ASE DOMT NOTICES

CH-34

CH-37

STUDENT HANDOUTS

NOVEMBER 1967

UNITED STATES ARMY AVIATION SCHOOL

FORT RUCKER, ALABAMA

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ASE DOMT NOTICES CH-34 AND CH-37 STUDENT HANDOUTS

DEPARTMENT OF MAINTENANCE TRAINING
UNITED STATES ARMY AVIATION SCHOOL
Fort Rucker, Alabama

Section I. COLLECTIVE OPEN LOOP SPRING CYLINDER ADJUSTMENT PROCEDURE

1. Apply 1, 500 psi to the auxiliary hydraulic system.

2. Check to be sure that the altitude channel servo motor is in the center of its travel. This is done by turning on the automatic stabilization system and observing the position of the altitude motor when the stabilization system is in standby.

3. Back off the collective stick friction adjustment so that the stick motion is not restrained.

4. Loosen the NAS 509-4 jam nut and back it off from the rod end; slide the NAS 513-4 lock washer along the shaft so that the rod end is free to turn.

5. If the collective stick drops, when let go, after being placed in mid travel, screw the S1665-61690 shaft out of the S1665-61686 rod end until the stick will stay where placed.

6. If the stick rises when released, screw the shaft into the rod end until the stick will remain where it is placed. Secure NAS 509-4 jam nut and lock wire to the NAS 513-4 lock washer.

7. Throw the auto-stabilization override switch both ways. The collective stick will either go up or down; the force required to restrain it from moving should not exceed three pounds applied to the grip.

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Section II. HYDRAULIC SYSTEMS OF THE CH-34

1. CONTROL SERVO SYSTEM

a. The control servo system illustrated in the CH-34 hydraulic circuit diagram, consists of two independent circuits, each with its own pump, reservoir, and servo installations. Normally, these circuits are both in operation with the signal from the pilot or autopilot passing to the auxiliary servos. The output from these servos passes to the primary servos and then to the main rotor. The tail rotor servo receives its signal directly from the pilot or Automatic Stabilization Equipment (ASE). The selector switch will normally be in the ON position except when hydraulic or mechanical failure requires that one of the circuits be turned off. However, before electrical current can energize the three-way solenoid valve to turn the desired circuit off, it must pass through a pressure switch in the remaining circuit. This switch will be closed only if there is a pressure of at least 1,000 psi in the remaining circuit. In this manner, the pilot may bypass a malfunction in one circuit or check the other circuit by eliminating one circuit completely. However, if the alternate circuit has a major malfunction (as shown by a loss in pressure) then the pressure switches will prevent the changing of circuits and the helicopter will be flown with the present difficulty in the system.

b. Both circuits include pressure transmitters which electrically sense the circuit hydraulic pressure and register this pressure on a dual pressure gage. Relief valves set at 1,750 psi will return pump output to the reservoirs in the event of excessive circuit pressures.

c. Operation of the primary circuit is as follows: the 1,500 psi variable-delivery pump forces hydraulic fluid through the discharge line to the three-way solenoid operated valve. During normal procedure this valve will be open allowing the fluid to enter the three main rotor servos. The pressure switch will be closed and the pressure transmitter will be activated. The return from the servos passes to the reservoir and then is resupplied to the pump to complete the operational cycle.

d. The auxiliary circuit operation is identical to that of the primary circuit with pump pressure passing through the open three-way valve to the bank of servos, tail rotor servo, and to the slop eliminator. This pressure, overcoming the spring force in the slop eliminator, will place slop in the system. The cycle is completed with the return from the servos passing to the reservoir and the resupply of the pump. When the auxiliary circuit is eliminated from the system the three-way solenoid valve connects the pressure lines of the servos and slop eliminator to the reservoir. This allows the spring in the slop eliminator to extend, eliminating the slop and providing a fixed pivot point in the control linkage for manual operation.

e. The pump for the auxiliary circuit is located on the engine; therefore, the auxiliary circuit becomes inoperative as a result of engine failure. The pump for the primary circuit is located on the transmission and receives power as long as the main rotor is turning.

CH-34 HYDRAULIC CIRCUIT DIAGRAM INDEX

Item Number	Nomenclature	Item Number	Nomenclature
1	Servo-main rotor	13	Variable-delivery pump
2	Servo-tail rotor	14	Pressure switch
3	Servo-auxiliary	15	Servo switch
4	Slop eliminator and bypass actuator	16	Pressure transmitter
		17	Dual pressure gage
5	Reservoir	18	Restrictor
6	Reservoir	19	Hydraulic fuse
7	Relief valve	20	Damper
8	Three-way solenoid valve	21	Master cylinder-brake valve
9	Filter		
10	Quick-disconnect	22	Six cubic inch accumulator
11	Quick-disconnect	23	Main rotor brake
12	Quick-disconnect		

2. PRIMARY SERVOS

TRAVEL REQUIREMENTS

a. Total required wobble plate travel = 4.22.

b. Total available travel in servo = 4.375".

c. Since the total possible movement of the wobble plate is not needed to control the helicopter the available movement is adequate.

3. EXPLANATION OF LINKAGE AND OPERATION

During normal operation the pilot's control stick input is transferred through (fig. 1) the auxiliary servo and introduced at point A which displaces member BC an equal amount through the slop at D. Since the pilot valve stem is attached to member BC at E the pilot valve is displaced, allowing the flow to the power piston. The piston rod is fixed at point G; therefore, the housing F is displaced so that the pilot valve is restored to its original position (assuming the pilot has stopped moving the stick). The output is equal to the input motion at point A, because the output motion of housing F simultaneously feeds back to close the pilot valve and stop the power piston. In the event of hydraulic failure, a bypass has been provided to equalize the pressure on either side of the power piston so that the piston will move freely. However, during manual operation the slop is still in the system.

4. EXPLANATION OF LINKAGE AND OPERATION

During normal operation the pilot's control stick input is introduced (fig. 2) at point A which pivots member AC about point C, displacing point B a proportional amount. This moves point D about fixed point E displacing point F. This moves point G about point I, which is fixed because the ASE is not on, displacing point H, which cracks the pilot valve, permitting flow to the power piston. The power piston then moves point C and the linkage to the rotor head. The motion of point C due to the power piston moves member AC about

A (assuming that the pilot has stopped moving the stick). This motion causes a proportional displacement of point B, which then moves points D, F, and G; point H moves proportional to the movement of G, and the pilot valve is closed, stopping the power piston. Because the output motion of point C simultaneously feeds back to close the pilot valve and stop the power piston, an output proportional to input is obtained.

5. EXPLANATION OF LINKAGE

The pilot's rudder pedals are connected to the tail rotor linkage (fig. 3) by means of cables A and B. Cable A is wrapped around a pulley with center D and is then connected to one end of the power piston. Cable B goes around a pulley with center E; the other of the two pulleys with center D and then down to the tail rotor linkage. The member CE, on which the four pulleys are mounted, pivots on point D. A differential link FH is connected to member CE by a link at F. The other end of the differential link H is actuated by the worm gear travel of the subservo motor and the mid point G is attached to the pilot valve stem.

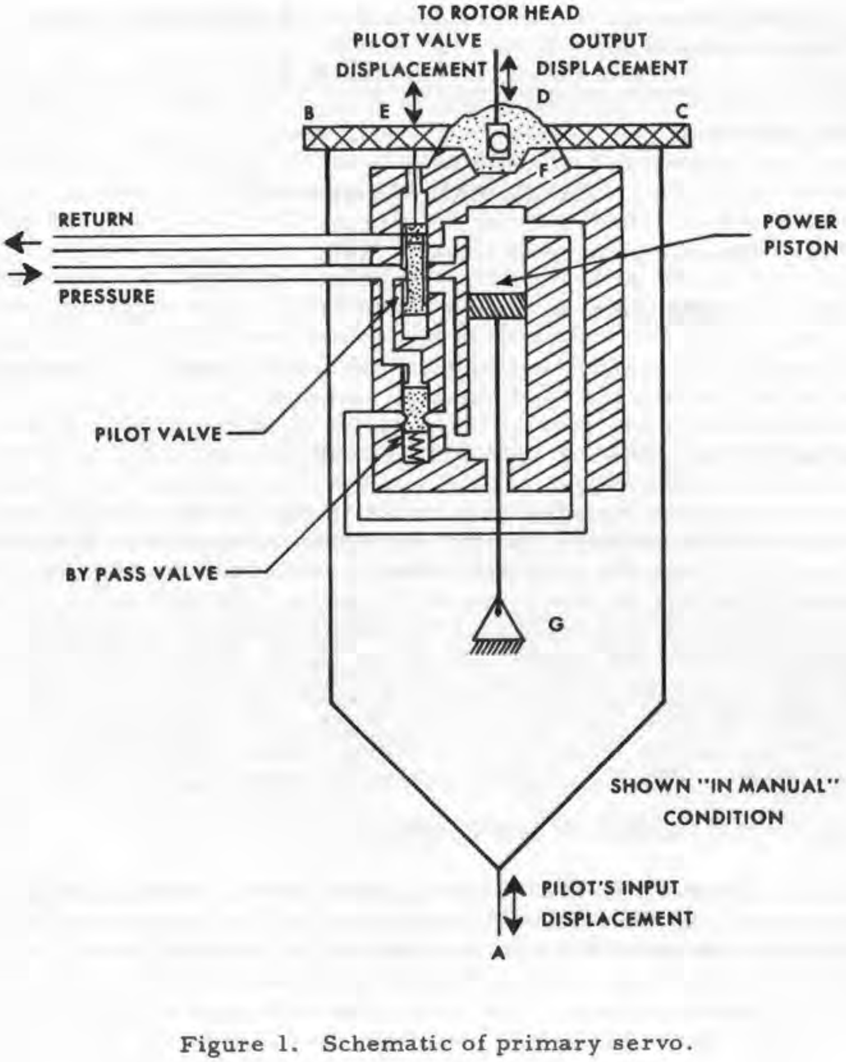
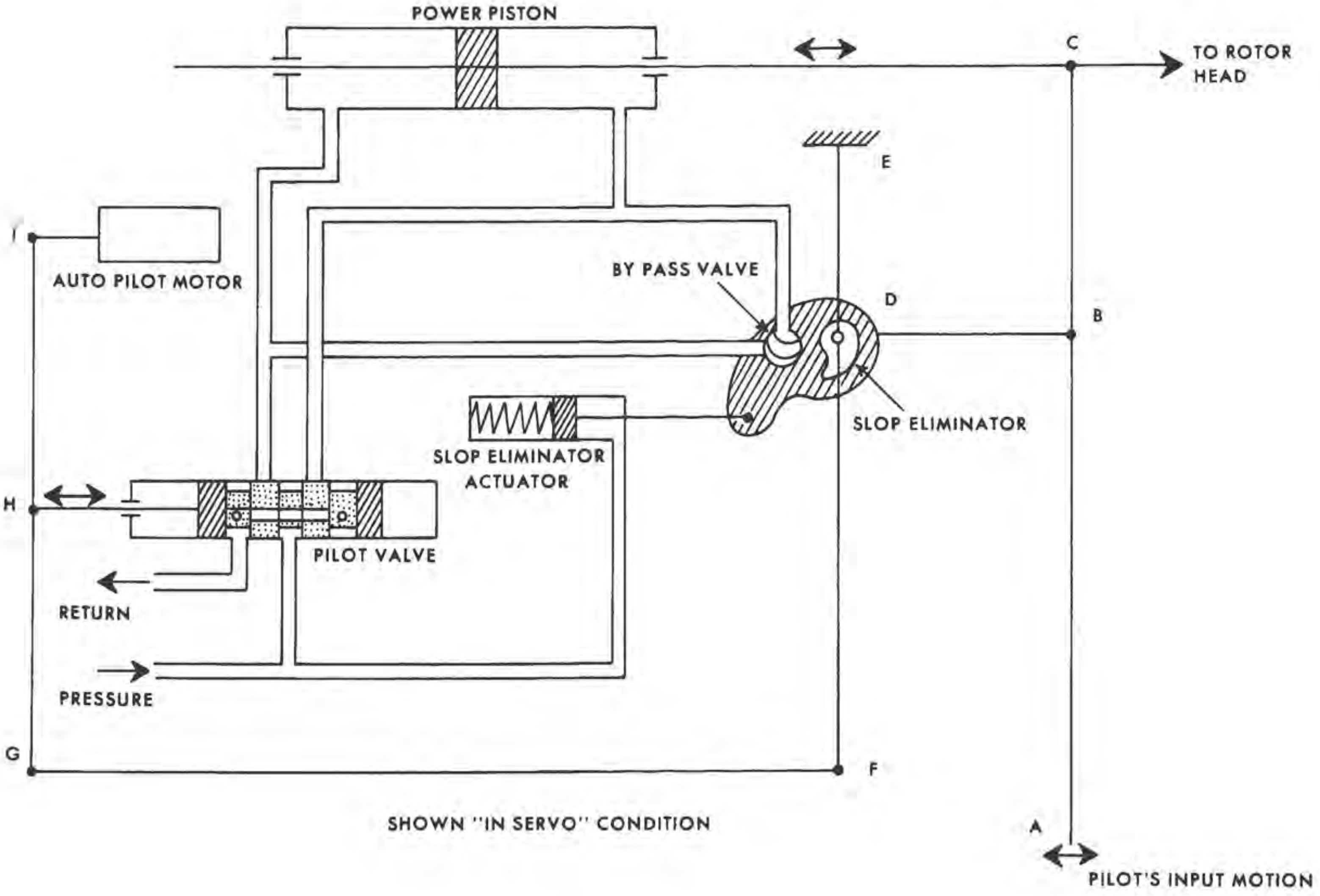


Figure 1. Schematic of primary servo.



SHOWN "IN SERVO" CONDITION

Figure 2. Schematic of auxiliary servos.

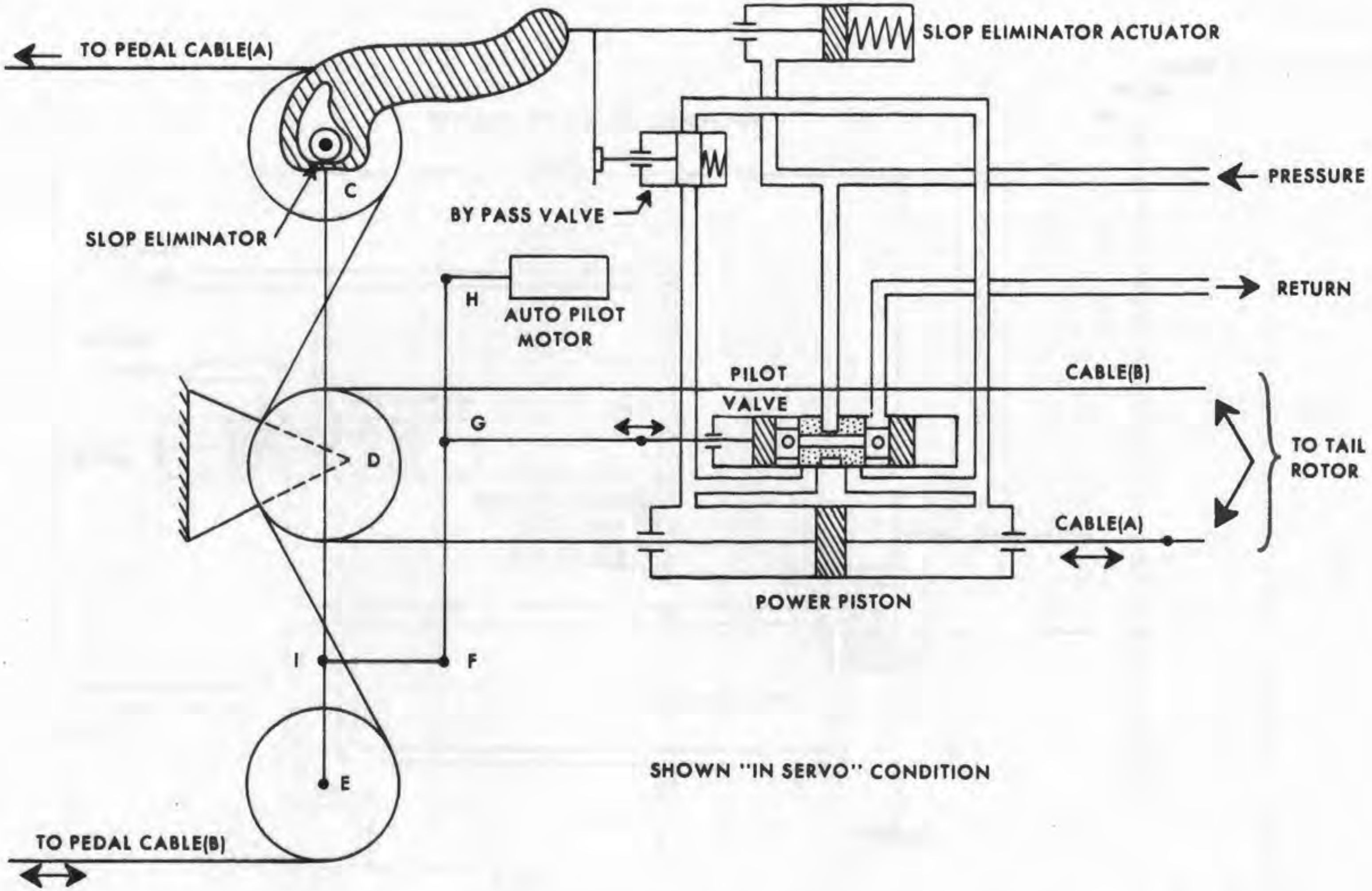


Figure 3. Schematic tail rotor servo.

6. OPERATION OF TAIL ROTOR SERVO

a. The pilot's motion of the pedals causes A and B to move. At this instant the power piston is stationary; therefore, the cable motion rotates the member CE about pivot point D. This motion is transferred to differential link FI which, with no autopilot input, pivots on point H. Point G is displaced, cracking the pilot valve and actuating the power piston. The piston moves the control cables, thus actuating the tail rotor linkage and the motion of the cables in such that it restores to its original position member CE. This moves differential link FH so as to close the pilot valve and stop the power piston.

b. In the event of hydraulic failure, a bypass and slop eliminator system allows the pilot to actuate the tail rotor link directly by means of the control cables. The slop eliminator fixes member CE so that it cannot rotate about D. The bypass system equalizes the pressure on either side of the power piston so that the piston will move freely.

7. HOIST PROVISIONS

a. The hoist provisions installed on the helicopter consist of an AND 20001 pad located on the main transmission to be used to drive a hydraulic pump which will supply power to the hoist system. This pump will be supplied with fluid from one of the servo reservoirs.

b. The hoist is designed to lift 600 pounds at a rate of 100 feet per minute (fpm). The stainless steel cable provided allows a free lift of 100 feet.

c. The winch has an automatic layering device and a built-in guillotine which will cut the cable at any point desired if an emergency should arise. The winch has a load holding brake, designed to hold a load limit of 1,875 pounds.

d. The hoist system is designed to operate at a pressure of 1,100 pounds per square inch (psi).

8. BRAKE SYSTEM

There are two independent brake systems in the CH-34 helicopter, a rotor brake and the wheel brakes.

a. The rotor brake system includes a master valve and cylinder, an accumulator for thermal compensation, and a brake which acts on a disk attached to the tail rotor drive shaft. The brake valve and cylinder are actuated by a lever located overhead on the pilot's side of the cockpit. The force required for maximum travel of the brake valve is approximately 40 pounds. The maximum stroke of 2.125 inches displaces 1.36 inches of fluid and produces an average pressure of 297 psi (this pressure will vary slightly since the preload charge in the accumulator will vary with temperature). The brake is so designed that it will bring the rotor to a stop, from a normal operating speed of approximately 200 rpm in 15 seconds, when full pressure is applied. There is a snap-over-center type input linkage provided with an integral stop at the parked position. The brake cylinder includes an integral reservoir with a sight gage, filter, and vent. The reservoir has a capacity of three cubic inches plus one cubic inch for airspace.

b. The wheel brake system consists of two identical independent systems, one for each wheel. These systems contain a toe-operated master cylinder, a brake parking valve, and the wheel brake acting on a disk on the wheel. The master cylinder has a stroke of 1.25 inches and a displacement of 0.6 cubic inches. The design maximum pressure of 800 psi produces a deceleration rate of 10 feet per second and should be obtained with a maximum force of 75 pounds on the foot pedals. The master cylinders have integral reservoirs. For locking the brakes, the brake parking valves are manually closed while holding pressure on the brake pedals. These valves are equipped with thermal compensators to adapt the locked system to changes in temperatures.

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Section III. ASE CONTROL GYRO AND AMPLIFIER (CG&A) GAIN SETTINGS

This Department of Maintenance Notice defines the latest method of establishing the proper CG&A gains for all model aircraft using the 1,005 K, L, M, or N CG&A boxes. All CG&A boxes being modified at lear and all subsequent production amplifiers will utilize a color-code for setting gains in lieu of the familiar numerals. Whenever the 12-signal adjustment panel is color-coded, the color-code must be used, otherwise the numeral settings. The following table will be used for setting gains in the 1,005 CG&A box in the CH-34 helicopter.

Table 1. Basic ASE with J-2 or C-4 compass (commerical and CH-34).

	YAW	ROLL	PITCH	ALTITUDE
Displ feedback	0 - Red	3 - White	4.6 Red	0 - White
Rate	2 1/2 - Red	3 - Red	3 - Red	5 - White
Displacement	4 - Red	0 - White	0 - Red	2 - White

1. TACHOMETER GENERATOR POTENTIOMETERS

Pitch, roll, and yaw --4
Altitude --3.5

2. FOLLOWUP (FU) NULL POTENTIOMETERS

With ASE in standby, adjust so as to center (null) the servo motor with an upper limit of six and a lower limit of four.

Section IV. THE MAGNETIC AMPLIFIER

The magnetic amplifier is a saturable core device; the degree of saturation will determine the amount of output. The magnetic amplifier is taking the place of the electron tube, in some power and control circuits.

1. OPERATING FUNDAMENTALS

a. A magnetic amplifier (mag amp as it is usually referred to) is another type of control valve, such as the electron tube. It is considered to be an amplifier if a small amount of power controls a relatively larger amount of power. In an electron tube the grid voltage controls plate current; in a mag amp the power is varied by inserting the device in series with the load to be controlled. Control is accomplished by varying the impedance of the output windings. The impedance to the flow of A. C. is effected by changing the degree of saturation of the core with a relatively small amount of D. C. or properly phased A. C. through a separate winding on the same core. An unsaturated core has relatively high impedance to A. C. and a saturated core offers little or no impedance except for the ohmic resistance of the wire.

b. Technically, a magnetic amplifier may be described essentially as a device which controls the A. C. reactance of a coil by controlling the effective permeability of the magnetic material upon which the coil is wound.

c. Figure 4 represents one type of magnetic amplifier. Specifically, it is used in the Sikorsky CH-34 ASE system.

d. There are five windings or coils wound around two laminated cores. These cores are similar in size, mass, cross-sectional area, etc. The excitation coil E is wound around both cores equally so that equal magnetic fields will be developed through each core simultaneously. Excitation voltage is 115 volts A. C. Around each core is wound an input and an output coil. The two input coils are connected to the B+ power supply. The output windings are connected in series but wound opposite each other.

e. Whenever point A is negative, point A' is also negative and points B and B' are positive.

f. The A. C. excitation voltage will develop a magnetic field in the core which will be constantly changing in direction at the excitation frequency. The input coils are loads for an electron tube output stage so they will have varying D. C. flowing through them dependent upon the output of the power output stage of the electron tube amplifier.

g. Whenever there is a NO SIGNAL condition and the output is balanced the current through coil A is equal to the current through coil B; the degree of saturation of the two cores must then be equal; hence, the impedance of output coil C will be equal to that of coil D, so that equal voltages are developed across coils C and D; they are wound opposite to each other so that the output legs are at the same potential level. The input voltage to the load or motor, as in the case of the CH-34 system, will then be zero volts as there is no differential in potential across the output windings.

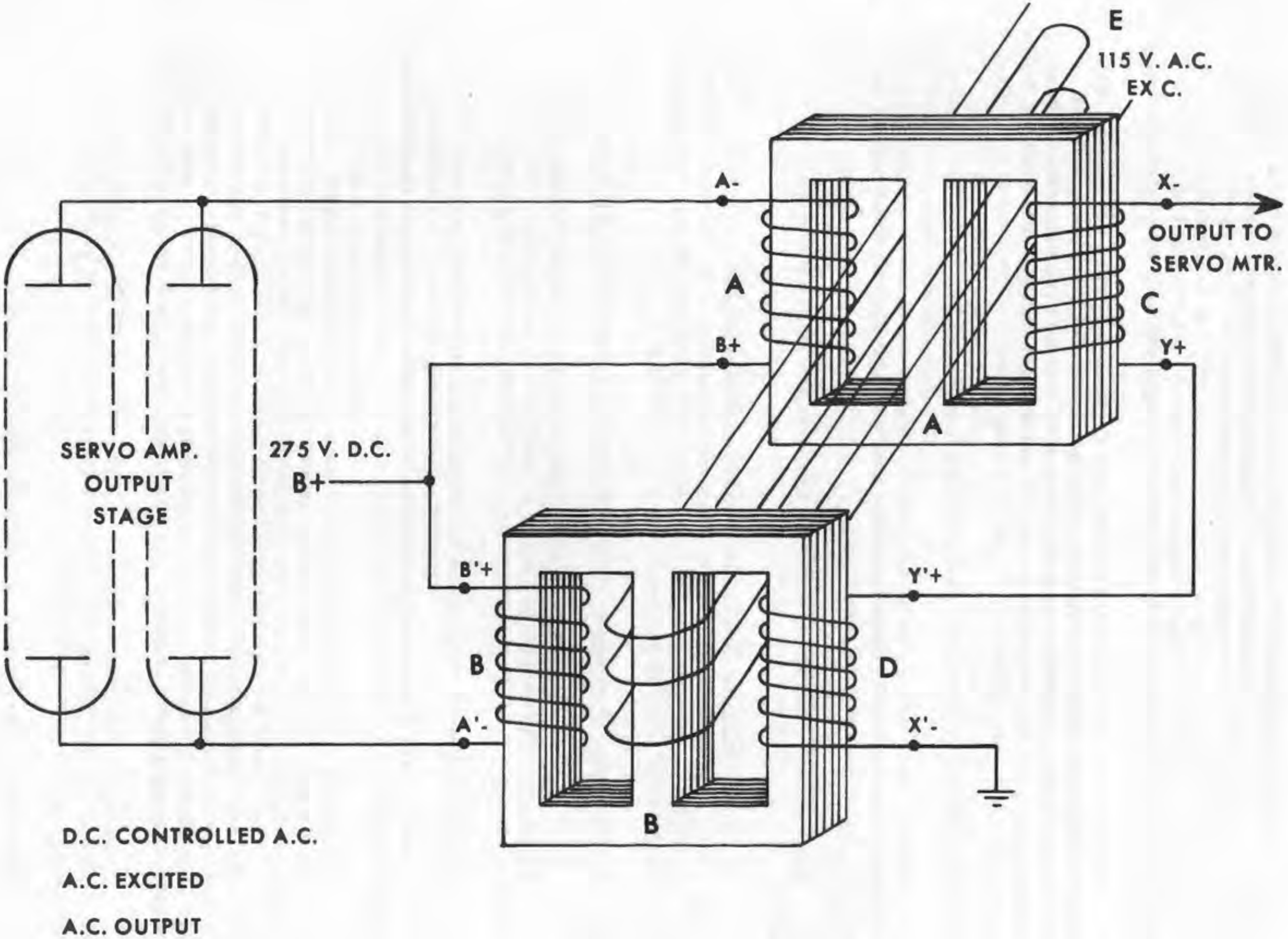

Figure 4. The magnetic amplifier.

h. Now, let us take the other condition where there is a signal being supplied to the amplifier and the power output stage is unbalanced as one set of tubes is conducting more than the other. For instance, coil A has more current flowing through it than coil B; polarity is that shown in Figure 4. If coil A has more D. C. flowing through it, then it is saturating core A to a higher degree than core B, hence output coil C offers less impedance to A. C. than coil D as the more the saturation, the lower the impedance.

i. The outcome of it all is that output coil C has less voltage developed across it than D has, that makes point X' higher in potential than point X (either positive or negative); the difference in potential will run the servo motor in one direction or the other dependent upon the input signals to coils A and B. The output voltage will be A. C. and either in-phase or out-of-phase with the reference phase.

2. ADVANTAGES OF MAGNETIC AMPLIFIERS

a. Parts. They contain no moving parts. Maintenance can be compared to that of a comparable transformer. When rectifiers are in integral parts, the rectifier will determine the life of the magnetic amplifier.

b. Ruggedness. The shock resistant qualities are equivalent to that of a transfomer.

c. Stability. Stability is less affected by variations in power supplies, in that there is no cathode-emission change with filament temperature. Unbalanced effects in balanced circuits due to cathode-emission changes are practically eliminated because of the inherent stability of a rectifier compared to a hot cathode.

d. Overloading. A magnetic amplifier can carry overloads equal to an equivalent transformer.

e. High gain. Power gain per stage is equal to that of a vacuum tube stage. They can be cascaded almost to any power gain. The efficiency is also greater.

f. Circuit isolation. The inputs and outputs are electrically isolated.

g. Safety. They can be safely operated in enclosed areas where sparking may cause a fire hazard.

h. Adaptability. These amplifiers can be built with special shaped cores for installation in confined areas. Amplifier gains can be changed by simply adjusting the D. C. fields. Gain control leads are less affected by stray RF pickup noises often encountered with high resistant high voltage components often found in equivalent tube circuits. Separate windings may be used to introduce feedback, either positively or negatively, to obtain increased amplification or degeneration to increase frequency response. In addition to the above, separate windings have been added to superimpose independently varying signals in either phase or amplitude or both for specific purposes.

i. Tube controlled core saturation. This, such as the CH-34 application, can be applied to many existing electron tube installations with a resultant increase in stability, operating range, and overload protection.

j. Readiness. They require no warmup time.

