TM 11-6615-204-12

TECHNICAL MANUAL

OPERATOR'S AND ORGANIZATIONAL
MAINTENANCE MANUAL

AUTOMATIC FLIGHT CONTROL SYSTEM
AN/ASW 12 (V) 2
(NSN 6615-00-771-4633)

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS, DEPARTMENT OF THE ARMY
MARCH 1975

WARNING

The automatic flight control system uses 115 volts. DO NOT make contact with exposed wires or connectors. Turn off all power supplies before making any connections or disconnections.

DON'T TAKE CHANCES!

TECHNICAL MANUAL

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 7 March 1975

Operator's and Organization Maintenance Manual

AUTOMATlC FLIGHT CONTROL SYSTEM AN/ASW-12(V)2 (NSN 6615-00-771-4633)

***This manual supersedes TM 11-6615-204-12,27 May 1965, Including all changes.**

LIST OF ILLUSTRATION

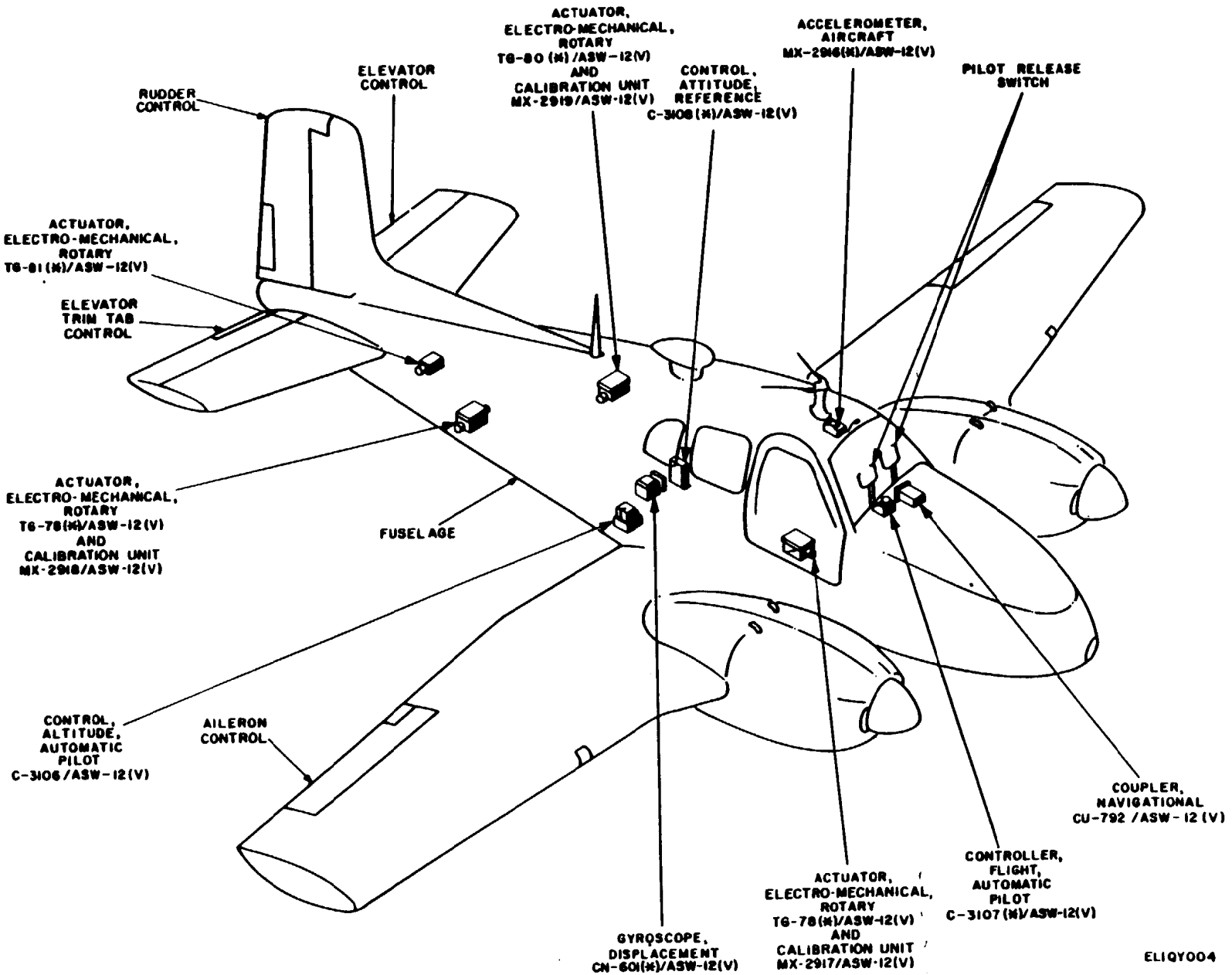

Figure 1-1. Typical installation of Automatic Flight Control System AN/ASW-12(V)2 in fixed-winged aircraft.

CHAPTER 1

INTRODUCTION

1-1. Scope

a. This manual covers operation and organizational maintenance instructions for the applications of Automatic Flight Control System AN/ASW-12(V)2 (fig. 1-1) as applied to a fixed-wing aircraft for yaw, pitch, and roll control.

b. An asterisk (*) contained in an official nomenclature indicates that all models of the equipment item are covered in this manual. Accelerometer, Aircraft MX-2916(*)/ASW-12(V) represents Accelerometers. Aircraft MX-2916/ASW-12(V) and MX-2916A/ASW-12(V). Actuator, Electra-Mechanical, Rotary TG-78(*)/ASW-12(V) represents Actuators, Electro-Mechanical, Rotary TG-78/ASW-12(V), TG-78A/ASW-12(V), and TG-78B/ASW-12(V). Actuator, Electro-Mechanical, Rotary TG-80(*)/ASW-12(V) represents Actuators, Electro-Mechanical, Rotary TG-80/ASW-12(V), TG-80A/ASW-12(V), and TG-80B/ASW-12(V). Actuator, Electro-Mechanical Rotary TG-81(*)/ASW-12(V) represents Actuators, Electro-Mechanical, Rotary TG-81A/ASW-12(V). Control, Attitude, Reference C-3108(*)/ASW-12(V) represents Controls, Attitude, Reference C-3108/ASW-12(V) and C-3108A/ASW-12(V). Controller. Flight. Automatic Pilot C-3107(*)/ASW-12(V) represents Controllers, Flight, Automatic Pilot C-3107/ASW-12(V) and C-3107A/ASW-12(V). Gyroscope, Displacement CN-601(*)/ASW-12(V) represents Gyroscopes, Displacement CN-601/ASW-12(V) and CN-601A/ASW-12(V).

c. Actuator, Electro-Mechanical, Rotary TG-79/ASW-12(V), TG-79A/ASW-12(V), and TG-79B/-ASW-12(V) is not used in any present configuration of Automatic Flight Control System AN/ASW-12(V)2. It is replaced in all aircraft by Actuators, Electro-Mechanical. Rotary TG-78/ASW-12(V), TG-78A/ASW-12(V), and TG-78B/ASW-12(V).

NOTE

Appendix C is current as of 6 December 1974.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DSAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33 A/AFR 75-18/MCO P4610.19B, and DSAR 4500.15.

1-4. Destruction of Army Materiel to Prevent Enemy Use

Demolition of the equipment will be accomplished only upon the order of the commander. Refer to TM 750-244-2 for procedures to prevent the enemy from using or salvaging this equipment.

1-5. Administrative Storage

For procedures. forms. and records, and inspections required during administrative storage of this equipment, refer to TM 740-90-1.

1-6. Reporting of Errors

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications. and Blank Forms) and forwarded direct to Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, NJ 07703.

Section II. DESCRIPTION AND DATA

1-7. Purpose and Use

a. Purpose. Automatic Flight Control System AN/ASW-12(V)2 is a three-axis system which provides automatic flight control for fixed wing aircraft. The flight control functions include automatically stabilized or pilot-commanded roll, pitch, yaw, and altitude control. The automatically stabilized controls also provide automatic steering control from interconnected electronic navigation equipment that may be installed in the aircraft.

b. Use. Automatic Flight Control System AN/ASW-12(V)2 is used in fixed-wing aircraft as an automatic

pilot (autopilot). The autopilot maintains the aircraft at constant attitude in the applicable flight axes (a above). The autopilot is also used as a flight aid by use of applicable command modes. In the common modes. the pilot introduces commands by the use of switches and controls that cause the aircraft to change its flight attitude. When the autopilot is used in conjunction with associated navigation equipment in the aircraft, the aircraft will automatically fly the course and attitude provided by the navigation equipments. The AN/ASW-12(V)2 is used to stabilize the aircraft roll, pitch, and yaw (heading) attitudes and to maintain a constant aircraft altitude. Constant altitude is maintained by an altitude sensing device that applies a correction signal to the pitch control axis. When used with navigation equipment, the AN/ASW-12(V)2 will maintain the flight course and attitude as determined by the navigation equipment. When used in AN/ASW-12(V)2 enables the pilot to control the flight attitude of the aircraft with the AN/ASW-12(V)2 controls.

1-8. Technical Characteristics

a. General

Operating ranges:	
Altitude	0 to 35,000 feet (ceiling) (barometric control limited to ±400 feet deviation from engaged altitude).
Temperature	-67° to + 131°F.
Pitch attitude	0° to ±25° maximum.
Roll attitude	0° to ±45° maximum.
Heading	Unlimited.
Power requirements	115 volts ac, 400 Hz, there phase at 115.7 volt-amperes and 27.5 volts dc at 9.8 amperes.
Calibration and testing facilities:	
Calibration	Resistance capacitane network factory-adjusted and do not require field adjustment.
Testing facilities	Test plugs furnishd with systems: test points available in components.

b. Actuators, Electro-Mechanical, Rotary TS-78(*)/ASW-12(V), TG-80(*)/ASW-12V.

Input power	115 volts ac. 400 Hz. single phase at 5.1 volt-amperes and 27.5 volts dc at 2.2 amperes.
Motors:	
Horsepower	0.01.
Speed (maximum)	7.200 rpm.
Maximum operating altitude	40,000 fat.
Output	Revolution of drum pulls control cables that operate the aircraft flight control surfaces.
Maximum drum travel	Unlimited (continuous) in both directions.
Output drum torque and speed	
TG-78/ASW-12(V)	50 in.-lb and 52 rpm
TG-78A/ASE-12(V) and TG-78B/ASW-12(V)	50 in.-lb and 80 rpm.
TG-80/ASW-12(V)	140 in.-lb and 19 rpm.
TG-80A/ASW-12(V) and TG-80B/ASW-12(V)	140 in-lb and 29 rpm.
Gear drive ratio	
TG-78(*)/ASW-12(V)	90.4:1.
TG-80(*)/ASW-12(V)	248.0:1

c. Actuator, Electra-Mechanical, Rotary TG-81(*)/ASW-12(V).

Input power required	27.5 volts at 0.2 ampere.
Motor	
H P	0.01.
Speed (maximum)	7,200 rpm.
Maximum operating altitude	40,000 feet.
Output	Revolution of drum pulls control cables that operate the aircraft roll trim controls.
Output drum torque	50 in.-lb
Output drum speed	3 rpm maximum.
Maximum drum travel	4 revolutions.
Gear drive ratio	2,000:1.

d. Calibration Units MX-2917/ASW-12(V) Through MX-2919/ASW-12(V).

Inputs ..... Electrical error signals from the control channel representing displacement from desired altitude.
Outputs ..... Electronically summed and modified displacement error signals.
Mounting or location ..... Mounted on and electrically connected to a rotary electromechanical actuator (b above).

e. Control, Altitude, Automatic Pilot C-3106/ASW-12(V).

Inputs:
Mechanical ..... Static air from an externally mounted pitot tube which detects altitude changes.

Electrical:
Ac ..... 115 volts, 400 Hz, single phase at 7 volt-amperes.
Dc ..... 27.5 volts at 0.17 ampere.
Output ..... Electrical signals reperesenting altitude.

f. Control, Attitutfe Reference C-3108 (*) /ASW-12 (V).

Input power requirements ..... 115 volts ac. 400 Hz, single phase at 35 volt-amperes and 27.5 volts dc at 1.5 amperes.
Input signals ..... Electrical signals from sensing devices that represent the aircraft roll, pitch, or yaw attitude.
Outputs ..... Electrical signals representing aircraft deviation from internally selected and synchronized attitude in the roll, pitch, and yaw axes. The signals are applied direct to appropriate power units (actuators, electromechanical rotary).

g. Controller, Flight, Automatic Pilot C-3107(*)/ASW-12(V).

Inputs:
Operating voltages ..... 115 volts ac, 400 Hz, single phase at 0.7 volt-ampere and 27.5 volts dc at 0.03 ampere.
Signals ..... Servo effort signals from all power units.
Outputs ..... Command signals to all control axes.
Indicator ..... Three servo effort indicators.
Controls ..... A combined turn and pitch and roll trim.

h. Coupler, Navigational CU-792/ ASW-12(V).

Inputs:
Operating voltages ..... 115 volts ac, 400 Hz, three phase at 19.5 volt-amperes and 27.5 volts dc at 1.0 ampere.
Signals ..... Navigational signals from associated electronic navigation equipments. Altitude signal from the C-3106/ASW-12(V).
Outputs ..... Automatic steering and flight control signals from selected navigational equipment.

i. Gyroscope, Displacement CN-601 (*)/ASW-12(V).

Inputs:
Operating voltages ..... 115 volts ac, 400 Hz, three phase at 37.2 volt-ampere and 27.5 volts dc at 0.26 ampere.
Mechanical ..... Housing mechanically positioned in roll and pitch with aircraft attitude changes.
Outputs ..... Electrical signals representing aircraft roll and pitch displacement.

Total axes of freedom ..... 2.
Total number of gimbals ..... 2.
Maximum displacement:
Pitch ..... ±85°
Roll ..... 260°.
Method of erection ..... Torque motors for both gimbals. Gyro is nonchangeable.

1-9. Items Comprising on Operable Equipment

Automatic Flight Control System AN/ ASW-12(V)2 (procured on Orders No. 109-PH-58, 3398-PP-59, 4408-PP-60, 5056-PP-61, and 4102-PZ-62) (fig. 1-1 and 1-2) is referred to as the three axis system and is installed in fixed-wing aircraft. The items in the chart below make up an operable Automatic Flight Control System AN/ASW-12(V)2.

NSN	Qty	Item	Dimensions (in.)			Weight (lb)
			Height	Depth	Width	
6615-00-771-5635	1	Accelerometer, Aircraft MX-2916/ASW-12(V)[a] or MX-2216A/ASW-12(V)[b]	2 5/8	2 5/8	2 3/4	1.0
1680-00-753-3972	1	Actuator, Electro-Mechanical Rotary TG-78/ASW-12(V)[a], TG-78A/ASW-12(V)[b], or TG-78B/ASW-12(V)[c].	4 1/32	4 5/8	8 3/16	5.5
1680-00-753-3970	1	Actuator, Electro-Mechanical Rotary TG-80/ASW-12(V)[a], TG-80A/ASW-12(V)[b], or TG-80B/ASW-12(V)[c].	4 1/32	4 5/8	8 3/16	5.5
1680-00-805-3991	1	Actuator, Electro-Mechanical, Rotary TG-81(*)/ASW-12(V).	2 13/16	3 3/4	7 9/16	5.0
6515-00-771-4638	1	Calibration Unit MX-2917/ASW-12(V)	1.0	1 5/8	2 1/2	0.2
6515-00-771-4639	1	Calibration Unit MX-2918/ASW-12(V)	1.0	1 5/8	2 1/2	0.2
6515-00-771-4640	1	Calibration Unit MX-2919/ASW-12(V)	1.0	15/8	2 1/2	0.2
6515-00-752-7613	1	Control, Altitude, Automatic C-3106/ASW-12(V).	5 5/32	4 3/4	7 5/16	3.2
6615-00-771-4634	1	Control, Altitude, Reference C-3108/ASW-12[a,b]) or C-3108A/ASW-12(V).[c]	4 7/8	3 1/8	7 5/16	4.5
6515-00-752-7612	1	Controller, Flight, Automatic Pilot C-3107/ASW-12(V)[a,b] or C-3107A/ASW-12(V)[c].	4 9/16 3 5/6	3 3/4 5 3/4	4 31/32 7 7/8	2.5 4.5
6515-00-771-4636	1	Coupler, Navigational CU-792/ASW-12(V)	4 7/8	7 5/8	6 7/8	5.0
6515-00-752-7668	1	Gyroscope, Displacement CN-601/ASW-12(V)[a,b] or CN-601A/ASW-12(V)[c].	6.0	7 47/64	6 1/4	8.0

a Procured on Orders No. 109-PH-58, 3398-PP-59, and 4406-PP-60.
b Procured on Order No. 5056-PP-61.
c Procured on Order No. 41012-PZ-62.

1-10. Common Names

Throughout the manua1, components are referred to by common names. Common names are assigned and used to avoid the use of cumbersome nomenclature. The components and functional common names for the AN/ASW-12(V)2 are listed in the chart below.

Nomenclature	Common name
Accelerometer Aircraft MX-2916/ASW-120(V) or MX-2916/ASW-12(V).	Accelerometer
Actuator. Electro-Mechaniccal, Rotary TG-78(*)/ASW-12(V).	Roll and pitch power unit.
Actuator, Electro-Mechanical, Rotary TG-80/ASW-12(V).	Yaw power unit.
Actuator, Electro-Mechanical, Rotary TG-81(*)/ASW-12(V).	Trim power unit.
Calibration Unit MX-2917/ASW-12(V).	Roll calibration card.
Calibration Unit MX-2918/ASW-12(V).	Pitch calibration card.
Calibration Unit MX-2219/ASW-12(V).	Yaw calibration card.
Control, Altitude, Automatic Pilot C-3106/ASW-12(V).	Altitude control.
Control, Altitude, Reference C-3108/ASW-12(V) or C-3108A/ASW-12(V).	Altitude reference control.
Controller, Flight. Automatic Pilot C-3107/ASW-12(V) or C-3107A/ASW-12(V).	Flight controller.
Coupler, Navigational CU-792/ASW-12(V).	Navigational coupler.
Gyroscope, Displacement CN-601/ASW-12(V) or CN-601A/ASW-12(V).	Vertical gyro.

1-11. Description of AN/ASW-12(V)2 System

a. General. The AN/ASW-12(V)2 consists of components that are required to perform the necessary flight control functions for the aircraft in which they are installed. The components can be divided into the following functional groups: power and drive, stabilization and command, sensor, and calibration. The system and functional groups of components that comprise the system are covered in b below and are illustrated in figure 1-3. The description of the individual components are covered in paragraphs 1-12 through 1-20.

b. Detailed (fig. 1-3). The AN/ASW-12(V)2 power and drive functional group consists of four components: the ro11, pitch, and yaw power units (para 1-13), and the trim power unit (para 1-14). The stabilization and command functional group consists of the navigational coupler (para 1-19),

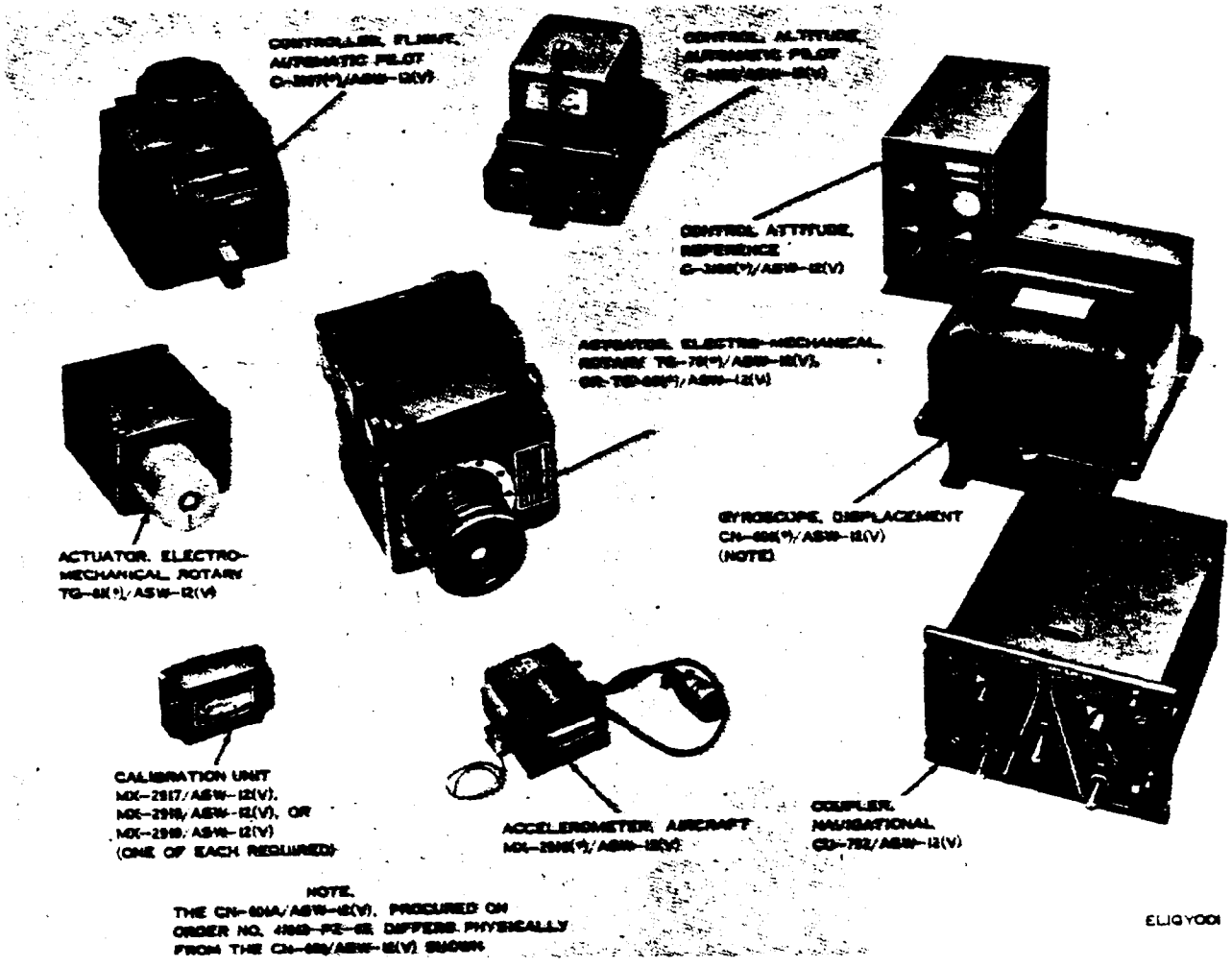

Figure 1-2. Components of Automatic Flight Control System AN/ASW-12(V)2.

the flight controller (para 1-18). and the attitude reference control (para 1-17). The sensor functional group consists of a vertical gyro (the CN-601/ASW-12(V) (para 1-20a) or the CN-601A/ASW-12(V) (para 1-20b)), an altitude control (para 1-16). and an accelerometer (para 1-12). The calibration functional group consists of the roll. pitch. and yaw calibration cards (para 1-15).

1-12. Description of Accelerometer, Aircraft MX-2916(*)/ASW-12(V)

(fig. 1-4)

a. The MX-2916(*)/ASW-12(V) is inclosed in a rectangulag cast housing with a cover flange on one end. Access to the internal parts is obtained by removing the access cover attached to the cover flange. The unit is installed in the aircraft and secured with screws inserted through the four mounting holes (two on each side) that are part of the cast housing. Electrical connections are ma& through the six-pin connector on the cable assembly. The cable assembly enters the unit through a hole on one side of the cast housing. On the other side of the cast housing is a ground bonding cable with a lug. Arrows on the nameplate indicate the axis of sensitivity.

b. Electrical Differences. Accelerometer. Aircraft MX-2916/ASW-12(V) provides a direct current (dc) acceleration output signal. Accelerometer, Aircraft MX-2916/ASW-12(V) provides both dc and alternating-current (ac) acceleration signals.

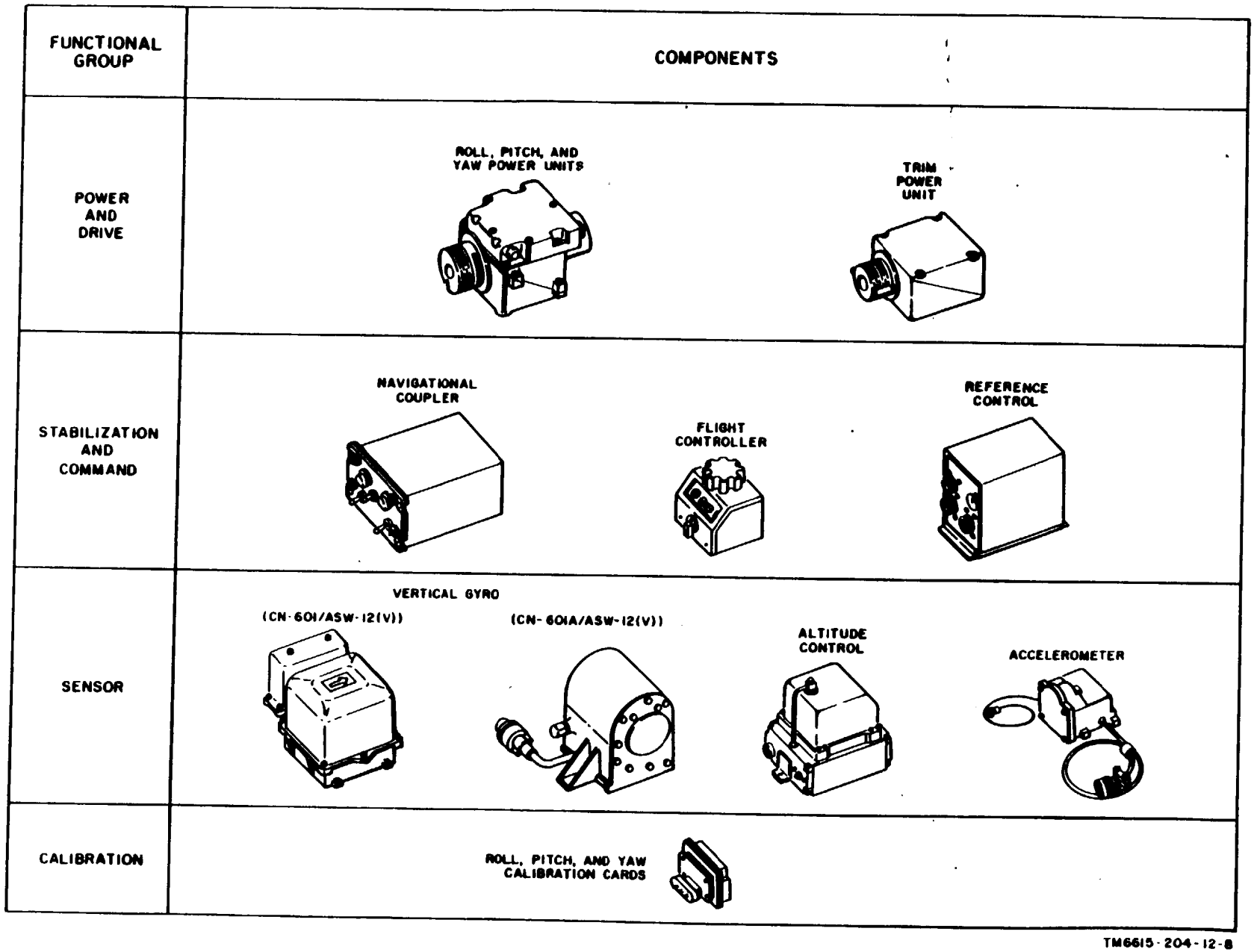

Figure 1-3. Classification of AN/ASW-12(V)2 components.

