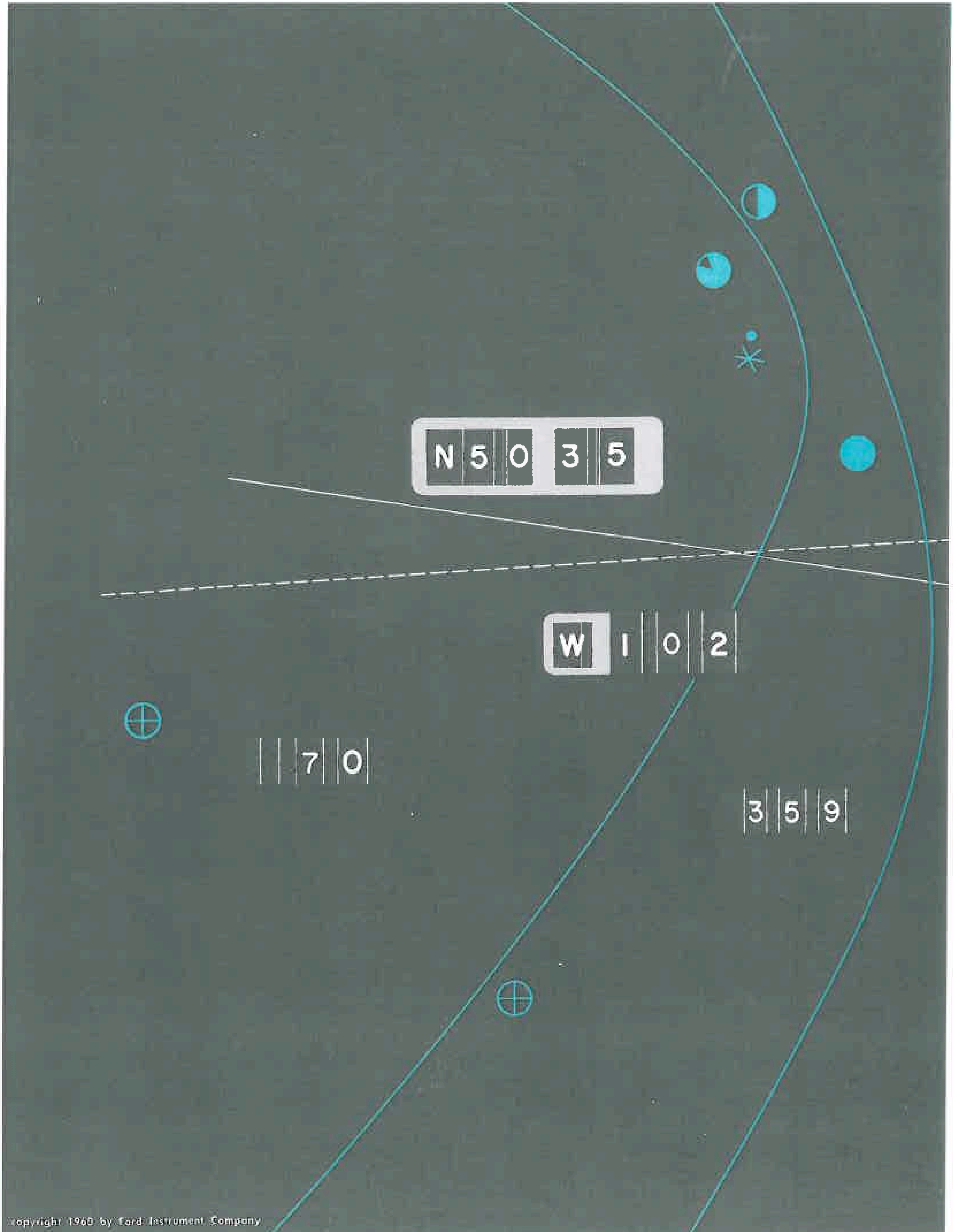
McKEOWN, P. J.

AUTOMATIC NAVIGATION COMPUTER

ASN-7

FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION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FORD INSTRUMENT

presents

ASN·7

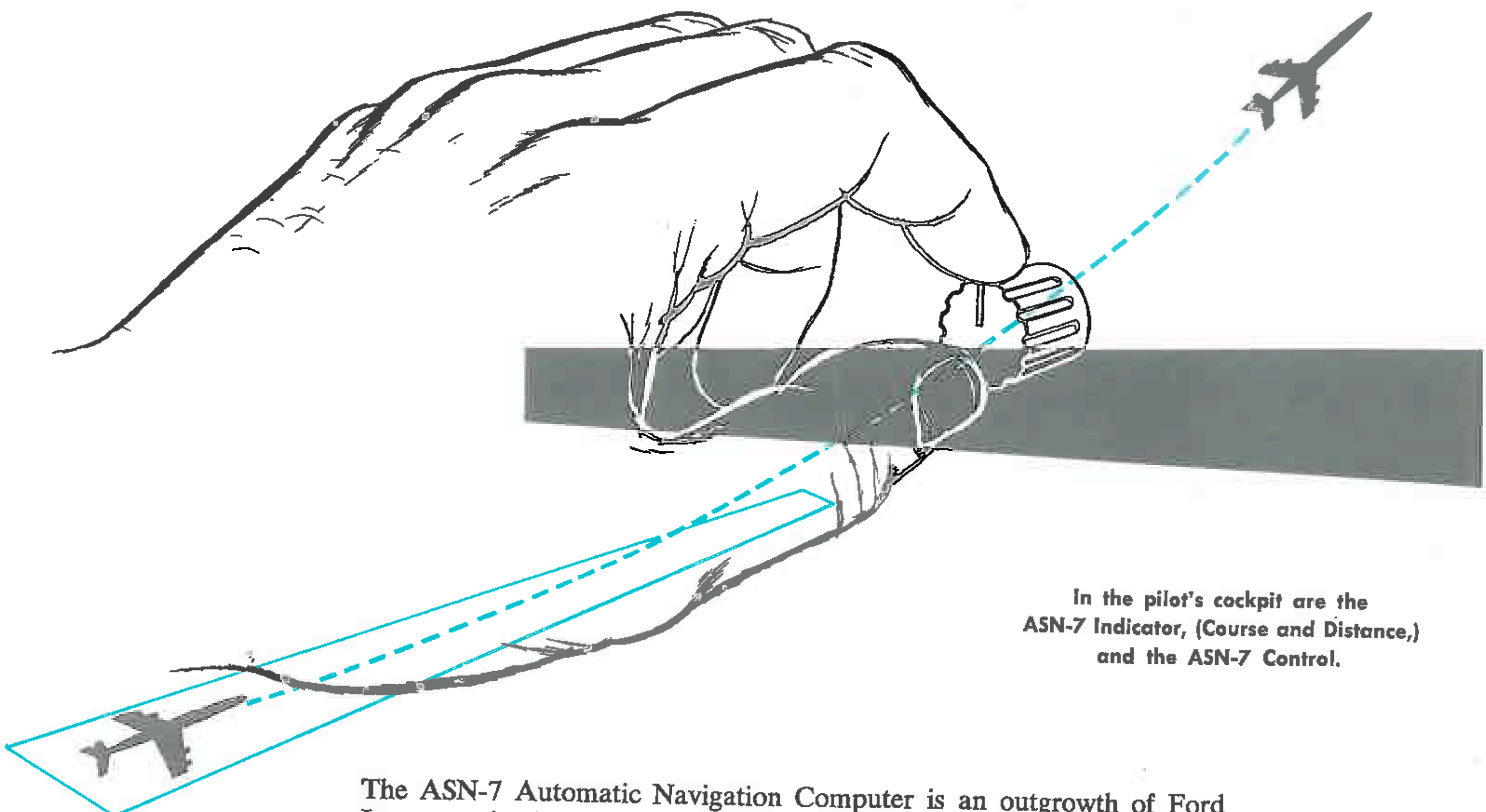
The ASN-7 is a self-contained navigational computer designed by Ford Instrument Company to simplify the navigation phase of flight. This brochure is planned to acquaint the reader with what it is, how it operates, and its advantages not only to the pilot, but to management and design groups of aircraft manufacturers, ground control centers, and the armed services.

Experts in the field of aerial navigation have said the ASN-7 "approaches the pilot's ideal as an aid to navigation."

