Propeller

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CHAPTER 61

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CHAPTER 61 - PROPELLERS

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GENERAL - DESCRIPTION AND OPERATION

PROPELLERS

On airplanes P-3 thru P-384, P-387, P-402 and P-403, the engines are equipped with 74 inch Hartzell HC-F3YR/C7479-2R or HC-F3YR-2F/FC7479-B2R three bladed, full feathering, constant speed, air dome propellers. Centrifugal force from the propeller counterweights, assisted by air pressure in the propeller dome, moves the blades to high pitch. Engine oil under governor-boosted pressure moves the blades to low pitch. On airplanes P-385, P-386, P-388 and after except P-402 and P-403, the engines are equipped with 74 inch Hartzell HC-F3YR-2UF/FC7479B-2R three bladed, full feathering, constant speed, air dome propellers. Centrifugal force from the propeller counterweights, the feather assist spring, and air pressure from the propeller dome moves the blades to high pitch. Engine oil under governor-boosted pressure moves the blades to low pitch. The propeller hub area and the air dome are enclosed by a spinner and bulkhead assembly.

PROPELLER SYNCHRONIZER

The propeller synchronizer automatically matches the left "slave" propeller rpm to that of the right "master" propeller. To prevent the left propeller from losing excessive rpm if the right propeller is feathered while the synchronizer is on, the synchronizer operation is limited to approximately ± 30 rpm from the manual governor setting. Normal governor operation is unchanged but the synchronizer will continuously monitor propeller rpm and reset the governor as required.

A magnetic pickup mounted in each propeller governor transmits electric pulses to a transistorized control box installed behind the pedestal. The control box converts any pulse rate differences into correction commands, which are transmitted to a stepping type actuator motor mounted on the left engine compressor mounting bracket. The motor then trims the left propeller governor through a flexible shaft and trimmer assembly to exactly match the right propeller rpm. The trimmer, installed between the governor control arm and the control cable, screws in or out to adjust the governor while leaving the control lever setting constant.

A toggle switch installed on the pedestal turns the system on. With the switch OFF, the actuator automatically runs to the center of its range of travel before stopping to assure that when next turned ON, the control will function normally.

To operate the system, synchronize the propellers in the normal manner and turn the synchronizer ON. The left propeller rpm will automatically be adjusted to correspond with the right. To change rpm, adjust both propeller controls at the same time. This will keep the left governor setting within the limiting range of the right propeller. If the synchronizer is ON but is unable to adjust the left propeller rpm to match the right, the actuator has reached the end of its travel. Turn the synchronizer switch OFF (allowing the actuator to run to the center of its range and the left propeller to be governed by the propeller lever), synchronize the propellers manually, and turn the synchronizer switch ON.

PROPELLER SYNCHROSCOPE

A propeller synchroscope, located in the tachometer case, operates to give an indication of synchronization of propellers. If the right propeller is operating at a higher rpm than the left, the face of the synchroscope, a black and white cross pattern, spins in a clockwise rotation. Left or counterclockwise, rotation indicates a higher rpm of the left propeller. This instrument aids the pilot in obtaining complete manual synchronization of the propellers.

"END"

