MOONEY NAV-COUPLER/HEADING LOCK

OPERATION & SERVICE INSTRUCTIONS MANUAL

NO. 11968-1

BRITTAIN INDUSTRIES, INC.

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1. **INTRODUCTION**

The purpose of this manual is to assist service and maintenance personnel in testing and calibration of the Nav-Coupler/Heading Lock System. This manual is concerned primarily with the Nav-Coupler/Heading Lock System. Reference is made throughout this manual to the basic 11968 manual to assure proper performance of the "Positive Control" system.

It is imperative that the "Positive Control" System is functioning properly before the Ground and Flight Test Procedures outlined in this manual are completed. Refer to manual 11968 for Basic System Operation.

This manual was automated on May 31, 2001. Changes were made only to correct typographical errors and to clarify content.

2. THEORY OF OPERATION

2.1 In the Nav-Coupler/Heading Lock System, the directional control of the aircraft is obtained by means of an Electro-Pneumatic Shunt Valve.

This Shunt Valve provides vacuum to the right and left servos to command aileron and rudder control. The variations in the voltage operating the Shunt Valve are produced in the Controller/Amplifier Assembly. This is accomplished by means of sensor and radio navigation equipment. In addition, a Heading Select Knob, located on the Controller/Amplifier operates the Shunt Valve for maneuvering of the aircraft.

2.2 Rate of turn (bank angle) depends upon the "Positive Control" system's Rate Gyro capability of matching the pneumatic imbalance produced by he Shunt Valve. For this reason, it is essential, for proper operation of the directional control system, that the roll/yaw stabilizing system be correctly adjusted. Refer to operation and service manual #11968 to verify proper operation of the "PC" system.

2.3 Magnetic Heading Control

2.3.1 Magnetic Heading information is obtained by means of the Heading Sensor resolving the earth's magnetic flux. When the heading azimuth on the controller is set to 90° and the aircraft is on a heading of 90°, the electrical heading circuit is balanced and zero voltage appears at the Shunt Valve in the Controller/Amplifier Assembly. When the controller heading azimuth is rotated to 180°, an electrical imbalance is generated. This imbalance produces an error signal which is amplified in the transistorized amplifier section. The amplified signal generates voltage on the right side of the Shunt Valve, causing the valve to open. With the right side of the Shunt Valve open, the aircraft turns to the right until an opposite error signal is developed by the Heading Sensor as it rotates with the aircraft in respect to the earth's magnetic field. When the aircraft takes up a heading of 180°, The Magnetic Sensor and the heading azimuth are in phase and the voltage at the Shunt Valve drops to zero centering the electro-pneumatic valve.

When the heading azimuth and the electrical output of the Magnetic Sensor are in phase, any change in the heading of the aircraft to right or left will produce an error signal from the sensor. The error signal will cause the Shunt Valve to be rotated to the right or left, as required, to bring the heading of the craft back to a point where there is no error generated at the sensor.

2. THEORY OF OPERATION (CONTINUED)

2.3 Magnetic Heading Control (Continued)

2.3.2 The Magnetic Heading Sensor is remotely mounted in the aircraft in a manner similar to a remote indicating compass. The sensor contains no moving parts and therefore, requires no servicing. When installed, the unit is not adversely affected by vibration.

2.3.3 The mounting of the sensor unit is designed to permit the sensing unit to move freely as a pendulum on the longitudinal axis of the aircraft. Acceleration and deceleration of the aircraft may displace the sensor on its pivots and may produce momentary changes in magnetic headings on East and West. Improper dressing of the harness leading from the sensor causing a restriction of the pendulous motion will exaggerate the heading error on East and West with changes in the attitude of the aircraft.

2.3.4 There is a definite relationship between the rate of turn (bank angle) and programmed magnetic headings. The transistorized circuitry which provides magnetic heading information is designed for certain "roll-out" characteristics which assume a given rate of turn (bank angle). If the rate of turn is greater than 3° per second, there will be a tendency for the aircraft to overshoot programmed magnetic turns to the East, North and West. If the rotor is turning too fast, a shallow turn is produced and programmed magnetic headings to the North will be slow in approaching the final heading and early deadbeat on East and West. Turns to the South with a shallow bank angle may overshoot the final Southerly programmed heading. Proper rate of turn, slightly less than standard rate, should allow for approximately 5° overshoot on East and West, with less than 5° overshoot on North and South.

2.3.5 Proper gyro speed will provide for optimum rate of turn. However, unequal turns to left and right may be caused by improper rigging of the aircraft. If an aircraft is rigged to fly with one wing down, or with the ball of the Turn and Bank off center, turns will be steeper in one direction than the other. In addition, final heading accuracy between 280° and 080° may be adversely affected. Proper rigging may be determined only when the Roll Trim Valve is in the neutral position.

2. THEORY OF OPERATION (CONTINUED)

2.3 Magnetic Heading Control (Continued)

2.3.6 As in all magnetic airborne devices, there are certain inherent errors caused by the vertical component of the earth's magnetic field. To minimize the undesirable effect of the vertical component, particularly while programming magnetic heading changes, there are compensating transistorized networks in the Controller/Amplifier Assembly. The amount of compensation produced may be varied by positioning the "Latitude Selector" on the Controller/Amplifier Assembly. For optimum performance, make certain that the latitude switch is set to correspond with the positions indicated on the map showing the Latitude Selector Zones.

