

**MIL-S-18732D**

1 MARCH 1968  
 SUPERSEDING  
 MIL-S-18732C  
 16 August 1968

**MILITARY SPECIFICATION**

# STEEL BARS, WIRE, FORGING STOCK, FORGINGS, TUBING (431), SPECIAL QUALITY

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

**1. SCOPE**

1.1 **Scope.** This specification presents requirements for a special quality of type 431 corrosion-resistant steel.

Fed. Std. No. 188 — Continuous Identification Marking of Iron and Steel Products

**2. APPLICABLE DOCUMENTS**

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

**MILITARY**

MIL-STD-129 — Marking for Shipment and Storage

MIL-STD-163 — Steel Mill Products, Preparation for Shipment and Storage

MIL-STD-753 — Corrosion - Resistant Steel Parts, Sampling, Inspection and Testing for Surface Passivation

**SPECIFICATIONS****MILITARY**

MIL-H-6875 — Heat Treatment of Steels (Aircraft Practice, Process for)

**STANDARDS****FEDERAL**

Fed. Std. No. 48 — Tolerances for Steel and Iron Wrought Products

Fed Test Method Metals, Test Std. No. 151 — Methods

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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

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*Society of Automotive Engineers, Inc.*  
*(Aerospace Material Specification)*

**AMS2303 — Aircraft Quality Steel  
Cleanliness**

(Application for copies of the above publication should be addressed to the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York, N. Y. 10017)

*Uniform Classification Committee*

**Uniform Freight Classification Rules**

(Application for copies of the above publication should be addressed to the Uniform Classification Committee, 202 Chicago Union Station, Chicago, Ill 60606)

**3. REQUIREMENTS**

**3.1 Chemical composition.** The chemical composition shall be as specified in table I.

TABLE I Chemical composition

Element	Percent	Check analysis tolerance (percent) <sup>1</sup>
Carbon	-0.13-0.17	0.01
Manganese	-0.30-0.80	.03
Silicon	-0.20-0.60	.05
Phosphorous	-0.040 (max)	.005
Sulfur	-0.030 (max)	.005
Chromium	15.50-16.50	.20
Nickel	-2.00-3.00	.07
Molybdenum	-0.25 (max.)	.03
Nitrogen	-0.10 (max.)	.01
Iron	Balance.	—

<sup>1</sup>Individual determinations may vary above or below the specified range to the extent shown in the check analysis column, except that elements in any heat shall not vary both above and below the specified range

**3.2 Quality.** All material supplied under this specification shall be magnetic particle inspected in accordance with the requirements of AMS2303 and shall comply with the frequency and severity limits specified therein.

**3.2.1 Microstructure.** After heat treatment to the HT-125 condition, materials shall not exhibit banding or segregation in excess of the limits of 3.2.1.1 or 3.2.1.2,

respectively. The limits apply to all fields of longitudinal sections of specimens shown in figures 1 and 2 and when examined at 250 diameters magnification.

**3.2.1.1 Free ferrite.** Material shall not contain banded free ferrite in excess of that indicated by figure 3. Blocky ferrite, not banded, shall not exceed 4 percent. Unacceptable microstructure containing excessive banded free ferrite is shown on figure 4.

**3.2.1.2 Retained austenite.** Material shall not contain banded retained austenite in excess of amount shown in figure 5. Figures 6 and 7 represent unacceptable microstructures. Blocky austenite, not banded, is permitted.

**3.3 Condition (as a product).** The material shall be furnished annealed, or otherwise heat treated to a hardness range of Brinell 229-302 (excluding forging stock).

**3.3.1 Surface condition.**

**3.3.1.1 Bar and forging stock, round.** Surfaces shall be ground or rough turned.

**3.3.1.2 Bar and forging stock, rectangular.** Surfaces shall be hot-rolled and free from scale. Slight surface imperfections which are removable within half the specified tolerances will not be cause for rejection.

**3.3.1.3 Tubing.** Surface imperfections such as handling marks, straightening marks, light mandrel and die or roll marks, shallow pits, and scale pattern will not be cause for rejection, provided the imperfections are removable without reducing the diameter or wall thickness of the tubing below the permissible tolerance limits. Imperfections shall be removed by grinding or buffing, except when the imperfections are open so that the root areas are visible to the unaided eye and the surfaces blend smoothly into the normal surfaces of the tubing.