TROUBLESHOOTING
PROPELLER SYNCHRONIZER

TROUBLE	PROBABLE CAUSE	REMARKS
1. Synchronizer inoperative.		
a. Circuit breaker trips.	a. Short in aircraft wiring.	a. Isolate and repair faulty component.
b. Intermittent readings on pins 6 & 8 or 7 & 8 (circuit breaker may also trip).	b. Intermittent short or open magnetic pickup in governor.	b. Repair or replace magnetic pickup.
c. Slave (left) governor pick-up gives open or short circuit reading on pins 6 & 8	c. Broken or grounded wire in magnetic pickup or slaved governor.	c. Repair or replace magnetic pickup.
d. Master (right) governor pickup gives open or short circuit reading on pins 7 & 8.	d. Broken or grounded wiring magnetic pickup of master governor.	d. Repair or replace magnetic pickup.
2. Poor synchronization.		
a. Pickup voltage exceeds 3 volts at cruise rpm.	a. Insufficient pickup to flyweight head clearance.	a. Reset pickup to give specified voltage output.
b. Pickup voltage is less than .5 volt at cruise rpm.	b. Clearance between pickup and flyweight head too great.	b. Reset pickup to give specified voltage output.
c. Synchronizer pulses out of synchronization when turned on but returns to center when turned off.	c. Leads No. 3 and No. 4 reversed or master and synchronizer leads reversed at Jones plug.	c. Rewire correctly.
d. Synchronizer pulses out of synchronization when turned on but returns to center when turned off and pins 6 & 8 or 7 & 8 have fluctuating readings.	d. Intermittent open or short in pickup or wiring.	d. Replace faulty pickup or wiring.
e. Synchronizer action is sluggish.	e. Excessive friction in trimmer or flexible rotary shaft.	e. Clean, lubricate, and check for misalignment of shaft in guide tube.
f. Synchronizer action too limited in range.	f. Excessive friction at one end of trimmer or actuator and trimmer were not centered when flexible rotary shaft was connected.	f. Clean, lubricate, and check for misalignment, recenter actuator and rod end, and re-engage shaft.
3. Actuator inoperative but magnetic pickups and control box function properly.	a. Shorted or open actuator motor winding.	a. Replace.

TROUBLESHOOTING
PROPELLER SYNCHRONIZER (Cont'd)

TROUBLE	*PROBABLE CAUSE*	*REMARKS*
4. Actuator not recentering.		
a. Actuator will not return to center after shutting synchronizer control off in flight.	a. Defective centering mechanism in actuator or incorrect clearance between flyweight head and pickup.	a. Replace actuator or reset magnetic pickup output as necessary.
b. Actuator has improper travel (should make 3 revolutions).	b. Defective centering mechanism in actuator.	b. Replace.
c. Actuator dead band determined by ohmmeter (pins 5 and 1 open circuit) is 7 to 26 steps wide (actuator will probably not recenter when switch is turned off).	c. Actuator switches stuck in depressed position.	c. Replace.
5. Oil leaks from magnetic pickup connection in governor body.	a. Defective O-ring between pickup and lock nut.	a. Replace.
	b. Defective gasket under lock nut.	b. Replace.
	c. Nut loose.	c. Tighten to 25 inch-pounds.
	d. Defective pickup.	d. Replace pickup.

CAUTION

Never turn pickup into flyweight head. Check voltage output.

"END"

GENERAL - MAINTENANCE PRACTICES

PROPELLER BLADE BEARING LUBRICATION

(Figure 201)

a. Remove the propeller spinner dome.

b. Remove the safety wire and covers from the six zerks.

c. Remove one zerk from each blade.

d. Lubricate the blade bearings with Hartzell DG Grease by placing the grease gun fitting on the remaining zerk of each blade. Fill until the grease is visible in the hole where the opposite zerk was removed.

e. Reinstall the zerk on each blade.

f. Clean excess grease from the propeller, reinstall the grease zerk covers and safety.

g. Reinstall the spinner dome.

PROPELLER REMOVAL

a. Remove the attaching screws and remove the spinner dome and cap.

b. Remove the retaining screws and the nose cowling fairing channels from the base of the propeller hub.

c. Remove the safety wire and remove the nuts around the propeller hub base with the special propeller torque wrench adapter (P/N 922 60-960000).

NOTE

When propeller deicer equipment is installed, it is necessary to disconnect the terminal wires on the starter ring gear.

d. Pull the propeller carefully from the mounting studs.

CAUTION

Do not damage the threads on mounting studs and be careful not to damage the spinner.