Contents

The ASN-7, in brief

A dead reckoning computer that continuously displays course and distance and present position

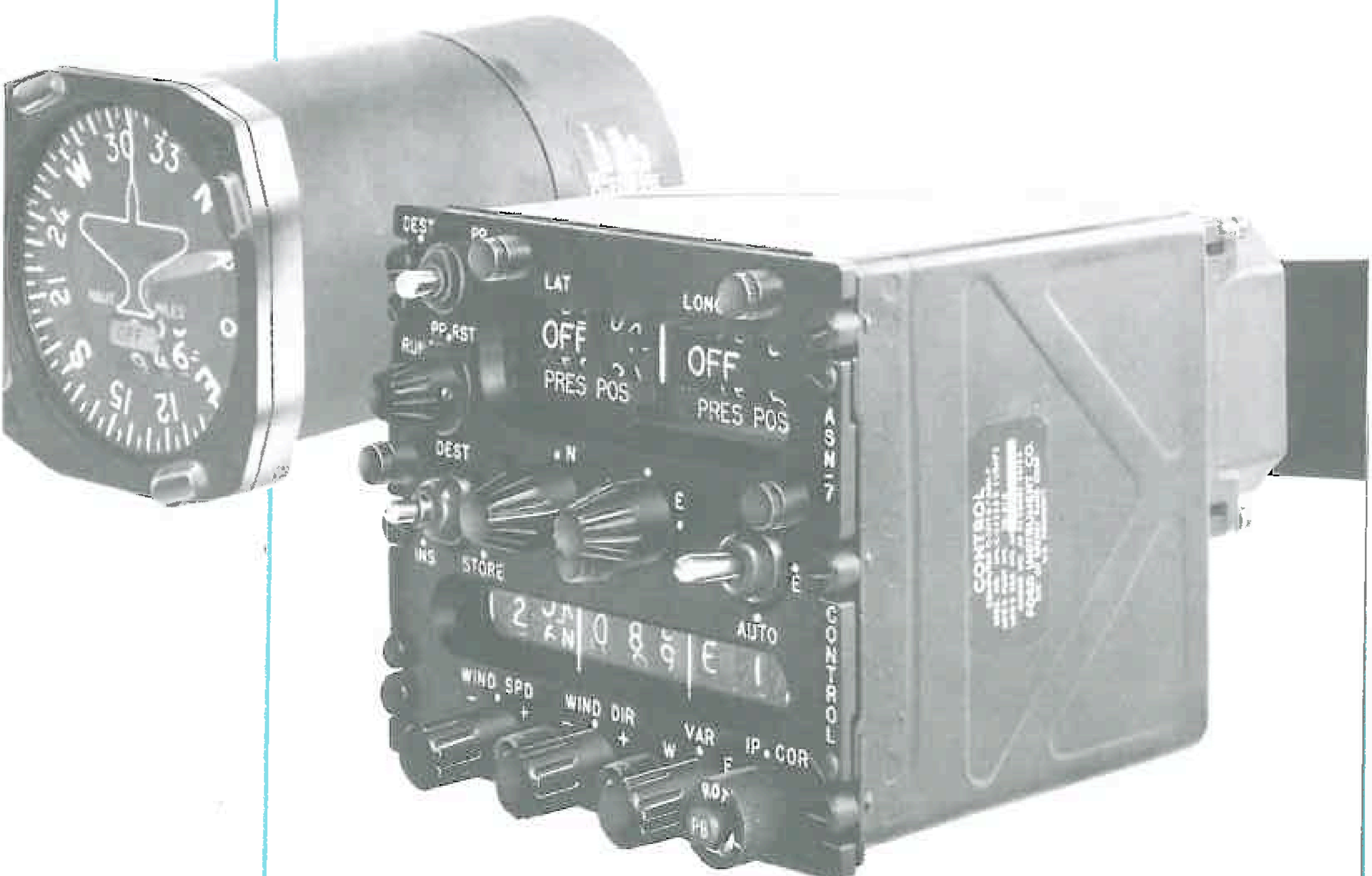


In the pilot's cockpit are the ASN-7 Indicator, (Course and Distance,) and the ASN-7 Control.

The ASN-7 Automatic Navigation Computer is an outgrowth of Ford Instrument's ASN-6, a widely used present position computer. The ASN-7 is a miniaturized computer which *not only* provides present position, but also shows the pilot the direction he should fly, the ground track he is flying, and the distance to his destination—no matter how his heading may change while in flight. This computer can be adapted to telemetering equipment and used in many special applications (such as traffic control). It has an auto-pilot output available as standard equipment. The ASN-7 is operational and is being used extensively by the U. S. Air Force in a wide variety of aircraft.

and its advantages for pilots and navigators

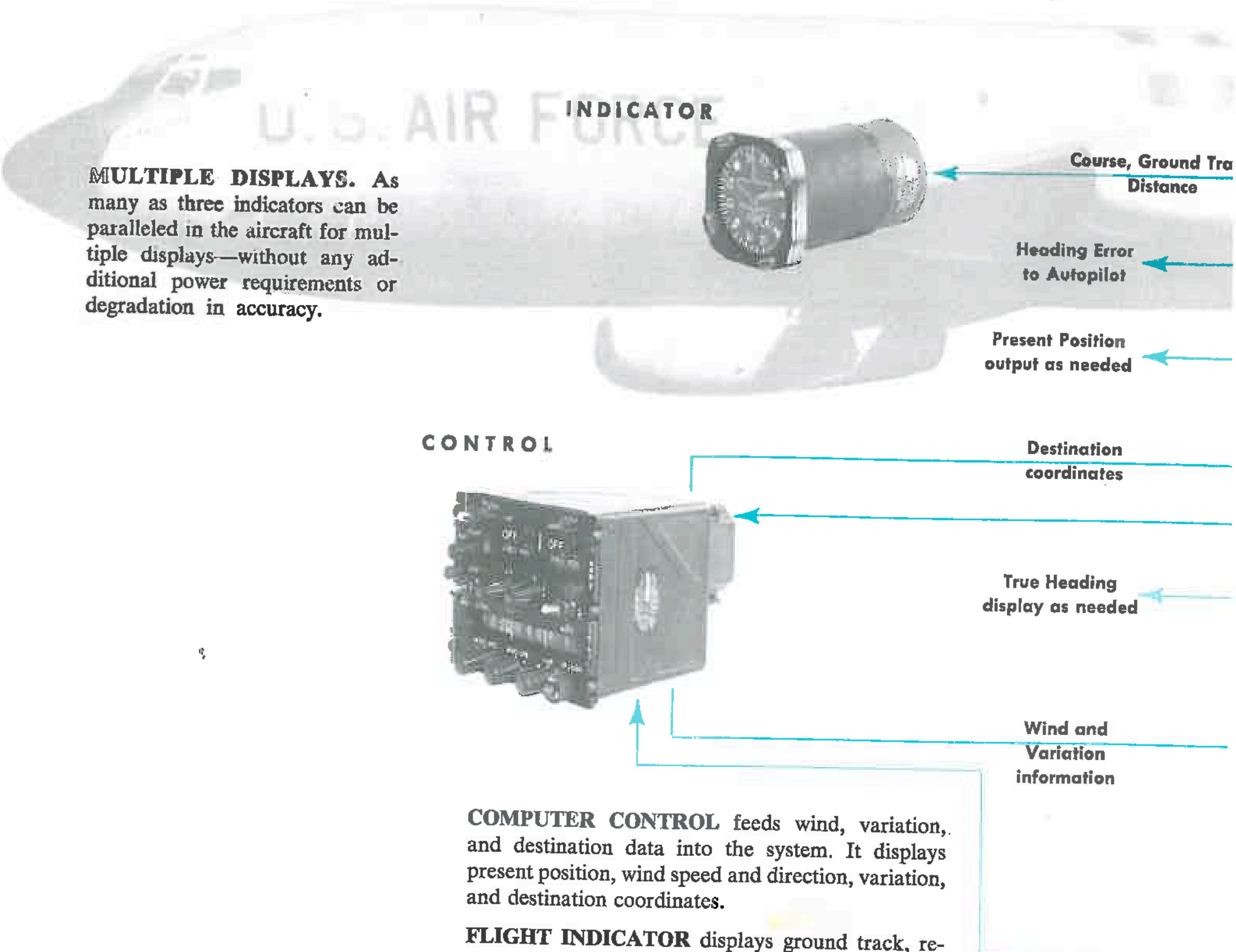
- There are no pre-flight requirements.
- Primary inputs are automatic and settings are simple.
- An alternate destination can be stored within the system for immediate use as desired.
- No monitoring of the equipment is required.
- No mental computation or manipulation of maps is necessary.
- ASN-7 provides continuous information during flight.
- Accuracy of ASN-7 is guaranteed.
- The ASN-7 is completely fail-safe.



The pilot and the ASN·7

COMPONENTS IN THE COCKPIT

MULTIPLE DISPLAYS. As many as three indicators can be paralleled in the aircraft for multiple displays—without any additional power requirements or degradation in accuracy.