**3.3.1.4 Wire.** Surfaces shall be cold drawn, ground, polished or pickled.

**3.3.2 Grain size.** Grain size shall be No. 3 or finer, as indicated in supplement A, Federal Test Method Standard No. 151, when tested in the HT-125 condition (excluding reforcing stock).

**3.4 Response to thermal treatment.** When heat treated as specified herein, the material shall develop the properties specified in table II.

**3.4.1 HT-200 condition.** HT-200 is achieved by (1) quenching in oil at  $52^{\circ} \pm 6^{\circ}$  C ( $125^{\circ} \pm 10^{\circ}$  F) from  $1,020^{\circ} \pm 14^{\circ}$  C ( $1,875^{\circ} \pm 25^{\circ}$  F); (2) cooling to room temperature in water; (3) soaking at  $-73^{\circ}$

$\pm 11^{\circ}$  C ( $-100^{\circ} \pm 20^{\circ}$  F) in a suitable refrigerant for 2 hours; (4) tempering at  $288^{\circ} \pm 14^{\circ}$  C ( $550^{\circ} \pm 25^{\circ}$  F) for 2 hours; and (5) retempering at  $288^{\circ} \pm 14^{\circ}$  C ( $550^{\circ} \pm 25^{\circ}$  F) for 2 hours.

**3.4.2 HT-125 condition.** HT-125 is achieved by quenching in vigorously agitated oil (Houghton  $\pm 2$  or oil of equivalent H value) at  $52^{\circ} \pm 6^{\circ}$  C ( $125^{\circ} \pm 10^{\circ}$  F) from  $1,024^{\circ} \pm 8^{\circ}$  C ( $1,875^{\circ} \pm 15^{\circ}$  F), cooling to room temperature in water, tempering at  $635^{\circ} \pm 14^{\circ}$  C ( $1,175^{\circ} \pm 25^{\circ}$  F) for 3 hours, and air cooling to room temperature. This heat treatment is used to provide maximum contrast for microstructure evaluation (see 3.2.1 and 4.5.2).

TABLE II Mechanical properties

Direction of testing and condition <sup>1</sup>	Ultimate tensile strength minimum (psi)	Yield strength at 0.2 percent offset or at extension indicated (E 28,000,000) minimum 2-inch gage		Elongation in 4 diameters (minimum percent)	Reduction of area (minimum percent)
		(psi)	Length (in)		
Longitudinal HT-200	200,000	150,000	0.0150	10	40

<sup>1</sup> Specimens shall have a minimum diameter of 0.250 inch

### 3.5 Dimensions and tolerances.

**3.5.1 Diameter or thickness.** Variations of measured dimensions from ordered dimensions shall be within the tolerance limits specified in Federal Standard No. 48.

**3.5.2 Exact lengths.** Bars of all sizes may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit, with tolerances as specified in table titled "Stainless and Heat Resisting Steels, Hot Rolled Bars, Length Tolerances" of Federal Standard No. 48.

**3.5.3 Mill lengths.** When exact or multiple lengths are not ordered, bars will be accepted in mill lengths of 8 to 20 feet, but not more than 10 percent of any order shall be fur-

nished in lengths shorter than 10 feet.

**3.6 Identification of product.** Bars shall be marked in accordance with Federal Standard No. 183. The following marking items shall be included in the legend:

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Heat number

Manufacturer's name or identifying trademark.

**3.6.1 Bars and wire smaller than  $\frac{1}{2}$  inch in diameter or  $\frac{3}{8}$  inch in width of flat shall be tagged with the above information at each bundle end and with an extra tag included in the bundle**

**3.7 Workmanship.** Material shall be sound and of uniform condition, smooth, clean, and

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free from scale and injurious defects such as cracks, seams, tears, grooves, laminations, pits, and blisters. Slight surface imperfections which are removable within half the specified tolerance will not be considered injurious defects.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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 inspections. All the inspections required herein for the testing of steel are classified as quality conformance inspections, for which necessary sampling techniques and methods of testing are specified in this section.

