MILITARY STANDARD

COMPRESSOR ROTOR BLADES, GAS TURBINE TANK ENGINE, PROCESSING, INSPECTION, AND IDENTIFICATION OF

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DEPARTMENT OF DEFENSE
WASHINGTON, D.C. 20301

Compressor Rotor Blades, Gas Turbine Tank Engine, Processing, Inspection, and Identification of

MIL-STD-1879(AT)

1. This Military Standard is approved for use by US Army Tank-Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: DRSTA-GSS, Warren, MI 48090, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

FOREWORD

This Military Standard establishes the acceptance criteria for the processing, inspection, and identification of gas turbine compressor rotor blades.

The procedures covered by this standard are intended to insure that gas turbine tank engine compressor rotor blades meet all acceptance criteria.

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FIGURES

TABLES

1. SCOPE

1.1 Purpose. Purpose of this standard is to insure gas turbine tank engine compressor rotor blades meet prescribed identification and acceptance criteria.

1.2 Scope. This standard applies to processing, inspection, and identification of wrought AM350 compressor rotor blades and midspan blades.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation bids, or request for proposal, form a part of this standard to the extent specified herein.

SPECIFICATIONS
MILITARY

MIPD-G-62410	- General Heat Treatment.
MIPD-M-62413	- Metal Removal, Electrochemical, Process for.
MIPD-P-62421	- Passivation, Stainless Steel, Process for.
MIPD-V-62427	- Varnish, Synthetic Resin Plus Graphite Lubricant Filler.
MIPD-M-62433	- Magnetic Particle Inspection.
MIPD-S-62448	- Steel, Corrosion and Moderate Heat Resistant (AM 350).

STANDARDS
MILITARY

MIL-STD-852	- Glass Bead Peening Procedures.
MIL-STD-1875(AT)	- Ultrasonic Inspection.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the US Army Tank-Automotive Command, ATTN: DRSTA-GSS, Warren, MI 48090 or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issue in effect on date of invitation for bids or request for proposal shall apply.

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)
SAE Standards and Recommended Practices

AMS 2430	- Shot Peening.
AS 478	- Identification Marking Methods.

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Avenue, Warrendale, PA 15096.)

3. DEFINITIONS

3.1 Glass bead peening. Glass bead peening is a method involving bombardment of small glass beads on a metal surface. Its purpose is to relieve stress, increase fatigue life, shape the peened item and increase resistance to stress corrosion of the metal.

3.2 Glass beads. Glass beads are microscopic spheres of solid, hard, tempered, chemically pure crown glass. The beads range in size from 0.0024 inch in diameter to 0.0661 inch in diameter (see MIL-STD-852).

3.3 Peening machine. Peening machine is an apparatus used to provide propulsion of wet glass beads against the work using air pressure to uniformly move the work through the bead stream in either translation or rotation, or both as required.

3.4 Glass bead slurry. Glass bead slurry is a medium for peening the work. It consists of glass beads in a water medium.

3.5 Peening intensity. Peening intensity is the measurement of arc height as measured on the test strip.

3.6 Arc height. Arc height is the combined height of longitudinal and transverse arcs across standard chords of the test strip.

3.7 Peening lot. A peening lot is a continuous run at a specified intensity. A peening lot shall terminate when peening machine is shut down, or glass bead slurry is replaced.

3.8 Effective bead life. Effective bead life is the time required to reach the maximum number of allowable broken beads.

3.9 Complete coverage. Complete coverage is uniform peening that totally removes the original texture of the surface finish.

3.10 Fatigue life. Number of cycles of stress that can be sustained prior to failure for a stated test condition.

3.11 Passivation. Changing of the chemically active surface of a metal to a much less reactive state.

3.12 Combination symbol. Combination symbol denotes that the source applying this identification shall be responsible for maintaining a record correlating the material heat lot, heat treat lot, and shot peen lot number.

4. GENERAL REQUIREMENTS

4.1 Equipment. The equipment used in the peening process is the following.

4.1.1 Heat treat furnaces. Heat treat furnaces shall be used for the initial heat treatment process of 5.1.1 and the stress relieving process of 5.1.3.

4.1.2 Subzero chamber. Subzero chamber shall be suitable for cooling materials in the heat treatment process. The chamber shall maintain a temperature not warmer than minus 100°F (minus 73°C).