PROPELLER INSTALLATION

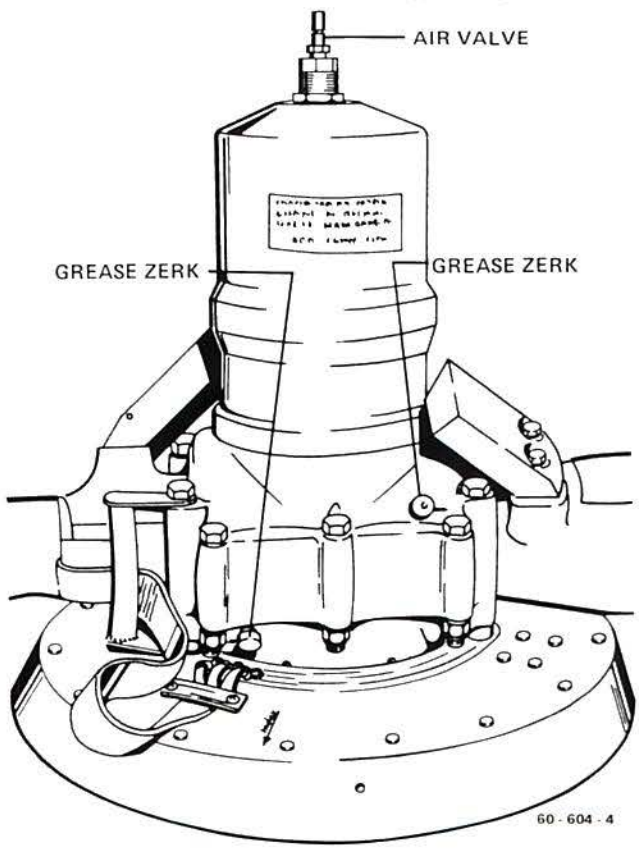
a. Install a new O-ring in the propeller flange extension and carefully position the propeller on the mounting studs. Install nuts and washers and snug down in a diagonal pattern. Torque nuts to 90 to 100 foot-pounds and safety wire.

CAUTION

Do not damage the threads on mounting studs and be careful not to damage the spinner.

NOTE

When using the special propeller torque wrench adapter, the torque valve must be recomputed. (Refer to Chapter 20-00-00.)



Propeller Servicing Point
Figure 201

b. Connect propeller deicer terminal wires, if installed, on the starter ring gear.

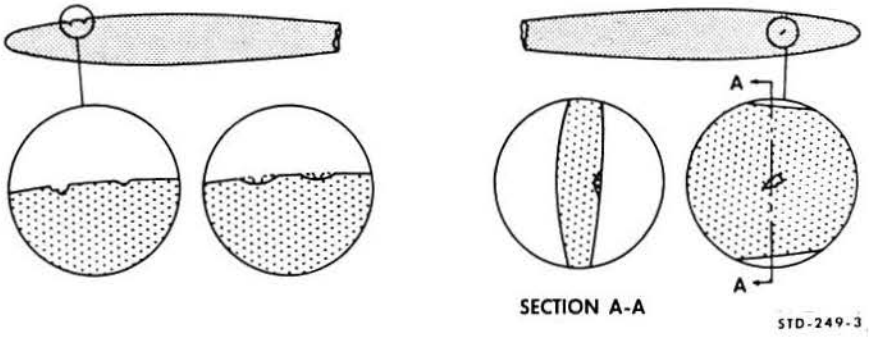
c. Install the nose cowling fairing channels with attaching screws.

d. Position the spinner dome and cap, and install the attaching screws.

e. Connect a dry air or nitrogen supply line to the air valve and fill to 80 psi for HC-F3YR-2/C7479B-2R, HC-F3YR-2F/FC7479-2R, HC-F3YR-2/C7479-2R, or HC-F3YR-2F/FC7479B-2R propellers. This should be done at 70 degrees F. Increase 2 psi for every 10 degrees of temperature increase. Decrease 2 psi for every 10 degrees of temperature decrease. Fill to 41 psi for HC-F3YR-2UF/7479-2R or HC-F3YR-2UF/FC7479B-2R propellers. This should be done at 70 degrees F.