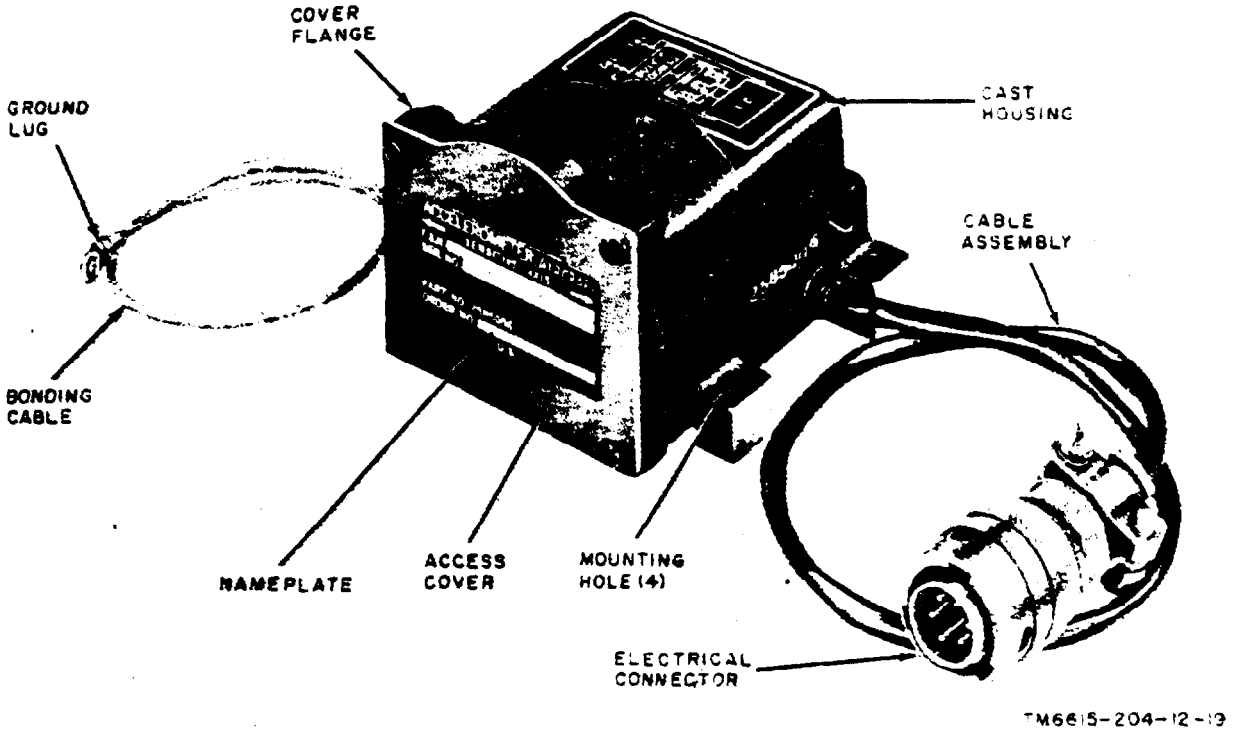

Figure 1-4. Accelerometer, Aircraft MX-2916(*)/ASW-12(V).

1-13. Description of Actuators, Electro-Mechanical, Rotary TG-78(*) /ASW-12(V), and TG-80(*)/ASW-12(V) (fig. 1-5)

The TG-78(*)/ASW-12(V), and TG-80(*)/ASW-12(V) are drum-type power units consisting of three major assemblies: the drum and bracket assembly (a below). the servo drive assembly (b below). and the amplifier assembly (c below). All drum-type power units are physically and electrically identical, except for power drive ratio (d below) and shear pins torques. The power drive ratio of the power unit is contained on decals attached to the sick of the servo drive assembly (fig. 1-6). The application of each unit is covered in e below.

a. Drum and Bracket Assembly. The drum and bracket assembly is a mechanical assembly containing a mounting base for installation in the aircraft and an output drum for control cable takeup.

b. Servo Drive Assembly. The servo drive assembly contains a dc permanent magnet motor (servomotor), which drives a power gear train and an Instrument gear train. Four captive screws secure the servo drive assembly on to the drum and bracket assembly.

c. Amplifier Assembly. The amplifier assembly is mounted on top of the servo drive assembly. Power is supplied through the electrical connector at the rear of the amplifier assembly. Transistors are mounted on both sides of the amplifier assembly.

d. Power Drive Ratios. The power drive ratio of each power unit is identified by three colored decals. The decals are located on the drum and bracket assembly. on the servo drive assembly (fig. 1-6). and in the aircraft near the area where the drum actuator is installed. The drive ratio for each power unit and the corresponding decal color are listed below.

Power unit,	Power gear drive ratio	Decal color
TG-78(*)/ASW-12(V)	90.4:1	Yellow
TG-80(*)/ASW-12(V)	248.0:1	Gray

e. Application. In the AN/ASW-12(V)2 system, the TG-78(*)/ASW-12 is used as the roll and pitch Power units and the TG-80(*)/ASW-12 is used as the yaw power unit.

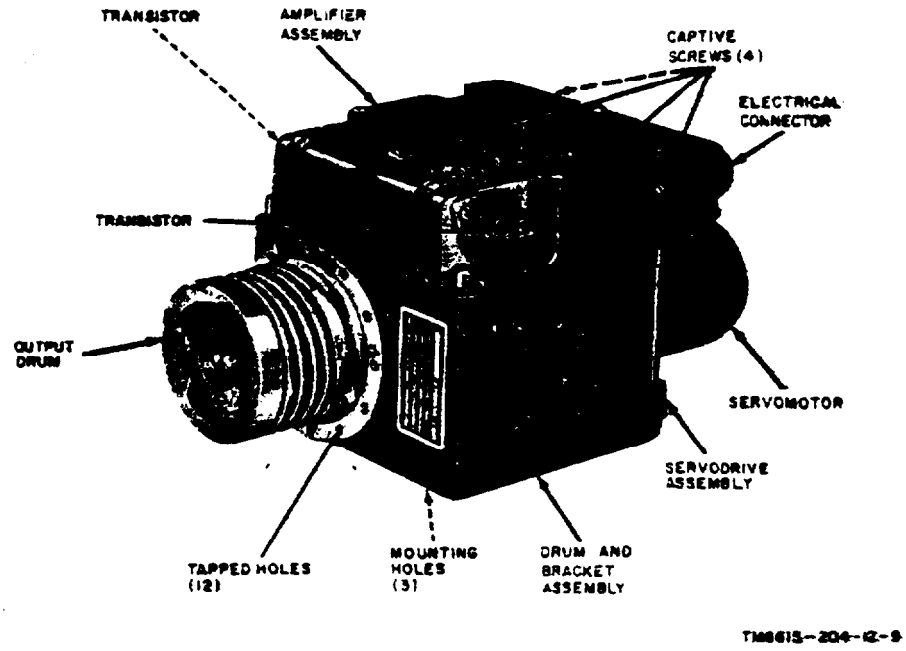

Figure 1-5. Actuator, Electro-Mechanical, Rotary TG-78(*)/ASW-12(V), ASW-12(V).

1-14. Description of Actuator. Electro-Mechanical, Rotary TG-81 (*)/ASW-12(V)

(fig. 1-7)

The TG-81(*)/ASW-12(V) is the trim power unit for the AN/ASW-12(V)2. The trim power unit output is applied through the rotary motion of the output drum. The trim power unit consists of two major assemblies which can be separated by removing the four captive screws.

a. Drum and Bracket Assembly. The drum and bracket assembly is similar to the drum and bracket assemblies of the roll, pitch, and yaw power units (para 1-13a). The differences are in the gear ratios (instrument train), power train ratios. and shear-pin torques.

b. Servo Drive Assembly. Four capitve screws secure the Servo drive assembly on top of the drum and bracket assembly. Power is applied through an electrical connector mounted at the rear of the servo drive.

1-15. Description of Calibration Units MX-2917/ASW-12(V) Through MX-2919/ASW-12(V)

(fig. 1-8)

Calibration Units MX-2917/ASW-12(V), MX-2918/ASW-12(V), and MX-2919/ASW-12(V) are the roll, pitch, and yaw calibration cards, respectively, for the AN/ASW-12(V)2. The calibration cards have four mounting holes. On the case of each calibration card is an identifying nameplate. An electrical connector is provided so that the calibration cards may be changed without unsoldering connections. When installed, the calibration card is mounted on and is electrically connected to the associated power unit or acceleration monitor.

1-16. Description of Control, Altitude, Automatic Pilot C-3106/ASW-12(V)

(fig. 1-9)

Control. Altitude, Automatic Pilot C-3106/ASW-12(V) is the altitude control for the AN/ASW-12(V)2. The altitude control consists of a pressure-sensitive assembly and electronic chassis. The pressure assembly is housed in a rectangular stamped cover with a sloping rear edge. The cover is secured to the base with four cover screws. The complete pressure-sensitive assembly is mounted on the electronic chassis with four mounting screws that are inserted through the pressure sensitive assembly base. The front of the elec-

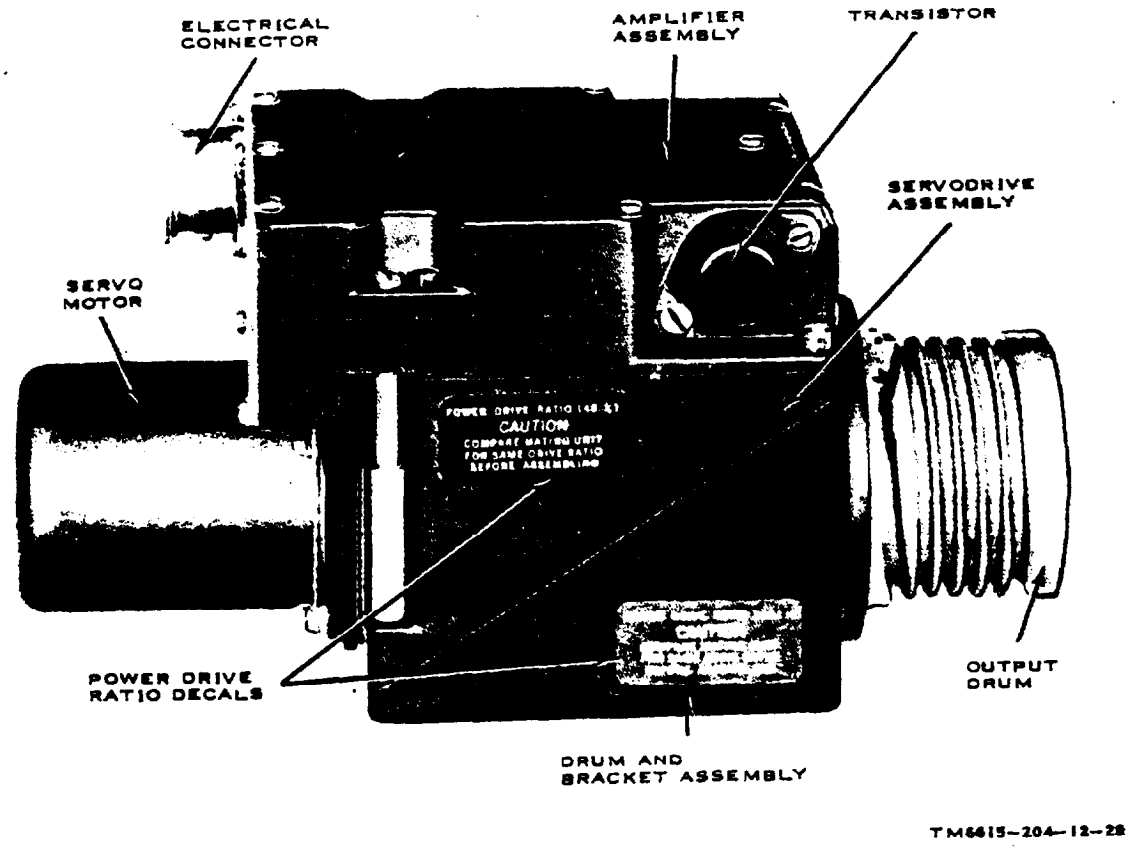

Figure 1-6. Drum-type power units, location of power drive ratio decals.

tronic chassis contains an electrical connector (J1), a static pressure input, two test jacks (J2, and J3), and an l-shaped mounting bracket with a mounting hole. The rear of the electronic chassis contains two 1-shaped mounting-brackets with mounting holes. When installed in the aircraft. the altitude control is secured to the airframe with bolts or screws that are inserted through the three mounting holes. All electrical connections are made through electrical connector J1. Atmospheric pressure for determining altitude is connected from a pitot tube to the static pressure input. (The altitude control is shipped with a plug installed in the static pressure input.) The atmospheric pressure is transferred from the static pressure input on the electronic chassis, through flexible tubing and tubing assembly to the pressure-sensitive assembly. Within the pressure-sensitive assembly, changes in altitude are detected by changes in pressure input.

1-17. Description of Control, Attitude, Reference C-3108(*)/ASW-12(V)

(fig. 1-10)

Control, Attitude, Reference C-3108(*)/ ASW-12(V) is the attitude reference control for the AN/ASW-12(V)2. The attitude control is housed in a rectangular case with a removable shaped cover. The front panel contains an elapsed time indicator and three electrical connectors (J1, J2, J3). The bottom of the front panel is bent to form a mounting lip. The lip edge contains two mounting holes. The bottom edge of the rear panel similarly contains two mounting holes. The bottom edge of rear panel similarly contains two mounting holes. When installed in an aircraft, the unit is secured to the airframe with bolts or screws inserted through the four mounting holes. All electrical connections to the attitude reference control are made through the three electrical connectors on the front panel.

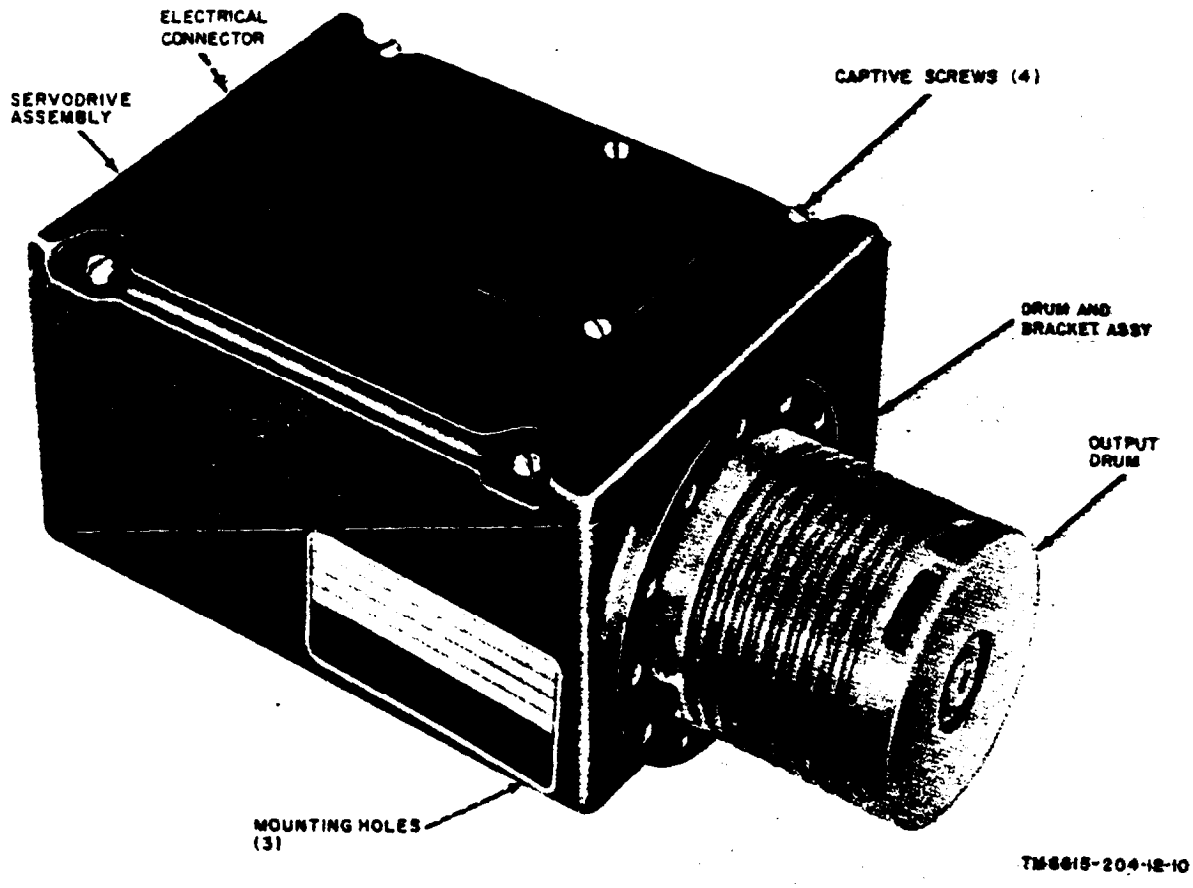

Figure 1-7. Actuator, Electro-Mechanical, Rotary TG-81(*)/ASW-12(V).

1-18. Description of controller, Flight, Automotic Pilot C-3107(*)/ASW-12(V)

(fig. 1-11 and 1-12)

controller, Flight, Automatic Pilot C-3107(*)/ ASW-12(V) is the flight controller for the AN/ ASW-12(V)2 system. The top horizontal surfaces of the flight controller contains a pitch (beep switch) roll control (TURN knob) (fig. 1-11). Tim roll control (TURN knob) can be rotated and moved fore and aft simultaneously. It is spring-loaded in the fore and aft movement so that it will return to the center detent position when released. Located on the front vertical part of the flight controller is a ROLL TRIM control. Three edge-lighted servo effort indicators (RUD, AIL, and EL) are located above the ROLL TRIM control on the sloping front panel of the flight controller. The servo effort indicators (pitch, roil, and yaw) show the direction and magnitude of the forces being exerted by the power unit on the aircraft primary controls. When the flight controller is installed in the aircraft, it is secured to the aircraft control panel or control pedestal with screws inserted into the three tapped mounting holes in the bottom (fig. 1-12). All electrical connections to the flight controller are made through the electrical connector on the rear of the unit. For some installations, the electrical connector may be moved to the alternate location (on the bottom of the flight controller).

1-19. Description of Coupler, Naviagational CU-792/ASW-12(V)

(fig. 1-13)

Coupler, Navigational CU-792/ASW-12(V) is the navigational coupler for the AN/ASW-12(V)2. The navigational coupler is housed in a rectangular metal box with a flanged front panel for mounting in an opening in the aircraft in instrument

panel. The main electronic chassis portion of the navigationaI coupler is covered by a chassis assembly cover. The front panel contains the operational controls consisting of two selector switches and three toggle switches that allow the operator (pilot) to select and engage the desired mode of operation. When the navigational coupler is installed in fixed-wing or rotary-wing aircraft, it is secured in the opening of the aircraft or helicopter instrument panel with four quick-disconnect fasteners. Two of the quick-dieconnect fasteners are located on each side. of the front paneI. All electrical connections to the unit are made through two electrical connectors (J1 and J2) on the rear of the unit.

1-20. Description of Gyroscope, Displacement CN-601(*)/ASW-12(V)

(fig. 1-14 and 1-15)

Gyroscope, Displacement CN-601(*)/ASW-12(V) is the vertical gyro for the AN/ASW-12(V)2. Although the two models of the verti-

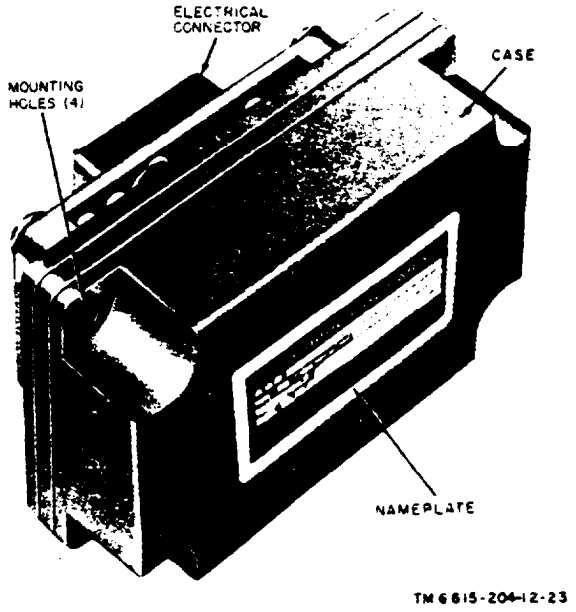

Figure 1-8. Calibration Unit MX-2917/ASW-12(V), MX-2918/ASW-12(V), or MX-2919/ASW-12(V).

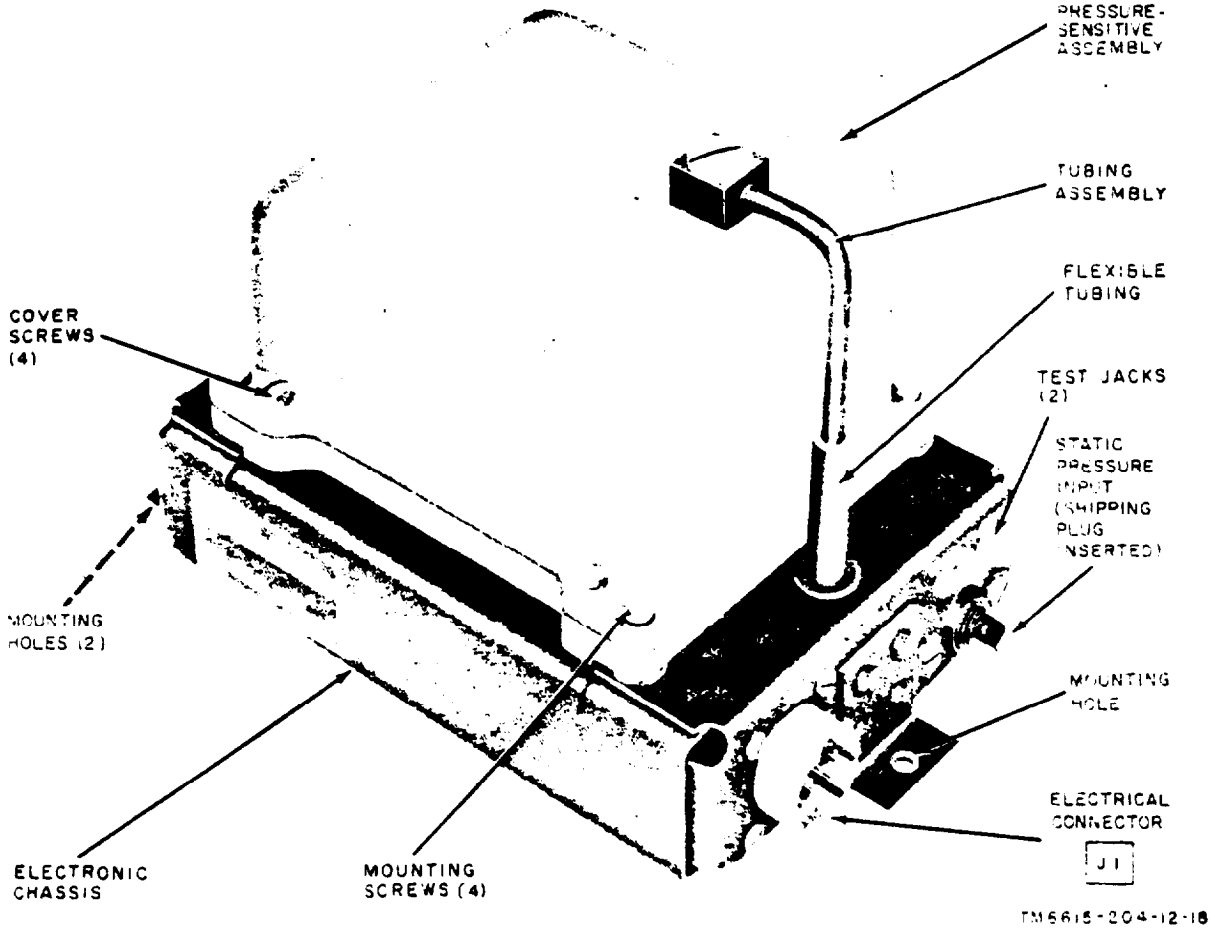

Figure 1-9. Control Altitude, Automatic Pilot C-3106/ASW-12(V).

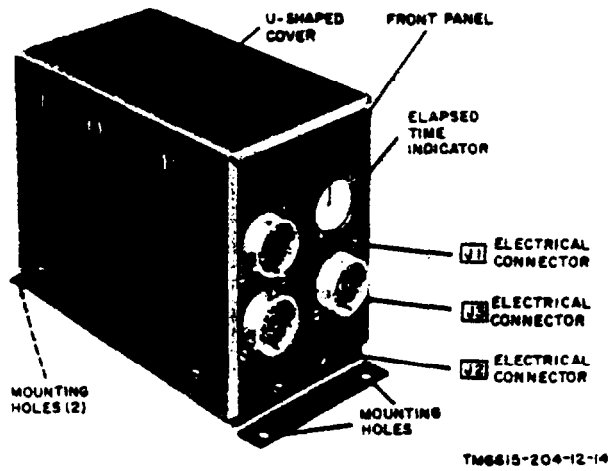

Figure 1-10. Control, Attitude Reference C-3108(*)/ ASW-12(V).

cal gyro differ physically and electrically, they are directly interchangeable.

a. Gyroscope, Displacement CN-601/ ASW-12(V) (fig. 1-14). The CN-601/ ASW-12(V) consists of two major assemblies, the gyroscope assembly and the erection control module, mounted on a single cast ban. Both the major assemblies are protected by covers that are secured in place with four screws. The erection control module is in a rectangular-shaped cover. On the top of the gyroscope assembly cover is a warning plate with an arrow that indicates the proper orientation of the unit when installed in an aircraft. When the unit is installed, it is secured in place with screws or bolts that are inserted through the three mounting holes on the cut base. All electrical connections to the vertical qyro are made through electrical connector J3 located on the cut base below the erection control module.

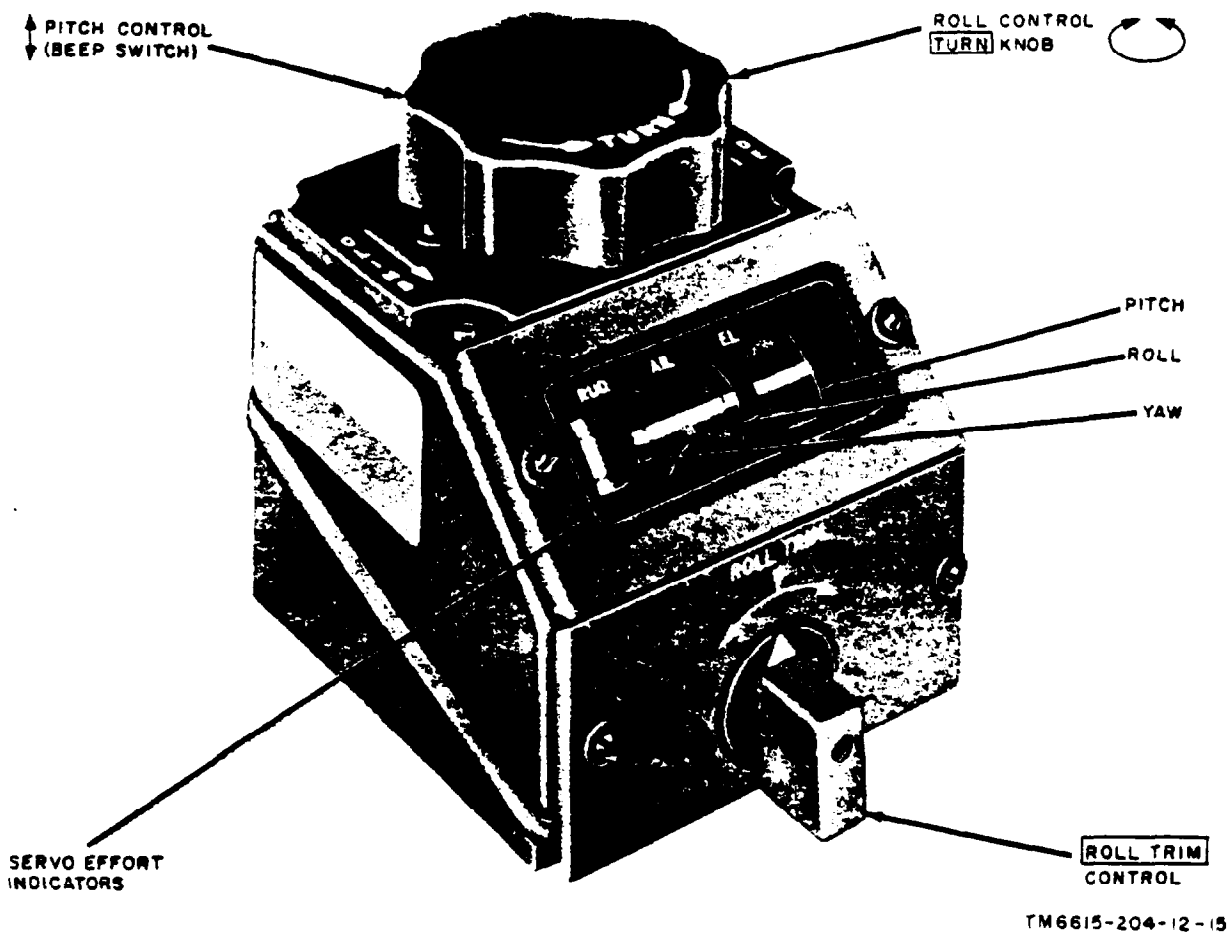

Figure 1-11. Controller, Flight, Automatic Pilot C-3107(*)/ASW-12(V), left-front view.

b. Gyroscope, Displacement CN-601A/ASW-12(V) (fig. 1-15). The CN-601A/ASW-12(V) consists of a gyroscope assembly and an erection control module (a above). The erection control module is attached to the bottom of the gyroscope assembly by eight flathead screws (not shown). At the top of the gyroscope assembly, an arrow (stenciled in white paint) indicates the proper mounting position for the unit. A dehydrator is included in the gyroscope to absorb moisture which could cause damage to bearings within the gyroscope assembly. One mounting, hole is located at the dehydrator plug side of the gyroscope assembly and two mounting holes are located at the other side of the gyroscope assembly.