2.3.7 It may be necessary to compensate the sensor for a particular installation. Adjustments are provided for N-S and E-W errors. These adjustments are to be made in a similar manner to adjusting a magnetic compass (See Pre-Flight Adjustments, Page 10).

2.4 Radio Navigation Coupling

2.4.1 Radio VOR coupling is obtained by means of additional circuits in the Amplifier. These circuits are connected to the left/right meter output of the VOR navigational equipment of the aircraft. Phasing of the connection to the VOR meter is such, that when the VOR deviation is to the right (in yellow zone), the electro-pneumatic Shunt Valve is rotated to the right, commanding the aircraft to turn to the right. When the VOR deviation is to the left (in blue zone) a left turn is commanded. The voltage generated in the VOR system to produce left and right meter movements also modulates the Nav-Coupler.

2.4.2 Omni heading intercept and hold is accomplished by selecting the desired VOR radial with the OBS selector of the navigational equipment. The indicated Omni radial is matched by selecting the same heading on the rotatable heading azimuth. When the aircraft is not on the selected VOR radial, the VOR deviation meter will be displaced from the center position. The displacement of the left/right needle represents a bi-polar meter voltage modulating the navigation portion of the autopilot coupler, causing the Shunt Valve to open and remain open until the bi-polar VOR meter voltage is zero. When the meter voltage becomes zero, the aircraft will continue to fly on the magnetic heading that has been selected on the heading azimuth.

2. THEORY OF OPERATION (CONTINUED)

2.4 Radio Navigation Coupling (Continued)

2.4.3 The relationship of the heading information to navigation information varies in the Capture and Track Modes. In the Capture mode, a full scale left/right meter deviation will produce a change in the heading as great as 60° from a selected magnetic heading. As the desired VOR radial is approached and the left/right meter displacement decreases, the aircraft will gradually turn toward the selected magnetic heading. In the Capture position, a VOR error signal equal to 1° off course will result in a change in selected heading of 6°. Maximum bank angle in the Capture mode is approximately a standard rate turn.

In the Track mode, the system is more sensitive to the VOR meter displacement, optimizing the tracking of a captured Omni radial. The track circuits provide for a ratio of 1° magnetic heading error. The bank angle in the Track mode is limited to approximately one-third of the maximum bank angle obtained in the Capture mode.

2.4.4 An added provision is provided in the Track circuit to optimized station crossing where the navigation signal shifts phase. While in the Track mode, the effectiveness of the VOR signal is limited to a maximum of 5° displacement. When the left/right needle exceeds a 5° off course deviation, magnetic heading data automatically supersedes radio navigation information, precluding rapid and excessive heading excursions while passing over a VOR station.

3. NAVIGATIONAL RADIO REQUIREMENTS FOR AUTOPILOT COUPLING

3.1 The autopilot coupler has been designed to accept a low impedance load of 10,000 Ohms. The intercept circuitry of the Nav-Coupler is floating with respect to ground. Optimum autopilot response may be obtained with as little as 35 millivolts across the left/right VOR meter circuit for 10° off course. (Bi-polar voltage up to 150 millivolts is acceptable and may be attenuated by the Nav-Coupler Amplifier Nav Sens adjustment). By reason of these characteristics, the Nav-Coupler will be found to be compatible with a great many different makes and models of navigation radio equipment.

3.2 There are considerable differences in the electrical characteristics and performance level of radio navigation equipment of various models and makes. They may be divided into two categories, ARINC standard and non-ARINC standard equipment.

3. **NAVIGATIONAL RADIO REQUIREMENTS FOR AUTOPILOT COUPLING (CONT.)**

3.2 (CONTINUED)

A. Radio navigation equipment meeting ARINC standards has provisions for three or more 1,000 Ohm loads. The autopilot coupling may be connected across the left/right VOR meter output without changing existing loads. All of the ARINC standard equipment will provide adequate signal levels for optimum operation of the autopilot Nav-Coupler.

B. Radio navigation equipment which is not designed to ARINC standards may be used, in most instances, with the autopilot coupler system. Some of the equipment in this category requires no circuit modification other than connecting the Nav-Coupler parallel to the VOR left/right meter. There is, in common usage, considerable radio navigation equipment which does not provide sufficient signal output for optimum operation of the autopilot coupler. Prior to ground check procedure, it may be determined whether the existing radio equipment is compatible with the Nav-Coupler by determining if a bi-polar voltage across the VOR left/right meter of 35 millivolts, minimum for 10° off course, is present. The compatibility of radio equipment in this group may also be determined by means of a ground check procedure wherein navigation error information is balanced against magnetic heading information (See page 10, Pre-Flight Adjustment). In the event that there is any question with regard to respective radio compatibility, the information in paragraph 3.1 should be transmitted to the respective radio equipment manufacturer for recommendations.

3.3 Some VOR equipment have a floating ground in the VOR indicator circuit. Coupling to the autopilot, which is also floating with respect to ground, may result in over-loading of the autopilot Amplifier circuits. This loading may result in an offset of the Shunt Valve in the Amplifier with a voltage differential across the yellow and orange test jacks when the VOR equipment is energized. This loading of the Amplifier may be corrected by placing a ground connection or jumper between lead #3 of the cable assembly and the chassis of the VOR converter.