NOTE

70 to 100 degrees F. Pressurize dome to 41 psi
40 to 70 degrees F. Pressurize dome to 38 psi
0 to 40 degrees F. Pressurize dome to 36 psi



Minor Propeller Blade Repair
Figure 202

PROPELLER BLADE REPAIR.
(Figure 202)

Minor nicks, dents and gouges may be dressed out by approved line personnel. Blend any nicks or gouges into the leading edge with smooth curves, and generous radii as shown in Figure 202. Reanodize the reworked area by the chromic acid process only.

PROPELLER GOVERNOR REMOVAL

a. Remove cotter pin, nut, washer and bolt attaching the adjusting rod end to the governor.

b. Disconnect the oil line, from the outboard side of the governor.

c. Remove the nuts and washers around the governor base. Remove the governor and cover the engine boss.

PROPELLER GOVERNOR INSTALLATION
(Figure 203)

a. Remove the cover from the engine boss; install a new gasket with the raised portion of the screen facing up.

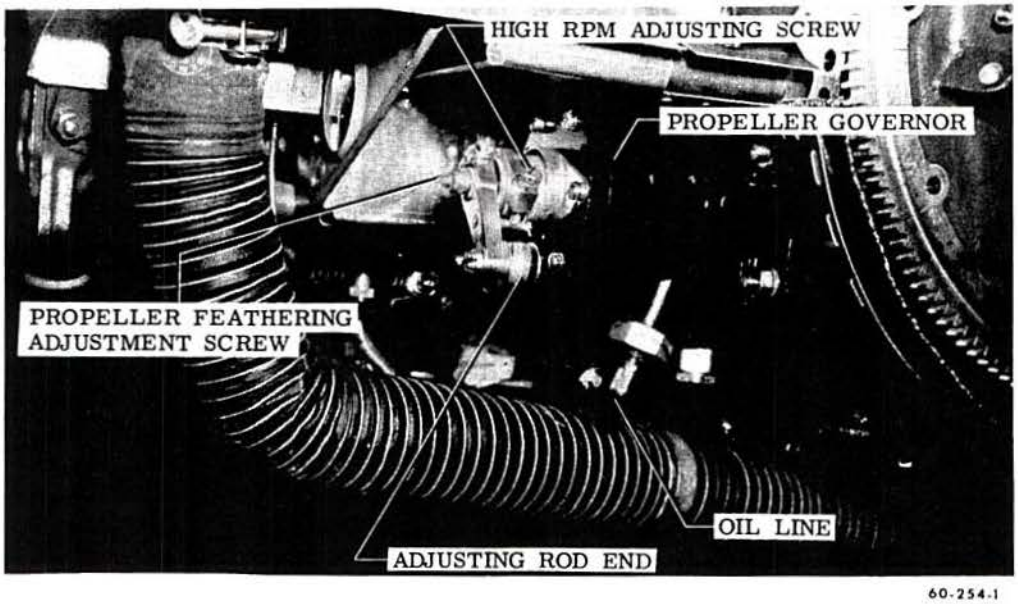
b. Align the governor spline with the engine drive spline, and install washers and nuts. Diagonally torque the nuts to 150 inch-pounds.

c. Connect the oil line to the outboard side of the governor.

d. Install the bolt, washer, nut and cotter pin attaching the adjusting rod end to the governor.

NOTE

To insure proper adjustment, do not turn the adjusting rod end when installing the governor.