1-21. Additional Equipment Required for Automatic Flight Control System AN/ASW-12(V)2

The following equipments, systems, components, and items are not supplied are part of the AN/ASW-12(V)2 but are required for use with it. The equipments, systems, components, and items are supplied as part of the electronic equipment configuration of the aircraft in which the AN/ASW-12(V)2 is installed.

a. Source of Primary Power. Power sources of 115 volts, 400 Hz three-phase at 115.7 volt-amperes and 27.5 volts dc at 9.8 amperes are required to provide operating voltages. The electrical power is obtained from the aircraft ac and dc electrical systems.

b. Interconnection Wiring. Electrical wiring between the components of the system and other associated items of the electronic configuration is required. The wiring, including all electrical connection and circuit breakers, is part of the overall aircraft electronic configuration wiring.

c. Standby Light. A standby light (usually amber in color) is installed in the aircraft to indicate that the autopilot system is ready to be engaged. The light will illuminate after power has been applied and upon completion of the 2 1/2-minute gym erection time delay. The standby light also is used an indication that the system has been disengaged or that command of the aircraft has been taken over by the pilot.

d. Associated Navigation Equipment. To provide automatic steering and navigation, the following electronic navigation equipments are installed in the aircraft and connected to the autopilot system to provide navigational data for use by the system.

(1) Vhf navigation receiving set. A very high-frequency (vhf) navigation receiving set that

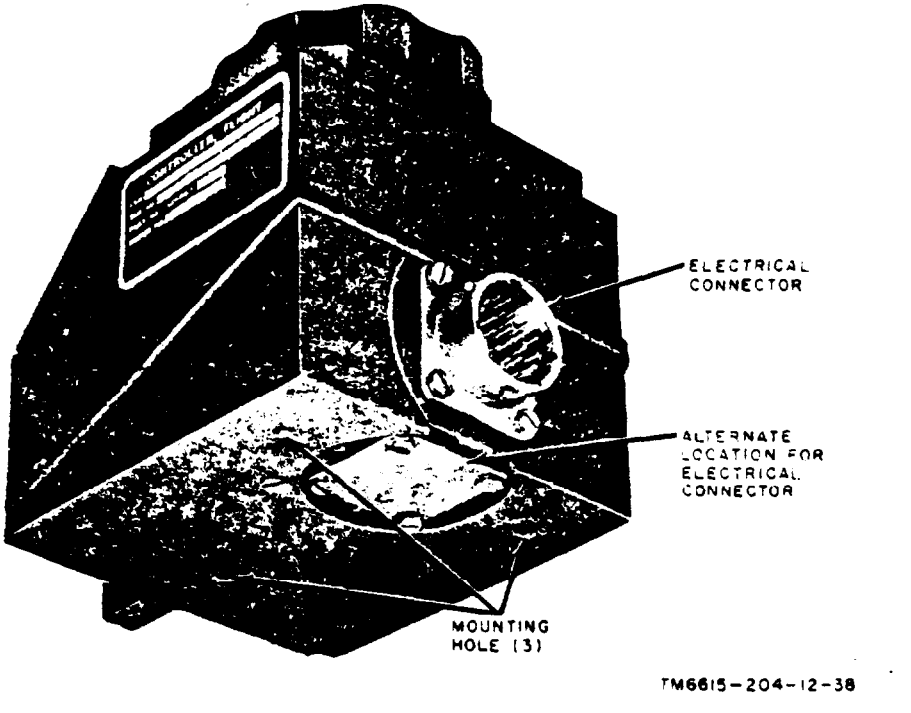

Figure 1-12. Controller, Flight, Automatic Pilot C-3107(*)/ASW-12(V), right-rear oblique view.

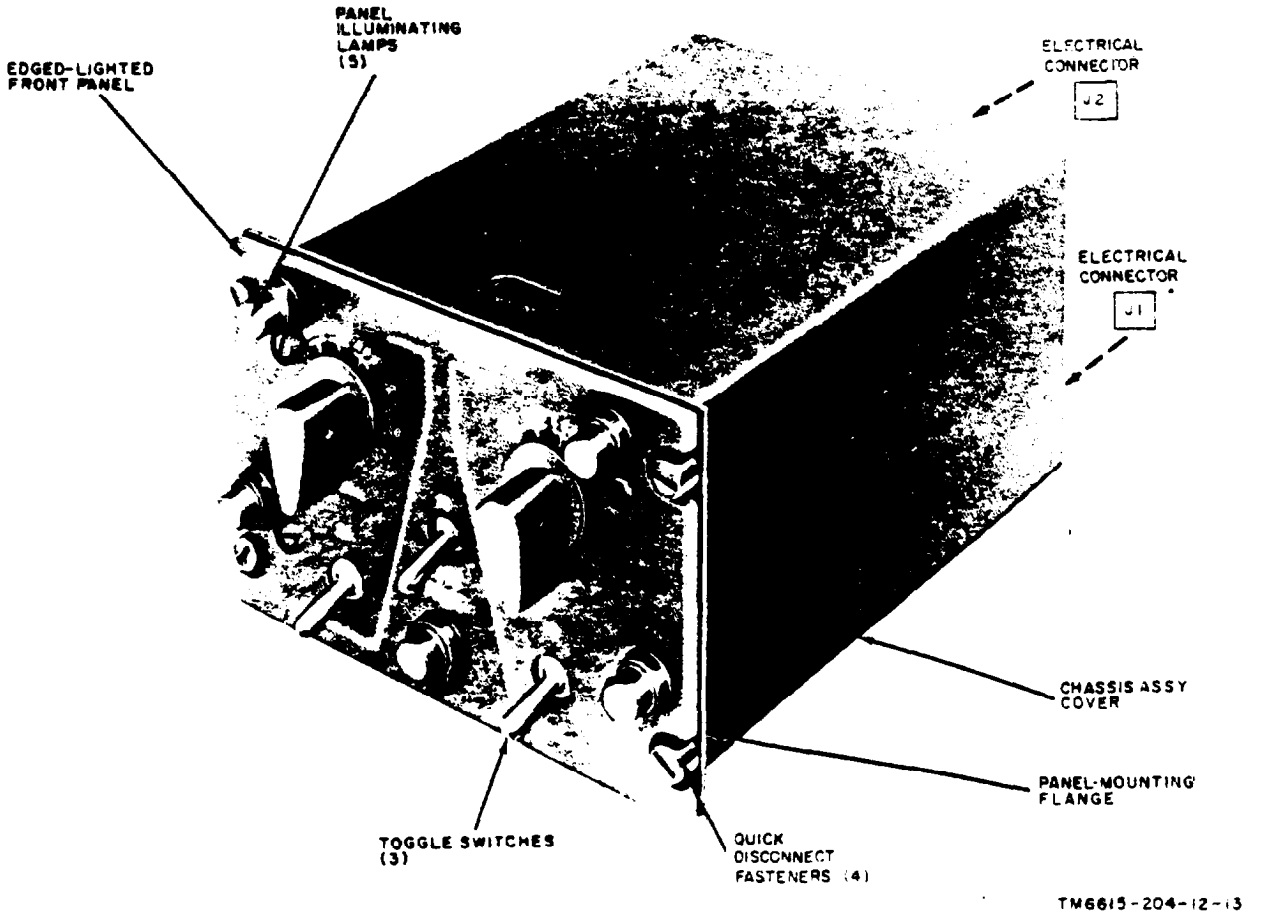

Figure 1-13. Coupler, Navigational CU-792-ASW-12(V).

provides vhf omnidirectional radio range (vor) and visual-aural radio range (var) data is required for the VOR and APP (approach) modes of operation.

(2) Doppler navigation system. A doppler navigation system that provides drift angle and groundspeed data is required for the lateral mode of operation.

(3) Radar altitude. A radar altimeter that provides absolute altitude (terrain clearance absolute altitude) is required for the RAD VERTICAL mod. of operation.

(4) Glide slope receiving set. A glide elope receiving set that receives runway glide slope signals is required for the automatic approach VERTICAL mod. of operation.

(5) Compass system. A slaved gyroscope magnetic compass set of the flux-gate compass type is required to provide a heading reference and heading changes data.

(6) Navigation instrumentation system. A navigation instrumentation system is required to provide heading data. The instrumentation system must include a course indicator with a course selector so that the pilot can select the desired course.

(7) Pitot static pressure system. A pitot static pressure system consisting of a pitot tube and the necessary tubing to provide static atmospheric pressure in required to provide altitude data to the system.

1-22. Differences in Component Models

a. Differences between accelerometer, Aircraft MX-2916A/ASW-12(V) and Accelerometer, Aircraft MX-2916/ASW-12(V). Accelerometer, Aircraft MX-2916A/ASW-12(V) (procured on Orders No. 5056-PP-61 and 41012-PZ-62) is identical with Accelerometer, Aircraft MX-2916/ASW-12(V) (procured on

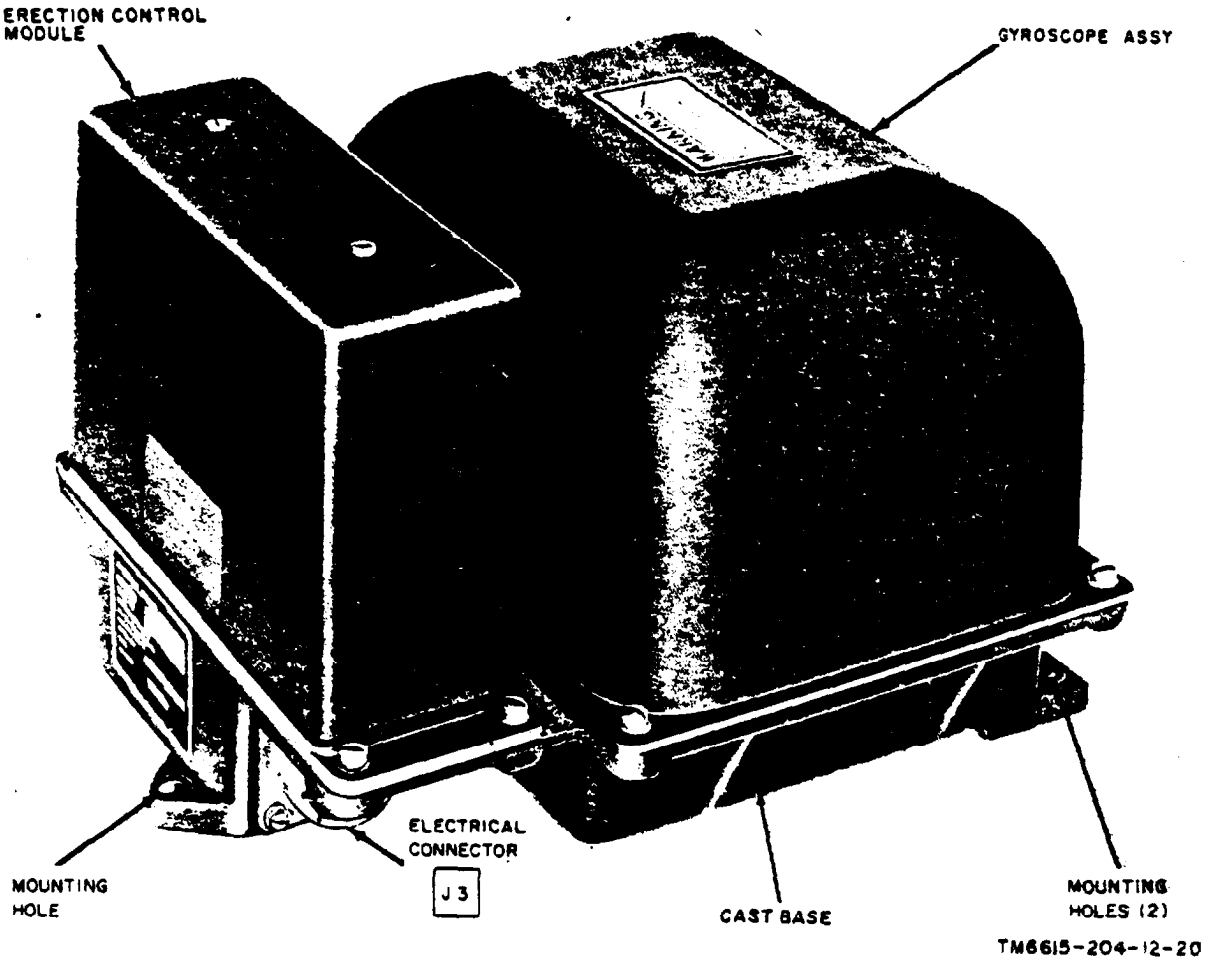

Figure 1-14. Gyroscope, Displacement CN-601/ASW-12(V).

Orders No. 109-PH-58, 3398-PP-59, and 4408-PP-60), except for the addition of two leads in the MX-2916A/ASW-12(V) which provide an ac output. The MX-2916A/ASW-12(V) may be used in place of the MX-2916/ASW-12(V); however, the MX-2916/ASW-12(V) cannot be wed in place of the MX-2916A/ASW-12(V).

b. Differences Between Actuator, Electro-Mechanical, Rotary TG-78A/ASW-12(V) and Actuator. Electro-Mechanical, Rotary TG-78/ASW-12(V). Actuator, Electro-Mechanical, Rotary TG-78A/ASW-12(V) (procured on Order No. 5056-PP-61) is identical with Actuator, Electro-Mechanical, Rotary TG-78/ASW-12(V) (procured on Order No. 109-PH-58, 3396-PP-59, and 4408-PP-60), except for differences in the gear ratio (instrument train), power drive ratio, clutch mechanism, and shear pin torque. The clutch assembly (mechanism) used in the TG-78A/ASW-12(V) may be used in the TG-78/ASW-12(V); however, the clutch assembly used in the TG-78/ASW-12(V) is not directly interchangeable, and cannot be wad in the TG-78A/ASW-12(V).

c. Differences Between Actuator, Electro-Mechanical, Rotary TG-78A/ASW-12(V) and Actuator, Electro-Mechanical, Rotary TG-78B/ASW-124(V). Actuator, Electro-Mechanical, Rotary TG-78B/ASW-12(V) (procured on Order No. 41012-PZ-62) is identical with Actuator, Mechanical, Rotary TG-78A/ASW-12(V) except for gear design and change of a peelable shim to a solid shim in the servo drive assembly and a change in the design of the servoamplifier assembly chassis. The two units are electrically and mechanically interchangeable.

d. Differences Between Actuator, Electro-Mechanical, Rotary TG-80/ASW-12(V) and

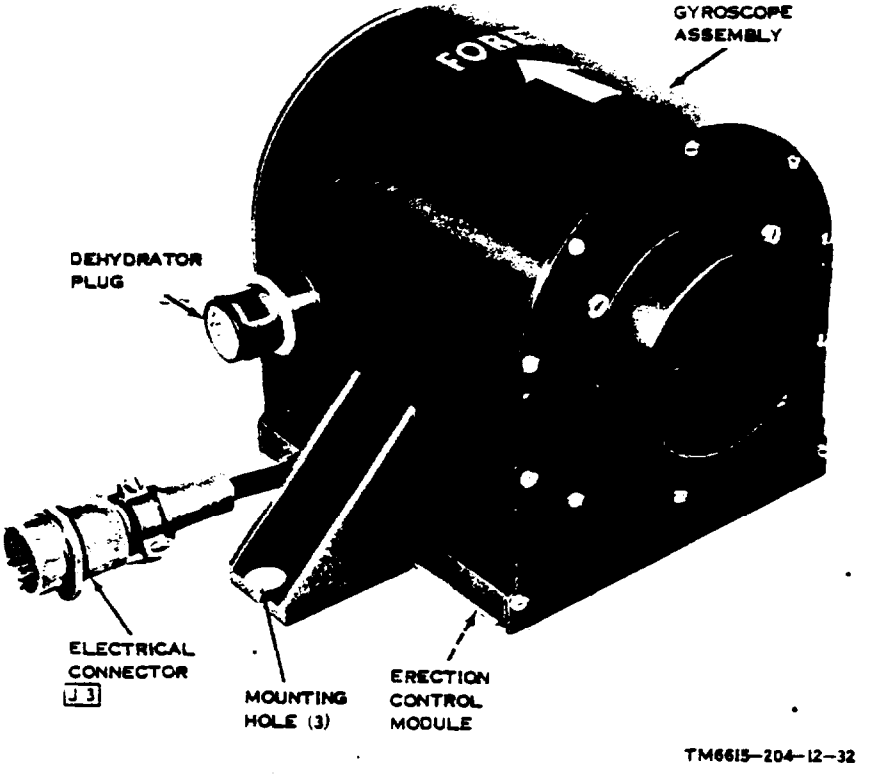

Figure 1-15. Gyroscope, Displacement CN-601A/ASW-12(V).

Actuutor, Electro-Mechanical, Rotary TG-80B/ASW-12(V). Actuator, Electro-Mechanical, Rotary TG-80B/ASW-12(V) (procured on order No. 41012-PZ-62) is identical with Actuator. Electro-Mechanical, Rotary TG-80/ASW-12(V) (procured on Orders No. 109-PH-58, 3398-PP-59, 4408-PP-60, and 5056-PP-61). except for gear design and change of a peelable shim to a solid shim in the servo drive assembly and a change in the design of the servoamplifier assembly chassis. The two units are electrically and mechanically interchangeable.

e. Differences Between Actuator, Electro-Mechanical, Rotary TG-81A/ASW-12(V) and Actuator, Electro-Mechanical, Rotary TG-81/ASW-124(V). Actuator, Electro-Mechanical, Rotary TG-81A/ASW-12(V) (procured on Order No. 41012-PZ-62) is identical with Actuator Electro-Mechanical, rotary TG-81/ASW-12(V) (procured on Orders No. 109-PH-58, 3398-PP-59, 4408-PP-60, and 5056-PP-61), except for gear design and changes in the electromagnetic actuator drive parts in the servo drive assembly. The two units are mechanically interchangeable.

f. Differences Between Control, Attitude, Reference C-3108A/ASW-12(V) and Control, Attitude, Reference C-3108/ASW-12(V). Control, Attitude, Reference C-3108A/ASW-12(V) (procured on Order No. 41012-PZ-62) is identical with Control. Attitude, Reference C-3108/ASW-12(V) (procured on Orders No. 109-PH-58, 3398-PP-59, 4408-PP-60, and 5056-PP-61), except for the ripple output of the demodulatar assembly and internal wiring conductor colors. The two units are electrically and mechanically interchangeable.

g. Differences Between Controller, Flight, Automatic Pilot C-3107A/ASW-12(V) and Controller, Flight, Automatic Pilot C-3107/ASW-12(V). Controller, Flight, Automatic Pilot C-3107A/ASW-12(V) (procured on Order No. 41012-PZ-62) is identical with Controller, Flight, Automatic Pilot C-3107/ASW-12(V) (procured on orders No. 109-PH-58, 3398-PP-59, 4409-PP-60, and 5056-PP-61), except for differences in the torque of the turn knob. The two units are electrically

and mechanically interchangeable.

h. Differences Between Gyroscope, Displacement, CN-601A/ASW-12(V) and Gyroscope, Displacement CN-601/ASW-12(V). Gyroscope, Displacement CN-601A/ASW-12(V) (procured on Order No. 41012-PZ-62) is electrically identical with Gyroscope, Displacement CN-601/ASW-12(V) (procured on Orders No. 109-PH-58, 3398-PP-59, 4408-PP-60, and 5056-PP-61). Minor differences exist in the mechanical puts and a major difference exists in the chassis design. The two units are electrically and mechanically interchangeable.

Section III. SYSTEM APPLICATION

1-23. General

The signal flow in the AN/ASW-12(V)2 (fixed-wing system) is divided into control channels for each of the three flight axes: pitch, roil, and yaw (fig. 1-16). Each of the control channels is expanded to indicate the use of the sensor units, the stabilization and command unite, and the power and drive units (fig. 1-3). The system is started by engaging the power units to the aircraft contro1 system. Engagement consists of operating (electrically) clutches that connect the power units to the aircraft control system. When the system is engaged, the flow of signal from the semsor units, stabilization and command units, and navigation aids afford attitude and heading stabilization, altitude control, and automatic path guidance, depending upon the operating mode selected. While each control channel is electrically independent from every other control channel on a signal basis, the operation of the roll control channel for command of banked turns is coordinated with the yaw control channel to insure that the turn will be a coordinated turn. Operation of the individual control channels is described in paragraphs 1-24, 1-25, and 1-26.

1-24. Pitch Axis Control Channel

(fig. 1-16)

a The AN/ASW-12(V)2 pitch axis control channel controls the pitch attitude of the aircraft. Signals from five sources are applied to the pitch power unit to position the elevator control. These signals are as follows:

(1) The vertical gyro signal, which indicates the pitch attitude changes of the aircraft.

(2) The flight controller signal, which indicates that a change in attitude is being commanded by the pilot.

(3) The altitude control signal, which indicates the change in barometric altitude. from the pitot static pressure system, from a selected altitude.

(4) The radar altimeter signal, which indicates the change in radar altitude from a selected altitude.

(5) The glide slope signal, which indicates the deviation in altitude between the path of the aircraft and the approach glide slope.

b. The vertical gyro signal and flight controller signal are used for attitude stabilization and command. The vertical gyro signal, representing the actual pitch attitude, is applied to the pitch control channel of the attitude reference control where it is compared with a reference or selected attitude established by the attitude reference control. The flight controller signal, which is also fed to the attitude reference control, changes the reference attitude at a fixed rate in a noseup or nosedown direction, depending on whether the beep switch knob is moved forward or rearward. Differences that exist between the reference attitude selected by the pilot and the actual pitch attitude, as sensed by the vertical gyro, are then fed to the pitch power unit and calibration card and trim power unit to position the elevator and trim elevator to the the difference. The two signals obtained from the flight controller maintain the aircraft at a desired pitch attitude.

c. Alternate signals can be injected into the pitch control channel to maintain a desired altitude through command of pitch attitude. The Altitude control signal is introduced when the barometric altitude (BAR) control function is selected and engaged at the navigational coupler. The signal is applied from the altitude control through the navigational coupler to the pitch control channel of the attitude references control, to command changes in pitch attitude reference to maintain a constant barometric altitude. In a similar manner, glide slope receiver (APP) and radar altimeter (RAD) signals may be used to control approaCh of radar altitude. Through a switching systems incorporated in the navigational coupler, it is not possible to operate more than one mode of altitude control at a time. To avoid conflicting commands to the attitude reference control, the flight controller command mode is deactivated when the VERTICAL engage switch (altitude) is at ON.

1-25. Roll Axis Control Channel

(fig. 1-16)

a The AN/ASW-12(V)2 roll axis control channel control the the attitude of the aircraft. Signals from six sources are fed to the roll power unit to position the aileron. These signals are as follows:

(1) The vertical gyro signal, which indicates the roll attitude of the aircraft.

(2) The flight controller signals, which indicate that a change in attitude is being commanded by the pilot. Two signals are available within the flight controller: a turn knob for commanding banked turns and a trim knob for trimming the attitude during straight flight without introducing heading changes. The yaw control channel operates with the turn knob signal to provide automatically coordinated turns.

(3) The vor signal from the vhf navigation set, which indicates the difference between a selected radial path to the station and the actual path of the aircraft.

(4) The localizer (LOC) signal from the vhf navigator set, which indicates the deviation of the aircraft from the center of the localizer beam during automatic instrument landing system (ils) approaches.

(5) The Doppler navigation signal, which indicates the difference between a preset path and the actual path of the aircraft.

(6) The heading select signal, which indicates the difference between a selected magnetic heading and the actual magnetic heading of the air craft

b. The vertical gyro signal and flight controller signals are used for attitude stabilization and command. The vertical gyro signal, representing the actual roll attitude, is applied to the roll axis of the attitude reference control where it is compared with a reference or selected attitude established by the attitude reference control. The flight controller signal from the TURN knob is also fed to the attitude reference control to change the reference attitude proportional to the rotation of the knob, roll right or roll left, depending on the direction in which the TURN knob is moved. When the knob is centered, the attitude reference will be set for level flight. Since the system is interlocked to engage only with the TURN knob centered, the aircraft is automatically commanded to level attitude upon engagement. After engagement, the aircraft is will be maintained in a level attitude. If any difference develop between the reference level attitude and the actual roll attitude, signals are fed to the toll power unit to position the aileron (AIL) to null the difference. The signal from the ROLL TRIM knob under localizer (LOC) operation will displace the aircraft with respect to the localizer beam. The resulting signals obtained from the vertical gyro and the flight controller maintain the aircraft at a desired roll attitude. Alternate signals can be injected into the roll control channel to maintain selected path orientations through the command of roll attitude. The vor signal is introduced when the VOR function is selected and engaged at the navigational coupler. The vor signal from the vhf navigation set is applied through the navigational coupler to the roll control channel in the attitude reference control to command changes in roll attitude reference. This action maintains the aircraft on the selected path navigation. In a similar manner, the instrument landing approach system signal from the vhf navigation set and the Doppler navigation signal may be used to control the selected paths of navigation. A switching system incorporated in the navigational coupler prevents the operation of more than one mode of path control at a time. To avoid conflicting commands to the attitude reference control, the use of the flight controller TURN knob (pilot operated) will automatically disengage any path mode which may have been previously engaged; that is, the pilot command of roll attitude takes precedence over the automatic path control mode.

1-26. Yaw AXIS Control Channel

(fig. 1-16)

a. The AN/ASW-12(V)2 yaw axis control channel maintains a constant heading in level flight and provides for turn coordination in banked flight. Signals from two source are fed to the yaw power unit and calibration card to position the rudder control. These signals are as follows:

(1) The compass system signal, representing the actual heading of the aircraft.

(2) The accelerometer signal, representing the side acceleration of the aircraft.

b. The compass system signal is used to provide heading stabilization. The signal is applied to the yaw control channel in the attitude reference control where it is compared with a reference heading established by the altitude reference control. Before the system is engaged. the heading reference is alignad with the prevailing compass heading. When the automatic flight control system is engaged, any difference that exists between the reference heading and the actual heading is fed to the yaw power unit and calibration cud to position the rudder and null the difference. When a roll attitude is commanded through the TURN knob or when the lateral channel of the navigational coupler is engaged.

the heading reference is automatically aligned with the actual changing heading. The accelerometer signal is applied to the yaw power unit to control the rudder and to minimize aircraft side acceleration.

