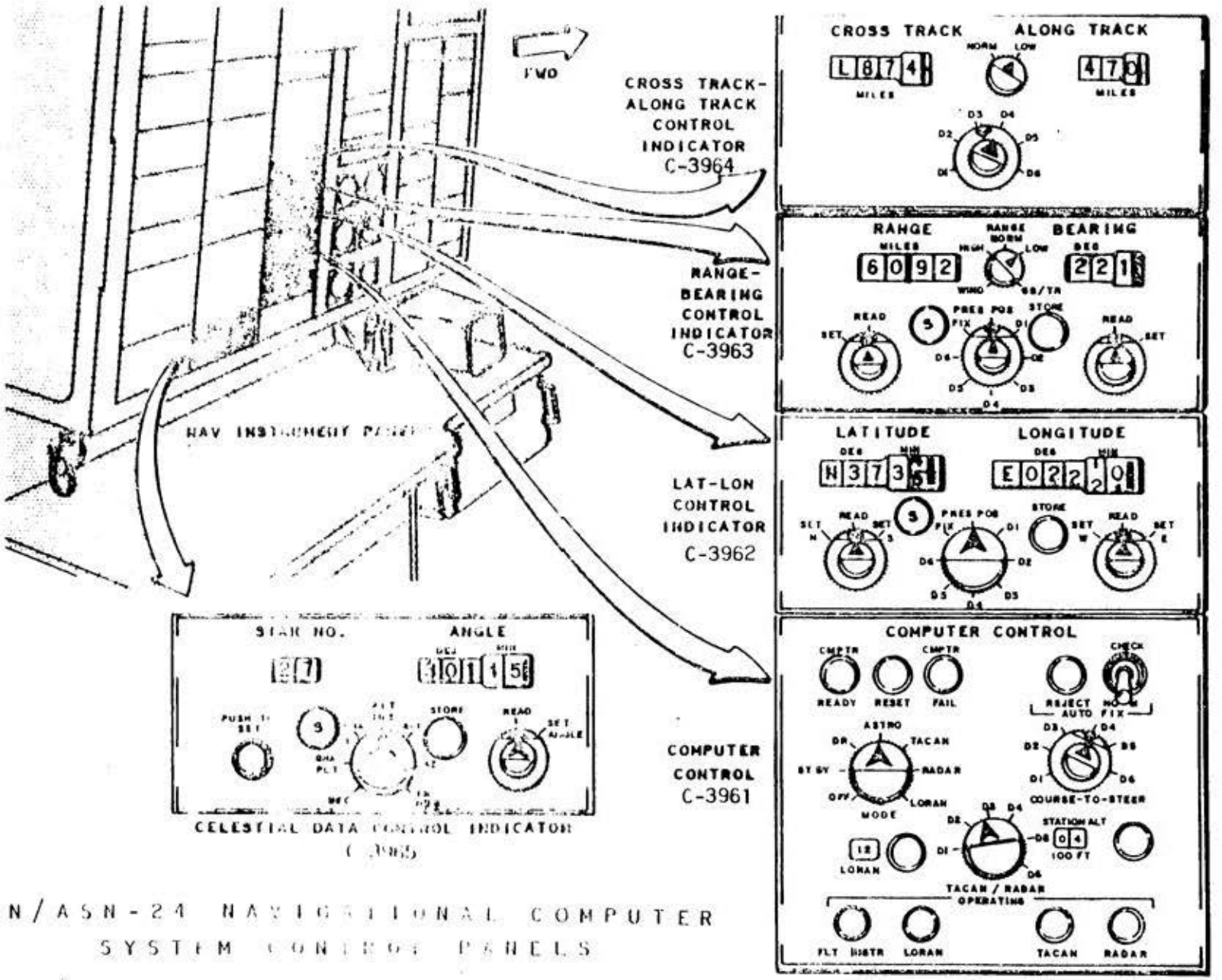
COMPUTER CONTROL C-8961

This control is used to energize the computer and to establish the operational mode. It is also used to indicate the validity of a fix and the operational status of associated navigational equipment. The operational mode is selected by the MODE switch. The positions of the switch are:

"OFF" - Computer deenergized.

"STBY" - Computer on standby basis.