Propeller Governor Installation
Figure 203

PROPELLER GOVERNOR ADJUSTMENT
(Figure 203)

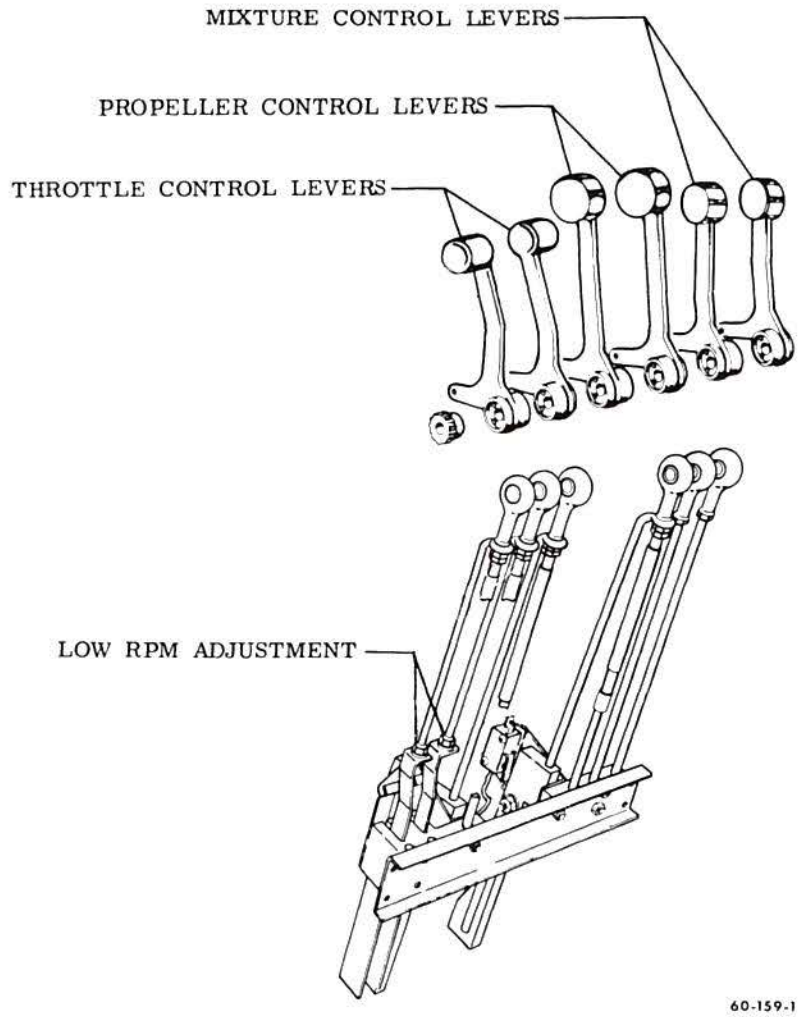
The propeller governor can be adjusted for high and low rpm setting and a feathering adjustment. The high rpm adjustment must be checked while the aircraft is in flight. Observe the take-off rpm to see if it exceeds the redline figure. If excessive rpm is observed, land the plane and adjust the high rpm screw inward to reduce the rpm to the redline figure. The high rpm adjustment screw is located at the rear of the governor just forward of the speed adjusting control lever. One complete revolution of the screw reduces the propeller rpm by approximately 25 to 30 revolutions.

FEATHERING ADJUSTMENT

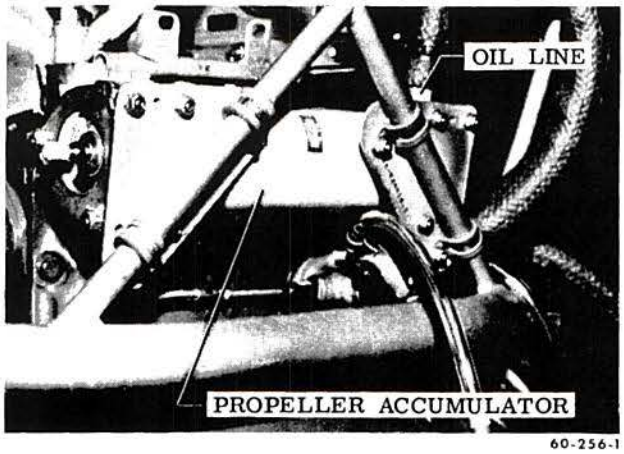
To adjust the feathering action, pull the control back through the detent and observe the point at which the rpm setting begins to fall off sharply, then bring the propeller back to low rpm. The point at which propeller feathering starts should be at 2,100 rpm. If adjustment is required turn the square-head screw on the end of the governor control shaft inward or outward to correct the setting. One half revolution of the screw inward will lower the feathering rpm approximately 100 revolutions. (See Figure 203.)

