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ACCELEROMETER

PART NUMBER

2094-Generic

**COMPONENT MAINTENANCE MANUAL
WITH
ILLUSTRATED PARTS LIST**

**REVISION N/C
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1. DESCRIPTION AND OPERATION

Description

The aircraft accelerometer (refer to Figure 1) is a mechanical device that uses displacement of a mass to turn pointers (hands) and provide an indication of the vertical acceleration of the aircraft in maneuvers and rough weather.

Operation

Movement of the mass is air damped to specified frequency response. The instrument is protected in a sealed case with an external release control. The instrument has three hands, one that indicates instantaneous vertical acceleration and two that indicate the upper and lower limits of acceleration experienced by the aircraft. The latter two hands, called memory hands, are operated by ratchet assemblies that are reset by operation of the release control.

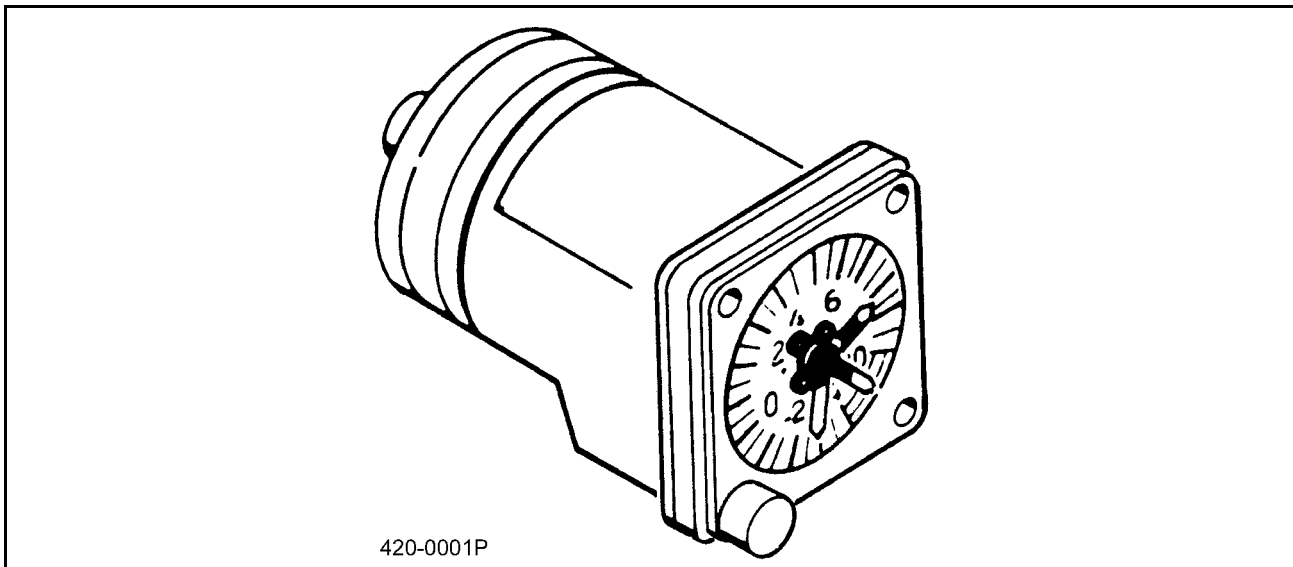


Figure 1. Accelerometer

Leading Particulars

Leading Particulars are given in Table 1.

Table 1. Leading Particulars

CHARACTERISTICS	DESCRIPTION
Use	Acceleration indication per specification MIL-A-25949 (ASG)
Type	ABU-4A/A
Indication and Range	-5 to +10g
Dynamic Scale Error Maximum	$\pm 0.3g$
Ambient Temperature Range	-54°C to +71° (-65°F to 160°F)
Power Source	5.0 ± 0.10 volts
Electrical Connector (Receptacle)	Mates with MS3116-8-3S

2. TESTING AND FAULT ISOLATION

Test Setup

Performance testing and fault isolation for the accelerometer will be performed on the QED Fixture P/N S-453. Refer to Table 2 for listing of special tools and test equipment.

Table 2. Test Equipment

Equipment	Manufacturer
Accelerometer Test Fixture, S-453	QED Inc., Santa Ana, California U.S.A. or local manufacture

Test Procedure

(1) Static Scale Error and Friction Test.

- (a) Hold instrument motionless with dial in vertical position and +5g at top; hand assemblies indicate +1 $\pm 0.2g$.
- (b) Hold instrument motionless with dial in vertical position and -3g at top; hand assemblies indicate -1 $\pm 0.2g$.
- (c) Hold instrument motionless with dial horizontal; hand assemblies indicate $0 \pm 0.2g$.
- (d) Check that friction does not exceed $\pm 0.2g$ with memory pointer engaged.



Dynamic Scale Error Test.

(a) Mount the accelerometer on test fixture and determine the scale errors for acceleration of -5g, -3g, 0g, +3g, +6g, +9g, and at any other point desired as listed in Table 3.

