Designation: A 289/A 289M – 97 (Reapproved 2008)

Standard Specification for Alloy Steel Forgings for Nonmagnetic Retaining Rings for Generators[1]

This standard is issued under the fixed designation A 289/A 289M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers nonmagnetic alloy steel retaining ring forgings for generators.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 Unless the order specifies the applicable "M" specification designation, the material shall be furnished to the inch-pound units.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 342/A 342M Test Methods for Permeability of Feebly Magnetic Materials

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 531/A 531M Practice for Ultrasonic Examination of Turbine-Generator Steel Retaining Rings

A 788/A 788M Specification for Steel Forgings, General Requirements

E 45 Test Methods for Determining the Inclusion Content of Steel

E 112 Test Methods for Determining Average Grain Size

E 165 Test Method for Liquid Penetrant Examination

3. Ordering Information and General Requirements

3.1 Material supplied to this specification shall conform to the requirements of Specification A 788/A 788M, which outlines ordering information, manufacturing requirements, testing methods and retesting procedures, marking, certification, product analysis variation, and additional supplementary requirements.

3.2 If the requirements of this specification are in conflict with the requirements of Specification A 788/A 788M, the requirements of this specification shall prevail.

3.3 Supplementary requirements of an optional nature are provided. They shall apply only when specified by the purchaser.

4. Manufacture

4.1 The steel shall be made by the electro-slag-remelt (ESR) process. The electrodes shall be made by either the basic electric furnace or ladle refining processes.

4.2 Sufficient discard shall be taken from each ingot to secure freedom from piping and undue segregation.

4.3 Forged rings shall be solution treated following hot working and prior to the cold expansion procedure.

4.4 Rings shall be rough machined prior to cold expansion or final heat treatment.

4.5 Rings shall be expanded by an appropriate method such as segmented dies, tapered plug, etc. in the temperature range of 60 to 390°F [15 to 200°C] in order to develop the required tensile properties.

4.6 After cold expansion, the rings shall be heated to between 575 and 750°F [300 to 400°C] at a rate not to exceed 75°F [40°C]/h, held at this temperature for 6 to 12 h, and then slow cooled to ambient temperature.

5. Chemical Requirements

5.1 *Heat Analysis*—The heat analysis obtained from sampling in accordance with Specification A 788/A 788M shall comply with Table 1 of this specification.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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TABLE 1 Chemical Requirements

	Composition, weight %
Carbon	0.10 max
Manganese	17.5–20.0
Phosphorus	0.060 max
Sulfur	0.015 max
Silicon	0.80 max
Nickel	2.00 max
Chromium	17.5–20.0
Nitrogen	0.45-0.80
Titanium	0.10 max
Aluminum	0.04 max
Vanadium	0.25 max

5.2 *Product Analysis*—When a product analysis is performed at the request of the purchaser, the provisions of Table 1 of Specification A 788/A 788M shall apply. The analysis shall be made from a forging representing each heat.

NOTE 1—The material shown in Table 1 of A 289/A 289M was formerly known as Class C.

6. Mechanical Properties

6.1 The rings shall conform to the tensile properties for the ordered grade listed in Table 2. The largest obtainable tension test specimen as specified in Test Methods and Definitions A 370 shall be used.

6.2 Unless Supplementary Requirement S2 is invoked, tension tests shall be performed in the temperature range of 68 to 80°F [20 to 27°C]. The yield strength at 0.2 % offset shall not exceed the tensile strength.

6.3 Rings shall conform to the Charpy V-notch requirements of Table 2 corresponding to the ordered strength grade when tested in the temperature range specified in 6.2.

7. Electrical Properties

7.1 The permeability of the forgings at a magnetizing force of 100 oersteds shall not exceed 1.5. Test bars and testing shall be in accordance with Test Methods A 342/A 342M.