LOW RPM ADJUSTMENT
(Figure 204)

The low rpm adjustment is made while the airplane is on the ground. To make this adjustment, pull the propeller lever back against the detent. Slowly move the throttle control lever forward until the rpm stabilizes. Observe the rpm setting. If the rpm varies from the specified low rpm setting of 2350 rpm the low rpm setting must be adjusted. The low rpm adjustment is made on the detent rod, which is located behind the instrument panel on the governor control



Propeller Low RPM Adjustment
Figure 204



Unfeathering Accumulator
Figure 205

linkage. To increase the setting, lengthen the rod; to decrease the setting, shorten the rod.

PROPELLER ADJUSTMENT

For high and low pitch adjustments, service, overhaul and maintenance procedures refer to the manufacturers applicable FAA Approved Propeller Manuals.

PROPELLER ACCUMULATOR

The propeller accumulators are located on the lower rear section of each engine. The accumulators should be inspected every 100 hours and charged with dry air or nitrogen to 125 psi.

PROPELLER ACCUMULATOR REMOVAL
(Figure 205)

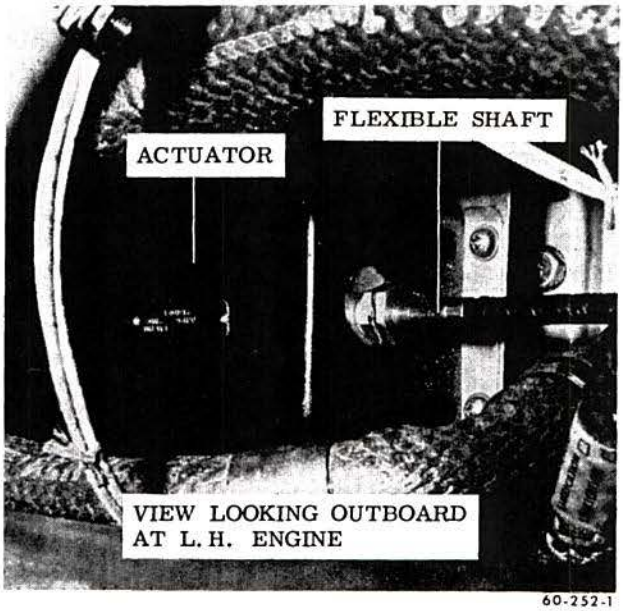
a. Check the propeller control lever for unfeathering (low pitch) position, to release accumulator pressure.

CAUTION

This system has approximately 300 psi of pressure with the propeller in full-feather position.

b. Remove the oil line from the end of the accumulator.

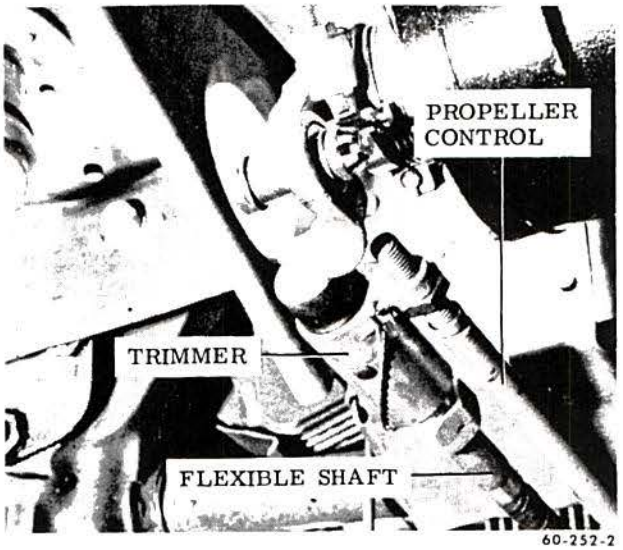
c. Remove the four clamps that hold the accumulator mounting brackets to the engine mount and remove the accumulator.



