

MIL-S-3644B  
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SUPERSEDING  
MIL-S-3644A  
3 Jul 1969

## MILITARY SPECIFICATION

## SHAFT ASSEMBLY, FLEXIBLE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 scope. This specification covers a flexible tuning shaft of varying lengths, to be furnished as a complete assembly or as component parts. (See 3.2 and 6.2).

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

\* 2.1.1 Specifications and standards. Unless otherwise specified (see 6.2), the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

## SPECIFICATIONS

## FEDERAL

QQ-A-225/5	Aluminum Alloy Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished, 2017.
QQ-A-250/1	Aluminum 1100, Plate and Sheet.
QQ-N-290	Nickel Plating (Electrodeposited).
QQ-P-416	Plating, Cadmium (Electrodeposited).
PPP-B-601	Boxes, Wood, Cleated-Plywood.
QQ-B-626	Brass, Leaded and Nonleaded; Rod, Shaped Forgings, and Flat Products with Finished Edges (Bar and Strip).
PPP-B-636	Box, shipping, Fiberboard.
TT-S-1732	Sealing Compound, Pipe Joint and Thread, Lead Free, General Purpose.

**Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: the Engineering Division, San Antonio ALC/MMEDO, Kelly AFB, Texas 78241 by using the self addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.**

FSC 3040

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MILITARY

MIL-P-116	Preservation, Methods of.
HIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-F-14072	Finishes for Ground Signal Equipment.

STANDARDS

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-1186	Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; with Appropriate Test Method of.

\* (Copies of specifications and standards required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

\* 2.2 Other publications . The following document(s) form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

NATIONAL BUREAU OF STANDARDS

Handbook H28                      Screw-Thread Standards for Federal Service.

(Application for copies should be addressed to the Superintendent of Documents , Government Printing Office, Washington DC 20402.)

\* AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM B 633                      Zinc on Iron and Steel, Electrodeposited Coating of

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

UNIFORM FREIGHT CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Classification Committee, 202 Chicago Union Station, Chicago, IL 60606.)

\* 2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

\* 3.1 First article. When specified (see 6.2), the manufacturer shall furnish one complete shaft, flexible, tuning assembly for first article inspection- The first article may be either a first article model or an initial production item which conforms to the requirements of this specification. In either case, the approved first article and the production items shall be identical and in accordance with the terms of the contract. Approval of the first article shall not relieve the manufacturer of the responsibility to furnish items in accordance with the requirements of this specification.

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3.2 Component parts. The tuning shaft shall consist of the following parts:

<u>Item</u>	<u>Quantity</u>	<u>Item name</u>
1	1	Casing, of the length specified (see 6.2)
2	1	Shafting, of the length specified (see 6.2)
3	2	Sleeve
4	2	Coupling nut
5	2	Spline assemblies
6	1	Tag

3.3 Material. The material for each part shall be as specified herein. When a definite material is not specified, a suitable material shall be used. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.3.1 Aluminum alloy.

3.3.1.1 Bars and rods. When aluminum-alloy bars or rods are used, the alloy shall conform to QQ-A-225/5.

3.3.1.2 Sheet. When aluminum alloy sheet is used, the alloy shall conform to QQ-A-250/1.

3.3.2 Brass. When brass is used, it shall conform to QQ-B-626.

3.4 Design and construction. The tuning shaft shall conform to the design construction, and physical dimensions shown on figure 1.

3.4.1 Interchangeability. Mechanical interchangeability shall exist between like assemblies, subassemblies, and replaceable parts, regardless of the manufacturer or supplier. Interchangeability for purposes of this paragraph does not mean identity, but requires that a substitution of such like assemblies, subassemblies, and replaceable parts be easily affected without physical modification of any part of the assemblies, including mounting, and without resort to selection.

3.4.2 Casing. The casing shall be of the interlocked type and shall be made from steel strip with asbestos packing. The strip and packing shall be wound together in a spiral so that the strip forms a continuous overlapping joint, the asbestos lying within the joint and being held by crimping the steel strip. The outside diameter of the finished casing shall be 0.335 inch maximum. The inside diameter shall be 0.245 inch minimum.