4.1.3 Peening machine. Peening machine (see 3.3) shall be capable of consistently reproducing the peening intensities required, and shall meet the requirements of AMS 2430 and MIL-STD-852.

4.2 Materials.

4.2.1 Glass bead slurry. Glass beads of sizes defined on applicable drawings, shall be used for peening the compressor blades. The beads shall be used in a water slurry consisting of 35 to 45 percent glass beads by volume.

4.2.1.1 Slurry monitoring. The glass bead slurry shall be monitored to insure the uniform spherical shape and the consistency of the slurry in the manner specified herein.

4.2.1.1.1 Frequency. The glass bead slurry shall be sampled and tested for conformance with 4.2.1.1.2 and 4.2.1.1.3 at a frequency which will establish the effective bead life (see 3.8) and the end point of slurry usefulness.

4.2.1.1.2 Slurry sample. A sample of the slurry shall be placed in a burette or calibrating flask, and the sample measured for consistency of glass beads by volume. If the volume falls below the minimum value, additional glass beads may be added to the slurry.

4.2.1.1.3 Broken beads. The glass bead slurry shall be examined to determine the amount of broken beads present in the slurry using an inspection method approved by the acquisition activity. When the amount of broken beads exceeds 20 percent, the slurry shall be discarded.

4.2.1.2 Glass bead slurry replacement. The glass bead slurry shall be discarded and replaced with fresh glass bead slurry when any of the following conditions have been met or exceeded:

(1) One half of the established effective bead life (see 3.8) has been reached.
(2) Broken glass beads exceed the allowable percentage (see 4.2.1.1.3).

4.2.2 Graphite varnish. Graphite varnish shall be as specified in MIPD-V-62427 and used as specified in 5.1.6.

5. DETAILED REQUIREMENTS

5.1 Required processing procedures and operations. The processing procedures shall include, but not be limited to, the following operations in the specified sequence.

5.1.1 Heat treatment. Heat treatment shall include both anneal and final heat treatment processes.

5.1.1.1 Anneal. In-process anneal or anneal prior to the final heat treatment shall be conducted so as not to impair the final microstructure of the material.

5.1.1.2 Final heat treatment. Final heat treatment includes three separate processes: equalizing and overtempering, hardening, and tempering in accordance with M1PD-G-62410.

5.1.2 Machining. Machining shall be completed before stress relieving and surface finishing. Electrochemical machining shall be in accordance with M1PD-M-62413.

5.1.3 Stress relief. After final machining, parts shall be stress relieved. Stress relieving heat treatment may be waived with the approval of the Government.

5.1.4 Passivation. Parts shall be passivated in accordance with M1PD-P-62421, prior to peening.

5.1.5 Glass bead peening. Glass beed peening shall be in accordance with AMS 2430 and MIL-STD-852. Peening areas and intensities shall be indicated on applicable blade drawings, and shall show complete coverage (see 3.9) of those peening areas.

5.1.6 Graphite varnish. When specified on the applicable blade drawing, the root contour shall be coated as specified in M1PD-V-62427.

5.1.7 Identification. Unless otherwise specified on compressor rotor blades drawing, the following information shall be marked on blades in accordance with AS 478, method 30.

a. Part number and revision letter.
b. Vendor identification (eg: trademark, symbol, or other approved marking).
c. Required inspection stamp. As an alternate method, the parts may be boxed, and the box or accompanying paperwork marked with the appropriate symbol.

5.1.7.1 Alternate marking. Alternate marking shall be electrolytically marked in accordance with AS 478, method 6A, within the following limitations:

a. On the concave surface of the airfoil.
b. On the upper three quarters of the airfoil.
c. Outside the designated area (see figures 1 and 2).

5.1.7.2 Additional marking. Unless otherwise specified on compressor rotor blade drawing, additional marking shall be applied as follows:

a. Material symbol. When the diamond shaped mark ( ) for blade material is specified on the blade drawing, the mark shall be applied in accordance with AS 478, method 2C1 or 2D1.

b. Heat number. The material heat lot and heat treat lot numbers shall be marked on the bottom of the blade root in accordance with AS 478, method 2C1 or 5B1.

c. Shot peen number (glass bead). The shot peen lot number shall be marked on the bottom of the blade root in accordance with AS 478, method 2C1 or 5B1.