No updating of dead-reckoning position but information may be inserted into the computer.



AN/ASN-24 NAVIGATIONAL COMPUTER
SYSTEM CONTROL PANELS

"DR" - Computer is operational and dead-reckoning is updated according to heading, ground speed, and drift information.

"ASTRO" - Provisions for updating of dead-reckoning information by an external Astro-Tracker (not installed at present).

"TACAN" - Dead-reckoning navigation is updated by range and azimuth information from a TACAN station. The geographical coordinates of the TACAN station must be inserted by the operator.

"RADAR" - Dead-reckoning information is updated by fixes made by the APN-59 Radar system. Insertion controls are part of the APN-59 Radar system. The operator must manually store the coordinates of the Radar target prior to updating the dead-reckoning position.

"LORAN" - Position fixes of the APN-157 are used to update the dead-reckoning position. Coordinates of the LORAN master and slave stations must be inserted by the operator.

It may be noted that the LORAN and TACAN positions provide continuous updating. The Radar position is a "one-time" update but may be repeated each time the operator places the APN-59 cross hairs upon the selected target and depresses the coordinate insertion button on the APN-59 precision marker control panel.

The CMPTR READY indicator signifies, when lit, that the computer has finished its warmup period and is ready to operate. The CMPTR FAIL indicator, when illuminated, shows that the computer has failed to correctly solve an internal test problem. The RESET button is used to reset the CMPTR FAIL circuit. In the event of continued failure of the computer to solve the self-check test the CMPTR FAIL indicator will re-light. The AUTO-FIX-REJECT indicator will illuminate when the computer determines that the fix being used to update dead-reckoning position is not credible. The credibility test is a 30-nautical-mile limit on the acceptable difference between dead-reckoned present positions and the position determined by the latest selected fix. If the distance is greater than 30 miles, the AUTO-FIX-REJECT indicator will illuminate and the fix is rejected by the computer unless it is stored manually by the operator. Manual storage is used when it is determined that the computer dead-reckoning position is not correct. The AUTO-FIX-CHECK-NORM switch allows the inspection of a fix before inserting into the computer. In the "CHECK" position, the auto-fix is read out on the LATITUDE-LONGITUDE control indicator but is not used to update dead-reckoned present position. In the "NORM" position credible fixes are accepted by the computer.

The COURSE-TO-STEER control consists of two concentric knobs. The outer or larger knob with the symbol ◀ (from) selects the coordinates of the departure or base point. The smaller or inner knob with the symbol ▶ (to) selects the coordinates of the desired destination. Selections on these knobs will control track angle error, cross track deviation and distance data utilized by flight instruments and autopilot.

The TACAN/RADAR selector switch is used to define the longitude, latitude and altitude of a TACAN station or Radar fix location that the computer will use when the MODE selector switch is in "TACAN" or "RADAR" position.

The LORAN switch and indicator are used to insert or read out the coordinates of LORAN master and slave stations. Present usage of the different numerical position is as follows:

LORAN Selector Position	Selects for Storage or Readout
1	Loran Master
2	Loran Slave A
3	Loran Slave B
4	Initial Point
5-12	General fixes

Readouts or insertions are made on the LATITUDE-LONGITUDE control indicator.

The STATION ALT indicator and knob are used to insert the altitude of a radar fix point or of a TACAN station when the coordinates are being stored into the computer. The value of altitude is automatically stored with the geographical coordinates and is used in converting slant range to ground range.

The OPERATING indicators show auxiliary equipment status and are illuminated under the following conditions:

FLT INSTR - Illuminated when ASN-24 is selected to control the autopilot and/or the flight instruments.

LORAN - Illuminated when the APN-157 is locked on to a master station and slave A and/or B. Sky wave reception will also cause the lamp to extinguish as well as loss of lock-on.

TACAN - Illuminated when TACAN No. 1 is locked on in range and/or azimuth.

LATITUDE-LONGITUDE CONTROL INDICATOR C-3962

This control indicator provides the capabilities of storing or reading out latitude and longitude of selected locations. The LATITUDE and LONGITUDE counters indicate the coordinates selected by the distination switch. "PRESENT POSITION-FIX" coordinates may be selected by the destination switch in lieu of the "D1-D6" destinations. Each counter has an associated pair of concentric knobs. The outer knob in each set will determine if the counters are used for readout or insertion of data.