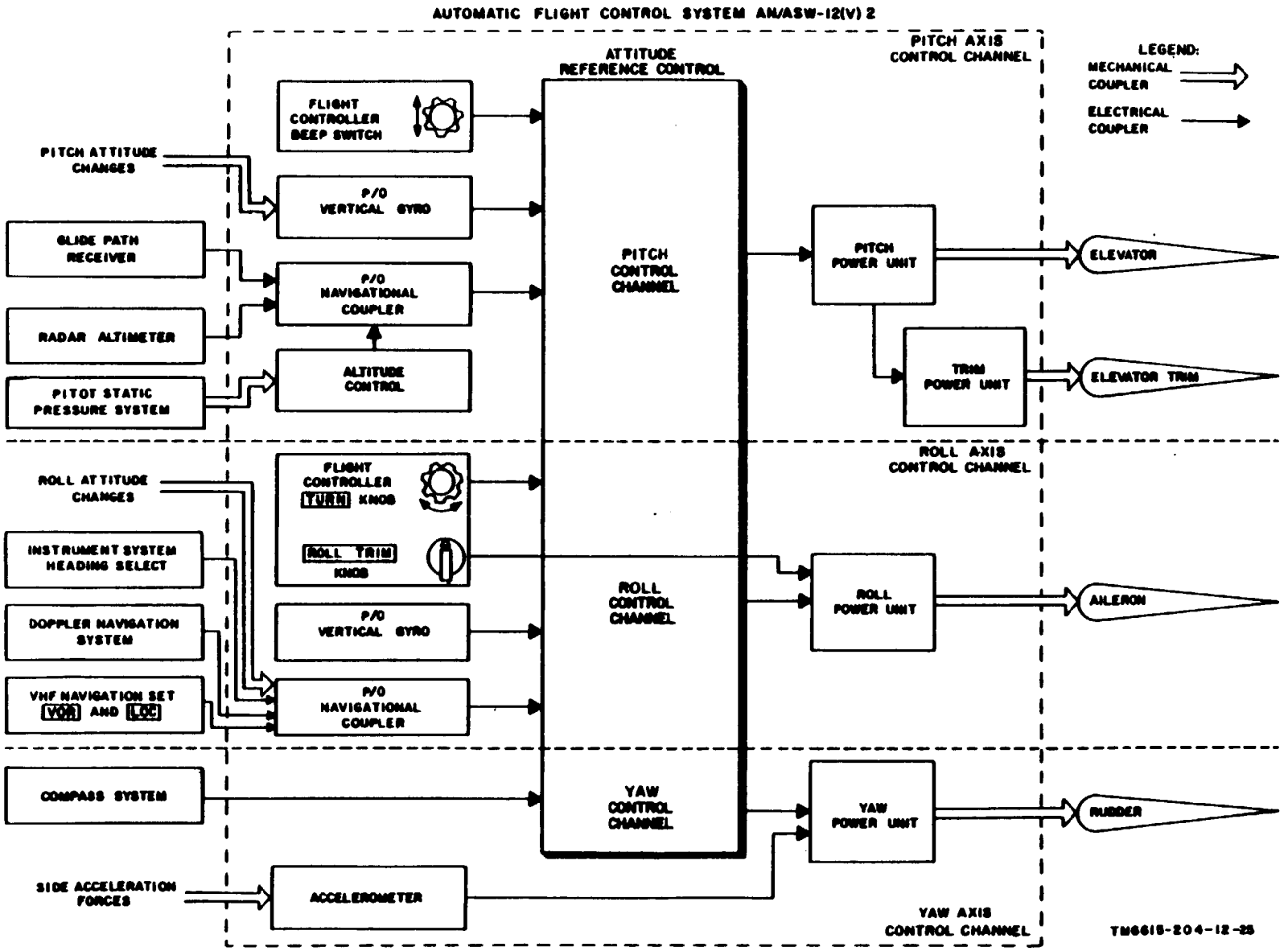

Figure 1-16. Automatic Flight Control System AN/ASW-12(V)2, block diagram.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. OPERATOR CONTROLS AND INDICATORS

2-1. Coupler, Navigational CU-792/ASW-12(V) Controls (fig. 2-1)

Control or indicator	Function
AUTO PILOT engage switch (attitude)	Magnetic hold switch. Engage attitude stabilization.
VERTICAL switch (altitude)	Magnetic hold switch. Engage altitude control channel.
LATERAL engage switch (steering)	Magnetic hold switch. Engages lateral control channel.
VERTICAL select switch	Selects mode of vertical operation.

Position	Function
BAR	Altitude is controlled by a referenced barometric pressure.
RAD	Altitude is controlled by the radar altimeter.
APP	Altitude is controlled by the glide slope receiver.

Control or indicator	Function
LATERAL select switch	Selects mode of lateral operation.

Position	Function
NAV	Provides automatic lateral control for the aircraft to a groundpatch preset by a Doppler navigational system.
VOR	Provides automatic lateral control for the aircraft to fly the vhf omnirange navigation signal.
LOC	Provides automatic lateral control for the aircraft to fly ils localizer beam.
HDG	Provides automatic lateral control for the aircraft to a selected magnetic campass heading.

2-2. Controller, Flight, Automatic Pilot C-3107/ASW-12(V) Controls and Indicators. (fig. 2-2)

Control or indicator	Function
Roll control (TURN knob)	Detent switch (interlock). Remove power from lateral engage control channel. Prevents system engagement unless TURN knob is in detent.

Position	Function
Roll control (TURN knob).	Adjusts roll control channel to change bank angle proportional to knob rotation with heading change.
Pitch control (beep switch).	Furnishes signal to change pitch attitude.

ROLL TRIM control	Adjusts roll attitude without heading change. When lateral mode is engaged, control the engaged function.
Servo effort indicators	Show the direction and magnitude of power unit force output.

Control or Indicator	Function
Indicator	**Function**
RUD	Shows servo effort applied to the rudder.
AIL	Shows servo effort applied to the aileron.
EL	Shows servo effort applied to the elevator.

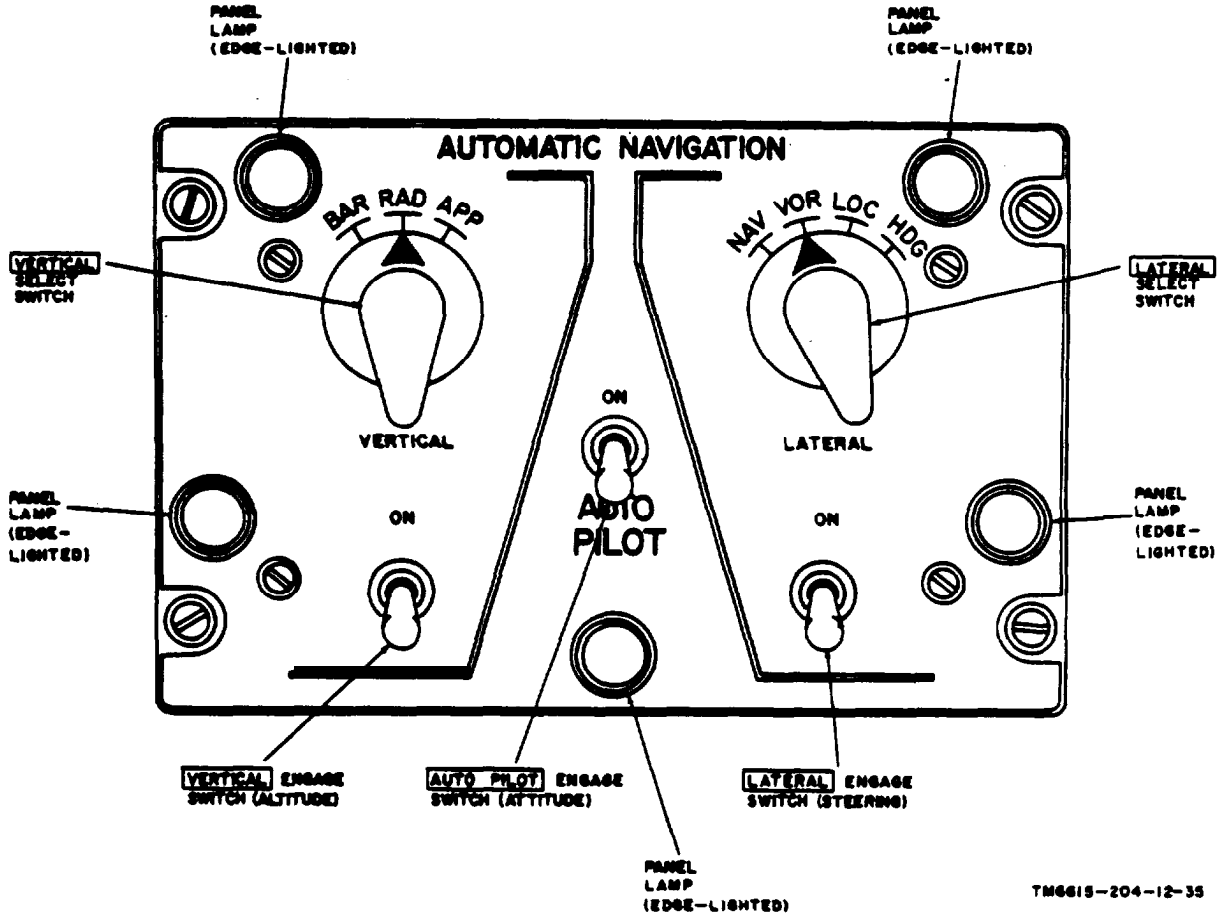

Figure 2-1. Coupler, Navigational CU-792/ASW(V), Controls

2-3. Aircraft Control and Indicators

a. The controls and indicators listed below are not supplied as part of the automatic flight control system but are supplied as part of the fixed-wing aircraft in which the automatic flight control system is installed. Refer to the applicable aircraft technical manual for location and exact details regarding the control and indicators.

Control or Indicator	Function and location
Pilot release switch	Flight control stick location; provides quick disconnect of system by removing power from the AUTO PILOT engage switch (attitude) holding coil.
Standby LIGHT	Installation hardware. After system power is applied, the study amber light will denote that the automatic flight control system is ready to be engaged. After the automatic flight control system has been initially engaged, the amber light denotes that the system has become disengaged either by pilot operation or by power failure.

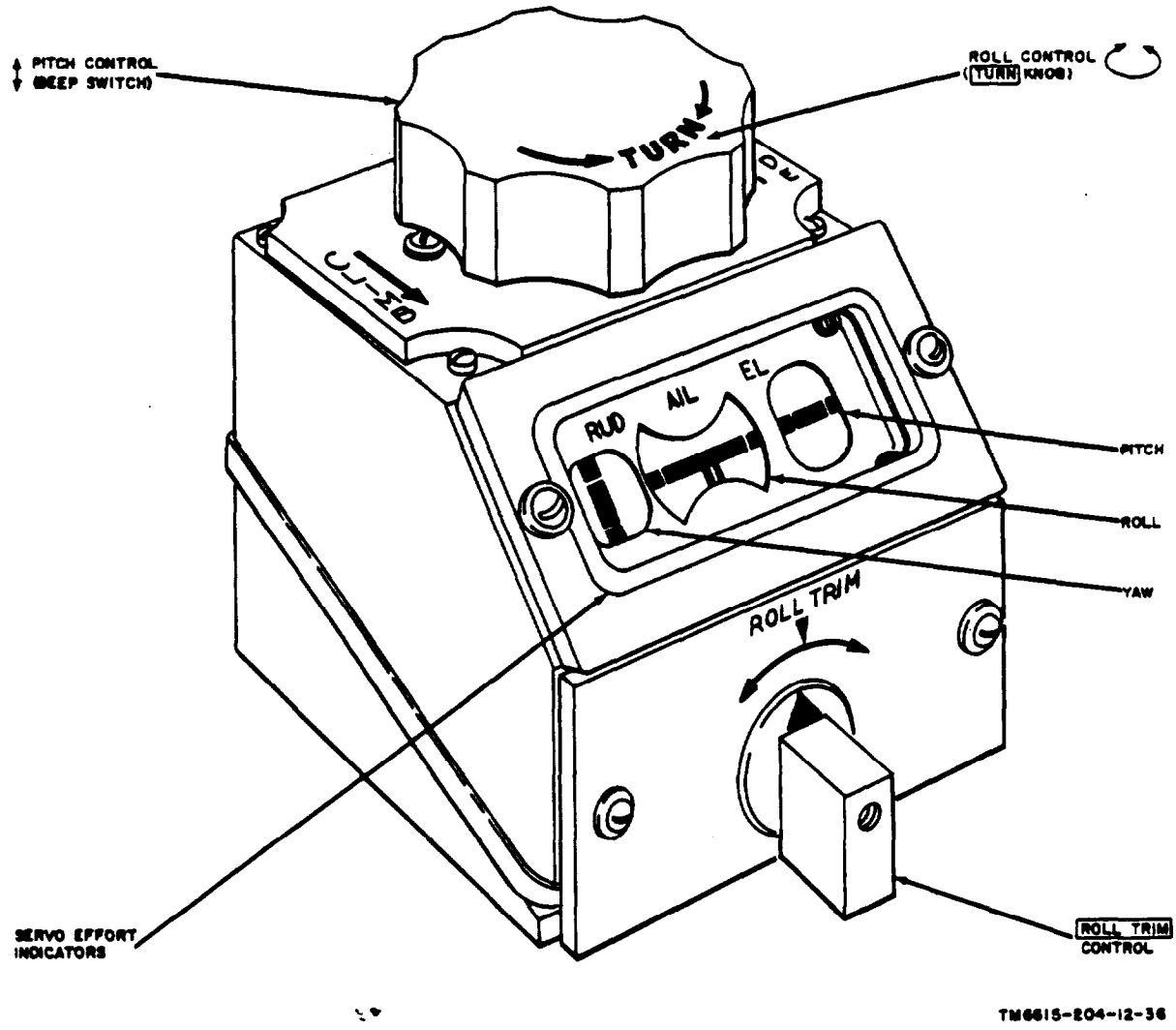

Figure 2-2. Controller, Flight, Automatic Pilot C-3107/ASW-12(V), controls and indicators.

b. The aircraft electrical system controls and indicators are covered in detail in the applicable aircraft technical manual.

Section II. OPERATION UNDER USUAL CONDITIONS

2-4. Modes of Operation

a. Modes. The various modes of operation available with the AN/ASW-12(V)2 system are listed below:

(1) Heading select (HDG). The HDG mode provides automatic lateral control for the aircraft to a selected magnetic compass heading.

(2) Navigation (NAV). The NAV mode provides lateral control of the aircraft to a groundpath preset into a Doppler navigation set.

(3) Localizer (LOC). The LOC mode provides lateral control of the aircraft to automatically fly the instrument landing approach system localizer beam.

(4) Very high-frequency omnidirectional radio range (VOR). The VOR mode provider lateral control of the aircraft to automatically fly a preselected radial of any very high-frequency omnidirectional radio range station.

(5) Barometric altitude (BAR). The BAR mode provides vertical control of the aircraft to maintain a constant barometric pressure altitude.

(6) Radar (RAD). The RAD mode provides vertical control of the aircraft to maintain a

constant altitude above the ground level (terrain clearance altitude), as measured by a radar altimeter.

(7) Approach (APP). The APP mode provides vertical control of the aircraft to automatically fly the glide slope path of the instrument landing approach system.

b. Operation. Operate the system for any particular mode of operation by performing the following steps:

(1) Starting procedure (para 2-5).
(2) Preflight operational check (para 2-6).
(3) Inflight operation procedure (para 2-7).
(4) Stopping procedure (para 2-8).

2-5. Starting Procedure

CAUTION

Remove the aircraft control locking devices or place them in the unlocked position and check ail controls for freedom of motion and full travel. If an abnormal indication is obtained during the starting procedure, turn the AUTO PILOT engage switch (attitude) off and refer to appropriate maintenance personnel for corrective maintenance.

a. Preliminary Switch Settings.

Switch	Required position
Roll control (TURN) knob) (fig. 2-2).	Center detent.
ROLL TRIM control (fig. 2-2)	Center mark aligned with index.
AUTO PILOT engage switch (attitude) (fig. 2-1).	Off.
VERTICAL engage switch (altitude) (fig. 2-1).	Off.
LATERAL engage switch (steering) (fig. 2-1).	Off.
VERTICAL select switch (fig. 2-1).	Off.
LATERAL select switch (fig. 2-1).	Any.
	Any.

CAUTION

DC power must be supplied to the system before applying ac power.

b. Preliminary Power Application. DC electrical power be available to the aircraft from one of the following sources: aircraft batteries, aircraft generators (when the aircraft engines are running), or an external de supply.

(1) Turn the aircraft 27.5-volt dc power supply on and check available power indications If a dc voltmeter is furnished in the aircraft, it should read between 24 and 30 volts.

(2) Turn the ac power supply on (inverter switch to ON) and check the ac voltmeter reading. It should read between 110 and 120 volts. In aircraft not equipped with an ac voltmeter, available power indications, such as the ac off light going on, or compass starting indications should be used in place of the ac voltmeter reading.

c. Automatic Flight Control System Engagement.

(1) Close the automatic flight control system circuit breakers and wait 2 1/2 minutes for gyroscope erection. The automatic flight control system cannot be engaged until the gyroscope has had 2 1/2 minutes in which to complete its fast erection cycle. This time cycle is necessary to assure the proper erection of the gyroscope.

(2) Turn the AUTO PILOT engage switch (attitude) to ON.

CAUTION

If all three servo effort indicators (fig. 2-2) are not centered, do not continue the starting procedure. Report malfunction to higher category of maintenance personnel.

d. Navigational Coupler Engagement.

(1) The auxiliary equipment used with each mode of operation must be powered electrically before the navigational coupler can be engaged.

(2) The recommended preflight procedures for each set of auxiliary equipment should be performed before navigational coupler engagement is attempted.

(3) When the above steps have been completed and the AUTO PILOT engage switch (attitude) is engaged, the LATERAL and VERTICAL select switches may be set to the desired positions and the lateral or vertical mode engaged.

2-6. Preflight Operational Chock

a. Turn on the main aircraft inverter and note that the AUTO PILOT engage switch (attitude) (fig. 2-1) will not hold in the ON position before 2 1/2 minutes have elapsed. After a 2 1/2-minute delay, the amber standby lamp lights, and the AUTO PILOT engage switch (attitude) will hold.

b. Operate the pilot release switch; the AUTO PILOT engage switch (attitude) (fig. 2-1) disengages.

c. Reengage the AUTO PILOT engage switch (attitude) and rotate the roll control (TURK knob) (fig. 2-2) to the right; the control wheel moves to the right. Rotate the roll control (TURN knob) to

the left; the control wheel moves to the left. Recanter the roll control (TURN knob).

d. Rotate the ROLL TRIM control to the right and left and note that the control wheel moves right and left in response. Recenter the ROLL TRIM control.

e. Push the pitch control (beep switch) forward: the pilot'r control stick moves forward. Pull the pitch control (beep switch) aft; the stick moves aft. Retrim the stick to neutral by wing the pitch control (beep switch).

f. Overpower the autopilot system by forcing the control wheel left and right and note that the ALL (roll) servo effort indicator moves counterclockwise and clockwise.

g. Overpower the autopilot system by forcing the control stick fore and aft and note that the EL (pitch) servo effort indicator moves up and down.

h. Force the stick aft and hold. The trim wheel moves slowly to give nosedown trim and the EL (pitch) servo effort indicator deflects nosedown. Force the stick forward and hold: the trim wheel moves slowly to give noseup trim and the EL (pitch) servo effort indicator deflects noseup.

i. Overpower the autopilot system by forcing the rudder pedals right and left. The RUD (yaw) servo effort indicator moves left and right.

j. Rotate the VERTICAL select switch to the RAD position. The VERTICAL engage switch (altitude) disengages. Attempt to engage the VERTICAL engage switch (altitude) and note that it will not engage unless power is applied to the radar altimeter.

k. Rotate the LATERAL select switch to the HDG position. Set the heading select indicator to agree with the aircraft heading and engage the LATERAL engage switch. Rotate the heading select indicator to command a left and right to turn and note that the control wheel moves to the left and right.

2-7. Inflight Operation Procedure

CAUTION

Do not engage the AN/ASW-12(V)2 unless all three servo effort indicators (RUD, AIL, and EL) (fig. 2-2) are centered.

a. Engagement.

(1) Perform the starting procedure for engagement of the automatic flight control system (part 2-5). Make aura that the aircraft is well coordinated before the AUTO PILOT engage switch (attitude) is turned to ON. (If some miscoordination exists at the time of engagement, it will be maintained unless the system is disengaged and the aircraft is coordinated before reengagement.)

(2) If the system is engaged during a climb or glide, the aircraft will continue to climb or glide at the prevailing pitch attitude.

(3) If the system is engaged while the aircraft is in a banked maneuver, the aircraft will roll out level, and the heading established at the time of engagement will be maintained.

(4) The system may be engaged in any pitch attitude of the aircraft up to 25^{o} climb or glide and any roll attitude of the aircraft up to 45^{o} right or left.

(5) After the system has been engaged, the servo effort indicators should be routinely monitored. Any steady-state deflection of the meters indicates a need for lateral and/or directional trim and can be removed by retrimming. Unless the aircraft is cleanly trimmed, the system will not provide optimum performance.

b. Command Operation (fig. 2-2).

(1) Pitch attitude. The rate of aircraft climb and descent (pitch attitude) may be set by the use of the pitch control (beep switch) on the flight controller. Pushing the pitch control (beep switch) forward will introduce a fixed nosedown pitch rate. Pulling the pitch control (beep switch) aft will produce a fixed noseup pitch rate. When the pitch control (beep switch) is released, the system will maintain the aircraft in the commanded attitude.

(2) Turns. To establish a coordinated turn, rotate the roll control (TURN knob) on the flight controller out of detent to the right for a right turn or to the left for a left turn. Return the aircraft to a level attitude by rotating the roll control (TURN knob) back into its detent position.

(3) Roll trim. To trim the aircraft roll attitude without a heading change, adjust the ROLL TRIM control to the right or left proportional to the amount of roll trim needed.

c. Vertical Navigational Coupler Operation. To perform the vertical coupler functions, the AUTO PILOT engage switch (attitude) must be placed to ON (fig. 2-1). Also, the applicable navigational aid must be energized. The pitch control (beep switch) (fig. 2-2) is inoperative whenever any VERTICAL function has been engaged.

CAUTION

Do not overpower the aircraft longitudinal control when any VERTICAL function has been engaged, except for emergency maneuver. If the

controls must be overpowered, operate the pilot release switch before releasing the control. If the controls are released without disengaging, an abrupt pitch maneuver may result.

(1) Barometric altitude control.

(a) Stabilize the aircraft rate of climb to less than 200 feet per minute.

(b) Set the VERTICAL select switch to BAR.

(c) Operate the VERTICAL engage switch (altitude) to ON. The aircraft will now be automatically stabilized to a constant barometric altitude.

(d) Permanent changes in altitude are accomplished by disengaging the VERTICAL engage switch (altitude), commanding the change in altitude with the pitch control (beep switch), stabilizing the rate of climb as indicated in (a) above, and reengaging VERTICAL engage switch (altitude). Do not overpower the primary controls to change, altitude.

(2) Radar altitude control.

(a) Stabilize the aircraft rate of climb to less than 200 feet per minute.

(b) Set the VERTICAL select switch RAD.

(c) Operate the VERTICAL engage switch (altitude) to ON. The aircraft will now be stabilized to a constant radar altitude.

CAUTION

If, over a period of time, the barometric altitude of the aircraft changes more than ±400 feet, disengage and reengage the VERTICAL engage switch (altitude). Loss of altitude stabilization will otherwise occur.

(d) Changes in altitude are accomplished by disengaging the VERTICAL engage switch (altitude), commanding the change in altitude with the pitch control (beep switch), stabilizing the rate of climb as indicated in (a) above, and reengaging the VERTICAL engage switch (altitude). Do not overpower the primary controls to change altitude.

CAUTION

Do not engage the LATERAL LOC mode on the back course ILS. The aircraft should approach the ils facility at approach speed.

(3) Approach control.

NOTE

The constant altitude portion of the approach may be made with the VERTICAL select switch in the barometric (BAR) altitude or radar (RAD) mode.

(a) Rotate the VERTICAL select switch to APP.

CAUTION

Do not engage the APP function unless the ILS glidepath indicator is centered because the aircraft will immediately maneuver to remove the error.

(b) When the aircraft instrument landing system (ILS) glidepath indicator shows zero glidepath error, operate the VERTICAL engage switch (altitude) to ON.

(c) The aircraft will now automatically fly the glidepath beam.

d. Lateral Navigational Coupler Operation. To operate the lateral functions, the AUTO PILOT engage switch (attitude) (fig. 2-1) must be placed to ON. Also, the applicable navigational aid must be energized. Any LATERAL function that has been engaged will be automatically disengaged when the roll control (TURN knob) on the flight controll is moved out of detent.

(1) Heading select.

(a) Set the heading select bug on the compass indicator to the prevailing heading.

(b) Rotate the LATERAL select switch to HDG.

(c) Operate the LATERAL engage switch (steering) to ON. The aircraft will be held to the heading set on the compass indicator.

(d) Changes in aircraft heading may be made by rotation of the heading select bug to the desired heading. For large heading changes, the heading select bug should not be set to load the aircraft by more than 150^{o}. In changing heading, the aircraft will perform a coordinated turn at approximately standard rate and then roll out when the desired heading is received.

(2) VOR select.

(a) Turn the vhf navigation receiver and set in the desired radial to the station.

(b) Bracket the beam with either the roll control (TURN knob) or the heading select (HDG). function to within less than half-scale on the course indicator and to within less than 20^{o} of the desired course to station.

(c) Rotate the LATERAL select switch to VOR.

(d) Operate the LATERAL engage switch (steering) to ON. The aircraft will now capture and hold the center of the vor beam. If a crab angle is required to fly the selected track, the magnitude and direction will be automatically computed and set in by the automatic flight control system.

(e) As the aircraft approaches the zone of confusion over the station the automatic flight control system will command the aircraft to track the erratic signal. While the commanded bank angles are small (less than 10^{o} and smoothly executed, erratic tracking may be eliminated by turning the LATERAL engage switch (steering) off until the VOR course indication has stabilized. The aircraft will fly through the zone of confusion at the heading prevailing upon disengagement of the LATERAL engage switch (steering).

(3) Localizer select.

NOTE

The banked turns commanded by the three-axis automatic flight control system during an automatic approach am limited to 25^{o}. An automatic localizer bracket should not be attempted unless the beam widths at the point of intercept and the turning rate of the aircraft in a 25^{o} bank are compatible. The standard Army ILS approach procedure performed at airspeeds between 70 and 140 knots will assure that these conditions are met.

(a) Perform usual approach procedures; use either the roll control (TURN knob) or the heading select (HDG) function. On the outbound leg, fly at least 1 minute beyond the outer marker bacon.

(b) Complete the approach procedure and set up a 45^{o} intercept of the localizer beam.

(c) When the ILS lateral indicator needle first reaches 80 percent of full-scale deflection, rotate the LATERAL select switch to LOC and operate the LATERAL engage switch (steering) to ON. The aircraft will bracket and hold the center of the localizer beam. If a crab angle is required to fly the localizer beam, the magnitude and direction will be computed automatically and set in by the automatic flight control system.

(d) At the point where the ILS glidepath indicator shows zero error (approximately at the outer marker beacon), rotate the VERTICAL select switch to APP (approach), regardless of whether a fully automatic vertical approach will be made. If glide slope capture and automatic tracking are desired, operate the VERTICAL engage switch (altitude) to ON (c(3) above).

(e) When the aircraft has descended to a minimum altitude, the automatic flight control system may be disengaged by operating the pilot release switch. The approach to touchdown may then be completed manually.

NOTE

Do not attempt a bracket capture of the localizer beam when the VERTICAL select switch is in the APP position. When the aircraft is coupled automatically to the localizer beam, the VERTICAL select switch must not be in the APP position before reaching the outer marker beacon.

2-8. Stopping Procedure

a. Monitor the aircraft controls. Prepare to take over manual operation.

b. The automatic flight control system may be disengaged by two methods:

(1) Place the AUTO PILOT engage switch (attitude) in the off position.

(2) Press the pilot release switch on the flight control stick.

NOTE

The AUTO PILOT engage switch (attitude) (fig. 2-1) will automatically be turned off when either ac or dc power is lost. In all cases of AUTO PILOT disengagement, the standby lamp (a steady amber light) will light. If the disengagement is caused by a power failure, the test switch adjacent to the standby lamp will extinguish the lamp. If the lamp does not estinguish by operation of the adjacent test switch. the system is ready to be reengaged. The specific light system varies with the aircraft in which the system is installed. Refer to the appropriate aircraft technical manual for the exact details.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

2-9. Operation With Command Mode Malfunctioning

a. Overpowering System. The individual control channels of the system may be over. powered if a malfunction occurs or to perform evasive maneuvers. If the control have been

overpowered, operate the pilot release switch before releasing the controls.

b. Command Mode Malfunction. If the action of the flight controller is lost, the system can still be used for stabilization.

(1) Center the roil control (TURN knob) (fig. 2-2) at the detent position.

(2) Canter the ROLL TRIM control.

(3) The pilot should manually establish the attitude of the pitch, roll, and yaw axes.

(4) Set the AUTO PILOT engage switch (attitude) (fig. 2-1) to ON.