4.3 Sampling and inspection for dimensions, finish, workmanship, packaging, and identification-marking requirements. Units of product shall be randomly selected to represent each lot of material of one heat, nominal dimensions, and offered for acceptance at one time, in accordance with table III.

TABLE III Sampling for examination of product

Lot size	Sample size	Acceptance number
1 to 7	All	0
8 to 40	7	0
41 to 110	15	1
111 to 160	25	2
161 to 301	35	3
Over 301	50	4

4.3.1 Method. Samples shall be visually inspected

#### 4.4 Chemical analysis.

4.4.1 Sampling. Samples for check chemical analysis shall be selected in accordance with Method III of Federal Test Method Standard No. 151, to represent each heat in the shipment.

4.4.1.1 Sample location. Samples for check chemical analysis shall be taken parallel to the axis of the material selected at a point midway between the center and the surface, except that material less than 1¼ inches thick shall be sampled through the entire cross section. The sample shall consist of not less than 2 ounces.

4.4.1.2 Waiver. Samples for check chemical analysis may be waived, provided that all of the material under inspection can be identified as being made from a heat previously analyzed and found to be in conformance with the chemical composition specified herein.

4.4.1.3 Additional samples. Where the material is not identifiable as to heat or where the identity of any portion of the shipment is obscure in any respect, samples shall be selected in accordance with table III.

4.4.1.4 Method. Analysis shall be in accordance with Method 111 or 112 of Federal Test Method Standard No. 151, except that in the event of dispute, Method 111 shall be used.

#### 4.5 Microstructure and grain size.

4.5.1 Sampling. A sample shall be selected to represent each 50 pieces of each size from each heat, except when the minimum cross sectional dimension exceeds 2 inches, a sample shall be selected to represent each 10 pieces. When materials are not identified or the identity is obscure in any respect, sampling shall be in accordance with table III. The steel manufacturer may use heat evaluation tests in lieu of finish testing (see 4.4.1.3).

**4.5.2 Method.** Specimens shall be heat treated to the HT-125 condition and sectioned parallel to the direction of rolling or drawing to expose surfaces as indicated by figure 8. Specimens shall be suitably polished, etched with Villella's etchant, and examined at 250 diameters magnification. Acceptance standards are as indicated by 3.2.1 and figures 1 through 7.

#### 4.6 Response to heat treatment.

**4.6.1 Sampling.** One tension test sample shall be selected from each 500 pieces or less of each configuration, produced under the same processing conditions, from the same heat, of the same size, essentially uniform in all respects and submitted for inspection at the same time. When materials are not identified or the identity is obscure in any respect, sampling shall be in accordance with table III. The steel manufacturer may use heat evaluation tests in lieu of finish testing.

**4.6.1.1 Heat lots.** Heat lots may be certified tests of four samples from intermediate mill products of sufficient size to provide short-of-center transverse specimens for testing.

**4.6.2 Preparation of specimens.** All tension test samples shall be given final machining before heat treatment, except for finish machining of bearing and close-tolerance surfaces. Tension specimens of Method 211 of Federal Test Method Standard No. 151 shall be used.

**4.6.2.1** Specimens shall be heat treated in accordance with equipment and process requirements of MIL-H-6875.

**4.6.3 Method.** Tension tests and determination of yield strength shall be conducted in accordance with Method 211 of Federal Test Method Standard No. 151.

**4.7 Rejection.** When the failure of one or more specimens indicates that the test sample fails to meet a specified requirement, the entire lot shall be rejected.

**4.7.1 Retest.** At the discretion of the supplier, retest will be permitted. A retest sample of five specimens shall be tested to replace each failed specimen of the initial sample. If one or more of the retest specimens fail, the lot shall be rejected with no further testing permitted.

**4.7.1.2 Resubmittal.** If the defectives in a lot previously rejected can be identified and reprocessed or removed, resampling at frequency of the initial sampling will be permitted.