Propeller Synchronizer Actuator
Figure 206

PROPELLER ACCUMULATOR INSTALLATION

a. Position the accumulator against the engine mount



Propeller Synchronizer Trimmer
Figure 207

and install the four attaching clamps.

b. Connect the oil line to the end of the accumulator.

c. Charge the accumulator with dry compressed air or nitrogen to 125.

SYNCHRONIZER FUNCTIONAL TEST
(Figure 206)

Proper operation of the propeller synchronizer can be determined by the following method. Turn the synchronizer on in the normal manner, then decrease the right propeller rpm in small increments. Both propellers should decrease together until the actuator reaches the end of its travel, then the left propeller should stabilize its rpm while the right continues to decrease. Increase the right propeller rpm until both propellers commence to increase rpm together. Turn the system OFF. An unsynchronized condition will develop as the actuator runs to its midrange position. When the synchronizer is turned ON, the left propeller should again synchronize with the right.

SYNCHRONIZER RIGGING
(Figure 207)

a. Disconnect the flexible trimmer shaft from the actuator.

b. Rotate the shaft in one direction until it reaches the internal stop in the trimmer. Check the propeller control to assure that it has full travel in both directions.

c. Rotate the shaft in the other direction until it reaches the stop, counting the turns. Again check the propeller control for full travel in both directions.

d. Rotate the shaft to the center of its range.

e. Count total turns available in the actuator motor and turn it to the center of its range. The motor can be turned by inserting a square shaft end into the drive.

f. With both the trimmer and the actuator motor centered, connect the flexible shaft.

g. Rig the propeller controls in the normal manner.

SYNCHRONIZER CHECKS

These checks will help locate the source of trouble should the synchronizer system malfunction. If no malfunctions are found among the units being tested, the transistorized control box is probably the source of trouble. An ohmmeter and voltmeter are required to conduct the tests outlined below.

SYNCHRONIZER WIRING CHECK
(Chart 201)

a. To eliminate the most obvious causes for malfunction, make sure that the aircraft master switch is ON, that the system circuit breaker is not tripped, and that the Jones plug receptacle is properly mated with the plug in the aircraft electrical system.

b. Unplug the control box, turn the aircraft master switch OFF, and pull the synchronizer circuit breaker before proceeding further with these checks.

CHART 201
SYNCHRONIZER RESISTANCE CHART

TEST BETWEEN RECEPTACLE NUMBERS:	OBTAIN		
		With actuator uncentered 180°	
	With actuator centered	Turn clockwise (facing drive end) to uncenter	Counterclockwise (facing drive end) to uncenter
5 and 1	Open circuit (high resistance)	6.5 to 8.5 ohms	6.5 to 8.5 ohms
5 and 3	Open circuit (high resistance)	Closed circuit 0 to 1 ohm	13 to 17 ohms
5 and 4	Open circuit (high resistance)	13 to 17 ohms	Closed circuit 0 to 1.0 ohms
4 and 1	6.5 to 8.5 ohms	6.5 to 8.5 ohms	6.5 to 8.5 ohms
4 and 3	13 to 17 ohms	13 to 17 ohms	13 to 17 ohms
3 and 1	6.5 to 8.5 ohms	6.5 to 8.5 ohms	6.5 to 8.5 ohms

c. Complete resistance checks. (See CHART 201.)

CAUTION

Zero the ohmmeter and read on the X1 to X10 scale during the following checks. Do not use a probe greater than .045 inch in thickness. Insert and remove the probe carefully to avoid damaging the pin connectors.

NOTE

Later propeller governors are equipped with an improved type of magnetic pickup. The new type has a solid steel pickup end; while the old type has a visible ceramic core. Any combination of new or old magnetic pickups is acceptable between engines.

d. Complete the following checks.

