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Standard Specification for Continuous Grain Flow Forged Carbon and Alloy Steel Crankshafts for Medium Speed Diesel Engines[1]

This standard is issued under the fixed designation A983/A983M; 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.

ε[1] NOTE—Editorial correction was made in Table 2 in March 2014.

1. Scope*

1.1 This specification covers continuous grain flow forged carbon and alloy steel crankshafts for medium speed diesel and natural gas engines.

1.2 The steel used in the manufacture of the forgings is required to be vacuum degassed.

1.3 The choice of steel composition grade for a given strength class is normally made by the forging supplier, unless otherwise specified by the purchaser.

1.4 Provision is made for treatment of designated surfaces of the crankshaft to provide enhanced fatigue strength, or wear resistance, or both.

1.5 Except as specifically required in this specification, all provisions of Specification A788/A788M apply.

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

1.7 The values stated in either inch-pound units or SI (metric) units are to be regarded separately as standard. Within the text and tables the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A503/A503M Specification for Ultrasonic Examination of Forged Crankshafts

A788/A788M Specification for Steel Forgings, General Requirements

A966/A966M Practice for Magnetic Particle Examination of Steel Forgings Using Alternating Current

A986/A986M Specification for Magnetic Particle Examination of Continuous Grain Flow Crankshaft Forgings

E45 Test Methods for Determining the Inclusion Content of Steel

E112 Test Methods for Determining Average Grain Size

E340 Test Method for Macroetching Metals and Alloys

2.2 *Other Standards:*

AWS D1.1 Structural Welding Code[3]

DIN 50 602[4]

JIS G 0555 Microscopic Testing Method for the Non-Metallic Inclusions in Steel[5]

3. Ordering Information

3.1 In addition to the ordering requirements of Specification A788/A788M, the following items should be included:

3.2 Choice of mechanical property class from Table 1.

3.3 Choice of chemical composition Grade from Table 2 if this purchaser option is exercised (4.1.3).

3.4 Whether surface hardening in designated areas is required, referencing Supplementary Requirements S10, S11, or S12, and providing the necessary instructions.

3.5 For crankshafts designed to include welded counterweights the purchaser may specify an alternate welding code to AWS D1.1 Structural Welding Code.

3.6 For alternate tensile and hardness test requirements specify Supplementary Requirement S2.

[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.

[3] Available from American Welding Society, 550 NW Le Jeune Rd., Miami, FL 33126.Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

[4] Available from Verlag Stahleisen mbh, Postfach 8229, D-4000 Dusseldorf, Germany.

[5] Available from Japanese Standards Association, 1-24 Akasaka 4, Minato-Ku, Tokyo 107, Japan.Available from Japanese Standards Organization (JSA), 4-1-24 Akasaka Minato-Ku, Tokyo, 107-8440, Japan, http://www.jsa.or.jp.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Tensile and Hardness Requirements

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
Tensile Strength, ksi [Mpa] min	80 [550]	100 [690]	110 [760]	120 [830]	130 [900]	140 [965]	150 [1035]
Yield Strength, (0.2% offset), ksi [Mpa] min	45 [310]	70 [485]	80 [550]	90 [620]	100 [690]	110 [760]	120 [830]
Elongation, min % in 2 in. (4D) [% in 62.5 mm] (5D)	20 [18]	18 [16]	18 [16]	17 [15]	16 [14]	15 [13]	14 [12]
Reduction of Area, % min	45	45	45	45	40	40	40
Brinell Hardness, min	163	207	229	248	262	285	302
Brinell Hardness, max	217	255	269	293	302	331	341