The inner knob is used to manually slew the counter to the value to be inserted into the computer. The STORE button initiates storage of the selected values of latitude and longitude. The STORE indicator will illuminate when storage information has been accepted by the computer. The STORE button should not be released until the STORE indicator illuminates. Storage of LORAN fixes is accomplished with the destination switch in the "FIX" position. When the LORAN switch on the COMPUTER CONTROL panel is in No's. "1, 2, 3, or 4", and the destination switch on the C-3962 control indicator is on "FIX" the counters will readout the coordinates of the selected LORAN fix. Storage of LORAN coordinates is also accomplished with the destination selector on "FIX" and the LORAN switch on positions "1, 2, 3, or 4". Storage is initiated on the C-6214 initial condition indicator. When the LORAN selector switch is in positions "5" through "12" and the destination switch in the "FIX" position the counter readout will be the selected Radar or TACAN fix. Storage of Radar and TACAN coordinates is accomplished by placing both destination dials in the C-3962 and C-3961 to the same "D" number. Slewing the counters to the appropriate values and depressing the STORE button on the C-3962 until the store light illuminates. After insertion the value of the coordinates may be checked by returning the counter READ-SET controls to "READ".

RANGE AND BEARING INDICATOR C-3963

This indicator is used to display range and bearing between points selected on the destination dial. (There are the same D1 -- D6 coordinates which were inserted on the C-3962 and C-3961 control indicators). Wind direction and magnitude and true ground speed are also selectable readouts.

Range and bearing readouts are available when the range selector switch is in the "HIGH", "NORM" or "LOW" position. The counter will indicate 0 - 9998 NM, 0 - 999.8 NM, and 99.98 NM respectively for the different positions. Range and bearing displayed is between the points selected on the concentric destination dials. The outer destination dial is marked ◀ (from). The inner dial is marked ▶ (to). Any combination of destinations as previously stored by the computer control and latitude-longitude control may be displayed. In addition, if the "from" dial is placed on "PRES POS" the range and bearing of any of the destinations

from present positions may be readout. When the selector switch is in the "WIND" position wind speeds of 0 to 1000 KN may be read on the RANGE counter. The wind direction will be readout on the BEARING counter. Wind values may be manually stored by moving the outer dials of the counter control knobs to "SET", slewing to desired values with the inner knobs and depressing the STORE button until the store lamp lights.

When range and bearing to a destination are known, they can be stored by way of the RANGE-BEARING control indicator. Range and bearing between positions selected on the destination selector switch are stored in the same manner as wind information except RANGE scale selector switch must be in the "HIGH", "NORM", or "LOW" position. When this store operation is performed the latitude and longitude of the destination (to) is automatically computed and stored in the "D" location.

The "GS/TR" position of the selector switch allows display of a ground speed and track on the range and bearing counters. Data cannot be stored manually in the range bearing control indicator when the selector switch is in the "GS/TR" position.

Wind values are normally computed from Doppler Radar information. If Doppler becomes inoperative or goes to memory the computer uses last known wind values. The operator can manually insert winds when the Doppler is inactive but valid Doppler information has priority and will override all previously inserted wind values. TACAN or LORAN fixes will also provide the computer with sources of wind information. Correction applied to presently indicated winds will be one-fourth of difference between wind from fix and last-remembered wind information. This weighing of data ensures smooth wind correction.

CROSS TRACK - ALONG TRACK CONTROL INDICATOR C-3964

This instrument indicates distance to go to the destination selected on the "to" dial of the destination dial and lateral deviation from the selected course (cross track). When the NORM-LOW switch is in the "NORM" position, ALONG TRACK counter indicates 0 to 1000 NM in .2 NM increments, CROSS TRACK scaling is 0 to 100 NM in 0.02 NM increments. When the switch is in the "LOW" position, scales are 0 - 100 NM, 0.02 increments for ALONG TRACK and 0 - 10 NM in 0.002 NM increments for CROSS TRACK.