Note: When agreed upon between the Government and the contractor, shot peen lot identification may be omitted from root of blade. However, a record shall be maintained correlating part number, date, shot peen lot number, and heat lot number.

d. Combination symbol. When a combination symbol (see 3.12) is used in place of the material heat lot, heat treat lot, and shot peen lot numbers, the combination symbol shall be marked on the bottom of blade root in accordance with AS 478, method 2C1 or 5B1.

5.2 Inspections. Inspections shall include visual and ultrasonic examinations and destructive tests.

5.2.1 Visual inspection. Blades shall be visually examined to verify conformance to the acceptance criteria specified herein.

5.2.1.1 Magnified inspection of peened surfaces. Magnified inspection shall be performed at 3.5x to verify the specified acceptance criteria.

5.2.1.2 Microscopic edge inspection. Microscopic examination of leading and trailing edges of the blades shall determine conformance to acceptance criteria specified herein.

5.2.2 Ultrasonic inspection. Ultrasonic examination shall be performed to detect imperfections in the leading and trailing edge of the blades. Ultrasonic inspection shall only be incorporated when specified on applicable compressor rotor blade drawings and with prior approval of the Government.

5.2.3 Destructive testing. Destructive testing shall be performed to determine conformance to the material acceptance criteria specified herein.

5.2.4 Designated and undesignated areas. The designated and undesignated areas for purpose of inspection shall be in accordance with figures 1 and 2.

5.3 Acceptance criteria.

5.3.1 Material properties. Material properties of the blades and midspans shall conform to MIPD-S-62448 and as specified herein.

5.3.1.1 Hardness. The hardness shall meet the requirements of applicable compressor rotor blade engineering drawings.

5.3.1.2 Fatigue life (beehive rig). When the sample blade is vibrated to its natural frequency at the stress level specified in table I, the blade shall not fail in less than the number of cycles specified in table I. Blade failure shall be determined by a drop in the natural frequency of 10 cycles per second. In the event of failure, the lot of blades represented by the sample shall be subject to rejection.

TABLE I. Fatigue life parameters.

Natural Frequency (Hz)	Test Stress Level (psi)	No. of Test Cycles (minimum)
201-500	109,000	150,000
501-1200	105,000	300,000
1201-3500	101,500	850,000

5.3.2 Imperfections. Cracks, folds, laps and bursts shall not be acceptable in any area of the blade.

5.3.3 Indications. Depressions, indentations free of foreign material, and angular intersections shall be acceptable in undesignated areas within the following limits:

a. Maximum dimension - 0.020 inch.

b. Maximum depth - 0.002 inch.

c. The distance of closest approach - 0.13 inch or greater.

d. Linear type indications not to deviate more than 20° from the radial direction of the blade.

e. A maximum combined total of six (6) nonmetallic indications for any one part shall be as follows:

(1) Two (2) indications greater in size than 0.020 inch but not exceeding 0.13 inch maximum dimension.

(2) Six (6) indications not exceeding 0.020 inch maximum dimension.

(3) Distance of closest approach 0.13 inch or greater.

(4) Indications not to deviate more than 20° from the radial direction of the blade.

5.3.4 Blends. Blended areas of the midspan blades shall be acceptable within the limits specified in table II and figure 3.

TABLE II. Acceptance criteria for blends.

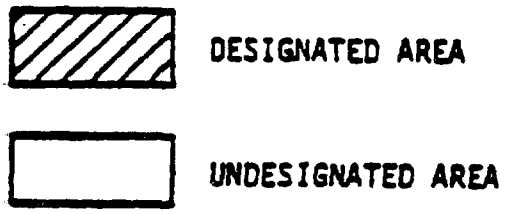
Blade area	Acceptance criteria
Pressure angle	Positives - Permitted within engineering drawing tolerances. Negatives a. Depth - 0.002 inch max. b. Width - 0.020 inch max. c. Length - 0.050 inch max. d. Distance of closest approach - 0.100 inch min. e. Not more than 3 per side.
Root platform and midspan shroud	Overblend of 0.005 inch max depth below engineering drawing contour is acceptable.
Airfoil to midspan and airfoil to root platform radii	Smooth overblends of 0.001 inch max depth below engineering drawing contours are acceptable.
Airfoil surfaces	a. Overblends of 0.001 inch max depth below engineering drawing contours are acceptable. b. Max dim. - 0.200 inch.