(5) Changes in attitude are made by disengaging the AUTO PILOT engage switch.

(6) Manually position the aircraft to the new attitude.

(7) Set the AUTO PILOT engage switch (attitude) to ON to hold the new attitude.

2-10. Operation With Other Modes Malfunctioning

If one of the LATERAL modes or VERTICAL modes malfunctions, select another mode if possible or disengage the LATERAL and VERTICAL engage switches (fig. 2-1) and continue the flight in the stabilization mode (AUTO PILOT engage switch (attitude) to ON).

2-11. Aircraft Power Failure

Aircraft electrical power systems include alternate power sources that can be used if the power fails. Refer to the applicable aircraft technical manual for the exact emergency procedures to follow if the power fails.

2-12. Operation Under Adverse Condition

The AN/ASW-12(V)2 is designed to operate under various climatic conditions, including a temperature range from -67° to 131°F. The effects of temperature extremes and other climatic condition, such as dust and humidity, are lessened by the protection which the aircraft gives to the components of the automatic flight control system. Following are some procedures that should be taken to minimize the effects of unusual climatic conditions.

a. Arctic Climates. Be sure the ambient temperature is -67°F. or above before engaging the automatic flight control system.

b. Tropical Climates. Extremes of humidity and normal tropical heat will not affect the operation of the system.

c. Desert Climates. Keep the equipment as free from dust as possible. Be sure the ambient temperature is 131°F. or below before engaging the automatic flight control system.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

3-1. Scope of Maintenance

NOTE

The pilot will not perform preventive or corrective maintenance. The maintenance duties assigned to the organizational maintenance repairman are listed below, together with a reference to the paragraphs covering the specific maintenance function for the automatic flight control system installed in a fixed-wing type aircraft. The duties include instructions for performing preventive maintenance and do not require tools, test equipment. and materials other than those allocated at organizational maintenance (para 3-2).

a. Intermediate preventive maintenance checks and services (para 3-5).
b. Cleaning (para 3-6).
c. Periodic preventive maintenance checks and services (para 3-7).
d. Preservation (para 3-8).
e. Troubleshooting based on operational symptoms (para 3-9).
f. Component removal and replacement (para 3-33 through 3-50).

3-2. Tools, Test Equipment, and Materials

a. Tools and Equipment.
(1) Tool Kit, Electronic Equipment TK-105/G.
(2) Multimeter AN/URM-105.
b. Materials.
(1) Fine sandpaper, No. 000.
(2) A clean, dry, lint-free cloth.
(3) A soft-bristle brush.
(4) Trichloroethane.

3-3. Preventive Maintenance

Preventive maintenance is the systematic care. servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 3-4 through 3-8 cover routine systematic care and cleaning essential to proper upkeep and operation of equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (para 3-6 and 3-7) outline functions to be performed at specific intervals. The checks and services are designed to maintain Army equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist the organizational repairman in maintaining combat serviceability, the charts indicate what to check, how to check, and the normal conditions; the Reference column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by the organizational repairman, higher category of maintenance or repair is required. Records and reports of the checks and services must be made in accordance with TM 38-750.

c. Maintenance Forms and Records. Maintenance forms and records to be used and maintained on this equipment am specified in TM 38-750. Paragraph 1-3 contains additional information concerning submission of specified forms.

3-4. Preventive Maintenance Chocks and Services Periods

Preventive maintenance checks and services of the three-aria system are required on an intermediate and periodic basis. An intermediate period is defined as once every 50 flying hours. A periodic interval is defined as once every 200 flying hours. Perform the checks and services in the applicable charts in the sequences given. Whenever a normal indication is not obtained, take corrective action in accordance with the information listed in the References column. All deficiencies and shortcomings will be recorded and those that cannot be remedied by the corrective actions referenced will be reported to higher category of maintenance by use of the forms and records specified in TM 38-750.

NOTE

No daily preventive maintenance checks and services are to be performed on

aircraft stabilization equipment; the preflight operational checks (para 2-6) will be used.

a. Intermediate. The intermediate preventive maintenance checks end services (para 3-5) must be performed once every 50 flying hours in addition to the regular preflight operational checks (para 2-6).

b. Periodic. The periodic preventive maintenance checks and services (para 3-7) must be performed once every 200 flying hours in addition to the preflight operational check and intermediate preventive maintenance checks and services.

3-5. Intermediate Preventive Maintenance Chocks and Services

Sequence No.	Item	Procedure	Reference
1	Equipment components	Check equipment to insure that the required units are installed and complete.	Applicable aircraft technical manual.
2	Exterior surface	Clean the component cases, front panel control and indicators, and cable connectors.	Para 3-6a through d.
3	Knobs, indicators, and switches	While making the operational check (item 4), see that the mechanical action is smooth and free of scraping a binding: also chock for proper operation of indicators. Check and tighten any loose knob, switch, or indicator.	Para 2-1, 2-2, and 2-3.
4	Operation	Perform a complete operational check in accordance with the referenced procedures.	Para 2-6 and 3-9.

3-6. CIeaning

NOTE

Perform the following procedures as referenced by the preventive maintenance checks and service charts.

Inspect the exterior of the automatic flight control system components. The exterior surfaces should be clean, free of dust, dirt, grease. moisture, and fungus. Perform the following procedures at intervals specified in the preventive maintenance checks and services charts.

a. Remove dust, loose dirt, and moisture with a. clean, soft cloth.

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

b. Remove grease, fungus, and ground-in dirt from the exterior surfaces of the automatic flight control system components: use a cloth dampened (not wet) with trichloroethane.

c. Remove dust, dirt, or moisture from the connectors of the automatic flight control system components.

d. Clean the front panels, indicators, and controls; use a soft, clean cloth. If necessary, dampen the cloth with water: mild soap may be used to make the cleaning more effective.

3-7. Periodic Preventive Maintenance Chocks and Services

NOTE

Items 3 and 4 are to be performed periodic inspection.

Sequence No.	Item	Procedure	Reference
1	Exterior surfaces	a. Check and tighten the component cases, rack mounts, shock mounts, and cable connections. Repair or replace any defective case or mounting.	a. Applicable aircraft technical manual.
		b. Check the component cases, mount. ing, and metal surfaces for rust	b. Para 3-8.

Sequence No.	Item	Procedure	Reference
		and corrosion. Remove any rust or corrosion.	
		c. Check safety wiring on equipment.	c. TM 55-1500-323-25.
2	Intercabling and connector.	Check all interconnecting cables for cuts, breaks, and fraying, and connectors for cracks or breaks. Repair or replace any cable with defective wires or connectors.	Applicable aircraft technical manual.
3	Publications	See that all publications pertinent to the equipment are complete, usable, and on hand. Check to see that all applicable changes are on hand.	DA Pam 310-4.
4	Modification work orders (MWO's).	Check to see that all URGENT MOW's have been applied, that all NORMAL MWO's have been scheduled, and that MWO stencils on the equipment are legible.	DA Pun 310-7.

3-8. Preservation

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB 746-10.

3-9. Troubloshooting Based on Operational Symptoms

a. General The symptoms appearing in the trouble isolation checklists (e below) are based on indications obtained while performing the preflight operational check. Place the system in operation by applying ac and dc power and perform the preflight operational check (para 2-6). When an abnormal indication is obtained, proceed to the trouble isolation checklists (e below). If a malfunctioning component is not located by using the procedures in the checklists, report all symptoms observed and any action taken to higher category maintenance personnel.

b. Test Plugs. The test plugs are included in the aircraft wiring. Refer to the wiring diagram for the specific aircraft to locate these test plugs for use in the trouble isolation checklists. The test plugs are designated W1P14 and W1P15 on the aircraft wiring diagram.

c. Replacement of Components. Refer to paragraphs 3-33 through 3-50 for details of component replacement.

d. Test Equipment and Tools Required. Multimeter AN/URM-105 is required for test voltage measurements from the test plugs included in the aircraft wiring. Tool Kit, Electronic Equipment TK-105/G includes the tools necessary for the disassembly, assembly, and organizational maintenance.

e. Trouble Isolation Checklist.

Item No.	Malfunction	Functional check	Corrective measures
1	AUTO PILOT engage switch (attitude) will not engage.	Check to to that ac and dc circuit breakers are in ON position and that roll control (TURN KNOB) is in detent position.	Check for 27 vdc at test plug W1P15-C after 2 1/2 minutes of power on. If no voltage appears, replace vertical gyro (para 3-49 and 3-50). Chock for 27 vdc between W1P15-B and W1P15-M. If a voltage exists, replace pilot release switch. If no voltage is preset, chock W1P15-F for 27 vdc with AUTO PILOT engage switch (attitude) manually held in ON position. If 27 VdC appears at W1P16-E and not at W1P15-F, replace altitude reference control (para 3-41 and 3-42). If 27 vdc appears at both test points replace navigational coupler (para 3-47 and 3-48).
2	LATERAL engage switch (steering) will not engage with AUTO PILOT engage switch (attitude) engaged.	Turn on selected navigational aid.	Replace navigational coupler (para 3-47 and 3-48).

Item No.	Malfunction	Functional check	Corrective measures
3	VERTICAL engage switch (altitude) will not engage with AUTO PILOT engage switch (attitude) engaged.	With VERTICAL select switch set at APP or RAD, check to see that appropriate receiver is turned on.	Replace navigational coupler (para 3-47 and 3-48).
4	Pilot release switch will not disengage. the autopilot system.	Depress pilot release switch and check for 27 vdc from W1P15-B to W1P15-M.	If 27 vdc does not appear, replace pilot release switch. If 27 vdc does appear, replace navigational coupler (para 3-47 and 346).
5	Changing position of LATERAL select switch does not cause LATERAL engage switch (steering) to disengage.		Replace navigational coupler (para 3-47 and 348).
6	Changing position of the VERTICAL select switch dose not cause. VERTICAL engage switch (altitude) to disengage.		Replace navigational coupler (para 3-47 and 3-48).
7	Improper pitch stabilization.	Check operation of pitch control (beep switch.	a. If control surface move, replace vertical gyro (para 3-49 and 3-50). b. If surfaces do not move, check for a changing voltage (0 to 10 vdc) at W1P15-Y with pitch control (beep switching) operating. c. If a changing voltage appears, replace pitch power unit (para 3-35 and 3-36). d. If no voltage change appears, replace attitude referencoecontrol and that controller (para 3-43 through 3-46).
8	Barometric altitude hold inoperative.	a. Check pitch control (beep switch) operation with VERTICAL engage switch (altitude) engaged. b. Check pitch control (beep switch) operation with VERTICAL engage switch (altitude) disengaged.	a. If control surface move, replace attitude reference control (para 3-43 and 3-44). b. If control surfaces do not function. disengage VERTICAL engage switch (altitude). c. If no operation occurs, replace attitude reference control (para 3-43 and 3-44). d. If proper operation occurs, replace navigational coupler and altitude control (para 3-47 and 3-48 and (para 3-41 and 3-42).
9	RADAR altimeter altitude hold inoperative or glidepath inoperative.	With VERTICAL select switch in APP or RAD position, check that appropriate receive is on.	a. Check pitch control (beep switch) operation with VERTICAL engage switch (altitude) direngaged: with switch (altitude) engaged. b. If surface operate with switch disengaged and does not whoa engaged, replace navigational coupler (para 3-47 and 3-48). c. If both positions operate surfaces, replace attitude reference control (para 3-43 and 3-44. d. If neither position operates surfaces, check change in voltage, (0-10 vdc) at W1P15-Y with pitch control (beep switch) operation. e. If voltage change is observed, replace pitch power unit (para 3-35 and 3-36).

Item No.	Malfunction	Functional check	Corrective measure
			f. If no voltage change is observed. replace attitude reference control (para 3-43 and 3-44).
			g. If all checks are satisfactory, replace radar altimeter or glide. path receiver (refer to applicable aircraft technical manual).
10	Pitch trim inoperative.		Replace trim power unit (para 3-37 and 3-38).
11	Pitch transient	Observe EL (pitch) servo effort indicator on flight controller.	a. If indicator shows large deflection. replace pitch power unit (para 3-35 and 3-36).
			b. If no deflection is shown by indicator, replace attitude reference control used then navigational coupler (para 3-43 and 3-44 and para 3-47 and 3-48).
12	Improper roll stabilization.	a. Check operation of roll control (TURN knob).	a. If control surfaces moves, replace vertical gyro (para 3-49 and 3-50).
		b. If control surfaces do not move, check change in voltage (0 to 10 vdc) at W1P15-X with rotation of roll control (TURN knob).	b. If voltage appears, replace roll power unit (para 3-35 and 3-36).
			c. If no voltage appears, replace attitude reference control (para-3-49 and 3-44).
13	Roll control (TURN knob) does not operate properly.	Rotate ROLL TRIM control.	a. If control surface door not move. replace roll power unit (para 3-35 and 3-36).
			b. If control surface moves, replace attitude reference control or flight controller (para 3-43 and 3-44 a 3-45 and 3-46).
14	ROLL TRIM control does not operate properly.	Rotate roll control (TURN knob)	a. If control surface does not move, replace roll power unit (para 3-35 and 3-36).
			b. If control surfaces moves,. replace attitude reference control or flight controller (para 3-43 and 3-44 a para 3-45 and 3-46).
15	Roll transient	Observe AIL (roll) servo effort indicator on flight controll.	a. If indicator shows large deflection. replace roll power unit (para 3-35 and 3-36).
			b. If no deflections is shown by indicator, replace attitude reference control and than navigation coupler (para 3-43 and 3-44 or 3-47 and 3-48).
16	No coordination in turns	See step 21.	
17	LOC, VOR, or NAV position of LATERAL engage switch inoperative	Check to see that appropriate receiver is in the ON position.	a. If roll control (TURN knob) operates control surfaces with LATERAL engage switch (steering) disengaged, replace navigational coupler (para 3-47 and 3-48).
			b. If roll control (TURN knob) does not operate control surface, check change in voltage (0 to 10 vdc) at W1P15-X with rotation of roll control (TURN knob).
			c. If a voltage change is observed, replace attitude reference control (para 3-43 and 3-44).
			d. If trouble is not connected, cheek LOC, VOR, and NAV receivers.
18	HDG position of LATERAL engage	Follow step 17	Check compass system.

switch inoperative.		
19 Improper heading stabilization.	Verify that compass system signal is reliable. With equipment disengaged, manually displace rudder pedals. Engage system and manually recenter rudder pedals. Remove force from pedals.	a. If rudder returns to its displaced position, replace altitude reference control (para 3-43 and 3-44. b. If rudder does not return to its displaced position, replace yaw power unit (para 3-35 and 3-36).
20 No turn coordination	With AUTO PILOT engage switch (attitude) off, manually displace rudder pedal. Engage equipment and manually recenter rudder. Remove force from pedal.	a. If rudder remains in center position, replace yaw power unit (para 3-35 and 3-36). b. If rudder returns to its displaced position, replace accelerometer (para 3-33 and 3-34).

Section II. TROUBLESHOOTlNG USING ANALYZER, FLIGHT LINE AN/ASM-80

WARNING

The automatic flight control system uses 115 volts. Do not make contact with exposed wires or connectors. Turn off all power supplies before malting any connections or disconnections. Don't take chances!

3-10. General Instructions

a. System troubleshooting at the flight line is performed in the aircraft while the equipment is operating as a system. When trouble occurs, tests made with Analyzer, Flight Line AN/ASNM-80 (flight line analyzer) can localize trouble to a specific component.

b. This section describes the systematic procedures to be followed to isolate the cause of the trouble and correct the fault. This section includes interlock system tests end tests for each control channel. A troubleshooting chart is provided for each test procedure.

c. Begin all testing with the interlock system tests. After performing the interlock system tests, conduct tests on the pitch, roll, or yaw control channel as required by the operator failure report. When the operator failure report is vague, conduct a complete system test. If the operator failure report is specific enough to localize the fault to a particular control channel, test the faulty control channel after completing the interlock system tests.

d. When a fault is indicated on the flight line analyzer during an operational test, refer to the troubleshooting chart at the end of each operational test. Symptoms given on these charts aid in localizing trouble to a faulty unit. Each symptom is referenced to a particular operational test.

e. When failure reports indicate that navigational coupling performance (VOR, LOC, HDG, and APP modes) is not satisfactory, complete all system tests. If all tests are satisfactory, the navigational coupler is probably defective and should be replaced. If unsatisfactory navigational coupling performance persists after the navigational coupler is replaced, the fault is probably located in the navigational equipment. Refer to the applicable technical manuals for test procedures.

f. When general automatic flight control system stabilization performance in any axis is reported as being unsatisfactory or has degenerated, test the system with the flight line analyzer. If all tests are satisfactory and flight performance is still unsatisfactory, excessive backlash in the power units or excessive looseness in the aircraft controls and control cables may exist. Inspect the power unit drum and bracket assembly for excessive backlash and the aircraft control system end cables for excessive looseness, and repair as required.

NOTE

If trouble is suspected in the aircraft controls, the maintenance repairman should inform the person in charge of aircraft maintenance. All repairs requiring adjustment of aircraft controls or control surfaces should be made by a qualified aircraft maintenance man.

g. If flight performance is still unsatisfactory after complete test and repair of backlash and looseness problem, the trouble may be due to marginal performance of the power unit amplifier or servo drive assembly. Replace these units in the particular axis as required. Whenever the

power unit is replaced, check the calibration unit. If performance is still unsatisfactory after all above repairs, replace calibration unit.

3-11. Test Techniques

a. Refer to TM 11-6625-518-12 for the operation of the flight line analyzer. The flight line analyzer S1 CHANNEL SELECTOR switch is used to select the channel to be tested. The channel test is then performed by switching the S2 TEST SELECTOR switch through its positions. All automatic flight control system switches must be in the disengaged position before starting any interlock or axis tests. AU teak must be performed in the order given.

b. Test results are monitored by observation of M1 METER TEST meter and the DS1 LAMP TEST lamp and the operation of the automatic flight control system and aircraft instruments. Test results are based on satisfactory test indications in the previous test steps. If the results of any test are inconclusive, the entire test procedure should be repeated.

c. If any results other than those specified are obtained, a system fault is indicated. Refer to the troubleshooting charts for identification of the defective unit.

3-12. Instructions for Unit Replacement

a. General Replacement Instructions. The instructions concerning unit replacement and the continuance of the test procedure depend on the unit to be replaced and the teat being performed. one of the instructions listed below is referenced by paragraph number in the Correction column of the troubleshooting chart to which it applies. Refer to the appropriate instruction before replacing a unit.

(1) Replace the faulty unit before continuing testing. After the unit is replace, recheck the entire interlock system and channel test.

(2) Proceed to the next test without replacing the-defective unit. After the completion of the system or channel testing, replace the defective unit and recheck the interlock system tests and the channel test.

(3) After completion of all testing, replace the defective unit and recheck this channel test.

(4) Complete the interlock system test before replacing the defective unit. After replacement, recheck the entire interlock system test.

b. Power Unit Replacement.

CAUTION

Coordinate the removal and replacement of the power units with the crew-chief of the aircraft. The installation of some of the components can affect the safe operation of the aircraft.

NOTE

The amplifier assembly of a power unit may be replaced without removing the entire power unit from the aircraft.

(1) Make sure a calibration unit with the correct nomenclature is installed on the power unit amplifier assembly.

CAUTION

Do not remove the drum and bracket assembly from the aircraft unless structural damage, deformation, or corrosion is noted, and then remove it only with the aid of an aircraft mechanic.

(2) Repair the drum and bracket assembly if excessive backlash between gear and drum is observed.

(3) When replacing the servo drive assembly, make sure the servo drive and drum and bracket assembly gears mesh correctly. (Match the decal colors on the drum and bracket assembly and servo drive assembly. The color matching procedure is critical. It assures that the drum and bracket assembly and servo gears mesh correctly).

c. Tag Information. When a unit is replaced, tag the unit removed from the aircraft with the information below.

(1) The channel on the flight line analyzer in which the fault was detected (position of S1 CHANNEL SELECTOR switch).

(2) Axis test procedure (test number) or applicable operational test number listed in this manual.

(3) Refer to the troubleshooting chart and list the probable malfunction as listed in the Probable trouble column.

3-13. Test Equipment Required

The only test equipment required for troubleshooting the automatic flight control system at organizational maintenance is Analyzer, Flight Line AN/ASM-80.

3-14. Preliminary Procedure

Follow the procedures in a through i below to connect the flight line analyzer to the automatic flight control system.

a. Depress the pressure equalizer valve on the

side of the flight line analyzer base to equalize Inside and outside pressure and remove the cover from the base of the flight line analyzer.

b. Set up the flight line analyzer in the aircraft' in a position convenient to aircraft teat connectors W1P14 and W1P15. (Refer to the aircraft manual for the location of the connectors.) If possible, at up the flight line analyzer in the cockpit so that aircraft controls are easily reached and the cockpit instruments may be observed.

c. Remove cables No. 1 and No. 2 from the accessory case.

d. Make sum all aircraft primary power switches are turned off.

e. Turn off the glidepath, radar altitude, VOR/LOC, and Dopplr NAV system circuit breakers. (See applicable aircraft technical manual.)

f. Set S1 CHANNEL SELECTOR and S2 TEST SELECTOR switches on the Right line analyzer to OFF.

g. Remove jumper plug W2P1 from aircraft bat connector W1P4 and the dust cap from aircraft teat connector W1P5.

NOTE

Store jumper plug W2P1 and the dust cap in a safe place for replacement after tests are concluded.

h. Remove the dust caps from flight line analyzer connectors J1 and J2 and from the connectors on cables No. 1 and No. 2.

i. Connect cables No. 1 and No. 2 to the flight line analyzer at J1 and J2 and to aircraft teat connectors W1P14 and W1P15.

3-15. Starting Procedure

NOTE

Connect an external power supply to the aircraft (to supply the primary power) to prevent excessive drain on the aircraft batteries.

Before starting the equipment, make sure the flight line analyzer controls and the aircraft power controls are set as indicated in the preliminary procedures (para 3-14); then perform the steps in a through d below.

a. Unlock the aircraft control stick and rudder pedals.

b. Turn on the aircraft primary electrical power switches (ac and dc power). Energize the aircraft dc and ac power circuit breakers and the fuses for the automatic flight control system, the compass system, the trim system. and the panel light circuits. (Refer to the applicable aircraft manual.)

c. On the flight line analyzer, turn the S1 CHANNEL SELECTOR switch to position A; the DS2 A.C. POWER and DS3 D.C. POWER lamps should light.

d. Push the PRESS TO TEST button on the DS1 LAMP TEST indicator. The lamp should light when the button is pushed.

3-16. Interlock System Test, General Instructions

a. Complete the operational tests for the interlock system (para 3-17) successfully before performing the operational tests for the pitch axis control channel.

b. If an equipment malfunction is indicated during an interlock system teat, refer to the interlock system troubleshooting chart (para 3-18). The symptoms given in the chart are cross-indexed with the operational teat numbers.

c. Unless otherwise instructed, leave all automatic flight control system and flight line analyzer switches in the positiona occupied during the previous teat.

3-17. Operational Test, Interlock System

a. Initial Tests (Test No. 1).

(1) Place all automatic flight control system switches in the off or disengaged position.

(2) Turn switch S1 CHANNEL SELECTOR to position A. The M1 METER TEST meter should indicate in the orange region, and the DS1 LAMP TEST lamp should be extinguished.

(3) Check the flight line analyzer connections and switch settings if incorrect indications are noted. Do not continue testing unit until the fault is corrected.

b. Vertical Gyro Erection Timing Cycle Check (Test NO. 2). Turn S2 TEST SELECTOR switch of the flight line analyzer to position 1. Energize the aircraft automatic flight control system ac and dc power circuit breakers. The DS1 LAMP TEST lamp should light in approximately 3 minutes.

c. Flight Controller Roil Control (TURN knob) Out-of-Detent Check (Test No. 3).

(1) Turn S2 TEST SELECTOR switch of the flight line analyzer to position 2.

(2) Rotate the flight controller roll control (TURN knob) out of the detent position. The DS1 LAMP TEST lamp should extinguish.

d. Flight Controller Roll Control (TURN Knob) in Detent Check (Test No. 4). Return the flight controller roll control (TURN knob) to the

detent position. The DS1 LAMP TEST lamp should light.

e. Pilot Release Switch Disengaged Mode Check (Test No. 5).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 3.

(2) Depress the pilot release switch on the aircraft control stick. The DS1 LAMP TEST should extinguish.

f. Pilot Release Switch Engaged Mode Check (Test No. 6). Release the pilot release SWITCH. The DS1 LAMP TEST lamp should light.

g. Copilot Release Switch Disengaged Mode Check (Tat No. 7). Depress the copilot release switch on the aircraft control stick. The DS1 LAMP TEST lamp should extinguish.

h. Copilot Release Switch Engaged Mode Check (Test No. 8). Release the copilot release switch. The DS1 LAMP TEST lamp should light.

i. Automatic Pilot Engage Switch Check Test No. 9).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 4.

(2) Move the navigational coupler AUTO PILOT engage switch (attitude) to ON. If the switch does not lock in the ON position, hold it in that position. The DS1 LAMP TEST lamp should light.

j. Automatic Pilot Engage Check (Test No. 10).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 5.

(2) Move the navigational coupler AUTO PILOT engage switch (attitude) to ON. If the switch does not lock in the ON position, hold it in that position for this test. The DS1 LAMP TEST lamp should light.

k. Automatic Pilot Engage Switch Solenoid Check (Test No. 11). Release the hold on the AUTO PILOT engage switch (attitude) if it is being held manually but do not disengage the switch; it should stay in the ON position. The DS1 LAMP TEST lamp should light.

1. Navigational Coupler VERTICAL Select Switch Barometric Mode Check (Test No. 12).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 12.

(2) Turn the navigational coupler VERTICAL select switch to BAR. The DS1 LAMP TEST lamp should light.

m. Navigational Coupler VERTICAL Select Switch Approach Mode Check (Test No. 13). Turn the VERTICAL select switch to RAD. The DS1 LAMP TEST lamp should light.

n. Navigational Coupler VERTICAL Select Switch Approach Mode Check (Test No. 14). Turn the VERTICAL select switch to APP. The DS1 LAMP TEST Lamp should light.

o. Navigational Coupler VERTICAL Engage Switch Engage Check (Test No. 16).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 13.

(2) Turn the VERTICAL select switch to BAR.

(3) Move the VERTICAL engage switch (altitude) to ON; the switch should stay in the ON position. The DS1 LAMP TEST lamp should light.

p. VERTICAL Engage Switch Disengagement Check (Test No. 16). Depress the pilot release switch. The DS1 LAMP TEST lamp should extinguish and the navigational coupler AUTO PILOT (altitude) and VERTICAL (altitude) engage switches should disengage.

q. VERTICAL Time-Delay Interlock Check (Test No. 17).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 14.

(2) Move the AUTO PILOT engage switch (attitude) to ON.

(3) Move the VERTICAL engage switch (altitude) to ON. The DS1 LAMP TEST lamp should light in approximately 2 seconds.

r. Pitch Control Channel Pilot Release Switch Disengage Function Check (Test No. 18). Depress the pilot release switch. The DS1 LAMP TEST lamp should light and AUTO PILOT (attitude) and VERTICAL (altitude) engage switches should disengage.

NOTE

1. In s through w below, note the LATERAL engage switch (steering) position and the DS1 LAMP TEST indication after positioning the LATERAL select switch and before engaging the LATERAL engage switch (steering).
2. Be sure the flight controller roll control (TURN knob) is in detent before performing the teats in s through x below.

s. LATERAL Select Switch Navigation Mode and LATERAL Engage Switch Interlock Check (Test No. 19).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 15.

(2) Move the LATERAL engage switch (steering) to ON: the switch does not hold at ON. Disregard the DS1 LAMP TEST indication in this step.

(3) Move the AUTO PILOT engage switch (attitude) to ON. The DS1 LAMP TEST lamp should be extinguished.

(4) Turn the LATERAL select switch to NAV. The DS1 LAMP TEST lamp should remain extinguished.

(5) Move the LATERAL engage switch (steering) to ON. The DS1 LAMP TEST lamp should light and the LATERAL engage switch (steering) should lock at ON.

t. LATERAL Select Switch Omnirange Mode and LATERAL Engage Switch Interlock Check (Test No. 20).

(1) Turn the LATERAL select switch to VOR. The DS1 LAMP TEST lamp should extinguish and the LATERAL engage switch (steering) should disengage.

