Designation: A 983/A 983M – 98

An American National Standard

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 A 983/A 983M; 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 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 Provision is made for treatment of designated surfaces of the crankshaft to provide enhanced fatigue strength, or wear resistance, or both.

1.4 The values stated in either inch-pound units or SI (metric) units are to be regarded separately as standards. 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 must be used independantly of the other. Combining values from the two systems may result in nonconformance with the specification.

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

1.6 Except as specifically required in this specification, all provisions of Specification A 788 apply.

2. Referenced Documents

2.1 *ASTM Standards:*

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[2]

A 503 Specification for Ultrasonic Examination of Large Forged Crankshafts[3]

A 788 Specification for Steel Forgings, General Requirements[3]

A 966/A 966M Test Method for Magnetic Particle Examination of Steel Forgings Using Alternate Current[3]

A 986/A 986M Specification for Magnetic Particle Examination of Continuous Grain Flow Crankshaft Forgings[3]

E 45 Practice for Determining the Inclusion Content of Steel[4]

E 112 Practice for Determining Average Grain Size[4]

E 340 Macro Etching Metals and Alloys[4]

2.2 *Other Standards:*

AWS D1.1 Structural Welding Code[5]

DIN 50 602 [6]

JIS G 0555 [7]

3. Ordering Information

3.1 In addition to the ordering requirements of Specification A 788, the following items should be included:

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

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

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

4. Materials and Manufacture

4.1 *Melting Practice*:

4.1.1 The steel making section of Specification A 788 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.

4.2 *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

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[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 01.05.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] Available from American Welding Society, Miami, FL.

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

[7] Available from Japanese Standards Association, 1-24 Akasaka 4, Minato-Ku, Tokyo 107, Japan.

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 Specification E 340. 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.

4.3.4 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 a temperature of (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 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 A 788 shall comply with Table 1 for the chosen grade, and the requirements agreed upon by Supplementary Requirement S4 if this was selected.

6. Mechanical Requirements

6.1 *Tension Testing*:

6.1.1 The heat treated forging shall comply with the requirements of Table 2 for the selected grade when tested in accordance with this section. See also Test Methods and Definitions A 370. It should be noted that when the SI system is specified the gage length for the tension test shall be measured over a length of 5D.

6.1.2 *Test Material*— An integral test prolongation equal in diameter to that of the starting bar diameter shall be provided at one end of each crankshaft subject to mechanical testing.

6.1.3 *Sampling*—The longitudinal axis of the axially oriented tension test specimen shall be located at the mid-radius position in the integral crankshaft test prolongation. Supplementary Requirement S5 provides for a tension test prolongation to be provided at both ends of the heat treated crankshaft, and Supplementary Requirement S6 provides for testing of each crankshaft in lieu of the test frequency specified in Supplementary Requirement S5.

6.1.4 *Orientation*— Longitudinal tension test specimens shall be taken from the crankshaft prolongation.

6.1.5 *Number of Tests*— Unless Supplementary Requirements S5 or S6, or both, are specified, one tension test specimen shall be tested to the requirements of Table 2, for the selected grade, at a frequency of one test per heat treatment load.

6.2 *Impact Testing*— If charpy impact testing of the crankshaft is required, Supplementary Requirement S7 shall be specified.

7. Grain Size

7.1 The grain size of the forging following heat treatment shall be ASTM 5 or finer when tested at the tension test location(s) in accordance with Practice E 112.

8. Surface Hardening

8.1 When required by the purchaser, and indicated in the crankshaft drawing, the crankshaft shall be surface hardened in designated areas for purposes of wear resistance, and when the bearing fillets are included, enhanced fatigue strength.

8.2 The method and extent of the surface hardening shall be specified by the purchaser by including reference to Supplementary Requirements S9 (nitriding), S10 (induction hardening of the bearing journals), or S11 (full induction hardening of bearing journals and fillets).

9. Nondestructive Examination

9.1 Because ac magnetizing equipment is required to be used, the magnetic particle examination of the crankshaft shall be done on completion of all machining operations. The

TABLE 1 Chemical Requirements Composition %

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
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	0.30-0.35
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	0.40-0.80
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
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
Silicon	0.15-0.40	0.15-0.40	0.15-0.040	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
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	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	0.20-0.35
Vanadium	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.15 max