(b)The dynamic scale error shall not exceed +/- 0.3g at any specified test point of Table 3.

Table 3. Dynamic Scale Movement

ACCELERATION	RPM	POSITION OF SEISMIC MASS*
-5	135.3	9.620
-4	121.2	9.588
-3	105.2	9.555
-2	86.0	9.522
-1	60.9	9.489
+1	61.5	9.326
+2	86.8	9.359
+3	106.1	9.391
+4	122.3	9.424
+5	136.5	9.457
+6	149.3	9.489
+7	161.0	9.522
+8	171.8	9.555
+9	181.9	9.588
+10	191.4	9.620

*Based on centerline of accelerometer mounted at 9.375 inch radius.

Response Characteristics.

(a)Use equipment that will impose linear sinusoidal motion to the accelerometer and is capable of producing the frequencies and double amplitude specified in Table 4. The acceleration vector of any harmonic measured on the test table shall not exceed 10 percent of the fundamental acceleration vector.



Table 4. Response Characteristic Test Settings and Tolerances

IMPRESSED FREQUENCY (CPS)	DOUBLE AMPLITUDE (INCHES)	APPLIED ACCELERATION (G)	INDICATED ACCELERATION (G)	
			MINIMUM	Maximum
5	2.0	5.13	4.8	5.8
*6	1.5	5.54	4.8	6.3
7	1.25	6.26	4.9	7.2
*8	0.75	4.92	3.4	5.6
9	0.50	4.16	2.6	4.7
10	0.50	5.13	2.8	5.8
11	0.50	6.21	0	6.7
*12	0.50	7.38	0	7.5
13	0.375	6.46	0	6.2
14	0.375	7.54	0	6.8
15	0.375	8.61	0	7.1
*16	0.25	6.57	0	5.0
18	0.1875	6.16	0	3.9
*20	0.1875	7.71	0	3.8

(b) The accelerometer shall be subjected to vibration applied along the axis passing through the +5 and -3 graduations of the dial. Test at each frequency and double amplitude listed in Table 4. During the test, total excursion of the pointer movement shall be recorded at each frequency stage of the test. The recorded value shall not exceed the maximum and minimum values listed in Table 4.

Instrument Lighting Test

- (a) With 4.5 +/- 1 volts DC applied to pins A and B of the electrical connector, note that the white area of the dial face is illuminated.
- (b) Observe the indicator face in total darkness. The pointer and all dial markings shall be clearly visible. The color and brightness should be uniform.
- (c) Fault Isolation (refer to Table 5)

Table 5. Fault Isolation Chart

Fault	Probable Cause	Remedy
Excessive error	Springs defective or loose	Replace
	Pivot defective	Replace
	Weight and rack assembly or caps defective or incorrectly installed	Replace
	Hand assemblies binding	Check for improper alignment
	Gear train or bearing components binding	Check for improper alignment
Light assembly inoperative	Power source improper	Adjust input power to proper value
	Light assembly defective	Replace light assembly
	Loose wiring connections or defective connector	Resolder or replace connector

3. DISASSEMBLY

Refer to TESTING AND FAULT ISOLATION Section to determine extent of disassembly required. Disassemble only to extent necessary to accomplish repairs and return unit to serviceable condition. Protect components from contamination by placing them in a closed, clean container after disassembly.

Disassemble accelerometer as follows: (refer to IPL Fig. 1).

- (a) Break seal by unsoldering strip (40) and removing epoxy over screws (45). Remove screws (45).
- (b) Do not remove bezel (25) from the case unless light assembly (95) or wedge (105) requires replacement.

CAUTION: BE CAREFUL NOT TO BEND THE SHAFT WHEN REMOVING HANDS.

- (c) Each hand assembly (155 through 165) is a press-taper fit on the shaft. Carefully pull each hand assembly from unit using instrument hand remover.

CAUTION: BE CAREFUL NOT TO DAMAGE SLEEVE (360) OR WEIGHT AND RACK ASSEMBLY (320) WHEN PRYING OFF CAPS (145).

- (d) Caps (145) are cemented to frame (365). Carefully pry off.

CAUTION: BE CAREFUL WHEN REMOVING BRIDGE ASSEMBLY (180) OR SPRING (195) WILL FALL FREE.

- (e) Remove hardware (185, 190) securing bridge assembly (180) and spring (195).
- (f) Note position of spring (205) and pawl (210) for reassembly. Use same shims (215) for reassembly.

- (g) Remove taper pins (230) from post (345) being careful to avoid damage to ratchet assembly (235).
- (h) Do not disassemble ratchet assemblies (235, 240). Use same shims (225) for reassembly.
- (i) Do not remove post (345), pivot (330), anchor (350), stops (370, 380), or sleeve (360) unless replacement is required.

4. CLEANING

Cleaning Materials

Cleaning materials are listed in Table 6.

