General Information

2-1. INTRODUCTION.

This manual provides specifications, service information and illustrated parts breakdown for the Cessna Nav-O-Matic 400 autopilot. The information contained in this manual is based on the latest data available at the time of publication, and is supplemented and kept current by service letters published by Cessna Aircraft Company. Service letters are sent to all Cessna Dealers to provide complete up to date information for servicing the Nav-O-Matic 400.

2-2. PURPOSE.

The Nav-O-Matic 400 is a two-axis automatic flight control system that governs position of the ailerons and elevators. In addition to holding the wings level and compensating for rotation about the pitch axis, the system provides automatic intercept and hold of any magnetic heading or VOR radial. A command turn, a command pitch, and an altitude hold feature are also included.

2-3. SPECIFICATIONS.

Input Power: Operates on 14 (13.5) or 28 (27.0) volts dc from aircraft primary power supply.
Power Requirement: 2.4 amperes at 13.5 volts and 1.2 amperes at 27.0 volts.
Actuator Disconnect Mechanism: Electric clutch.
Actuator Overpower Mechanism: Mechanical slip clutch.
Actuator Torque: 60 inch-pounds maximum.
Total Weight: 20.3 pounds (not including connectors, interconnecting cables, circuit breaker, or engage switch)

2-4. UNITS AND ACCESSORIES.

The units and accessories for an installation are listed in Table 2-1.

2-5. DESCRIPTION OF UNITS.

Computer Amplifier.

The Computer Amplifier is the major unit of the Nav-O-Matic 400. With the exception of a d-c servo amplifier in each of the actuators, all electronic circuits for the system are contained in this unit. The computer amplifier also houses the altitude sensor mechanism.

Two flanges attached to the sides of the unit provide four drilled mounting holes. Electrical input and output connections are made through three connectors adjacent to one of the mounting flanges. Connection to the static air source is made through a nylon fitting adjacent to the nameplate.

Control Unit.

The Control Unit is a panel-mounted unit used to direct operation of the autopilot. All operating controls for the system are mounted on the front panel of this unit. The functions of these controls are described in table 2-3. An on-off switch mounted on the rear of the unit may be used to disable the attitude gyro while electrically centering the system during installation. The switch disables the attitude gyro when pushed to the left while viewing the rear of the unit.

The dust cover, which is permanently attached to the instrument panel by four mounting screws, serves as a mounting for the control unit. A rotatable tab, controlled by a screw on the front panel, permits removal of the main chassis from the dust cover.

Input and output connections to the control unit are made through three connectors on the rear of the unit.

Attitude Gyro.

The attitude Gyro is an air-driven, panel-mounted instrument which provides a visual indication of the aircraft pitch and roll attitude. Electrical signals representing pitch and roll deviations from straight and level flight are controlled by a-c pickoff windings mounted in the pitch and roll axes. The voltages representing these deviations and input voltages to the unit from the rest of the system are routed through a seven-pin connector mounted on the rear of the instrument case.

Directional Gyro.

The directional gyro is an air-driven, panel-mounted instrument that provides a stable visual indication of the aircraft heading to the pilot and provides electrical heading information data to the autopilot. Heading information is presented to the pilot by a rotating circular dial on the face of the unit. Electrical heading data is sent to the autopilot by a syncro control transmitter which is linked to the dial.

The dial is graduated at five-degree intervals throughout 360 degrees. Major graduations are inscribed at ten-degree intervals. Numerals, with the last digit omitted, define every 30 degrees. The four cardinal compass points are identified. The heading of the aircraft is indicated by an aircraft silhouette inscribed on the glass face. The glass face also includes markers that indicate relative headings of 45, 90, 180, 270, & 315 degrees from magnetic heading. A gyro calibration knob on the front permits the pilot to set the gyro to correspond with the aircraft heading and allows recalibration as required to offset precession.

Power input and signal output connections to the control transmitter are made through a five pin connertor on the rear of the gyro case.

TABLE 2-1. UNITS AND ACCESSORIES

Refer to Table 2-2 for actuators required in a particular aircraft.