CELESTIAL DATA CONTROL INDICATOR C-3965

This control indicator is used to set in the "read" celestial parameters. The PUSH TO SET button is used to select a particular star for insertion or readout of data. Storage of data is accomplished in a manner similar to the other control indicators. The READ-SET ANGLE outer knob is positioned to "SET ANGLE".

The counter is slewed to the desired value by the inner knob and the STORE button is depressed until the store light illuminates. The selector knob allows various parameters to be stored or read. The available positions are as follows:

"DEC"	-	Read or store declination of celestial body selected by PUSH TO SET button.
"GHA PLT"	-	Read or store Greenich Hour Angle of selected sun or planet.
"GHA T"	-	Store or read the Greenwich Hour Angle of the first point of Aries.
"ALT INT"	-	Read altitude intercept, (difference between the calculated and actual elevation angle of the selected celestial body.
"ALT"	-	Elevations cycle of the celestial body.
"AZ"	-	Read true bearing of the celestial body.
"TR HDG"	-	Read aircraft true heading.

MODE CONTROL INDICATOR C-6213

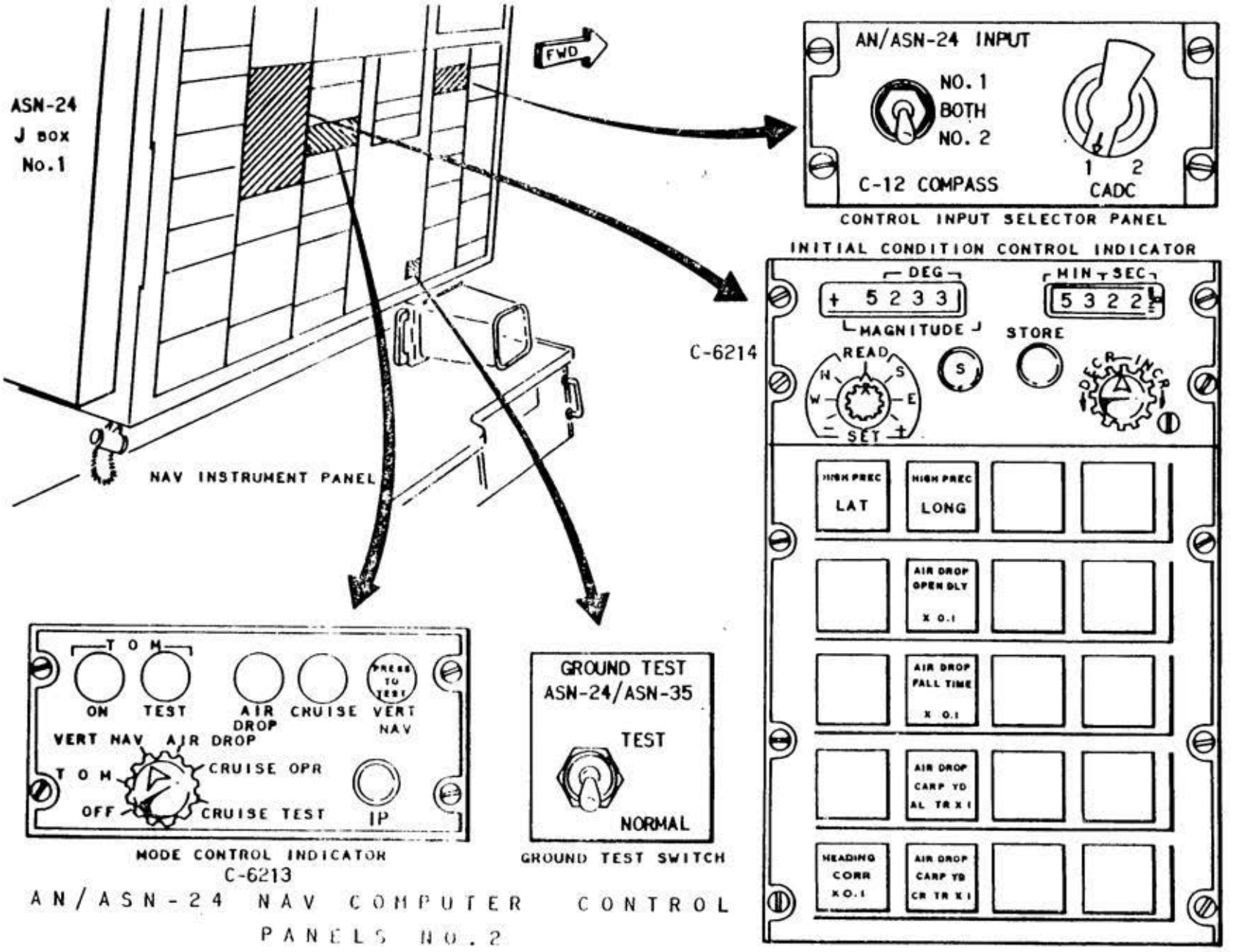
This indicator is used in the air drop mode of operation, "TOM", "VERT", "NAV", "CRUISE OPR" and "CRUISE TEST" positions of the selector switch are not presently used. The "VERT NAV" position should not be confused with the AWLS Vertical Navigation which is a different system.