## 5. PREPARATION FOR DELIVERY

### 5.1 Packaging and packing.

**5.1.1 Levels A and B.** Material shall be prepared for shipment in accordance with MIL-STD-163.

**5.1.2 Level C.** Material shall be packed in boxes or crates so constructed as to insure acceptance by common or other carrier and safe delivery at destination. Shipping containers shall comply with the Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

**5.2 Marking of shipment.** Interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129 and MIL-STD-163. The identification shall include the following information listed in the order shown:

- (a) Stock No. or other identification number as specified in the purchase document.
- (b) Steel (bars, wire, forging stock, forgings, or tubing, as appropriate) 431, special quality MIL-S-18732, size and shape (round, square, hexagon, or flat).
- (c) Heat No.
- (d) Quantity contained, feet or pounds

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(as defined in the contractor's order for each size and shape).

(e) Name of contractor (and name of manufacturer, if not the same).

(f) Contract or order No.

**6. NOTES**

**6.1 Intended use.** The steel covered by this

specification is intended for use in the manufacture of highly stressed structural parts exposed to corrosive environments and operating temperatures to 500° F for materials heat treated to the HT-200 condition. The material is useful for one component of threaded stainless steel fasteners because of a tendency to resist seizure when in contact with other types of corrosion resisting steel.

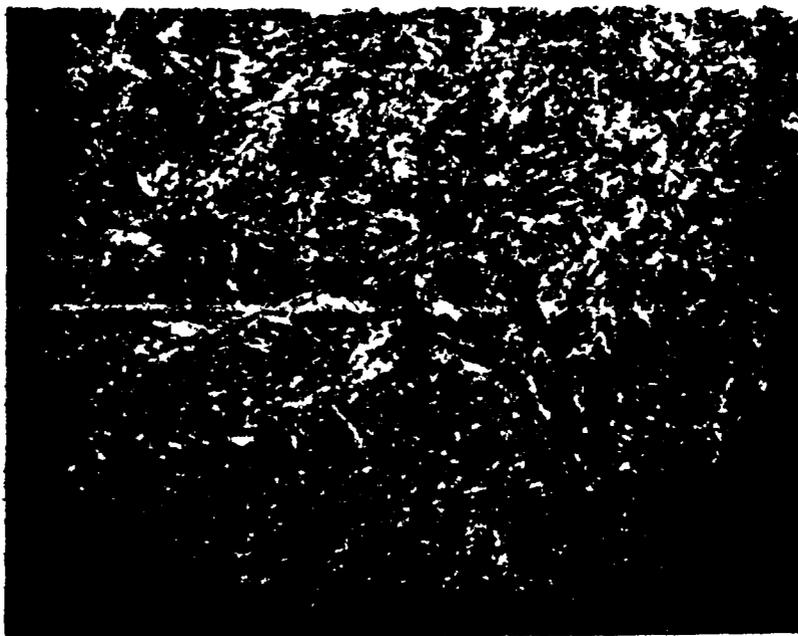


FIGURE 1. Desired microstructure (100% Martensite)

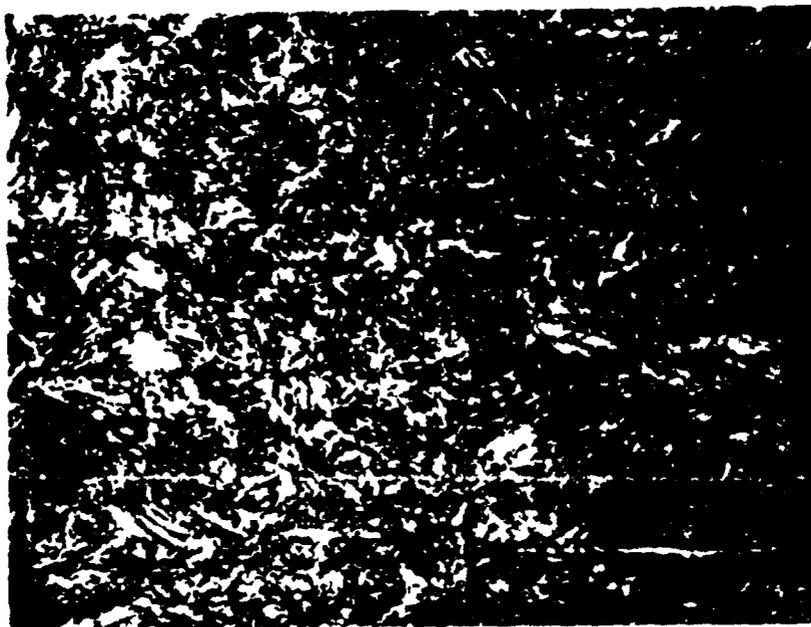


FIGURE 2 Acceptable microstructure containing small amount of banded free ferrite