NOTE: Equivalent substitutes may be used for listed items.

Table 6. Cleaning Materials

Material	Source/Specification
Solvent, cleaning	P-D-680, Type II
Brush, sable hair	Commercially available
Cloth, lint-free	Commercially available

Cleaning Requirements

WARNING: USE SOLVENT IN A WELL-VENTILATED AREA. KEEP AWAY FROM OPEN FLAME. AVOID INHALING FUMES OR PROLONGED CONTACT OF SOLVENT WITH SKIN.

- (a) Dust hands (155 through 165, IPL Fig. 1) with a sable hair brush followed by wiping with a lint-free cloth, moistened sparingly in solvent, federal Specification P-D-680.
- (b) Clean all remaining non-electrical metallic parts in solvent, Federal Specification P-D-680.
- (c) Dry thoroughly with clean compressed air not in excess of 15 psig.

5. CHECK

General Requirements

- (a) Inspect all parts under strong light and use a 15-power microscope for signs of corrosion, distortion, cracks, stripped threads, scoring or any damage that might impair the efficient operation of the unit.
 - (b) Inspect identification plate (5) for legibility and security of attachment.
 - (c) Inspect all springs for out-of-roundness.
 - (d) Inspect electrical connection for frayed wires and signs or arcing.
-

Refer to Figure 2 for continuity.

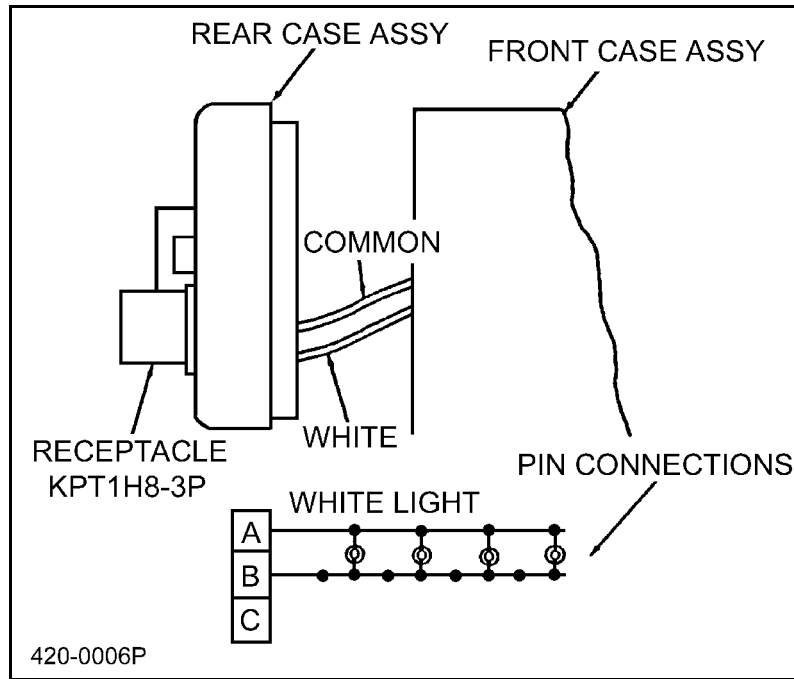


Figure 2. Wiring Diagram



6. REPAIR

Repair Materials

(Repair materials are listed in Table 7.)

NOTE: Equivalent substitutes may be used for listed items.

Table 7. Repair Materials

Material	Source/Specification
Cloth, Crocus	P-D-458
Cloth, Aluminum Oxide Polishing	P-D-451

Repair Procedure

NOTE: Surfaces treated with abrasives must be cleaned in accordance with the CLEANING Section 4. before reassembly.

(a) Polish out minor nicks and scratches in ferrous metal components using crocus cloth. Repair damaged threads with a sharp thread chaser. Remove burrs using a fine tooth file.

Replacement

(a) Replace all components which are damaged beyond repair or do not meet inspection requirements of Paragraph 5. Check

(b) If pivot (330, IPL Fig. 1), post (345) or anchor (350) requires replacement, ensure that holes are not enlarged and that new parts (particularly taper pins and projections) press fit and face in same direction as part removed.

(c) Replace all packings, retaining rings, and pins if removed.

(d) Make certain new bearings are entirely free of protective lubricants.

WARNING: USE SOLVENT IN WELL-VENTILATED AREA. AVOID PROLONGED INHALATION OF FUMES OR CONTACT WITH SKIN. OBSERVE FIRE PRECAUTIONS.

(e) If identification plate was removed, remove any old adhesive from surface of case assy (100) with solvent P-D-680, Type II and let dry before applying new identification plate (5). Smooth out identification plate and make sure corners and edges are secure.

7. ASSEMBLY

Assembly Materials

Assembly materials are listed in Table 8.

NOTE: Equivalent substitutes may be used for listed items.