When the mode control selector switch is in the "AIR DROP" position, the computer is alerted to compute air drop functions. The AIR DROP indicator illuminates when the aircraft has arrived at the CARP and extinguishes when the aircraft has passed the last effective parachute release point.

The IP button is used to notify the computer that the aircraft is passing over the Initial Point (IP) and updates the dead-reckoned position to the coordinates of the IP.

INITIAL CONDITION CONTROL INDICATOR C-6214

The indicator provides for storing and monitoring parameters in the AIR DROP mode. It can also be used in storing LORAN station coordinate information. When the HIGH PREC LAT or the HIGH PREC LONG button is depressed and the READ-SET knob is placed in the appropriate "SET" position (N or S for latitude,



AN/ASN-24 NAV COMPUTER CONTROL PANELS NO. 2

E or W for longitude) high precision coordinates may be installed as IP (LORAN Station 4), and "D" number, or LORAN Master and Slave locations (LORAN Stations 1, 2 and 3). Storage is accomplished by depressing the STORE button until the store light illuminates. Two slew knobs are provided, one for the DEG - MAGNITUDE counter and one for the MIN-SEC counter. When AIR DROP CARP YD AL TR x 1 button is depressed the DEG-MAGNITUDE counter will display distance remaining along track between the initial impact point and final impact point. When the AIR DROP CARP YD CR TR x 1 push button is depressed the DEC-MAGNITUDE counter will indicate computer cross track distance from initial impact point and final impact point.

The AIR DROP OPEN DLY x 0.1 and AIR DROP FALL TIME x 0.1 push buttons permit storage of parachute ballistics into the computer memory. The HEADING CORR x 0.1 button is depressed when a correction to the ASN-24 true heading is to be stored for readout.

The GROUND TEST switch is used to bypass the touchdown relay which disables the ASN-24 when the aircraft is on the ground. In "NORMAL" position the computer will not update dead-reckoning position while the aircraft is on the ground. However coordinates may be stored. In "TEST" position the ground disabling lines are bypassed and tests may be performed upon the computer.

The AN/ASN-24 INPUT selector switch is used to select "CADC 1" or "CADC 2", and "C-12 COMPASS NO. 1 - NO. 2 - BOTH" as inputs to the computer.

SPECIFICATIONS

ASN-24 NAV COMPUTER SET

CHARACTERISTIC	SPECIFICATION
Number of components	9 and 2 switch panels
Total weight	121 lbs.
Type memory	Rotating drum
Drum speed	6000 RPM nominal
Drum tracks	70
Words per track	64
Bits per word	25
DC power requirements	145 watts 28 volts, DC
DC power limits	21 to 29 volts, DC

SPECIFICATIONS (continued)

CHARACTERISTIC	SPECIFICATION
AC power requirements	130 VA 26 volts, AC 380 to 420 Hz 410 VA ØA 300 VA ØB, ØC 115/200 volts, AC 3 phase 380 to 420 Hz 58 watts 5 volts, AC
AC voltage limits	26 volts, AC 24.5 - 26.5 volts, AC 115 volts, AC 108.5 - 117.5 volts, AC 5 volts, AC 3 - 6 volts, AC
Fuses (converter chassis)	F1-F10 2 amperes F11 4 amperes F12, 13, 15, 16, 17 1.5 amperes F14 0.25