3. **NAVIGATIONAL RADIO REQUIREMENTS FOR AUTOPILOT COUPLING (CONT.)**

3.4 The autopilot Nav-Coupler is capable of responding to minute deviations of the left/right VOR indicator. This sensitivity level is necessary to obtain optimum Omni Capture and Track performance. Make certain the radio navigation equipment is functioning properly, and that the left/right needle is steady. The use of an Omni Simulator or Omni Station capable of producing a full left/right meter deflection is recommended. With left/right needle centered, check for radio interference causing erratic needle movement, this must be at a minimum. Check generator and voltage regulator. Make certain they are filtered sufficiently against producing electrical interference. Check Omni course width and sensitivity to equipment manufacturer's specifications.

NOTE: The autopilot equipment must respond to the electrical information appearing across the left/right VOR meter. If this information is inaccurate, undesirable autopilot coupling will result.

3.5 The Nav-Coupler Amplifier/Controller Assembly is available on in a 12 volt model. Before proceeding with ground check of the Nav- Coupler System, make certain that a 12 volt power supply is available for the Controller/Amplifier.

3.6 Verify that the aircraft's voltage regulator is producing the proper voltage. This check should be made with a maximum electrical load applied and a fully charged battery. (Low voltage will result in sub-standard operation of the Navigation Coupler. Low voltage may also result in a decreased rate of turn). After installation of the Nav-Coupler, it must be determined that the operation of the radio navigation equipment meets the radio manufacturer's minimum performance specifications, using specifications and procedures specified in the radio manufacturer's service and maintenance manual.

3.7 Wires #3 and #4 from the controller harness are to be connected in parallel to the left/right meter movement of the VOR/LOC indicator. An optional double-pole, double-throw switch may be installed to enable the pilot to switch the Nav-Coupler from the #1 VOR to #2 VOR if desired.

The output from the two Omni converters must be equal or mismatching will occur.

4. SURVEY OF AUTOPILOT INSTALLATION AND BASIC REQUIREMENT

The intended purpose of this section is to furnish the installer and maintenance personnel with a procedure to be followed to verify proper installation and function of the autopilot components and system. Accompanying each autopilot is an inspection report which parallels the following procedure. Experience has shown that needless man hours and flight test hours will be saved by following the survey and methodically checking off the inspection record. Once the installer or service personnel is familiar with the equipment the survey, a complete checkout of the entire system, may be accomplished within a thirty minute period.

4.1 Airframe Requirements

4.1.1 Prior to installing any automatic flight control equipment, the aircraft should be flown to determine whether the basic "Positive Control" system is properly operating. An aircraft which is out of rig should be corrected in order to avoid asymmetrical turns, etc. Refer to manual 11968 for proper operation of the basic system.

4.1.2 The following items must be verified for proper operation before proceeding with the ground adjustment procedures:

(A) Primary Vacuum Setting

1. Refer to Paragraph 3.2, Manual 11968.
2. Cut-Off Valve operation, refer to Paragraph 3.3, Manual 11968.
3. Pilot Valve operation; refer to Paragraph 3.4, Manual 11968.
4. Gyro rotor speed adjustment, refer to Paragraph 3.6, Manual 11968.
5. Rate Gyro valve centering, refer to Paragraph 4.1, Manual 11968.

4. SURVEY OF AUTOPILOT INSTALLATION & BASIC REQUIREMENTS (CONT.)

4.2 Electrical System Requirements

4.2.1 In as much as proper navigational radio operation is essential for proper autopilot functions in the Capture and Track modes, the autopilot installer and service personnel should make certain that the aircraft's electrical system is operating according to the airframe manufacturer specifications. Low voltage and/or inadequate filtering for the aircraft's electrical system will adversely affect operation of the VOR left/right needles.

NOTE: In addition to checking for aircraft's electrical system, refer to Paragraph 3 for navigational radio requirements.

4.2.2 The Heading Sensor should be free to pivot or swing fore and aft. Care must be exercised in securing the harness leading from the sensor so as not to interfere with this motion.

4.2.3 The sensor should be installed in an area that is free of magnetic fields. Proximity to a power supply, remote indicating compass, etc., may result in inconsistent magnetic variations which cannot be compensated.

4.2.4 The Controller/Amplifier and cables may be adversely affected by RF radiation on certain frequencies. Such interference, although uncommon, may result from locating the autopilot sensor in the proximity of a VHF antenna (See Pre-Flight Adjustments, Page 10).

4.2.5 Lead #1 is system ground, make certain this lead is not connected with any other ground leads.

4.3 Radio Navigation Coupling

4.3.1 Determine the compatibility of the navigational radio equipment according to the compatibility chart, located in the installation manual.

4.3.2 Temporarily connect leads #3 and #4 of the cable assembly to the VOR indicator until proper left/right phasing has been determined. Refer to the installation manual for proper pin connections.

5. PRE-FLIGHT ADJUSTMENTS

5.1 The following ground-test procedure should be used to determine that the electrical and vacuum portions of the equipment are functioning properly before flight testing is attempted.

5.1.1 In order to perform the ground-test adjustments, it will be necessary to partially remove the Controller/Amplifier from the instrument panel. This can be accomplished by turning the latching screw counter-clockwise until the latch is disengaged. Diagram #1 shows the location of the latching screw and the controls which will be adjusted during ground-test.

5.1.2 After disengaging the latch, the Controller/Amplifier may be pulled approximately one half way out of the instrument panel in order to obtain access to the necessary controls. A 10,000 Ohm per volt, or greater sensitivity, voltmeter is to be connected to the orange and yellow test jacks located in the low right front corner of the Controller/Amplifier. Set the voltmeter to the 10 or 12 volt DC range.

5.1.3 Unless otherwise noted, the Hemisphere Switch should be set to the intermediate "T" (test) position and the Zone Switch should be set to the proper zone number as described in paragraph 6.1.2.

