MOONEY "POSITIVE CONTROL"

OPERATION & SERVICE INSTRUCTIONS MANUAL

NO. 11990

BRITTAIN INDUSTRIES, INC.

TULSA, OKLAHOMA

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1. INTRODUCTION

1.1 This manual is concerned primarily with the two axis system. No reference is made to the Dynertial Pitch Control or Magnetic Heading Lock. Both of these items are described and dealt with in separate operating and service instruction manuals.

1.2 The purpose of this manual is to assist service and maintenance personnel in testing and calibration of the "PC" system. Table "A" lists possible problems and corrective procedures. Paragraph #9 provides a system analysis in the event that Table "A" does not reveal the difficulty.

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

2. SYSTEM DESCRIPTION

2.1 General

The system is a pneumatically operated two axis automatic control device using vacuum power from the aircraft engine driven vacuum pump. The system consists of a Turn Coordinator Gyro Sense Element which meters vacuum to a cylinder-piston servo assembly. These servos are attached to the aileron and rudder controls, providing for a dual control system.

This system is intended to maintain lateral stability and prevent excessive changes in heading in turbulent air without pilot control.

2.2 Operation

Stability and control of the airplane about the roll and yaw axis is obtained by the gyro assembly. Part of the roll and yaw rate act on the sensitive gyro rotor element producing output signals, in this manner a single gyro element is sensing motion about the roll and yaw axes providing basic two axis stability augmentation.

Aircraft roll or yaw rates displace the rate gyro. The resulting output signal is coupled to a spoolsleeve rotary valve. The spool is rotated inside the sleeve in proportion to yaw and roll rates. The spool moves between the vacuum supply port and one of the output ports. The other output port is opened to atmosphere, relieving the vacuum. The resulting vacuum differential is directed to the proper pneumatic servo correcting the original roll or yaw error. In straight and level flight, the vacuum differential is zero and the servos are balanced.

2. SYSTEM DESCRIPTION (CONTINUED)

Provision has been made in this system to allow for roll trim. This function may be used to compensate for asymmetrical fuel and passenger loading and to optimize system performance in climb, cruise and let down configurations. During low speed climb, a combination of right rudder/aileron control is required to maintain wing level flight. Turning the roll trim knob to the right compensates for this condition. Also, during high speed descent, left rudder/aileron trim required is accomplished by turning the valve to the left. The roll trim valve will not compensate for improper aircraft rigging. If the aircraft is properly trimmed, the unit will maintain an average heading over a long period of time; the unit will not maintain an absolute preselected heading without the addition of the Magnetic Heading Lock. For optimum performance the aircraft must be rigged to fly with the Turn Coordinator centered.

The system disconnect push-button located in the control wheel, operates a pneumatic relay. When the push button is depressed, the servo vacuum supply is relieved. The pilot may then command turns without overriding the system. Releasing the push button re-activates the system. Normal maneuvers may be readily accomplished without depressing the disconnect button. Overpower forces are small and no damage will result to either the aircraft or the system.

3. GROUND TEST PROCEDURE

After the installation has been accomplished in accordance with the appropriate installation manual, perform the following ground tests and procedure:

3.1 All vacuum lines must be free of kinks and sharp bends. Make certain that lines have been purged of foreign matter before operating the system.

NOTE: Do not operate the system if lines are disconnected from servos. Do not fly aircraft with servo bibs capped or lines plugged.

3. **GROUND TEST PROCEDURE (CONTINUED)**

3.2 Aircraft Vacuum (Primary Vacuum)

Start the aircraft's engine and increase the RPM to 1700. An external vacuum pump may be used if the vacuum source is attached to the engine side of the aircraft vacuum relief valve. Adjust the aircraft's vacuum relief valve to the upper limit of the aircraft manufacturer's specifications. Make certain the regulator is properly functioning.

3.3 Cut-Off Valve Operation

The Cut-Off Valve actuates the pneumatic relay sequencing vacuum to the gyro valve.