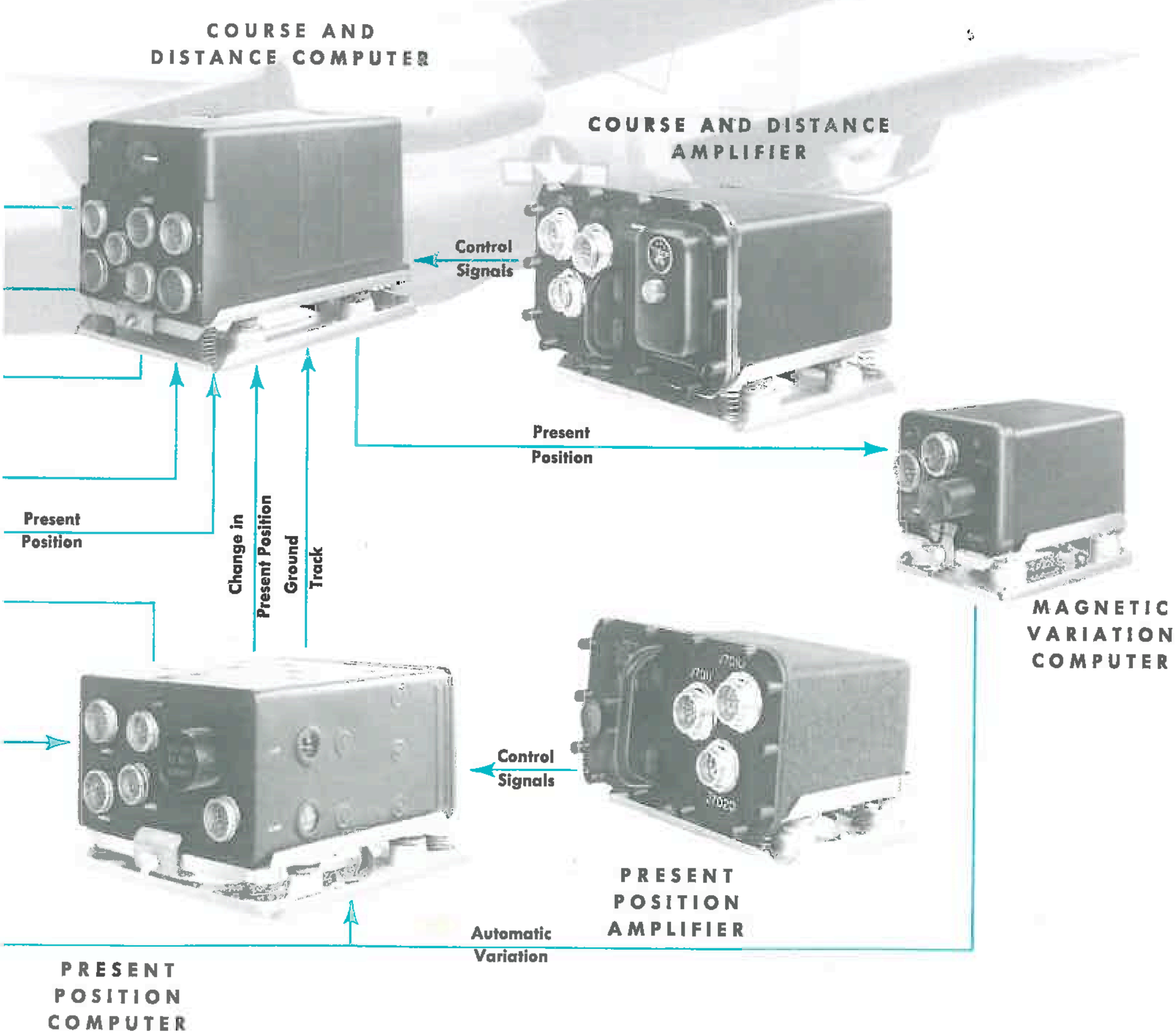
COMPUTER CONTROL feeds wind, variation, and destination data into the system. It displays present position, wind speed and direction, variation, and destination coordinates.

FLIGHT INDICATOR displays ground track, required course, heading error and distance to the and destination coordinates. It is console mounted.

REQUIRED PANEL SPACE is only 5¾″ wide x 4⅞″ high for the computer control, and 3¼″ square for the indicator (actually a dodecagon).

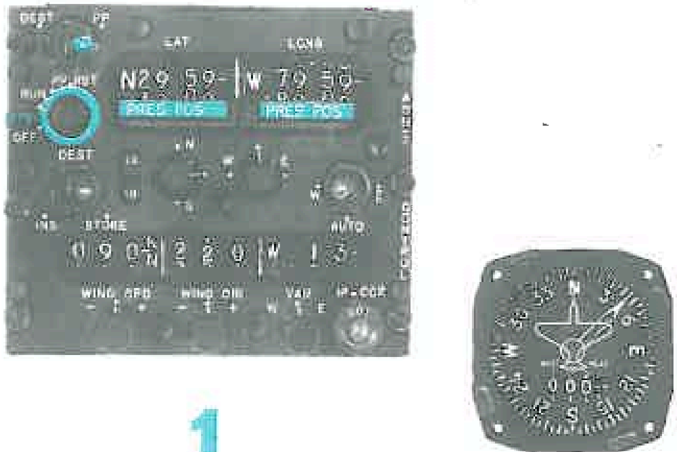
This schematic shows the direction of flow of information in the ASN-7. No special power system is required, as the ASN-7 uses standard 28 v dc and 115 v 400 cycle regulated ac. Typical power consumption is 25 w dc and 219 va ac in the normal run mode; and 36 w and 236 va during insertion of information.

REMOTELY LOCATED COMPONENTS



Flying the ASN·7

Let us suppose you are ready to take off in an airplane equipped with the ASN-7 computer se In the cockpit, all you will see will be the Indicator and the Control shown in these pictures All other units are remotely located. You



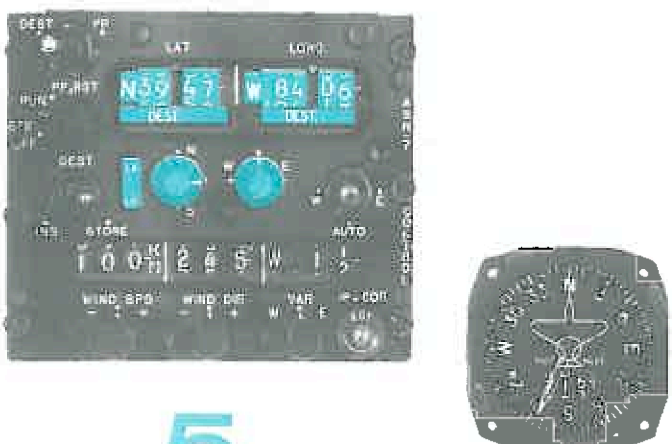
1

SET MODE SELECTOR AT STANDBY. For this flight, let us assume takeoff from Mitchell Air Force Base. **SET DISPLAY SELECTOR SWITCH FOR PRESENT POSITION.** Now we are ready to insert information.

2

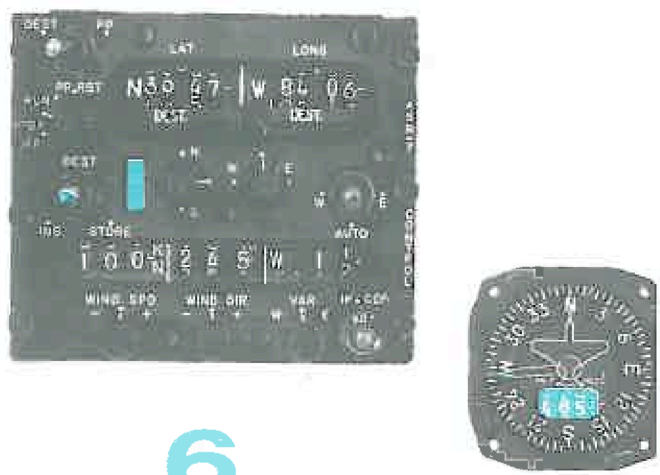
SET PRESENT POSITION WITH SLEW SWITCHES. Mitchell AFB's position is 40° 44′ North Latitude and 73° 36′ West Longitude.

INDICATOR shows a difference between present position and destination of the previous flight.



5

SET DESTINATION POSITION WITH SLEW SWITCHES. Assume destination is Wright-Patterson Air Force Base, 39° 47′ North Latitude and 84° 06′ Longitude. La and Lo flags appear.



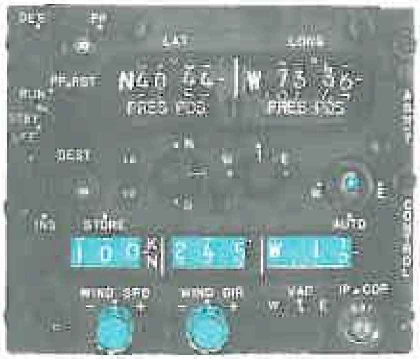
6

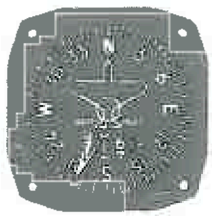
SET STORAGE SWITCH TO INSERT POSITION. This inserts destination information into computer.

RHUMB LINE COURSE AND DISTANCE FROM MITCHELL AFB TO W-P AFB ARE AUTOMATICALLY COMPUTED AND DISPLAYED. Pointer indicates course; counter indicates distance to be flown.

The LA and LO flags disappear.

know your present position and you know your destination, so you are now ready to navigate with the ASN-7. See how easy it becomes, by operating the controls which are marked in red on the illustrations on this page.

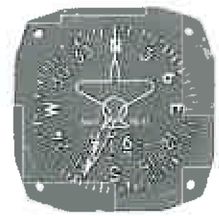




3

SET METEOROLOGICAL WIND DATA. In this case, let us assume wind speed is 100 knots and wind is from 245°.

SET SWITCH TO AUTOMATIC VARIATION. Unit calculates magnetic variation for the computer and automatically displays it.



4

CHANGE DISPLAY SELECTOR SWITCH TO DESTINATION. Now we are ready to insert destination information.

FLYING WITH DOPPLER

THE ASN-7 IS COMPATIBLE with several currently available Doppler radars. Use of radar of this type brings ground speed and drift angle directly into the ASN-7 system.

The same steps described in 1-6 are followed, except that meteorological data need not be set in (see 3). Instead, the wind speed counter is slewed back below 0, and a flag reading GND. SPD. appears, indicating that the system is in its GROUND SPEED MODE—for operation with Doppler inputs. The wind direction reading becomes irrelevant. The variation switch is set to AUTOMATIC, as before.

3a

From the foregoing descriptions of the operation of the ASN-7, it is evident that at no time is the pilot required to make any computation. It merely is necessary for him to insert his present position and destination and wind information (unless he is flying with Doppler; then the wind requirement is obviated). At any time during the flight, the display selector switch can be turned either to show present position or destination.