\* 3.4.2.1 Steel strip. The steel strip shall be not less than 0.010 inch thick and  $0.225 + 0.015$  inch wide, and shall be zinc-plated in accordance with ASTM B 633.

3.4.2.2 Asbestos packing. The asbestos packing shall be 3-ply, 10-cut, or equal.

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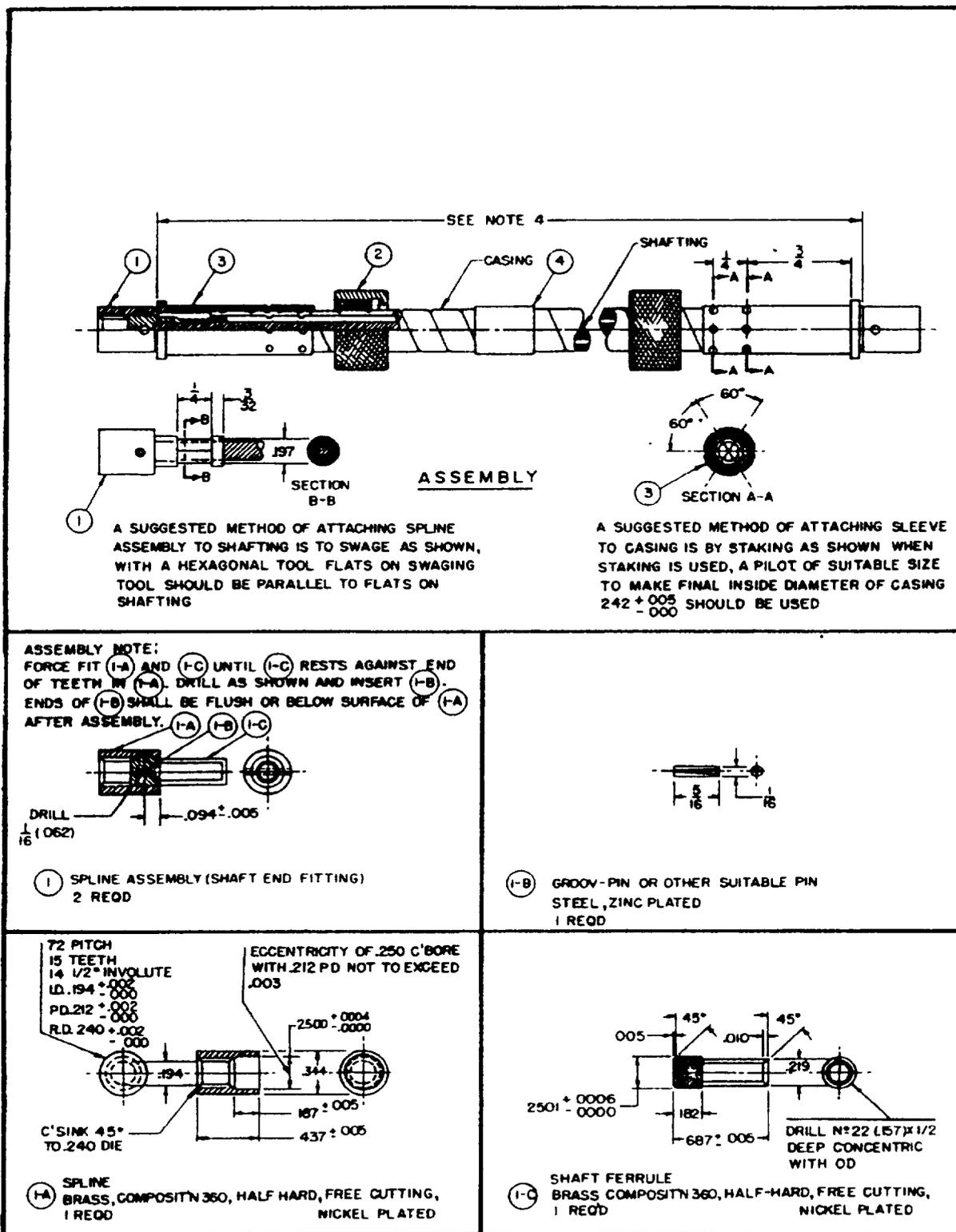


FIGURE 1. Flexible tuning shaft.