(2) Move the LATERAL engage switch (steering) to ON. The DS1 LAMP TEST lamp should light and the LATERAL engage switch (steering) should lack at ON.

u. LATERAL Select Switch Localizer Mode and LATERAL Engage Switch Interlock Check (Test No. 21).

(1) Turn the LATERAL select switch to LOC. The DS1 LAMP TEST lamp should light and the LATERAL engage switch (steering) should disengage.

(2) Move the LATERAL engage switch (steering) to ON. The DS1 LAMP TEST lamp should light and the LATERAL engage switch (steering) should lock at ON.

v. LATERAL Select Switch Heading Select Mode and LATERAL Engage Switch (Steering) Interlock Check (Test No. 22).

(1) Turn the LATERAL select switch to HDG. The DS1 LAMP TEST lamp should extinguish and the LATERAL engage switch (steering) should disengage.

(2) Move the LATERAL engage switch (steering) to ON. The DS1 LAMP TEST lamp should light and the LATERAL engage switch (steering) should lock at ON.

w. LATERAL Select Switch Disengage Function Check (Test No. 23). Turn the LATERAL select switch to LOC. The DS1 LAMP TEST lamp should extinguish and the LATERAL engage switch (steering) should disengage.

x. Pilot Release Switch Check for Total Disengagement (Test No. 24).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to OFF.

(2) Depress the pilot release switch on the aircraft control stick. The AUTO PILOT engage switch (attitude) should disengage.

3-18. Troubleshooting Chart, Interlock System

The troubleshooting chart listed below is based on the fact that an operational test has failed. The Symptom column indicates the operational tart No. that failed and its paragraph references.

NOTE

Refer to the replacement instructions in paragraph 3-12 before replacing a unit of the automatic flight control system. Unless otherwise indicated, follow the instruction in paragraph 3-12a.

Symptom (test failure)		Probable trouble	Correction
Test No.	Para		
1	3-17a	Defective cable connections between flight line analyzer test and test connectors.	Check for defective cables and connectors.
2	3-17b	Defective vertical gyro erection circuitry in erection control module.	Replaces defective vertical gyro (para 3-49 and 3-50).
3	3-17c	Defective flight controller TURN knob detent switch 9S4.	Replace defective flight controller (para 3-45 and 3-46).
4	3-17d	Defective flight controller TURN knob detent switch 9S4.	Replace defective flight controller (para 3-45 and 3-46).
5	3-17e	Defective pilot release switch aircraft pilot control stick.	Replace defective aircraft pilot release switch.
6	3-17f	Defective pilot release switch.	Replace defective aircraft pilot release switch.
7	3-17g	Defective pilot release switch on aircraft copilot control switch.	Replace defective aircraft pilot release switch.
8	3-17 h	Defective pilot release switch on aircraft copilot control stick.	Replace defective aircraft pilot release switch.
9	3-17i	Defective navigational coupler AUTO PILOT engage switch (attitude) circuit.	Replace defective navigational coupler (para 3-47 and 3-48).
10	3-17j	Defective attitude reference control.	Replace defective attitude reference control (para 3-43 and 3-44).

Symptom (test failure)		Probable trouble	Correction
Test No.	Para		
11	3-17k	Defective solenoid in AUTO PILOT engage switch (attitude) in navigational coupler,	Replace defective navigational coupler (para 3-47 and 3-48).
12	3-17l	Defective barometric (BAR) mode circuits in navigational coupler (VERTICAL select) switch).	Replace defective navigational coupler (para 3-47 and 3-48).
13	3-17m	Defective radar (RAD) mode circuit in navigational coupler IVERTICAL select switch).	Replace defective navigational coupler (para 3-47 and 3-48).
14	3-17n	Defective approach (APP) mode circuit in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48).
15	3-17o	a. If VERTICAL engage switch (altitude) locks. ON but DS1 LAMP TEST lamp does not light, navigational ampler VERTICAL select switch is defective.	a. Replace defective navigational coupler (para 3-47 and 3-48).
		b. If DS1 LAMP TEST lamp does not light and VERTICAL engage switch (altitude) does not lock ON, VERTICAL engage switch (altitude) or relay 3K6 in navigational coupler is defective.	b. Replace defective navigational coupler (para 3-47 and 3-48).
		c. If DS1 LAMP TEST lamp lights when VERTICAL engage switch (altitude) is depressed but switch does not lock at ON, switch solenoid in navigational coupler is defective.	c. Replace defective navigational coupler (para 3-47 and 3-48).
16	3-17p	Defective AUTO PILOT engage switch (altitude) or VERTICAL engage switch (altitude) circuit in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48).
17	3-17q	Defective vertical time-delay circuit in altitude control.	Replace defective altitude control (para 3-41 and 3-42).
18	3-17r	Defective AUTO PILOT engage switch (attitude) or VERTICAL engage switch (altitude) in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48).
19	3-17s	a If LATERAL engage switch (steering) locks at ON prior to automatic pilot engagement, navigational coupler LATERAL engage switch (steering) or relay 3K3 is defective.	a. Replace defective navigational coupler (para 3-47 and 3-48).
		b. If DS1 LAMP TEST lamp lights before or after automatic pilot is engaged (with roll control (TURN knob) in detent position) and prior to engagement of LATERAL engage switch (steering), a malfunction in navigational coupler relay 3K1 or flight controller detent switch may exist.	b. Isolate trouble to flight controller or navigational coupler as fellows: (1) Engage AUTO PILOT engage switch (attitude). (2) Move LATERAL select switch to NAV. (3) Engage LATERAL engage switch (steering). (4) If LATERAL engage switch (steering) locks at ON, rotate roll control (TURN knob of the flight controller out of detent position. If LATERAL engage switch (steering) disengages, replace navigational coupler (para 3-47 and 3-48). If LATERAL engage switch (steering) does not lock at ON, replace flight controller (para 3-45 and 3-46). Retest after unit replacement. If fault still persists after one unit has been replaced, replace other unit and retest. Reappearance of fault after this replacement indicates an aircraft wiring malfunction.

Symptom (test failure)		Probable trouble	Correction
Test No.	Para		
		c. If LATERAL engage switch (steering) does not lock at ON after automatic pilot is engaged and DS1 LAMP TEST tamp doom not light, fault may be in either navigation coupler LATERAL engage circuitry or flight controller roll control (TURN knob) detent switch.	c. TO isolate trouble to flight controller navigational coupler, use following procedure: (1) Rotate roll control (TURN knob) out of detent position; if DS1 LAMP TEST lamp lights, replace navigational coupler (para 3-47 and 3-48). Retest after unit replacement. (2) If fault still persists, replace flight controller (para 3-45 and 3-46) and retest. Reappearance of fault after replacement indicates a malfunction in aircraft wiring.
		d. If LATERAL engage switch (steering) locks at ON after automatic pilot is engaged and DS1 LAMP TEST lamp does not light, fault is in navigational coupler.	d. Replace navigational coupler (para 3-47 and 3-48).
20	3-17 t	Defective VOR mode circuit in navigational coupler (LATERAL select switch).	Replace defective navigational coupler (para 3-47 and 3-48).
21	3-17u	Defective localizer (LOC) mode circuit in navigational coupler (LATERAL select switch).	Replace defective navigational coupler (para 3-47 and 3-48).
22	3-17v	Defective heading (HDG) mode circuit in navigational coupler (LATERAL select switch).	Replace defective navigational coupler (para 3-47 and 3-48).
23	3-17w	Defective LATERAL engage switch (steering) circuit in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48).
24	3-17x	An interlock function which has previously tested has failed.	Return to the first test step of the interlock tests and retest.

3-19. Pitch Control Channel Tests, General Instructions

a. Test the pitch control channel functions with the flight line analyzer S1 CHANNEL SELECTOR switch in position B and the S2 TEST SELECTOR switch rotated through all its test positions.

b. Complete the interlock system tests (para 3-17) before performing the pitch control channel operational tests.

c. If an equipment malfunction is indicated during a pitch control channel test, refer to the pitch control channel troubleshooting chart (para 3-21). The symptom listed in the chart are cross-indexed with the operational test numbers.

d. Unless otherwise instructed, leave all automatic flight control system and flight line analyzer switches in the positions occupied during the previous test.

3-20. Operational Test, Pitch Control Channel

a. Initial Test (Test No. 1).

(1) Turn all automatic flight control system switches to the off or disengaged position.

(2) Turn the S2 TEST SELECTOR switch of the flight line analyzer to OFF.

(3) Check to see that the S1 CHANNEL SELECTOR switch of the flight line analyzer has been turned to position B. The DS1 LAMP TEST lamp should not light, and the Ml METER TEST meter should read in the orange region.

b. Pitch Control Channel Attitude Reference Control Synchronization Check (Test No. 2). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 1. The M1 METER TEST meter should indicate in the orange region.

c. Pitch Control Simulated Attitude Synchronization Check (Test No. 3). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 2. The M1 METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region. The needle motion should be continuous and smooth.

d. Pitch Control Channel E-Z Simulated Synchronization Check (Test No. 4). Turn the S2 TEST SELECTOR switch of the flight line

analyzer to position 3. The Ml METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region in the opposite direction from deflection in test No. 3 (*c* above). The needle motion should be continuous and smooth: the magnitude of deflection into the blue region should be approximately the same as observed in test No. 3 *(c* above).

e. Pitch Control Channel Demodulator Gain *Check (Test No. 5).* Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 4. The Ml METER TEST meter should indicate in the blue region; the meter needle may initially deflect beyond the final indication.

f. Pitch Control Channel Simulated Beep Command Function *Check (Test No. 6*) . Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 5. The M1 METER TEST meter needle should cycle from one blue region to the other blue region or with a minimum swing of 60 meter scale divisions: the needle may gradually offset and cycle into one of the blue regions only.

g. Pitch Control *Channel Synchronization Realignment Check (Test No. 7).* Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 6. Transient Ml METER TEST deflections may be noted; the final value steady-state reading should be in the orange region.

h. Pitch Control Channel Beep Command Function Up (Manual) Check (Test No. 8).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 7.

(2) Move the flight controller TURN knob to CLIMB. The Ml METER TEST meter needle should begin to deflect from the orange region to the blue region. Continue to hold the flight controller knob until the meter indicates 60 percent in the blue region. The rate of meter deflection should be smooth and continuous.

i. Pitch Control Channel Beep Command Function Down (Manual) Check (Test No. 9). Move the flight controller TURN knob to GLIDE. The Ml METER TEST meter needle should begin to deflect from one blue *region* to the other blue region in the opposite direction from the deflections noted in test No. 8 *(h* above). The rate of meter deflection should be smooth and continuous.

j. Pitch Control Channel Vertical Gyro Synchronization Alignment Check (Test No. 10). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 14. Transient meter deflections on the Ml METER TEST meter may benoted;thefinalsteadyreadingshouIdbeinthe orange region.

k. Pitch Control' Channel Vertical Gyro Vertically and *Precession Check (Test No. 11).*

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 15.

(2) Move the S3 PRECESSION switch of the flight line analyzer to position B. The, M1 METER TEST meter needle should gradually deflect from the orange region to the blue region. Hold the S3 PRECESSION switch until the needle deflects to at least the 80-percent index in the blue region.

NOTE

The operator may proceed to the *next* test step when the needle returns past the 30-percent index in the meter yellow region and need not await the complete return to the orange region. If the operator observes that the meter does begin to return and no fault is suspected, the return of the meter pointer to yellow can be speeded by placing the S3 PRECESSION switch to position A for short periods. If a gyro fault is suspected, the operator should wait until a complete return of the meter needle is observed. A complete return should take between 1 and 4 minutes.

l. Fitch Control Channel Vertial Gyro Slow Erection Check (Test No. 12). Release the S3 PRECESSION switch when Ml METER TEST meter indicates above 80-percent index in the blue region. The meter needle should gradually return to the orange region.

m. Pitch Power Unit Amplifier Balance Check (Test No. 13).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 17.

(2) Adjust the R1 BALANCE control of the flight line analyzer until meter Ml reads in the orange; then lock the R1 BALANCE control by turning the LOCK knob. (This adjustment is sensitive: the operator should rotate the control knob slowly in the positive (+) or negative (-) direction until the *meter* indicates in the orange region.)

n. *Pitch Power Unit Amplifier Gain Check* (Test *No.* 14).

(1) Unlock and center the aircraft longitudinal control stick.

CAUTION

Do not leave the S2 TEST SELECTOR switch at position 18 for more than 15 seconds: the pitch power unit may overheat and become damaged.

(2) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 18. The M1 METER TEST motor needle should deflect into the blue region; the aircraft longitudinal control stick should move and the flight controller EL trim meter should deflect.

o. Pitch Power Unit Displcement Gain Check (Test No. 15). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 19. Transient deflection on the Ml METER TEST meter may be noted: the final steady-state reading should be in either the blue or yellow region.

p. *Pitch Power Unit* Displacement *Gain Check (Test No. 16).*

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 20.

(2) center the aircraft pitch trim wheel. Transient deflections on the M1 METER TEST meter may be noted; the final steady-state reading should in the orange region.

q. Pitch Trim Power Unit *Check (Test No. 17).*

(1) Turn the S2 TEST SELECTOR switch *of* the flight line analyzer to position 21.

(2) Overpower the aircraft longitudinal control stick until the Ml METER TEST meter reads full full in the yellow region; continue to overpower. keeping the meter at the 30-percent yellow indication for approximately 15 seconds. The aircraft pitch trim wheel should slowly rotate.

CAUTION

Do not overpower for periods greater than 15 seconds; the power unit motor may overheat and become damaged

3-21. Troubleshooting chart, Pitch Control channel

The troubleshooting chart listed below is baaed on the fact that an operation test has failed. The *Symptom* column indicate the operational teat No. that failed and its paragraph reference.

NOTE

Refer to the replacement. instructions in paragraph 3-12 before replacing a unit of the automatic flight control system. Unless otherwise indicated, follow the instructions in paragraph 3-12 *a.*

Sympton (test failure)		Probable trouble	Correction
Test No.	Para		
1	3-20 *a*	Defective cable connections between flight line analyzer and automatic flight control system test connector	Check for defective cable and connectors.
2	3-20 *b*	Defective synchironization. If M1 METER TEST meter does not indicates in orange region (drifts or offsets out of orange into blue or yellow), fault is in either attitude reference control synchronization circuitry or the navigational coupler.	Isolate trouble to attitude reference control or navigational coupler as follows *a.* Proceed to fixed-wine altitude axis test (para 3-30. Conduct tests No. 1, 2, 3, and 4 in order. *b.* The navgational coupler is at fault and should be replaced if: (1) In test No. 2, meter needle off set is reduced and remains at specific meter reading. (2) In either test No. 3 or No. 4 meter needle ayachronizes (deflects away from the reading noted in test No. 2 by at least 40-meter increments and then return to the test No. 2 reading). *c.* The attitude reference control is at fruit and should be replaced if meter does not synchronize. *d.* After unit replacement,return to fixed-wing pitch control channel test and re-chock tat No. 2. If fault persists, replace other unit. Reappearance of fault after replacement of both units indicates a possible malfunction in aircraft wiring or flight line analyzer connection. *e.* After fault is cleared, recheck interlock system and pitch control channel test.

Sympton (test failure)		Probable trouble	Correction
Test No.	Para		
3	3-20 *c*	*a.* If M1 METER TEST meter deflects but does not return to orange. fault is the same a that noted is operation test No. 2 above.	a. Isolate fault to attitude reference control or navigational coupler: we procedures described in 2 above.
		b. If Ml METER TEST motor does not doflect but ramains in orange region, attitude reference control is at fault.	b. Replace attitude reference control (para 3-43 and 3-44).
		c. If M1 METER TEST meter noodle deflects and to orange region and motion is not smooth and continuous (motion is jerky), attitude reference control is defective.	C. Replace attitude reference control (para 3-43 and 3-44).
4	3-20 *d*	Same as test No.3	Same as test No. 3.
5	3-20 *a*	Defective relay 2K2 in attitude reference control.	Replace defective attitude reference control (para 3-43 and 3-44).
6	3-20 *f*	Defective noseup or nosedown beep commend function in attitude reference control.	Replace defective attitude reference control (para 3-43 and 3-44).
7	3-20 *g*	Defective synchronization. Fault has developed in assemblies proviously tested in test No. 1 through No. 4 (attitude reference control).	Retest tests No. 1 through No. 4; if no fault is detected. check the aircraft wiring and flight line analyzer connections. If fault is detected. replace as indicated .
8	3-20 *h*	Defective noseup command function from controller (TURN knob switch 9S1).	Replace power unit serve drive and amplifier and 3-46).
9	3-20 *i*	Defective nosedown command function from flight controller (TURN knob switch 9S2).	Replace defective flight controller (para 3-46 and 3-36).
10	3-20 *j*	Defective vertical gyro (defective gyro assembly or erection control module).	Proceed to test procedure in paragraph 3-23 *m* After channel test is completed. replace defective vertical gyro and recheck entire channel test sequence.
11	3-20 *k*	Defective erection control module or vertical gyro assembly.	Replaced defective vertical gyro (para 3-49 and 3-50).
12	3-20 *l*	Defective erection circuit in vertical gyro assembly or erection control module.	Replace defective vertical gyro (para 3-49 and 3-50)
13	3-20 *m*	Defective amplifier assembly 4A2	Replaced defective pitch powrer unit (para 3-35 and 3-36).
14	3-20 *n*	*a*. Defective pitch power unit amplifier *assembly 4A2* (if Ml METER TEST meter needle does not deflect into the blue region.	*a.* Replace defective pitch Power unit (para 3-35 and 3-36).
		b. Defective flight controller serve effort indicator 9Ml (if M1 METER TEST meter needle deflects into blue but EL trim meter does not deflect).	*b.* Replace defective flight controller para 3-35 and 3-36).
		c. Defective serve drive assembly 4Al (meter, gear train. or clutch or a damaged shearpin in the drum and bracket assembly (if M1 METER TEST meter deflect to blue region and no aircraft control stick motion is observed.	*e.* Remove amplifier and serve drive assembly from power unit drum and bracket. Inspect gear, pin. and shaft assembly in bracket to so. if shearpin bar failed. If shearpin failure exits, replace entire gear. pin and shaft assembly (para 3-12). **CAUTION** Make sure the assembly has correct gear and pin; this is a critical. replacement. If shearpin has not failed. replace serve drive assembly (para 3-35 and 3-36).
15	3-20 *o*	Pitch power unit (defetive serve drive assembly or amplifier assembly).	Replace power unit serve drive and amplifier assembly (Para 3-35 and 3-36).
16	3-20 *p*	Defective motor in pitch power unit servo drive assembly 4A1.	Replace defective pitch power unit serve drive assembly (para 3-35 and 3-36).

Symptom (test failure)		Probable trouble	Correction
Test No.	Para		
17	3-20 *q*	*a.* Defective power unit assemblies (if M1 METER TEST meter does not deflect when control stick is overpowered. fault has developed is power unit assemblies previously tested in tests No. 13 through 16). *b.* Defective trim power unit (if M1 METER TEST meter indicates correctly and trim wheel does not rotate).	*a.* Perform tests No. 13 through 16 in order. If no fault is detected. check flight line analyzer cable. If fault is indicated. replace faulty unit as indicated. *b.* Replace defective trim power unit (para 3-37 and 3-38). **CAUTION** When trim power unit is replaced, the limit switch travel and the slip clutch setting must be set for each particular aircraft type. Refer to applicable aircraft techinal manual for slip. clutch setting. Final adjustment of switches must be made when actuator servo drive assembly is installed in aircraft. Refer to aircraft manual for switch setting specifications.

3-22. Roll Control Channel Tests, General Instruction

a. Test the roil control channel functions with the flight line analyzer S1 CHANNEL SELECTOR switch in position C and the S2 TEST SELECTOR switch rotated through its test positions (para 3-23).

b. Complete the operational teats for the interlock system (para 3-17) successfully before performing the operational tests for the roll axis control channel.

c. If an equipment malfunction is indicatad during roll channel test, refer to the roll control channel troubleshooting chart (para 3-24). The symptoms given in the chart are cross-indexed with the operational test numbers.

d. unless otherwise instructed, leave all automatic flight control system and flight line analyzer switches in the position occupied during the previous test.

3-23. Operational Torts, Roll Control Channel

a. Roll Control Channel Initial Test (Test No. 1).

(1) Place all automatic flight control system switches in the off or disengaged position.

(2) Set flight controller TURN knob in detent.

(3) Turn the S1 CHANNEL SELECTOR switch of the flight line analyzer to position C and the S2 TEST SELECTOR switch of the Sight line analyzer to OFF. The Ml METER TEST meter should indicate in center of the orange region.

b. Roll Control Channel Attitude Reference Synchronization and Flight Controller Roll Control TURN Knob Detent Switch Check (Test No. 2). Turn the S2 TEST SELECTOR switch of the Flight line analyzer to position 1. Transient meter needle deflections may be noted on the M1 METER TEST meter but the final steady-state reading should be in the orange region.

c. Roll Control Channel Simulated Synchronization Chech (Test No.3). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 2. The M1 METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region. NeedIe deflection should be continuous and smooth.

d. Roll Control Channel E-Z Simulated Synchronization Check (Test No.4). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 3. The Ml METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region in the opposite direction from the deflection in, test No. 3 *(c* above). The needle deflection should be continuous and smooth and the magnitude of deflection into the blue region should be approximately the same ae observed in test No. 3 *(c* above).

e. Roll Control Channel Demodulator Gain Check (Test No. 5). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 4. Meter Ml should indicate in the blue

region; a maximum meter deflection may be noted.

f. Simulated Roll Attitude Synchronization Check (Test No. 6). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 10. Transient needle deflections may be noted on the Ml METER TEST meter, but the final steady-state meter reading should be in the orange region.

g. Roll Level-Out Check (Test No. 7). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 11. The Ml METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region: the needle motion should be continuous and smooth.

h. Roll Control Channel Synchronization *Realignment Check (* Test *No. 8).* Turn the S2 TEST SELECTOR switch of the fIight line analyzer to position 12. Transient needle deflections may be noted on the Ml METER TEST meter, but the final steady-state meter reading should be in the orange region.

i. *Roll Control Turn Knob Clockwise Command Function Check (Test No. 9)* .

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 13:

(2) Rotate the flight controller TURN knob. of the flight controller fully clockwise. The Ml METER TEST meter needle should deflect from the orange region 'to the blue region with a continuous and smooth motion and the DSL LAMP TEST lamp should light.

j. Roll Control TURN Knob Counterclockwise Command Function Check (Test No. 10). Rotate the roll control TURN knob *of* the flight controller fully counterclockwise. The DS1 LAMP TEST lamp should light and the Ml METER TEST meter needle should deflect *from* one blue region to the other blue region with a continuous and smooth *motion* in the opposite direction from the deflection noted in test No. 9 *(i* above).

k. Roll Control TURN Knob Null Accuracy *Check (Test* No. *11).* Return the roll control TURN knob of the flight controller to detent. The Ml METER TEST meter needle should return to the orange region and DS1 LAMP TEST lamp should extinguish.

1. Roll Control Channel Vertical Gyro *Synchronization Alignment Check (Test No. 12).* Turn the S2 TEST SELECTOR switch of the flight line analyzer to posittion 14. Transient needle deflections *may* be noted on the Ml METER TEST meter, but the final steady-state meter reading should be in the orange region.

m. Roll Control Channel Vertical Gyro Vertically Check (Test *No. 13)..*

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 15.

(2) Turn the navigational coupler VERTICAL select switch to BAR. Meter Ml should indcate in the orange region.

n. Roll Control *Channel Vertical* Gyro *Precession-to-Right Check (Test No. 14)* Move and hold S2 PRECESSION switch of the flight line analyzer in position B until DS 1 LAMP TEST lamp lights. The Ml METER TEST *meter* needle should gradually deflect from the orange region to the blue region.

NOTE

The DS1 LAMP TEST should light before Ml METER TEST meter reaches a maximum indication in the blue region. If DS1 LAMP TEST lamp lights before the meter needle reaches the 80-percent index (in the blue region), continue to/ hold the S3 PRECESSION switch in position B until the 80-percent index is reached; then release the switch. A DS1 LAMP TEST indication in the orange or the yellow region indicated a malfunction.

o. Roll Control Channel Vertical Gyro Erection Check (Test No.15).

(1) When the S3 PRECESSION switch is released (test No. 14, n above), the Ml METER TEST meter needle should gradually return to the orange region and the DS1 LAMP TEST lamp should extinguish.

(2) Unless gyro erection fault is suspected, proceed to test No. 16 when the M1 METER TEST meter needle returns past the 30-percent index on the meter yellow region. Do not wait for complete return to the orange region. (If the operator observes that the meter begins to return and no fault is suspected, the return *of* the meter needle to the yellow region may be speeded up by placing S3 in position A for brief periods.)

(3) If vertical gyro trouble is suspected, wait until the M1 METER TEST meter needle returns to the orange region. Complete return should take from 1 to 4 minutes.

p. Roll Control Channel Vertical Gyro Precession-to-Left Check (Test No. 16).

(1) Turn the St TEST SELECTOR switch of the flight line analyzer to position 16.

(2) Move the S3 PRECESSION switch to positive A. The Ml METER TEST meter needle should gradually deflect through the orange to the opposite blue region, in the opposite direction from the deflection from the deflection noted in

test No. 14 *(n* above).

(3) Hold S3 PRECESSION switch until the Ml METER TEST meter needle deflects into the blue region. The DS1 LAMP TEST should light before the meter indicates maximum in the blue region but not while the meter indicates in the orange *or* the yellow region.

(4) Release the S3 PRECESSION switch after the DS1 LAMP TEST lamp lights.

q. Roll Control Channel Vertical Gyro Automatic Erection Cutoff (AECO) Check (Test No. 17). When the S3 PRECESSION switch is released (test No. 101, the Ml METER TEST meter needle should remain in the blue region and the DSl LAMP TEST should remain lighted.

r. Vertical Gyro Automatic Erection Cutoff Disconnect Interlock Check (Test No. 18). Turn the VERTICAL select switch of the navigational coupler to APP. The DSl LAMP should extinguish and the Ml METER TEST meter needle should gradually deflect back to the orange region.

NOTE

Unless a vertical gyro fault is suspected, proceed to the next test when the meter needle returns past the 30.percent meter index in the yellow region; do not wait for complete return. If the operator observes that the meter begins to return and no fault is suspected, the meter pointer may be brought back to yellow more rapidly by placing switch S3 in position B for brief periods. Complete return of the meter needle to the orange region should take from 1 to 4 minutes.

s. Roll Power Unit Amplifier Balance Check (Test *No. 19).*

(1) Center the flight controller ROLL TRIM knob.

(2) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 17.

(3) Adjust the Rl BALANCE contlrol under the Ml METER TEST meter indicates in the orange region and lock R1 by turning the LOCK knob.

NOTE

If unsuccessful test results are observed, gradually offset the ROLL TRIM control of the flight controller 10^{o} from center and note if meter M1 deflects in the blue region or if the lateral stick moves. If this action occurs, the test results are satisfactory.

t. Roll Power Unit Amplifier Gain Check (Test No. 20).

(1) Unlock and center the aircraft lateral con tro1 stick.

(2) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 18. The M METER TEST meter needle should graduall. deflect into the blue region, the lateral control stick should move in the lateral direction, and the flight controller AIL meter should deflect.

CAUTION

Switch S2 must not be left in position 18 for more than 15 seconds: the power unit may. overheat and become damaged.

NOTE

If unsuccessful test results are observed, gradually offset the ROLL TRIM control of the flight controller 10^{o} from center and note if meter Ml deflects in the blue region or if the lateral stick moves. If this action occum. consider the teat results to be satisfactory.

u. Roll Power Unit Displacement Gain Check (Test No. 21). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 19 Transient needle deflections may be noted on M METER TEST meter but the final steady-state reading should be either in the blue or in the .yellow region.

v. Roll Power Unit Closed Loop Synchronization and Motor Threshold Check (Test No. 22). Turn the S2 TEST SELECTOR.switchs of the flight line analyzer to position 20. Transient needle deflections may be noted on the M1 METER TEST meter but the final steady-state reading should be in the orange region.

w. ROLL TRIM Knob Check (Test No. 23).

(1) Turn the S2 TEST SELECTOR switch to position 21.

(2) Gradually rotate the ROLL TRIM control on the flight controller fully counterclockwise (then clockwise) and then return it to the center. Transient needle deflections may be noted on the Ml METER TEST meter which should indicate in the orange region; the aircraft control stick should move laterally.