5.2 <u>Shunt Valve Pneumatic Centering</u>

Prior to plumbing the Shunt Valve of the Remote Gyro Assembly into the roll/yaw system, it is important to determine that the Shunt Valve is pneumatically centered. No adjustment should be made of the Shunt Valve however, until it has been definitely determined that there are no leaks in the roll/yaw systems and that the pneumatic centering of the Gyro Sense Element Valve is within ± 0.2" Hg. of zero (See paragraph 4.1, manual 11968).

5.2.1 Disconnect the two latex servo lines plumbed to the Shunt Valve. On these bibs plumb a 10" - 0" - 10" Hg. differential gauge. Apply vacuum to the shunt valve by operating the system. If differential gauge indicates an off center condition of more than ± 0.2" Hg., remove black royalite cap from the Shunt Valve body. Unlock Allen setscrew and rotate the slotted brass head right or left as required to obtain zero inches of Hg. on the differential gauge. Only minute adjustments, never more than 5°, in either direction from its original position will be required. After each adjustment, gently tap or vibrate the valve assembly.

5. **PRE-FLIGHT ADJUSTMENTS (CONTINUED)**

5.2 Shunt Valve Pneumatic Centering (Continued)

Command an electrical displacement of the Shunt Valve through the heading control to determine whether or not the mechanism returns to pneumatic zero ± .2" Hg.. After every deflection, return function knob to "OFF" position: this eliminates any electrical off center condition from interfering with pneumatic centering since the driving mechanism is spring loaded to center. After centering the valve, lock Allen setscrew. Check again for center.

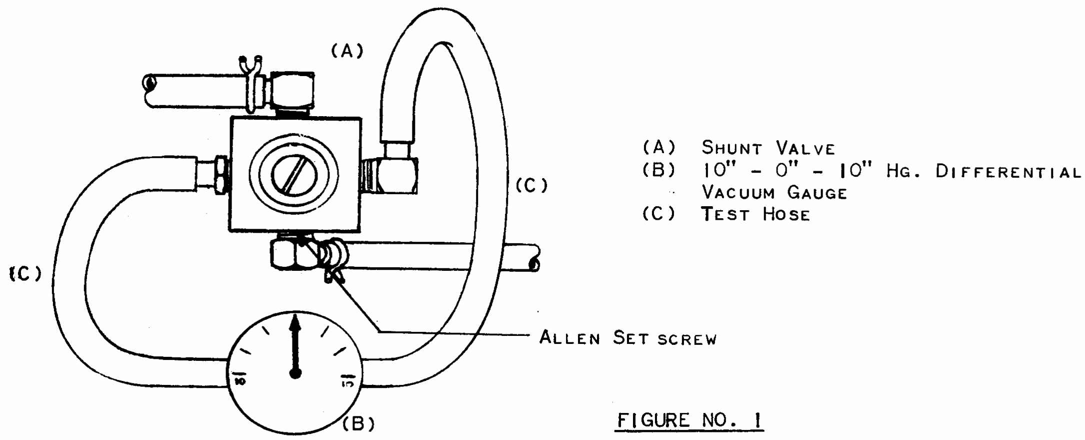


FIGURE NO. 1

5.3 Heading Gain Adjustment

5.3.1 Adjust the "HDG" dial to the aircraft heading, as indicated by zero volts on the DC voltmeter. Turn the "HDG" dial to a heading of ± 30° from the previously determined heading. From the map shown on diagram determine the position of the aircraft within its zone. Adjust the "HDG" gain control shown in Diagram 1 until the voltmeter reading corresponds to that shown in Figure 2 for the appropriate aircraft location within the zone.

5. **PRE-FLIGHT ADJUSTMENTS (CONTINUED)**

5.3 Heading Gain Adjustment (Continued)

AIRCRAFT POSITION WITHIN MAGNETIC ZONE	OUTPUT VOLTAGE FOR ± 30° HEADING ERROR
SOUTHERN BOUNDARY	6.8 VOLTS
SOUTHERN QUARTER	6.4 VOLTS
CENTER	6.0 VOLTS
NORTHERN QUARTER	5.7 VOLTS
NORTHERN BOUNDARY	5.4 VOLTS

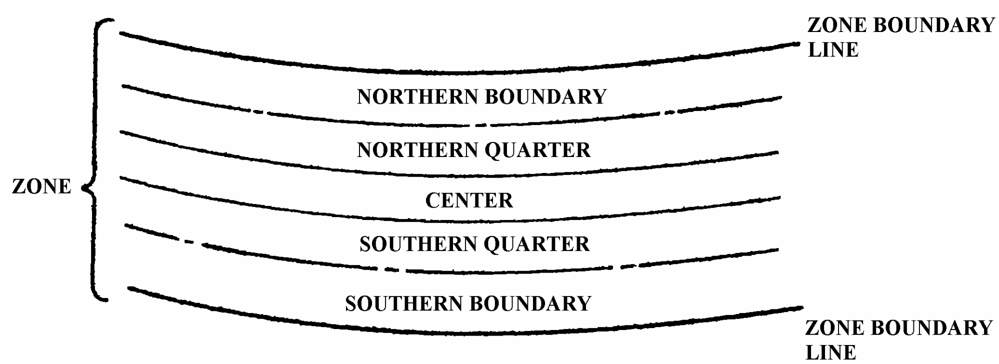


FIGURE NO. 2

5.4 VOR Gain Adjustment

5.4.1 Before making this adjustment to the Navigation Coupler, make certain that the VOR Receiver and Converter-Indictor are operating properly. When used in one of the radio-navigation modes, the performance of the Navigation Coupler is dependent upon the quality of the signal from the VOR Converter. It is advisable to determine that the VOR Receiver and Converter meet the manufacturer's specifications before connecting the Navigation Coupler.