3. DISADVANTAGES OF MAGNETIC AMPLIFIERS

a. Impedance Range. The impedance of mag amp cannot be increased to infinity or decreased to zero; therefore, reflected impedances must be considered. With full output, core saturated, the output impedance is reduced almost to the D. C. resistance of the core windings are rectifiers, if used. Inputs may be designed with an impedance of a fraction of an ohm up to a megohm or more.

b. Aging. If feedback units requiring rectifiers are used then the life of the rectifier is the aging factor.

c. Frequency Limit. The upper frequency limit is approximately 500, 000 cycles. (The frequency response does not pertain to Sikorsky application as it operates at 400 cycles.)

d. Size. In many low-powered applications the mag amp may be heavier and larger than competitive units; this is especially true of 60-cycle components. The size of the core is inversely proportional to frequency; for a given capacity or output, a 60-cycle mag amp will be approximately five times the size of a 400-cycle mag amp.

e. Cost. The initial cost will be higher than comparative components but its life is much longer. Production methods are improving so that the cost per hour of a mag amp will be much lower than its counterpart, the electron tube.

f. Substituted. Magnetic amplifiers cannot be substituted for all electron tube applications. Each application must be weighed individually to see if the magnetic amplifier is qualified to do the job.

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Section V. VERTICAL STEEL GYRO

The vertical steel gyro covered in this information notice pertains to the gyro used in the 1,005 M&N ASE Control Gyro and Amplifier and the 7,002C Vertical Gyro Control used with the 4,005H Vertical Gyro Indicator. The vertical gyro is a conventional lear two gimbal electrical gyro whose spin axis is maintained in a truly vertical position by a gravity reference, the reference being an electrolytic switch assembly. The vertical gyro is a non-indicating type which furnishes electrical signals that define the attitude of the gyro rotor axis with respect to the pitch and roll axis. The electrical characteristics of the vertical gyro can be grouped into four circuits. They are the gyro rotor, erection, signal, and snubber circuits.

1. GYRO ROTOR

a. The gyro rotor is a three-phase, 400-cycle, inductive motor utilizing all three phases of the inverter. The gyro rotor spins at approximately 22,000 rpm. The acceleration time needed to reach 22,000 rpm is approximately two minutes; this necessitates a time delay from the time of energization to the time of engagement. The power necessary to operate the gyro is 115 volts A.C., 400 cycles.

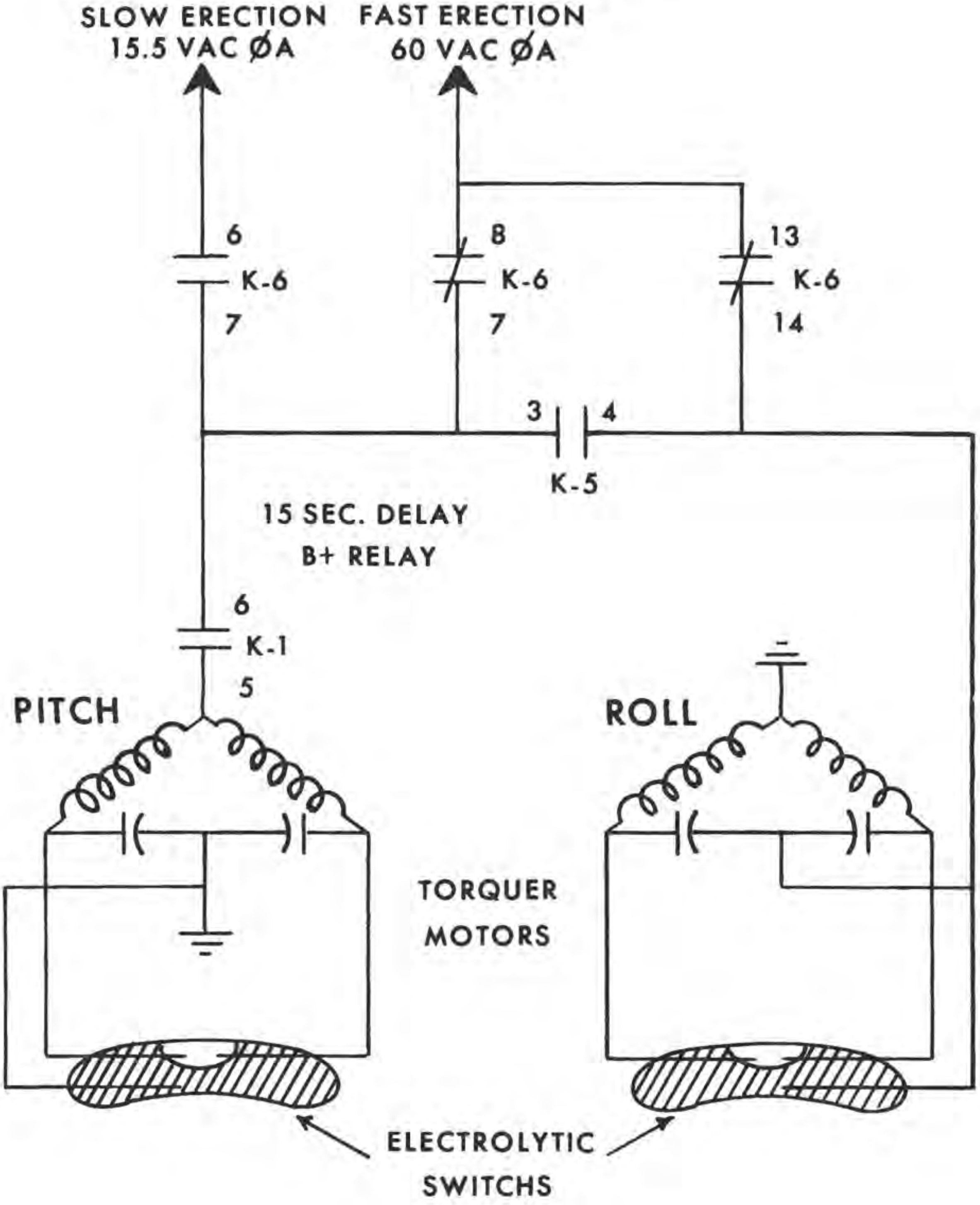
b. To reduce phase A loading, during the initial acceleration of the rotor, a resistor is connected in series with the phase A winding to reduce current flow. Once the gyro rotor has accelerated slightly, the resistor is shunted out by contacts of a 15-second time-delay relay actuated by the B+ power supply. This resistor is called the gyro start resistor, R-131.

2. ERECTION CIRCUIT

a. The gyro spin axis (fig. 5) is maintained vertical to the earth by a gravity sensing electrolytic switch assembly, of which there are two, one for pitch and one for roll. The switch assembly, in turn, will control a torquer motor which will precess the respective gimbal to maintain a vertical spin axis. Because of precession, the roll torquer is mounted about the lateral axis; the pitch torquer mounted about the longitudinal axis.

b. To have the axis vertical at the end of the acceleration time, a high excitation voltage is applied to the torquer motors during the first 2 1/2 minutes. Once the spin axis is erect, a low excitation voltage is all that is needed to keep it erect. A relay, K-6, will automatically reduce the 60 volts A.C. fast-erection voltage to 15.5 volts A.C. slow-erection voltage at the end of the engage-time delay. Fast erection is approximately 20° - 40°/minute; slow erection is approximately 2° - 4°/minute.

c. The erection torquer motors are split field, inductive motors using a rotor mounted on the gyro gimbals. These motors do not rotate, as you would normally assume; but instead, will apply a force to the rotor which, in turn, will precess the gimbal for erection. The electrolytic switches will control the torquer motors by acting as variable resistors; varying by the amount of area covered by the liquid and unbalancing a bridge



1005 N BOX

Figure 5. Vertical gyro erection system.

circuit which, in turn, will cause a phase shift through the torquer motors creating a force which, when applied, at the torquer rotors will precess the gimbals in such a direction to keep the spin axis vertical.

d. The erection system will maintain the spin axis vertical to within ±1/4° of true vertical.

Note. There are two cautions to be observed with respect to the electrolytic switch assemblies. They are never -

(1) Use an ohmmeter to measure resistance of the torquer windings or switch assembly as the current will affect the electrolytic characteristic.

(2) Allow fast erection voltage to be maintained on the torquers for any time longer than the normal two to three minutes. Any prolonged application of fast erection causes the torquer to heat excessively; the heat will affect the switch assembly necessitating replacement of the gyro assembly. This can occur on the CH-34 aircraft by allowing the "Auto Stabe" circuit breaker to stay in its OPEN position or pulled out for any reasonable length of time greater than two to three minutes. With this in mind, a strict rule can be observed, which is, never pull the circuit breaker out. Always use the "Auto Stabe Release" switch, located on the cyclic stick grips; if the circuit breaker is out because of a short circuit, pull the "Auto Stabe" Phase A fuse out also.

3. SIGNAL CIRCUIT

a. The signal components or pick-offs are of the two-wire rotor and three-wire stator synchro type. Two synchros are used, one furnishes a signal which defines the attitude of the pitch axis, the other the roll axis.

b. The rotor is excited by 115 volts A. C. ØA, the stator being our signal source.

c. The synchros develop a signal proportional to aircraft attitude with respect to the horizon. The signal is an A. C. signal whose amplitude determines the amount of displacement of the helicopter from the horizon and the phase determining the direction of displacement.

4. SNUBBER CIRCUIT

The snubber is a ØA - ØC sensitive device which locks the gimbals whenever the gyro is not operating. The crystal diode will allow D. C. to operate the snubber and a relay will delay the releasing of the snubber 15 seconds after power is applied to prevent nutation of the gyro (oscillation). The gyro start, K-1, relay is energized by the B power supply for the CG&A and is automatically delayed by approximately 15 seconds due to the rectifier tube warming up.

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Section VI. ADJUSTMENTS AND TEST REQUIREMENTS FOR CH-34A TAIL ROTOR SERVO YAW OPEN LOOP SPRING ADJUSTMENT

The maximum operating pressure is 1, 500 psi. Adjustments and test requirements apply to all models that have ASE installed.

1. BYPASS VALVE AND ACTUATOR ADJUSTMENT

a. Apply 1, 500 psi to the HI port of the servo. A hand-hydraulic pump may be used here or you may put 1, 500 psi into the auxiliary hydraulic system. With the bypass actuator fully retracted (bottomed in the housing), rotate the piston rod of the actuator on its rod end either clockwise or counterclockwise until the cam surface .002" to .007" (Dim A), (fig. 6). Secure check nut and lock washer to clear housing and safety.

b. Lower the pressure until the two scribe marks on the cam surface line up with the center line of the cam roller. With hydraulic pressure holding this position, adjust S1640-61718 bolt until head just contacts flange on S1665-61667 valve extension. Advance or back off bolt minimum amount required to lock bolt in position with the cotter pin through the S1665-61669 rod end assembly. Tighten AN316-7R locknut to prevent slop (fig. 6).

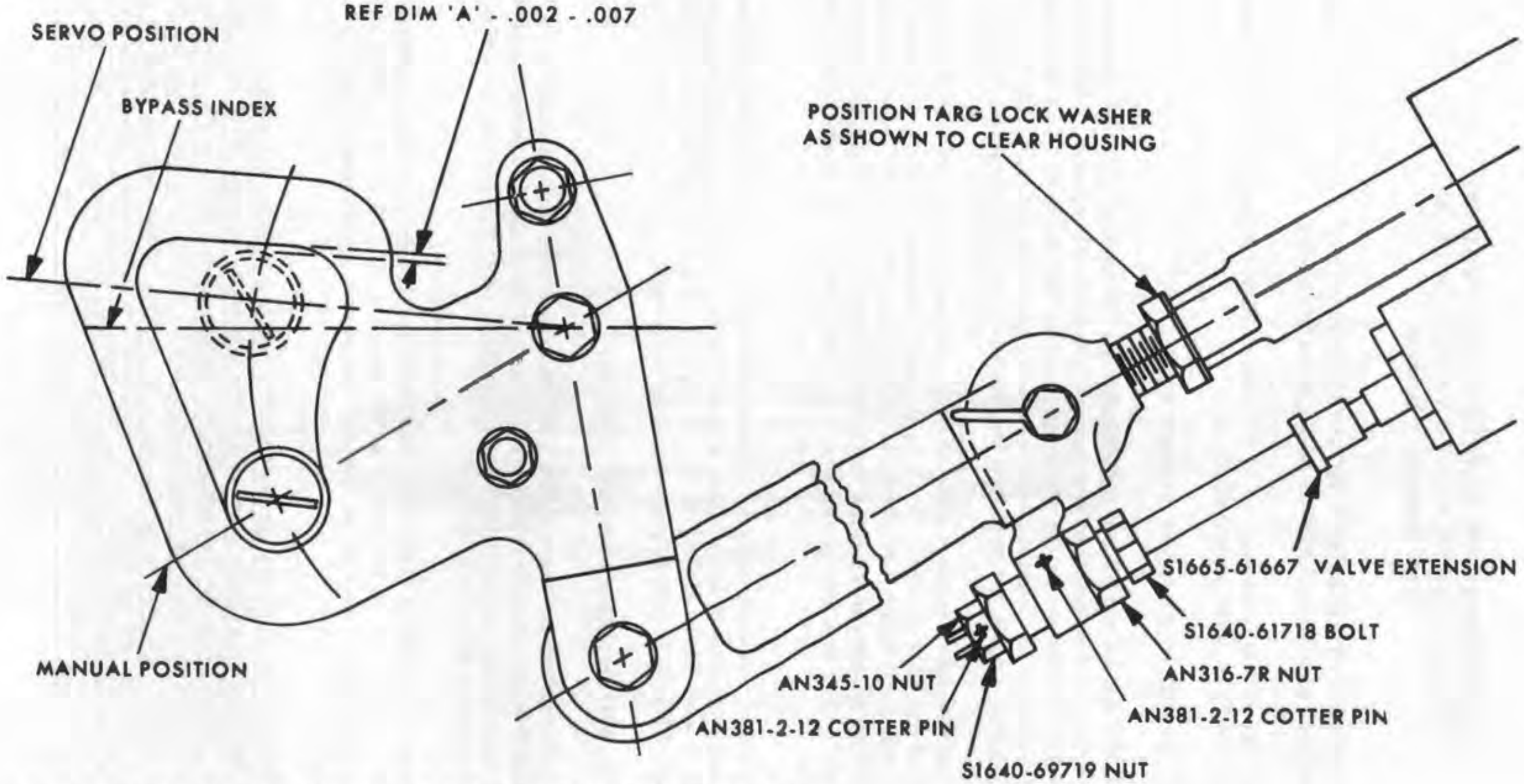
c. Cut hydraulic pressure entirely (cam in MANUAL position); with bypass actuator extended and cam roller bottomed, adjust S1640-61719 nut to obtain approximate .010" clearance with S1640-61718 bolt. Back off nut minimum amount to insert cotter pin and tighten AN345-10 nut to prevent slop in thread.

2. SERVO-VALVE ADJUSTMENT (PILOT VALVE)

a. Remove the spring cylinder S1665-61555 (yaw open loop spring) from the tail rotor servo by disconnecting the cylinder from the servo housing. In subsequent tests, insure that the free end of the cylinder does not interfere with the motion of the pulley support arm when operating the servo motor.

b. Open engine clamshell doors and attach an auxiliary hydraulic pump, self-regulated, to maintain 1,500 psi to the three quick-disconnects located on the right side of the engine. Also, provide a means for driving the servo motor electrically to either end of its travel.

Note. To operate the yaw servo motor, apply external electrical power to the aircraft. After the 2 1/2-minute time delay has elapsed, engage ASE so that the green light stays on. Then push the standby button to place the ASE in the standby mode. Put the channel selector switch in YAW so that the servo motor position may be observed on the null indicator. Now, the servo motor may be driven from stop-to-stop by pressing the OVERRIDE switch to the left or right. It is possible to tell when the servo motor reaches one end of its travel by listening for the CLICK as the motor hits the stop. With hydraulic power applied, the roller will move back and forth in the cam with the motion of the servo motor.



S-58 TAIL ROTOR SERVO SLOPPY LINK & BYPASS ACTUATOR INSTALLATION

Figure 6. Actuator installation.

c. Be sure that the yaw servo motor is in the center of its travel (nulled). To determine this fact, place the channel selector switch in the YAW position and center the null indicator needle with the yaw followup adjusting pot on the motor box.

d. Run the servo motor to its extreme forward position by the use of the OVERRIDE switch. Adjust the S1665-61590 rod assembly until the roller is approximately 1/16" from the end of the cam. Now, run the servo motor to its other end. The gap obtained between the roller and cam should equal the gap obtained with the servo motor on its forward stop. If not, re-adjust the rod assembly until these distances are equal. As a further check, return the servo motor to its mid position; reduce hydraulic pressure to zero; and observe roller and cam as the cam actuator returns the cam to MANUAL position. The roller should move into the closed end of the cam without striking either side of the cam surface. (If the roller is striking the side of the cam surface, the roller will rotate.) Be sure to check both upper and lower roller. If the roller does strike either side of the cam surface, re-adjust the S1665-61590 rod assembly until you obtain the desired results.

e. With the pedals in approximately nautral position, check to be sure that the pedals do not move when the servo motor is run from one end of its travel to the other. These tests insure proper servo valve adjustment so that the servo motor, by itself, cannot put the servo into open loop.

3. PERFORM THE CABLE DRAG OR FRICTION CHECK

Disconnect the pedal damper and with 1, 500 psi applied to the auxiliary system, check the force necessary to move the pedals with servo ON. Use a spring scale on the pedals; measure the force required to move the pedals throughout the full range of pedal travel. This force is not to exceed 20 pounds in either direction. Except for the last inch of travel, the force required may be 25 pounds maximum. Forces above 25 pounds may be attributed to improper cable tension, dirty cables, pulleys, and fairleads or mechanical binding and must be eliminated before proceeding.

4. CHECK FOR PROPER OPERATION OF PEDAL DAMPER

a. Connect the pedal damper and apply 1, 500 psi hydraulic pressure to the auxiliary system.

b. With a 44-pound load (plus the friction load previously measured) applied at the pedals, the pedals are to move full travel in either direction in 18 ± 3 seconds.

c. Check the damper springs by rapidly applying a reversing force of 20 pounds plus the measured friction load to the pedals. The pedals should deflect approximately one inch when the load is applied.

5. OPEN LOOP RATES

a. ASE in standby.

b. Adjust the open loop spring so that the pedals move full travel in either direction in 26 to 32 seconds when the override switch is thrown.

c. Adjustment of the yaw open loop spring (fig. 7) steps (1) through (4) are preliminary adjustments.

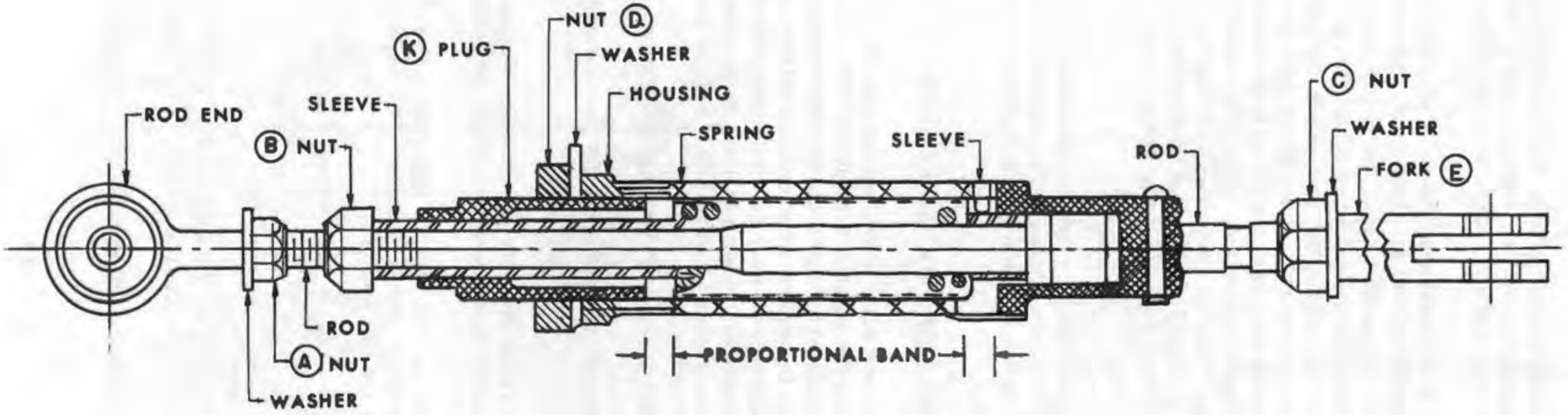


Figure 7. Yaw open loop spring.

(1) Adjust the rod end to two threads beyond the safety hole; lock in that position and safety.

(2) Adjust the sleeve nut B on the cylinder rod until the spring is held firmly but under no preload. Tighten B nut until you can barely turn the external sleeve with your fingers.

(3) Loosen the fork end locknut, C, and washer at the aft end of the cylinder; thread the rod into the fork end as far as possible.

(4) Loosen the plug locknut, D, and thread out plug K so that approximately 3/8" of thread is showing beyond the locknut, D. (Approximately three threads.)

(5) Connect the open loop spring to the servo housing and pulley bar.

(6) Apply system pressure (1, 500 psi) to the auxiliary servo system. Run left pedal full forward by throwing override switch to left. With pedals in this position (feet off), run the servo motor electrically to its forward stop by throwing override switch to right. Thread out the rod from the fork E assembly until the pedals move full travel from full left to full right in 26 to 32 seconds.

(7) With pedals in this position (full right, feet off) run motor to aft stop by throwing override switch to left. Thread in the plug K until the pedals move full travel from right to left in 24 to 28 seconds.

(8) Safety all adjustments on the spring cylinder assembly and recheck the setting by repeating steps 6 and 7. Observe the pedals for proper rate.

(9) If pedal rate is not 26 to 32 seconds for full travel in either direction, re-adjust the open loop spring and recheck again after safetying. To increase pedal speed from left to right pedal, thread out rod from fork E assembly. To increase pedal speed from right to left pedal, thread in plug K. To decrease pedal speed in either direction, make opposite adjustments.

(10) Check the proportional band by centering the servo motor with the yaw trim knob. Engage ASE. Then move the yaw trim knob slowly until pedals move. The null indicator should read at least one-half of half travel, but not more than three-fourths of half travel. The pedals may jiggle and jump before the indicator reads one-half of half travel, as you turn the yaw trim knob; but, they should not go into open loop before one-half of half travel is reached. If they do, the proportional band is too small.

(11) To increase the proportional band, tighten the B nut by turning it exactly two revolutions on the rod. This will compress and preload the spring and increase the left proportional band. Turn fork E into rod exactly one revolution, thereby increasing the right proportional band and decreasing, by one-half, the left proportional band. Recheck pedal rate and re-adjust, if necessary. Recheck proportional band.

(12) Using a spring scale, check the amount of force needed to move the pedals against the ASE when the motor is at one stop. Throw the override switch, thus moving the pedals into open loop. With your spring scale hooked to the pedal moving away from you, check the pull required to stop the pedals. It should not exceed 40 pounds. With a 105-pound load applied to the pedals, check the time to move pedals through their full travel in the opposite direction. This time is not to exceed 32 seconds.

Note. If in an isolated case due to accumulation of tolerances, the override or the hold forces are exceeded, the limits may be met by making one or all of the following changes:

(a) Reduce the friction in the cable system below the specified maximum.

(b) Select a pedal damper that is on the low time limit (14 to 15 seconds).

(c) Set the pedal rates to the maximum 32 seconds rate.

(13) To make a spring jump check, move the override switch one side and back to center rapidly. The pedals should jump approximately 1".

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Section VII. CYCLIC STICK TRIM SYSTEM

1. FUNCTION

a. The cyclic stick trim system provides a means of positioning the cyclic stick to any position desired by the pilot and also a means of holding the stick in that position. A secondary function of the system is to put artificial feel in the cyclic control system.

b. The system includes two magnetic brakes and two force gradient springs, one each for lateral and fore-and-aft motion of the cyclic stick. A master switch is used to control the system and two stick trim buttons are used to allow the pilots to control the system when it is turned ON. These buttons are located on the cyclic stick grips.

c. Locations of the components are shown in inserts (fig. 8).

2. OPERATION

a. The stick trim master switch, which is marked "stick trim off" and "trim on" will provide master control of the system. With the switch placed in the ON position, the electrical circuit is open and the solenoid in the magnetic brake is deenergized. A return spring will then apply a force to the stationary plate which will make a contact with the rotating plate and lock the rotating plate in that position. The rotating plate is attached to the shaft of the magnetic brake (fig. 9), which through a gear train is attached to the external arm, this will keep the cyclic stick in one position because of spring tension. The cyclic stick may be displaced from this initial position, but a resistance force caused by the force gradient spring progressively increases. When pressure is released, the action of the force gradient spring returns the stick to its original position. The stick trim system may be disengaged to take a new stick position by pushing in the stick trim button on either cyclic stick grip. These switches are push-button, normally open, momentary switches. Pushing the stick trim button in will close the switch, which will energize the solenoid in the magnetic brake. This will produce a magnetic field which will attract the stationary plate and disengage it from the rotating plate; this, in turn, will allow the external arm to be free to rotate approximately 90° and reposition the cyclic stick. When the switch is released, the magnetic brake functions to lock the external arm in one position and the trim action of the system is moved to operate around a new position.

b. The master switch can either be in the STICK TRIM OFF or TRIM ON position. The gear ratio of 1:60 is used to give the system mechanical advantage in holding against stick motion with very little force at the clutch.

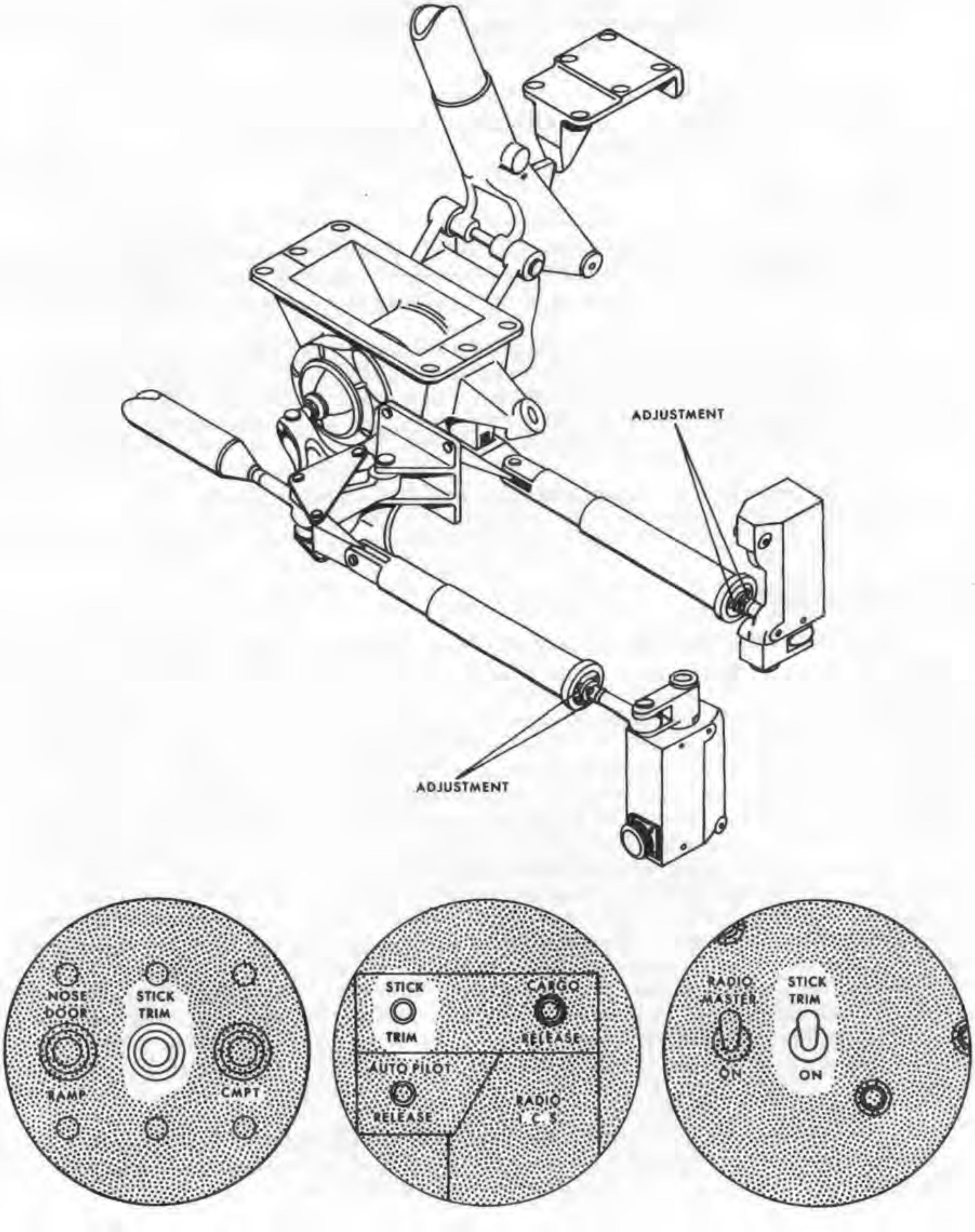
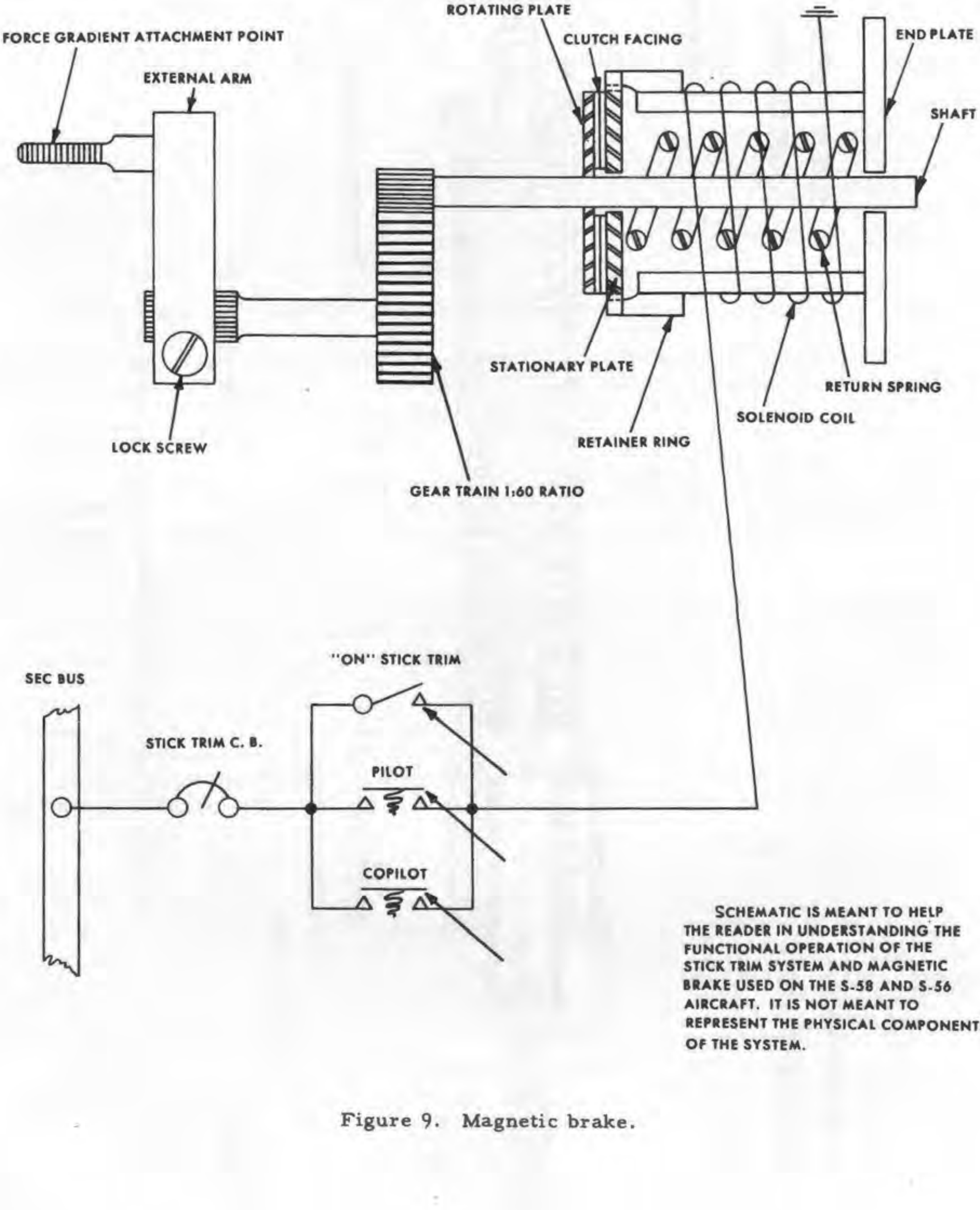


Figure 8. Location of components.