Table 8. Assembly Materials

Material	Source/Specification
Epon 828	Shell Chemical Corporation New York, NY
Catalyst, RF 14	Shell Chemical Corporation New York, NY
Epoxy, No. 2216	Minnesota Mining & Mfg Co St Paul, Minnesota
Loctite 271	Loctite Corp. Newington, Connecticut
Solder, SN 50	QQ-S-571

Assemble accelerometer assembly as follows: (refer to IPL Fig. 1)

CAUTION: BE CAREFUL NOT TO BEND SHAFT. APPLY PRESSURE TO RACE DIAMETER ONLY TO AVOID DAMAGE WHEN INSTALLING BEARINGS (260 AND 315).

- (a) Carefully install main shaft (290, IPL Fig. 1).
- (b) Hold the instrument with arm (335) in 7 o'clock position and shaft horizontal. Place spring positioning fixture against the bottom of weight and rack assembly (320). Align shaft (290) notch horizontally to mesh with weight and rack, shaft will lock at the 1g position.
- (c) Index assembly (245) must contact and act as the travel stop for arms of both ratchet assemblies.

NOTE: Install spring (205) and pawl (210) in exactly the same position as those removed in para. 3.B. (6).

- (d) If spring (205) or pawls (210) are replaced, attach spring to pawl with a light solder tack, using Sn 50 solder, Federal Specification QQ-S-571.
- (e) Carefully install the two ratchet assemblies securing each hairspring with taper pins (230). Give ratchet hairsprings one-half turn preloading upon installation using hairspring adjustment tools.
- (f) Ensure that ratchet assemblies (235) and actuator (220) are free and pawls (210) properly engage and disengage the ratchets.
- (g) Align spring end of arm (310) with index assembly (245), then tighten screw (265).
- (h) Fasten forward end of spring (305) with setscrew (300).
- (i) Install dial (170) but do not install caps (145).
- (j) Install hand assemblies (155 through 165) at the 2g position.
- (k) Fasten free end of spring (305) to the anchor (350) and secure with screw (270).



(l) Perform static scale error test per para. 2. B. (1) and adjust spring tension by lessening screw (270) and applying torsional loading to the spring. Tighten screw. Repeat as required for correct indication.

(m) Remove and reposition hand to adjust mainspring tension.

(n) After adjustment is complete, cut off excess mainspring length.

CAUTION: APPLY RESIN MIXTURE SPARINGLY TO MAKE AIRTIGHT SEAL BETWEEN CAPS (145) AND FRAME (365) ONLY. DO NOT LIFT CAPS AFTER APPLICATION OF THE RESIN MIXTURE, OR MIXTURE MAY BE SQUEEZED INSIDE OF SLEEVE AND CAUSE MALFUNCTION.

NOTE: Pot life of epoxy after mixing is about 20 minutes. Use same mixture to bond light assembly (95) to bezel (25) if removed.

(o) Install caps (145) with a mixture of three parts by weight Epon 828 and one part RF14 Catalyst (Shell Chemical Corp., New York, NY).

(p) After attachment of caps (145), wrap at least four turns of adhesive tape around mechanism and caps to ensure caps are retained during adhesive hardening. Cure by air-drying for 10 hours at temperature of +22C (72°F) or above, or oven cure at one hour at +66°C (+150°F).

(q) Install dampening screws (150) finger tight, then remove adhesive tape.

(r) Perform dynamic scale error test per paragraph 2.B.(2).

(s) Perform response test per paragraph 2.B.(3) and adjust dampening as follows:

1. Turn dampening screws (150) all the way in and start testing at 5 cps.
2. Back out screw one-sixth turn at a time and check response at each frequency noted by asterisk in Table 4.
3. Reset hands between each adjustment to bring instrument within limits of Table 4.
4. If proper response characteristics cannot be achieved, check for leakage around caps (145).

(t) Recheck static scale error per paragraph 2.B.(1).

(u) Inspect mechanism assembly (145 through 380) for the following:

1. All parts clean.
2. Pawls properly aligned.
3. Check for pawl slippage by tapping lightly.
4. All setscrews tight.

(v) Inspect main shaft (290) for full movement 30° either side without friction or roughness.

(w) Inspect spring (205) for flatness and concentricity.

(x) Inspect hand assemblies (155 through 165); all three hands must line up.

(y) Bond wedge (105) to front case assembly (100) using epoxy No. 2216 (Minnesota Mining and Mfg. Co., St. Paul, Minnesota).



- (z) If removed, install bezel and light assembly (25, 95) on front case assembly (100).
- (aa) Replace packings (75) on knob assy (70) and install in rear case assembly (80); then place spring (65) and washer (60) over shaft of knob and secure with pin (55). Check to see knob turns when pulled.
- (bb) Install mechanism assembly (145 through 380) in front case assembly (100) then using wiring diagram, Figure 2, hook up wires to connector (85, IPL Fig. 1) in rear case subassembly (80).
- (cc) Solder a new seal strip (40) completely around instrument case assembly. Make certain that strip makes a completely air-tight seal.
- (dd) Seal screws (45) with Epon 828.
- (ee) Install release knob (10) with pin (15). Use Loctite 271 on screws.
- (ff) Perform all tests under Section 2. Testing and Fault Isolation.