5. **PRE-FLIGHT ADJUSTMENTS (CONTINUED)**

5.4 VOR Gain Adjustment (Continued)

5.4.2 If a simulator is used, or if a very strong, steady signal is received, the following procedure may be followed:

With the DC voltmeter connected to the test jacks, place the mode selector switch in the "HDG" position. Set the OBS on the VOR indicator to a 5° bearing error. Set the "HDG" dial to the aircraft heading, as indicated by zero output on the voltmeter. Turn the mode switch to the "CAP" position. Adjust the Nav pot until a reading of 5 volts is obtained on the voltmeter.

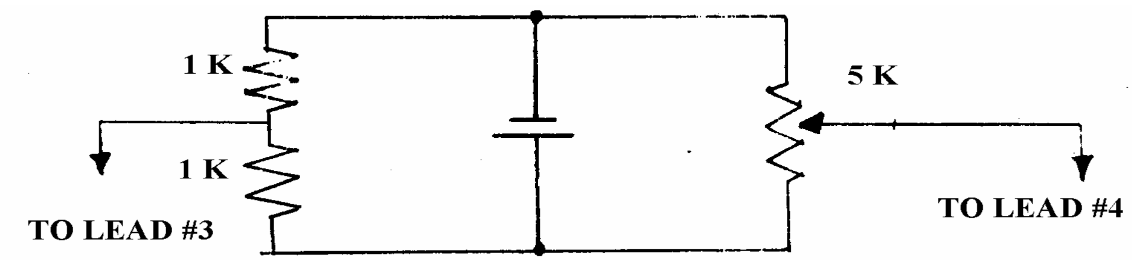
NOTE: Because of the time constants in the radio-navigation circuit, it will be necessary to adjust the gain control and heading dial slowly in order to obtain accurate settings.

5.4.3 When the received VOR signal is weak or unsteady, it will be necessary to use the following alternate adjustment procedure:

Using a VOR simulator or a station within range, determine that the left/right meter deflection is a function of bearing error. This can be done by first zeroing the left/right meter and adjusting the OBS dial to the proper bearing and then noting the needle deflection as the OBS is adjusted to a bearing 5° away from that initially obtained. After the needle deflection of the left/right meter is established for a 5° bearing error, turn off the VOR receiver and converter-indicator. Connect the test circuit shown in Figure 2A across leads #3 and #4 which connect the output of the VOR indicator to the Navigation Coupler. Adjust the potentiometer in the test circuit until the left/right indicator is deflected to the same point as was established for a 5° bearing error. Proceed with the gain adjustment in the same manner as when using a received signal.

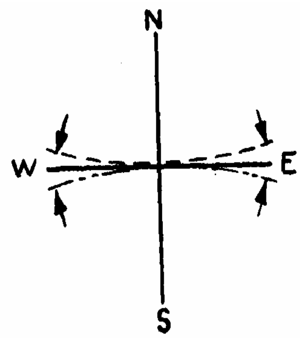
5. **PRE-FLIGHT ADJUSTMENTS (CONTINUED)**

5.4 VOR Gain Adjustments (Continued)

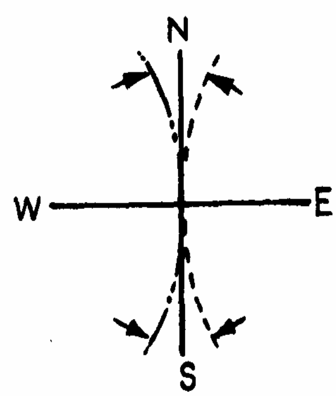


5.5 Magnetic Heading Compensation

To compensate the Magnetic Heading Sensor, use the same technique as used in compensating the primary aircraft compass. Rotation of the E-W adjustment clockwise or counter-clockwise will bend East and West headings both towards North and South. Example:



Rotation of the N-S adjustment clockwise or counter-clockwise will bend both North and South towards East or West. Example:



Example #1: A reading of 085° east and 275° West would necessitate rotating E-W adjustment to bend both East and West 5° towards South, bringing west to 270° and East to 090°.

5. **PRE-FLIGHT ADJUSTMENTS (CONTINUED)**

5.5 Magnetic Heading Compensation (Continued)

Example #2: North is 355° South is 185°. Rotate the N-S adjustment to bend both North and South towards east 5°, bringing North to 0° and South to 180°.

5.5.1 Adjustments for Magnetic Headings should be made according to the following sequence:

(A) Utilize a compass rose. However, if a compass rose is not available use a master compass. Align aircraft up with North, set function switch to "HDG" and set Hemisphere switch on "T". Connect a voltmeter to the test jacks shown in Diagram #1.

(B) Rotate heading azimuth card to obtain "0" volts on the test meter, make certain heading card is approximately on "0" and not 180°. The following readings should be noted and recorded on Figure 3A: The reading from the azimuth card, the ship's compass and the Directional Gyro.