SCHEMATIC IS MEANT TO HELP THE READER IN UNDERSTANDING THE FUNCTIONAL OPERATION OF THE STICK TRIM SYSTEM AND MAGNETIC BRAKE USED ON THE S-58 AND S-56 AIRCRAFT. IT IS NOT MEANT TO REPRESENT THE PHYSICAL COMPONENTS OF THE SYSTEM.

Figure 9. Magnetic brake.

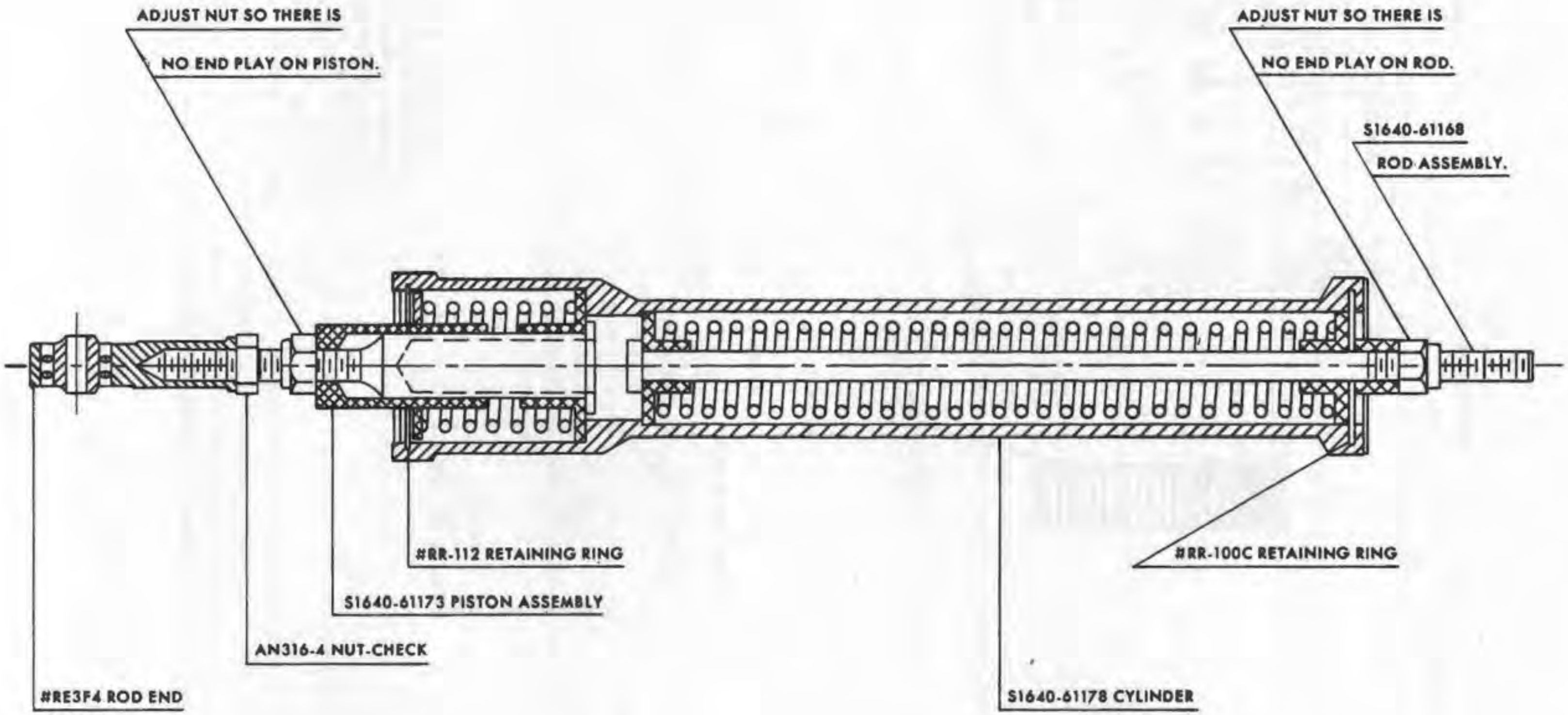


Figure 10. Force gradient cylinder assembly (S1640-61167).

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Section VIII. PILOT'S CH-34 ASE CHECKOUT PROCEDURE

Note. The information contained in this notice is designed to serve as a guide to the acceptability of ASE following component changes and/or re-adjustments. Performance checks in the field need not necessarily conform in all instances to the stringent requirements listed in this notice. The experience and understanding of checkout pilots should be the determining factor in reckoning with differences between actual performance and the performance called for in this notice.

1. CHECKS BY CONTRACTOR TEST PILOTS

The Service School would like to remind recipients of this notice that the following checks are used by contractor test pilots to determine ASE acceptability before delivery.

2. GROUND AND FLIGHT TESTS

a. Engage rotors with automatic stabilization circuit breaker pulled. After generator cuts in, reset circuit breaker and start stop-clock at the same time. After two minutes hold automatic stabilization engage light in and stop the stop-clock when the light comes on. (Should be two to three minutes.)

b. Return the automatic stabilization to standby and place the override check switch in left forward down position. (Null indicator should swing full left.) Move the cyclic stick rapidly, longitudinally and laterally, as far as possible without hitting the blade droop stops. Back off the throttle as far as possible and move the collective pitch up three inches and back down rapidly. Any resistance or seizing of the controls will indicate improper adjustment of the control linkage. Turn off stick trim and remove collective friction for this test. Move the override check switch to the right aft up position and repeat the check. Be sure that the override check switch is returned to the center (OFF) position and the guard is closed before any operation of the helicopter.

Note. The maximum achievable rates of control movement for cyclic, right and forward and collective up will be slower than in the opposite direction but should not be less than a rate corresponding to approximately full stick travel in one second. There will be some right pedal force (which the pilot should be careful to resist if the rotor is turning) but this should not exceed 40 pounds to hold. The pedal force and slower rates of control travel will reverse when the override switch is in the other test position. There will be a collective force which should not exceed three pounds at the grip to override. Adjust the friction to keep the stick from moving when the override switch is thrown.

c. Put the ASE in standby. Push standby button on control panel; move the selector switch to each channel and observe that the null indicator is centered; hold the collective stick two inches off the low stop and the cyclic stick approximately centered; shut off and then turn on the auxiliary servo. The maximum stick jump should not exceed 1/8". Be sure that the selector switch is returned to pitch.

d. Check and align the J-2 compass and place the control switch in the slaved position; turn on stick centering; check in several trim positions to see that button on both sticks disengages stick trim when pushed, and engages when released; check that when disengaged, the drag on stick is negligible. The maximum allowable slop in the stick with auxiliary servo pressure up and stick centering on is ± 1/8" for both pitch and roll. (Check this item carefully as excessive slop has a large effect on the performance of the stabilization equipment.)

e. Reengage the automatic stabilization and observe that the null indicator travels with fore-and-aft stick movements. Adjust the CG trim knob to the approximate CG.

f. Check the operation of all three disengage buttons (one on control panel and one on each stick) and reengage ASE; check tail rotor pedals for full travel freedom (if possible); check operation of all four yaw disengage switches by placing a foot lightly on the pedal being checked and rotating the yaw trim control one-half turn. No pedal movement should occur; wait three seconds before removing foot from pedal; again, no pedal motion should occur; repeat with next pedal until all four are checked; observe the operation of each pedal switch by pressing the yaw cut-out bar on each end. If the unit is not properly adjusted, it may bind when actuated at one end or the other; check the turn buttons on each stick using the procedure described for the pedal switch.

g. Taxi with automatic stabilization engaged and observe that heading is held constant with feet off pedals. The helicopter may be turned right or left by yaw trim changes or pedal changes.

h. Set up a stabilized hover and trim stick centering to remove all stick forces. The helicopter should maintain hover attitude HANDS OFF; although, position drift will depend upon wind. Adjust CG trim to center needle.

i. Make ± 7" Hg manifold pressure (abrupt) power changes. The helicopter should maintain heading within ± 5° transient error.

j. Start a turn on the spot with feet on the pedals. When the heading is somewhere near being into the wind and the rate of turn is 15° per second, remove feet from the pedals. Do not move the pedals to slow the rate of turn. The helicopter should continue to turn for no more than 30° and then return to the heading where feet were removed within three overshoots.

k. Make a 36° heading change by moving the yaw trim control smoothly and slowly (take two seconds) one full turn to the left. The helicopter should follow this command in a jerky manner but should not overshoot the 36° of heading change. Rotate the yaw trim control rapidly one full turn to the right (within one-half second). The new heading should be stabilized with no more than three overshoots.

l. Land and wait five seconds for the yaw servo motor to stop oscillating. To make a jump takeoff, feet off the pedals, by starting with 2,800 rpm and 28" Hg manifold pressure and then pulling the collective to its high pitch stop in 1 1/2 seconds. The manifold pressure should reach 57" Hg. The helicopter should maintain heading with a maximum transient error of 40°.

Note. The gross weight during this maneuver should be about 11,000 pounds (forward or aft CG loading).

m. Make a transition to forward flight without recourse to pedals except to change heading as necessary. There should be no undesirable yawing oscillation.

n. Stabilize at 80 knots forward speed and trim stick centering to remove all forces; check null indicator which should remain approximately centered; engage barometric altitude at approximately "0" vertical speed. Helicopter should maintain airspeed attitude and altitude ± 25 feet, hands off. As a means of quality control the attitude check should be made on a smooth day in at least every fifth CH-34. On a smooth day the attitude of the helicopter should be held within ± 1° in both roll and pitch. To observe a change in attitude in the pitch axis put a mark in line with the horizon and eye on the central section of the front window. Holding the eye fixed with respect to the helicopter and mark on the windshield, the horizon should move ± 1/2" with respect to the mark for a pitch attitude change of ± 1°. To observe a change in attitude in the roll axis, place a mark on the stationary side window on the copilot's side in line with the horizon and eye. Holding the eye fixed with respect to the helicopter and mark on the window, the horizon should move ± 1" with respect to the mark for a roll attitude change or ± 1°.

o. In straight and level flight, disengage ASE with standby button; wait about five seconds and reengage; note any strong "kick" when engaging or disengaging. If there is a lateral jump in the helicopter, place the channel selector switch at roll and observe the position of the indicator needle. If it is off center for a stabilized 80 knots flight conditions, note exactly the position of the needle. This can be done by noting to what letter of the meter's name the needle is pointing. Then, upon landing, relay this information to the crew chief and have him set the roll canceller according to instructions. This check may also be made in a hands-off hover.

p. With barometric altitude engaged establish a 25° to 30° banked left turn by depressing the stick turn button and holding against the stick centering forces. After 180° of turn, release all controls and the helicopter should return to level flight at the same altitude ± 5 feet, and lock on the new heading. Repeat in a right turn using the stick turn button on the copilot's stick.

q. With barometric altitude engaged, place feet on the pedals and establish a 25° to 30° banked left turn and trim the stick centering to remove all forces and release the stick. Continue the turn for 360°. Note that the helicopter should stabilize in the turn without excessive oscillation in roll, pitch, or more than ± 5 feet altitude change. Repeat the maneuver to the right.

r. With barometric altitude still engaged and in straight and level flight at 85 knots, pull stick to a position corresponding to the approximate 75-knot (approximately one-hald inch of back stick) stick position and stick trim centering; release controls (pull and hold maneuver). Do not move collective pitch stick. The helicopter should hold the original altitude within 20 feet and hold its altitude and new airspeed without excessive oscillation or overshoot. Allow three minutes to return to original altitude.

s. In straight and level flight at 75 knots airspeed, with barometric altitude engaged, move the cyclic stick to a position corresponding to 85-knot stick position; trim the stick centering and release controls (push and hold maneuver). Do not move collective pitch stick. The helicopter should hold the original altitude within 20 feet and hold its attitude and new airspeed without excessive oscillation or overshoot. Allow three minutes to return to original altitude.

t. Establish a hover (0 to 15 knots) at 1,000 feet altitude; trim stick centering and engage the barometric altitude control; fly hands and feet off for five minutes and observe any instability or altitude change.

u. Establish straight and level flight at 90 to 100 knots; trim stick centering and engage barometric altitude; release all controls for five minutes; observe any changes in altitude, heading, attitude, or airspeed. Up to moderate turbulence, airspeed should hold ± 5 knots and altitude ± 20 feet at 1,000 feet.

v. Disengage barometric altitude and with feet off pedals enter autorotation. The helicopter should maintain heading within a 5° transient error; check hands-off stability in autorotation; execute flare and power recovery with feet off pedals and note any change of heading.

w. In straight and level flight, at 80 knots, put the autopilot in standby; throw the override switch to one side. After the helicopter has been stabilized, note that a force is required to hold the pedals from moving and that the stick is displaced from the normal position for that particular flight condition. Next, push the pilot's or copilot's ASE release button. The pedal force should disappear and the controls should return to the normal position within 10 minutes.

x. Make landings and takeoffs with feet off tail rotor control pedals; observe any heading changes; check for undesirable ground resonance effects.

y. Observe any resistance or feedback in the controls. If at any time this should occur, note the conditions of flight plus nature of difficulties and terminate the flight. If possible, before terminating flight, turn off, first, the auxiliary and then the primary servo to see if the bind is relieved.

SAMPLE CHECKLIST

PILOT ACCEPTANCE TEST FOR ASE IN THE CH-34

HELICOPTER NO. ________ PILOT ________ DATE ________ WEATHER COND (TURB) ________

FLIGHT CONDITION	CHECK	OBSERVATION	REMARKS
1. Rotor engage	Time delay, 2 to 3 minutes.		
2. Engine warmup	Override check (collective 3 pounds to override; yaw 40 pounds to hold), adjust collective friction.		
3. Engine warmup	Stick jump maximum 1/8".		
4. Engine warmup	J-2 compass, stick centering-maximum slop ± 1/8".		
5. Engine warmup	Null indicator, CG trim.		
6. Engine warmup	Disengage buttons, yaw disengage, switches on pedals.		
7. Taxi	Yaw (holds heading ± 10°).		
8. Hover	Maintain attitude ± 2°. Set CG trim.		

FLIGHT CONDITION	CHECK	OBSERVATION	REMARKS
9. Power changes	Yaw (holds heading for ± 7" Hg, ± 5°).		
10. Hover	Yaw pedal turn, 15°/ second turn rate, maximum 3 overshoots.		
11. Hover	Yaw trim turn - maximum 3 overshoots.		
12. Jump takeoff	Yaw holds heading 40° maximum error.		
13. Transition to forward flight	Yaw should be stable.		
14. Forward flight 80 knots	Barometric altitude ± 25 feet, null indicator approximately centered, altitude stable within ± 1° on a smooth day.		
15. Forward flight 80 knots	Disengage and re-engage no large jump.		
16. Turn button, turn and release, left and right	Should return to level flight ± 5 feet altitude and lock on new heading.		
17. Hands-off turn, left and right	Should stabilize in turn and hold altitude ± 5 feet.		

FLIGHT CONDITION	CHECK	OBSERVATION	REMARKS
18. Push and hold 75 to 85 knots	Should hold altitude within 25 feet. Altitude should be stable.		
19. Five-minute hover	Attitude and altitude should be stable.		
20. Five-minute hands off straight level 90 knots	Should hold airspeed ± 5 knots and altitude ± 20 feet.		
21. Autorotation and flare feet off	Should hold heading ± 5°.		
22. Cruise 80 knots	Throw override, push release. Yaw force should disappear and sticks should return to normal position.		
23. Feet off landing and takeoffs	Heading should hold ± 10°; should be no undesirable ground resonance tendencies.		

Section IX. FLYING OF CH-34 WITH ASE PROVISIONS BEFORE ASE IS CHECKED OUT AND/OR ASE NOT INSTALLED

1. It has come to the attention of engineering that helicopters with ASE provisions are sometimes being flown without making the hydraulic servo hard-over check because the ASE is not in operating condition. This can be extremely hazardous if ASE is never energized because the hard-over check is the only means for determining conclusively that the servo valves of the auxiliary servo unit are properly adjusted and that the open loop springs are properly set. If a servo valve or open loop spring is improperly set, a small displacement of the servo motor could put the servo into open loop so that the pilot could not move his flight controls. The servo motor could move due to the vibration of the helicopter if either the .002" diameter wire spring, that holds the motor centered when no power is on ASE was loose, or if the servo motor was originally off center (maladjusted or not adjusted), and the springs caused the motor to center.

2. To enable the pilot to make the ASE hard-over check, all ASE components must be installed in the helicopters. However, if it is necessary to fly the helicopter before these components can be completely checked out, it would be necessary to perform the following checks:

a. Servo motor bind.

b. ASE in standby.

c. Note setting of channel selector switch.

d. Hold motor input-position switch in input position.

e. Turn appropriate FU NULL POT smoothly and slowly in one direction and reverse.

f. Observe the indicator. During a smooth, slow input in either direction there may be a small indicator needle movement which should not exceed two needle widths. Any movement greater than this width indicates excessive servo motor bind. When the servo motor reaches its stop, the needle should move at least one-fourth half travel. This should occur when POT has been turned almost all the way in either direction.

g. Release motor input-position switch so that it is in POSITION position.

h. Adjust FU NULL POT to null servo motor (center the needle), POT setting should be between 4 and 6.

i. Repeat motor bind check for the other channels. NULL each channel before proceeding to the next.

j. When checking the yaw servo motor bind, connect a volt-ohmmeter to terminals TB101-1 (Gnd) and TB102-1 in the motor box. Then observe the voltage necessary to start the motor moving at any point in its travel. The maximum steady voltage necessary to start the motor should not exceed 15 volts except for the last one-fifth half travel when approaching the stop, where it should not exceed 20 volts. The maximum intermittent voltage rise should not exceed 15 bolts above the steady when driving from center toward the stop. There should be no voltage above 15 volts when driving from the stop to center.

3. Make a hard-over check. Check capacity of manual flight controls to override ASE as follows:

a. Leave ASE in standby, then move override check switch to one side. The indicator needle should swing hard-over.

b. The collective stick will either rise of fall. The force required to move the collective in the opposite direction should not exceed three pounds. The collective stick friction nut should be loose for this check.

c. Move cyclic stick rapidly to fore-and-aft, and left and right extremes at random; move collective stick up and down rapidly. Any resistance (except for three pounds on collective) or seizing of the controls indicates improper adjustment of the control linkage.

d. Move override check switch to the other side and repeat above check.

Note. With the override check switch to the left, the maximum achievable rate of cyclic stick motion right or aft, or the collective stick up, will be slower than in the opposite directions, but not less than full stick travel in about one second. The slower rates will reverse when the override check switch is in the opposite position. There will be a force moving the pedals left and the collective up which should not exceed 80 pounds on the pedals or three pounds on the collective.

CAUTION: Whenever making the hard-over check to the right, the collective stick should always be held firmly to prevent its rising and overspeeding the engines.

4. If a servo motor does not pass the bind test but can be driven from stop-to-stop and positioned in the center so that the hard-over check can be made, the servo motor may be passed for flight until it can be repaired. If the yaw or collective open loop springs are not adjusted, they should be removed from the helicopter and then the only force in yaw will be the restriction of the pedal damper which should not exceed 44 pounds for full travel in 16" 12". Also, the only force in collective will be the weight of the stick tending to drop. This is approximately seven pounds.

a. If it is necessary to fly an ASE helicopter without the ASE installed, ASE components should first be installed, the hard-over check made, the servo motors centered, and then the ASE may be removed. However, if any adjustments are made on the servo or open loop springs, the ASE should be reinstalled to enable the hard-over check to be made.

b. Although the above procedures do allow flying ASE helicopters before the ASE is completely checked out, it is imperative that the ASE be checked out and flown as soon as possible so that a sufficient amount of ASE flight time can be logged to turn up any up any intermittent malfunction of the equipment that might exist.

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Section X. CH-34A ASE

1. GENERAL DESCRIPTION

a. The ASE is designed to improve the handling characteristics of the helicopter to permit hands-off attitude stabilization or automatic cruise by introducing absolute static and dynamic stability.

b. The ASE used in these helicopters differs from some fixed wing autopilots in that the ASE may be engaged prior to takeoff and left engaged during the entire flight; the ASE has only 20 percent authority relative to pilot control authority. Stability corrections are introduced into the flight control system in such a manner that the pilot has complete control of the helicopter through normal use of the flight controls because of the 20 percent authority design.

c. The ASE will maintain aircraft attitude, altitude, and heading by controlling the aircraft about four freedoms, which are pitch, roll, yaw, and altitude.

d. Table 2 lists the ASE components, their locations, and number required for aircraft.

e. The ASE may be engaged at any time after the rotor head has been engaged and the generator has cut in; except for a brief (2 1/2 minute) time delay to allow the gyros to erect and come up to speed. A time-delay relay prevents inadvertent engagement prior to expiration of this period.

f. The ASE receives its electrical power from the 27.5 volts D.C. ship's power supply from the primary bus and 115 volts A.C. 3 Ø delta 400 cycles from the main or spare inverter.

g. With the ASE engaged at the attitude mode, the pilot may continue to fly the helicopter in the normal fashion; the only noticeable difference would be that the helicopter is dynamically stable and will maintain any fixed attitude for any fixed control position. For instance, the pilot can manually operate the controls in the usual fashion and, upon release of the controls, the ASE will automatically hold the fuselage on the new heading and at the attitude at which the controls were trimmed to when released.

h. As a further convenience to the pilot, a heading trim adjustment is provided by which the pilot may make small course adjustments without disengaging the yaw channel. For large course changes the pilot merely operates the stick and pedals in the usual fashion; the yaw channel is automatically disengaged and nulled any time the pilot's feet are on the rudder pedals. With forward flight, large heading corrections made with the yaw-trim knob will make the aircraft go into a flat turn because of roll stabilization.

i. The only adjustment required of the pilot is a bias adjustment necessary to compensate for CG changes. This can be set at any time to the approximate CG using

Table 2. Equipment components.

COMPONENTS	NO. REQ.	LOCATION	PART NO. OR MODEL NO.
Control gyro and amp.	1	Transmission deck - stb'd side	Lear, 1005N
Control panel assembly	1	Console - cockpit	Lear, 2560C
Altitude control	1	Electronic comp't - aft blk'hd	Lear, 2203G
Stick canceller	2	Clutch fan comp't	Lear, 911D
Motor box assembly	1	Aft blk'hd - cockpit	S1645-61145-1
Emergency release relay	1	Canted bulkhead - behind pilot - transmission	33 HSX-30
Motor release time-delay relay	1	Canted bulkhead - behind pilot - transmission	HF-01-No-28
Servo motor assembly	3	Auxiliary servo	S1665-61755
Servo motor assembly	1	Tail rotor servo	S1665-61755
Release button	2	Pilot and copilot cyclic grip	
Pedal switch	4	Rudder pedals	

the CG trim know on the control panel. The null indicator serves as a check on this, a tendency for the needle to remain on one side of the meter indicates the need for CG compensating adjustments. Maladjustment of this knob reduces the efficiency of the pitch stabilization and may make the helicopter unstable in pitch with comsumption of fuel.

j. Any time after the ASE has been engaged, if the pilot desires to maintain constant altitude during cruising flight he need only adjust the collective pitch to give zero rate of climb and push the barometric altitude hold button. Differential collective pitch signals will then be introduced into the collective pitch control system to maintain the altitude at which the altitude mode was engaged. Since the throttle compensating linkage takes its signal after the autopilot and pilot collective pitch input are combined, collective correction should not disturb engine rpm, and power will be adjusted, as required, within the capabilities of the throttle synchronizer.

k. The CH-34A aircraft is equipped with the J-2 compass system which will provide, not only, navigation indication to the pilot but also directional stable reference for the ASE. Directional signals are introduced to the ASE from the J-2 gyro whenever the ASE is engaged.

l. On the pilot's collective stick grip is located the hydraulic servo shutoff switch to prevent inadvertent simultaneous disengagement of both primary and auxiliary servos; the switch is arranged in such a manner that only one set of servos may be disengaged at any one time and both servos are ON when the switch is in the normal center position. The ASE operates through the auxiliary servo and so disengagement of the auxiliary servo serves as a disconnect for the entire ASE system. While no electronic failure is anticipated, which can lead to a dangerous flight condition requiring this disengagement, this switch allows the pilot to eliminate any undesirable effects introduced by hydraulic malfunction.

m. An emergency auto-stabe release button is incorporated on both the pilot's and copilot's cyclic stick grip. Actuation of either button disengages all modes and ASE operation. Depressing the engage button on the ASE control panel will reengage attitude mode operation.