FUNCTION	RANGE	ACCURACY
Present position latitude	N 90 - S 90 degrees	±0.5 percent of distance traveled plus 0.3 minute of arc
Present position longitude	W 180 - E 180 degrees	±0.5 percent of distance traveled plus 0.3 minutes of arc
Multiple destinations storage	N 90 - S 90 latitude E 180 - W 180 longitude	±0.2 minute of arc
Range		
Flat earth	0-100 NM	±0.5 NM
Great circle	100-1,000 NM 1,000 - 10,000 NM	±0.52 NM ±1.3 NM
Bearing		
Flat earth	0-100 NM	±0.2 DEG

SPECIFICATIONS (continued)

FUNCTION	RANGE	ACCURACY
Great circle	100 - 1,000 NM 1,000 - 10,000 NM	±0.2 DEG
Along Track distance	0 - 100 NM 100 - 10,000 NM	±0.02 NM ±0.2 NM
Cross Track distance	0 - 10 NM 10 - 100 NM	±0.002 NM ±0.02 NM
TACAN fix	5 - 75 NM 75 - 200 NM	±0.4 NM ±0.7 NM
Radar fix	0 - 30 NM 0 - 300 NM	±0.4 NM ±0.4 NM
LORAN fix	0 - 1000 NM (day) 0 - 1500 NM (night)	±0.25 NM ±0.25 NM

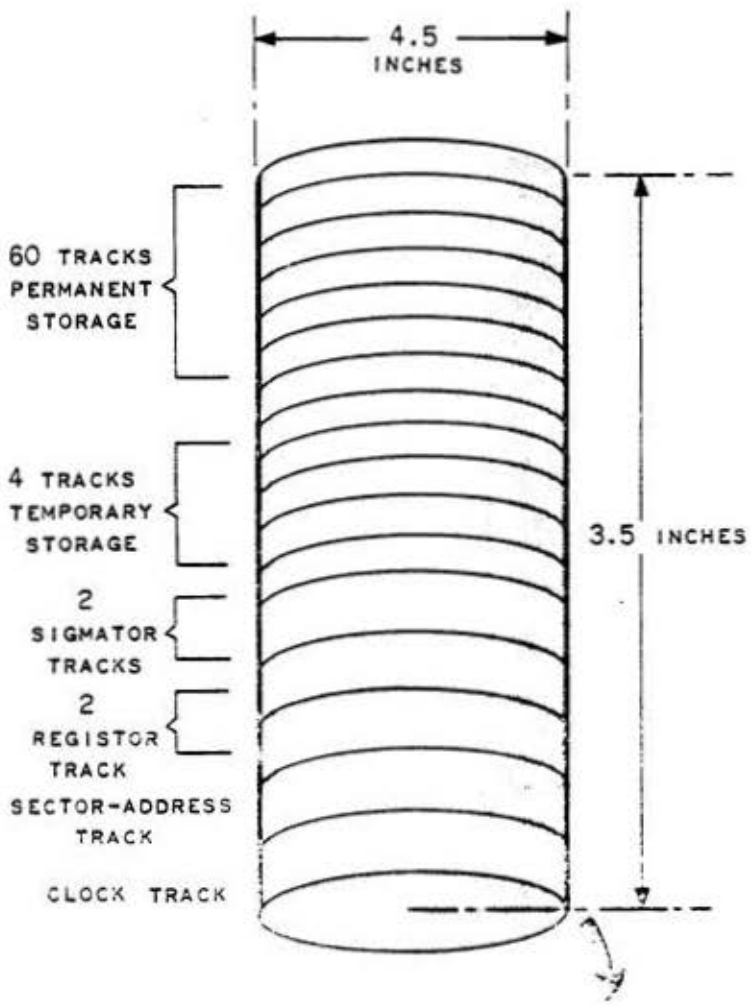
BLOCK DIAGRAM THEORY OF OPERATION

The heart of the computer is a small, rotating magnetic drum. Information is stored in binary form upon the drum. Facilities are provided for temporary and permanent storage of information. Information is retrieved as needed for computations and displays.