3-24. Troubleshooting chart, Roll control Channel

The troubleshooting chart listed below is baaed on the fact that an operational test has failed. The *Symptom* column indicates the operational test No. that failed and its paragraph reference.

NOTE

Refer to the replacement instructions in paragraph 3-12 before replacing any unit of the automatic flight control system. Unless otherwise indicated, follow the instmctions in paragraph 3-12.

Symptom (test failure)		Probable trouble	Correction
Test No.	Para		
1	3-23 *a*	Defect in analyzer test setup.	Check for defective flight line analyzer cables. connectors, etc.
2	3-23 *b*	*a* .Defective navigational coupler or attitude reference control. If Ml METER TEST meter not indicates in center of orange region or if contact meter needle oscillation is observed. fault may be in either attitude reference control or navigatioal coupler.	*a*. Isolates fault to the navgational couples or attitude reference control as follows: (1) set heading selector indicator (of aircraft radio navigation system) to align with Prevailing heading indicated on heading select instrument. (Refer to applicable aircraft technical manual fur location and operation of radio navigational equipment). (2) Set LATERAL select switch of navigational coupler to HDG position. (3) Rotate heading select knob (of radio navigational system) slowly (approximately 60.°cIockwise and then 60°. counterclockwise) from original setting. If meter needle reponds by moving in one direction and the other as knob is rotated, replace navigational coupler (para 3-47 and 3-48). (4) After unit replacement. repeat test in (1), (2),and (3) above. If faulk persists,replace attitude reference control (para 3-43 and 3-44). Reappearence of fault after replacement indicates possible malfunction in aircraft wiring or flight line analyzer setup. After fault is cleared, recheck interlock and roll control channels tests.
		b. If DSl LAMP TEST lights, a malfunction has occurred since testing was complated in paragraph 3-17 *o*.	*b*. Return to interlock test No. 19 (para 3-17 *s)* and retect If test is satisfactory, perform test No. 2 (para 3-23 *b*).
3	3-23 *c*	*a*. If METER TEST meter deflected and then does not return to orange, fault is in one of units listed in item *2a* above.	*a*. Isolate fault to attitude reference control or navigational coupler *(2a* above).
		b. If Ml METER TEST meter does not deflect remains in orange region. attitude reference control is at fault.	*b*. Replace attitude reference control (para 3-43 and 3-44).
		c. If Ml METER TEST meter does not doflect and returns but motion is not smooth and continuous (motion is jerky). attitude reference control is faulty..	*c*. Replace attitude reference control (para 3-43 and 3-44).
4	3-23 *d*	Same as 3 above	Same as item 3 above.
5	3-23 *e*	Malfunction in attitude reference control relay 2K7.	Replace detective attitude reference control (para 3-43 and 3-44). If fault persists, replace flight controller (para 3-46 and 3-46) and retest. Reappearance of fault after replacement indicates a possible malfunction of aircraft wiring.

Sympton (test failure)		Probable trouble	Correction
Test No.	Para		
6	3-23 *f*	If incorrect indication occurs, malfuction may have developed is a unit previously tested in test No. 1 through 5 (para 3-23 *a* through *e)*.	Repeat tests No. 1 through 5 (para 3-23 *a* through *e)* and replace defective unit.
7	3-23 *g*	If incorrect indication occurs. the fault is in attitude reference control roll level circuitry	Replace defective attitude reference control (para 3-43 and 3-44). If persists. replace flight controller (para 3-45 and 3-48) and retest. Reapperance of fault after replacement indicates malfunction of aircraft wiring.
8	3-22 *h*	If indication occurs, malfunction may nave develped in unit previously tested in tests No.1 through 5(para *3-23a* through *e)*.	Perform test No. 1 through 5 again and replace defective unit.
9	3-23 *i*	*a*. meter does indicate properly.flight controller turn circuitry is defective.	*a*. Replace defective. flight controller (para 3-45 and 3-46).
		b. If DSl LAMP TEST lamp does not indicate properly, flight controller TURN knob detent switch 9S4 is defective.	*b.* Replace defective flight controller (para 3-46 and 3-46).
10	3-23 *j*	*a.* If meter M1 does not indicated property, flight controller turn circuitry is defective.	*a.* Replace defective flight controller (para 3-45 and 3-46).
		b. If DSl LAMP TEST lamp does not indicate properly. flight controller TURN knob detent switch 9S3 is defective.	*b.* Replace defective flight controller (para 3-45 and 3-46).
11	3-23 *k*	*a.* If meter M1 does not indicate properly, flight controller turn circuitry is defec tive.	*a*. Replace defective flight controller (para 3-45 and 3-46).
		b. If DSl LAMP TEST lamp does not indicate properly, flight controller TURN knob detent switch 9S3 or 9S4 is defec. tive.	*b.* Replace defective flight controller (para 3-45 and 3-46).
12	*3-23 1*	Defective vertical qyro	Proceed to test procedure given in test No. 19 (para 3-23s) and skip all test in between. Upon completion of channel testing. replace faulty vertical qyro (para 3-49 and 3-50 and recheck entire axis test sequence.
13	*3-23m*	Defective vertical gyro.	Same as item 12.
14	*3-23n*	*a.* If DSl LAMP TEST lamp lights prior to Ml METER TEST meter indicating in blue region or does not light at all, vertical gyro roll erection control cut-off circuitry is defective.	*a.* Same as item 12.
		b. If Ml METER TEST meter does not deflect from orange to blue region defect is in vertical gyro.	*b*. Same. as above.
		c. If M1 METER TEST meter deflects to full scale blue and DS1 LAMP TEST lamp does not light. fault is in vertical gyro assembly.	*c*. Same as above.
15	*3-23 i*	*a.* If Ml METER TEST meter does not retura toward orange, fault is in vertical gyro	*a.* Same as item 12.
		b. If Ml METER TEST meter meter but DSl LAMP TEST lamp does not extinguish,suspect possible aircraft wiring defet a flight line analyzer test setup.	*b*. Check for defect in aircraft wiring or flight line analyzer test setup.
16	3-23 *p*	*a*. If Ml METER TEST does not deflect from orange to blue region probable fault is defective pitch synchro or pitch brushes in vertical gyro.	*a.* Same as item 12.

Sympton (test failure)		Probable trouble	Correction
Test No.	Para		
		b. If DS1 LAMP TEST lamp lights prior to M1 METER TEST meter indicating in blue region, automatic erection control of vertical gyro is defective.	*b.* Same as *a* above.
		c. If DS1 LAMP TEST lamp does not light at all and M1 METER TEST meter deflects into blue region, navigational coupler VERTICAL select switch 3S5 is defective.	*c.* Proceed to test procedure given in test No.19 (para 3-23 *s)* Upon completion of channel testing, replace faulty navigational coupler (para 3-47 and 3-48) and recheck the entire axis test sequence.
17	3-23 q	Defective erection control module erection cutoff relay in the vertical gyro.	Same as item 12.
18	3-23 *r*	*a.* If DS1 LAMP TEST lamp does not extinguish, but M1 METER TEST meter return to orange region, VERTICAL select switch 3S5 in navigational coupler is defective..	*a.* Same as item 16 *c* above.
		b. If DS1 LAMP TEST lamp extinguishes, but MI METER TEST meter does not return to orange region, relay 1K1 vertical gyro erection control module is defective.	*b.* Replace defective vertical gyro (para 3-49 and 3-50).
19	3-23 *s*	Defective amplifier assembly of roll power unit.	Replace defective amplifier portion of roll power unit (para 3-35 and 3-36).
20	3-23 *t*	*a.* If M1 METER TEST meter does not deflect into blue region, defect is in roll power unit amplifier assembly 5A2.	*a.* Replace defective amplifier portion of roll power unit (para 3-35 and 3-36)
		b. If M1 METER TEST meter deflects into blue but AIL trim meter does not deflect, fault is defective servo effort indicator 9M1 in flight controller.	*b.* Replace defective flight controller (para 3-45 and 3-46).
		c. If M1 METER TEST meter deflects to blue and no aircraft lateral stick motion is observed, fault may be in servo drive assembly 5A1 motor, gear train, or clutch; or should sheared shearpin in drum and bracket assembly.	*c.* Remove both amplifier and servo drive assemblies from power unit drum and bracket assembly. Inspect gear, pin, and shaft assembly in bracket to see if shearpin has failed. If shearpin failure exists, replace entire gear, pin and shaft assembly (para 3-12). **CAUTION** Make sure assembly has correct gear and pin; this is an important replacement. If shearpin has not failed, replace servo drive assembly (para 3-35 and 3-36).
21	3-23 *u*	Defective roll power unit	Replace power unit servo drive assembly and amplifier assembly (para 3-35 and 3-36).
22	3-23 *v*	Defective motor in roll power unit servo drive assembly 5A1.	Replace defective roll power unit servo drive assembly (para 3-35 and 3-36).
23	3-23 *w*	*a.* IF M1 METER TEST meter does not have steady-state orange indication, fault has developed in power unit assemblies previously tested in tests No. 19 through 22.	*a.* Repeat tests No.19 through 22 in order. If no fault is detected, check flight line analyzer test setup.
		b. If no aircraft lateral stick motion exists, roll trim potentiometer 9R1 in flight controller is defective.	*b.* Replace defective flight controller (para 3-45 and 3-46).

3-25. Yaw Control Channel, General Instructions

a. Test the yaw control channel functions with the flight line analyzer S1 CHANNEL SELECTOR switch in position D and the S2 TEST SELECTOR switch rotated through its test position (para 3-26).

b. Complete the interlock system operational tests (para 3-17) before performing the in operational tests for the yaw axis control channels.

c. If an equipment malfuction is indicated during a yaw axis test, refer to the yaw control channel troubleshooting chart (para 3-27). The symptoms given in the chart are cross-indexed with the operational test numbers.

d. Unless otherwise instructed, leave all automatic flight control system and flight line analyzer switches in the position occupied during the previous test.

3-26. Operational Tests, Yaw Control Channel

a. Yaw Control Channel Initial Test (Test No. 1).

(1) Place all automatic flight control system switches in the off or deenergized position.

(2) Set fIight controller roll control TURN knob in detent.

(3) Turn the S1 CHANNEL SELECTOR switch of the flight line analyzer to position D and switch S2 to OFF. The Ml METER TEST meter should indicate in the orange region and the DSl LAMP TEST lamp should not light.

b. Yaw Control Channel Attitude Reference synchronization check (Test No. 2). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 1. The DS1 LAMP TEST lamp should be extinguished. Transient needle deflections may be noted on the M1 METER TEST motor but the final steady-state reading should be in the orange region.

c. Yaw Control Channel Simulated Attitude Synchronization Check (Test No. 3). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 2. The M1 METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region with a continuous and smooth motion.

d. Yaw Control Channel E-Z Simulated *Synchronization Check (Test No. 4).* Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 3. The M1 METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region with a continuous smooth motion in the opposite direction from the deflection in test No. 2 *(c* above); the magnitude into the blue region should be approximately the same as that observed in test No. 3 *(c* above).

e. Yaw Control Channel Demodulator Gain check (Test No. 5). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 4. Ml METER TEST meter should read in the blue region (a maximum meter deflection may be noted).

f. Flight Controlled TURN Knob Command Signal Interlock Check (Test NO. 6). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 8. The M1 METER TEST meter needle should deflect from the blue to the orange region.

g. Yaw Control Channel Realignment Synchronization Check (Test No. 7). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 12. Transient deflections may be noted on the M1 METER TEST meter but thee final steady-state meter reading should be in the orange region.

h. Flight Controller TURN Knob Clockwise Detent Check (Test No. 8).

(1) Turn the S2 TURN SELECTOR switch of the flight line analyzer to position 13.

(2) Rotate the flight controller roll control (TURN Knob) fully clockwise. The Ml METER TEST meter should indicate in the orange region and the DS1 LAMP TEST lamp should light.

i. Flight Controller TURN Knob Counterclockwise Detent Check (Test No. 9). Rotate the TURN knob fully counterclockwise. The M1 METER TEST meter should indicate in the orange region and the DS1 LAMP TEST lamp should light.

j. Flight Controller TURN Knob Detent Switch Actuated Check (Test No. 10). Return the TURN knob to detent. The Ml METER TEST meter should indicate in the orange region and the DS1 LAMP TEST lamp should extinguish.

NOTE

For tests No. 11, 12, and 13, compass alignment and slaving may be conducted on compasses which have manual slaving provision. An optional method, if desired, is to unbolt the compass and, rotate it approximately 10^{o}. counterclockwise and then 10^{o} clockwise.

CAUTION

Make sure the compass is firmly bolted to its mounting after completing these tests.

k. Aircraft Compass Synchronization Alignment Check (Test No. 11).

(1) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 14.

(2) Align the aircraft compass. Transient needle deflections may be noted on the Ml METER TEST meter but the final steady-state Reading should be in the orange region.

l. Aircraft Compass Clockwise Slaving *Check (Test No. 12).*

(1) Turn the S2 TEST SELECTOR switch to position 15.

(2) Slave the compass 10^{o} clockwise. The Ml METER TEST meter needle should deflect from the orange region to the blue region and gradually *return* to the orange region.

NOTE

Proceed to the next test when the meter needle returns past the 30-percent index in the yellow region; do not await the complete return to orange. If a compass fault is suspected, wait until a complete return is observed. A complete return should take between 1 and 4 minutes. If the meter pointer begins to return and no compass malfunction is suspected, the operator may speed up the return of the pointer by slaving it back or returning the compass to its original position.

m. Aircraft Compass Counterclockwise Slaving Check (Test No. 13). Slave the compass 10^{o} counterclockwise. The Ml METER TEST meter needle should deflect from the orange region to the blue region in the opposite direction from deflection as noted in test No. 12 (1 above) and gradually return to the orange region.

NOTE

Proceed to the next teat when the meter needle returns past the 30-percent index in the yellow region: do not await the complete return to orange. If a compass fault is suspected, wait until a complete return is observed. A complete return should take between 1 and 4 minutes. If the meter pointer begins to return and no compass malfunction i *suspected,* the operator may speed up the return of the pointer by slaving it back or returning the compass to its original position.

n. Yaw *Power* Unit *Amplifier Balance Check (Test No. 14).*

(1) Turn the S2 TEST SELECTOR switch to position 17.

(2) Adjust the Rl BALANCE knob until M1 METER TEST meter indicates in the orange region and then lock R1 by turning the LOCK knob.

NOTE

This is a sensitive teat; rotate the Rl knob slowly in the positive (+) or negative (-) direction until the meter indicated in the orange region.

o. Yaw Power Unit Amplifier Balance check (Test No. 15).

(1) Unlock and center the aircraft directional (rudder) pedals

(2) Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 18. The Ml METER TEST meter needle should deflect into the blue region, the aircraft directional (rudder) pedals should move, and the flight controller (RUD) meter should deflect.

CAUTION

DO not leave S2 in position 18 for more than 15 seconds to prevent the power unit from overheating and becoming damaged.

p. Yaw *Power* Unit *Displacement Gain Check (Test No. 16).* Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 19. Transient needle deflections may be noted on the M1 METER TEST meter but the final steady-state reading should be either in the yellow or blue region.

q. Yaw *Power Unit Closed Loop Synchronization and Motor Threshold Check (Test No. 17).* Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 20. Transient needle deflections may occur on Ml METER TEST meter but the final steady-state reading should be in the orange region.

r. Yaw Control Channel Accelerometer Check (Test No. 18). Turn the S2 TEST SELECTOR switch *of* the flight line analyzer to position 22. The Ml METER TEST meter should indicate in the orange region but may offset into the yellow region if the aircraft is not level.

s. Yaw Control Channel Accelerometer Clockwise. Gain Check (Test No. 19). Unbolt the accelerometer and rotate it 90^{o} clockwise about its sensitive aria. The Ml METER TEST meter needle should deflect into the blue region.

t. Yaw Control Channel Accelerometer

Counter&c&wise *Gain Check (Test No. 20).* Unbolt the accelerometer and rotate it 90° counterclockwise about its sensitive axis The M1 METER TEST meter needle should deflect into the blue region.

3-27. troublshooting chart, Yaw control Channel

The troubleshooting chart listed below is based on the fact that an operational test has failed. The Symptom column indicates the operational test *No.* that failed and its paragraph reference.

NOTE

Refer to the automatic flight control system replacement instruction in paragraph 3-12 before replacing a unit of the automatic flight control system. unless otherwise indicated, follow the instructions in paragraph 3-12.

Sympton (test failure)		Probable trouble	Correction
Test No.	Para		
1	3-2 *a*	Defective cable connections between flight line analyzer and automatic flight control system test connectors.	Check for defective cables and connectors.
2	3-26 *b*	*a.* If Ml METER TEST meter indicates other than in orange region, fault is in attitude reference control yaw control channel synchronization circuitry.	*a.* Replace defective attitude reference control (para 3-48 and 3-44).
		b. If DSI LAMP TEST lamp lights, malfunction has developed since indicated test (para 3-17 *s).*	*b. Return to* interlock text No. 19 (para 3-17 s) and retext. If text is satisfactory recheck in text 2 (para 3-21).
3	3-26 *c*	*a.* If meter M1 needle deflects and does not return to orange region is in attitude reference control.	*a.* Replace defective attitude reference control (para 3-43 and 3-44).
		b. If meter M1 does not deflects but remains in orange region, attitude reference control is at fault.	*b.* Replace defective attitude reference control (para 3-43 and 3-44).
		c. If meter M1 needle deflects and returns, but motion is not smooth and continuous (motion is jerky), attitude reference control is defective.	*c.* Replace defective attitude reference control (para 3-43 and 3-44).
4	3-26 *d*	same as test No.3 above.....	Same as test No. 3 above.
5	3-26 *e*	Defective relay in attitude reference control.	Replace defective attitude reference control (para 3-43 and 3-44).
6	3-26 *f*	Defective turn control relay 2K6 in attitude reference control.	Replace defective attitude reference control (para 3-43 and 3-44).
7	3-26 *g*	If incorrect indication occurs, malfunction may have developed in component previously checked in test No.1 through 5 (attitude reference control).	Repeat test No. 1 through 5 (para 3-26 *a* through *e).*
8	3-26 *h*	*a.* If DS1 LAMP TEST lamp does not light. roll control (TURN knob) switch (is flight controller) in defective.	*a.* Replace defective flight controller (para 3-45 and 3-46).
		b. If M1 METER TEST meter indicates other than in orange region, malfunction may have developed in component previously checked in tests No. 1 through 5 (attitude reference control).	*b.* Repeat tests No.1 through 5 (para 3-26 *a* through *e).*
9	3-26 *i*	*a.* If DS1 LAMP TEST lamp does not light, roll control (TURN knob) detent switch (in flight controller) is defective.	*a.* Replace defective flight controller (para 3-45 and 3-46).
		b. If METER TEST meter indicates other then in orange region, a malfunction may have developed in component previously checked in tests No. 1 through 5 (attitude reference control).	*b. Repeat tests No.* 1 *through* 5 (para 3-26 *a* through *e).*
10	3-26 *j*	*a.* If DSl LAMP TEST lamp does not extinguish roll control (TURN knob) detent switch (in flight controller) is defective.	*a.* Replace defective flight controller (para 3-45 and 3-46).

Symptom (test failure)		Probable trouble	Correction
Test No.	Para		
		b. If METER TEST meter indicates than in orange region, a malfunction may have developed in component previously checked in test No.1 through 5 (attitude reference control).	*b.* Repeat tests No. 1 throuch 5 (para 3-23 *a* through *e*).
11	3-26 *k*	Defective aircraft compass.	Proceed to test procedure given in paragraph 2-26 *n.*
12	3-26 *l*	Defective clockwise slaving in aircraft compass.	Proceed to test procedure given in paragraph 3-26 *n.*
13	3-26 *m*	Defective counterclockwise slaving in aircraft compass.	Replace defective aircraft compass.
14	3-26 *n*	Defective power unit amplifier assembly 6A2.	Proceed to test procedure given in test No. 18 (para 3-26 *r)* and skip all tests in between. Upon completion of channel testing. replace faulty amplifier on the power unit (para 3-35 and 3-36) and recheck the entire axis test sequence. Amplifier assembly may be replaced without removing entire power unit.)
15	3-26 *o*	*a.* If M1 METER TEST meter does not deflect into the blue region, defect is in yaw power unit amplifier assembly 6A2.	*a.* Same as item 14 above
		b. If M1 METER TEST meter deflects into blue region and, RUD trim meter does not deflect, fault is defective flight controller.	*b.* Replace defective flight controller (para 3-45 and 3-46).
		c. If M1 METER TEST meter deflects to blue and no aircraft RUDDER PEDAL motion is observed. fault may be in servo drive assembly M1 (motor, gear trim, or clutch or shearpin in drum and bracket assembly).	*c.* Remove both amplifier and servo drive assemblies from power unit drum and bracket. Inspect gear, pin, and shaft assembly in drum and bracket assembly to see if shearpin has failed. If shearpin has failed. replace entire gear, pin. and shaft assembly (para 3-12). **CAUTION** Make sure assembly has correct gear and pin; this is a critical replacement. If shearpin has not failed,replace servo drive assembly (para 3-35 and 3-36).
16	3-26 *p*	Defective yaw power unit amplifier assembly.	Replace power unit servo drive assembly (para 3-35 and 3-36).
17	3-26 *q*	Defective motor in yaw power unit servo drive assembly 6A1.	Proceed to test procedure given in test No. 18 (para 3-26 r). upon completion of channel testing. replace fault servo drive assembly (para 3-35 and 3-36) and recheck the entire axis test sequence.
18	3-26 *r*	If the M1 METER TEST meter indicates in the blue region, accelerometer demodulator 7A1 is defective.	Replace defective accelerometer (para 3-33 and 3-34).
19	3-26 *s*	If no meter reading is observed, demodulator 7A1 (accelerometer subassembly) is defective.	Replace defective accelerometer (para 3-33 and 3-34).
20	3-26 *t*	If no meter reading is observed, demodulator 7A1 accelerometer subassembly is defective.	Replace defective accelerometer (para 3-33 and 3-34).

3-28. Altitude Control Channel Tests, General Instructions

a. Test the altitude control channel functions with the flight line analyzer S1 CHANNEL SELECTOR switch in position E and the S2 TEST SELECTOR switch rotated through its

test positions (para 3-29).

b. Complete the interlock system operational tests (para 3-17) before performing the operational tests for the altitude control channel.

c. If an equipment malfunction is indicated during an altitude control channel test, refer to the altitude control channel troubleshooting chart (para 3-30). The symptoms given in the chart are cross-indexed with the operational test numbers.

d. Unless otherwise instructed, leave all automatic flight control system and flight line analyzer switches in the positions occupied during the previous teat.

3-29. Operational Tests, Altitude Control

a. Altitude Control *Initial Test (Test No.* ***1).***

(1) Check to see that all automatic flight control system switches are in the off or disengaged position.

(2) Turn the Sl CHANNEL SELECTOR switch of the flight line analyzer to position E and the S2 TEST SELECTOR switch to OFF. The Ml METER TEST meter should read in the orange region and the DSI LAMP should not light.

b. Altitude Control Attitude Reference Control Synchronization Check (Test No. 2). Turn the S2 TEST SELECTOR switch of the flight line analyzer to position 1. Transient needle deflections may occur on the M1 METER TEST meter but the final steady-state reading should be in the orange region.

c. Altitude Control Simulated Attitude Synchronization Check (Test No. 3). Turn the S2 TEST SELECTOR switch to position 2. M1 METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region with a continuous, smooth motion.

d. Altitude Control E-Z Simulated Syn*chronization Check (Test No. 4).* Turn the S2 TEST SELECTOR switch to position 3. M1 METER TEST meter needle should deflect from the orange region to the blue region and back to the orange region with a continuous smooth motion in the opposite direction from the deflection observed in test No. 3 *(c* above); the magnitude of deflection into the blue region should be approximately the same as the deflection observed in teat No. 3 *(c* above).

e. Attitude Reference Cotrol Pitch *Check (Test No. 5).* Turn the S2 TEST SELECTOR switch to position 4. The Ml METER TEST meter should indicate in the blue region; a maximum meter deflection may be noted.

f. Dc Barometric Altitude Control Signal Interlock Check (Test No. 6).

(1) Turn the S2 TEST SELECTOR switch to position 5.

(2) Turn the VERTICAL *select* switch on the navigational coupler to BAR. The Ml METER TEST meter should indicate in the orange region.

g. DC Barometric Altitude Contro Displacement Gain Check (Test No. 7). Move the navigational coupler VERTICAL engage switch (altitude) to ON. The Ml METER TEST meter needle deflection should cycle back and forth between the two blue regions with a continuous, smooth motion.

h. Synchronization Control Realignment Check (Test No. 8) Turn the S2 TEST SELECTOR switch to position 6. The navigational coupler VERTICAL engage switch (altitude) should disengage. Transient deflection may be noted on the Ml METER TEST meter but the final steady-state indication should be in the orange region.

i. Altitude Control AC Barometric Altitude Integral Gain Check (Test No. 9).

(1) Turn the S2 TEST SELECTOR switch to position 7.

(2) Move the VERTICAL engage switch (altitude) on the navigational coupler to ON. The Ml METER TEST meter needle should cycle back and forth between the two yellow regions on the meter.

NOTE

If deflections are symmetrical, a cycled meter deflection is acceptable within a tolerance limit which is bounded by the 40-percent index in the blue region and the outer edge of the orange region (10-percent index).

j. Altitude Control AC and DC Barometric Channel Balance Check (Test No. 10).

(1) Turn the S2 TEST SELECTOR switch to position 13.

(2) The navigational coupler VERTICAL engage switch (altitude) should disengage.

(3) Move the VERTICAL engage switch (altitude) on the navigational coupler to ON. The Ml METER TEST meter should read in the orange region.

A. Altitude Control Barometric Sensor Electrical Pickoff Check (*Test* No. *11).* Turn the S2 TEST SELECTOR switch to position 22. M1 METER TEST meter should read in the orange region.

1. Altitude Control Barometric Sensor *Engagement, Null. and Sensitivity Check (Test No. 12).*

(1) Move the AUTO PILOT engage switch (attitude) on the navigational coupler to ON.

(2) If desired or 'if fault is suspected. connect a pilot static tester (MB-l) to the altitude control static pressure port and simulate altitude changes.

(3) Move the VERTICAL engage switch (altitude) on the navigational coupler to ON. The Ml METER TEST meter should read in the orange region when zero pressure differential is applied to the port. The application of a ±300-foot simulated altitude pressure differential should result in a test meter needle deflection into the blue region.

m. Pilot Release Switch Damgage Function Check (Test No. 13).

(1) Turn the S2 TEST SELECTOR switch to OFF.

(2) Depress and release the pilot release switch on the control stick. The AUTO PILOT engage switch (attitude) and the VERTICAL engage switch (altitude) should disengage.

3-30. Troubleshooting Chart, Altitude Control

The troubleshooting chart listed below is based on the fact that an operational test has failed. The Symptom column indicates which operational test No. has failed and its paragraph reference.

NOTE

Refer to the replacement instructions in paragraph 3-12 before replacing any unit of the automatic flight control system. Unless otherwise insructed. follow the instructions in paragraph 3-12.

Sympton (test failure)		Probable trouble	Correction
Test No.	Para		
1	3-29 *a*		Check for defective flight line analyzer cables and connectors
2	3-29 *b*	If M1 METER TEST meter does not read in center of orange region, fault is in attitude reference control synchronization circuitry or navigational coupler.	To isolate trouble to attitude reference control or navigational coupler, continue or navigational coupler, continue troubleshooting in the following manner: Proceed to tests No.3 and 4(para 3-26 *c* and *d)* in order. The navigational coupler is at fault and should be replaced if during test No.3 or 4 meter needle synchronizes (deflects away from the reading noted in test No.2 by at least 40-meter increments and then returns back to this offset value). If meter does not synchronize, replace attitude reference control (para 3-34 and 3-44). Reappearance of fault after both units have been replaced indicates a possible aircraft wiring fault
3	3-29 *c*	*a.* If M1 METER TEST meter does not deflect out of orange reading, attitude reference control is defective.	*a.* Replace attitude reference control (para 3-43 and 3-44).
		b. If M1 METER TEST meter deflects into blue region and does not return to orange region, attitude reference is defective.	*b.* Replace attitude reference control (para 3-43 and 3-44).
		c. If M1 METER TEST meter needle deflects and returns but motion is not smooth and continuous, pitch servo assembly 2A6 or synchronizer amplifier 2A5 in attitude reference control is fective.	*c.* Replace defective attitude reference control (para 3-43 and 3-44).
4	3-29 *d*	same as 3 above	Same as 3 above.
5	3-29 *e*	Defective relay 2K2 in attitude reference control.	Proceed to test No. 12 (para 3-29) and skip all tests in between. Upon completion of channel testing, replace attitude reference control and recheck entire control channel test sequence.
6	3-29 *f*	Defective relays 3K4 and 3K5 in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48.