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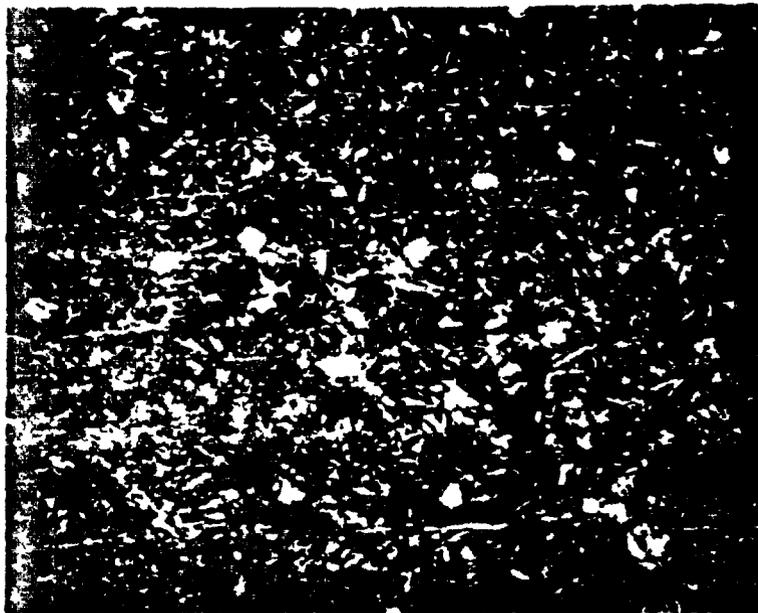


FIGURE 3 Acceptable microstructure containing maximum amount of banded free ferrite permitted in any field

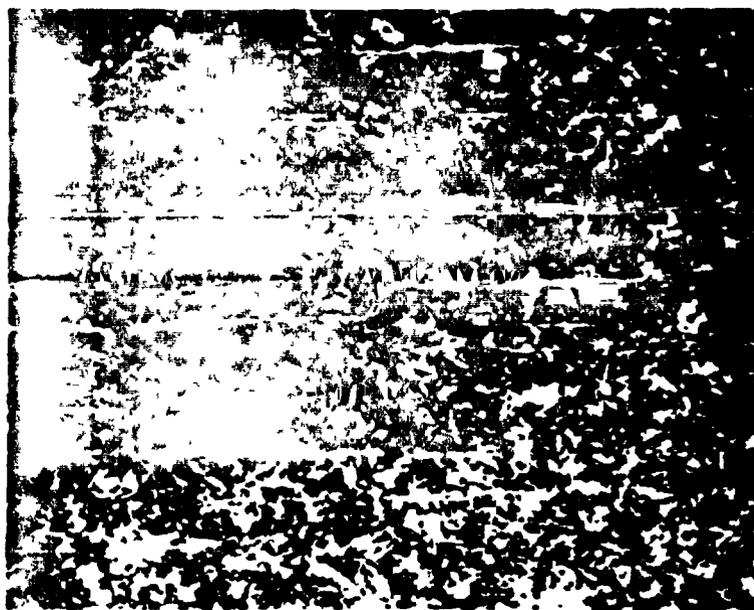
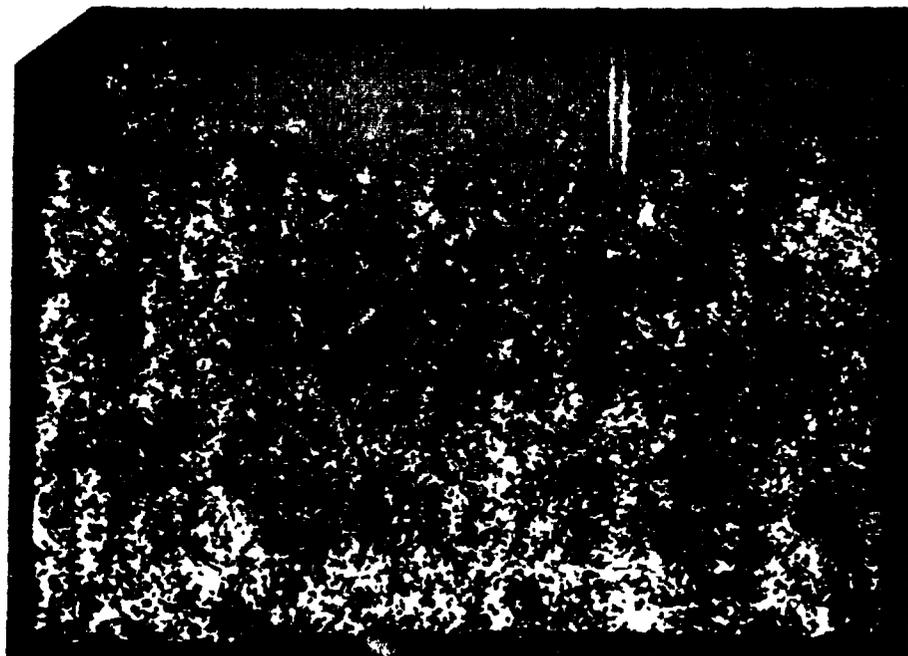