On the following two pages, the insertion of an *alternate* destination **is** described.

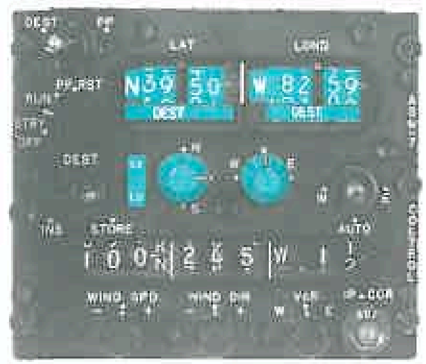
Storing an alternate destination

The ASN-7 computer has the capability of storing an alternate destination, which simplifies navigation when the primary destination is weathered in, or when flights of more than 1000 miles are planned. Operation of the storage feature is very simple, as shown above.

1

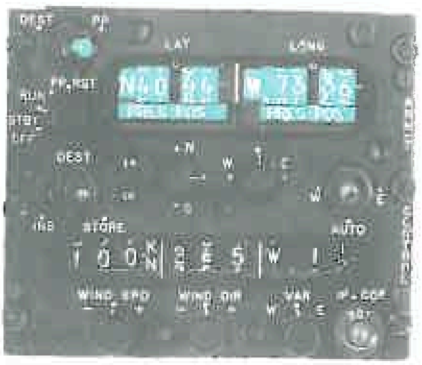
After the original destination has been inserted, following the procedure on pages 8 and 9, the alternate destination may be stored.

THROW STORAGE SWITCH TO STORAGE POSITION. This is to prepare for insertion of the alternate destination.



2

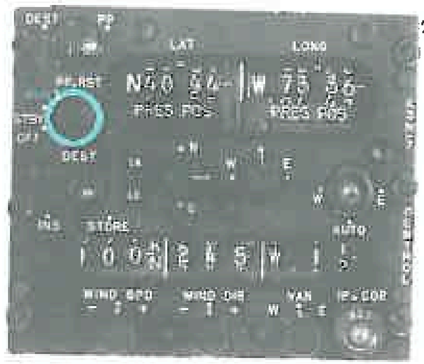
SET ALTERNATE DESTINATION WITH SLEW SWITCHES. We may have to fly on to Lockbourne Air Force Base, 39° 50′ N. Lat., 82° 59′ W. Long. Storage flags appear in windows at left to indicate Lat. and Long. display is not original destination. These flags continue to show until the alternate destination is inserted into the computer during a flight.

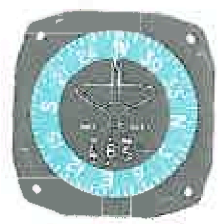


3

RETURN DISPLAY SELECTOR SWITCH TO PRESENT POSITION. We are now ready for takeoff.

TURN MODE SELECTOR SWITCH FROM STANDBY TO RUN. This can be done at takeoff. It can also be done as we fly over departure checkpoint, which may be noted either visually or by radio aids.



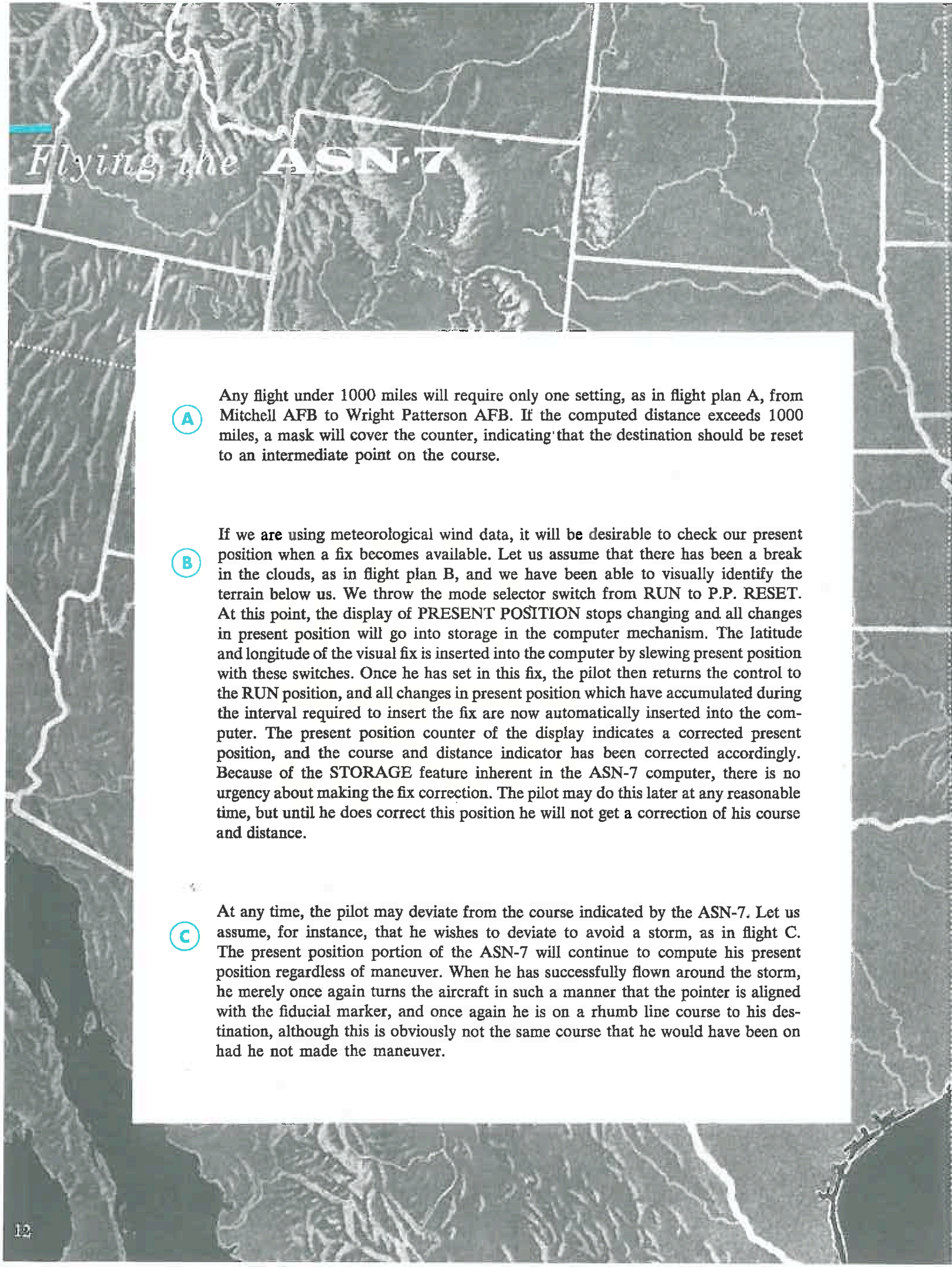


4

FLY THE AIRCRAFT TO LINE UP POINTER WITH FIDUCIAL MARKER. This will put you on the required ground track to destination. If at any time the pilot desires to fly to the alternate destination, he can insert this information by setting the storage switch to INSERT position. At that time, the LA and LO flags will disappear.

Once a plane is airborne, the ASN-7 can handle navigation for any flight. On the next pages, a variety of actual flight situations involving the ASN-7 are described.