TABLE 2 Room Temperature Mechanical Property Requirements

Grade	Tensile Strength, min, ksi [MPa]	0.2 % Offset Yield Strength, min, psi [MPa]	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %	Charpy V-Notch Energy, min. ft/lb [J]
1	145 [1000]	135 [930]	28	60	70 [95]
2	155 [1070]	145 [1000]	25	55	65 [88]
3	165 [1140]	160 [1105]	20	50	60 [81]
4	170 [1170]	165 [1140]	19	48	58 [79]
5	175 [1205]	170 [1170]	17	45	55 [75]
6	185 [1275]	180 [1240]	14	40	50 [68]
7	195 [1345]	190 [1310]	12	35	40 [54]
8	200 [1380]	195 [1345]	10	30	35 [47]

8. Number and Location of Tests

8.1 The number of tension tests shall be as ordered by the purchaser, but in no case shall there be less than one tension test for each ring.

8.2 Tangentially oriented tension test samples shall be located at the midwall location of an integral prolongation forged at one or both ends of the ring, as shown in Fig. 1. The specimens shall be removed after cold working and subsequent stress relief.

8.3 A minimum of one set of three tangentially oriented Charpy V-notch specimens shall be removed from the inside diameter location of the test prolongation as shown in Fig. 1. The notch shall be aligned parallel to the longitudinal axis of the ring. The purchaser may specify the side of the specimen to be notched and that the distance of the root of the notch from the inside diameter of the ring be different from that shown in Fig. 1.

9. Metallographic Tests

9.1 The inclusion content of the material shall be determined in accordance with Method A of Test Methods E 45 utilizing a sample taken from the tension test location. The maximum allowable rating for any inclusion type shall be 3.0.

9.2 Grain size shall be determined according to Test Methods E 112 from a sample taken from the midwall tension test location in the test prolongation. The results shall be reported for information.

9.3 A photomicrograph at a magnification of 100x shall be taken of the etched microstructure from the grain size sample and submitted with the certification data required by the specification and Specification A 788/A 788M.

10. Nondestructive Tests

10.1 The ring shall be free from cracks, seams, laps, shrinkage, and other injurious defects.

10.2 An ultrasonic examination of the machined ring shall be made by the manufacturer in accordance with Practice A 531/A 531M. The acceptance criteria shall be by agreement between manufacturer and purchaser.

10.3 A liquid penetrant examination of the finished ring shall be made by the manufacturer in accordance with Test Method E 165. The acceptance criteria shall be agreed to between the manufacturer and the purchaser.

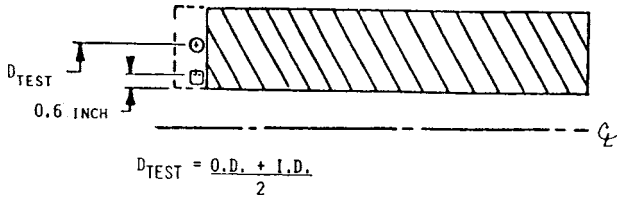

FIG. 1 Outside Diameter and Inside Diameter as Required by Drawing

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11. Keywords

11.1 alloy steel; cold worked; generator retaining rings; nonmagnetic; steel forgings

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified by the purchaser in the inquiry and order. Details of these supplementary requirements shall be agreed upon between the manufacturer and the purchaser.

S1. Charpy V-Notch Impact Tests

S1.1 Requirements for energy absorption at room temperature as determined on Charpy impact specimens shall be specified by the purchaser.

S2. Alternative Elevated Temperature Tensile Requirements

S2.1 Tensile tests shall be performed at 200 to 220°F [95 to 105°C] and shall meet the requirements of Table S1.

NOTE S1—The Charpy V-Notch test temperature requirements are not altered by this requirement.

TABLE S1 Alternative Elevated Temperature Tensile Requirements (200-220°F)

Grade	Tensile Strength, min, ksi [MPa]	0.2 % Offset Yield Strength, min, psi [MPa]	Elongation, 2 in. [50 mm] min,%	Reduction of area, min,%
1	120 [830]	110 [760]	25	60
2	125 [860]	120 [830]	23	58
3	135 [930]	135 [930]	19	56
4	140 [965]	140 [965]	17	55
5	145 [1000]	145 [1000]	15	54
6	155 [1070]	155 [1070]	13	52
7	165 [1140]	165 [1140]	10	51
8	170 [1170]	170 [1170]	10	50

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