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3.4.3 Shafting. The shafting shall be left-lay constructed of at least five layers of steel wire, alternately wound on a mandrel. The outside diameter of the completed shafting shall be 0.150 +0.000 inch,  
-0.005

3.4.3.1 Shafting ends. The ends of the shafting shall be formed cold to a hexagonal cross section, or other means shall be taken to prevent untwisting during rough handling, shipping, et cetera. (See assembly drawing on figure 1).

3.4.4 Sleeve (casing end fitting). The sleeve shall be in accordance with detail 3 on figure 1A.

3.4.5 Spline assembly (shaft end fitting). The spline assembly shall be in accordance with detail 1 on figure 1.

3.4.6 Coupling nut. The coupling nut shall be in accordance with detail 2 on figure 1. Screw-threads shall be of the American National form, in accordance with Handbook H28.

3.4.7 Tag. A tag shown in detail 4 on figure 1A shall be attached to the tuning shaft in the location shown on the assembly drawing on figure 1.

### 3.5 Casing.

3.5.1 Bend. When tested as specified in 4.4.2.1, the casing shall not fail or show permanent deformation or damage of any kind.

3.5.2 Pressure resistance. The casing shall show no evidence of leakage when tested as specified in 4.4.2.2.

3.5.3 Static load. When tested as specified in 4.4.2.3, the casing shall not fail or be damaged in any way.

3.5.4 Push-back. The casing shall withstand a 3/4 inch minimum push-back per foot when tested as specified in 4.4.2.4.

### 3.6 Shafting.

3.6.1 Deflection due to torque. The angular deflecting of the shafting per foot of shafting length shall not exceed 7.0 degrees in either direction when tested as specified in 4.4.3.1.

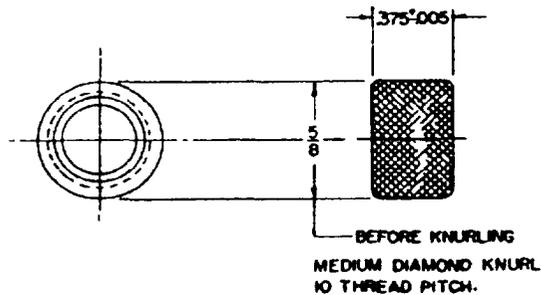
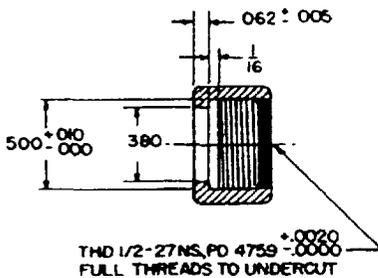
3.6.2 Torque to rotate. The torque required to rotate the shaft shall not exceed 0.12 pound-inch when tested as specified in 4.4.3.2.

3.6.3 Torsional strength. The shafting shall withstand a torque of 8 1/2 pound-inches in both the winding and unwinding directions without breaking or showing permanent deformation when tested as specified in 4.4.3.3. The winding direction is the direction in which the outside winding tightens.

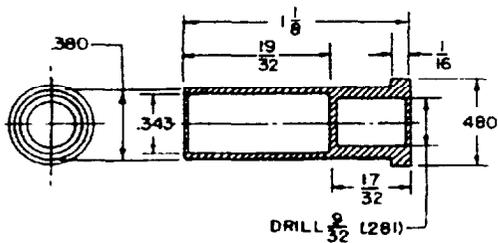
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**NOTES**