FIGURE 4 Unacceptable microstructure containing excessive banded free ferrite



**FIGURE 5. Acceptable microstructure containing maximum amount of banded retained austenite permitted in any field of examination**

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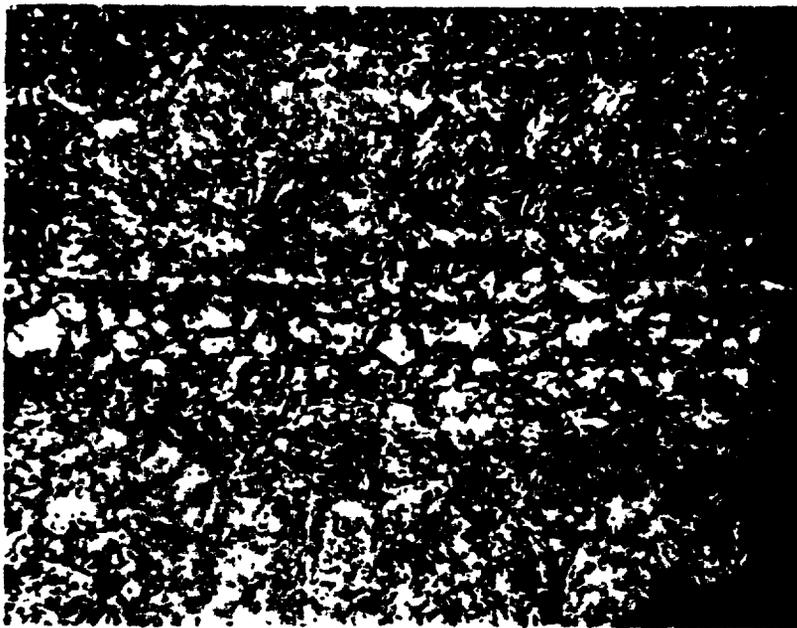


FIGURE 6 Unacceptable microstructure containing excessive banded retained austenite



FIGURE 7 Unacceptable microstructure containing excessive banded retained austenite