2. DESCRIPTION AND OPERATION OF ASE AUXILIARY AND TAIL ROTOR SERVOS

a. The CH-34A type helicopter has two independent sets of servos operating in pitch, roll, collective channels, and one set for tail rotor (yaw) control. The primary, located at the star, reacts the flight loads under normal conditions. Located closer to the pilot input and just prior to mixing of cyclic and collective stick inputs is the auxiliary servo. The auxiliary servo serves as a means of introducing the ASE signals as well as a standby servo in case of primary failure.

b. The servo system introduces the ASE actuation into the control system for the pitch, collective, roll control channels. The yaw channel uses a different design; but, the principle is similar. The key to the differential input system employed in the Sikorsky ASE is found in the working of the ASE auxiliary servo.

c. To see how this servo operates, consider first the normal operation in response to a pilot-applied signal. The pilot's control stick input is introduced at point A which pivots member AC about point C. Point B is moved a proportional amount, moving point D about fixed point E. Point F is moved, moving point G about point I (since the autopilot is now off, point I is fixed). This moves point H, actuating the pilot valve, permitting flow into the power piston, which then moves point C and through the mixing unit, the rotor head link. The motion of C due to the power piston moves member AC about A (assuming that the pilot has stopped moving his stick). This motion causes a proportional displacement of point B, which then moves points D, F, and G. Point H moves proportional to the movement of G, and the pilot valve is closed, thus stopping the power piston. Because the output motion of C simultaneously feeds back to close the pilot valve and stop the power piston, an output proportional to input is obtained.

d. With the ASE in operation, the sensing system of the ASE directs a voltage through amplifiers to the servo motor. Mounted on the threaded shaft of the motor is a nut which is part of a trunnion assembly. This assembly is moved linearly in one direction or the other by the rotation of the motor shaft in much the same manner as a jackscrew. The motor rotation develops a voltage in the tachometer generator which serves to dampen the motor. The attendant displacement of the trunnion assembly develops a proportional voltage in the displacement transducer. These two voltages are mixed and returned to the amplifier, acting to cancel the input from the sensing units, thereby ensuring that the motor response to the input voltage is smooth and precise.

e. The trunnion assembly is connected, by a yoke, at I to one end of the differential link IG. Any motion of the trunnion is thus transmitted directly through point H to the pilot valve. Unless the human pilot is moving his stick, point A is fixed and therefore points B, D, F, and G are fixed. The motion of point I moves point H cracking the pilot valve and actuating the power piston, the displacement of which moves point C and is fed through the mixing unit to the rotor head. It is of particular advantage that the servo motor operates the small pilot valve directly, thus demanding a very small power requirement. The same feedback is in operation in this case as before; namely, displacement of point C about fixed point A moves point B and subsequently points D, F, and G. Point G now moves about point I to move point H so that the pilot valve closes and stops the motion of the power piston.

f. It is important to remember that members GI and AC are in effect differential links by means of which mixing of the pilot and ASE inputs, which we have just followed separately, may be accomplished. The two input signals mix in any combination to produce an output motion proportional to the differential input motions. The output motions are combined at the power piston, which contains the control stops, rather than at the pilot's stick, so that the pilot always has complete freedom to move the output anywhere within its limits regardless of ASE actuator position.

g. Should the hydraulic pressure drop as in the case of a hydraulic failure, the pilot can control the helicopter through the same chain of command. In such a case, a bypass and slop eliminator system allows him to operate the linkage with no lost motion and without interference from the power piston. A pressure failure would rotate the slop eliminator (due to the compressed spring expanding against the piston with the pressure removed) so as to anchor the point D. Simultaneously the valve at K is rotated to open the bypass across the power piston.

h. There are some basic similarities between the block diagram of the yaw channel. The ASE yaw servo is different from the design hitherto described.

i. The pilot's rudder pedals are connected to the tail rotor linkage by means of cables A and B. Cable A is wrapped around a pulley with center C, around one of the two concentric pulleys with center D, and is then connected to one end of the power piston. Cable B goes around a pulley with center E, the other of the two pulleys with center D, and then down to the tail rotor linkage. The member CE on which the four pulleys are mounted pivots on point D. A differential link FH is connected to member CE by a link at end F. The other end of the differential link H is actuated by the trunnion assembly travel of the servo motor; the mid point G is attached to the pilot valve spindle. The pilot valve is hydraulically connected to the power piston as before.

j. To prevent too hard an input at the pilot's pedals from overloading the tail cone, a damper is provided to restrain the pilot's pedals; the restrain being hardly noticeable with small or slow pedal movements. The pilot's input motion of the pedals causes cables A and B to move. At this momemt the power piston is stationary; therefore, the cable motion rotates the member CE about pivot point D. The motion is transferred to differential link FH; which, with no autopilot input, pivots on point H. Point G is displaced, cracking the pilot valve and actuating the power piston. The piston moves the control cables thus actuating the tail rotor linkage; the motion of the cables is such that it restores to its original position member CE. This moves the differential link FH so as to close the pilot valve and stop the power piston.

k. In the event of hydraulic failure, a bypass and slop eliminator system allows the pilot to actuate the tail rotor link directly by means of the control cables. The slop eliminator fixes member CE so that is cannot rotate about D. The bypass system equalizes the pressure on either side of the power piston so that the piston will be moved freely.

l. With the ASE engaged, an input from the ASE motor is introduced at point H of the differential link. Unless the pilot is introducing a simultaneous input, point F remains stationary and point G is moved, actuating the pilot valve and the power piston. The power piston moves the control cables and the cable motion is such that it moves member CE so as to restore the differential link to a position where the pilot valve is closed, thus stopping power piston. In normal operation, the ASE inputs are small and the member CE is actuated by the cable motion due to the power piston and thereby closes the pilot valve. Thus, no feedback motion is reflected at the pilot's pedals and the system is said to be in closed loop. However, should the ASE inputs be large, the increasing resistance of the open loop spring J restricts member CE, thus forcing any further motion of the power piston to move the cables A and B, moving the pilot's pedals. The system is now in open loop with feedback motion being introduced at the pilot's control pedals.

m. The addition of the yaw open loop spring increases the authority of the yaw channel from the normal 20 percent. The pilot may overcome the pedal motion introduced by the open loop condition by merely overcoming the force of the pedal damper and spring and thus maintaining the limited authority concept. The motor loop operates exactly the same as in the other channels; i.e., the output motion from the servo motor which moves point H also actuates the displacement transducer and the tachometer generator, the signals from which are mixed and returned to the amplifier, tending to oppose the input signal to the amplifier. Thus, when the servo motor has turned a certain amount, the feedback signal cancels the input voltage and the motor stops, so that for any given input signal the servo motor causes only a proportional displacement of point H.

3. COMPONENT DESCRIPTION

a. Control Panel. The pilot's operating controls for the ASE are located on a control panel mounted on the console between the pilot and copilot.

(1) The controls consist of four push-button switches labeled ENGAGE and BAR ALT. Pushing the engage switch puts the helicopter in the attitude mode of operation with pitch, roll, and yaw stabilization. Pushing the bar alt switch, once the ASE has been engaged, will establish the automatic cruise mode by adding altitude. stabilization to pitch, roll, and yaw.

(2) Control of fuselage attitude controls translational velocity; this mode of operation will allow the pilot to maintain constant speed and altitude on a steady magnetic heading for automatic cruise flight.

(3) The control panel contains a null indicator, a CG trim learsyn, and a yaw trim differential transformer. The null indicator; a center reading micro-ammeter is used to monitor either servo motor position or servo motor input starting voltage. In flight the null indicator monitors the pitch channel to detect any need for trimming the helicopter longitudinally. When the necessity for trimming arises, indicated by an off-center needle, the pilot will use the CG trim knob and cyclic stick to reset the pitch attitude of the ship. The yaw trim knob is used for minor heading corrections. Each index mark represents 1° of aircraft heading. One revolution of the yaw trim knob will turn the helicopter 36°. Large heading changes should be made through the normal controls, when in forward flight; otherwise, the helicopter will make a flat turn because of roll stabilization.

b. Control Gyro and Amplifier (CG&A). The CG&A is the heart of the ASE system and contains the following main sub-assemblies:

(1) Servo amplifiers - one each for pitch, roll, altitude, and yaw.

(2) Multiple channel - turn amplifier and roll integrator.

(3) Vertical gyro.

(4) Twelve - signal adjustment assemblies.

(5) Five - signal adjustment assemblies.

(6) Yaw synchronizer assembly.

Besides the above mentioned sub-assemblies the CG&A chassis contains excitation transformers, relays, control transformers, and power supplies. The following is a brief explanation of each of the main sub-assemblies:

(a) Servo amplifiers. They are used to amplify, discriminate, mix, and further amplify the displacement and derived rate signals. These assemblies are plug-in channels secured by a screw and consist of five JAN 6072 vacuum tubes and associated circuitry.

(b) Multiple channel amplifier. This is also a plug-in channel used as the roll integrator and turn amplifier.

(c) Vertical gyro. The function of the vertical gyro assembly is to provide a stable reference from which the pitch and roll displacement signals are derived. The assembly is contained in a hermetically sealed can in one atmosphere of helium. The main sub-assemblies of the vertical gyro are -

1. Three-phase inductive motor.
2. Erection system.
3. Displacement signal synchros.
4. Gimbal snubber.

The three-phase inductive-type motor is used to rotate the rotor at approximately 22,000 rpm so that the gyroscopic principles of rigidity and precession are present.

The erection system consists of a gravity sensitive electrolytic switch assembly which will control a split-phase torquer motor. This torquer motor will apply a force which, through precession, will precess the gimbal to erect and keep the spin axis vertical to the earth regardless of aircraft attitude. There is a switch and torquer motor for pitch and roll.

The signal deriving synchros, one each for pitch and roll, are mounted so that they will delivery an electrical signal whenever the helicopter is not in a level attitude. The rotor is excited by 115 volts A.C. Ø A and the signal output is from the stator. The stator output signal is also fed into a resistor network where the three-wire signal is converted to a single wire signal and also attenuated.

The gimbal snubber is used to keep the gimbals locked when the ASE is shutoff.

(d) Twelve-signal adjustment assembly. This assembly is a plug-in unit consisting of 12 potentiometers. Access to these potentiometers, for adjustments, is through the CG&A front cover. The potentiometers will adjust the gain of the displacement, rate, and feedback signals of all four channels. Normally, these adjustments should not be moved as they are factory adjusted. If, in any case, they must be checked or re-adjusted, only qualified personnel should make the changes.

(e) Five-signal adjustment assembly. This assembly is a plug-in unit consisting of five potentiometers. The NULL IND SENS and NULL IND CENT will adjust the centering and the sensitivity of the null indicator circuit. The VEL GEN QUAD will null the yaw turn velocity generator quadrature bridge circuit. The BAR ALT PRE AMP and ALT RESET will adjust the gains of those circuits.

(f) Yaw synchronizer assembly. This assembly is a hermetically sealed unit which is made up of the yaw synchro transformer, turn motor, turn motor velocity generator, and gear train from the motor to the rotor of the synchro. This assembly in conjunction with the turn-motor loop is used to keep the yaw channel nulled, at all times, except when the ASE is engaged and the pilot's feet are off the pedals.

(g) CG&A chassis. This chassis contains all of the wiring to complete the circuitry within the CG&A. The chassis also has four tubes, one of which is the BAR ALT PRE PRE-AMP. Two are used to develop the 275 volts D.C. B+ and 150 volts D.C regulated B+. A 26Z5W is used as the rectifier for step-up transformer, T-5; the OA2 cold cathode is used as the gas regulator for the 150 volts D.C. B+. The forth is not used in CH-34A aircraft, but is needed to complete a filament string. The CG&A chassis contains numerous transformers, both power and coupling, and relays K-1 through K-7 and time-delay relay K-9. The function of these relays will be described later.

c. Motor Box Assembly.

(1) The motor box assembly is located between pilot and copilot covering the auxiliary servo assembly. It is the junction box which connects the servo motors to the ASE circuits. The back of the assembly contains the magnetic amplifiers, phase shift capacitors, transducer excitation transformer, T101, and the associated circuitry. The front panel contains test switches and adjustment potentiometers. The test switches are -

(a) Override,

(b) Motor,

(c) Selector,

(d) Channel disengage switches, and

(e) Motor bind test jacks.

(2) The channel selector and motor switches combine to determine the channel and the type signal to be monitored by the null indicator. The channel selector as the name implies, will connect the channel desired to the indicator. The motor switch is spring-loaded into the position position and this will indicate servo motor position and the input position will indicate starting voltage for the servo motor. The disengage switch will control 115 ØA excitation voltage to individual servo gage switch and control 115 ØA excitation voltage to individual servo motors. Test jacks are used to measure starting voltage with a voltmeter.

(3) The panel also contains two sets of four potentiometers each, labeled TACH GEN and FU NULL. The TACH GEN POTS will adjust the excitation to the TAC GENS of the servo motor assembly which will dampen motor rotation. The FU NULL centering POTS will null the channel followup circuit and hence null the servo motor.

d. Barometric Altitude Controller.

(1) The altitude controller is a pressure-sensitive device containing a set of aneroids; the case is vented to the aircraft's static line. A descent or ascent of the helicopter will be sensed by the aneroids through a sector gear and linkage. This mechanical movement is transposed to an electrical signal through a clutch to an EI type electrical pick-off. The clutch will be engaged only when the pilot has depressed the BAR ALT switch on the control panel.

(2) The moisture that condenses in these controllers and lines is detrimental to proper operation and for this reason the static line drains, which are located on the aft starboard bulkhead in the electronics compartment, should be drained daily.

e. Stick Canceller. There are two stick cancellers, which are two-tap learsyns, located in the clutch-fan compartment connected to the pilot's cyclic stick linkage. The stator is fixed firmly to the aircraft structure and the rotor is connected to and rotated by motion of the cyclic stick. One canceller is for pitch and the other for roll. The functions of these cancellers are to cancel any vertical gyro signals that are developed because of aircraft attitude which is set up by the pilot. It is for this reason that the pilot may leave the ASE engaged for his entire flight and make any attitude changes in the normal fashions without disengaging the ASE.

f. Servo Motor Assemblies.

(1) The servo motor assemblies are used to introduce the ASE signals into the aircraft flight controls. Three motors are mounted on the auxiliary servo, one each for pitch, roll, and altitude. Another is mounted on the tail rotor servo for yaw. They are two-phase inductive-type motors.

(2) The rotary motion of the motor is changed to a linear motion by a screw-jack arrangement. This linear motion is restricted by mechanical stops to a total of .250" or 10 revolutions of the motor. This limited travel gives the ASE the limited 20 percent authority that it has. The linear motion of the trunnion will displace one end of the servo differential link which, in turn, will displace the servo pilot valve. The motion of the servo motor assembly also develops a feedback displacement signal by moving the wiper arm of a wire-wound linear displacement transducer. The rotary motion will develop from a tachometer generator, an out-of-phase signal to dampen servo motor momentum.

g. Release Switches. The release switches are located, one each, on the cyclic sticks and are used to put the ASE into the released mode. In this mode the motors are first nulled and then all of the phase A excitation to the motor box is eliminated by the use of a two-second time-delay relay. By eliminating the excitation to the motor box which, in turn, supplies the motors, the motor is not free to operate because of loss of excitation and will stay in their nulled positions because of two centering springs.

h. Pedal. There is a pedal switch on each rudder pedal. Normally, these are all closed switches, wired in series, and their function is to place the yaw channel into a standby condition whenever the ASE is engaged and the pilot is turning the aircraft and wants to stabilize at some new heading. In the standby condition, the yaw channel is nulling itself for the new heading desired.

4. ASE CHANNEL OPERATION

a. Pitch Channel.

(1) The pitch channel receives a signal proportional to fuselage attitude with reference to the horizon. A voltage, proportional to angular displacement, will be derived from the vertical gyro pitch synchro pick-off. This is a three-wire signal. A resistor network will convert the three-wire signal to single wire for use in the ASE.

(2) K-4 relay contacts are shown in a deenergized condition. K-4 will energize when the ASE is engaged.

(3) The displacement signal is fed into the grid of the displacement pre-amp stage and also to the grid of the rate pre-amp after first passing through the rate gain POT in the 12-signal adjustment panel. The basic displacement signal carries two bits of information; first, the amplitude is proportional to the amount of displacement of the helicopter; and secondly, phase determines the direction of displacement, either nose-up or nose-down. One other bit of information is needed to result in a good tight system, and that is the rate of displacement. To sense the rate of displacement, the displacement

signal is amplified, sent to the rate discriminator circuit. When it is discriminated and a D. C. signal derived, the D. C. signal is then differentiated and a leading signal derived proportional to the rate of change of the displacement signal. Both the rate and displacement signals are mixed at the input transformer of the mixer-discriminator stage and the resultant signal discriminated to determine the polarity and eventually the direction of rotation of the servo motor. The resultant signal is applied at the grids of a parallel output stage. The plate load of the output stage is the input winding of the magnetic amplifier. (The MAG AMP is discussed in another Service School Information Notice.)

(4) Plate current will affect the flux in the cores of the MAG AMP. Any unbalance of plate current will change the degree of saturation of either core which, in turn, changes the impedance of each of the output windings resulting in an A. C. signal; the amplitude, of which, determines the amount and rate of displacement; the phase, of which, determines the direction the servo motor will rotate. This signal is applied to the control field of a two-phase inductive-type motor. The fixed field is excited with 114 volts A. C. ØA. Connected across the control windings is a phase-shift capacitor which will shift the control voltage approximately 90° for proper servo motor operation.

(5) Rotation of the servo motor will change electrical energy to mechanical energy and accomplish three jobs, which are -

(a) Displace the fore-and-aft pilot valve of the auxiliary servo which, in turn, will affect the power piston, fore-and-aft primary servo, fixed and rotating star, pitch-change rods, and change the pitch of the main rotor blades which, through aerodynamics coupling, will complete the major loop and return the fuselage to its original attitude.

(b) Develop voltage from the transducer to the feedback which will cancel the input signal to the servo motor. The feedback signal is needed so that proportional control of the servo motor can be had.

(c) Rotate the drag cup of a tachometer generator which will produce a signal proportional to servo motor rotation which will dampen servo motor momentum.

(6) The feedback (minor) loop signal is developed at the wiper contact of a wire-wound transducer (linear potentiometer). The transducer is excited with 8 volts A. C. The center of the winding is referenced at ground potential and whenever the servo motor is centered, zero volts are picked off by the transducer. Whenever the servo motor is not centered, the transducer will pick off anywhere from 0 to 4 volts A. C. either in-phase or out-of-phase, dependent upon rotation.

(7) This signal is routed through the feedback gain POT to determine signal strength; then fed in series to the output windings of the tachometer generator. The combined signals, aiding on the displacement half cycle of the aircraft and opposing on the return half cycle, will pass through the normally closed contacts of K-4 relay (when ASE is in standby) and through the displacement gain POT (which determines the gain of the displacement pre-amp stage) and onto the cathode of the displacement pre-amp tube. This cathode signal will cancel the effect of the gyro signal on the grid and result in proportional control of the servo motor.

(8) The minor loop is always closed. When engaged, the signal cannot pass through contacts 4 and 5 of K-4, but must pass through contacts 3 and 4 instead.

(9) Once the servo motor rotates and displaces the blades, the aircraft now will start to return to its original attitude. As the helicopter returns, the ASE must now sense the rate of return and also prevent overshooting of the helicopter. The blades will be repositioned as follows: as the helicopter returns, the gyro signal begins to diminish and the transducer signal is now stronger than the gyro, hence the feedback signal will drive the servo motor in the opposite direction since the feedback signal is opposite in phase to the gyro signal. The rate and tachometer generator signal will prevent the aircraft from overshooting the original attitude.

(10) With ASE in engage, the stick canceller and CG trim learsyn will also affect cathode voltage.

(11) The stick canceller will develop a signal proportional to cyclic stick position (fore-and-aft) from neutral. Whenever the pilot desires an attitude other than true level the stick must be displaced which, in turn, develops a signal equal in amplitude but effectively opposite in phase to the gyro signal; hence, the pitch amplifier sees a null signal keeping the helicopter at the desired attitude. The stick canceller also allows the pilot to change attitude without disengaging the ASE.

(12) The CG trim learsyn located on the control panel is used to correct for any shifting of CG due to load shift or fuel consumption. Retrimming will be a coordinated effort of the CG trim and cyclic stick.

(13) With the ASE in standby, the servo motors will null themselves because the only signal in the system is the feedback signal; hence, if the servo motor is at some point other than center, the transducer wiper is picking off a voltage which, when applied to the amplifier, will drive the motor to null.

b. Roll Channel.

(1) The roll channel operates similar to the pitch channel except for some minor differences.

(2) Wherever we stated fore-and-aft, it should now read lateral; pitch should be changed to roll.

(3) There is no CG trim in roll and the stick canceller signal is fed into an integrator circuit where it is lagged to minimize ground resonance effect by the dampening stick motion. The vertical gyro and canceller signals will mix and cancel at the output transformer of the integrator circuit.

(4) The major and minor loops are identical with that of the pitch channel.

c. Altitude Channel.

(1) The plug-in amplifier and major and minor loop serve the same function as in pitch and roll.

(2) The altitude error signal is derived from a barometric altitude controller. This controller contains two sets of aneroids which sense barometric pressure changes, an anti-backlash sector gear, clutch, and an EI pick-off coil. The aneroids have a range of operation from 1,000 feet to 50,000 feet; but the EI pick-off has a range of ±250 feet from the point of engagement.

(3) When the pilot engages BAR ALT the electromagnetic clutch will connect the I bar of the pick-off to the expanding and contracting aneroids. Any altitude change after engagement will be sensed and sent to the BAR ALT PRE-AMP stage (V-2) in the CG&A chassis. This stage is needed to amplify the signal up to the level of pitch and roll before entering the plug-in amplifier channel. The gain of this stage is controlled by the BAR ALT PRE-AMP gain POT in the five-signal adjustment panel. The output is sent, through relay contacts 6 and 7 of K-7 and 12 and 13 of K-4, to the plug-in channel.

Note. The complex relay circuitry is needed to keep the rate grid grounded during all modes of operation (ASE). The rate grid is grounded as a result of the static port of the aircraft. Experience has told us that the static port of the aircraft is always picking up pressure variations because of rotor blast; because of these pressure fluctuations the aircraft may fly erratically when BAR ALT is engaged. If we were to send these erratic signals, sensed by the controller, to the rate circuit they would tend to over-correct and aggravate the condition that already prevails. So for this reason it is imperative that the altitude rate circuit be grounded out at all times. The static port creates one more source of trouble and that is the moisture and rain water that may enter the static system and affect proper altitude controller operation. The static lines have two drains which should be drained daily to minimize altitude troubles. These drains are located in the aft-starboard bulkhead in the electronics compartment.

(4) Notice that there is no stick canceller or other means of cancelling the BAR ALT signal other than the feedback loop, which means the altitude channel must be disengaged any time the pilot desires to make cyclic and/or collective changes. The altitude channel should be engaged at a zero rate of climb to preclude any possibility of running out of authority with the servo motor.

d. Yaw Channel (fig. 11).

(1) The J-2 gyro synchro pick-off signal is used as the stable reference platform for yaw stabilization. The three-wire synchro signal from the gyro is fed to the input stator of the yaw trim differential transformer located in the control panel. The physical position of the output stator is controlled by the pilot through a knob geared by a 10:1 ratio. With the system engaged the pilot need only turn the knob to turn the helicopter. The signal from the yaw trim synchro is fed into the stator of the yaw synchro. The rotor of the yaw synchro will develop an error voltage which can either become a synchronizing signal or a yaw error signal, depending upon the condition of the yaw channel.

(2) Prior to engagement, or with the ASE engaged and the pilot's feet on the rudder pedals, the yaw channel will be in standby.

(3) During these conditions, relay K-2 is deenergized and the major loop is open. At the same time, the yaw sync loop is closed through contacts 13 and 14 of K-3 when ASE is not engaged or contacts 12 and 13 of K-4 and 10 and 11 of K-5 when ASE is engaged but the pilot's feet are on the pedals.

(4) Any error that shows up at the output of the yaw synchro, when the yaw channel is in standby, will be amplified by the yaw sync amplifier and drive the yaw sync turn motor to position the rotor of the yaw synchro for a null output. This arrangement will keep the output of the yaw synchro nulled so that the ASE will lock onto any heading desired by the pilot upon engagement or release of the controls.

(5) The rest of the major and minor loops are similar in operation to the other channels.

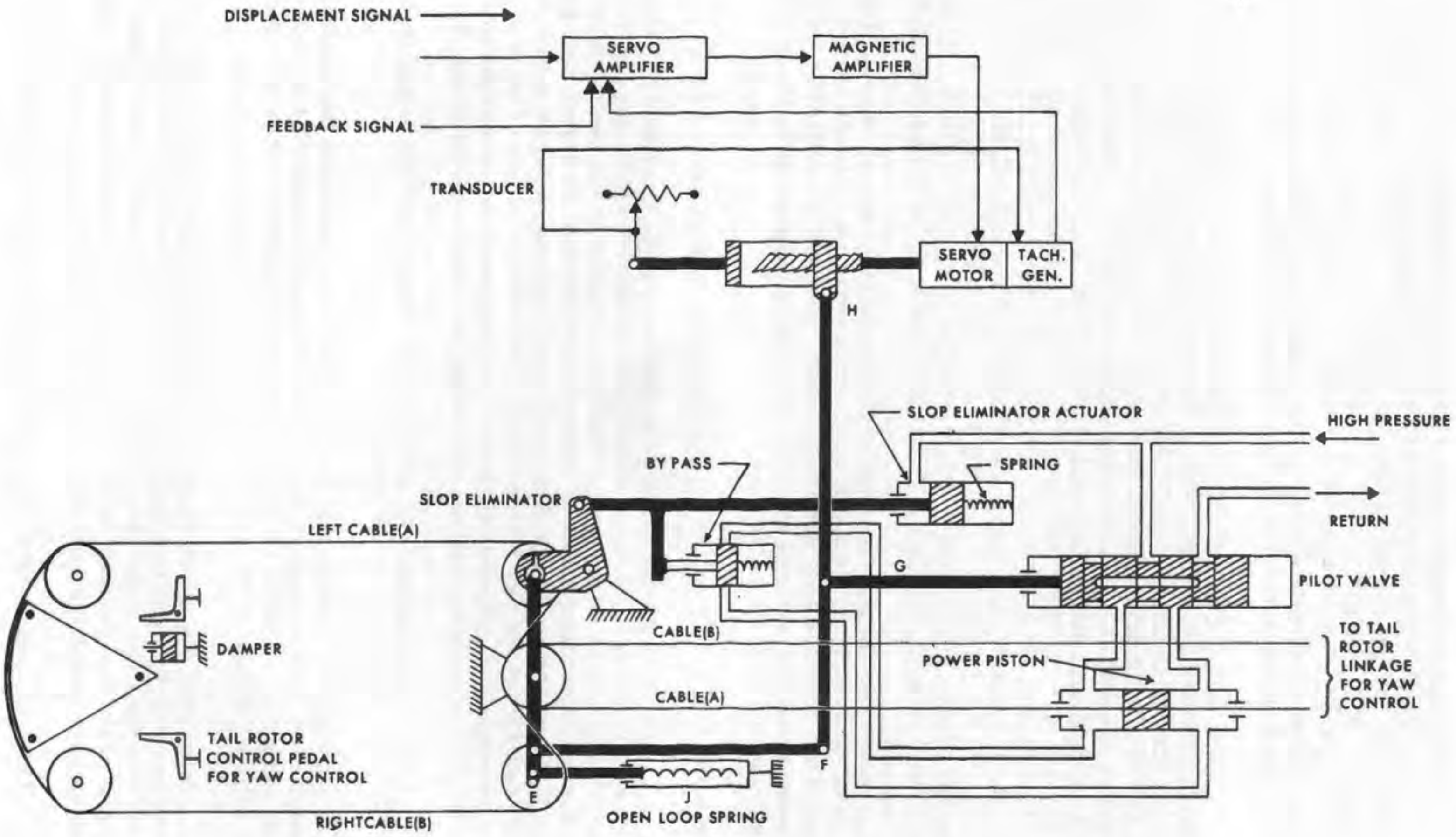

Figure 11. Tail rotor ASE servo.

DEPARTMENT OF MAINTENANCE TRAINING
UNITED STATES ARMY AVIATION SCHOOL
Fort Rucker, Alabama

Section XI. SLAVED GYRO MAGNETIC COMPASS SYSTEM TYPE J-2/C-4

The J-2 system combines the action of a magnetic compass and a directional gyroscope to give an accurate, reliable, and continuous azimuth heading. For instrument flights it is the most essential navigational aid. Its simple operation also makes it very useful for all types of instrument approaches, aerobatics, and tactical missions. The J-2 Compass System obtains reliable readings by combining the most desirable features of the gyro and the magnetic compass. The system consists of a remote compass transmitter, a compass amplifier, a directional gyroscope, a repeater amplifier, and settable dial indicator(s). These five components work together to transmit stabilized heading information to your settable dial indicator(s) and ASE when provision has been made.

1. COMPASS TRANSMITTER

The compass transmitter (fig. 12) is a inductor-type compass that senses the magnetic heading of the aircraft and generates a corresponding signal. Since this transmitter is only two 9/32 inches thick, it can be installed within the wing or tail of the airplane, where magnetic disturbances are lowest. It is mounted in the tail cone in the CH-34 helicopter.

Figure 12. Compass transmitter.

2. DIRECTIONAL GYRO CONTROL

The directional gyro control (fig. 13) houses the directional gyro, leveling and slaving torque motors and flux valve and heading synchro.

Figure 13. Directional gyro control.

a. Directional Gyro.

(1) With the gyro principles of rigidity, in space and precession, we are able to maintain the spin axis horizontal to the earth's surface and north seeking with proper signals from the remote compass transmitter (flux valve).

(2) The principle of rigidity allows the gyro to operate free of the remote compass transmitter; it will maintain approximately the same heading for extended periods of time. The gyro when free will drift, due to friction, at a very slow and definite rate. The rate being approximately 6°/hour. This is called free-gyro operation. When operating from signals, the flux valve is said to be slaved.

b. Slaving Torque Motor. The slaving torque motor precesses the gyro maintaining the spin axis bearing north.

c. Leveling Torque Motor. The leveling torque motor precesses the gyro maintaining the spin axis level to the earth's horizon. The signal to operate it is received from a liquid level switch, which is gravity sensitive.

d. Flux Valve Synchro. The flux valve synchro reproduces the signal from the remote compass transmitter, comparing it with the position of the gyro. Should it drift, the resultant signal will be used to maintain the gyro bearing north.

e. Heading Synchro. The heading synchro produces the signal which is used to position the needle, of the settable dial indicator, showing aircraft heading. This signal can also be used to operate the yaw channel of ASE.

3. SLAVED MAGNETIC COMPASS AMPLIFIER - TYPE A-2

The amplifier performs two functions, first, by comparing the signal from the remote compass transmitter and the position of the directional gyro, it will produce a signal of proper phase and amplitude which will maintain the gyro spin axis to magnetic north by the slaving torquer. Second, during the first two to three minutes of operations, through internal relays, the slaving and erection torquer motors have a high erection voltage applied to them. This will bring the spin axis of gyro to bearing north and horizontal to the earth's surface much faster. Once the system is up to normal operation, within two to three minutes, the internal relays reduce the erection voltage to normal erection (slow erection) and will remain at slow erection as long as D. C. power is maintained to the amplifier.