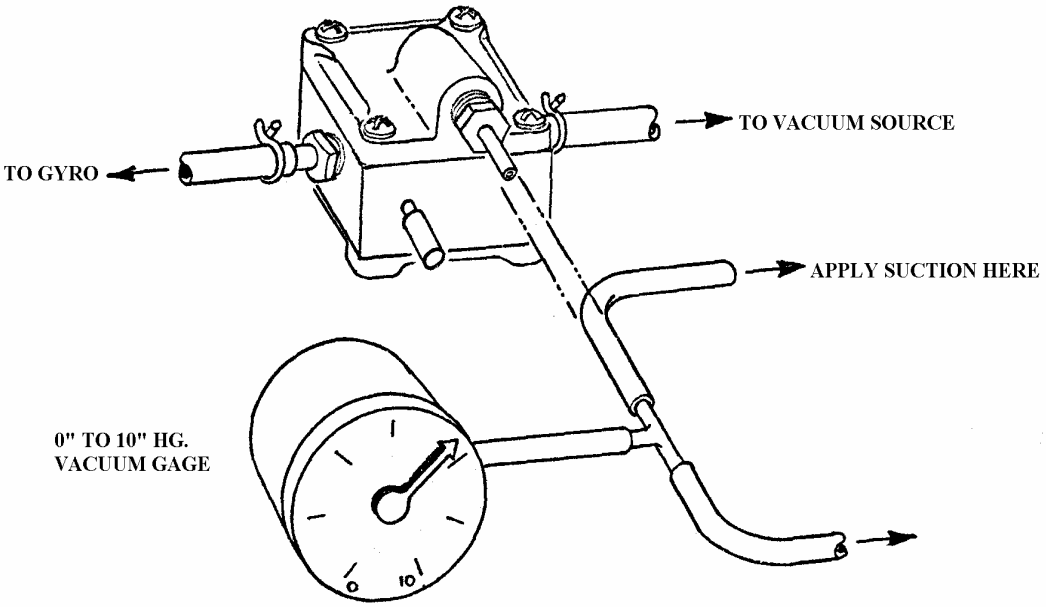

FIGURE 1

Disconnect gray line at pilot valve. Tee as per Figure 1 with a suction gauge on one side and other line open so that suction can be applied. Apply about 5" Hg. suction. Valve should not leak more than 2" Hg. in thirty seconds. Depress valve and vacuum should drop immediately and the button should return to its normal position.

3. GROUND TEST PROCEDURE (CONTINUED

3.4 Pilot Valve Operation

The pilot valve is a pneumatic relay that shuts off the vacuum supply to gyro valve when Cut-Off Valve is depressed and relieves the vacuum in the servos so that the system does not load the controls.

To test the pilot valve disconnect the gray line on the sequenced vacuum side of the valve and plumb a 0-10" vacuum gauge as shown. With vacuum on the system and Cut-Off Valve not depressed, reading on gauge should be 4.0" Hg. +.