8. STORAGE

Store accelerometer as follows:

- (a) Seal accelerometer assembly in a clean polyethylene bag and tag with part number, description and date.
- (b) Store under cover at ambient room temperature and humidity.

9. SPECIAL TOOLS, FIXTURES AND TEST EQUIPMENT

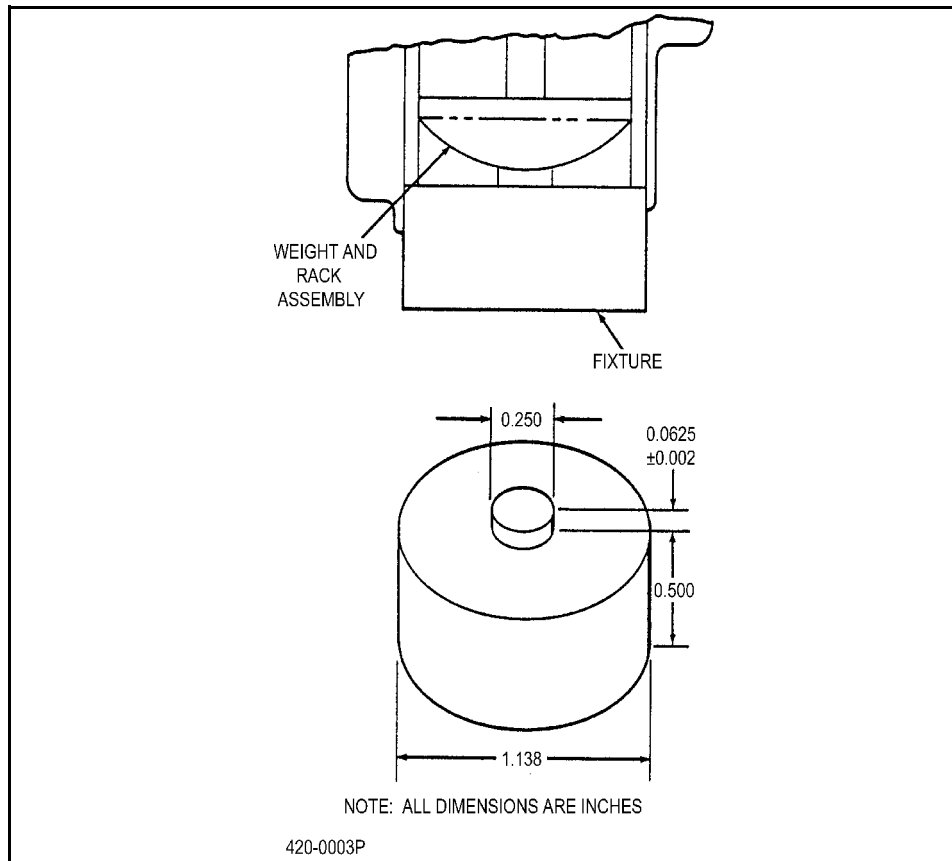
Special tools, fixtures and test equipment are listed in Table 9.

NOTE: Equivalent substitutes may be used for listed items.

Table 9. Special Tools, Fixtures and Test Equipment

Nomenclature	Range/Rating	Manufacturer
Accelerometer Test Stand, S-453	N/A	QED
Hand Remover	N/A	
Hairspring adjustment Tools, S-446 (Min) and S-447 (Max)	N/A	Local Manufacture (Figure 4)
Spring Positioning Fixture	N/A	Local Manufacture (Figure 3)