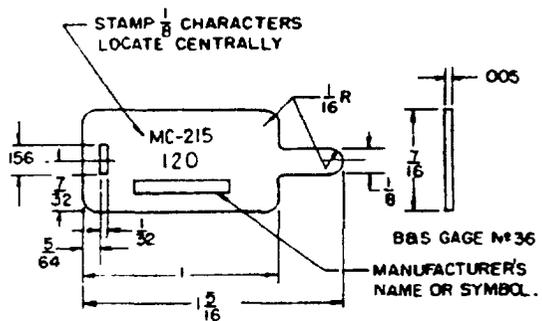
- 1 DIMENSIONS ARE IN INCHES
- 2 TOLERANCES UNLESS OTHERWISE SPECIFIED, FRACTIONAL DIMENSIONS  $\pm 1/64$ , DECIMAL DIMENSIONS  $\pm .002$
- 3 REMOVE ALL BURRS AND SHARP EDGES
- 4 BEFORE ACTUAL CUTTING, AND DURING CUTTING AND HANDLING OF THE SHAFTING, EXTREME CARE SHALL BE USED TO PREVENT UNWINDING OF THE SHAFTING OR INDIVIDUAL STRANDS THEREOF WITH CASING STRETCHED TO MAXIMUM LENGTH, CUT CASING LONGER THAN SHAFTING BY  $3/8$  INCH PER FOOT. PUSH BACK CASING AS REQUIRED TO ASSEMBLE SPLINES TO SHAFTING
- 5 AT ASSEMBLY, COAT SHAFTING WITH GREASE CONFORMING TO MIL-G-23827
- 6 AFTER ASSEMBLY, APPLY THREAD LUBRICANT CONFORMING TO TT-S-1732 (2)
- 7 ASSEMBLY (2) & (3) AT BOTH ENDS OF CASING ATTACH ONE (1) AT ONE END OF SHAFTING (SEE SECTION B-B (1)) AND ASSEMBLE SHAFTING AND CASING, THEN ATTACH OTHER (1) AT UNFINISHED END OF SHAFTING.



- (2) COUPLING NUT  
ALUMINUM ALLOY, 2017, CONDITION T, ANODIZED  
2-REQD



- (3) SLEEVE (CASING END FITTING)  
STEEL, CADMIUM PLATED  
2-REQD



- (4) TAG  
ALUMINUM ALLOY, 1100, 1/2 H  
1 REQ'D

FIGURE 1A. Flexible tuning shaft.

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3.7 Finish. The finish of all parts shall be of the proper thickness for the intended purpose, in accordance with MIL-F-14072. Finishes shall conform to the following specifications as applicable (see figures 1 and 1A):

Anodic coatings, for aluminum and aluminum alloys: MIL-A-8625

Cadmium plating: QQ-P-416

Nickel plating: QQ-N-290

Zinc plating: ASTM B 633

3.8 Marking. The tag shall be permanently and legibly marked with the type and length of the tuning shaft and the manufacturer's name or symbol, as shown in detail 4 on figure 1A. Length shall be represented by a 3-digit number indicating the length of the shaft in inches, as shown in the example on figure 1A.

3.9 Workmanship. Tuning shafts shall be manufactured and workmanlike manner in accordance with good design and sound practice.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. Unless otherwise specified (see 6.2), the inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.2.1).
- b. Quality conformance inspection (see 4.2.2).

\* 4.2.1 First article inspection. First article inspection shall be applied to the first article item or initial production item noted in 3.1. Unless otherwise specified (see 6.2), first article inspection shall consist of the examination in 4.2.3 and all tests under 4.4. Failure of the first article to pass the examination or any of the tests, shall be cause for rejection. The sample shall consist of the following specimens:

- a. One 10 foot shaft assembly, complete.
- b. One 10 foot length of casing.
- c. One 10 foot length of shafting.
- d. One 8 inch length of shafting for "torque to rotate" test.

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- e. Two sleeves.
- f. Two spline assemblies.
- g. Two coupling nuts.
- h. One tag.

4.2.1.1 Test routine. The sample tuning shaft and parts shall be subjected to the first article tests specified in Table I, in the order listed. Failure in any one of the tests will be cause for rejection.