Figure 14. Slaved magnetic compass amplifier - type A-2.

4. SETTABLE DIAL INDICATOR

a. The settable dial indicator presents the true magnetic heading of aircraft as established by remote compass transmitter and directional gyro.

b. The set course enables the pilot to rotate pointer and compass card; to maintain the needle indication vertical as a reference for turning or straight flight.

c. Three settable dial indicators may be used with one system and, by incorporating a B-7A type gyrosyn repeater amplifier, six more indicators may be used.

5. GYROSYN REPEATER AMPLIFIER

The B-7A gyrosyn repeater amplifier must be used in CH-34A aircraft equipped with ASE as an isolation state between the settable dial indicators and the yaw channel of ASE equipment to prevent any yaw oscillation due to feedback from the indicators to the ASE.

6. AUXILIARY UNITS

a. The signal cycle error compensator is attached to the remote compass transmitter to eliminate magnetic deviations caused by aircraft electrical equipment and ferrous metal. This is used when a mounting location free of these disturbances cannot be found.

b. The quandrantal or transmission error compensator is used when accuracies of more than one-half of 1° is required.

7. OPERATION INSTRUCTIONS FOR J-2 COMPASS SYSTEM

a. The J-2 compass system is connected directly to the main power supply through an A. C. - D. C. interlock relay. This enables application of power to the system only when the proper A. C. and D. C. powers are present.

b. Allow three minutes to elapse so that the gyro can come up to speed, erect, and align to north. At this time, the needle of the settable dial indicator will indicate the heading of the aircraft.

c. The settable dial indicator should be referred to as a magnetic compass indicator. The heading of the aircraft is read directly from the indicator.

d. The set course knob enables the pilot to have a vertical needle indication at any degree of 360° that he desires to fly. Example: If the pilot desired to maintain a heading of 050° and have needle vertical, he would adjust set course knob so that 50° on the compass card would coincide with the index mark at the top of indicator; then he would change heading of aircraft until needle was vertical. Now, he can maintain a constant heading by keeping the needle vertical.

e. When flying in polar regions where a magnetic compass is of little value because of magnetic disturbances, the pilot may free the gyro from the remote compass transmitter by operating the slaving cut-out switch. When operating on free gyro the pilot must consider the drift of gyro which is approximately 6°/hour and also the latitude at which he is flying for apparent drift.

8. COMPASS A. C. - D. C. POWER INTERLOCK

a. The J-2 compass system (fig. 15) should have an A. C. - D. C. power interlock circuit to prevent the compass system from repeating its fast slaving cycle due to interruption of the aircraft A. C. power supply. The interlock should be so arranged that a momentary loss of A. C. power will not interrupt the D. C. power.

b. An interruption of D. C. power to a compass system will result in a repetition of the fast slaving cycle with a slaving rate of approximately 90°/minute and a duration of two to three minutes. If the helicopter is accomplishing any change of altitude or airspeed during this two to three-minute period, the flux valve will sense the vertical component of the earth's field and transmit an erroneous heading to the indicator. Upon return to normal flight altitude and constant airspeed, a heading error will be apparent. Upon completion of the fast slaving cycle, the error will be corrected by slow slaving at the rate of 2°/minute. Many time, the magnitude of the error introduced will take unreasonably long to correct under slow slaving.

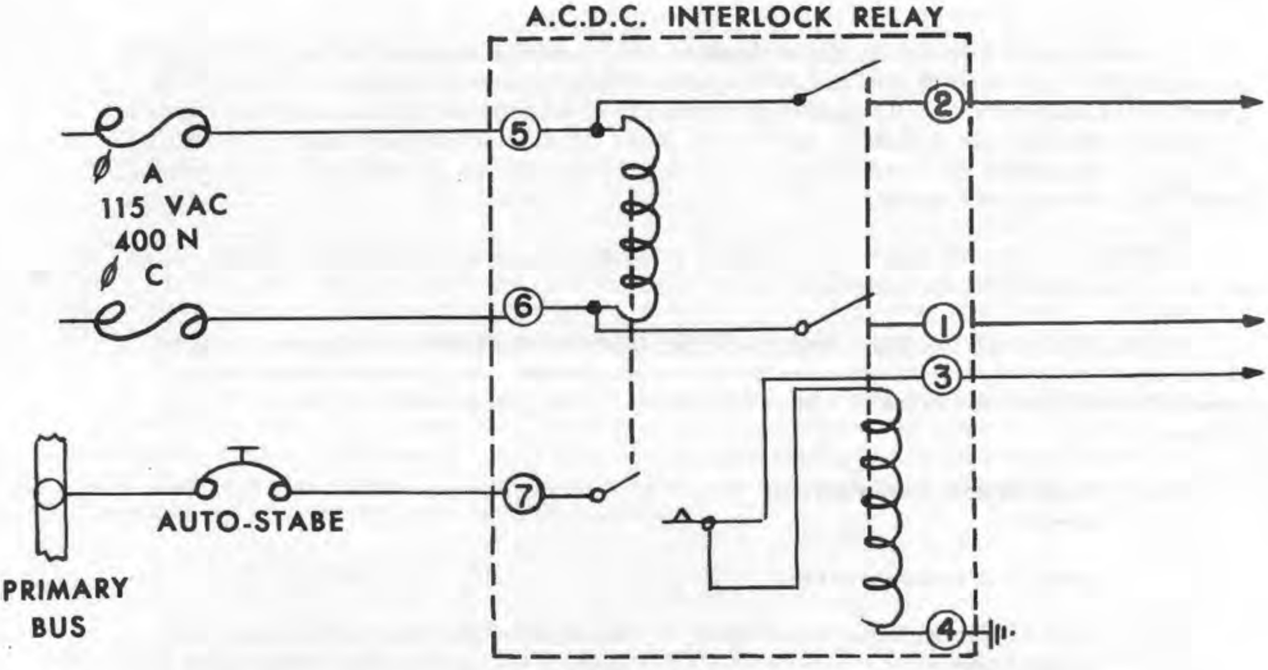

Figure 15. Compass A. C. - D. C. power interlock.

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Section XII. PLANE CAPTAIN'S PREFLIGHT CHECK OF ASE (CH-34A) (THREE MINUTES REQUIRED FOR THIS CHECK)

The procedure below should be used to check out the autopilot system AN/ASN23 before flight. In order to test the ASE system properly both electrical and hydraulic power must be available. The hydraulic power can be provided by running the engine or connecting a ground hydraulic unit to the quick-disconnects at the engine shroud. For electrical power the rotor may be engaged to operate the generator or an external power supply may be connected.

CAUTION: Do not use the helicopter's battery alone for power as this will cause an excessive drain on the battery.

A less thorough preflight inspection can be made with electrical power only in cases where it isn't possible to provide hydraulic power. An external power supply should be used as the source of electrical power. The steps in the check-out are as follows:

1.	Push in auto stabe circuit breaker.	
2.	Switch on main inverter.	
3.	After three minutes press the engage button;	the button light should come on, and remain lit when pressure has been removed.
4.	Press the standby button;	the engage light should go out.
5.	Rotate the channel selector switch (on the motor box) to alt, roll, yaw, and back to pitch;	the null indicator should be centered for each position of switch. If the null indicator is OFF in one channel the FU NULL POT may need a slight adjustment. Note. The FU NULL POTS should not be adjusted lower than Number 4 or higher than Number 6.
6.	Press engage button.	
7.	Move cyclic stick fore-and-aft;	the null indicator should move with stick motion. (As stick moves forward, the null indicator should go left.)
8.	Rotate CG trim knob;	null indicator should follow CG trim knob motion. (CG trim knob moved left should deflect null indicator left.)

9.	While moving CG trim knob, move pitch channel disengage switch (on motor box) to OFF;	null indicator should cease to follow CG trim knob motion.
10.	Return CG trim knob to mid position.	
11.	Return pitch channel disengage switch to ON.	
12.	Move stick forward to cause hard-over indication on null indicator.	
13.	Press the standby button on the control panel;	the light on the engage button should go out and the null indicator should return to center.
14.	Rotate the channel selector switch to roll.	
15.	Press engage button.	
16.	Move cyclic stick from side-to-side;	the null indicator should follow the direction of motion of the stick. (A short time lag will be noticed from the time the stick is moved until the null indicator comes to rest.)
17.	While the cyclic stick is being moved from side-to-side, move the roll channel disengage switch to OFF;	the null indicator should cease to follow the stick.
18.	Return the roll channel disengage switch to ON.	
19.	Move the cyclic stick to one side to provide a hard-over indication on null indicator.	
20.	Press the release button on the pilot's cyclic stick;	the engage button light should go out and the null indicator should return to its center.
21.	Re-center cyclic stick.	
22.	Press the engage button.	
23.	Rotate the channel selector switch to yaw.	

24.	Move the yaw trim knob clockwise;	the null indicator should deflect to the right. (The pedals should jump if hydraulic pressure is applied.)
25.	While rotating the yaw trim knob back and forth, move the yaw channel disconnect switch to OFF;	the null indicator should cease to follow yaw trim motion.
26.	Return yaw channel disengage switch to ON.	
27.	Use the yaw trim knob to drive the null indicator hard-over in either direction.	
28.	Depress the pedal switch on the pilot's right pedal;	null indicator should return to null.
29.	Repeat steps 27 and 28 until all four pedal switches have been tested.	Note. Moving the yaw trim knob while any pedal switch is depressed should have no effect on the null indicator.
30.	Rotate channel selector switch to ALT.	
31.	Press BAR ALT engage button;	null indicator may jump but should return to center.
32.	Press BAR ALT OFF;	BAR ALT button light should go out.
33.	Reengage BAR ALT.	
34.	Press standby button;	BAR ALT and engage button lights should go out.
35.	Lock collective stick friction (this step necessary only if engine is running).	CAUTION: An error in the following test could cause an overspeed if the engine were running and the collective friction not locked.
36.	Move the override check switch on the motor box to the left (left, forward, down, increase position);	null indicator should move to the left.
37.	Press the release switch on the copilot's cyclic stick;	the null indicator should return to the center at the end of approximately two seconds.
38.	Press engage button.	
39.	Move override switch to center or OFF position;	null indicator should return to center.

40. Press standby button.

This completes the short checkout and leaves the ASE system ready for operation.

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Section XIII. ASE TEST PROCEDURE - (CH-34)

PURPOSE: To define the procedure to be followed in checking out aircraft furnished with the ASE after initial installation or whenever ASE has been crabbed. Whenever a component has been changed, a guide to the checks that should be made will be found in Table 5.

Note. This check can be performed on any aircraft, whether or not it has a coupler installed.

ENCLOSURE:

a. Table 3 - ASE Gain Settings.

b. Table 4 - ASE Input Responses.

c. Table 5 - Checks to be Accomplished upon Replacing an ASE Component.

1. PRELIMINARY PROCEDURE

a. Before checking out the ASE as specified in paragraphs 2, 3, 4, and 5; accomplish the following steps:

(1) Put hydraulic pressure on the auxiliary servo system.

(2) Attach external electrical power source.

(3) Engage inverter circuit breakers (in the overhead panel in the cockpit).

(4) Engage circuit breaker for ASE (in the overhead panel in the cockpit).

(5) Observe that instrument panel voltmeter indicates 27.5 volts.

(6) Engage ground check relay circuit breaker (battery junction box).

(7) Listen for gyro whine inside CG&A (indicating gyro is running).

(8) Check all ASE cable connections for tightness.

(9) Be sure stick trim system is on.

2. SYSTEM CHECK PROCEDURE

a. Adjustment Check. Check all adjustments per Table 3.

CAUTION: Do not throw override check switch unless each FU NULL potentiometer has been set within limits of four to six.

b. Null Indicator Centering. To determine if the null indicator is properly centered (double checking the null indicator reading) run a servo motor to each end of its travel with ASE engaged using either CG trim, yaw trim, or stick canceller. Note that when the motor reaches its stop (audible click) the null indicator needle is almost full-half travel of the indicator. The needle should go equal travel to each side of center; if the null indicator needle does not go equal travel, either the null indicator centering potentiometer is out of adjustment or the transducer is not centered. To determine if the null indicator centering is out of adjustment repeat this same test using at least two other channels. If, in the other channels, the null indicator needle moves to the same position as in the first test for full travel of the motor, the null indicator centering is off. Center it by using the null indicator centering potentiometer in the CG&A five-signal adjustment assembly. If the needle goes equal travel from center in the other channels the transducer is not centered. Reject that servo motor assembly and replace it. After the null indicator is properly centered check that the extreme positions of the needle coincide with the two marks on the meter through use of CG trim, yaw trim, or stick canceller. If they do not, use the five-signal adjustment assembly null indicator sensitivity potentiometer (NULL IND SENS POT) to adjust so that the extreme needle positions will coincide with the marks. The setting of the null indicator centering may change during warmup and will reach its steady-state operating point after approximately 45 minutes. Since the drift is slow, the final warmup need not be waited for but should be checked if there is a discrepancy.

c. Phasing, Motor Bind, and Dead Band Check. With ASE in standby, check phasing, motor bind, and dead band as follows:

(1) Phasing.

(a) Note setting of channel selector switch.

(b) Move override check switch to one side and observe indicator needle and power piston motion.

CHANNEL	SWITCH LEFT NEEDLE LEFT	SWITCH RIGHT NEEDLE RIGHT
Pitch	Piston aft	Piston forward
Altitude	Piston aft	Piston forward
Roll	Piston aft	Piston forward
Yaw	Piston forward (left pedal)	Piston aft (right pedal)

(c) Return override check switch to center, observing needle. Needle should not oscillate.

(d) Move override check switch to other side and check needle-motor phasing. Return switch to center and check needle oscillation.

(e) Move channel selector switch to another channel and repeat above steps. Repeat for all channels.

CAUTION: Make sure override check switch is in center position when through with this part of test.

(2) Servo motor bind (two methods, the first is preferred).

(a) First - voltmeter.

1. Connect an A. C. voltmeter to the test jacks on front of motor box.

2. Observe setting of channel selector switch.

3. Observe the voltage necessary to start the motor moving at any point in its travel. The maximum steady voltage necessary to start the motor should not exceed 15 volts except for the last one-fifth half travel when approaching the stop, where it should not exceed 20 volts. The maximum intermittent voltage rise should not exceed 15 volts above the steady voltage when driving from center toward the stop. There should be no voltage above 15 volts when driving from the stop toward center.

4. Re-center motor, FU NULL POT should be between four and six.

5. Repeat for all channels.

(b) Second - null indicator (fig. 16).

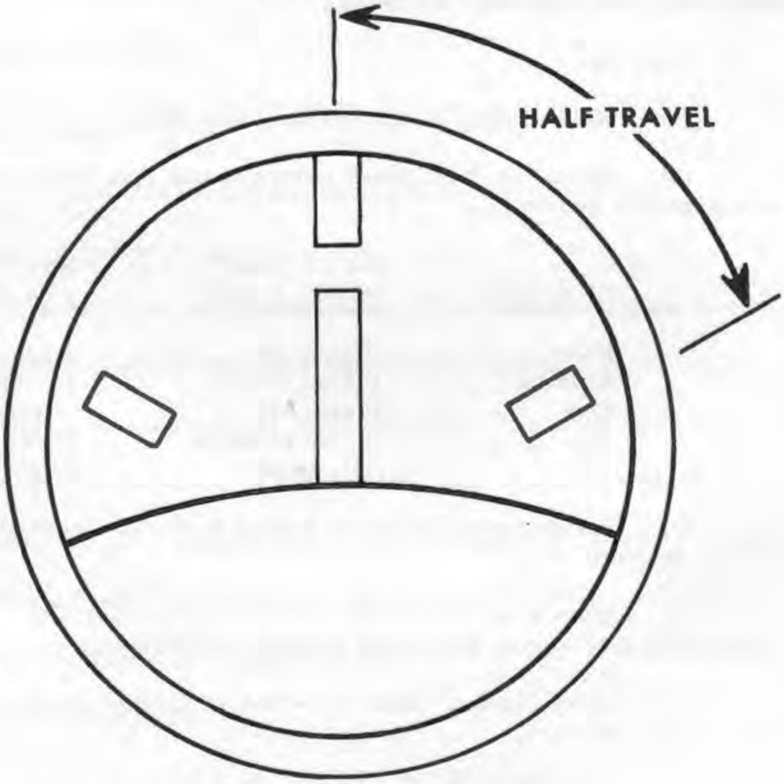

Figure 16. Null indicator.

1. Note setting of channel selector switch.

2. Hold motor input-position switch in input position.

3. Turn appropriate FU NULL POT smoothly and slowly in one direction and reverse.

4. Observe the indicator. During a smooth, slow input, in either direction, there may be a small indicator needle movement which should not exceed two needle widths. Any movement greater than this width indicates excessive servo motor bind. When the servo motor reaches its stop, needle should move at least one-fourth half travel. This should occur when POT has been turned almost all the way in either direction.

5. Release motor input-position switch so that it is in POSITION position.

6. Adjust FU NULL POT to null servo motor (center the needle), POT setting should be between four and six.

7. Repeat motor bind check for the other channels Null each channel before proceeding to the next.

(3) Dead band.

(a) Note setting of channel selector switch.

(b) Turn corresponding FU NULL POT smoothly and slowly in one direction and reverse.

(c) Observe motion of power piston and indicator needle.

1. Power piston should move when needle moves one needle width from center.

2. Piston should move back-and-forth from ± one needle width motion.

(d) Null the servo motor.

(e) Repeat servo dead band check for the other channels then null each channel before proceeding to the next.

d. Mode Engage Check. Check ASE mode engagement as follows:

(1) Press engage and BAR ALT buttons. Green button lights should illuminate for each mode.

Note. If there is no coupler, BAR ALT mode will not engage unless jumper plug P-1 is installed in CG&A.

(2) Check standby and off buttons (below engage buttons). The standby button disengages all modes of operation; the off buttons disengage the particular modes of operation.

(3) Press engage button and check pilot and copilot release buttons. The engage button light should go out when either is operated.

(4) Check the motor release time-delay relay as follows:

(a) Press engage button; channel selector switch to pitch.

(b) Adjust CG trim to run motor to one-half of one-half travel.

(c) Press pilot release button; servo motor should return to null.

(d) Press engage button; servo motor should be one-half or one-half travel in one second or less.

(e) Override switch hard-over in either direction.

(f) Press pilot release button; indicator needle should return to center within two and one-half seconds.

(g) Return the override switch to center.

e. Engage and Canceller Null Check.

(1) Check altitude engage error.

(a) Set channel selector switch at altitude.

(b) Press engage button.

(c) Press BAR ALT button. The needle should not change positions more than one-third half travel after BAR ALT was pressed.

(d) Press standby button.

(2) Check yaw engage error.

(a) Set channel selector switch at yaw.

(b) Press engage button and move yaw trim until needle moves to one side.

(c) Press and hold down one of the four pedal switches. The needle should return to null (center).

(d) Try to move the needle with the yaw trim (it should not move).

(e) After four to five seconds release the pedal switches slowly. They should not stick in actuated position. Needle should remain in center.

(f) Repeat until all four pedal switches have been checked individually.

(g) Displace needle again by moving yaw trim; then press standby button. Needle should return to null position.

(3) Check pitch canceller null as follows:

(a) Set the channel selector switch at pitch.

(b) Put the rigging pins in the cyclic stick and check stick movement due to tolerances on the rigging pins. (If there is slop, put stick in the center position.)

(c) Check that three red dots on rotor stator and housing of each canceller are aligned.

(d) Press engage button.

(e) Disconnect pitch canceller connector (in clutch fan compartment).

(f) With CG trim, center null indicator needle.

(g) Reconnect connector. Needle may move off center, if it does, re-null the indicator by loosening the three canceller screws, rotate the canceller housing, and tighten screws.

(h) Disconnect connector again, the needle may move a little but return to its null position.

Note. The pitch canceller is now adjusted for zero or null output.

(i) Reconnect connector and safety screws.

(4) Check roll canceller null as follows:

(a) Set channel selector switch at roll.

(b) Leave rigging pins in cyclic stick and check that stick is centered.

(c) Check that three red dots on roll canceller are aligned.

(d) Loosen CG&A from its shock mount and raise front outboard end to tilt CG&A 1° with respect to true vertical. (Use an accurate bubble-type protractor resting solidly on the flat surface of the CG&A cover to measure the angle.)

(e) Indicator needle should be centered. If needle is off center, loosen screws, rotate roll canceller until needle is centered, and tighten canceller screws.

(f) Secure CG&A in shock mount and remove rigging pins from cyclic stick.

(5) Re-adjust roll canceller after flight observation. If pilot crabs aircraft because of excessive lateral jump, when engaging or disengaging the ASE, the roll canceller should be re-adjusted as follows:

(a) Find out from the pilot the exact position of the indicator needle when the channel selector switch is at roll during hands-off cruise or hover.

(b) Set channel selector switch at roll.

(c) Move cyclic stick to place indicator needle in exact position specified by pilot.

(d) Loosen roll canceller screws and rotate canceller to center needle. Tighten roll canceller screws.

f. Input Response Check. Press engage button and check smoothness, the direction and magnitude of input response of each channel is as described below.

(1) Set channel selector switch at pitch and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Move cyclic stick smoothly fore-and-aft, from one extreme to the other observing needle. The indicator needle should follow stick motion. (Stick forward should move needle left.)

(c) Center the stick and adjust CG trim to center needle.

(d) Move stick fore-and-aft 5 ± 1 inch measure at top of stick from center. The motor should hit stops (audible clicks) and needle should indicate full half travel.

(e) Move stick suddenly; needle motion should be deadbeat.

(f) Move CG trim one-fourth turn starting at either stop. Motor should hit other stop.

(2) Set channel selector switch at roll, adjust roll rate gain on CG&A to 0, and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Move stick smoothly from side-to-side, from one extreme to the other, observing needle. The needle should follow stick motion (stick right should move needle right).

(c) Tilt CG&A 1° front (outboard) and up.

(d) Move stick right and left 4 ± 1 inch measured at top of stick from center. The motor should hit stops (audible clicks) and needle should indicate full half travel.

(e) Move stick suddenly. Needle should lag stick motion, and settle in about six to eight seconds.

(f) Adjust roll rate gain on CG&A in accordance with Table 3.

Table 3. ASE gain settings.

	YAW	ROLL	PITCH	ALTITUDE
Displ Feedback	0 Red	3 White	4.6 Red	0 White
Rate	2 1/2 Red	3 Red	3 Red	5 White
Displacement	4 Red	0 White	0 Red	2 White
Tachometer Generator	4	4	4	3.5
Followup Null	As required to center the servo motors. (Null indicator needs to be centered.) Dial setting lower limit 4; upper limit 6.			

(3) Set channel selector switch at yaw and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Move yaw trim smoothly and slowly at least one revolution. The indicator needle should follow trim control motion.

(c) Move yaw trim 7 ± 2° right or left (one scribe mark - 1°). The motor should hit stop and needle should indicate full half travel.

(d) Move yaw trim suddenly. The needle should overshoot about 500 percent.

(4) Press BAR ALT button, set channel selector switch at altitude, and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Two men will be needed for this check. Pinch rubber tube leading to altitude control about one inch from fitting on altitude control. Holding tube in this manner, pinch tube with the other hand on portion nearer control. Observe needle. Needle should move right at least one-eighth half travel.

(c) Release tube. Needle should return to center.

g. Inter-channel Noise Check.

(1) Check inter-channel noise as follows:

(a) Introduce inputs to one channel.

(b) Set channel selector switch at each of the three other channels.

(c) Observe indicator. Inputs introduced to one channel should have no effect on the other channels; therefore, needle should not move.

(d) Repeat for all channels.

(e) Return channel selector switch to pitch and close switch guard.

3. GYRO INPUT RESPONSE CHECK

Check the roll, pitch, and yaw gyro inputs as listed in Table 4.

4. YAW CONTROL SYSTEM CHECK

a. Proportional Band.

(1) Set channel selector switch at yaw and then press engage button.

(2) Turn yaw trim slowly in one direction until pedals begin to move.

(3) Observe indicator needle when pedals begin to move. The needle should be at least at one-half half travel.

(4) Turn yaw trim slowly in opposite direction until pedals begin to move.

(5) Observe needle when pedals begin to move. The needle should be at least at one-half travel in opposite direction.

(6) Turn yaw trim to center the needle.

b. Open Loop Pedal Rate.

(1) ASE in standby.

(2) Move override check switch to one side. Pedals should move.

(3) Wait until pedals stop moving then snap override check switch to other side and measure time between start and stop of pedal motion. The time interval should be between 24 to 28 seconds.

(4) Repeat pedal rate; check starting at opposite motor stop.

CAUTION: Return override check switch to center position after this check.

c. Pedal Damper Spring.

(1) ASE in standby.

Table 4. ASE input response.

	Input	Meter needle motion	Motor motion	Power piston motion	Amount of input motion for full travel of meter for Table 3 settings	Servo motor control correction (reference) equivalent	Response to a sudden in input
ROLL	Gyro rolls outboard side down (reference)	Left	Fwd	Aft	For one-half of one-half travel lift inboard 10° ± 2°; let outboard end set in shock mount	Stick left	Overshoot
	Stick right = canceller input	Right	Aft	Fwd	8 ± 2 inches full travel or 4 ± 1 inch for half travel	Stick right	Six to eight seconds to settle out
PITCH	Gyro pitches nose down (reference)	Right	Aft	Fwd	For one-half of one-half travel lift rear 5° ± 1° front sit in shock mount	Stick aft	Overshoot
	Stick aft = canceller input	Right	Aft	Fwd	10 ± 2 inches full travel or 5 ± 1 inch for half travel	Stick aft	Deadbeat
	CG trim forward = knob CCW	Left	Fwd	Aft	90 or one-fourth turn for full travel	Stick forward	Deadbeat
YAW	Gyro yaws right = helicopter heading increase	Left	Aft	Fwd	7° ± 2° = one-half travel	Pedal left	Overshoot
	Yaw trim right = CW	Right	Fwd	Aft	7° ± 2° = one-half travel	Pedal right	Overshoot
ALTITUDE	Altitude decrease = static pressure increase	Right	Aft	Fwd	Pinching the rubber tube should give one-eighth of half travel	Increase collective	

(2) Observing pedals, move override check switch to one side and then back instantaneously. Pedals should jump about one inch.

(3) Check jump in other direction.

CAUTION. Return override check switch to center position after this check.

d. Force to Override Pedals.

(1) ASE in standby.

(2) Move override check switch to one side. Wait for pedals to stop.

(3) Use a spring scale to measure force needed to move pedals in opposite direction. The force should not exceed 105 pounds for a pedal rate of 26 to 32 seconds for full travel. Also, the force should not exceed 40 pounds to hold pedals from moving to a stop.

Note. Inability to attain 26- to 32-second rate with less than 105 pounds override force is probably caused by excessive friction, binding control cables, faulty pedal damper, or an incorrectly adjusted pilot valve.

e. Collective Low Pitch.

(1) Auxiliary hydraulic pressure ON.

(2) Lower collective stick, as far as it will, and hold in this position.

(3) Throw override switch to the right; observe the collective power piston, it should not move.

(4) Return override switch to the center.

Note. If piston does move, readjustment of the low pitch stop must be accomplished.

5. OVERRIDE CHECK

Check capacity of manual flight controls to override ASE as follows:

a. Leave ASE in standby; move override check switch to one side. The indicator needle should swing hard-over.

b. The collective stick will either rise or fall. The force required to move the collective stick in the opposite direction should not exceed three pounds. The collective stick friction nut should be loose for this check.

c. Move cyclic stick rapidly to fore-and-aft, and left and right extremes at random. Move collective stick up and down rapidly. Any resistance (except for three pounds on collective) or seizing of the controls indicates improper adjustment of the control linkage.

d. Move override check switch to other side and repeat above check.

Note. With the override check switch to the left, the maximum achievable rate of the cyclic stick motion right or aft, or the collective stick up, will be slower than in the opposite directions, but not less than full-stick travel in about one second. The slower rates will reverse when the override check switch is in the opposite position. There will be a force moving the pedals left and the collective up which should not exceed 105 pounds on the pedals or three pounds on the collective.

CAUTION: Return override check switch to center position after this check.

6. TURN-OFF PROCEDURE

a. Press standby button.

b. Make sure override check switch is in center position.

c. Check that each servo motor is nulled.

d. Lock FU NULL and TACH-GEN POTS.

e. Turn off equipment.

Table 5. Checks to be accomplished upon replacing an ASE component.

This chart is to be used as a guide in determining what specific checks should or can be made whenever an ASE component has been replaced. This chart is not the optimum and can be expanded whenever desired. The idea behind this chart is that a complete ASE check need not be made everytime a component has been replaced.

COMPONENT BEING REPLACED

Servo Motor	Motor Box	CG&A	Control Panel	Stick Canceller	Altitude Controller	MA-1 Compass Components	33HSX-30, G-V-28	Tail Rotor Servo*	Auxiliary Servo*	Pedal Damper	CHECK(S) TO BE MADE
x		x									Null indicator centering and sensitivity
x	x	x	x	x	x	x					Phasing
x											Servo motor bind
x											Servo motor dead band
	x	x	x				x				Mode engage
		x			x						Altitude engage error
		x				x					Yaw engage error
		x		x							Pitch canceller null
		x		x							Roll canceller null and flight test
x	x	x	x	x							Input response (Table 4) - pitch
x	x	x		x							Input response (Table 4) - roll
x	x	x			x						Input response (Table 4) - altitude
x	x	x	x			x					Input response (Table 4) - yaw
x	x	x									Interchannel noise
								x		x	Proportional band
								x		x	Yaw open loop pedal rate
								x	x	x	Override forces
										x	Pedal damper spring

Note. When replacing a canceller or servo motor, it is only necessary to make the checks in that channel.