Set Directional Gyro to "0" and uncage. Turn aircraft to 090° on Directional Gyro. Rotate azimuth card on heading lock to approximately 090° to obtain "0" volts on voltmeter. Record the heading shown on azimuth card in Figure 3A, also, the reading of the ship's compass. Proceed in exactly the same manner with South and West headings. After all the readings have been recorded, draw an azimuth as per Figure 3, and record the actual error in the headings.

	Ship's Compass	Directional Gyro	Heading Lock
N =	355°	0°	010°
E =	093°	090°	090°
S =	180°	180°	177°
W =	273°	270°	277°

FIGURE NO. 3A

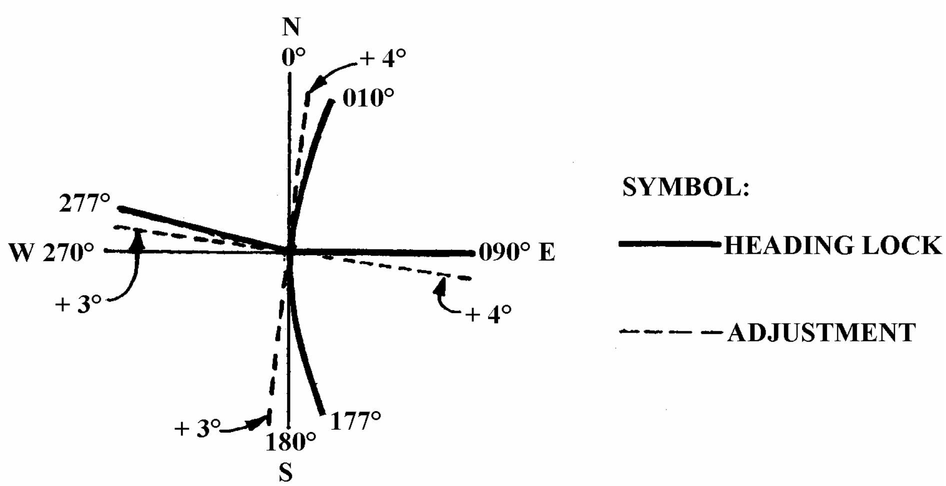


FIGURE NO. 3

5. PRE-FLIGHT ADJUSTMENTS (CONTINUED)

5.5 Magnetic Heading Compensation (Continued)

(C) From Figure 3, as plotted in Figure 3A, you can see exactly what has to be done. In this case, you would bend North and South to read, North + 4° and South + 3°. Bend East and West 4°, making West equal + 3° and East + 4°. From this we now have + 4° on North, + 4° on East, + 3° on South and + 3° on West (dotted line). The headings are all high and the next adjustment would be accomplished on the Controller as follows.

5.6 HDG Dial Adjustment

5.6.1 If all readings are high or low, loosen the setscrew securing the "HDG" dial to the resolver shaft, and rotate it slightly to bring selected headings into alignment with actual headings.

6. OPERATIONAL FLIGHT CHECK AND ADJUSTMENTS

6.1 Pre-Flight Checks

6.1.1 Review the Ground Check Inspection Record and make certain that all items have been covered.

6.1.2 Make certain the Latitude Switch on the Controller/Amplifier is on the appropriate number (check Latitude Selector Zone Map, See Diagram #II). Place the Hemisphere selector switch in the appropriate position, (i.e. "N" for Northern Hemisphere - "S" for Southern Hemisphere).

6.1.3 If so desired, magnetic headings may be verified for accuracy in flight by reference to section lines. For this purpose flight test should be conducted with a voltmeter across the yellow and orange test jacks, rather than referencing only the final heading of the aircraft. The controller must be partially removed for this purpose.

6.1.4 Complete the aircraft logs for the installation and have the appropriately rated pilot, who is to flight test the installation, familiarize themselves with the "Owner's Operating Manual".

6.1.5 While taxiing the aircraft, observe the aircraft as it is turned to the right, that the control wheel will rotate to the left and vice-versa. This verifies proper output and phasing of the Gyro in the roll/yaw system.

6. OPERATIONAL FLIGHT CHECK AND ADJUSTMENTS (CONTINUED)

6.1 Pre-Flight Checks (Continued)

6.1.6 With the engine running and nose wheel straight forward, select "HDG" mode and command right and left turns by rotating the "HDG" knob. Rotate the heading azimuth to correspond with the aircraft's heading and select the "CAP" mode. Verify that VOR needle deflection to the right and left commands right and left turns respectively.

6.2 Functional Operation

6.2.1 Climb to a safe altitude above the terrain. Attempt to find smooth air in which to conduct flight test. Trim the airplane for straight and level flight at cruise configuration. The Roll Trim Valve should be "centered" with the aircraft loaded symmetrically. If it is apparent that the airplane is not properly rigged, re-rigging will be necessary before continuing with the flight adjustment. An out-of-rig aircraft will cause autopilot heading errors and/or low wing condition.

6.2.2 If a malfunction should occur in any of the flight control units, the system can be overpowered with pressure on the manual controls. The entire autopilot may be disengaged by depressing the Cut-Off valve in the control wheel.

6.3 Rate of Turn (Bank Angle)

6.3.1 With the aircraft laterally trimmed in level flight, and at constant cruising speed, select the "HDG" mode.

6.3.2 Center the Roll Trim Valve and command a 90° turn to the left by rotating the heading azimuth. Note the aircraft bank angle which should be 15° to 18° at cruise speed. Repeat this procedure to the right. If the turns are asymmetrical, it will be necessary to adjust the Shunt Valve. Refer to Figure 4 for this adjustment. Adjustments to the Shunt Valve may be made during flight or on the ground.

