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AEROSPACE MATERIAL SPECIFICATION

AMS 2440

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Revised

INSPECTION OF GROUND, CHROMIUM PLATED STEEL PARTS

1. SCOPE:

1.1 Purpose: This specification covers the requirements, procedures, and accept/reject criteria for inspecting ground chromium plated surfaces for grinder-induced damage to the chromium plate and substructure.

1.2 Application: Primarily for nondestructive testing of heat treated, high strength, 180,000 psi (1240 MPa) or higher tensile strength, low-alloy steel parts which have been chromium plated and subsequently ground.

1.2.1 It is possible to have areas of overheated chromium plate without damage to the substrate. Overheating sufficient to damage the substrate will be exhibited by indications in the ground chromium plated surface.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Materials Specifications (AMS) shall apply. The applicable issue of other documents shall be specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2640 - Magnetic Particle Inspection
AMS 2645 - Fluorescent Penetrant Inspection
AMS 3041 - Magnetic Particles, Wet Method, Oil Vehicle
AMS 3042 - Magnetic Particles, Wet Method, Dry Powder
AMS 3044 - Magnetic Particles, Fluorescent, Wet Method, Dry Powder
AMS 3045 - Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle
AMS 3155 - Oil, Fluorescent Penetrant, Solvent Soluble
AMS 3157 - Oil, Fluorescent Penetrant, High Fluorescence, Solvent Soluble
AMS 3161 - Oil, Inspection, Odorless, Heavy Solvent

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2.2 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.2.1 Military Specifications:

MIL-I-6866 - Inspection, Penetrant, Method of
MIL-I-25135 - Inspection Material, Penetrant

2.2.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-867 - Temper Etch Inspection

2.3 ASNT Publications: Available from American Society for Nondestructive Testing, 4153 Arlington Plaza, Columbus, OH 43221.

SNT-TC-1A - Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing

3. TECHNICAL REQUIREMENTS:

3.1 Materials:

3.1.1 Magnetic particle materials shall consist of an odorless inspection oil conforming to AMS 3161 and magnetic particles conforming to AMS 3041, AMS 3042, AMS 3044, or AMS 3045 as applicable.

3.1.2 Fluorescent penetrant materials, emulsifiers, and developers shall have high sensitivity and shall conform to the requirements of AMS 3157 or MIL-I-25135, Group VI, or better. High sensitivity AMS 3155 or MIL-I-25135, Group V, penetrants may be used provided equivalent sensitivity to the Group VI penetrant can be demonstrated in side-by-side tests using MIL-I-25135 cracked panels or equivalent. For such demonstrations, both penetrants shall be used with non-aqueous wet developer.

3.2 Equipment and Lighting: Equipment and lighting shall meet the requirements of AMS 2640, AMS 2645, or MIL-I-6866 as applicable.

3.3 Preparation of Parts:

3.3.1 Steel parts shall have been temper etch inspected in accordance with MIL-STD-867 and magnetic particle inspected in accordance with AMS 2640 for damage prior to plating.

3.3.2 All ground chromium plated parts shall be cleaned and dried to remove lubricants, grease, oil, coolants, soaps, alkalies, and other substances which would interfere with inspection. Vapor degreasing, hand wiping, or both, with a clean solvent such as acetone, methyl-ethyl-ketone or 1,1,1 - trichloroethane are suitable for this purpose.

3.4 Ground Parts: Parts shall be fluorescent penetrant inspected in accordance with AMS 2645 or MIL-I-6866 after all plating and grinding operations and then magnetic particle inspected in accordance with AMS 2640. Parts shall be free of defects indicative of abusive grinding, plating induced damage, or both.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Fluorescent Penetrant Inspection: Shall be accomplished only by inspectors qualified in penetrant inspection and certified to SNT-TC-1A, Level II. Questionable indications shall be resolved by a Level III penetrant inspector.

4.1.1 Each part shall be fluorescent penetrant inspected in accordance with AMS 2645 or MIL-I-6866 as follows, using materials specified in 3.1.2 and equipment specified in 3.2.