*When replacing the auxiliary and/or tail rotor servo, all servo motor checks should be made, in addition to those listed.

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Section XIV. ALTITUDE CONTROLLER - LEAR MODEL NO. 2203G

The altitude control is used in conjunction with the ASE in Sikorsky helicopters to maintain barometric altitude. The controller senses barometric pressure altitude at all times and, when energized, couples any change in pressure altitude through a clutch to an electrical pick-off. Any output change in phase and magnitude at the pick-off is sensed by the ASE which, in turn, controls the helicopter altitude.

The controller has a mechanical range of -1,000 to 50,000 feet and an electrical range of ± 250 feet with a sensitivity of one foot. Its use in conjunction with the ASE will maintain the helicopter within ± 25 feet of a present altitude, if properly used.

The controller can be broken down into three sections; they are the sensing source, pick-off circuit and clutch circuit.

1. SENSING SOURCE

The sensing source is a pair of dual aneroid bellows which are pressure sensitive devices. The bellows will expand or contract due to atmospheric pressure surrounding them. These bellows are coupled mechanically to a sector gear which attaches to the electrically operated clutch. Any expansion or contraction of the bellows due to changes in atmospheric pressure will rotate the clutch disk. When the electrical clutch is energized it couples these changes to the pick-off assembly called the EI coil. Because the sensing source depends on atmospheric pressure for operation, the controller must be vented to the aircraft's static.port for proper operation (fig. 17).

2. PICK-OFF CIRCUIT

a. The pick-off circuit consists of a coil form in the shape of an E which has three windings. The two outer windings are connected in series but wound opposite. They are excited by a common source which is 30 volts A. C. at 400 cycles per second (cps). The center winding is the output winding which senses any differential between the two excitation windings flux fields. Coupling of these flux fields is dependent upon the position of the movable I bar which is perpendicular to the E when the clutch is not energized. It is held in this position by centering springs. With the I bar in this position, coupling between the two outer windings is equal due to equal air gaps between the I bar and the E pole shoes. Two equal and opposite fields are induced into the output windings; thus, cancelling each other out (fig. 18A).

b. When the clutch is engaged any additional expansion or contraction of the bellows, due to altitude changes of the helicopter, will cause displacement of the I bar. This displacement causes an unbalance between the two flux fields being induced into the output winding due to reluctant changes.

c. Since the two fields are of opposite polarity, the one of greater amplitude will predominate across the output leg. This will then appear as an error signal to the ASE where it will be used to return the helicopter back to the preset altitude (fig. 18B).

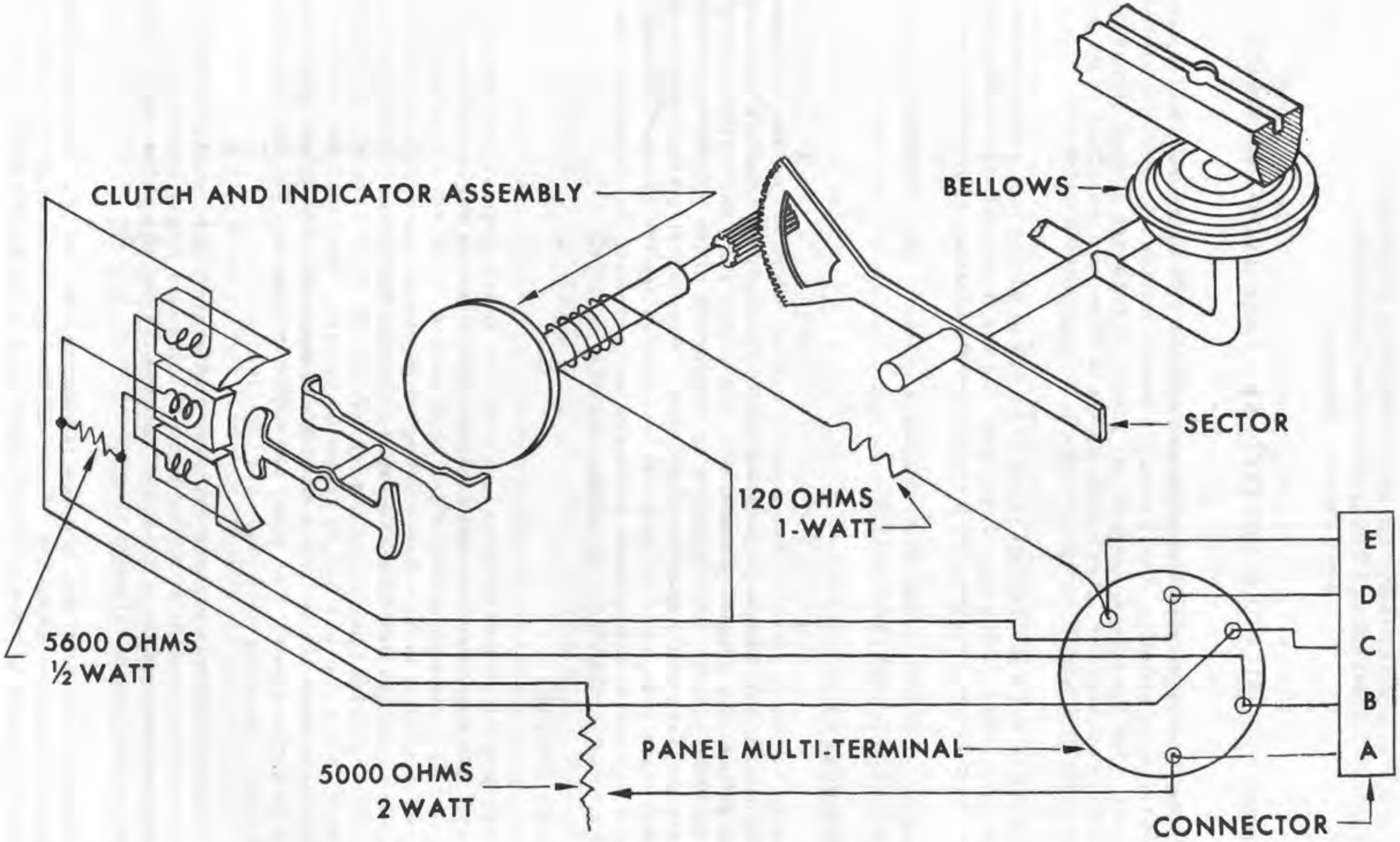

Figure 17. Clutch and indicator assembly.

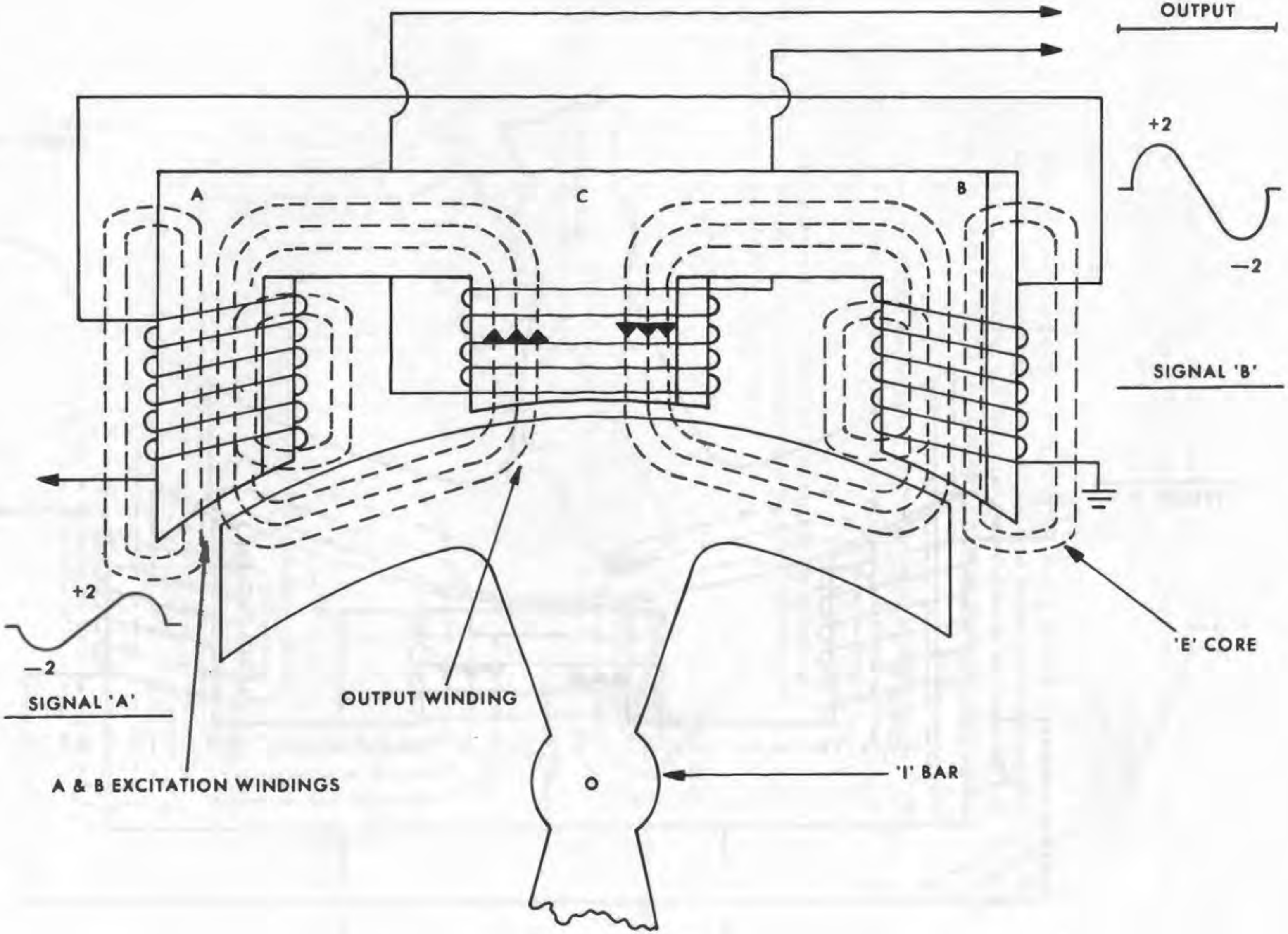

Figure 18A. Output windings.

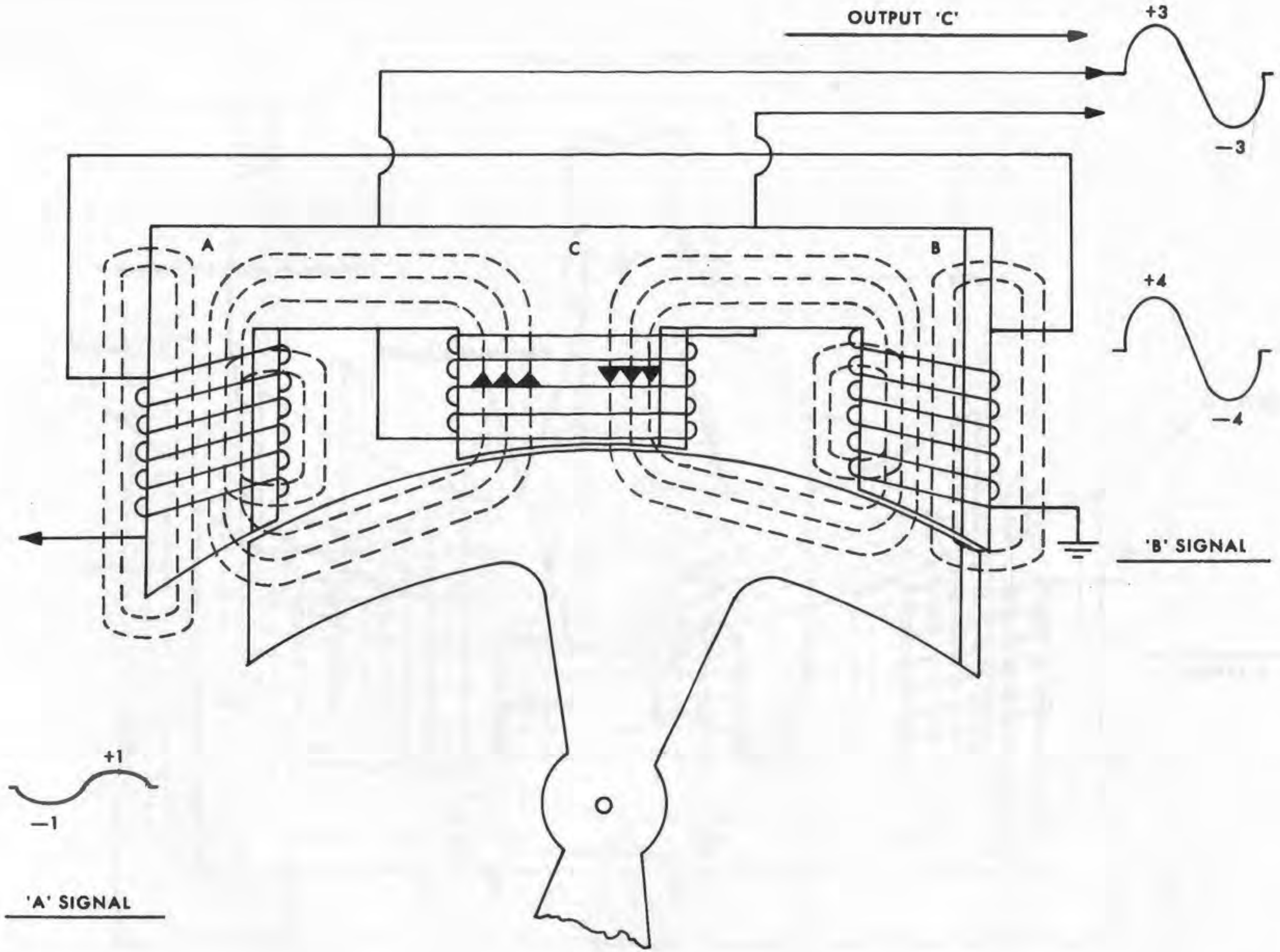

Figure 18B. Predominating flux field.

d. The output voltage of the controller will be four millivolts ± .2 millivolts per foot. The phase of the signal will indicate the direction of displacement; the amplitude will indicate the amount of displacement.

3. CLUTCH CIRCUIT

a. The controller clutch is a D. C. operated solenoid device energized by depressing the BAR ALT switch in the ASE control panel. When deenergized, the clutch is disengaged preventing altitude changes, detected by the aneroids, from repositioning the I bar of the EI coil thereby allowing the centering springs to maintain a nulled output.

b. When BAR ALT is engaged, the clutch coil will energize, engaging the clutch thereby mechanically coupling any changes in altitude sensed by the aneroids to the pick-off assembly.

c. Since there is a ± 250 feet limitation due to the construction of the clutch and EI coil, it is necessary to engage BAR ALT at zero vertical speed and to disengage prior to changing altitudes (fig. 19).

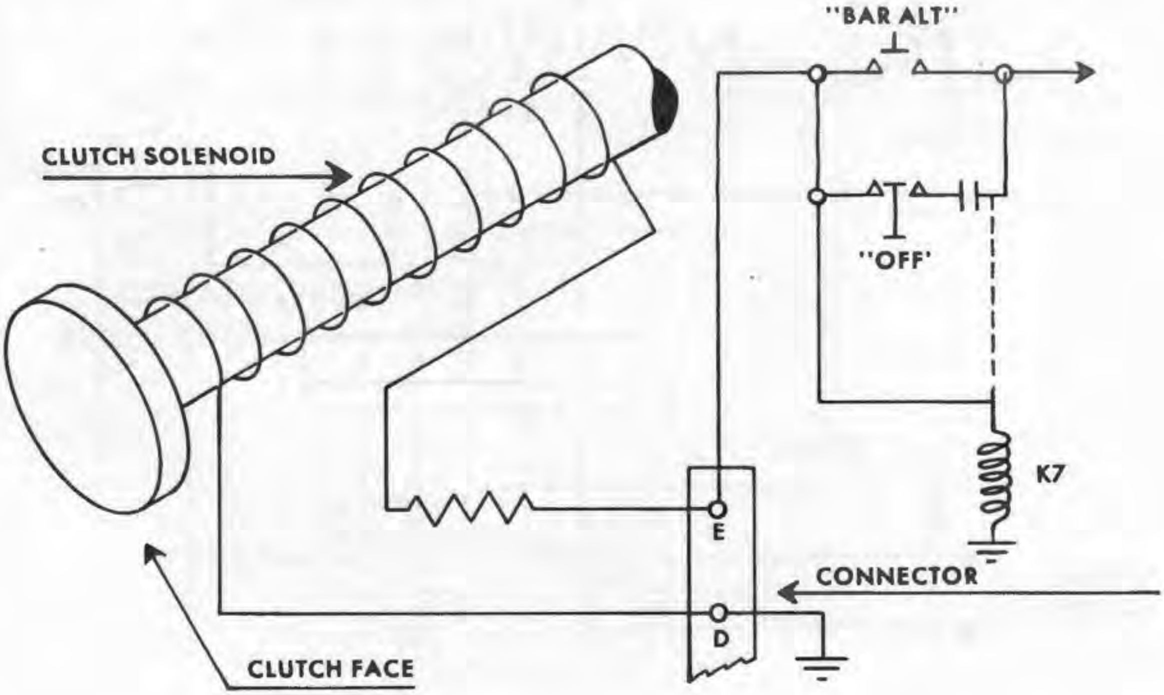

Figure 19. Clutch circuit.

4. SPECIAL NOTES

a. Since the altitude control is vented to the aircraft's static port, moisture becomes a major maintenance problem. In order to minimize the effect of moisture on the control, the parts have been anodized and cadmium-plated. To minimize moisture content within control, maintenance personnel should drain the aircraft static lines daily.

b. For efficient operation of the control, the bellows should be mounted vertical to the earth. This can be accomplished by observing that the exterior name plate is horizontal to the earth when the control is in place in the aircraft. Figure 20 is a schematic of the altitude controller.

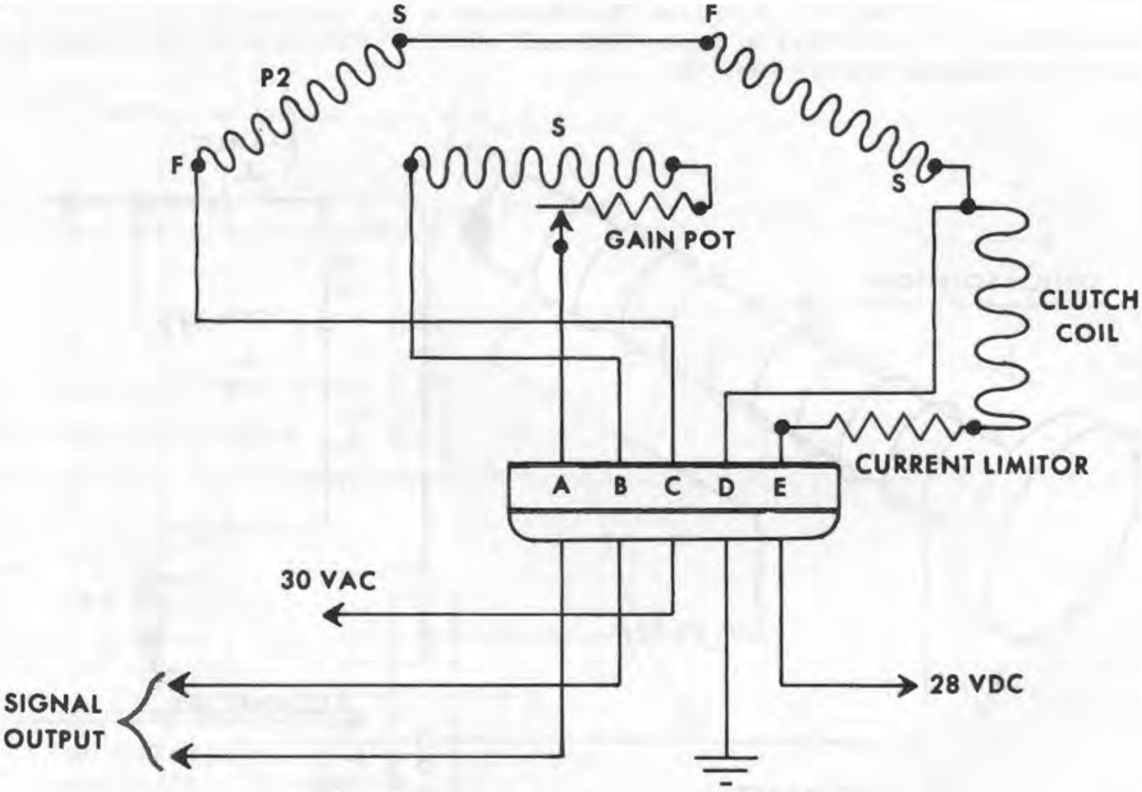

Figure 20. Schematic of altitude controller.

Section XV. CH-37B RIGGING INSTRUCTIONS

1. MAIN ROTOR RIGGING DESCRIPTION

a. CH-37B model helicopters (Table 6) are equipped with tandem servos at the rotor head and at the tail rotor. The first stage of the tandem servos is supplied with hydraulic pressure from a pump on the main transmission. The second stage of the tandem servos is supplied with pressure from a pump on the accessory case of the right engine. The ASE servo is supplied with pressure from the utility system which receives its pressure from a pump on the left engine.

b. In order to eliminate the possibility of damage to the aircraft, during the rigging procedure, all rigging is to be done with a maximum pressure of 1,000 psi applied to the first stage quick-disconnects located at the first stage hydraulic panel mounted on the left aft side of the main transmission. The auxiliary servo must be left in manual. (No pressure to the utility system.)

c. Any adjustable rod in the control system may be adjusted, as required, to obtain correct blade angles.

d. All angular dimensions are measured at the blade hub with the blades pulled around to the full autorotation position.

e. Refer to the flight control rigging schematic of the entire control system for the location of rigging pins, fixed and adjustable rods, and all important dimensions.

Table 6. Rigging dimensions.

BLADE ANGLES	NARROW CHORD BLADES	WIDE CHORD BLADES
Low pitch	+8° ± 1/2°	+4° 12' ± 12'
High pitch	+20° ± 1/2°	+16° 12' ± 30'
Left lateral	-4° ± 1°	-7° 48' ± 1°
Right lateral	+20° ± 1°	+16° 12' ± 1°
Forward	-6° ± 1°	-9° 48' ± 30'
Aft	+20° ±1°	+16° 12' ± 30'

f. Use either the rigging tool or a propeller protractor to set and check the main blade angles. Refer to Information Notice 56-7 and 56-44 for use of the rigging tool or propeller protractor.

2. RIGGING PROCEDURE

a. Install rigging pins through the yoke assemblies of both cyclic sticks (Table 7). This centers the cyclic sticks in their mid position. Apply 1,000 psi to the first stage.

b. Raise the collective pitch sticks and install rigging pins through the bell cranks on the aft face of Station 80. This will place the collective pitch sticks in mid position.

c. Install a rigging pin in the mixing unit at Station 176-3/4. This will center the mixing unit bell cranks.

Table 7. Automatic stabilization servo unit rigging dimensions.

POWER PISTON	DIMENSION "A"
Fore-and-aft	2.610 inches
Lateral	2.594 inches
Collective	2.594 inches
Directional	2.594 inches

Note. Dimension "A" is the distance from the end of the cylinder to the center of the attachment hole in the fork of the power piston.

d. Make sure that the ASE servo cams are in the manual position (slop entirely eliminated). Set the fore-and-aft, lateral, and collective power pistons to the proper dimensions as indicated under Dimension "A" on the flight control and rigging schematic and under Table 7 of this notice. Spacers of soft material on the servo piston shafts may be used to establish Dimension "A".

Note. Control range is determined by internal stops within the ASE servo. The closer Dimension "A" is set, the more accurate the blade angle readings will be.

e. Adjust rods, as necessary, to achieve the above situation (fig. 21).

f. Install a rigging pin through the left lateral servo input bell crank at Station 229-1/8.

g. Install a rigging pin through the right lateral servo input bell crank at Station 258-1/2.

h. Install a rigging pin through the fore-and-aft servo input bell crank at Station 229-1/8.

i. Disconnect the servo input vertical rods from the input linkage of the three servos. Lower the servos slowly and evenly until the power pistons bottom.

Note. The next step is designed expressly to position the star assembly in a parallel position to and at a specific dimension below the lower plate of the rotor head.

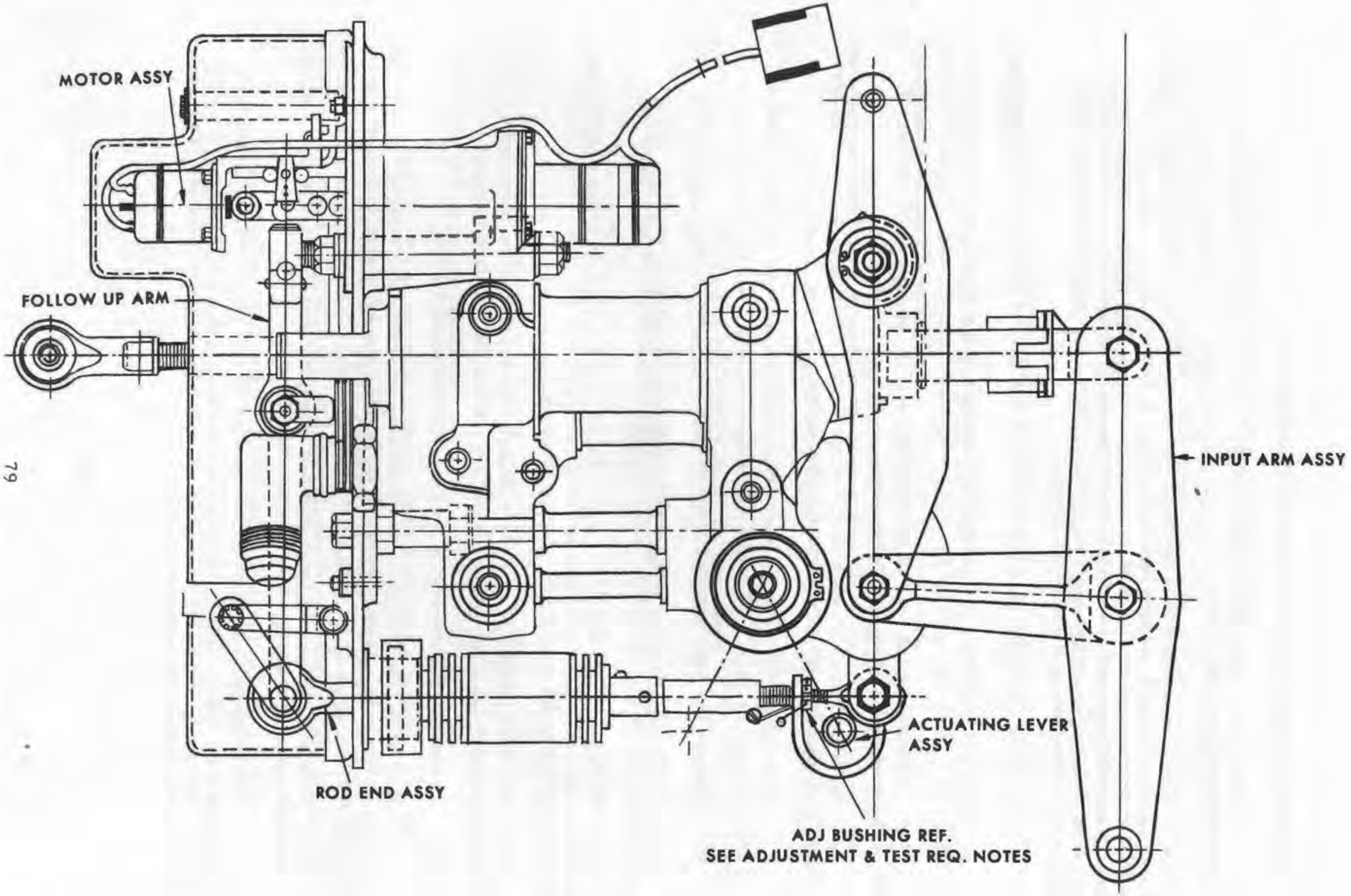

Figure 21. Auxiliary servo unit.

3. LEVELING THE STAR WITH THE RIGGING CLAMP

a. Install the rigging clamp S1570-10382-4 on the main rotor shaft between the star assembly and the rotor head.

b. Move the input arms of the three servos slowly and simultaneously to raise the star assembly until it bottoms against the rigging clamp which, in turn, will be raised to bottom against the lower plate of the rotor head. With the star held in this position, and with the input arms in the neutral position, adjust and connect the three servo input rods to the input arms of the servos. Be careful not to let the star settle from its full raised position against the clamp.

c. Remove all rigging pins except those at the base of the cyclic control sticks.

d. Remove the ASE servo piston shaft spacers if you used them for rigging the ASE servo.

CAUTION: Make sure all pins are removed or damage to the system will result as a consequence of control movement.

e. Move the collective pitch sticks to the full low position (collective ASE servo power piston bottomed internally within the ASE servo).

f. Lock the collective pitch sticks in this position with the friction control on the sticks.

g. Remove the rigging clamp from the main rotor shaft.

Note. The star will still be level with the main rotor head plates since there is no lateral lead in the CH-37 control system.

h. Be sure that all blades are pulled forward in the plane of rotation to the full autorotative position. (Dampers against the autorotative stops.) Make certain they remain there during the rest of the rigging procedure.

i. Use the rigging tool or place a propeller protractor on the blade hub or the sleeve lugs. Adjust the short adjustable control rod for the low pitch setting.

j. Repeat this process for each of the four remaining blades.