NAME	PART NUMBER	DIMENSIONS(inches)			WEIGHT (Pounds)
		Height	Width	Depth	
Actuators	26360-0000 (14 volt Type PA-510A)	4 1/8	7 7/8	4	4.3
	29510-0000 (28 volt Type PA-511A)	4 1/8	7 7/8	4	4.3
	29510-0200 (28 volt Type PA-511A-2)	4 1/8	7 7/8	4	4.3
	29510-0300 (28 volt Type PA-511A-3)	4 1/8	7 7/8	4	4.3
	29510-0400 (28 volt Type PA-511A-4)	4 1/8	7 7/8	4	4.3
	29510-0500 (28 volt Type PA-511A-5)	4 1/8	7 7/8	4	4.3
Computer-Amplifiers	30520-0014 (14 volt Type CA-520A)	5 15/16	5 1/16	11 1/4	5.6
	30520-0028 (28 volt Type CA-520A) (used on 336 and 337 models)	5 15/16	5 1/16	11 1/4	5.6
	30520-1028 (28 volt Type CA-520A) (used on models 310 &320)	5 15/16	5 1/16	11 1/4	5.6
Control Units	30510-1114 (14 volt Type C-520A)	2 11/16	4 7/8	4 3/16	1.0
	30510-1128 (28 volt Type C-520A)	2 11/16	4 7/8	4 3/16	1.0
Gyro-Attitude	30475-0100 (Type G-519A)	3 3/8	3 3/8	7 1/16	2.4
Gyro-Directional	30370-0100 (Type G-520A)	3 3/8	3 3/8	9 1/16	2.7
Filter Kit	35094	—	—	—	—

Principles of Operation

2-6. BASIC PRINCIPLES OF OPERATION

General.

The Attitude Gyro is used to sense changes in the roll or pitch attitude of the aircraft. A change in either of these attitudes from straight and level flight is translated into an error signal by the Computer Amplifier. If an error signal is the result of roll, the roll actuator positions the ailerons to correct the error. If an error is the result of pitch, the pitch actuator positions the elevators to correct the error. If error signals from the roll and pitch attitudes are simultaneous, both actuators will operate at once. With the ailerons in the position necessary to correct a roll error, a feedback voltage, equal in magnitude and opposite in polarity to the error voltage, causes the roll actuator to stop. As the roll angle corrects toward straight and level flight, the error signal decreases; the feedback signal, which was previously equal to the error signal, causes the roll actuator to drive the ailerons toward their neutral position. The aircraft flies smoothly into the desired attitude with the feedback signal continuously reducing the aileron angle as the attitude error decreases.

The method of correcting errors in the pitch attitude is similar to that used for correcting roll errors.

Engagement of Autopilot.

When the Control Unit ON-OFF switch is ON, low-voltage dc is connected through the contacts of power relay K1 to the clutch solenoids of the roll and the pitch actuators. With the clutch solenoids energized, a mechanical linkage is established between each of the actuators and its respective control surface. Motion of the actuators is transmitted through these linkages to the control surfaces.

Roll Hold.

If a wind gust causes the aircraft to roll, the attitude gyro provides an output signal proportional to the deflection of the gyro gimbal from its position during straight and level flight.

An inductive pickoff with one primary and a split secondary winding is mounted adjacent to the gimbal. A movable element attached to the gimbal controls coupling between the primary and secondary windings of the pickoff. When the aircraft is in straight and level flight, coupling between the primary and both secondary windings is equal. If the aircraft rolls, a corresponding deflection of the gimbal will result. This deflection causes a motion of the pickoff element which alters coupling between the primary and secondary windings. Increased coupling between the primary and one secondary winding and decreased coupling between the primary and other secondary winding cause a voltage to appear at the secondary winding output. The phase of this voltage depends on the direction of the roll; the magnitude is proportional to the roll angle.

As shown in Figure 2-2, with the aircraft in a bank, the output of the roll pickoff (roll error signal) is demodulated and coupled through a sensitivity control to the roll chopper-modulator. The sensitivity control is factory-adjusted to limit the roll demodulator output to a voltage representing approximately a 20-degree bank angle. The roll chopper-modulator modulates a 400 cps reference voltage with the roll error signal. This error signal is amplified, demodulated, and coupled to a d-c servo amplifier. The servo amplifier output is applied to the roll actuator servo motor which repositions the ailerons.