4.1.1.1 Examine part under black light without developer for mud-cracks and grinder-induced damage utilizing the criteria of 4.1.2 and Figs. 1 through 8.

4.1.1.2 Apply non-aqueous developer.

4.1.1.3 Repeat inspection under black light as in 4.1.1.1.

4.1.2 Acceptance Criteria:

4.1.2.1 Mud-Cracking:

4.1.2.1.1 Mud-cracking in chromium plate is not invariably indicative of abusive grinding (See Fig. 1) and, consequently, is not always a rejectable penetrant indication. Mud-cracking due to grinding is always rejectable except when permitted by the drawing.

4.1.2.1.2 When crack indications are in chromium runout areas, or areas designated on the drawing where imperfect chromium is acceptable, the part may be accepted provided magnetic particle inspection verifies that no cracks exist in the substrate.

4.1.2.1.3 If there is a directional quality to the mud-crack pattern, where it occurs in bands or spirals (See Fig. 2), it is a clear indication of abusive grinding and is unacceptable.

4.1.2.2 Crazed Surface: A more closely knit network of smooth microcracks normally present in chromium plating is acceptable. Generally this pattern cannot be resolved with the unaided eye and appears as a crazed surface on the chromium plating. Figs. 3 and 4 illustrate the difference between mud-cracks and microcracks.

4.1.2.3 Spiraling and Banding: A part is unacceptable if a clear grinder pattern consisting of spirals, bands, or chatter marks (interrupted spirals or bands) is evident (See Fig. 5). A combination of two or more patterns may be superimposed and cover the entire ground surface or any portion of it.

4.1.2.4 Plunge: Abusive plunge grinding is indicated by patterns like spiraling and banding except that they form a single band of constant width. Figs. 6 and 7 illustrate severe plunge grinding resulting in unacceptable damage to the steel substrate adjacent to a radius.

4.1.2.5 Extraneous Indications: Sometimes scratches or wear patterns are shown by fluorescent penetrant inspection. Such patterns are not rejectable but caution shall be exercised to distinguish between patterns on undamaged chromium and patterns indicating chromium damage. Using the procedures outlined herein, reclean and reinspect as required for resolution. Fig. 8 illustrates some extraneous patterns compared with patterns indicative of abusive grinding.

4.2 Magnetic Particle Inspection: Each part acceptable by fluorescent penetrant inspection shall be magnetic particle inspected. Inspection shall be accomplished by inspectors qualified in magnetic particle inspection and certified to SNT-TC-1A, Level II. Questionable indications shall be resolved by a Level III magnetic particle inspector.

4.2.1 Magnetic particle inspect each part in accordance with AMS 2640 as follows, using materials as in 3.1.1 and equipment as in 3.2.

4.2.1.1 A petroleum distillate liquid vehicle with a fluorescent paste suspension or black oxide suspension shall be used.

4.2.1.2 Under the required lighting (black light for fluorescent suspension or white light for black oxide suspension), examine the part for grinder or plating-induced damage, or both, utilizing the acceptance criteria of 4.2.2.

4.2.1.3 Care shall be exercised during magnetic particle inspection of ground chromium plated surfaces to ensure that indications are not washed off by suspension oil flowing down the part. Multiple applications of current (one following right after another) shall be used to reduce the danger of washing off indications.

4.2.1.4 Carefully evaluate all indications to ensure that they are the results of plating or grinding-induced damage. Magnetic particle inspection can induce extraneous indications such as magnetic writing, flow lines, etc.

4.2.1.5 The effectiveness of magnetic particle inspection of a steel substrate through the chromium plate is limited by the thickness of the plate.

4.2.1.6 Fig. 9 illustrates some typical indications of cracks in the steel substrate as revealed by magnetic particle inspection of a chromium plated part damaged during grinding of the chromium.