Symptom (text failure)		Probable trouble	Correction
Text No.	Para		
7	3-29 *g*	Defective VERTICAL select switch 3S5, relay 3K4 or 3K5, or defective vertical control channel 3A5 in navigational coupler.	Replace defective navigational coupler (papa 3-47 and 3-48
8	3-29 *h*	If incorrect indication occurs, a malfunction may have developed in a component previously checked in test No. 1 through 5.	Repeat tests No.1 through 5 (para 3-29 *a* through *e)*.
9	3-29 *i*	Defective vertical calibration card 3A6, VERTICAL select switch 3S, or relays 3K4 and 3K5 in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48).
10	3-29 *j*	Defective vertical axis channel 3A5, vertical calibration card 3A6, relays 3K4 and 3K5 in navigational coupler.	Replace defective navigational coupler (para 3-47 and 3-48).
11	3-29 *k*	Defective control assembly 8A1 or demodulator 8A2 in altitude control.	Replace defective altitude control (para 3-41 and 3-42).
12	3-29 *l*	Defective control assembly 8A1 or demodulator 8A2 in altitude control.	Replace defective altitude control (para 3-41 and 3-42).
13	3-29 *m*	Defective navigational coupler	Replace defective navigational coupler (para 3-47 and 3-48).

3-31. Stopping Procedure

a. Turn the flight line analyzer S1 CHANNEL SELECTOR switch and S2 TEST SELECTOR switch to OFF.

b. Turn all aircraft primary power switches to off.

c. Disconnect cables No. 1 and No. 2 of the flight line analyzer from the aircraft test connector.

3-32. Reconnecting Procedure

a. Reconnect automatic flight control system jumper plug W2P1 to the aircraft test plug connector: replace the dust cap on the connector.

CAUTION

The automatic flight control system will not operate if jumping plug W2P1 is not in place

b. Return all aircraft manual controls to their neutral position and lock the controls. (Refer to aircraft technical manual.)

c. Reenergize the glidepath, radar altitude, VOR/LOC, and Doppler navigation system circuit breakers

d. Check to see that the aircraft compass and accelerometer are firmly bolted in place if the units were unbolted during testing.

Section III. COMPONENT REMOVAL AND REPLACEMENT

3-33. Removal of Accelerometer, Aircraft MX-2916(*)/ASW-12(V)

a. Disconnect the electrical connector.

b. Disconnect the ground wire from the air frame.

c. Note the position of the arrow on the case.

d. Remove the four mounting screws, note the mounting position, and remove the accelerometer.

3-34. Replacement of Accelerometer, Aircraft MX-2916(*)/ASW-12(V)

a. Place the new accelerometer in the same position from which the old accelerometer was removed and secure it with the four mounting screws.

b. Connect the ground wire to the airframe.

c. Connect the electrical connector.

d. Record the hour of operation.

3-35. Removal of Actuators, Electro-Mechanical, Rotary TG-78(*)/ ASW-12(V).

and TG-80(*)/ASW-12(V)

a. Disconnect the electrical connector (fig. 1-5).

b. Loosen the four captive screw at the slanting break in the case which hold the servo drive assembly to the output drum and bracket assembly. (The screws are seen easily when the direction power unit is viewed from above.)

c. Lift up on the servo drive assembly to

remove it from the output drum and bracket assembly.

d. Loosen the four screws (fig. 3-1) and remove the four washers; remove the calibration card from the power units.

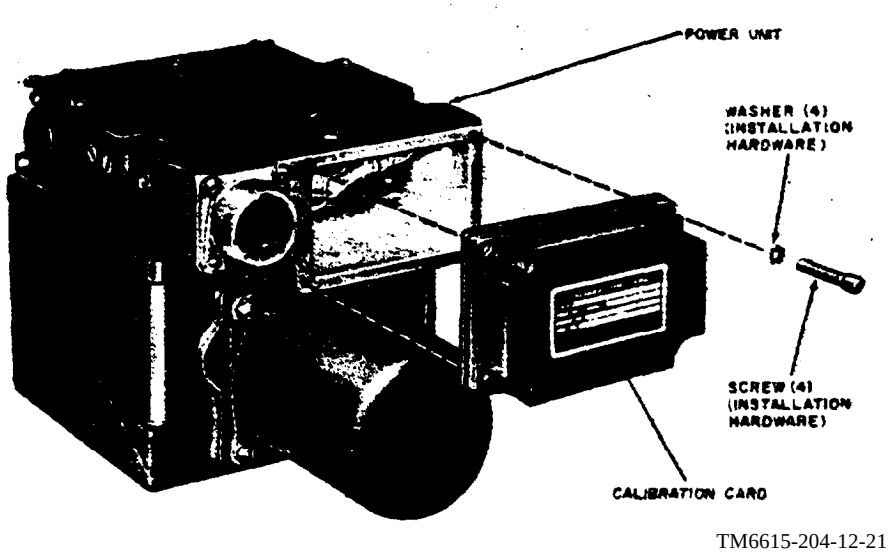

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Figure 3-1. Calibration card, mounting location.

NOTE

Do not remove the output drum and bracket assembly from the helicopter.

3-36. Replacement of Actuators, Electro-Mechanical, Rotary TG-78 (*)/ASW-12(V), and TG-80(*)/ ASW-12(V)

a. Replace the servo drive assembly on the drum and bracket assembly (fig. 1-5). Refer to (1) and (2) below.

(1) The power drive ratio of each power unit is identified by three colored decal. The decals are located on the drum and bracket assembly, the servo drive assembly (fig. 1-6). and in the aircraft near the area where the drum actuator is installed.

2. The variable drive ratios and their corresponding colored decals are listed in the chart below:

Power drive ratio	*Color of decal*	*Color of characters*
18:1	Black	white
30:1	Brown	white
50:1	Red	white
90.4:1	Yellow	Black
148.1:1	Blue	White
248.0:1	Gray	Black

b. Tighten the four captive screws at the slanting break in the case.

c. Connect the electrical connector.

d. Replace *the* calibration card on the power unit (fig. 3-1).

e. Replace the four washers and tighten the four screws.

NOTE

When replacing a power unit, be sure to remove the calibration card and reinstall it in the replacement power unit as shown in figure 3-1. when a replacement calibration card is supplied. compare the part numbers on each calibration card to be sure the parts are the same.

f. Record the hours of operation.

3-37. Romoval of Actuator, Electro-Mechanical, Rotary TG-81(*)/ASW-12(V)

Remove the trim power unit as follows:

a. Disconnect the electrical connector (fig. 1-7).

b. Loosen the four captive screws (fig. 1-7) that secure the trim servo drive assembly to the drum and bracket assembly.

c. Lift the trim servo drive assembly straight up from the drum and bracket assembly.

NOTE

Do not remove the drum and bracket assembly.

3-38. Replacement of Actuator, Electro-Mechanical, Rotary TG-81(*)/ASW 12(V)

Replace the trim power unit as follows:

CAUTION

The slip clutch assembly and the differential screw and thimble (electrical limit stop) must be adjusted in accordance with the values specified in the aircraft technical manual trim power can be installed installed in the aircraft. To make the settings, refer to the instructions given in the aircraft technical manual.

a. connect the automatic flight control system power cable to the trim servo drive assembly electrical connector (fig. l-7). Place the trim servo drive assembly in a position where it will drive without interference.

b. Apply power to the automatic flight control system and engage the automatic flight control system by performing the procedure given in paragraph 3-5.

c. Gently overpower the pitch power unit by pushing the aircraft flight controller pitch control (beep switch) forwvd for 15 seconds. Stop the forward motion for 30 seconds and continue to apply pressure at 15-second intervals until the trim servo drive assembly stops driving. If the trim servo drive assembly does not drive, pull the pitch control (beep switch) back until the trim power unit electrical limit is reached and then push the pitch control (beep switch) forward.

CAUTION

Do not push the pitch control (beep switch) forward for periods longer than 15 seconds. Replace the pressure on the Pitch Control (beep switch) for 30 seconds between each 15-second interval. If the EL serve effort indicator needle in the flight control (fig. 2-2) travels more than one needle width per minute the pitch power unit may become damaged.

d. P1ace the AUTO PILOT engage switch (attitude) in the off position.

e. Rotate the aircraft manual trim wheel to the nosedown automatic pitch trim limit (degrees) as specified in the literature furnished with the aircraft.

f. Disconnect the automatic flight control system power cable from the trim servo drive assembly. Place the trim servo drive assembly onto the drum and bracket assembly in the aircraft.

NOTE

Be sure the pinion gear in the trim servo drive assembly meshes with the output drum drive gear.

g. Tighten the four captive screws that secure the trim servo drive assembly to the drum and bracket assembly. Connect the automatic flight control system power cable to the trim servo drive assembly electrical connector

h. Rotate the aircraft manual trim wheel to the neutral (0^o) position.

i. Engage the automatic flight control system by placing the AUTO PILOT engage switch (attitude) in the ON position.

j. Repeat the procedure in c above. Check the aircraft manual trim wheel to see if it has rotated to the nosedown automatic pitch trim limit (degree) specified in the literature furnished with the aircraft.

k. Gently overpower the pitch power unit by pulling the aircraft flight controller pitch control (beep switch) back for 15.second intervals. Stop the backward motion for 30 seconds and continue to apply pressure at 15-second intervals until the trim servo drive assembly stops driving.

CAUTION

Do not pull the flight controller pitch control (beep switch) back for periods greater than 15 seconds. Release the pressure on the flight controller pitch control (beep switch) for 30 seconds between each 15-second interval. If the EL servo effort indicator needle in the flight controller travels more than one needle width par minute, the pitch power unit may become damaged.

l. Check the manual trim wheel to see if it has rotatad to the noseup automatic pitch trim limit (degrees) Specified in the literature furnished with the aircraft.

m. Repeat the procedures in *c* through (above as necessary to obtain the proper manual trim wheel rotations.

n. Secure the trim power unit captive screws (fig. 1-7) with sefety wire and record the hours of operation.

3-39. Removal of Calilbration Units MX-2917/ASW-12(V),MX-2918/ASW -12(V), and MX-2919/ASW-12(V)

(fig. 3-1)

a. Loosen the four screws and remove the *four* washers.

* U.S. GOVERNMENT PRINTING OFFICE: 1979-[illegible]

b. Remove the calibration card from the power unit.

3-40. Replacement of Calibration Units MX-2917/ASW-12(V), MX-2918/ASW -12(V),and MX-2919/ASW-12(V)

a. Replace the calibration card on the power unit.

b. Replace the four washers and four screws. and tighten.

3-41. Removal of Control, Altitude. Automatic Pilot C-3106/ASW-12(V)

(fig. 1-9)

a. Disconnect electrical connector J1.

b. Disconnect the static pressure input.

c. Remove the three mounting screws and remove the altitude control.

3-42. Replacement of Control, Alititude, Automatic Pilot C-3106/ASW-12(V)

(fig. l-9)

a. Place the new altitude control in position and secure it with the three mounting screws.

b. Connect the static pressure input.

c. Connect electrical connector Jl.

d. Record the hours of operation.

3-43. Removal of Control, Altitude, Reference C-3108(*)/ASW-12(V)

(fig. 1-10)

a. Remove electrical connectors J1, J2, and J3.

b. Remove the four mounting screws and remove the directional reference control.

3-44. Replacement of Control Altitude, Reference C-3108(*)/ASW-12(V)

(fig. 1-10)

a. Place the new directional reference control in position and secure it with the four mounting screws.

b. Connect electrical connectors J1, J2, and J3.

c. Record the hours of operation.

3-45. Romoval of Controller, Flight, Automatic Pliot C-3107(*)/ASW -12(V)

(fig. 1-12)

a. Disconnect the electrical connector.

b. Remove the three mounting screws from the underside of the flight controller.

c. Remove the flight controller.

3-46. Replacement of Controller, Flight, Automatic Pilot C-3107(*)/ASW -12(V)

(fig. l-12)

a. Place the new flight controller in position and secure it with the three mounting screws.

b. Connect the electrical connector.

c. Record the hours of operation.

3-47. Removal of Coupler, Navigational CU-792/ASW-12(V)

(fig: 1-13)

a. Unfasten the four quick-disconnect fasteners, releasing the navigational coupler from the instrument panel.

b. Disconnect electrical connectors J1 and J2.

c. Remove the navigational coupler.

3-48. Replacement of Coupler, Navigational CU-792/ASW-12(V)

(fig. 1-13)

a. Connect electrical connectors J1 and J2 to the navigational coupler.

b. Place the new navigational coupler in the instrument panel.

c. Secure the navigational coupler with the four quick-disconnect fasteners.

d. Record the hours of operation.

3-49. Removal of Gyroscope, Displacement CN-601(*)/ASW-12(V)

(fig. 1-14 and 1-15)

a. Disconnect electrical connector J3.

b. Remove the three mounting screws.

c. Remove the vertical gyro.

3-50. Replacement of Gyroscope, Displacement CN-601(*)/ASW-12(V)

(fig. 1-14 and l-15)

a. Place the new vertical gyro in position and secure it with the three mounting screws.

b. Connect electrical connector J3.

c. Record the hours of operation.

APPENDIX A

REFERENCES

The following is a List of referencea applicable to the operation and organizational maintenance of Automatic Flight Control System AN/ASW-12(V)2.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7,8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 11-6625-518-12	Operator and Organizational Maintenace Manual: Analyzers, Flight Line AN/ASM-80 and AN/ASM-80A.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Material to Prevent Enemy Use (Electronics Command).

APPENDIX C

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provider a summary of the maintenance operations covered in the equipment literature. It authorizes categories of maintenance for specific maintenance function on repairable items and components and the tools and equipment required to perform each function This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance functions

Maintenance functions shall be limited to and defined as follows:

a. Adjust. Maintain within prescribed limits by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

b. Align. TO adjust specified variable elements of an item to bring about optimum or desired performance.

c. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy to detect and adjust any discrepancy in the accuracy of the instrument being compared.

d. Inspect. To determine the serviceability of an item by comparing its physical mechanical. and/or electrical characteristics with established standards through examination.

e. Install. The act of emplacing, seating, or fixing into position an item, pert, module (component or assembly) in a manner to allow the proper functioning of the equipment/system.

f. Overhaul. That maintenance effort (service/action) necessary to restore. an item to a completely/operational condition as prescribed by maintenance standards (e.g.. DMWR) in pertinent technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

g. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation include the act of returning to zero those age measurements (hours, miles, et.) considered in classifying Army equipment/components

h. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate. replace) or other material activities (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly module/component/assembly, end item or system.

i. Replace. The act of substituting a serviceable like-type pert, subassembly, module (component or assembly) in a *manner* to allow the proper functioning of an equipment/system.

j. Service. Operations required periodically to keep en item in proper operating condition; i.e., to clean, preserve, drain, paint or to replenish fuel/lubricants/hydrauiic fluids *or* compressed air supplies

k. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

l. Symbols. The uppercase letter placed in the appropriate column indicates the lowest level at which that particular maintenance function is to be performed.

C-3 Explanation of Format

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to match components, assemblies., subassemblies, and modules with the next higher assembly.

b. Column 2, Functional Group. Column 2 lists the next higher assembly group and the item names of components, assemblies, subassemblies and modules within the group for which maintenance is authorized.

c. Column 3, Maintenance Function. Column 3 lists the twelve maintenance functions defined in paragraph C-2 above. Each maintenance function

required for an item shall be specified by the symbol among those listed in d below which indicated the level responsible for the required maintenance. Under this symbol there shall be listed an appropriate work measurement time value determined as indicated in e below.

d. Use of Symbols. The following Symbols shall be used to prescribe work function responsibility:

C-Oparator/crew
O-organixation
F-Direct Support
H-General support
D-Depot

e. Work Measurement Time. The active repair time to perform the maintenance function shall be included directly below the symbol identifying the category of maintenance. The skill levels used to obtain the measurement times shall approximate those found in typical TOE units. Active repair time is the average aggregate time required to restore an item (subassembly, assembly, component, module, and item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, isolation/ diagnostic time, and QA/QC time in addition to the time required to perform specific maintenance functions identified for the tasks authorized in the maintenance allocation chart. This time will be expressed in man-hours and carried to one decimal place (tenths *of hours).*

f. Column 4, Tools and Equipment. This Column shall be used to specify, by code, those tools and and equipment required to perform the designated function.

g. Column 5, Remarks. Self-explanatory.

C-4. Explanation of format of Table I (Tool and Test Equipment Requirements)

The Columns in table I are as follows:

a. Tools and Equipment. The numbers in this column coincide with the numbers used in the tools and equipment column of the maintenance allocation chart. The numbers indicates the applicable tool the maintenance function.

b. Maintenance Category. The *codes* is *this* column indicate the maintenance category normally allocated the facility.

c. Nomenclature. This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

d. Federal Stock Number. This column *lists* the Federal stock number of the specific tool or test equipment.

NOTE

For requisitioning purposes, the Federal stock number must be converted to the National stock number by adding "-00" after the Federal stock classification (FSC) code (first four digits For example, FSN 6625-553-0142 converts to NSN 6625-00-553-0142.

e. Tool Number. Not used.

(Next printed page is C-3)

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	FUNCTIONAL GROUP (2) COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTION (3) INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	(4) TOOLS AND EQUIP-MENT	(5) REMARKS
01	AUTOMATIC FLIGHT CONTROL SYSTEM AN/ASW-12(V)2	0 0.1	0 0.2	0 0.2	0 0.2				0 2.0	0 2.0			3, 9, 15, 31	Replace components.
0101	ACCELEROMETER, AIRCRAFT MX-2916A/ ASW-12(V)	0 0.1	0 0.1	0 0.2					0 0.2				9, 31	
			F 0.2							F 2.5			10, 11, 30	Repair A1 demodulator only.
			H 0.2										2, 5, 8, 10, 11, 16, 33	
											D 3.5		24	Contractor overhaul.
0102	CALIBRATION UNITS MX-2917/ASW-12(V) MX-2918/ASW-12V) MX-2919/ASW-12(V)	0 0.1	0 0.2	0 0.2					0 0.3				9, 31	
			F 0.2							F 1.5			31	
			H 0.2								H 2.5		2, 8, 10, 11, 30	
0103	ACTUATOR, ELECTRO-MECHANICAL, ROTARY TG-78(8)/ASW-12(V) TG-79/ASW-12(V) TG-80(8)/ASW-12(V) TG-81/ASW-12(V)	0 0.1	0 0.1	0 0.1					0 0.3				9, 31	
			F 0.2							F 1.5			10, 30	
			H 0.2										2, 6, 8, 10, 11, 15, 29, 33	
											D 3.5		2, 6, 7, 8, 10, 11, 14, 15, 28, 29, 30, 33	

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	FUNCTIONAL GROUP (2) COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTION (3)											(4) TOOLS AND EQUIP-MENT	(5) REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
0104	CONTROL ALTITUDE, AUTOMATIC PILOT C-3106/ASW-12(V)	0 0.1	0 0.2	0 0.2					0 0.2				9, 31	
			F 0.3							F 1.5			10, 17, 30	
			H 0.3										2, 8, 10, 11, 15, 17, 19, 29, 30	
											D 3.4		2, 8, 10, 11, 15, 18, 19, 20, 31, 32, 33, 34	Control assembly A1 is contractor overhauled.
0105	CONTROLLER, FLIGHT AUTOMATIC PILOT C-3107(*)/ASW-12(V)	0 0.1	0 0.2	0 0.2	0 0.2				0 0.2				9, 31	
			F 0.3							F 1.5			10, 30	
			H 0.3										2, 8, 10, 11, 15, 19, 29, 30	
											D 3.4		2, 8, 10, 11,15, 19, 20, 21, 31, 32, 33, 34	

SECTION XI. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	FUNCTIONAL GROUP (2) COMPONENT ASSEMBLY NOMENCLATURE	INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	(4) TOOLS AND EQUIP-MENT	(5) REMARKS
0106	CONTROL, ATTITUDE REFERENCE C-3108(*)/ ASW-12(V)	0 0.1	0 0.2	0 0.2					0 0.2				9, 31	
			F 0.3							F 1.5			10, 30	
			H 0.3										2, 8, 10, 11, 15, 19, 26, 29, 30	
											D 3.4		2, 8, 10, 11, 15, 19, 20, 26, 31, 32, 33, 34	
0107	GYROSCOPE, DISPLACEMENT CN-601(8)/ASW-12(V)	0 0.1	0 0.2	0 0.2					0 0.3				9, 31	Replace complete assembly
			H 0.3			H 0.2				H 3.0			2, 4, 8, 10, 11, 13, 15, 16, 30	No repair for sealed gyroscope subassembly.
											D 4.1		2, 4, 8, 10, 11, 13, 15, 16, 24, 25, 27, 32, 33, 35	Sealed gyroscope is contractor overhauled
0108	COUPLER, NAVIGATIONAL CU-792/ASW-12(V)	0 0.1	0 0.2	0 0.2	0 0.2				0 0.3				9, 31	
			F 0.2			F 0.3				F 3.5			10, 30	
			H 0.2										1, 2, 8, 10, 11, 12, 15, 23, 29	
											D 4.7		1, 2, 7, 8, 10, 11, 12, 15, 22, 23, 29, 30, 34	

TABLE I. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOLS AHD EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL NUMBER	TOOL NUMBER
1	H, D,	AMPLIFIER, DEMODULATOR AM-3261/ASW-12(V)	6110-868-8129	
2	F, H, D	ANALYZER, BENCH TEST AM/ASM-125	6625-987-9381	
3	O, H	ANALYZER, FLIGHT LINE AN/ASM-80	6625-987-9382	
4	H, D	FIXTURE, GYRO ADAPTER MX-3723/ASW-12(V)	6625-987-8532	
5	H, D	FIXTURE, TEST ACCELEROMETER, LINEAR MX-4043ASW-12(V)	6625-987-8595	
6	H, D	FIXTURE, TEST, ROTARY ACTUATOR MX-3719/ASW-12(V)	6625-987-8530	
7	D	MACHINIST DIAL INDICATOR (0.001 SCALE)		
8	F, H, D	MILLIVOLTMETER, METER ME-227/U	6625-892-5117	
9	0	MULTIMETER AN/URM-105	6625-999-6282	
10	F, H, D	MULTIMETER ME-26/U	6625-913-9781	
11	H, D	MULTIMETER TS-352B/U	6625-242-5023	
12	H, D	OSCILLOGRAPH-RECORDER R0-207/ASW-12(V)	6625-658-7870	
13	H, D	OSCILLOSCOPE AM/USM-281	6625-987-6603	
14	H, D	SPRING SCALE (0-501b)		
15	O, F, H, D	STOP WATCH		
16	D	TABLE, TILTING, GYRO TEST MX-4042/ASW-12(V)	4920-889-1880	
17	F, H, D	TESTER, PITOT STATIC (MB-1) AIRCRAFT PRODUCTS 381-100		
18	D	TEST SET, ALTITUDE CONTROL TS-1643/ASW-12(V)	6625-987-8596	
19	H, D	TEST SET, ATTITUDE CONTROL TS-1656/ASW-12(V)	6625-973-4186	

TABLE I. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOLS AND EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL NUMBER	TOOL NUMBER
20	H, D	TEST SET, ATTITUDE REFERENCE CONTROL TS-1659/ASW-12(V)	6625-987-8602	
21	D	TEST SET, AUTOMATIC CONTROLLER TS-1658/ASW-12(V)	6625-987-8601	
22	D	TEST SET, COUPLER TS-1652/ASW-12(V)	6625-987-8599	
23	H, D	TEST SET, COUPLER TS-1661/ASE-12(V)	6625-987-8635	
24	H, D	TABLE, TILTING, GYRO TEST MX-4708/ASW-12(V)		
25	D	TEST SET, DISPLACE GYROSCOPE TS-1644/ASW-12(V)	6625-987-8597	
26	H, D	RESISTOR, DECADE ZM-16/U	6625-669-0266	
27	D	TEST SET, GYRO CONTROL TS-1660/ASW-12(V)	6625-987-8634	
28	H, D	TEST SET, ROTARY ACTUATOR TS-1663/ASW-12(v)	6625-973-4185	
29	H, D	TEST SET, TRANSISTOR TS-1836/U	6625-8932628	
30	F, H, D	TOOL KIT, ELECTRONIC EQUIPMENT TK-100/G	5180-605-0079	
31	0	TOOL KIT, ELECTRONIC EQUIPMENT TK-105/G	5180-610-8177	
32	H, D	VIBRATING MACHINE, GYROSCOPE MX-3722/ASW-12(V)	6615-973-4184	
33	F, H, D	VOLTMETER, METER ME-30/U	6625-643-1670	
34	H, D	VOLTMETER, PHASE ANGLE ME-223/U	6625-810-3917	
35	D	MAGNETIC FIELD COMPASS		

GLOSSARY

APP-A glidepath approach mode providing vertical control of the aircraft so that the aircraft will automatically fly the glide slope path of an ILS system.

Attitude-The position of the aircraft pitch, roll, and yaw axes with respect to fixed references.

Axis-An airplane is considered to have mutually perpendicular axes each passing through the center of gravity. The longitudinal axis, sometimes called the X-axis, runs length wise in the plane of symmetry from fore to aft: the lateral axis, sometimes called the Y-axis runs from side to side: the vertical *or* normal axis, sometimes called the Z-axis, *NM* in the plane of symmetry from the back to the belly.

BAR-A barometric mode providing vertical control of the aircraft by measuring changes in barometric altitude from a selected altitude.

Command signal-A signal introduced into the automatic flight control system by the pilot resulting in a Specific control of the aircraft through the system.

Control channel-An internal channel in the automatic flight control system to provide a movement of the aircraft controls in a particular flight axis or function such as pitch, roll, yaw, collective pitch, and rpm.

Control monitoring- The pilot, when engaging or disengaging the automatic flight control system or when flying on automatic flight control near the ground or other aircraft follows through or monitors the cockpit controls by allowing his hands and feet to ride *on* the controls.

Disengage-To return the aircraft to manual control or place the automatic flight control system or control channel in standby status.

Engage-To select or place the automatic flight control system or a control channel is operation.

Glidepath-The center of the radio beam which provides the correct glide angle for aircraft approach to the runway.

Hardover- A violent movement of the aircraft controls because of manual or automatic flight control system application which would cause a drastic change in aircraft attitude.

HDG- See Heading.

Heading-Course or direction of flight: compass bearing.

ILS-Instrument landing approach system. A system for guiding aircraft during a final ap*proach.* Specifically referring to the glidepath and localizer signals *from* the ILS ,receivers.

Lateral axis- See *Axis.*

LOC-A localizer beam mode providing lateral control of the aircraft so that the aircraft will automatically fly the ILS localizer beam.

Longitudinal axis- See *Axis.*

NAV-A navigational mode providing lateral control of the aircraft automatically to a groundpath preset by a Doppler navigational system.

Overpower- Forcing or holding the aircraft controls away from the position sought by the automatic flight control system.

Pilot release- switch-A pushbutton on the pilot and copilot controls which, when closed, will disengage the automatic flight control system.

Pitch-The movement of an aircraft about its lateral axis.

RAD-A radar altimeter mode providing vertical control of the aircraft so that the altitude of the aircraft will automatically be controlled by a radar altimeter.

Roll-The movement of an aircraft about its longitudinal axis.

Servo effort indicator- Zero-centered dc voltmeter deflecting to either side of the index thereby showing the amount of automatic flight control system effort.

Slide acceleration-The movement of the aircraft on a horizontal plane which generates a centrifugal-type force.

Stabilization-The results of the automatic flight control system effort in maintaining the equilibrium of the aircraft in an established flight mode.

Synchronization-During manual flight, the automatic flight control system continually adjusts or synchronizes its flight references to the existing pitch or heading attitude and to the existing altitude. At engagement, the automatic flight control system will take over smoothly, with *no* aircraft deviation from the existing attitude or altitude.

VOR-Very high frequency omnidirectional radio range. Specifically referring to the signals from the VOR receiver.

Yaw- The movement of an aircraft about its vertical axis; thereby, to change heading.

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Chief of staff

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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