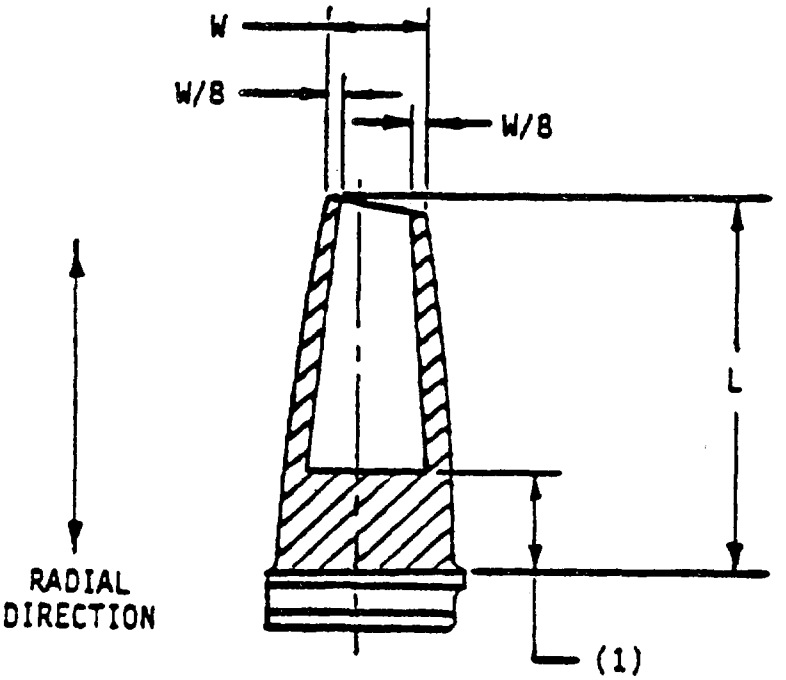
Notes:

(1) See figure 3 for blade areas.

(2) Negatives must be inspected using an indicator, not a straight edge.

5.3.5 Leading and trailing edge contours. The blade and vane leading and trailing edge contours shall conform to engineering drawing. Unacceptable contours are illustrated in figure 4.