TABLE 2 Chemical Requirements Composition %

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 7A	Grade 8	Grade 8A
Carbon	0.43-0.53	0.43-0.52	0.28-0.33	0.38-0.48	0.30-0.48	0.35-0.45	0.28-0.35	0.38–0.48	0.30-0.35	0.38–0.48
Manganese	0.60-1.10	0.75-1.10	0.40-1.00	0.75-1.10	0.65-1.00	0.65-1.00	0.40-1.00	0.40–1.00	0.40-0.80	0.40–0.80
Phosphorous	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max
Sulfur	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max
Silicon	0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40	0.15–0.40	0.15-0.40	0.15–0.40
Nickel	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1.30-1.70	1.30–1.70
Chromium	. . .	0.20-0.35	0.80-1.20	0.80-1.20	0.80-1.20	0.80-1.20	2.8-3.3	2.8–3.3	1.00-1.40	1.00–1.40
Molybdenum	. . .	0.10 max	0.15-0.25	0.15-0.25	0.15-0.25	0.30-0.50	0.30-0.50	0.30–0.50	0.20-0.35	0.20–0.35
Vanadium	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.15 max	0.15 max

4. Materials and Manufacture

4.1 *Melting Practice:*

4.1.1 The steel making section of Specification A788/A788M shall apply together with mandatory vacuum degassing.

4.1.2 Supplementary Requirement S1 may be used if nonmetallic inclusion rating of the steel is required.

4.1.3 Unless otherwise specified by the purchaser (3.2), the forging supplier shall select the chemical composition grade to be used from Table 2.

4.2 *Forging:*

4.2.1 The use of bar from starting stock produced by slitting a rectangular section is not permitted.

4.2.2 The procedure used in forging the crankshaft shall ensure that the centerline of the starting forged or rolled bar will follow the centerline contour of the main bearings, webs, and crankpins of the crankshaft.

4.2.3 The grain flow present between adjacent main bearing journals, webs, and the intervening crankpin shall be demonstrated for the first article testing of a new crankshaft design by a given forging facility. This need not be repeated for other crankshafts of the same design that differ from the first article crankshaft by the number of crankpin throws or, by agreement with the purchaser, for V-Cylinder configurations of the same engine. The axial grain flow shown after etching a centerline longitudinal section of the *main bearing-web-crankpin-web-main bearing* section shall be approved by the purchaser. Etching shall be done in accordance with Test Method E340. Using Supplementary Requirement S2, additional grain flow sections may be taken by agreement between the manufacturer and purchaser.

4.3 *Heat Treatment for Mechanical Properties:*

4.3.1 Heat treatment of crankshaft forgings may be done either before or after rough machining, at the manufacturer's option. By the use of Supplementary Requirement S3 the purchaser can specify that heat treatment be done after rough machining.

4.3.2 When counterweights are to be attached to the crankshaft by welding (see 4.3.4), then the heat treatment for mechanical properties shall follow after completion of the welding. Intermediate post weld heat treatment may be applied to the assembly at the manufacturer's option.

4.3.3 Heat treatment for mechanical properties shall consist of normalizing followed by tempering at a subcritical temperature, or austenitizing, liquid quenching and subcritical tempering. A normalizing cycle may precede the austenitizing stage.

4.3.3.1 The minimum tempering temperature shall be 1100°F [595°C].

4.3.4 If the crankshaft design includes attaching counterweights to the webs by welding, then the manufacturer shall qualify the weld procedure and welders in accordance with a written procedure acceptable to the purchaser. The procedure shall incorporate AWS specifications.

4.3.5 If forgings receive thermal stress relief after completion of heat treatment, then the stress relieving temperature shall not exceed (T-50)°F [(T-30)°C] where T is the tempering temperature. If this stress relieving temperature is exceeded, then the mechanical testing required in Section 6 shall be repeated.

4.3.6 If crankshaft counterweights are to be welded to the webs, then the welding shall be done to a written, and qualified procedure conforming to AWS D1.1 Structural Welding Code or another similar welding code acceptable to the purchaser. This procedure shall contain instructions concerning repair of counterweight welds, including preheat and post weld heat treatment requirements.

5. Chemical Composition

5.1 *Heat Analysis*—The heat analysis obtained after sampling in accordance with Specification A788/A788M shall comply with Table 2 for the chosen grade, and the requirements agreed upon by Supplementary Requirement S4 if this was selected.