4.2.2 Evaluation Procedure: Parts showing suspected indications shall be wiped free of magnetic medium. The magnetic particle inspection shall be repeated and, if the indications remain, exploration of the defect indications shall be made in accordance with the following:

4.2.2.1 Burnish or polish suspected areas with fine, 220 grade or equivalent, abrasive paper.

4.2.2.2 Demagnetize the part.

4.2.2.3 Reapply magnetic medium and magnetic field and reexamine.

4.2.2.4 If the indications remain, the part is unacceptable.

4.3 Post Inspection Requirements: The chromium plate on parts shall be inspected for conformance to the applicable drawing and specification dimensional and surface finish requirements. Parts not meeting dimensional and surface finish requirements are not acceptable.

4.4 Reworking: Rejected parts may be stripped, temper etch inspected in accordance with MIL-STD-867, and magnetic particle inspected in accordance with AMS 2640 prior to replating when approved by the cognizant engineering authority.

4.5 Reports: The vendor shall report for each shipment, on an appropriate form, the type of penetrant, emulsifier, and developer used, the process and type of magnetic substance used, the magnetizing procedure (including the magnetizing current used and a description of the method used for determining the adequacy of this magnetization level), and the number of parts inspected. This report shall also include a statement that all parts in the shipment conform to the standards specified by purchaser.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Parts which have satisfactorily passed this inspection process shall be individually packaged and the package marked to indicate conformance. Packaging shall conform to 5.2.1.

5.2 Packaging:

5.2.1 Parts shall be packaged in such a manner as will ensure that the required physical characteristics and properties of the plating are preserved.

5.2.2 Containers of packaged parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.2.1 and 5.2.2 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts not conforming to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 Procedures meeting the requirements of this specification have been classified under Federal Standardization Area Symbol "NDTI".

This specification is under the jurisdiction of AMS Committee "B".