A feedback potentiometer in the roll actuator is also repositioned in response to motion of the servo motor. The output of this potentiometer is a d-c voltage representing aileron position and is always equal in magnitude to the error signal. This follow-up voltage serves to tell the computer-amplifier when the aileron is in the desired position by nulling out the error voltage. The aileron, therefore, assumes some position which is directly related to the magnitude and polarity of the error voltage.

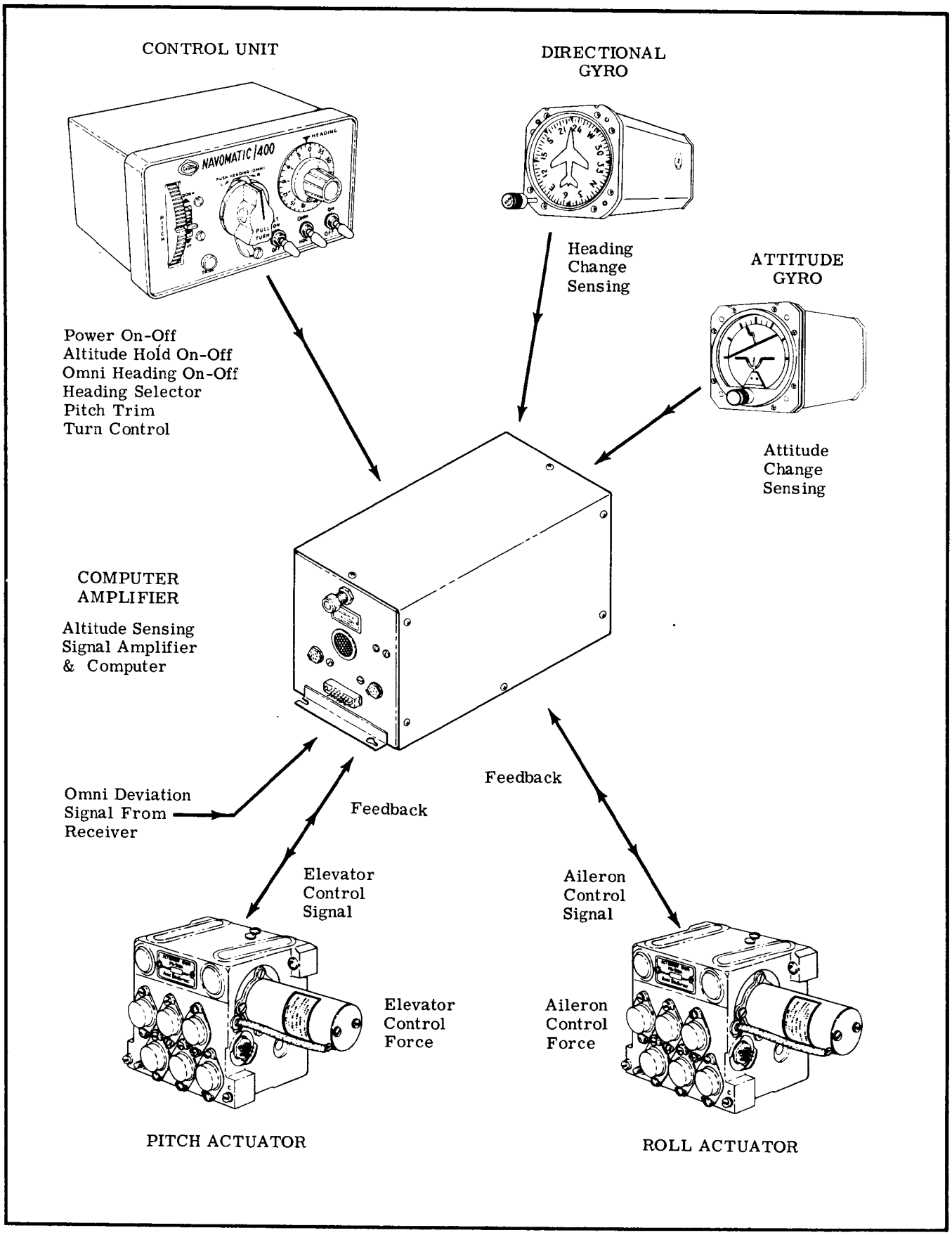

Figure 2-2. Simplified Functional Diagram and Components of the Nav-O-Matic 400