1. Using an ohmmeter, test that the resistance between pin receptacles 7 and 8 of the Jones cinch socket (see Figure 208) is 52 to 68 ohms (new pickup), or 90 to 110 ohms (old pickup) with pin receptacle 6 disconnected at the pickup.

2. Check that the resistance between pin receptacle 6 and 8 is 52 to 68 ohms (new pickup), 90 to 110 ohms (old pickup) with pin receptacle 7 disconnected at the pickup.

e. Make the following checks with an ohmmeter connected to the pin receptacles of the Jones cinch socket (P/N 233032).

1. Check that an open circuit (very high-resistance) exists between pin receptacle 8 and airplane ground and between pin receptacle 2 and ground.

2. Check that a closed circuit (zero ohms) exists between pin receptacle 1 and ground.

f. Turn the airplane master switch ON and reset the synchronizer circuit breaker, but leave the control box unplugged.

g. Using a DC voltmeter, check that the voltage between pin receptacles 1 and 2 is the same as the supply voltage and that the polarity of pin number 1 is negative while that of pin number 2 is positive.

h. Using a 5000 ohm/volt AC voltmeter and with the engines running near cruise rpm, probe pins 6 and 8 for pickup voltage on the left (slave) engines and pins 7 and 8 for pickup voltage on the right (master) engine. These values should be between 1/2 volt minimum and 3 volts maximum.

i. When the system is in compliance with the preceding check values, plug the control box into the synchronizer system. If the synchronizer system still malfunctions, the source of trouble is probably either in the control box itself or is the result of a mechanical failure of the flexible shaft or governor speed trimming device.

j. Check the speed pickups mounted on the governor for oil leaks or looseness.

k. Remove the flexible rotary shaft and rotate the actuator through its range. It should stop positively at each end of its range and should rotate freely except for the ratcheting effect of the detent wheel. The normal output torque is 15 ounce-inches. Make sure the actuator is returned to the center of its range.

Adjust the governor trimmer by turning the squared end of the flex shaft by hand (a turning fixture may be required to turn the shaft in the direction to decrease rpm). Under any circumstances, a turning fixture 1/4 inch in diameter should be adequate for rotating the trimmer freely throughout its range. After thus verifying that the friction between the rotating parts is at an acceptable level, recenter the trimmer and attach it to the actuator.

If the response of the system to the preceding checks has been satisfactory, the airplane is ready for flight.

FLIGHT CHECKS

a. Check the effect of rpm and/or power setting (particularly in the lower cruise range) on synchronizer action. If operation at lower rpm resulted in improved synchronization, inspect the drives to the governors.

b. Reduce the electrical load and turn off the generator and all other electrical units, except the master switch, and synchronizer if synchronizing improves, abnormal voltage spikes on the airplane bus from some other electrical accessory may have been upsetting the synchronizer. Isolate the offending accessory and repair it. If the trouble lies in the control box, replace it.

100-HOUR INSPECTION

PROPELLER - Inspect the propeller for nicks, dents, cracks, evidence of leakage, condition and security.

AIR DOME - Check the propeller air dome for correct pressure.

DEICER BOOTS - Check the boots for hot spots, exposed heating element wires, tears and security to the blades.

SPINNER AND BULKHEAD - Check the spinner and bulkhead for nicks, dents, cracks, condition and security. Check deicer boot wires for security at the starter ring gear.

PROPELLER GOVERNORS - Inspect the governor for oil leakage, condition and security.

CONTROL LEVERS - Check levers for smooth and free movement and cushion. Check controls at the governor for security and full travel against the stops.

ACCUMULATOR - Inspect for oil leakage, condition and security. Check air pressure.

SYNCHRONIZER - Check all components of the system for condition and security. Any discrepancies noted during ground or flight should be isolated using the troubleshooting chart and the wiring check. Consult Woodward Governor Bulletins 33032A and 33049C for further detailed information.

"END"