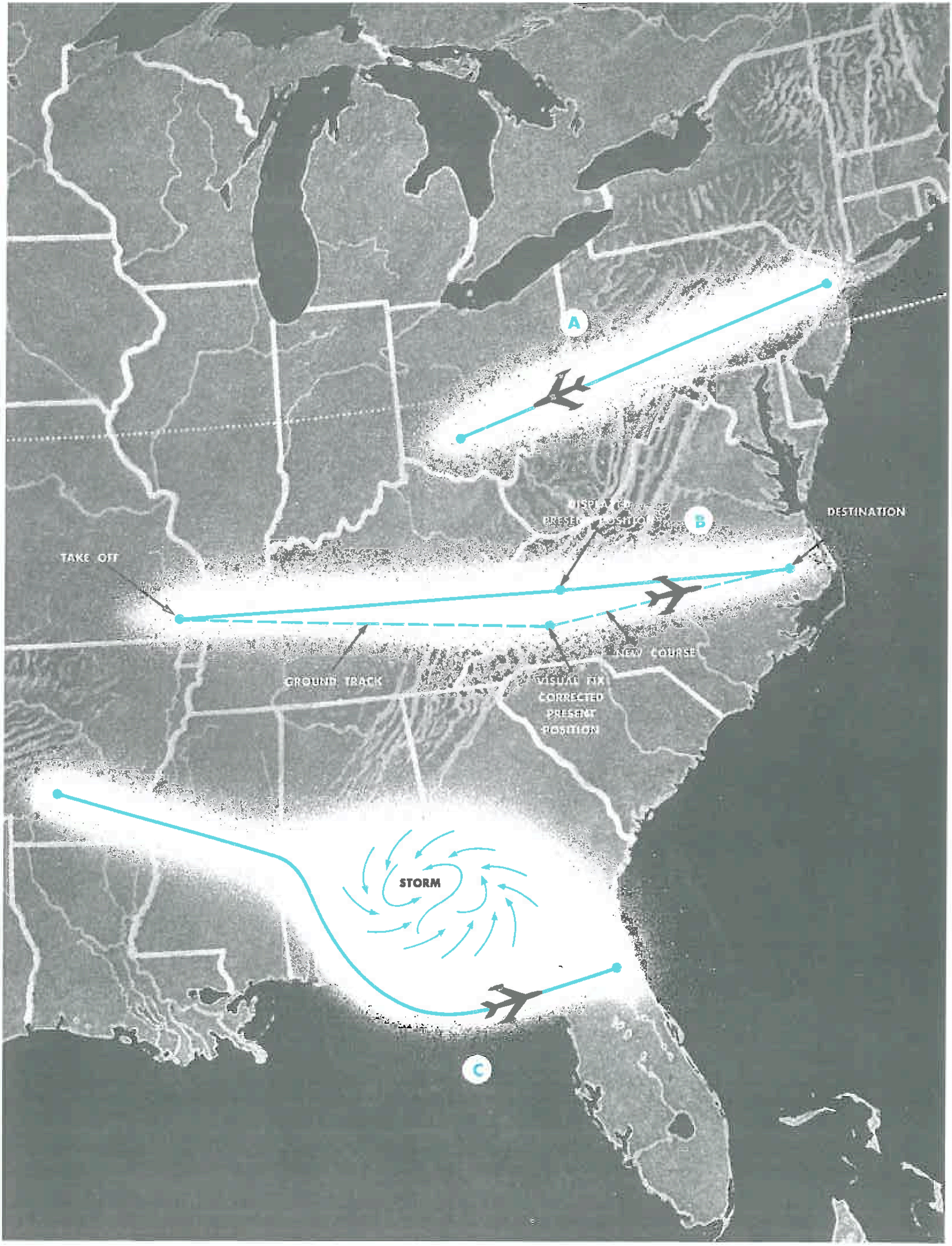
Flying the ASN-7



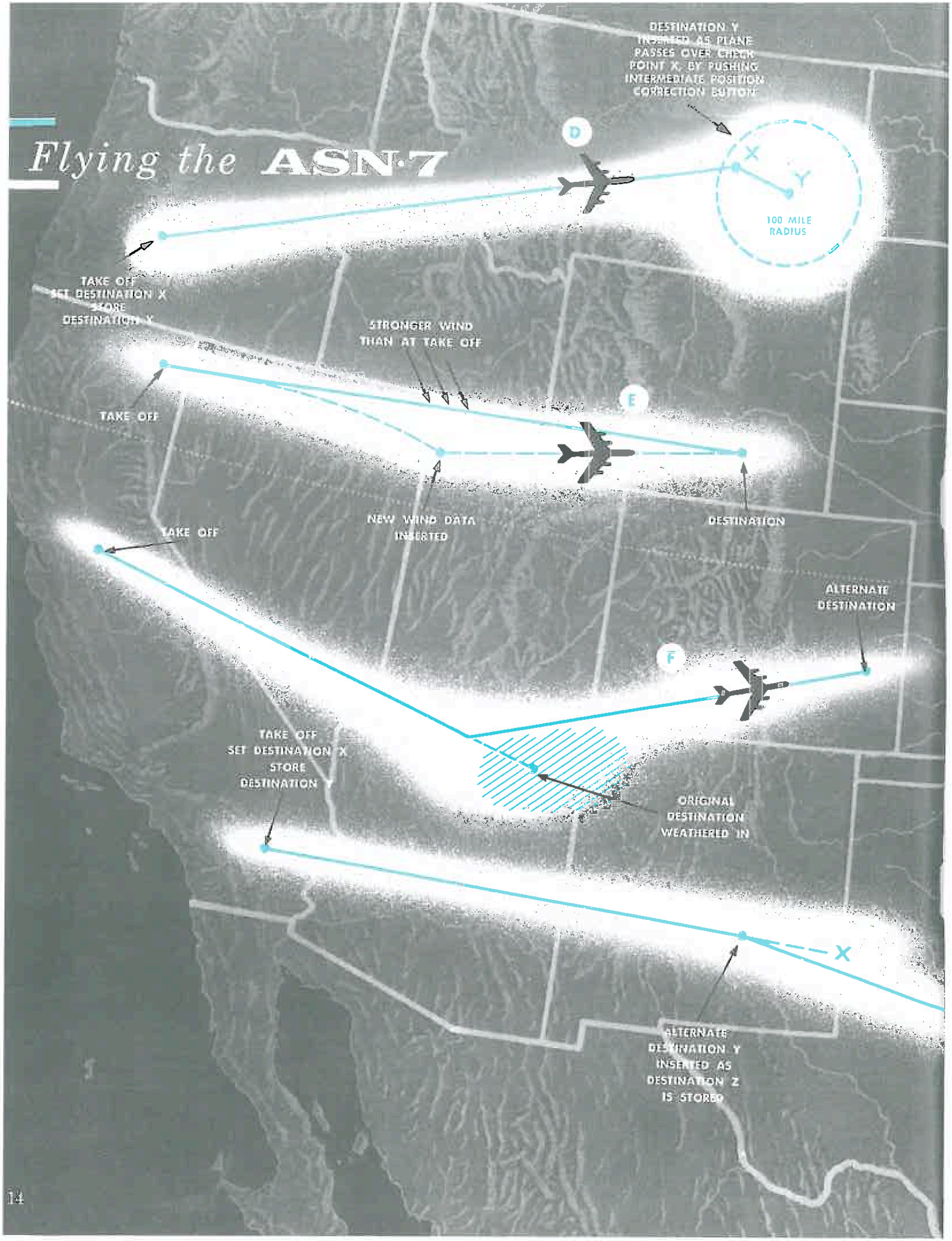
(A) Any flight under 1000 miles will require only one setting, as in flight plan A, from Mitchell AFB to Wright Patterson AFB. If the computed distance exceeds 1000 miles, a mask will cover the counter, indicating that the destination should be reset to an intermediate point on the course.

(B) If we are using meteorological wind data, it will be desirable to check our present position when a fix becomes available. Let us assume that there has been a break in the clouds, as in flight plan B, and we have been able to visually identify the terrain below us. We throw the mode selector switch from RUN to P.P. RESET. At this point, the display of PRESENT POSITION stops changing and all changes in present position will go into storage in the computer mechanism. The latitude and longitude of the visual fix is inserted into the computer by slewing present position with these switches. Once he has set in this fix, the pilot then returns the control to the RUN position, and all changes in present position which have accumulated during the interval required to insert the fix are now automatically inserted into the computer. The present position counter of the display indicates a corrected present position, and the course and distance indicator has been corrected accordingly. Because of the STORAGE feature inherent in the ASN-7 computer, there is no urgency about making the fix correction. The pilot may do this later at any reasonable time, but until he does correct this position he will not get a correction of his course and distance.

(C) At any time, the pilot may deviate from the course indicated by the ASN-7. Let us assume, for instance, that he wishes to deviate to avoid a storm, as in flight C. The present position portion of the ASN-7 will continue to compute his present position regardless of maneuver. When he has successfully flown around the storm, he merely once again turns the aircraft in such a manner that the pointer is aligned with the fiducial marker, and once again he is on a rhumb line course to his destination, although this is obviously not the same course that he would have been on had he not made the maneuver.


A
DISPLACED PRESENT POSITION
B
DESTINATION
TAKE OFF
NEW COURSE
GROUND TRACK
VISUAL FIX CORRECTED PRESENT POSITION
STORM
C