6. **OPERATIONAL FLIGHT CHECK AND ADJUSTMENTS (CONTINUED)**

6.3 Rate of Turn (Bank Angle) (Continued)

By Rotating the slotted screws of the Shunt Valve as shown in Figure 4, balance the left and right turns within 3° of each other. For Example: If you have a noted 17° left bank and a 28° right bank, adjust the right bank slotted screw clockwise until the bank angle matches the left bank angle. **CAUTION:** Rotate these screws in small increments, never more than one turn in either direction.

NOTE: Rotor speed can be increased in order to stabilize Heading Lock on Northerly headings (See Paragraph 3.6.1, Manual 11968) If rotor speed increase causes a decrease in bank angle, re-adjust Shunt Valve stops.

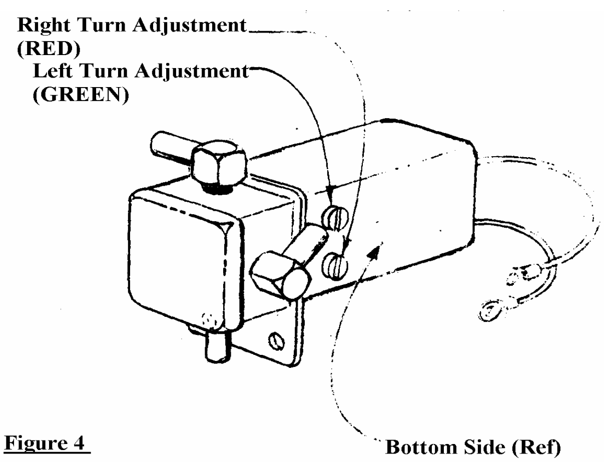


Figure 4

6.4 Directional Control

6.4.1 With the mode function knob in the "HDG" position and the Latitude Selector in the appropriate zone specified in Diagram II, program turns by rotating the heading azimuth. There is a definite relationship between the rate of turn (bank angle) and programmed magnetic headings. The transistorized circuitry which provides magnetic heading information is designed for certain "Roll Out" characteristics which pre-suppose a given rate of turn (bank angle). If the rate of turn is greater than 3° per second, there will be a tendency for the aircraft to over-shoot programmed magnetic turns to the East, North and West. If too shallow of a turn is produced, programmed magnetic headings to the North will be slow in approaching the final heading and nearly exact on east and west.

6. OPERATIONAL FLIGHT CHECK AND ADJUSTMENTS (CONTINUED)

6.4 Directional Control (Continued)

6.4.1 Continued

Turns to the South with a shallow bank angle may over-shoot the final Southerly programmed heading. Proper rate of turn, slightly less than standard rate, should allow for approximately 5° over-shoot on East and West, with less than 5° over-shoot on North and South.

6.4.2 Proper trimming or rigging of the aircraft is essential for precise headings. If an aircraft is rigged or trimmed to fly with one wing down, or with the ball of the Turn-and-Bank off center, turns will be steeper in one direction than the other. In addition, final heading accuracy between 280° and 080° may be aversely affected.

6.4.3 While evaluating the accuracy of the autopilot magnetic headings, it must be remembered that reference to a Directional Gyro should take into consideration precessional errors. Reference to the aircraft's magnetic compass must allow for compass errors.

6.4.4.1 If an airborne VOR test signal is available, verify the adjustment of the Nav-Sens. This may be readily accomplished by allowing the aircraft to stabilize on a random magnetic heading. Center the VOR needle and dial 5° "OBS" off course, place the mode function knob on "CAP" and observe on the Directional Gyro the number of degrees of turn that have been commanded by the 5° VOR needle displacement. (5° Omni error should produce from 23° to 26° heading change).

6.4.5 Observe the VOR needle to make certain that there are no erratic movements. (If erratic needle action is noticed, check the Omni Converter and Navigation Receiver for intermittent operation).

7. EMERGENCY PROCEDURES

7.1 If a malfunction should occur in any of the flight control units, the system can be overpowered merely with pressure on the manual controls. The entire autopilot may be disengaged by depressing the Cut-Off Valve on the control wheel.

8. RETURNING AIRCRAFT TO SERVICE

8.1 Upon completing the flight test, entry should be made in the aircraft log that the autopilot system has been test flown and evaluated for proper function by an appropriately rated pilot. (Ref; FAR Part 91.167A).