Figure 3. Spring Positioning Fixture



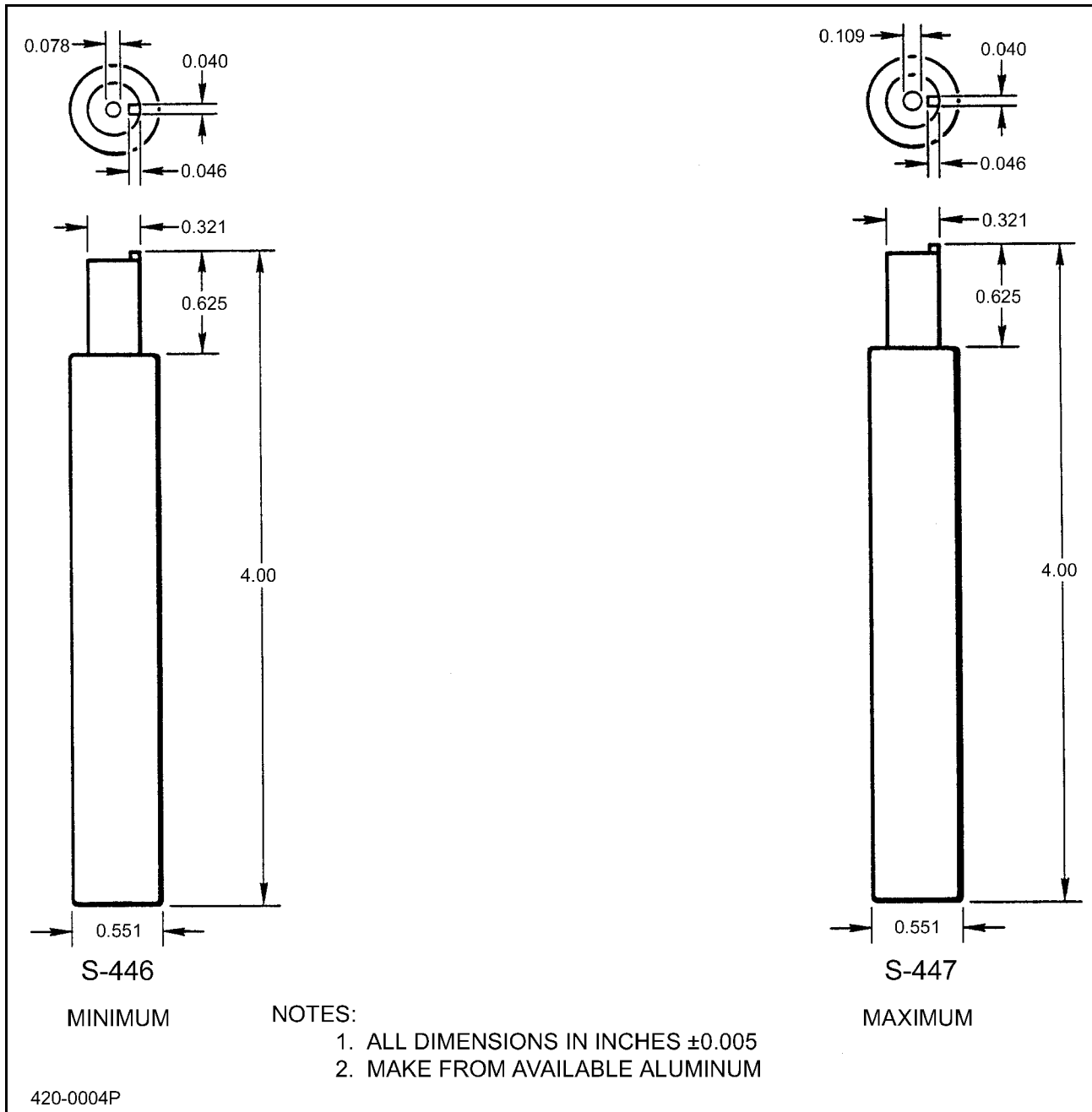
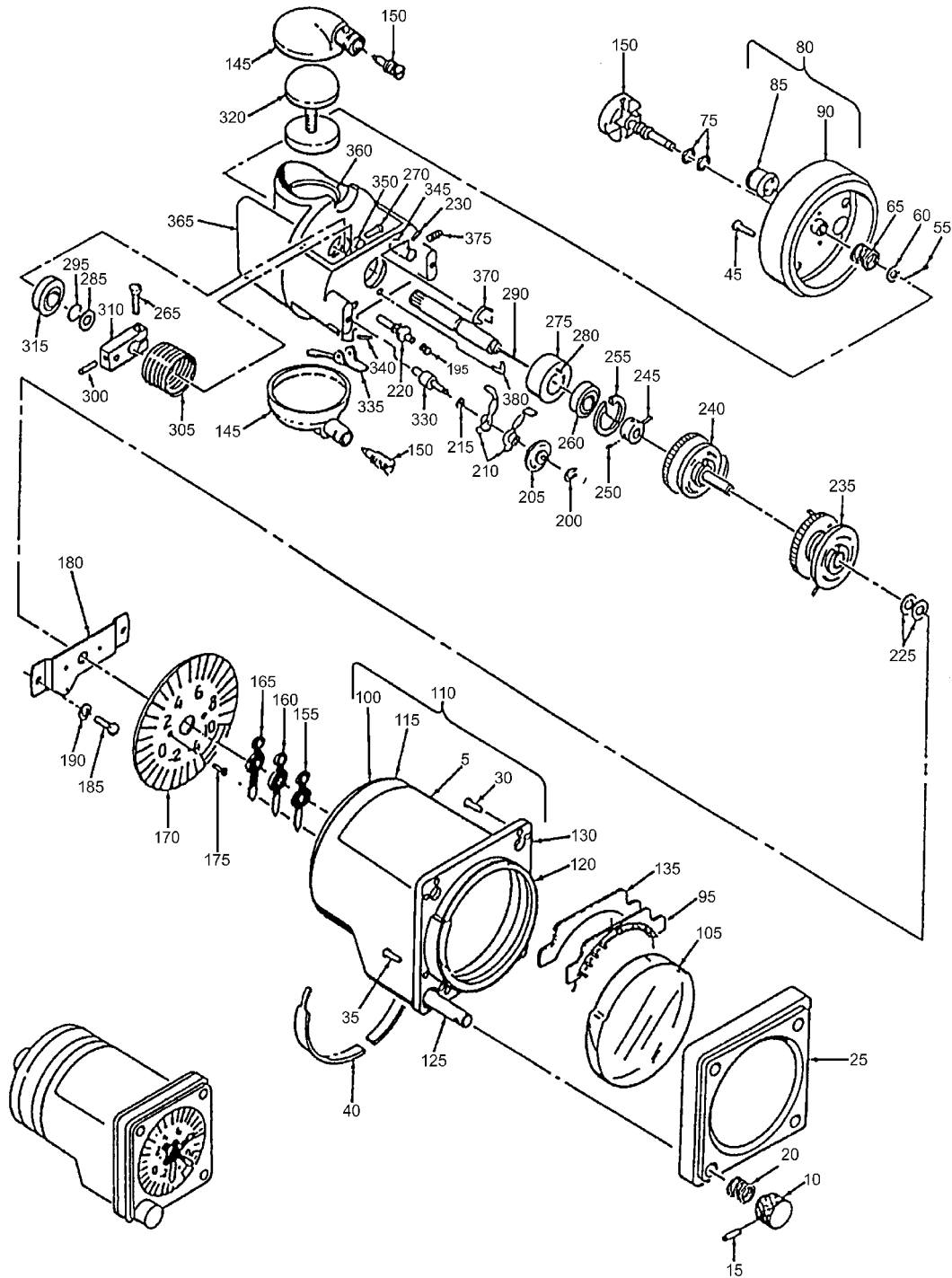