CAUTION: Do not adjust the mechanical low pitch stick stops at the collective pitch sticks at this time. Make certain that these stops are not hitting during the rigging process thus far.

k. Unlock the collective pitch stick and raise it until the collective power piston is in the ASE servo bottom. Lock the stick in this position.

l. Place a propeller protractor (or use the special tool) on the blade hub and read the high pitch angle. If it is not within tolerance, chances are that you did not set the proper Dimension "A" on the ASE servo collective power piston; recheck; also make sure you're not hitting the mechanical stops.

m. Set the high pitch mechanical stops at the base of the collective pitch sticks to have a .010 inch clearance.

n. Move the collective pitch sticks to the low position (piston bottomed in the ASE servo) and lock it in place with the friction lock.

o. Remove the rigging pins from the base of the cyclic sticks.

p. Rotate the main rotor until a blade is positioned with its long control rod over the left lateral servo.

q. Move the cyclic stick from extreme right to extreme left until the lateral power piston in the ASE servo bottoms, first in one direction and then in the other. Check the angles on the blade with the stick in the left position and then in the right position.

r. With the stick full left, set the left stick mechanical stop to have a .010 inch clearance.

s. With the stick full right, set the right stick mechanical stop to have a .010 inch clearance.

Note. If lateral stick ranges do not come out right, ascertain whether there is sufficient total travel. If you do not get the correct range of blade angle change, check all linkage and bell cranks for structural interference. If lateral range is good, but you have too much pitch on one throw and not enough on the other throw, the range can be shifted by simultaneously adjusting the lateral servo input vertical rods equally and oppositely.

t. Rotate the main rotor head until the blade that was over the left lateral servo is now positioned with its long control rod over the fore-and-aft servo.

u. Move the cyclic stick forward and aft until the fore-and-aft power piston in the ASE servo bottoms, first in one direction and then in the other. Check the angles on the blade with the stick full forward and then with the stick full aft. (Make certain that the mechanical stops are not hitting at this time.)

v. With the stick full forward, set the forward stick mechanical stop to have a .010 inch clearance.

w. With the stick full aft, set the aft stick mechanical stop to have .010 inch clearance.

x. To change autorotation rpm, adjust the short pitch-change rods on the main rotor head. Lengthen the rods to increase rpm and shorten the rods to decrease rpm. Refer to your current flight handbook for autorotation rpm, flight test CG's, altitudes, and gross weights.

CAUTION: When adjusting the short pitch-change rods to change autorotation rpm, always be sure to give each one the same number of turns. After the adjustment of the rods, check the main rotor blades for proper track.

y. Before a flight check is made, be certain that all blocks, pins, and spacers have been removed; everything is safetied, all hydraulic test connections removed, and all connections checked for security.

4. QUICK-RIGGING CHECK

a. When component time replacements are made, dimensions should be accurately transferred from the unit being replaced to its replacement part. This can be easily done with a trammel bar.

b. In this manner, rotor heads and control rods can be replaced without rerigging of the entire flight control system. A quick-rigging check must be made whenever parts are replaced in this manner or whenever a question is raised as to the correctness of a ship's rigging.

Note. A normal condition will, very often, exist where the rigging pins cannot be inserted with the system properly rigged and tracked. No rigging pins are involved in making a quick-rigging check.

c. Apply 1,000 psi hydraulic pressure to the first stage panel (fig. 22).

d. Place the rigging clamp on the main rotor shaft.

e. Raise the collective pitch stick slowly and carefully cycle the cyclic stick until the star is positioned firmly against the rigging clamp.

f. Lock the cyclic stick in this position by means of the stick trim system.

g. Lower the collective stick, remove the rigging clamp, and check the low collective pitch blade angle.

h. Move the collective stick to the high pitch position and check the high angle.

i. Return the collective stick to low pitch and lock it in the low pitch position.

j. Check the fore-and-aft and lateral blade angles.

Note. The angles noted in Table 8 are before blades are tracked. After tracking and autorotation these angles may vary. Blade angles, after tracking and autorotation, are allowed a maximum of ±1° beyond the tolerances given in Table 8.

k. After tracking and autorotation adjustments have been made, adjust the blade control locks for proper blade fold position. Align the No. 5, 3, 4, and 2 blade control lockpins in that order. Adjust the blade lock guide in the No. 2 sleeve and spindle, as required.

CAUTION: Never try to move the flight controls while the control locks are engaged and there is pressure to the main or ASE servos.

5. TAIL ROTOR RIGGING

a. Install rigging pin in the torque shaft arm at Station 24-1/2. Screw the pedal adjustors in or out until they are positioned approximately in their mid position. Adjust the length of rods between the pedals and adjustor, if required, to make sure that both sets of pedals are vertical. Install a rigging pin through the bell crank at Station 182.68.

b. Make sure that the ASE servo cams are in the manual position. Set the yaw ASE servo power piston to Dimension "A" and adjust the rods, as required, to make the proper connections.

c. Install a rigging pin in the aft quadrant at Station 612-1/2. Adjust cables as required for rigging pin installation.

d. Set cable tension according to the following temperature corrected tail rotor cable tension chart:

TEMPERATURE RANGE DEGREES F	TEMPERATURE RANGE DEGREES C	CABLE TENSION IN POUNDS
-65 to -56	-53.9 to -48.9	33 to 44
-55 to -36	-48.3 to -37.8	44 to 62
-35 to -16	-37.2 to -26.7	62 to 79
-15 to +4	-26.1 to -15.6	79 to 96
+5 to +24	-15.0 to -4.5	96 to 114
+25 to +44	+3.9 to +6.6	114 to 132
+45 to +64	+7.2 to +17.7	132 to 150
+65 to +84	+18.3 to +28.8	150 to 168
+85 to +104	+29.4 to +40.0	168 to 186
+105 to +124	+40.6 to +51.1	186 to 204
+125 to +144	+51.7 to +62.2	204 to 222
+145 to +160	+62.8 to +71.1	222 to 236

Note. This chart is for ambient air temperature with the cables at the same temperature as the outside skin of the aircraft. Set initial cable tension with the aircraft hangared for a minimum of one-half hour. Do not set cable tension with the aircraft parked in the hot sun. Do not check cable tension immediately after an aircraft has been moved to an area of different temperature unless a minimum of one-half hour has elapsed. When checking the cable tension with the aircraft in the sun, a 25 percent deviation is allowed from the above table; under no condition is the cable tension to exceed 300 pounds. If the variable is exceeded, allow the aircraft to stand at constant temperature for one-half hour before resetting cable tension.

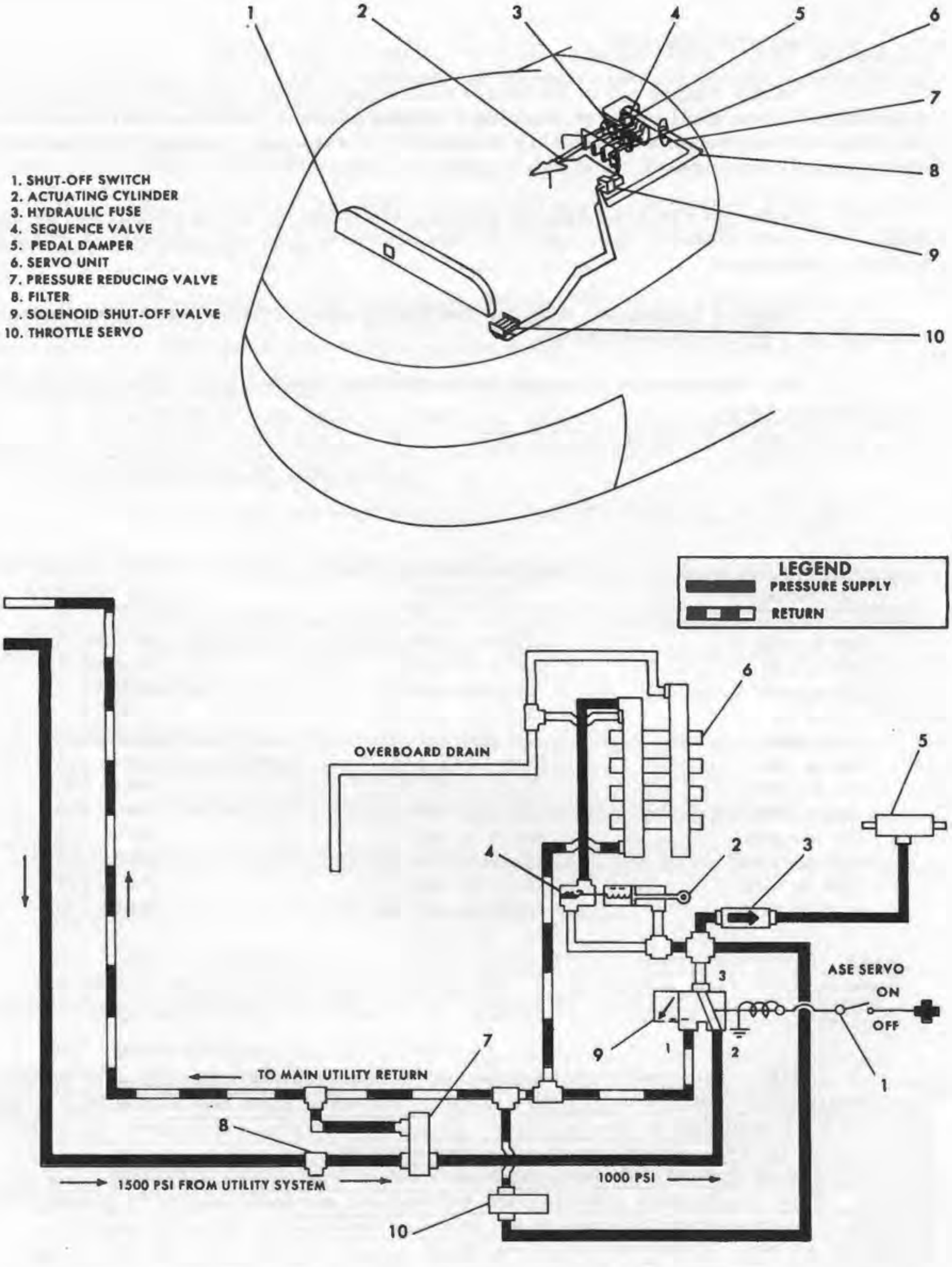

Figure 22. Automatic stabilization servo, throttle servo, and pedal damper system (model CH-37B).

e. Install a rigging pin in the pylon idler bell crank.

f. Set the input arm on the tail rotor tandem servo to 6-5/16 inch as shown on the flight control schematic. Adjust the last push rod in the pylon so that it connects to the input arm.

g. Remove all rigging pins.

h. Apply 1,000 psi to the first stage hydraulic panel quick-disconnects.

i. Install the blade restrainer assembly on the tail rotor to prevent the blades from flapping.

j. Have someone in the cockpit step on full left rudder. Make sure that the mechanical stops on the torque shaft do not contact and that the yaw power piston in the ASE servo bottoms internally.

k. If the aircraft is not equipped with a rigging indicator at the tail rotor, compensate a propeller protractor to the tail rotor head.

l. Move a blade until it points directly aft. Level the leading edge of the blade until it is horizontal.

m. Unsafety the short pitch-change rods, back off the locknuts, and rotate the rod barrel (just as you would a turnbuckle) until the blade reads PLUS 27° (leading edge of the blade pointing inboard toward the tail rotor gear box). This is left rudder.

Note. If a protractor is used, place it against the blade cuff for readings.

n. Now, bring each of the remaining three blades around to the FULL AFT position and repeat the process until all blades read PLUS 27° left rudder.

o. The four blades are now synchronized to a common pitch setting and the left rudder stop is formed by the internal stop on the yaw power piston in the ASE servo.

p. Set the left rudder mechanical stop at the base of the torque shaft in the cockpit to have a .010 inch clearance.

q. Now have someone in the cockpit step on right rudder pedal.

r. Set the mechanical stop in the cockpit to strike the torque shaft pad when MINUS 6° is read on any blade (leading edge horizontal tip cap pointing aft). With right rudder, the leading edge of the blade will point outboard away from the tail rotor gear box.

s. Safety all rods, stops, etc; and remove external hydraulic pressure.

t. Track the tail rotor blades, adjusting as necessary.

6. STICK CENTERING

a. Center the cyclic sticks fore-and-aft and laterally by pinning the sticks with rigging pins. Use 1,000 psi to the first stage quick-disconnects if the controls are to be moved.

b. Center the arms on the magnetic brakes in mid position.

c. Check the force gradient spring cylinders to insure that there is no end play.

d. Connect the cylinders to the arms on the magnetic brakes.

e. Make the following checks:

(1) Connect 1,000 psi to the utility system quick-disconnects in the left wheel well.

(2) Place the ASE servo switch in the ON position.

(3) Place the stick trim switch in the ON position.

(4) Remove the pins from the cyclic sticks.

(5) The sticks should not have more than one-eighth inch free play in any direction.

(6) Breakout force to move the sticks should be 1-1/2 to 2-1/2 pounds in any direction measured at the grip.

(7) The maximum load to move the stick from one stop hard-over to the other stop should be from 6-1/2 to 9 pounds.

(8) With the stick trim switch in the OFF position, the sticks should move freely in any direction with a one-half to three-fourth pound load at the grip.

7. ASE SERVO VALVE TIMING CHECK

a. Apply 1,000 psi to the utility system quick-disconnects.

b. Place the ASE servo switch in the SERVO ON position.

c. Put the ASE in standby and check to insure that all servo motors are electrically held in the center of their travel by accomplishing the following steps:

(1) Attach external electrical power source.

(2) Engage inverter control and inverter power circuit breakers.

(3) Engage ASE circuit breaker.

(4) Observe that the instrument panel voltmeter indicates 27.5 volts D.C.

(5) After two minutes hold the auto-stabe engage button in.

(6) When the green light comes on press the standby button. ASE is now in standby.

(7) Note the setting of the channel selector switch on the servo motor box and notice the position of the null indicator needle. If the needle is centered, the servo motor is electrically centered. If not, center the motor by turning the appropriate followup null adjustment.

(8) Repeat step 6 for all channels.

(9) Place hard-over switch in the center position.

d. Hold the cyclic stick and the collective stick approximately in the center of their travel.

e. Turn the ASE servo switch OFF and ON.

f. If the stick jump is excessive, the servo valve is not properly adjusted. Tolerance on stick jump is ± one-eighth inch (fig. 23).

8. PEDAL DAMPER CHECK

a. Apply 3,000 psi hydraulic pressure to the utility system quick-disconnects in the left wheel well.

b. Turn ASE servo-throttle servo-pedal damper switch to the ON position.

c. Disconnect the yaw open loop spring.

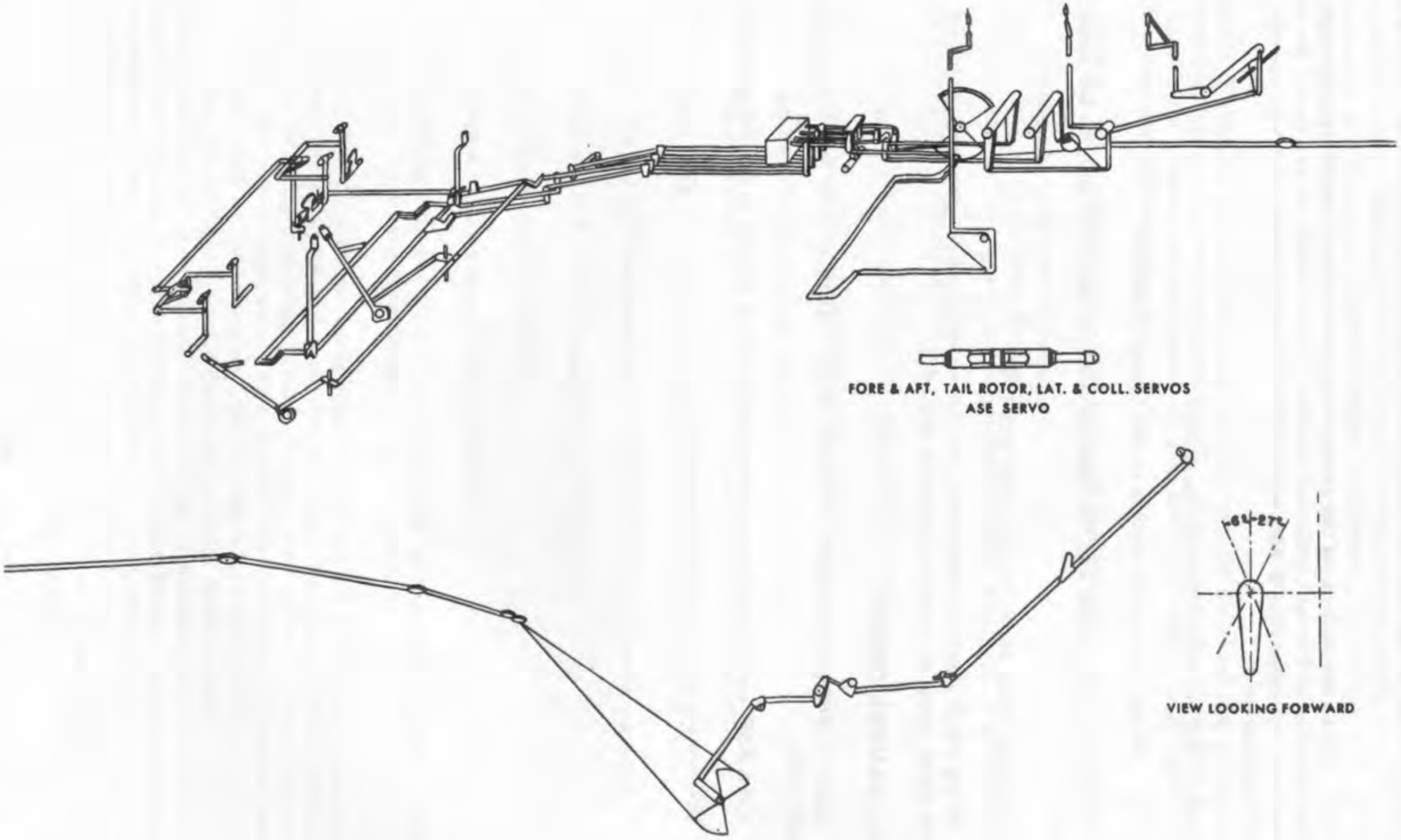

Figure 23. CH-37B flight controls schematic.

d. Apply a 20-pound load to the pedal at approximately the center of the pedal. The pedals should move through their full range in 20 ± 4 seconds. Check the pedals in both directions. If difficulty is encountered on this check, for pedal rate adjustment and other channel open loop rates, see Information Notice 56-30G. (See Figures 24A and 24B.)

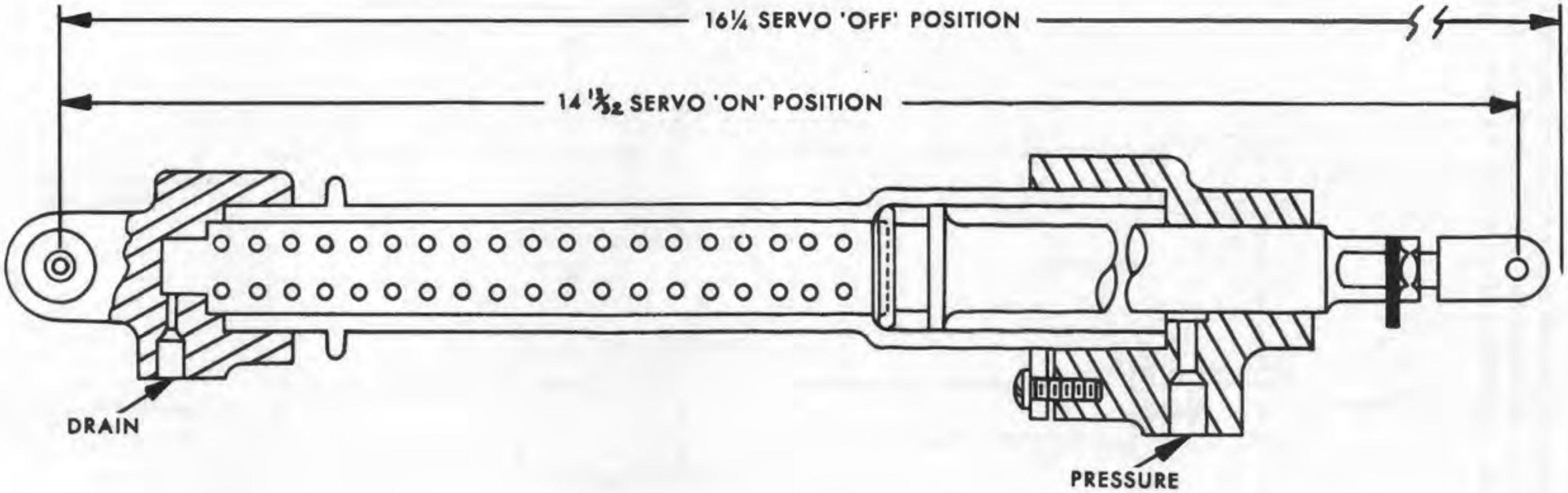

Figure 24A. Actuating cylinder.

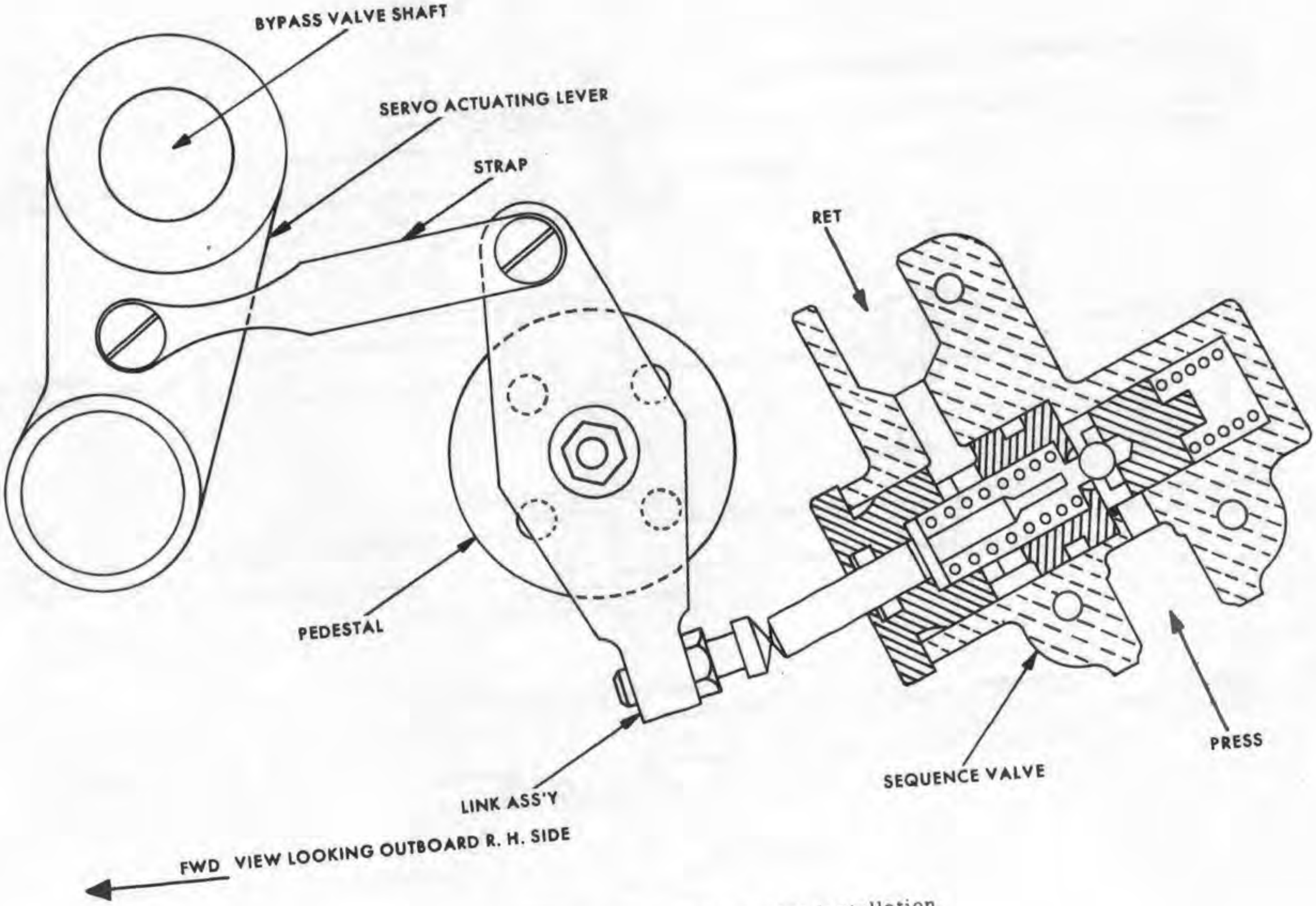

Figure 24B. ASE sequence valve installation.

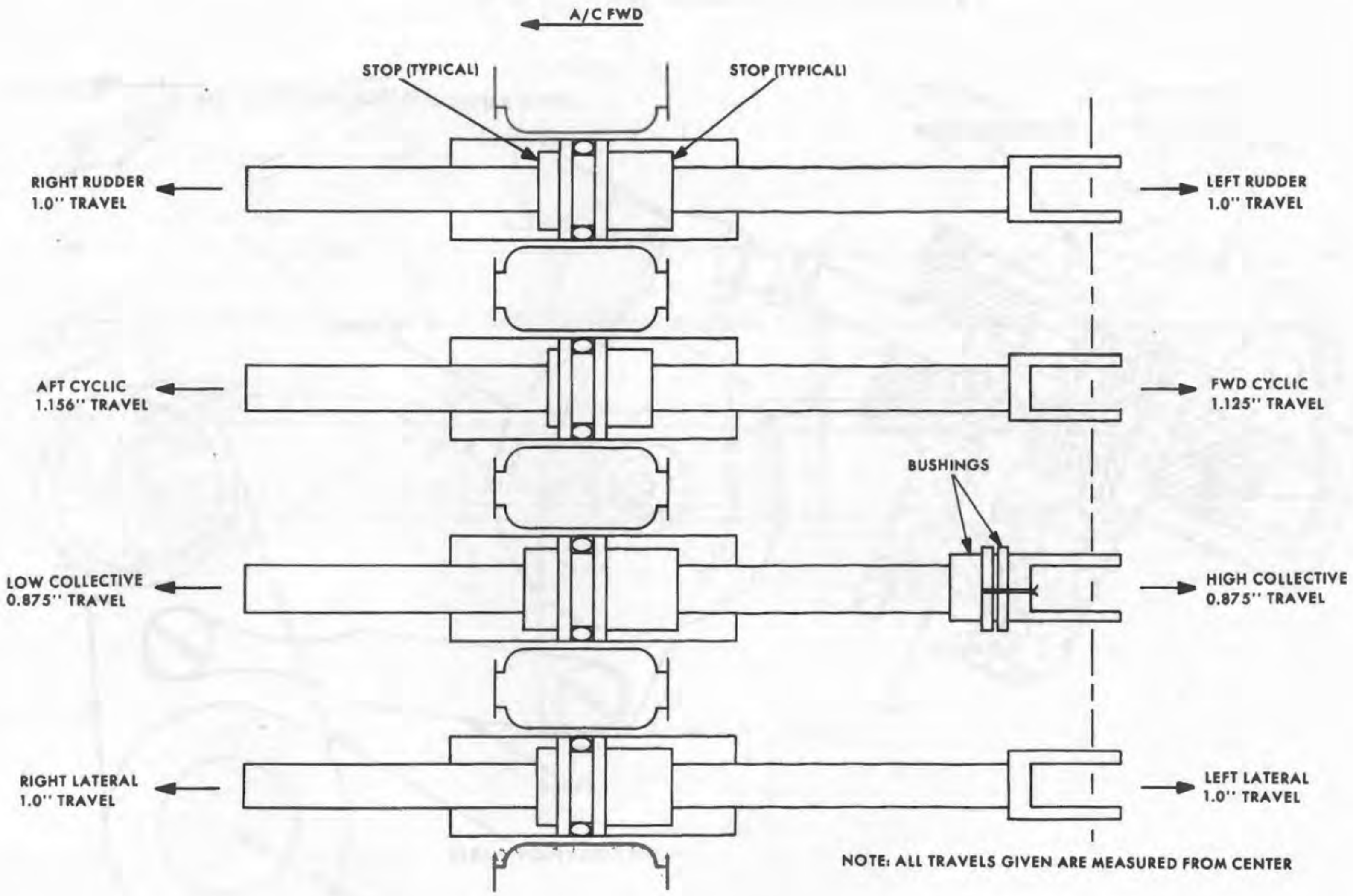

Figure 25. CH-37B ASE servo schematic.