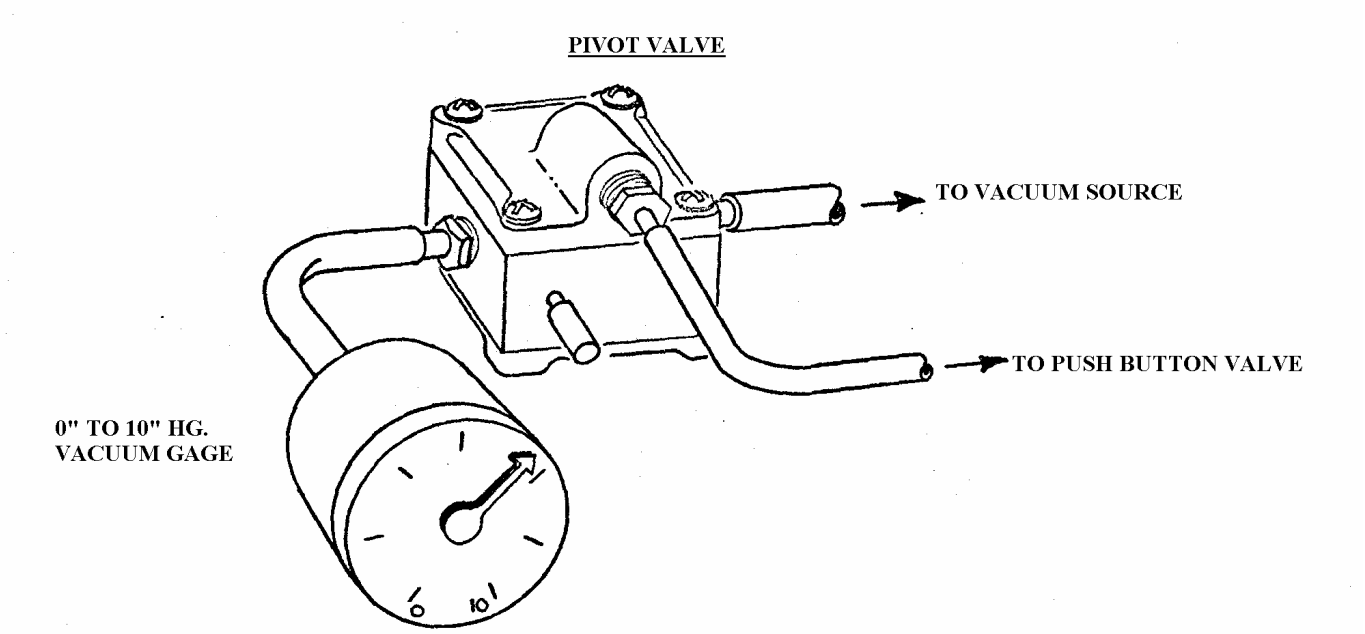

FIGURE 2

Upon depressing Cut-Off Valve, gauge should drop to 0" Hg. If vacuum is not relieved pilot valve is not shutting off completely and should be replaced.

4. ROLL TRIM

4.1 The roll trim knob should be approximately centered during flight. However, roll trim knob position may vary as much as 90° from center without indicating a faulty system. If the gyro unit is removed from the aircraft (requiring the removal of the knob) and then re-installed, the knob should be centered with the same degree of rotation right and left.

5. FLIGHT CHECK

5.1 While taxing yaw the aircraft to the left the control wheel should turn to the right. Yawing the aircraft to the right should cause the control wheel to turn left. If the phasing is reversed, the red and green tubing attached to the gyro is also reversed. Refer to the appropriate installation manual for proper tubing connections.

5.2 Before take-off when the aircraft is standing still, rotate the control wheel against the servo force. Depress the Cut-Off Valve button. The force required to overpower the system should be relieved.

5.3 Climb to a safe altitude in smooth air and level flight at cruise configuration. If it is apparent that aircraft is not properly rigged, re-rigging will be necessary before continuing with the flight test.

5.4 Depress the Cut-Off Valve. The system should instantly become inoperative. Release this Cut-Off Valve and the system should instantly re-engage. Depress the Cut-Off Valve and command a standard rate turn. Release the Cut-Off Valve and the aircraft should recover smoothly.

5.5 The roll trim will normally handle asymmetrical fuel and passenger loading in cruise configuration. Fully deflected roll trim generally will not exceed 1/4 of a standard rate turn. The system may be easily overpowered at any time.

6. EMERGENCY PROCEDURES

6.1 Malfunctions can be overridden with pressure on the flight controls, and the system may be disengaged by depressing the push button.

6.2 If a loss of vacuum occurs (indicated by a low vacuum warning light), the system will become inoperative. No adverse effect upon the airworthiness of the aircraft is encountered. A check for leaks in the vacuum system should be conducted as soon as possible. If no leaks are found, check the vacuum pump and the aircraft vacuum relief valve.

7. MAINTENANCE

7.1 Once the system has been adjusted, no further maintenance other than inspection of the various units for security and general condition is required. The gyro filter should be replaced only as required.

7.2 If high or low vacuum indicator illuminates, inspect the entire aircraft vacuum system for leaks, stoppages, etc. Refer to the aircraft manufacturer's specifications for maintenance of the instrument vacuum system.

8. TROUBLE SHOOTING

8.1 Table "A" lists possible flight control malfunctions, their causes and steps to be taken to correct them. In the event that a malfunction is not covered by Table “A”, refer to Paragraph 9.

TABLE "A"

REPORTED TROUBLE	PROBABLE CAUSE	REMEDY
1. Insufficient or excessive vacuum.	Faulty vacuum pump or relief valve	Perform test #1 and adjust vacuum if necessary.
2. Aircraft Hunts	1. Partial closure or leak in servo vacuum line	Perform test #2
	2. Improper gyro operation	Perform test #3
	3. Improper vacuum to valves and instruments	Perform test #1 and adjust vacuum if necessary.
	4. Faulty servo	Perform test #2