Read and write heads are spaced to provide 70 tracks on the storage drum. 1600 slots are scribed vertically and equally spaced around the drum circumference. The 1600 slots thus formed are filled with magnetic material and acts as 112,000 miniature magnets (70 tracks x 1600 lines). Write heads are used to provide a source of magnetization of the individual magnets (bits). The direction of magnetization. NM or SM indicates a 1 or 0. When the magnetic drum is rotated past a read head the polarity of the magnetization is sensed and a signal corresponding to a 1 or 0 is produced. Since the drum is rotated past the read and write heads at a 6000 RPM rate, storage and retrieval is accomplished at a rapid rate.

The 70 available tracks are used for various purposes, while 60 tracks are used for permanent storage of information. Temporary storage of data such as a sum or product which is needed for a larger scale problem solution is provided by 4 tracks.

The 2 sigmator (summation integrator) tracks are used to store incremental pulse accumulation, real time accumulations, integration, exterpolation, etc.



DETAIL OF INDIVIDUAL TRACK

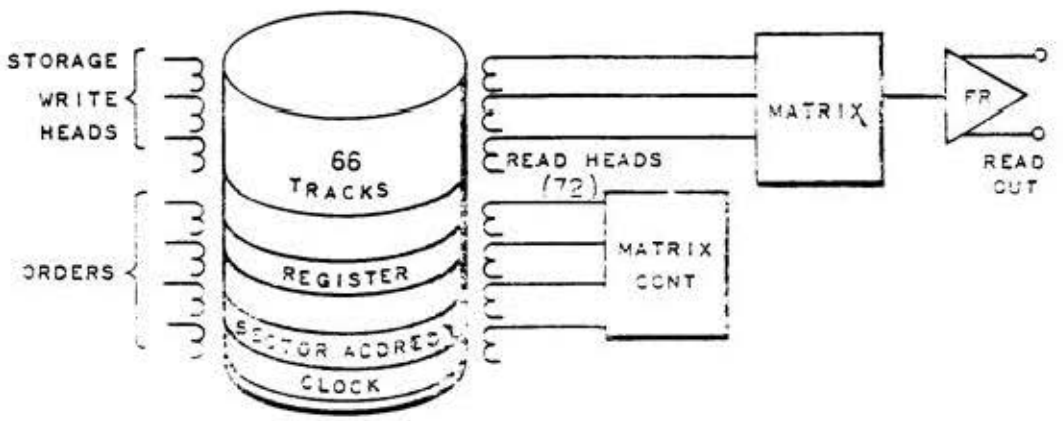
MEMORY DRUM

Drum register tracks are used to hold words being manipulated as either operands or instructions. (An operand is any one of the quantities entering into or arising from an argument, a result, a parameter, etc.).

The Sector-Address tracks primary purpose is to define each of the 64 sectors, or words around the drum. (25 bits per word x 64 words = 1600 bits per track.) The sector-address track is also used as a synchronizing device in determining individual bit location within a word.

The Clock track supplies timing pulses required by the computer. By synchronizing computer circuits to the clock pulses, slight variations in drum speed will not adversely affect operation. The clock track is pre-recorded with all of its 1600 bits magnetized in the same direction. Each bit then will initiate a pulse which is in synchronization with that particular bit in the other 69 tracks.