Flying the ASN·7

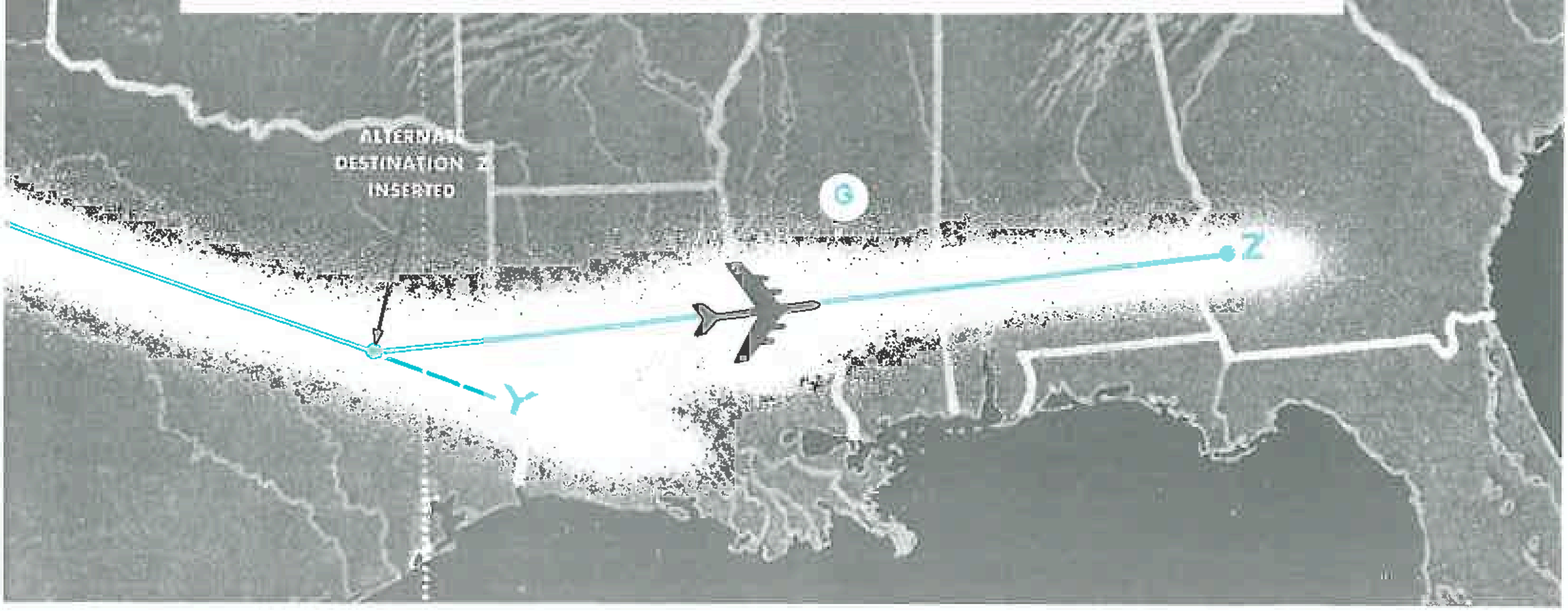


(D) When extreme terminal accuracy is desired, as on tactical missions, the INTERMEDIATE POSITION CORRECTION pushbutton on the ASN-7 control can be used. This feature takes advantage of any known check point within 100 miles of the actual target. The pilot inserts the check point as a "preliminary" destination and stores the actual target as an "alternate" or secondary destination. After take-off, the indicator guides the pilot toward the check point. As the plane nears it, he arms the IP COR button by turning its knob counterclockwise. As the plane passes over the check point the pilot pushes the button. The ASN-7 then corrects the display of present position to that of the actual coordinates of the check point. In sequence, the alternate destination (actual target) is automatically brought out of storage and entered into the system; the course and distance to this destination appear on the indicator. The change in present position accrued during this cycling operation is automatically compensated for by the system. This entire operation is in essence an automatic fix correction.

(E) In flight plan E, let us assume that the pilot has received information of a change in meteorological conditions, and has changed the wind information from its previous value. This action results in a change in the computed ground track which requires the pilot to turn the aircraft so the pointer is once again aligned with the fiducial marker. The computer corrects for drift angle in such a way that, after Present Position is corrected, the aircraft accomplishes its desired ground track to destination.

(F) In flight F, let us suppose that the plane has been told to land at its alternate destination because its original destination is weathered in. In order to do this, the pilot merely switches the storage switch from STORAGE to INSERT. The new destination is automatically inserted into the computer which computes a new course and distance to destination. Once the stored destination has been inserted into the computer, it is possible to set another alternate destination into STORAGE. The availability of the computer to accept a new destination is indicated by the disappearance of the LA and LO flags. Therefore, the pilot may, at all times, have the ASN-7 computing to one destination, with an alternate destination in STORAGE.

(G) The pilot may easily navigate on flights longer than 1000 miles by setting new alternate destinations into the computer. Note in flight G that the procedures described previously for alternate destinations are carried on over again until the final destination has been reached.



ASN·7 *satisfies modern flight needs*

Cockpit panel space is at a premium in modern aircraft. The pilot is confronted with a vast array of dials, pointers, needles, markings, knobs, levers, buttons and switches. This complex environment makes the pilot's task very difficult.

Ford Instrument Company has designed the ASN-7 Navigation Computer to make the pilot's job easier and more foolproof, to eliminate mental and physical tasks which have heretofore complicated flight, and to provide more useful information with less effort and in less space.

On the following pages, you may see how the ASN-7 has satisfied these needs in terms of current requirements.

INPUTS

HEADING
From Gyro Compass, such as types J-2, J-4, N-1

VELOCITY
From True Air Speed and Mach Number Computer such as types A-1, A-2, C-1 and C-2
From Central Air Data Computer such as MG-1
From radar derived ground speed

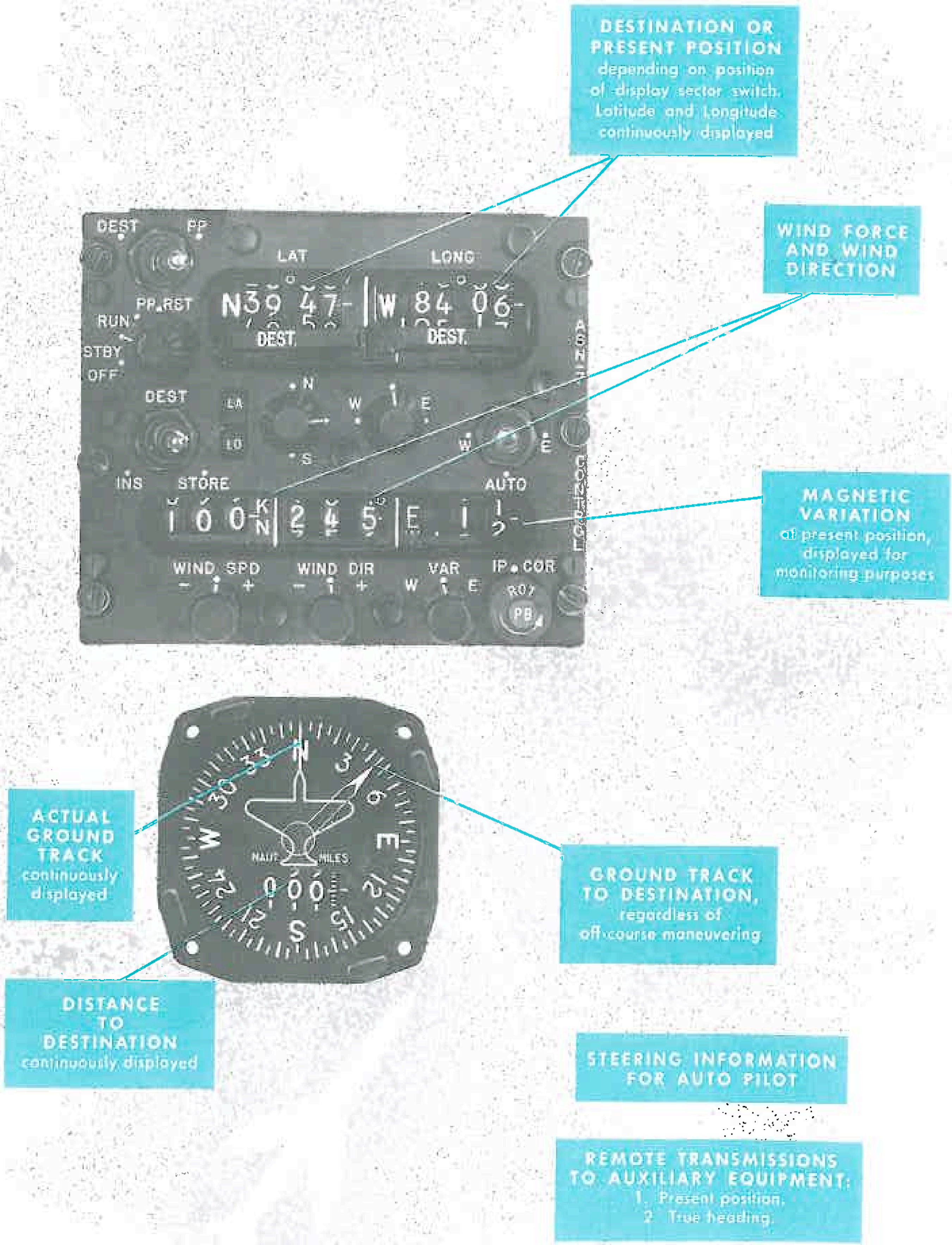
MAGNETIC VARIATION
From Automatic Variation Computer
From manual setting

WIND SPEED AND WIND DIRECTION
From Doppler Radar
From other special equipment
From manual setting

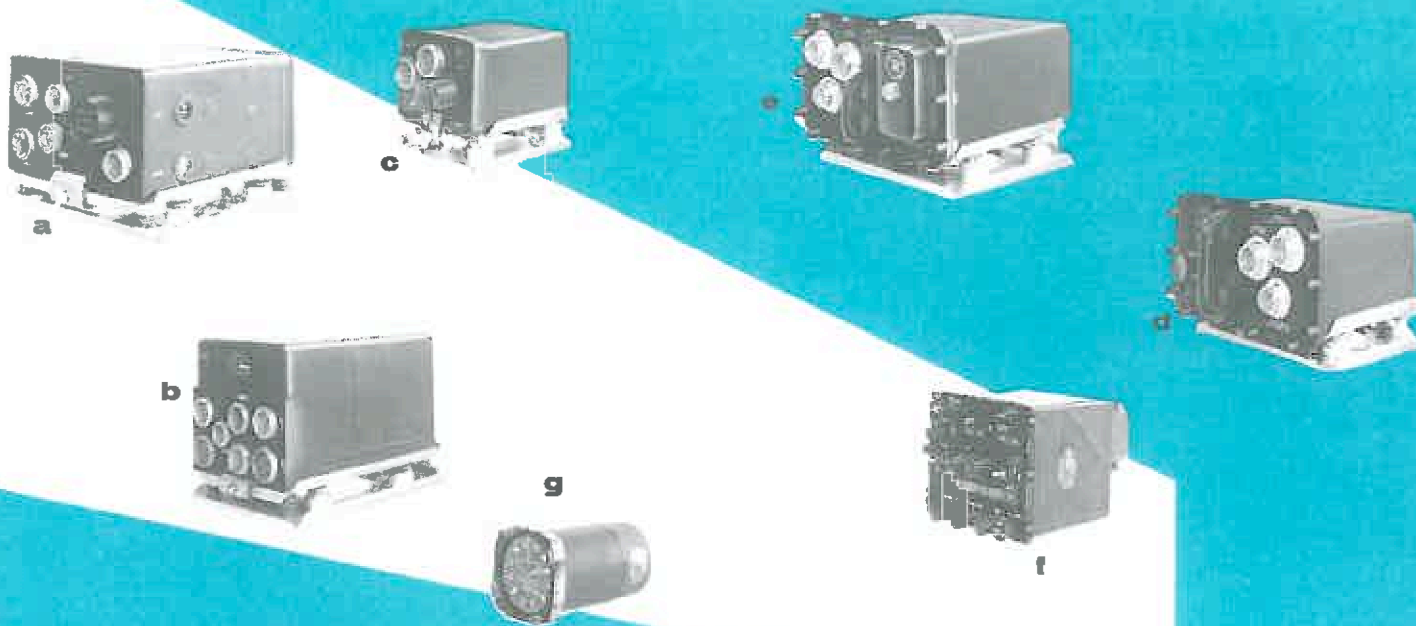
PRESENT POSITION
From initial manual setting of latitude and longitude
From fixing information sources