Section XVI. ASE COMPONENTS

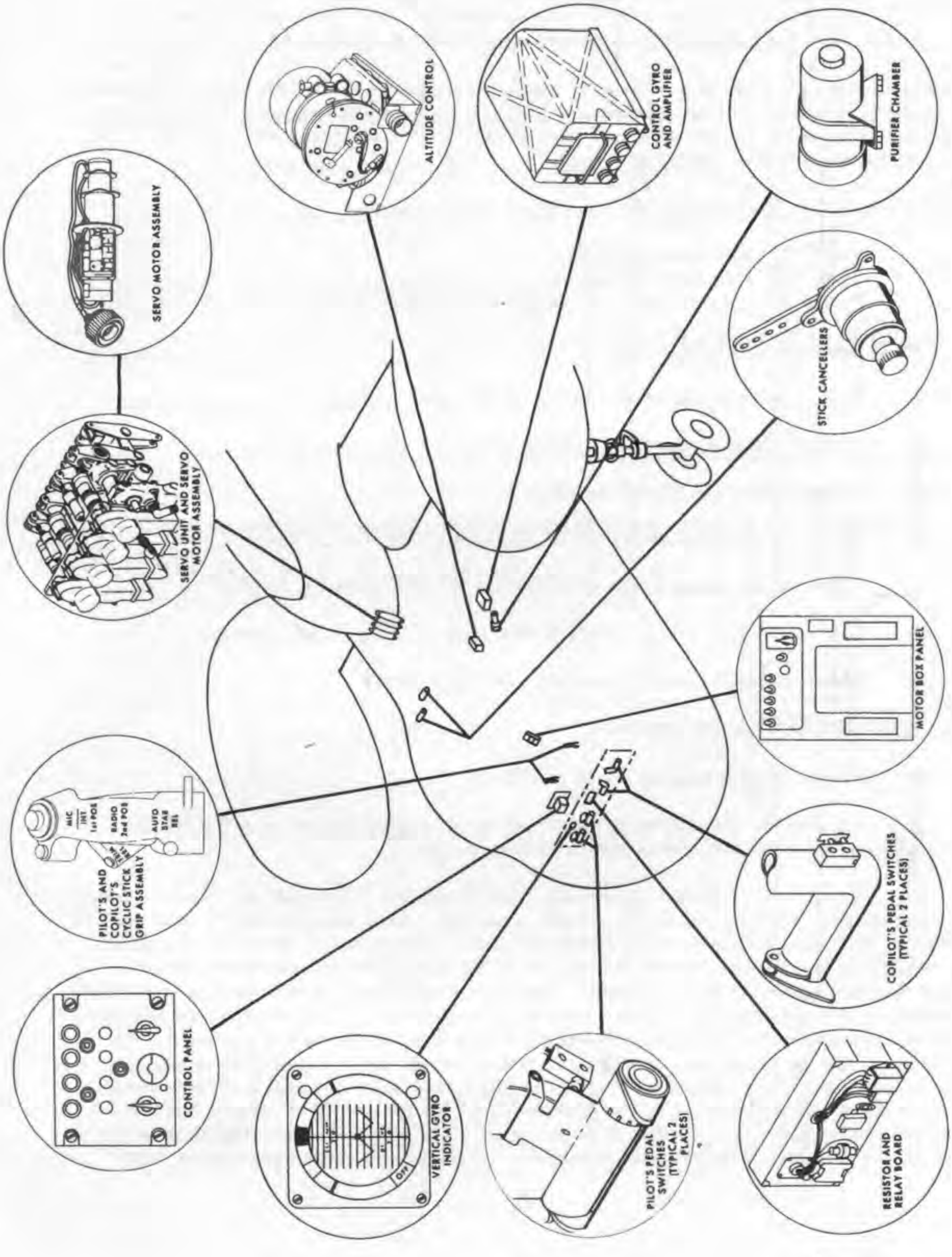

Figure 26. ASE components (model CH-37B).

DEPARTMENT OF MAINTENANCE TRAINING
UNITED STATES ARMY AVIATION SCHOOL
Fort Rucker, Alabama

Section XVII. CH-37B ASE TEST PROCEDURE

PURPOSE: To define the procedure for testing the ASE on those CH-37 aircraft which have been furnished with lear-component ASE. This procedure should be followed after initial installation; whenever ASE has been crabbed, and whenever an ASE or J-2 compass component has been changed.

ENCLOSURE: The following tables are listed an enclosures:

Table 8. ASE Gain Settings.
Table 9. ASE Input Response.
Table 10. Checks to be Accomplished upon Removal of an ASE Component.

1. PRELIMINARY PROCEDURE

a. Apply hudraulic pressure to the ASE servo system.

b. Attach external electrical power source.

c. Engage inverter circuit breaker.

d. Engage circuit breakers for compass and ASE (in cockpit).

e. Observe that instrument panel voltmeter indicates 27.5 volts.

f. Listen for gyro whine inside CG&A (indicating gyro is running).

g. Check all ASE cable connections for tightness.

2. SYSTEM CHECK PROCEDURES

a. Check all adjustments as per Table 8.

CAUTION: Do not throw override check switch unless each FU NULL potentiometer has been set within limits of four to six.

b. Check null indicator centering. To determine if the null indicator is properly centered (double checking the null indicator reading), run a servo motor to each end of its travel, with ASE engaged using either CG trim, yaw trim, or the stick canceller. Note that when the motor reaches its stop (audible click) the null indicator needle is almost full half travel of the indicator. The needle should go equal travel to each side of center; if the null indicator needle does not go equal travel, either the null indicator centering potentiometer is out of adjustment or the transducer is not centered. To determine if the null indicator centering is out of adjustment, repeat this same test using at least two other channels. If, in the other channels, the null indicator needle moves to the same position as in the first test for full travel of the motor, the null indicator centering is off. Center it by using the null indicator centering potentiometer in the CG&A five-signal adjustment assembly. If the needle goes equal travel from center in the other channels, the transducer is not centered. Reject that servo motor assembly and replace it. After the null indicator is properly centered, check that the extreme positions of the needle coincide with the two marks on the meter. If they do not, use the five-signal adjustment assembly NULL IND SENS POT to adjust so that the extreme needle positions will coincide with the marks. The setting of the NULL IND centering may change during warmup and will reach its steady-state operating point after approximately 45 minutes. Since the drift is slow, the final warmup need not be waited for; but, should be checked if there is a discrepancy.

c. Make the phasing, motor bind, and dead band check. With ASE in standby, check phasing, motor bind, and dead band as follows:

Note. The ASE must be in the engage mode before pressing the standby button for it will put it in standby.

(1) Phasing.

(a) Note setting of channel selector switch.

(b) Move override check switch to one side.

(c) Observe indicator needle motion and power piston motion.

CHANNEL	SWITCH LEFT NEEDLE LEFT	SWITCH RIGHT NEEDLE RIGHT
Pitch	Piston aft	Piston forward
Altitude	Piston forward	Piston aft
Roll	Piston aft	Piston forward
Yaw	Piston aft	Piston forward

(d) Return override check switch to center, observing needle; needle should not oscillate.

(e) Move override check switch to other side and check needle-motor phasing. Return switch to center and check needle oscillation.

(f) Move channel selector switch to another channel and repeat above steps; repeat for all channels.

CAUTION: Make sure override check switch is in center position when this part of test is completed.

(2) Servo motor bind. Two methods are given; the first is preferred.

(a) Voltmeter. When checking servo motor bind, connect a VOM, Simpson 260, or equivalent, to terminals TJ1 and TJ2 on the motor box. Place the channel selector switch to desired channel and then observe the voltage necessary to start the motor moving at any point in its travel. The maximum steady voltage necessary to start the motor should not exceed 15 volts except for the last one-fifth travel when approaching the stop, where it should not exceed 20 volts. The maximum intermittent voltage rise should not exceed 15 volts above the steady when driving from center toward the stop. There should be no voltage above 15 volts when driving from stop to center.

(b) Null indicator. Note setting of channel selector switch.

(c) Input position switch. Hold motor input position switch in input position.

(d) FU NULL POT. Turn appropriate FU NULL POT smoothly and slowly in one direction and reverse.

(e) Observe indicator. During a smooth, slow input in either direction there may be a small indicator needle movement which should not exceed two needle widths. Any movement greater than this width indicates excessive servo motor bind.

(f) Input position switch (release). Release motor input position switch so that it is in POSITION position.

(g) Adjust FU NULL POT to null servo motor (center the needle), POT setting should be between four and six.

(h) Repeat motor bind. Repeat motor bind check for the other channels. Null each channel before proceeding to the next.

(3) Dead band.

(a) Note setting of channel selector switch.

(b) Turn corresponding FU NULL POT smoothly and slowly in one direction and reverse.

(c) Observe motion of power piston and indicator needle.

1. Power piston should move when needle moves one needle width from center.

2. Piston should move back and forth for ± one needle width motion.

(d) Null the servo motor.

(e) Repeat servo dead band check for the other channels. Null each channel before proceeding to the next.

d. Mode Engagement Check.

(1) Press engage and BAR ALT buttons. Green button lights should illuminate for each mode.

(2) Check standby and off buttons located below engage buttons. The standby button disengages all modes of operation; the off buttons disengage the particular modes of operation.

(3) Press engage button and check pilot's and copilot's release buttons. The engage button light should go out when either is operated.

(4) Motor release time-delay relay check.

(a) Press engage button; channel selector switch to pitch position.

(b) Adjust CG trim to run motor off center.

(c) Press pilot's release button; servo motor should return to null immediately.

(d) Press engage button, servo motor should move off center (as in (b) above) in one second or less.

(e) Place ASE in standby.

(f) Override switch hard-over in either direction.

(g) Press pilot's release button. The indicator needle should return to center after two seconds.

(h) Return the override switch to center.

e. Engage and Canceller Null Check.

(1) Check altitude engage error.

(a) Set channel selector switch at altitude.

(b) Press engage button.

(c) Press BAR ALT button. The needle should not change positions more than one-fourth half travel after BAR ALT button was pressed.

(2) Check yaw engage error.

(a) Set channel selector switch at yaw.

(b) Press engage button and move yaw trim until needle moves to one side.

(c) Press and hold down one of the four pedal switches. The needle should return to null (center).

(d) Try to move the needle with the yaw trim. It should not move.

(e) After four to five seconds, release the pedal switch. Needle should remain in center.

(f) Repeat until all four pedal switches have been checked individually.

(g) Release pedal switches slowly. They should not stick in actuated position.

(h) Displace needle again by moving yaw trim and then press standby button. Needle should return to null position.

(3) Check pitch canceller null as follows:

Note. This check is done with the aircraft on level terrain.

(a) Set the channel selector switch at pitch.

(b) Put the rigging pin in the cyclic stick and check stick movement due to tolerances on the rigging pin. If there is slop, put stick in the center position.

(c) Check that three red dots on rotor, stator, and housing of each canceller are aligned.

(d) Press engage button. Needle should be in center.

(e) Loosen canceller screws and rotate canceller until the null indicator reads one-half of one-half travel to the right.

(f) Tighten screws.

(4) Check roll canceller null as follows:

(a) Set channel selector switch at roll.

(b) Leave rigging pins in cyclic stick and check that stick is centered.

(c) Check that three red dots on roll canceller are aligned.

(d) Indicator needle should be centered. If needle is off center, loosen screws and rotate roll canceller until needle is centered. Tighten canceller screws.

(5) Re-adjustment of roll canceller after flight observation. If pilot crabs aircraft because of excessive lateral jump when engaging or disengaging the ASE, the roll canceller should be re-adjusted as follows:

(a) Find out from the pilot the exact position of the indicator needle when the channel selector switch is at roll during hands-off cruise or hover.

(b) Set channel selector switch at roll.

(c) Move cyclic stick to place indicator needle in exact position specified by pilot.

(d) Loosen roll canceller screws and rotate canceller to center needle. Tighten roll canceller screws.

f. Input Response Check. Press engage button and check smoothness, direction, and magnitude of input response of each channel as described below.

(1) Set channel selector switch at pitch and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Move cyclic stick smoothly fore-and-aft from one extreme to the other observing needle. The indicator needle should follow stick motion. (Stick forward should move needle left.)

(c) Center the stick and adjust CG trim to center needle.

(d) Move stick fore-and-aft 6 ± 3/4 inch measured at top of stick from center. The motor should hit stops (audible clicks) and needle should indicate full-half travel.

(e) Move stick suddenly. Needle motion should be deadbeat.

(f) Move CG trim one-fourth turn starting with servo motor at either stop. Motor should hit other stop.

(2) Set channel selector switch at roll. Adjust roll rate gain on CG&A to 0 and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Move stick smoothly from side-to-side, one extreme to the other, observing needle. The needle should follow stick motion (stick right should move needle right).

(c) Move stick right and left 2 ± 1/2 inch measured at top of stick from center. The motor should hit stops (audible clicks) and needle should indicate full one-half travel.

(d) Move stick suddenly. Needle should lag stick motion, and it should take six to eight seconds to settle.

(e) Adjust roll rate gain on CG&A in accordance with Table 8.

(3) Set channel selector switch at yaw and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Move yaw trim smoothly and slowly at least one revolution. The indicator needle should follow trim control motion (yaw trim right, needle right).

(c) Move yaw trim 6 ± 1° right or left (one scribe mark = 1°), from center (null) position of null indicator. The motor should hit its stop and the needle should indicate full half travel.

(d) Move yaw trim suddenly. The needle should overshoot about 200 percent.

(4) Press BAR ALT button, set channel selector switch at altitude, and make the following checks:

(a) Needle should not oscillate when controls are not actuated.

(b) Two men will be needed for this check. Pinch rubber tube leading to altitude control about one inch from the fitting on the altitude control base. Holding the tube in this manner, pinch tube with the other hand on portion nearer control. Observe needle. Needle should move right approximately one-fourth half travel.

(c) Release tube. Needle should return to center.

g. Inter-channel Noise Check. Check inter-channel noise as follows:

(1) Introduce inputs to one channel by means of cancellers, trims, gyros, or pinching rubber tube.

(2) Set channel selector switch at each of the three other channels.

(3) Observe indicator. Inputs introduced to one channel should have no effect on the other channels; therefore, the needle should not move.

(4) Repeat for all channels.

(5) Return channel selector switch to pitch and close switch guard.

3. GYRO INPUT RESPONSE CHECK

Check the roll, pitch, and yaw gyro inputs as listed in Table 9.

4. YAW CONTROL SYSTEM CHECK

a. Proportional Band.

(1) Set channel selector switch at yaw and then press engage button.

(2) Turn yaw trim slowly in one direction until pedals begin to move.

(3) Observe indicator needle when pedals begin to move. The needle should be at least one-fourth half travel (no more than one-half).

(4) Turn yaw trim slowly in opposite direction until pedals begin to move.

(5) Observe needle when pedals begin to move. The needle should be at least one-fourth half travel in opposite direction (no more than one-half).

(6) Turn yaw trim to center the needle.

b. Open Loop Pedal Rate.

(1) Press engage button.

(2) Move override check switch to one side. Pedals should move.

(3) Wait until pedals stop moving then snap override check switch to other side and measure time between start and stop of pedal motion. The time interval should be 20 ± 4 seconds.

CAUTION: Return override check switch to center position after this check.

c. Pedal Damper Spring.

(1) Press engage button.

(2) Observing pedals, move override check switch to one side and then back instantaneously. Pedals should jump about one inch and then return to original position.

(3) Check jump in other direction.

Note. Cyclic stick should not be against stops when making this check.

CAUTION: Return override check switch to center position after this check.

d. Force to Override Pedals.

(1) Press engage button.

(2) Move override check switch to one side. Wait for pedals to stop.

(3) Use a spring scale to measure force needed to move pedals in opposite direction. The force should not exceed 50 pounds for a pedal rate of 24 seconds for full travel. Also, the force should not exceed 25 pounds to hold pedals from moving to a stop.

Note. Inability to attain a 24-second rate with less than 50 pounds override force is probably caused by excessive friction, binding control cables, faulty pedal damper, or an incorrectly adjusted pilot valve.

5. OVERRIDE CHECK

Check capacity of manual flight controls to override ASE as follows:

a. Leave ASE in standby, then move override check switch to the right. The indicator needle should swing hard-over right.

b. The collective stick will rise. The force to move the collective stick in the opposite direction should not exceed 10 pounds at the grip. The collective stick friction lock should be loose for this check.

c. Move cyclic stick rapidly to fore-and-aft, left and right extremes at random. Move collective stick up and down rapidly. Any resistance or seizing of the controls indicates improper adjustment of the control linkage, except for the 10-pound (maximum) on collective.

d. Move override check switch to the left and repeat above check.

Note. With the override check switch to the left, the maximum achievable rate of cyclic stick motion right or aft or the collective stick up will be slower than in the opposite directions, but not less than full stick travel in about one second. The slower rates will reverse when the override check switch is in the opposite position. There will be a force moving the pedals left which should not exceed 50 pounds to override.

6. CHANNEL DISENGAGE SWITCHES

a. Press engage button to engage ASE and then engage BAR ALT.

b. With the channel selector switch in pitch position, place needle of null indicator to a one-half of half travel position.

c. Turn off pitch disengage switch and move stick forward and aft. The needle should not move.

Table 8. ASE gain settings.

	YAW	ROLL	PITCH	ALTITUDE
Followup	0.5	3	5	0
Rate	2.1	4	3.8	0
Displacement	5.5	0	2	3
Tachometer Generator	4	4	4	4
Followup Null	As required to center the servo motors. (Null indicator must be centered.) Dial setting lower limit 4; upper limit 6.			

d. Repeat procedure a through c for roll, alt, and yaw using roll cyclic stick, pinch BAR ALT tube, and yaw trim knob respectively as input. Place channel switch in the respective position for each test.

CAUTION: Return override check switch to center position after this check.

7. TURN-OFF PROCEDURE

a. Press standby button or release switch.

b. Make sure override check switch is in center position.

c. Check that each servo motor is nulled.

d. Lock FU NULL and TACH-GEN POTS.

e. Turn off equipment.

Table 9. ASE input response.

FOR LEAR COMPONENT ASE IN S-60 AND CH-37

Input	Meter needle motion	Motor motion	Power piston motion	Amount of input motion for full travel of meter for Table 8 settings	Servo motor control correction (reference) equivalent	Response to a sudden input	
Gyro rolls right	Left	Fwd	Aft	For full one-half travel lift outboard 8° ± one-half degree. Let inboard end set in shock mount.	Stick left	Overshoot	ROLL
Stick right + canceller input	Right	Aft	Fwd	Four inches ± one stop-to-stop travel or 2 ± one-half inch for full half travel.	Stick right	Six to eight seconds to settle out	
Gyro pitches nose-down (reference)	Right	Aft	Fwd	For full one-half travel lift rear 5° ± 1° Let front sit in shock mount.	Stick aft	Overshoot	PITCH
Stick aft - canceller input	Right	Aft	Fwd	Six inches ± three-fourth full half travel	Stick aft	Deadbeat	
CG trim forward - knob CCW	Left	Fwd	Aft	One-eighth turn for full half travel.	Stick forward	Deadbeat	
Gyro yaws right - helicopter heading increase	Left	Fwd	Aft	6° ± 1° full one-half travel	Pedal left	Overshoot	YAW
Yaw trim right -CW	Right	Aft	Fwd	6° ± 1° full one-half travel	Pedal right	Overshoot	
Altitude decrease - static pressure increase	Right	Fwd	Aft	Pinching the rubber tube should give one-fourth of full half travel	Increase collective		ALTITUDE

Table 10. Checks to be accomplished upon removal of an ASE component.

CHECKS	REF PAGE	ASE COMPONENT									
		Servo Motors	Motor Box	CG&A	Control Panel	Canceller	J-2 Compass	Alt Controller	Pedal Damper	ASE Servo	Emergency Release and/or Motor Release Time-Delay Relay
Null Indicator Centering	1	x	x	x						x	
Phasing	2	x	x	x	x					x	
Servo Motor Bind	3	x								x	
Dead Band	3	x								x	
Mode Engage Check	4		x	x	x						x
Altitude Engage Error	4			x				x			
Yaw Engage Error	4			x			x				
Pitch Canceller Null	5			x		x					
Roll Canceller Null	5			x		x					
Input Response - Pitch	5	x	x	x	x	x				x	
Input Response - Roll	6	x	x	x		x				x	
Input Response - Yaw	6	x	x	x	x		x			x	
Input Response - Alt	6	x	x	x				x		x	
Inter-channel Noise Ck	6			x							
Gyro Input Response	7		x	x							
Proportional Band	7	x							x	x	
Open Loop Pedal Rate	7	x							x	x	
Pedal Damper Spring	7	x							x	x	
Override Check	8	x							x	x	

Note. It is only necessary when replacing a canceller or a servo motor to accomplish the checks pertaining to that channel.

Section XVIII. CH-37B YAW AND COLLECTIVE OPEN LOOP SPRING ADJUSTMENTS

1. PEDAL RATE ADJUSTMENT

a. System Check. It is assumed that all forces of the system have been checked at the pedals and all binds have been eliminated. The preliminary pedal force checkout is as follows:

(1) Apply system hydraulic pressure.

(2) With the yaw open loop and pedal damper disconnected a force, of no greater than one pound at the pedals, should move the control system.

(3) With the pedal damper reconnected, apply a steady force of 20 pounds tangential to the pedals. The control system should move from end-to-end in 20 ± 4 seconds.

b. Yaw Open Loop Adjustment (fig. 27).

Note. The first four steps may be a bench adjustment prior to installation on the servo unit. Letter references apply to the schematic on the last page of this notice.

(1) Loosen all adjusting locking nuts, A, B, C, and remove bolt F.

(2) Back out cap D one-fourth of an inch so that spring and rod assembly J may move freely in the spring cylinder K.

(3) Adjust sleeve E until spring is held firmly with no slop, but under no preload. From this starting point, turn sleeve E 1-3/4 turns clockwise. This will preload the spring 300 to 340 pounds. Lock this adjustment with locking nut A.

(4) Turn cap D clockwise until spring and shaft assembly J is held firmly with no slop, but under no preload. From this point back out cap D one-half turn; this will enable the spring and shaft assembly J to move freely approximately ± .035 travel.

(5) Place spring and rod assembly J in its approximate mid travel position. Adjust rod end G until bolt F may be replaced.

(6) Apply system hydraulic pressure to the ASE servo unit.

(7) Apply power to the ASE.

(8) Put the ASE in the standby position and the channel selector switch in the yaw channel.

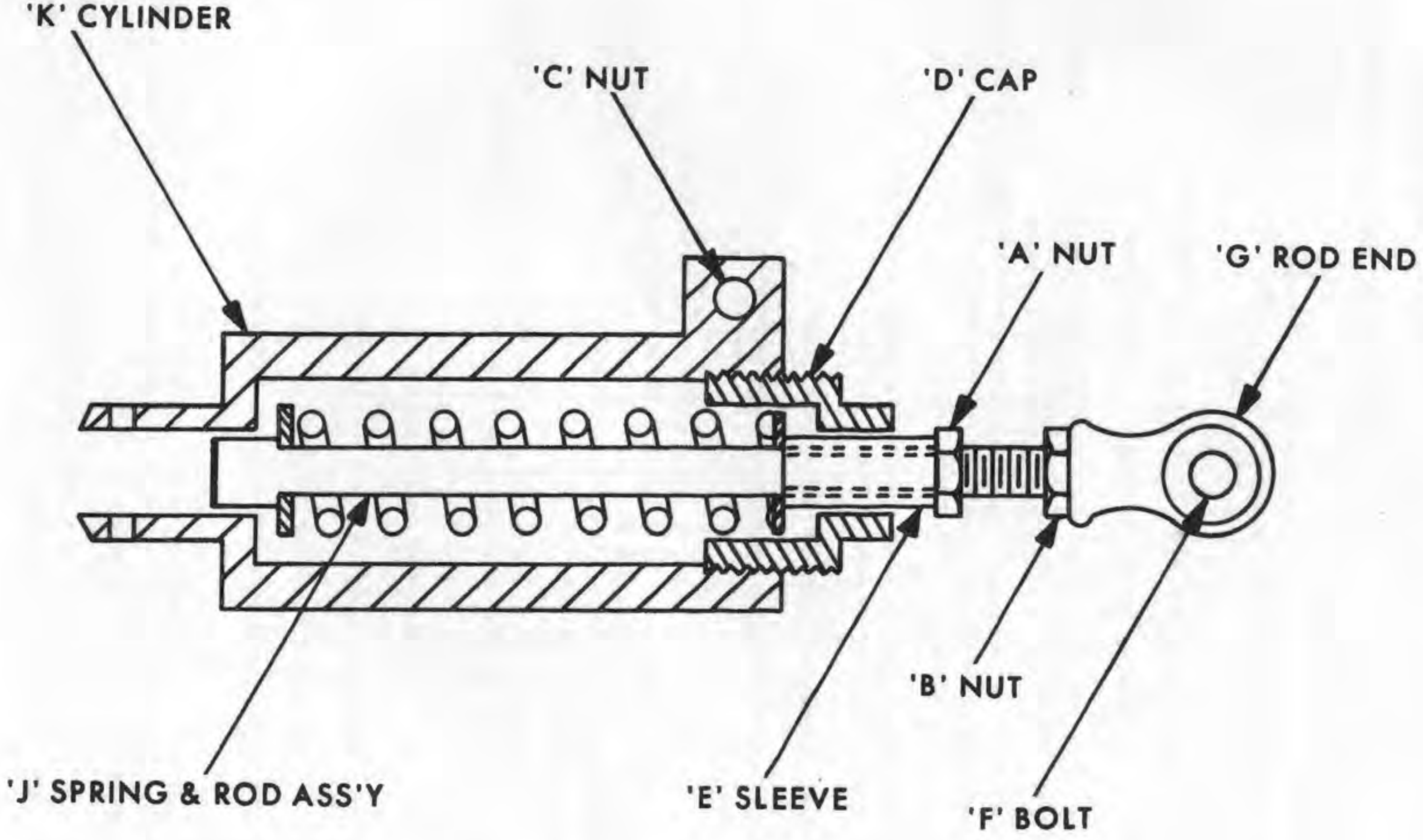

Figure 27. Open loop spring schematic.

(9) Adjust the pedal rates from right to left as follows:

(a) Place the right pedal in the FULL FORWARD position.

(b) Turn the hard-over switch to the left position. The pedals should move from full right to full left in 20 ± 4 seconds.

(c) If the pedals move too fast, decrease the rate by turning the spring and rod assembly J into the rod end G. If the pedals move too slow or not at all, increase the rate by making the opposite adjustment.

(10) Adjust the pedal rates from left to right as follows:

(a) Place the left pedal in the FULL FORWARD position.

(b) Turn the hard-over switch to the right position. The pedals should move from full left to full right in 20 ± 4 seconds.

(c) If the pedals move too fast decrease the rate by turning the cap D counterclockwise out of the spring cylinder K. If the pedals move too slow or not at all, increase the rate by making the opposite adjustment.

(11) Lock adjustment nut B and C. Recheck pedal rates to insure that the time for full travel is 20 ± 4 seconds in either direction.

(12) Check proportional band as follows:

(a) Place the pedals in the mid position.

(b) Engage ASE.

(c) With feet off the pedals, rotate the yaw trim knob very slowly until pedals start to move. Observe the null indicator needle. If the pedals start to move before the needle has traveled two divisions from the center in either direction, the proportional band is too small.

(d) To increase the proportional band, turn sleeve E one-fourth turn clockwise. Turn rod and spring assembly J clockwise into rod end G half this amount (one-eighth of a turn).

(e) Repeat steps (a) through (c).

(13) Check the override forces as follows:

(a) Put the ASE in standby.

(b) Put the pedals in the mid position.

(c) Turn the hard-over switch to the left. The pedals will move toward the left. The force required to hold the pedals stationary should not exceed 25 pounds. The force required to move the pedals from full left to full right in 20 ± 4 seconds should not exceed 50 pounds.

(d) Turn the hard-over switch to the right. The pedals will move toward the right. The force required to hold the pedals stationary should not exceed

25 pounds. The force required to move the pedals from full right to full left in 20 ± 4 seconds should not exceed 50 pounds.

2. COLLECTIVE OPEN LOOP ADJUSTMENT

It is assumed that all binds have been eliminated between the collective stick and the ASE servo.

Note. The first four steps may be a bench adjustment prior to installation on the servo unit. Letter references apply to the schematic on the last page of this notice.

a. Loosen adjusting locking nuts A, B, C, and remove bolt F.

b. Back out cap D one-fourth of an inch so that spring and rod assembly J may move freely in the spring cylinder K.

c. Adjust sleeve E until the spring is held firmly with no slop, but under no preload. Lock this adjustment with locking nut A.

d. Turn cap D clockwise until spring and shaft assembly J is held firm with no slop, but under no preload.

e. Adjust rod end G until bolt F may be replaced.

f. Back off all friction adjustment from the pilot's collective pitch stick.

g. Apply system hydraulic pressure to the ASE servo unit.

h. Apply power to the ASE.

i. Put the ASE in the standby position.

j. Turn the spring and rod assembly J out of the rod end G until the weight of the collective pitch stick is balanced by the spring force when the stick is in the approximate mid position.

k. Turn the hard-over switch to the left.

(1) This will drive the collective pitch stick to the bottom position. Center the hard-over switch and raise the stick two inches. From this starting point, turn the hard-over switch to the right. The collective pitch stick should rise to the top stop.

(2) If the stick does not rise from its lower position, turn spring and rod assembly J out of rod end G.

(3) Turn the hard-over switch to the right. This will drive the collective pitch stick to the top position. Center the switch and lower the stick two inches. From this starting point turn the hard-over switch to the left. The collective pitch stick should fall to the bottom stop.

(4) If the stick does not fall from its top position, turn spring cap D approximately three-fourths of a turn clockwise into the spring cylinder K.

l. Hold the collective pitch stick in some mid travel position.

(1) After engaging ASE and BAR ALT, pull the collective pitch stick to within two inches of top stop. The stick should return to its original position.

(2) Push the collective pitch stick to within two inches of the bottom stop. The stick should return to its original position.

m. Check the override forces as follows:

(1) Put the ASE in standby.

(2) Throw the hard-over switch to one side.

(3) Wait for the stick to stop moving.

(4) Use a spring scale to measure the force required to move the stick in the opposite direction through the full range of control. It should not exceed 10 pounds at the grip.

(5) Repeat check with hard-over switch in opposite direction.