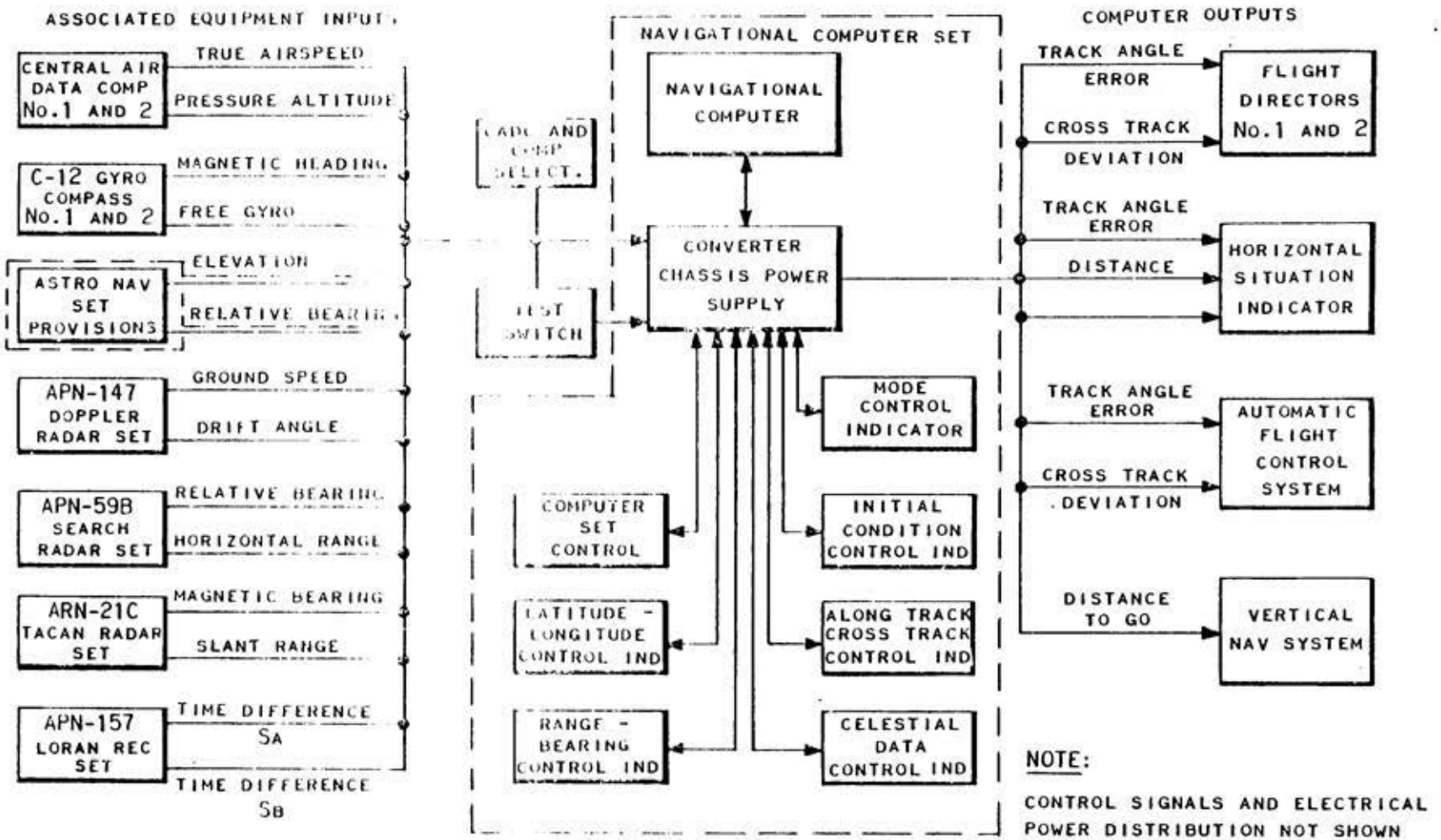
Outputs from the 66 storage tracks (permanent, temporary and sigmator) are controlled by the Register, Sector-Address and Clock tracks. Read heads provide a continual output to a matrix which is controlled by the remaining tracks. Since readout is accomplished by one Flip Flop (FF), it is readily apparent that



SIMPLIFIED MEMORY READ-OUT

one portion of one track can be read at one time. The anomaly of 72 read heads on 66 tracks is explained by the fact that some tracks have more than one read head. Multiple head on a single track allow recirculation of data to that track.

Information is inserted into the drum by write heads which furnish a magnetomotive force of approximately 15 ampere-turns to the drum bit which is located 0.001 of an inch from the write head. The applied force is sufficient to saturate the bit magnetically. South-north polarization of the bit represents a zero. Polarity of the magnetization of the bit depends on the direction of current flow in the write head. All bit information may be erased by writing new information over the old.



DATA FLOW AND SYSTEM TIE-IN

Much of the information used by the computer is of analog type. An input-output unit (which is part of converter chassis - power supply PP-3214) is used to translate the input analog signals to binary digital form for the computer. Reconversion of the binary signals going from the computer to analog form is also accomplished in this unit. A typical example of this conversion is the changing of an input synchro signal such as the C-12 compass output to digital form for use of the computer.