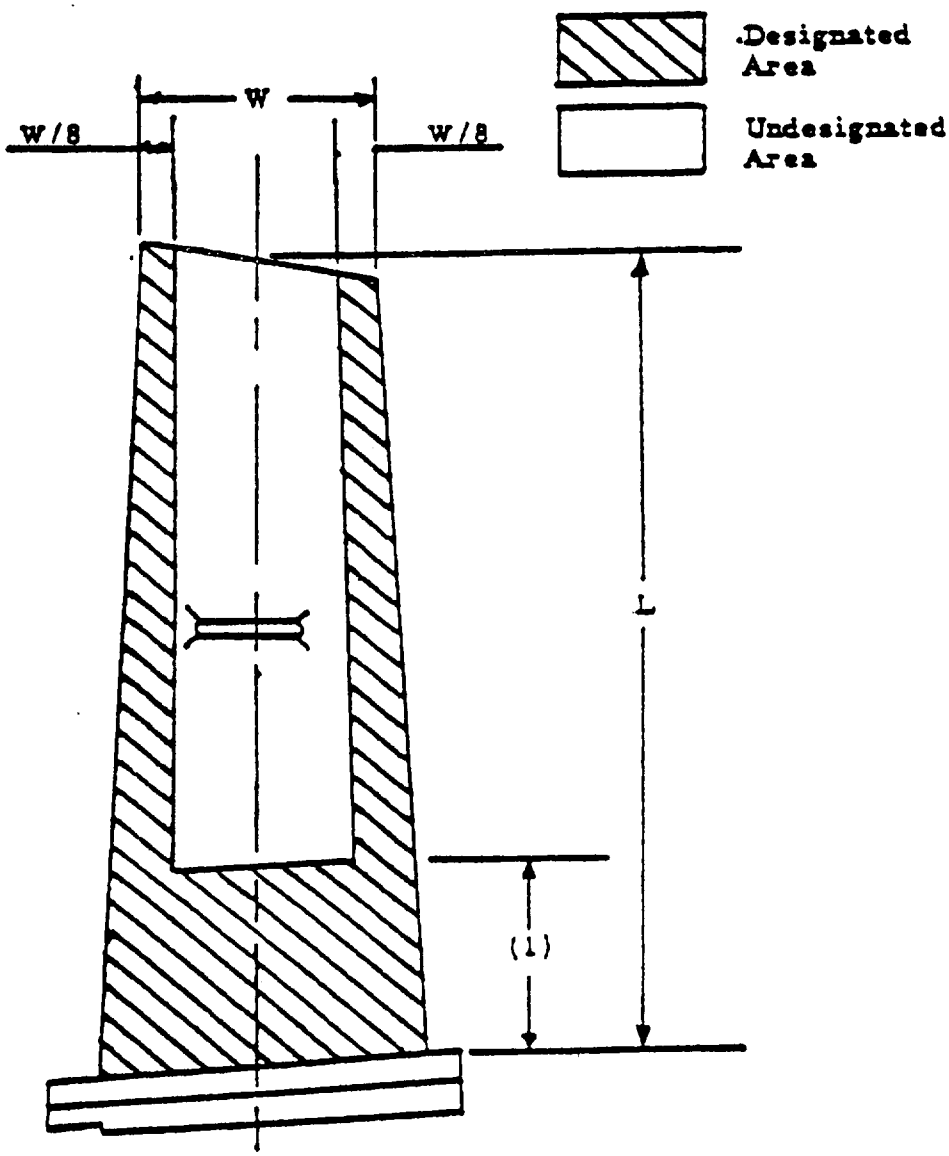


NOTES:

(1) The designated area shall be L/4 or 0.25 inch whichever is greater.

(2) Figure applies to both concave and convex surface.

FIGURE 1. Designated and undesignated area of a typical blade.



NOTES:

(1) The designated area shall be L/4 or 0.25 inch, whichever is greater.

(2) Figure applies to both concave and convex surfaces.

FIGURE 2. Designated and undersignated area of a typical midspan blade.