DESTINATIONS
From manual setting of latitude and longitude

FIX CORRECTION
From manual setting
From Tacan
From Omni DME
From celestial Data Computer
From radar devices


DESTINATION OR PRESENT POSITION
depending on position of display sector switch. Latitude and Longitude continuously displayed
WIND FORCE AND WIND DIRECTION
MAGNETIC VARIATION
at present position, displayed for monitoring purposes
ACTUAL GROUND TRACK
continuously displayed
GROUND TRACK TO DESTINATION,
regardless of off-course maneuvering
DISTANCE TO DESTINATION
continuously displayed
STEERING INFORMATION FOR AUTO PILOT
REMOTE TRANSMISSIONS TO AUXILIARY EQUIPMENT:
1. Present position.
2. True heading.
DEST
PP
LAT
LONG
PP RST
RUN
STBY
OFF
DEST.
DEST.
DEST
INS
STORE
AUTO
WIND SPD
WIND DIR
VAR
IP COR
NAUT MILES

ASN·7 *satisfies modern flight needs*



WEIGHTS, SIZES AND SWAY SPACE

TOTAL WEIGHT: 71-5/8 LBS. WEIGHT EXCLUDING SHOCK MOUNTS: 66-7/8 LBS.

	UNIT	NUMBER	WEIGHT (LBS.)	DIMENSIONS (TO NEAREST 64th) L	W	H	SWAY SPACE (PLUGS CONNECTED) L	W	H
a	PRESENT POSITION COMPUTER SHOCK MOUNT	CP-221 MT-1318	16.75 1.2	10-31/32 9-15/32	8-7/16 9-7/16	5 1-3/4	12-5/16	9-5/8	6-9/16
b	COURSE & DISTANCE COMPUTER SHOCK MOUNT	CP-289A MT-1736	18 1.0	10 9-3/4	5-27/32 6-7/8	5-21/32 1-1/2	12-3/16	7-1/16	7-1/8
c	MAGNETIC VARIATION COMPUTER SHOCK MOUNT	CP-290 MT-1744	4.5 0.65	7-3/32 5-25/32	4-11/32 4-7/8	3-7/16 1-1/2	8	5-5/16	4-15/16
d	PRESENT POSITION AMPLIFIER SHOCK MOUNT	AM-1069 MT-1909	8.75 1.0	8-1/64 8-35/64	8-55/64 6-1/8	5-7/64 1-3/4	9	9-57/64	6-1/4
e	COURSE AND DISTANCE AMPLIFIER SHOCK MOUNT	AM-917A MT-2012	8.0 0.9	9-11/32 8-17/32	8-55/64 7-3/8	5-7/64 1-1/2	10-9/16	9-57/64	6-27/64
f	COMPUTER CONTROL UNIT *	C-1317A	8.25	7-11/16	5-1/32	4-25/32	6-1/2	5-1/32	4-25/32 (CLEARANCE REQUIRED IN REAR OF PANEL)
g	INDICATOR *	ID-390	2.63	6-27/64	3-1/8 DIAMETER		6-61/64	3-1/8 DIAMETER (CLEARANCE REQUIRED IN REAR OF PANEL)	

*Dimensions of control and indicator do not include panel mounting flanges (see page 6 for required panel space).

RANGES

SPEED .... 70 to 2000 knots
DISTANCE .... Unlimited (1000 miles on any one leg)
VARIATION .... 0 to 180 degrees East and West
WIND FORCE .... 0 to 200 knots
WIND DIRECTION .... 360 degrees

ACCURACY

The ASN-7 is guaranteed to meet very high standards of accuracy. It far surpasses that delineated in specification MIL-C-25528.

In operation, system accuracy can be increased considerably by reducing wind errors. The pilot can, on the basis of successive visual or radio fixes, determine the "effective wind" and adjust the wind inputs accordingly. And it is further possible to incorporate devices whereby accurate wind information is derived by equipment completely self-contained in the aircraft: for example, the Automatic Fix Corrector (see page 22), or Doppler radar, inertial components, etc.

COMPARISON OF GREAT CIRCLE AND RHUMB LINE DISTANCES

The shortest distance between two points on the earth's surface is, of course, a great circle arc passing between those two points. A rhumb line course between the same two points is necessarily longer, although it is more convenient to fly since a constant heading is maintained. The decision as to whether or not to use a rhumb line course depends on whether the increase in distance is justified.

Under certain conditions, the rhumb line distance is very nearly equal to the great circle distance. These conditions may be summarized as follows: First: Differences between the two is a function of distance involved. For short distances, such as the 1000 mile legs navigated by ASN-7, the two paths are nearly coincident. Second: All meridians are both great circles and rhumb lines. Therefore, any rhumb line between points near the same meridian is very nearly a great circle arc. Third: The equator is both a great circle and a rhumb line. Hence, in low latitudes, rhumb lines and great circles are very nearly coincident.

A more quantitative comparison of rhumb line and great circle distances has been made by actual computation of the difference in distance between the two paths for various possible flights, as shown on the graphs.

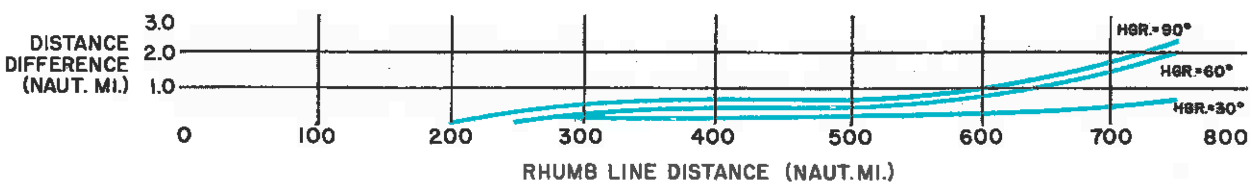


FIGURE A is a plot of the differences between rhumb line and great circle distances, versus the rhumb line distance for various rhumb line headings. Curves are for flights with an initial latitude of 50°N., and represents "average" flights at "average" latitudes.

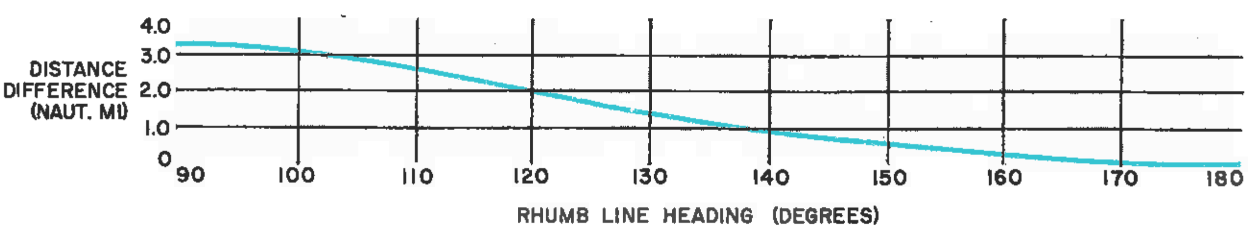


FIGURE B is a plot of the distance difference versus rhumb line heading for a 500 mile flight with an initial latitude of 70°N. Distance difference increases with increasing latitude, and is also a function of heading. At low latitudes the distance difference is a maximum for some heading intermediate between 0° and 90° since at these latitudes the parallels of latitude approach rhumb lines, and the meridians (Hgr=0°) are both great circles and rhumb lines. At higher latitudes however, only the meridians are both rhumb line and great circles, so the distance difference is a maximum for headings near 90°.

Considering that most flights are made well below 70° and that flights along rhumb line paths need not exceed 500 miles in length, indications are that a rhumb line computer solution is an extremely good approximation of the shortest distance. Also, the Polar Heading Adapter, (page 22) extends these same considerations to the terrestrial polar areas.

ASN·7 *satisfies modern flight needs*

HUMAN ENGINEERED—OPTIMUM OPERATIONAL ENVIRONMENT

An integrated control and display panel provides the operational environment that permits the pilot to concentrate on the most vital mission aspects.