Figure 4. Hairspring Adjustment Tools



IPL Figure 1. Aircraft Accelerometer, Exploded View

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FIG. ITEM	PART NUMBER	AIRLINE PART NO.	NOMENCLATURE 1 2 3 4 5 6 7	EFF CODE	UNITS PER ASSY
1-1	2094-25		ACCELEROMETER ASSY		REF
5	S128-4-1		.PLATE, Identification		1
10	2119-114		.KNOB, Release		1
			(ATTACHING PARTS)		
15	MS171435		PIN, Spring		1
20	2119-147		SPRING, Helical		1
25	2118-357-1		.BEZEL (ATTACHING PARTS)		1
30	AN501D1-3		.SCREW		4
35	AN501D2-3		.SCREW		4
			---*---		
40	2119-103		.STRIP, Seal		1
45	MS51959-12		.SCREW		3
-50	2094-013		.REAR CASE ASSY		4
55	2103-105		..PIN		1
60	S107-9		..WASHER, Flat		1
65	2118-347		.. SPRING, Helical (84830)		1
70	2118-340		..KNOB ASSY		1
75	AN6227-1		..PACKING, PREFORMED		2
80	2094-014		..CASE, REAR, SUBASSY		1
85	KPT1H8-3P		..CONNECTOR (71468) (KPT1H-8-3P)		1
90	2118-338		...CASE, REAR		1
95	2119-884		.LIGHT ASSY		1
100	2094-012-6		.FRONT CASE ASSY, (Partial Breakdown Follows)		1
105	2100-300		..WEDGE		1
110	2094-001-1		..CASE, FRONT, SUBASSY		1
115	2100-504		...TUBE, CASE		1
120	2100-302		...RING, EXPANSION		1
125	2100-014		...BELLOWS AND SHAFT ASSY		1
130	2118-358		...FLANGE, CASE		1
135	2119-856		.PAD		1
140	2094-010-2		.MECHANISM ASSY		1
145	2117-013		..CAP		2
150	2117-197		..SCREW, Damping		2
155	2089-251-1		..HAND ASSY		1
160	2089-251-2		..HAND ASSY		1
165	2089-251-3		..HAND ASSY		1
170	2117-817		..DIAL ATTACHING PARTS		1