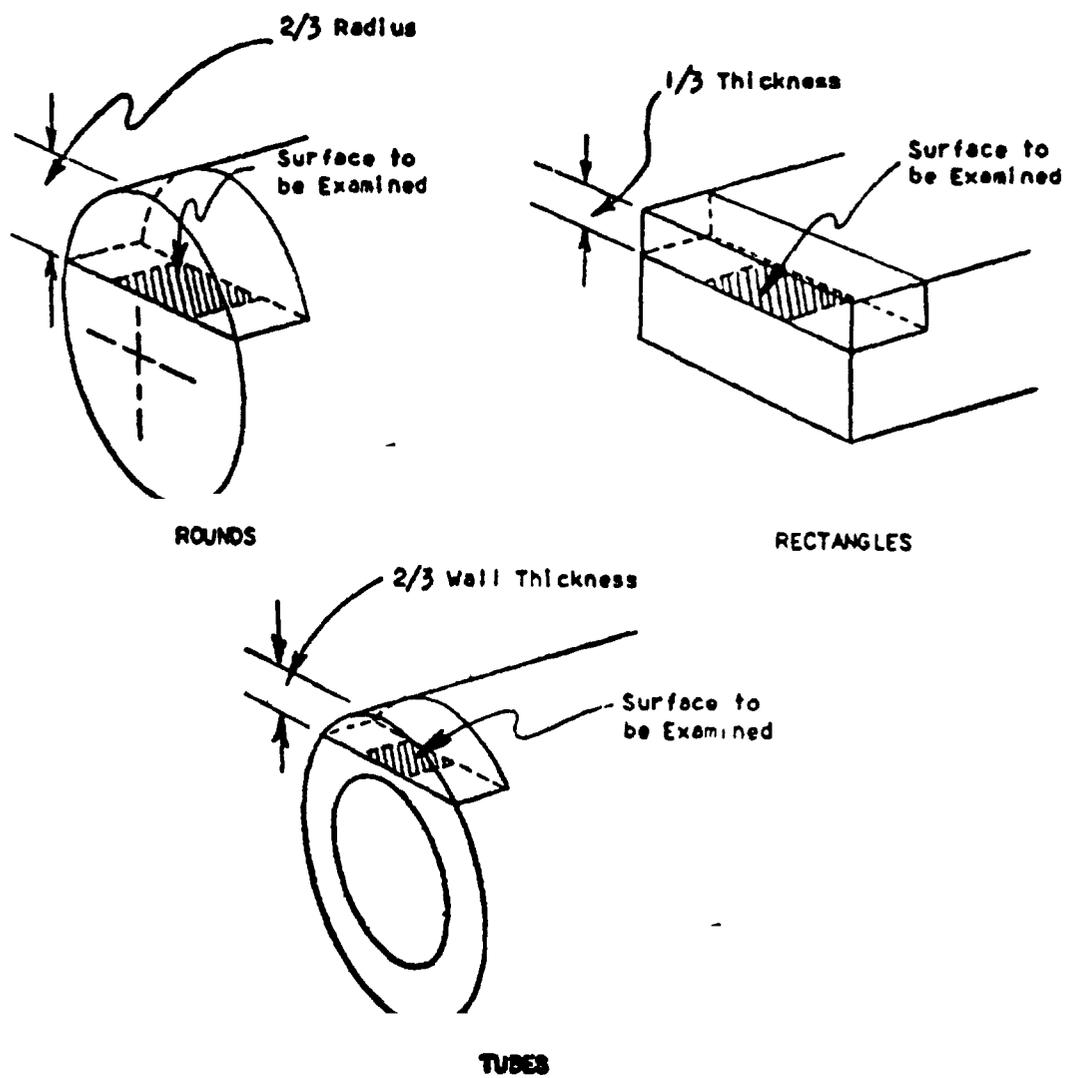


FIGURE 8. Location of micro-specimens

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**6.2 Precaution.**

**6.2.1 Heat treatment.** This material is not recommended for use after heat treatment to a strength level other than as specified in table II because of the possibility of developing low impact strength and unsatisfactory corrosion resistance.

**6.3** The surfaces of parts manufactured from this type of steel will be passive when tested in accordance with MIL-STD-753.

**Custodians:**

Army—MR

Navy—AS

Air Force—11

**Reviewer activities**

Army—MI, MU, WE

**6.4 Ordering data.** Procurement documents should specify:

- (a) Title, number, and date of this specification.
- (b) Quantity, thickness, size or shape (see 3.3).
- (c) Level of packaging and packing desired.

**6.5** Cold heading wire is not covered by this specification and should be purchased to ASTM A493.

**Issuing activity:**

Navy—AS

Project No. 9510-0093

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1 DOCUMENT NUMBER

2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

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4. TYPE OF ORGANIZATION (Mark one)

VENDOR

USER

MANUFACTURER

OTHER (Specify)

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

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8 DATE OF SUBMISSION (YYMMDD)

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