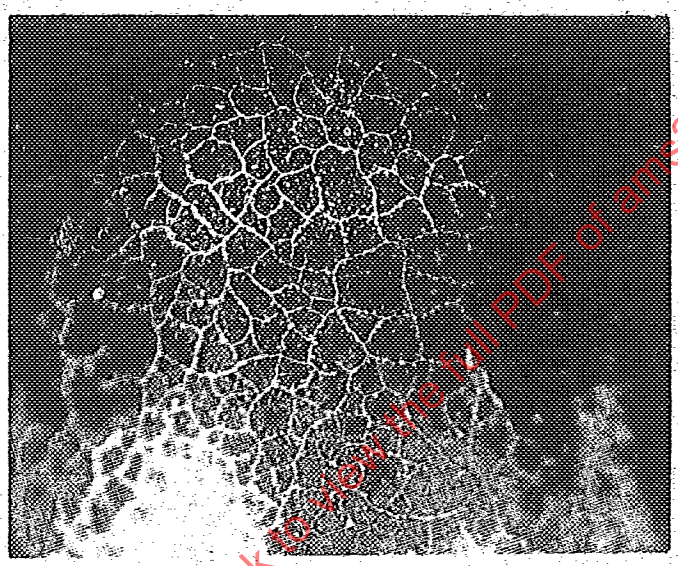
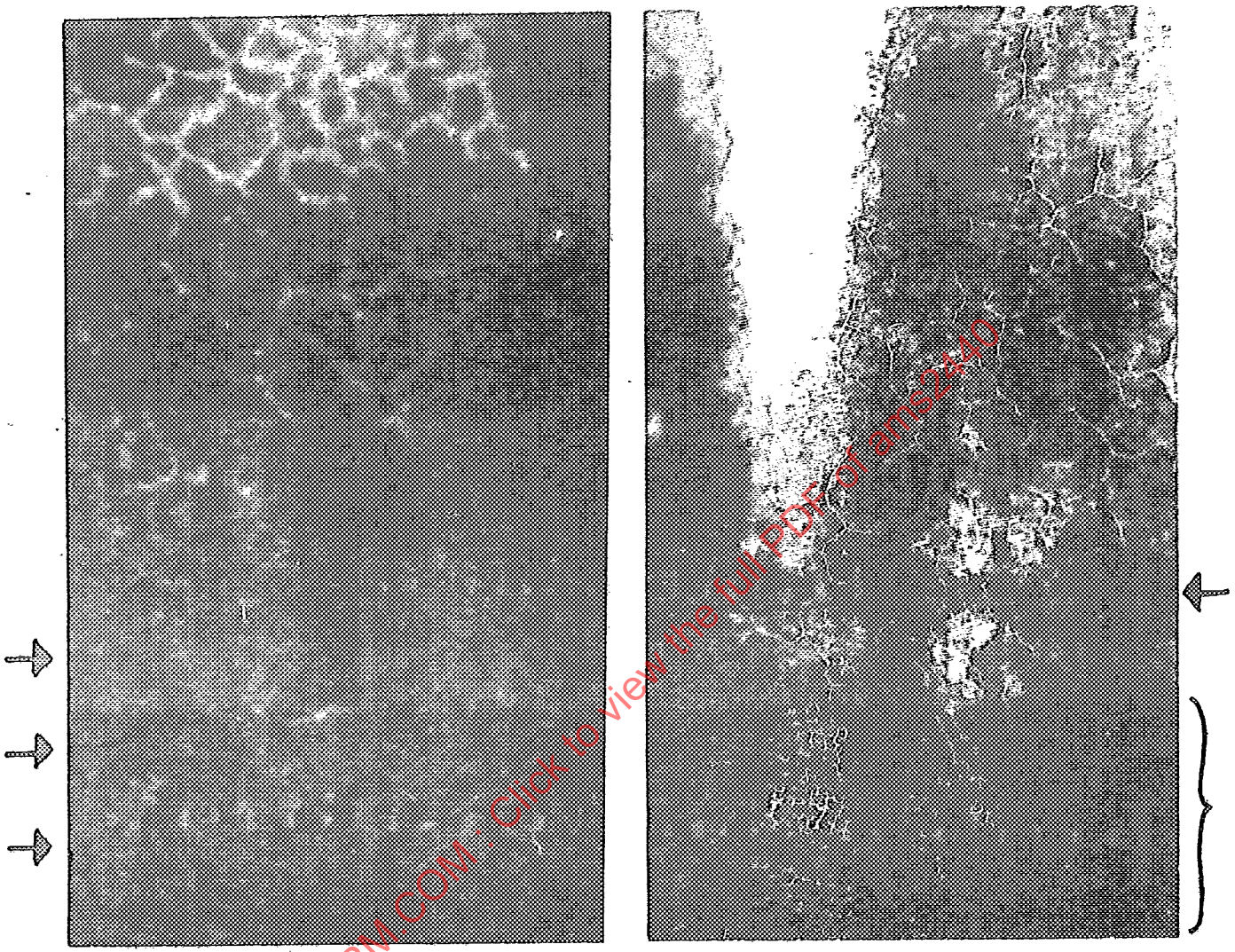


FIGURE 1

Fluorescent penetrant inspection of an as-plated cylindrical specimen (photographed in black light) reveals cracks resulting from plating stresses. The photo illustrates the fact that mud-cracking is not necessarily the result of abusive grinding.