This means data should be presented in a form that is readable, unambiguous, non-redundant, in order to shorten the link between observation and control; related functions are combined in a single display; most-often-used controls and displays are given priority. The ASN-7 has many 'human-engineered' features:

Knobs and switches have different "feel".
Provision for fast or slow slewing.
Warning flags are safety feature.
Numerals are extra large for better visibility.
Pilot has right control "feel" even when wearing heavy gloves.
One indicator presents all vital navigation information.
Counters synchronize instantaneously, upon switchover from Present Position to Destination (or vice versa).

VERSATILITY

Fly over all terrain, all weather, under all environmental conditions, without intermediate fixes.

Variation information can be inserted automatically or manually.
Unlimited range through enroute insertion of destinations.
Accessories are available for polar navigation, automatic fix correction, and extraction of drift angle and ground speed from general purpose radar.

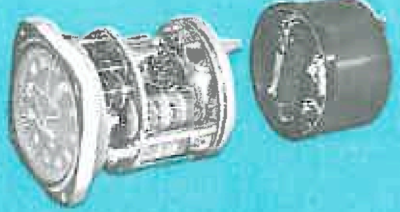
RELIABILITY

COMPONENTS

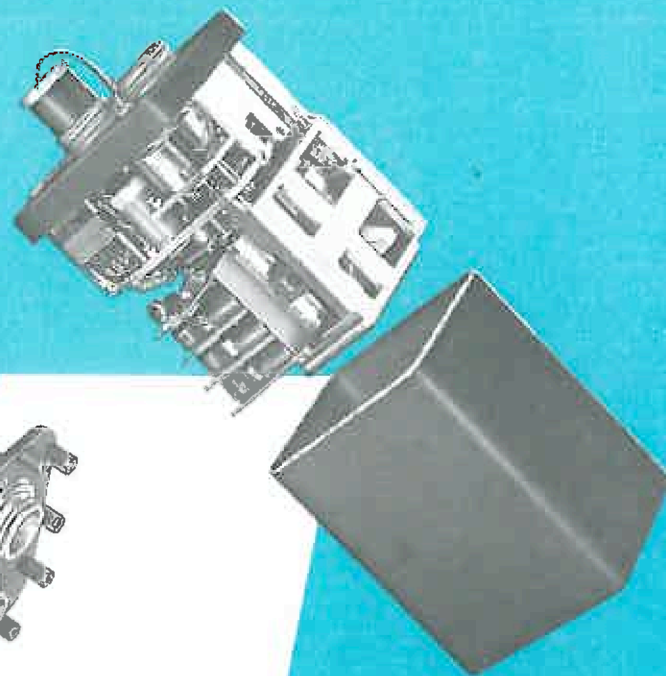
Completely transistorized.
No heaters.
No blowers.
Five of the seven boxes are hermetically sealed.
Guaranteed life over 1000 hours.
Shelf life of seals—over five years.
Operational reliability has been demonstrated.

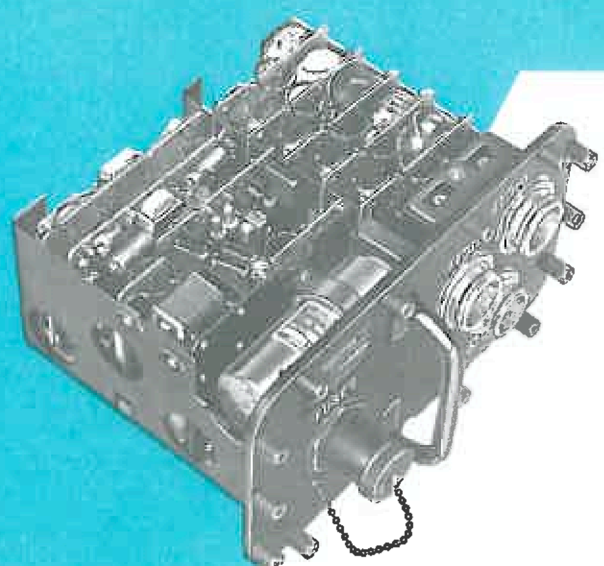
ENVIRONMENTAL TESTS

ASN-7 operates between −65° F and 160° F.
Designed for operation at altitudes up to 50,000 ft.
Equipment withstands vibration of 5 to 500 cps.
Withstands shock of 10 G's.
Non-magnetic.
No radio noise problems.
It is built to withstand dust, sand, fungus and humidity and other factors required by mil spec MIL-E-5272A.



All ASN-7 components are easy to get at for maintenance, in spite of their miniaturized assemblies.





CHECKABILITY

"Switch-on-check" takes only 30 seconds.

System uses "Go-no-go" checker for line maintenance.

Test unit for Depot repair and maintenance is portable and fly - away, and *completely* self-contained.

SERVICEABILITY

Maintenance is easy.

Amplifier modules simplify maintenance.

Fuses are easily replaced and spares are contained in units.

Troubles can be easily pin-pointed.

Test set indicates not just trouble, but *source* of trouble.

ACCESSORIES UNDER DEVELOPMENT

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POLAR HEADING ADAPTER

The Polar Heading Adapter supplies true heading under a variety of operating conditions. Automatic navigation equipment operation in Polar regions is restricted by two things: First, magnetic storms and the small horizontal component of the earth's field make compass indications erratic and inaccurate, and second, the rapid convergence of longitudinal meridians requires excessive rates of those portions of the equipment concerned with longitude.

Polar Heading Adapter facilitates automatic navigation in the polar regions by computing necessary corrections to directional gyro or magnetic heading information and supplying a suitably corrected, accurate heading output at all latitudes for use in a navigational computer. The necessary electrical and mechanical components are contained in a single hermetically sealed remotely located unit. A modified compass control panel located in the cockpit contains necessary mode switching and controls.

The Polar Heading Adapter operating in conjunction with an ASN-7 will do the following:

1) Accept heading inputs from slaved magnetic compass or directional gyro.
2) Calculate true aircraft heading with high accuracy in either true or transverse coordinate systems and thus enable all latitude navigation with greater accuracy.
3) Coordinate-convert from transverse coordinate inputs to true coordinate (lat & long) outputs which are available to other equipments (e.g. astro tracker).
4) Calculate Pc (polar correction angle—the angle of transverse north pole from true north pole as a function of position).

AUTOMATIC FIX CORRECTOR

The recently evolved concept of ground correcting the airborne navigation computers permits the use of the Automatic Fix Corrector in the terminal area, where errors have accumulated during flight. When the position error and the time within which it is accumulated are employed to correct the manually set-in wind, the computer may be used on the outgoing leg of a mission with reasonable assurance that the last set-in wind information is correct. This is the function for which the Automatic Fix Corrector was designed.

Position information is received from a digital data link, which in turn is fed into the AFC. This data is compared with the computed position, and in conjunction with a time interval, is used to compute an effective wind. The position correction and the suitably weighted effective wind are then inserted into the ASN-7.

Should the winds shift during a given interval of time, a new position and wind correction factor are made upon receipt of the next position fix. Manually inserted fixes can also be used to compute a weighted effective wind. These fixes would be achieved by flying over two separate check points. This versatility allows for computation of winds in areas where no data link equipment is available.

Ford estimates that production models of the Automatic Fix Corrector will weigh approximately 12.5 pounds and occupy 175 cubic inches.

ADAPTER, GROUND SPEED AND DRIFT ANGLE

This instrument works in conjunction with any search radar already installed in the aircraft, or with a fire control radar whose antenna system may be tilted for ground coverage. As a result, no extensive structural modifications to the airframe normally associated with a new radar installation are called for.

The Adapter can supply ground speed and drift angle information as dial indication, as a voltage suitably scaled for use in associated navigation equipment, or as a combination of these two methods. The information is supplied completely automatically, either continuously or upon demand. Except for the display device, if any, the equipment can be remotely located. It requires no in-flight or pre-flight alignment. It does not call for human supervision at any time.

(As of November, 1959)

In this table, Ford Instrument's ASN-7 is compared to four other course and distance computers designed for airborne application.

THE ASN-7 COMPARED

FEATURES	ASN-7	COMPUTER A	COMPUTER B	COMPUTER C	COMPUTER D
Continuous Display of Course and Distance	Yes	Yes	Yes	Yes	Yes
Continuous Display of Present Position	Yes	No	Yes	Yes	No
Fully Transistorized	Yes	Yes	Yes	Yes	Yes
Compatible with Doppler Radar	Yes	No	No	Yes	No
Weight Under 70 Pounds	Yes	Yes	Yes	No	Yes
Course and Distance Accuracy Better than 6 Mile Circle in 1000 Miles	Yes	No	No	Yes	No
Present Position Accuracy Better than 1-1/2% of Distance Traveled	Yes	No	Yes	Yes	No
In Full Production	Yes	No	No	No	No
Operational Type Ground Support Equipment Available	Yes	No	No	No	No
Now in Operational Aircraft	Yes	No	No	No	No

About Ford Instrument Company

Ford Instrument Company is a division of Sperry Rand Corporation. It is organized primarily to develop, design, and produce high precision control and computer systems for military and commercial applications. Ford has an extremely diversified background in automatic weapons control. The techniques it has developed have had a great influence on the nature of modern warfare.

Ford abilities range from development and production of naval, missile, land based and airborne controls and computers to data processing systems, nuclear reactors and ever-increasing automatic control applications.

Four decades of experience, and large manufacturing facilities, enable the company to handle complex research, development and production contracts with smooth coordination.

FORD INSTRUMENT COMPANY

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