TABLE A CONTINUED

REPORTED TROUBLE	PROBABLE CAUSE	REMEDY
3. Aircraft does not hold directional heading.	1. Incorrect trim of aircraft	Adjust aircraft basic per aircraft manufacturer's specifications
	2. Excessive friction in system	Examine the aircraft's primary control system for excessive friction. Lubricate all hinge points per aircraft manufacturer's specifications.
	3. Improper vacuum to valves and instruments	Perform test #1 and #2 and adjust vacuum.
	4. Faulty gyro	Perform test #3
4. Aircraft recovers one direction, but not the other	1. Partial closure or leak in servo vacuum line	Perform test #2
	2. Loose or disconnected servo cable.	Perform test #2
	3. Faulty servo	Perform test #2
	4. Faulty rate gyro	Perform test #3
5. Aircraft tends to roll to one side	1. Leak or partial restriction in servo vacuum line	Perform test #2
	2. Improper gyro operation	Perform test #3
	3. Faulty servo	Perform test #2
6. Continuous wheel oscillation in smooth air.	1. Too high vacuum setting	Perform test #1
	2. Improper gyro operation	Perform test #3
7. Slow recovery from turn in one direction	1. Excessive friction in primary control system.	Examine the aircraft's primary control system to determine that no excessive friction exists. Lubricate all hinge points per aircraft manufacturer's specifications.
	2. Leak or partial restriction in servo vacuum line.	Perform test #2
	3. Loose or disconnected servo cable.	Perform test #4
	4. Faulty servo	Perform test #2
	5. Improper gyro operation	Perform test #3

9. TROUBLE SHOOTING TESTS

9.1 The tests referred to in Table "A" are to be conducted as required by the "Remedy" column of Table "A". As each test is conducted, the results the results should be noted. If the result differs from the correct indication follow the procedure indicated.

In the event that reported malfunctions are not covered by Table "A", the following tests should be used for a thorough system analysis.

9. TROUBLE SHOOTING TESTS (CONTINUED)

9. 2 TEST #l Vacuum Setting

Start the aircraft's engine and increase the RPM to 1700.

Adjust the aircraft vacuum relief valve to the upper limit of the aircraft manufacturer's specifications. If this vacuum reading is unobtainable, refer to the aircraft manufacturer's vacuum system specifications and maintenance instructions.

9.3 TEST #2 Vacuum Line and Servo Leak Test

IMPORTANT - All servo lines and servos must be free from any leaks to insure proper Autopilot Operation. While making an initial installation, and before upholstery or side panels are replaced, leak check the installed servo lines and servos. This should be done before lines are connected to the Gyro Sens Element.

Vacuum leak check is accomplished by inserting a test suction gauge in a closed servo line and extending the piston by moving the aircraft control surfaces (see Figure 6). Move the control column to fully extend the piston of the servo being tested. This will provide a vacuum in the system that is indicated on the suction gauge. Hold the control column firmly against the stops. Make certain that the servo piston is stationary. If no leak exists, the suction gauge reading will remain constant. Test the other servos and tubing in the same manner.

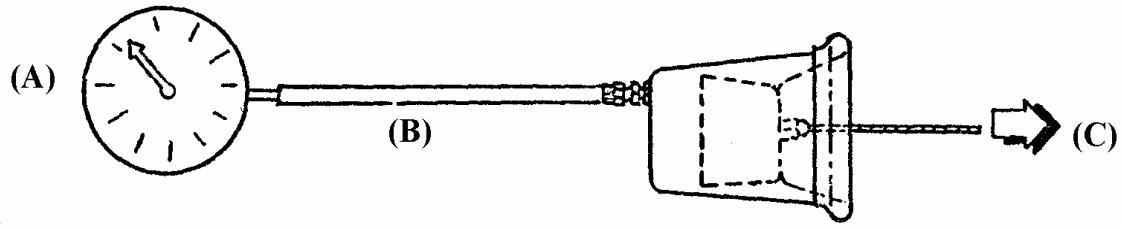

FIGURE 6

9. TROUBLE SHOOTING TESTS (CONTINUED)

9. 4 TEST #3 Proper Gyro Operation

Disconnect red and green Poly-Flo tubing from back of rate gyro. Plumb a differential gauge across the two bibs. Yaw aircraft. Note needle deflection on differential gauge indicating Turn Coordinator gyro deflection. When aircraft stops yawing gyro should come back to center within + .2" Hg. of the reading first obtained. Gyro should be replaced if it does not center properly.

9.5 TEST #4 Installation Inspection

Rotate the aircraft control wheel. The attachment to the respective servos must be tight and the servo piston extended, with rubber seal not stretched. Examine the aircraft's primary control system for excessive friction. Lubricate all hinge points per aircraft manufacturer's specifications.

10. EMERGENCY PROCEDURES

10.1 If a malfunction should occur in the flight control units the system can be overpowered with pressure on the manual controls. The system may be disengaged by depressing the Cut-Off Valve.

11. RETURNING AIRCRAFT TO SERVICE

11.1 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 91.167 A.)