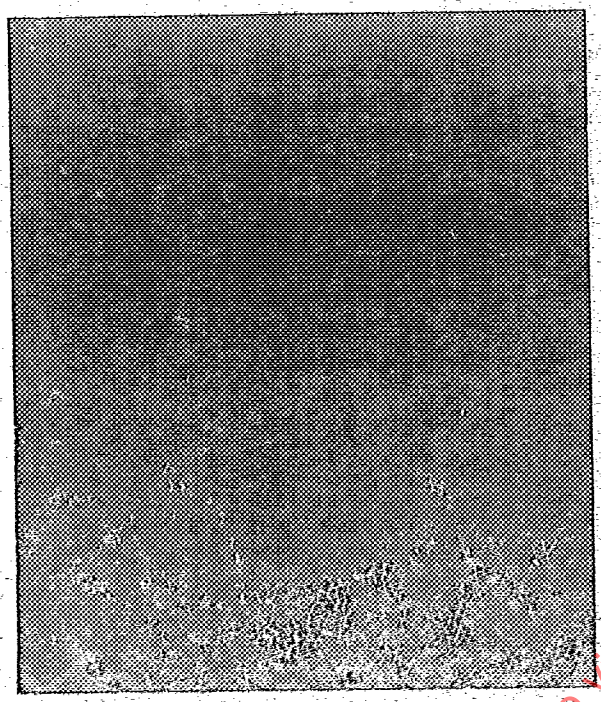


A 3X B 3X

FIGURE 2

A. An abusively ground specimen, photographed during fluorescent penetrant inspection in black light, shows typical grinder-induced pattern present on an abusively ground surface.

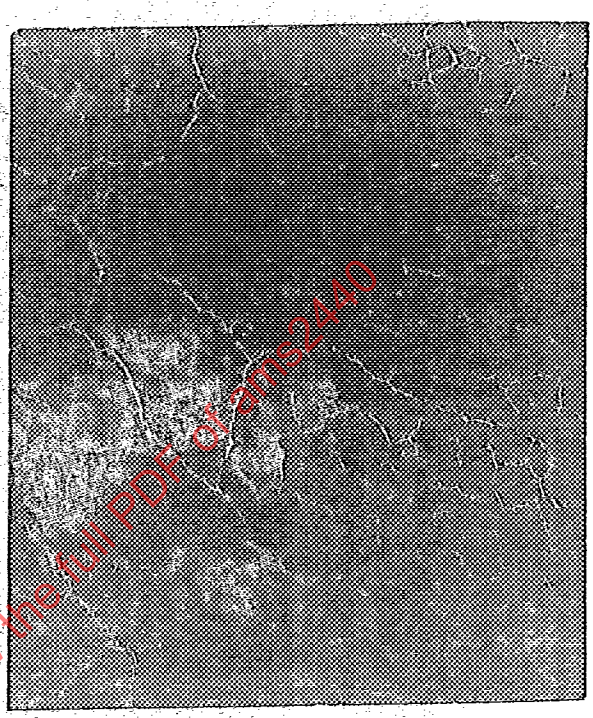
B. The same view of the specimen, with the penetrant developer removed, in order to reveal the exact nature of the rejectable indications in the grinder-induced pattern.



10X

FIGURE 3

The nature of micro-cracking revealed in this enlarged black light photograph of a specimen during fluorescent penetrant inspection shows the acceptable condition designated as a crazed surface.



10X

FIGURE 4

This photo compares the unacceptable condition designated "Mud-cracking" in a grinder pattern (left side of photo) with the crazed surface indication of Fig. 3.