TABLE 1. First article tests

Test	Requirement paragraph	Test paragraph
<b>Test group I - all specimens</b>		
<b>Visual and mechanical inspection</b>	3.3 to 3.4.7, incl. 3.8 and 3.9	4.4.1
<b>Test group II - casing only</b>		
<b>Bend</b>	3.5.1	4.4.2.1
<b>Pressure resistance</b>	3.5.2	4.4.2.2
<b>Static-load</b>	3.5.3	4.4.2.3
<b>Push-back</b>	3.5.4	4.4.2.4
<b>Test group III - shafting only</b>		
<b>Deflection due to torque</b>	3.6.1	4.4.3.1
<b>Torque to rotate</b>	3.6.2	4.4.3.2
<b>Torsional strength</b>	3.6.3	4.4.3.3

4.2.2 Quality conformance inspection. Unless otherwise specified (see 6.2 quality conformance inspection shall be applied to the production units offered for acceptance under the contract. Quality conformance inspection shall consist of a through c as follows, and failure of any unit to pass an examination or test shall be cause for rejection of the unit:

- a. Product examined (see 4.2.3).
- b. Test methods (see 4.4).
- c. Inspection of preparation for delivery (see 4.5).

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4.2.3 Product examination. Unless otherwise specified (see 6.2), each shaft assembly shall be visually examined to determine compliance with requirements of section 3.

4.3 Sampling for inspection. Sampling and inspection shall be in accordance with MIL-STD-105. The acceptance quality level (AQL) shall be as specified in table II.

4.3.1 Test routine. Sample tuning shafts shall be subjected to the tests specified in table II, in the order listed.

TABLE II. Inspection tests.

Test	Requirement paragraph	Test paragraph	Acceptable quality level (AQL)
			Percent defective
Visual and mechanical inspection (complete assembly)	3.3 to 3.4.7 incl., 3.7, 3.8 and 3.9	4.4.1	2.5
Bend (casing only)	3.5.1	4.4.2.1	1.0
Pressure resistance (casing only)	3.5.2	4.4.2.2	2.5
Push-back (casing only)	3.5.4	4.4.2.4	1.0
Deflection due to torque (shafting only)	3.6.1	4.4.3.1	1.0

4.4 Test methods.

4.4.1 Visual and mechanical inspection. Tuning shafts shall be inspected to verify that the materials, design, construction physical dimensions, marking, and workmanship are in accordance with the applicable requirements. (See 3.3 to 3.4.7 incl., 3.7, 3.8 and 3.9).

4.4.2 Casing.

4.4.2.1 Bend. The casing shall be bent into a 180 degree arc having a radius of 3 inches at both room ambient temperature and at -55 centigrade. (See 3.5.1).

4.4.2.2 Pressure resistance. The casing shall be filled with grease until a pressure of 30 to 40 pounds per square inch has been exerted. (See 3.5.2).

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4.4.2.3 Static load. A straight length of the casing shall be subjected to a static load of 125 pounds applied in line with the axis of the casing for a period of 5 minutes (see 3.5.3).

4.4.2.4 Push-back. The casing shall be stretched to its maximum length and measured, then compressed to its minimum straight-line length and measured again (see 3.5.4).

4.4.3 Shafting.

4.4.3.1 Deflection due to torque. A torque of 16 ounce-inches shall be applied to the shafting first in the winding and then in the unwinding direction (see 3.6.1).

4.4.3.2 Torque to rotate. With the 8-inch length of shafting inside a 90 degree bend of 4 inch mean radius, the torque required to rotate the shafting at room ambient temperature and at -55° centigrade, under no load, shall be determined. The bend shall be made of seamless tubing having an inside diameter of 0.25 inch (see 3.6.2).

4.4.3.3 Torsional strength. A load of 8 1/2 pound inches shall be applied to a straight section of shafting in both the winding and unwinding directions for a period of 1 minute in each direction.

NOTE: Torque required to rotate the shafting in swaged area of a lined sleeve must exceed torsion strength of shaft.

4.5 Inspection of the preservation, packaging, packing and marking for shipment and storage. Sample items or packs shall be inspected to determine the preservation, packaging, packing and marking for shipment and storage conform to the requirements of section 5.