-Item Not Illustrated

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FIG. ITEM	PART NUMBER	AIRLINE PART NO.	NOMENCLATURE 1 2 3 4 5 6 7	EFF CODE	UNITS PER ASSY
1-					
175	2103-103		..SCREW		2
			---*---		
180	2117-809		..BRIDGE ASSY		1
			ATTACHING PARTS		
185	S117S2-6		..SCREW		2
190	MS35338-134		..WASHER		2
			---*---		
195	2117-118		..SPRING, Helical		1
200	MS16633-4006		..RING, Retaining (79136)		1
205	2117-208		..SPRING, Torsion		1
210	2117-015		..PAWL		2
215	S143-1		..SHIM		AR
220	2119-860		..ACTUATOR		1
225	S143-2		..SHIM		AR
230	2103-105		..PIN, Taper		2
235	2117-016		..RATCHET ASSY, Minimum		1
240	2117-017		..RATCHET ASSY, Maximum		1
245	2117-012		..INDEX ASSY		1
			ATTACHING PARTS		
250	24D125-4		..SETSCREW		1
			---*---		
255	MS16625-4050		..RING, Retaining		1
260	S102		..BEARING, Ball		1
265	MS16995-2		..SCREW		1
270	AN501D0-3		..SCREW		1
275	2117-225		..SLEEVE ASSY, (Partial Breakdown Follows)		1
280	2117-212		...PIN		1
285	S107-1		..WASHER		2
290	2117-175		..SHAFT, Main		1
295	MS16632-4018		..RING, Retaining (79136)		1
300	24D125-4		..SETSCREW		1
305	2117-180		..SPRING, Helical		1
310	2117-186		..ARM, Mainspring		1
315	S102		..BEARING, Ball		1
320	2117-216		..WEIGHT AND RACK ASSY		1
-325	2117-215		..FRAME AND SLEEVE ASSY		1
330	2119-104		...PIVOT		1
			---*---		

-Item Not Illustrated

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EHF - HDL	O@QS MTL ADQ	@HQKMD O@QS MN-	NOMENCLATURE 0 1 2 3 4 5 6	DEE BNCD	TMR ODQ @RRX
1-					
335	2119-117		...ARM335		1
			ATTACHING PARTS		
340	S373-1		...PIN		1
345	2117-192		...POST		1
350	2117-181		...ANCHOR		1
-355	2117-014		...FRAME ASSY		1
360	2117-194		...SLEEVE		1
365	2117-182		...FRAME		1
370	2119-301		..STOP, Maximum (ATTACHING PARTS)		1
375	24D125-2		..SETSCREW		1
			---*---		
380	2119-302		..STOP, Minimum		1

-Item Not Illustrated



ACCELEROMETER CMM Cross Reference

PART NUMBERS	USE CMM NUMBER (WITH THESE DIFFERENCES)	DESCRIPTION
2094-2	2094-2	MACAIR 68J818004, ABU-4A/A, MIL-A-25949D
2094-5	2094-5	LOCKHEED 673670-101, ABU-4A/A, MIL-A-25949D
2094-6	2094-25 (electrical connector and lighting)	VARIOUS, MS23009, TYPE ABU-4A/A, NSN: 6610-01-049-8747, LOCKHEED 16VF5017-1
2094-7	2094-2	ABU-4/A, MIL-A-25949D
2094-8	2094-25 (electrical connector, dial and lighting)	RAYTHEON BEECH 101-384168-1, TYPE ABU-4A/A
2094-15	2094-25 (electrical connector and lighting)	ABU-4A/A, MIL-A-25949D
2094-16	2094-25 (electrical connector and lighting)	MACAIR (T-45) DA920A0134-1, ABU-4A/A, MIL-A-25949D
2094-17	2094-17-2 (dial)	PILATUS (PC-7) 999.71.11.517, ABU-4A/A
2094-17-2	2094-17-2	PILATUS 999.71.11.518, ABU-4A/A
2094-19	2094-19	PILATUS (PC-9) 999.71.11.519, ABU-4A/A
2094-20	2094-25 (electrical connector and lighting)	MS23009-2, MIL-A-25949D, ABU-4A/A with NVIS LIGHTING

2094-21	2094-21	AERMACCHI, MIL-A-25949D, ABU-4A/A
2094-22	2094-25 (electrical connector, dial and lighting)	RAYTHEON BEECH (JPATS), 101-384168-3, ABU-4A/A
2094-23	2094-23	KAI [DAEWOO] (KT-1), ABU-4A/A, MS23009-2, MIL-A-25949D
2094-25	2094-25	KAI [SAMSUNG] (KTX-2) 85TV0060-1
2094-27	2094-25 (lighting)	AERMACCHI
2100-501	2100	TYPE ABU-6/A, MIL-A-27195
2117-800	2117-800	MS28025-1, TYPE B-6, 6610-00-531-4625, BENDIX 3419-5A-A1
2118 B	2118	TYPE ABU-8A/A, MIL-A-27261
2118-354	2118 (electrical connector and lighting)	SIKORSKY - 101, TYPE ABU-8A/A, MIL-A-27261
2118-360	2118 (electrical connector and coated wedge)	SIKORSKY - 102, TYPE ABU-8A/A, MIL-A-27261
2118-363	2118 (paint)	CASA, TYPE ABU-8A/A, MIL-A-27261
2118-364	2118 (lighting)	LOCKHEED (C-5) W/ NVIS LIGHTING, TYPE ABU-8A/A, MIL-A-27261
2118-365	2118 (calibration and paint)	CASA, TYPE ABU-8A/A, MIL-A-27261
2119-500	2119-500	TYPE MA-1, MIL-A-25719