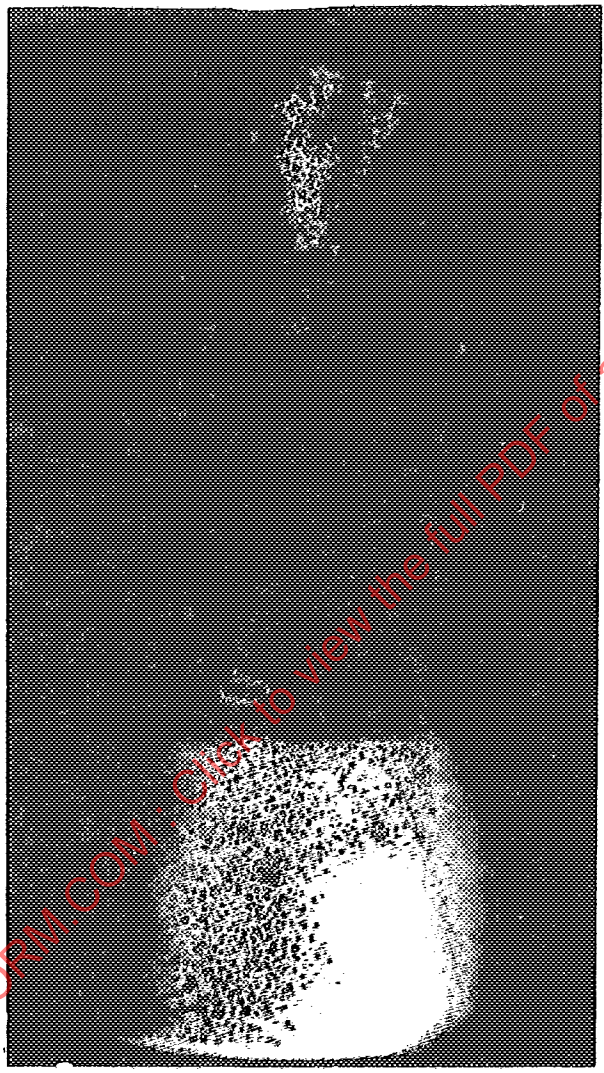


FIGURE 5

Abusive grinding of a chromium plated cylindrical part. Spiraling, banding, and plunge grinding indications are all illustrated on this part. Photographed under black light during fluorescent penetrant inspection.

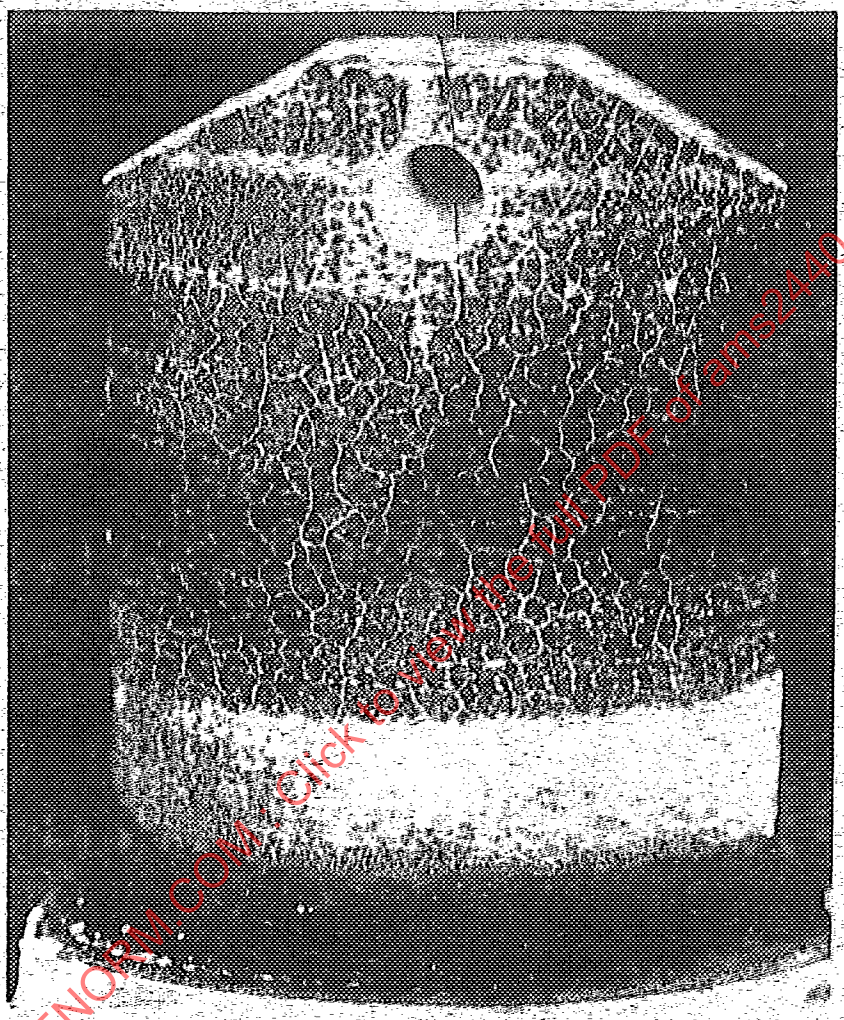


FIGURE 6

Fluorescent penetrant inspection of an abusively ground part reveals mud-cracking and banding indications. See Fig. 7.