\* 5. PACKAGING

5.1 Preservation and packaging. Preservation and packaging shall be level A or C as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning and drying. Tuning shafts shall be cleaned in accordance with process C-1 and dried in accordance with procedure D1 or D4 of MIL-P-116.

5.1.1.2 Unit protection. The tuning shafts shall be preserved at each end of the shaft with P2 preservative in accordance with MIL-P-116, method Ic. The preserved shafts shall then be individually unit packaged in a container conforming to PPP-B-636, class domestic. Tuning shafts 72 inches or less in length shall be placed straight in flat containers with necessary cushioning to prevent damage. Tuning shafts more than 72 inches in length shall be soiled on a wood or fiberboard form or core-mounted in the container. The inside diameter of the coil shall be not less than 24 inches. Suitable cushion material shall be placed in the corners of the container to prevent shifting or kinking of the shaft in transit.

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5.1.2 Level C. Cleaning, drying, preservation and unit protection shall be in accordance with manufacturer's commercial practice.

5.2 Packing. Packing shall be level A, B or C as specified (see 6.2).

5.2.1 Level A. A tuning shaft packaged as specified in 5.1 shall be packed in an overseas type shipping container conforming to PPP-B-601. The container shall be uniform size and shape and minimum tare and cube. Closure and strapping shall be in accordance with the appendix to PPP-B-601.

5.2.2 Level B. Level B packing shall be the same as Level A except that the shipping container shall be domestic type.

5.2.3 Level C. The tuning shaft packaged as specified in 5-1 shall be packed in a manner to insure carrier acceptance and safe delivery at destination. Containers shall be in accordance with Uniform Freight Classification Rules or regulations of other carriers applicable to the mode of transportation.

5.3 Physical protection. Interior cushioning, anchoring, blocking and bracing shall be in accordance with MIL-STD-1186.

5.4 Marking. In addition to any special marking required by the contract or order, interior containers and shipping containers shall be marked in accordance with the requirements of MIL-STD-129.

## 6. NOTES

6.1 Intended use. The tuning shaft covered by this specification is intended for manually-operated remote control of electronic and communication equipment used in aircraft. The tuning shaft is capable of operation in both clockwise and counter-clockwise directions.

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. First article, when required (see 3.1).
- c. Classification of inspection if different (see 4.2).
- d. First article inspection, if different (see 4.2.1).
- e. Quality conformance inspection, if different (see 4.2.2).
- f. Product examination, if different (see 4.2.3).
- g. Selection of applicable level of preservation, packaging, and packing required (see 5.1 and 5.2).

6.2.1 Indirect shipments. The packaging, packing, and marking specified in Section 5 apply only to direct purchases by or direct shipments to the Government and are not intended to apply to contracts or order between the manufacturer and prime contractor.

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6.3 Structural details (suggested).

6.3.1 Casing. Steel for steel strips used in making the casing should have a tensile strength between 45,000 and 50,000 pounds per square inch,

6.3.2 Shafting. Suggested nistruction of shafting is as follows: First layer composed or three wires, second layer, SIX wires; third layer, nine wires; and fourth and fifth layers, ten wires each. Suggested wire is 0.013 inch in diameter, with a tensile strength of 240,000 to 260,000 pounds per square inch.

6.4 Matters relating to tuning shafts furnished in accordance with this specification for use in the design, production, or procurement of equipment, should be referred to the cognizant bureau or service.

\* 6.5 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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(Project 3040-0016)

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**NOTE.** This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

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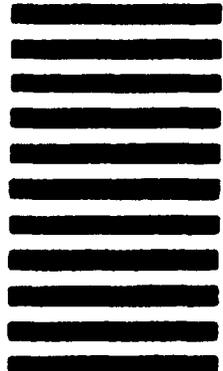
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3b. ADDRESS (Street, City, State, ZIP Code)

## 5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation.

## 6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) - Optional

7b. WORK TELEPHONE NUMBER (Include Code) - Optional

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