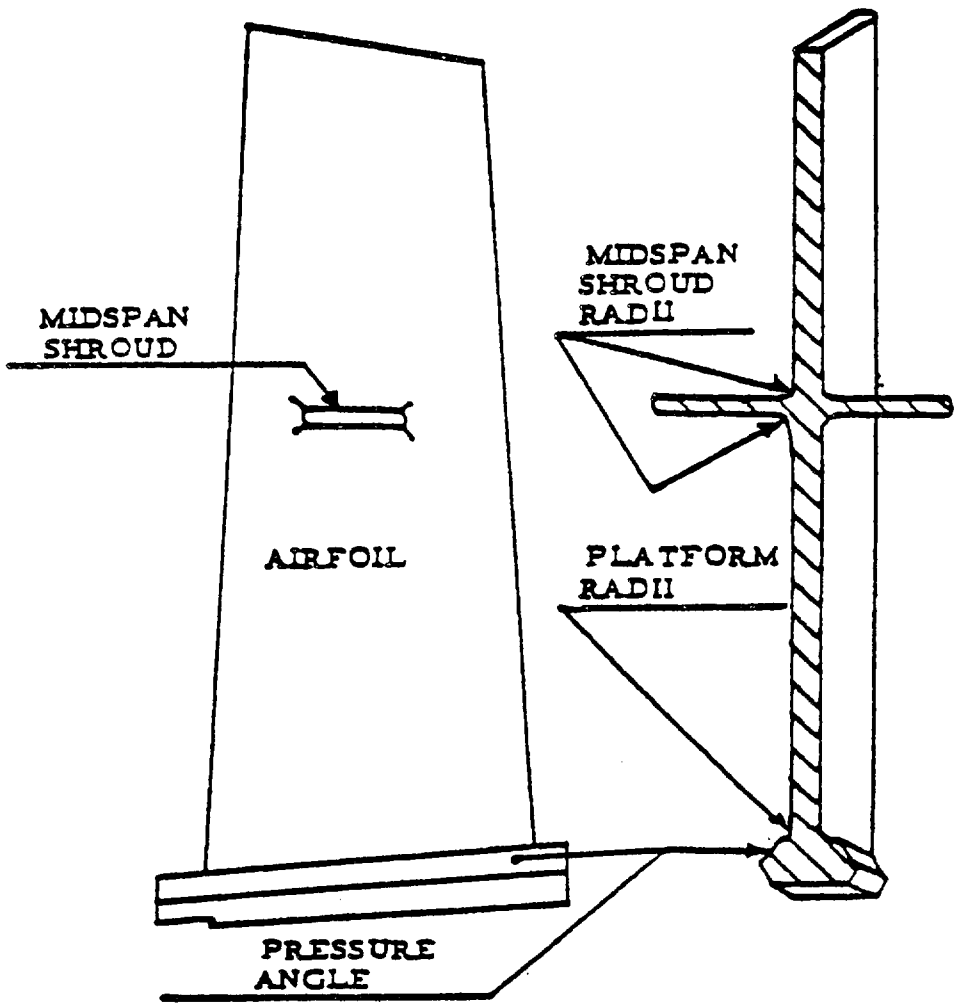


FIGURE 3. Definition of blade areas.

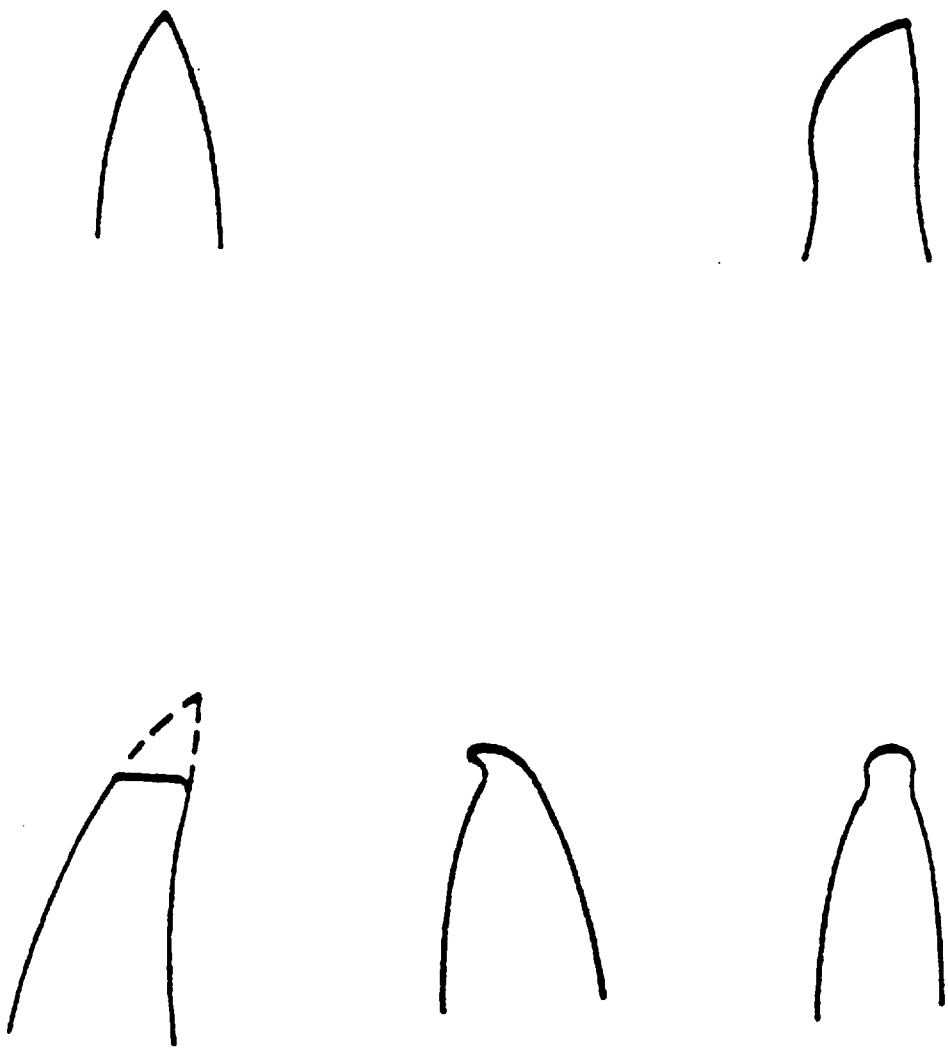


FIGURE 4. Unacceptable leading or trailing edge contours.

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