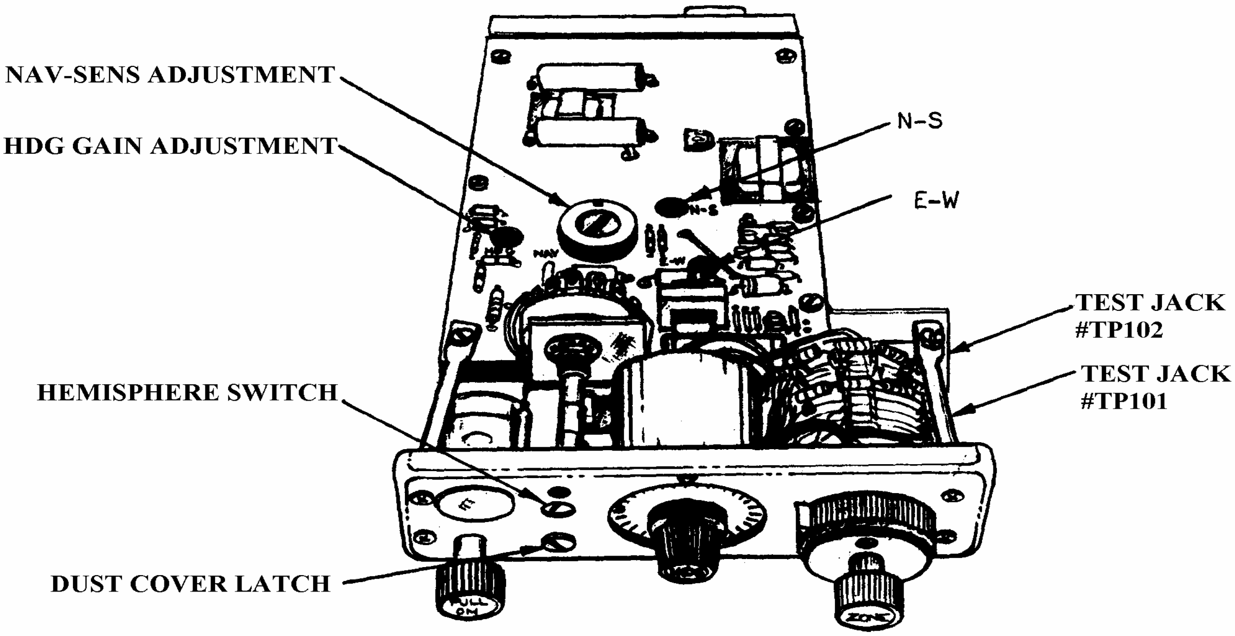


DIAGRAM NO. I

LOCATION OF FIELD ADJUSTMENTS

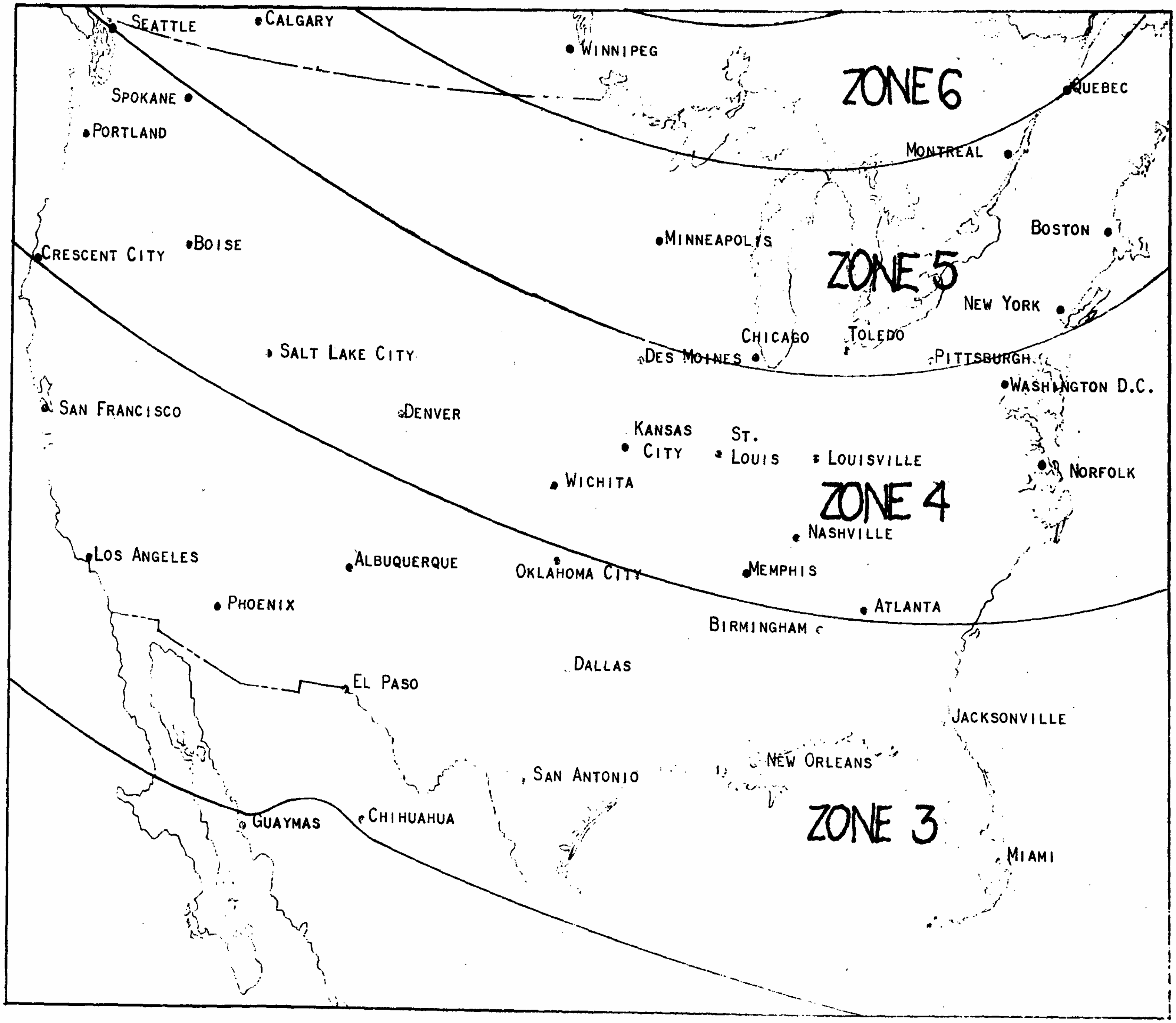


DIAGRAM NO. 11