Austenitic Manganese Steel Castings: Metallographic Techniques and Microstructures

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Atlas of Microstructures for Austenitic Manganese Steel Castings

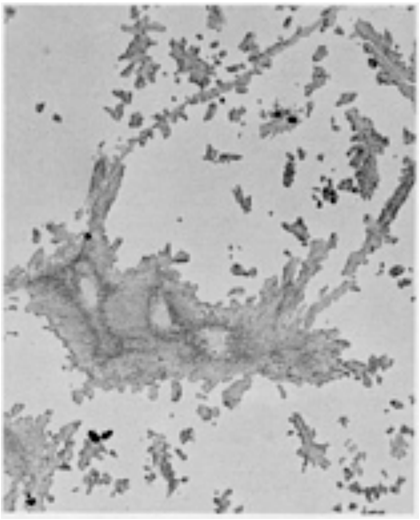

Fig. 1

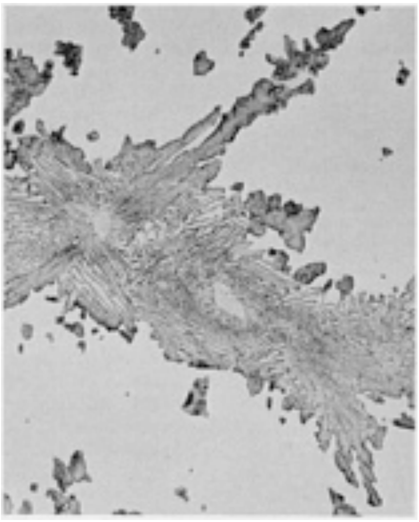

Fig. 2

ASTM A128 grade A alloy, as-cast. Microstructure consists of austenite grains with darker carbides. In Fig. 2, the carbides consist of a relatively massive core surrounded by lamellar carbides. 4% picral. Fig. 1: 100×. Fig. 2: 200×

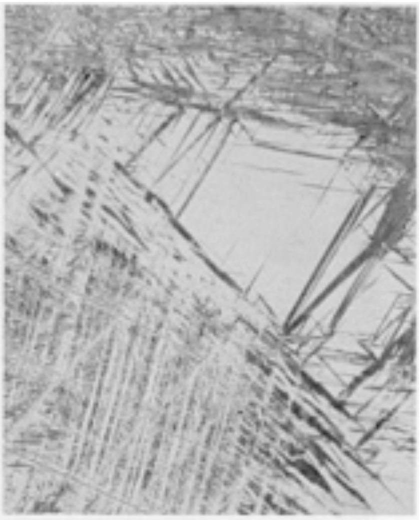

Fig. 3 ASTM A128 alloy, heat treated at 1065 °C (1950 °F), and water quenched. Structure near the casting wear surface shows martensite formed during deformation as a result of decarburization of the austenite (light phase). 4% picral. 500×

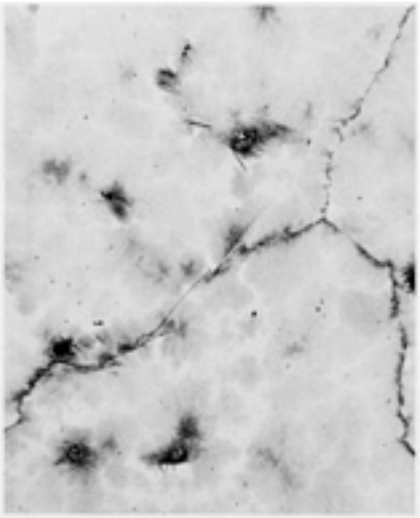

Fig. 4 Experimental alloy, as-cast. Microstructure shows untransformed austenite and cementite in interdendritic positions, along with the outlines of pearlite colonies (grayish areas). Boiling alkaline sodium picrate (see Table 1 for composition). 100×

Fig. 5 Experimental alloy, heat treated at 1120 °C (2050 °F) for 3 h and water quenched. Austenite grains show annealing twins formed during transformation from as-cast pearlite. Only traces of

grain-boundary carbides are visible. This microstructure is acceptable. Sodium chromate in glacial acetic acid (see Table 1 for composition). 100×

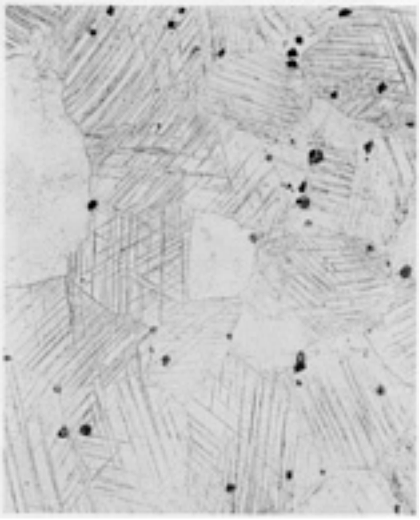

Fig. 6 ASTM A128 alloy, cast and heat treated at 1065 °C (1950 °F), water quenched, machined into tensile specimen, and tested. Austenite grains show different amounts of twinning, depending on individual grain orientation. Etchant: Same as Fig. 5. 100×

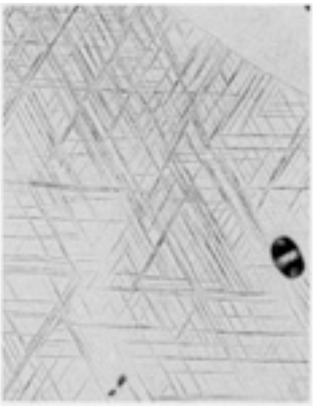

Fig. 7 ASTM A128 grade D alloy, cast and heat treated at 1035 °C (1900 °F) for 3 h, water quenched, machined into tensile specimen, and tested. Depicted is a single austenite grain with deformation twins. This figure also illustrates the tendency of large "primary" twins to obstruct further twinning. Sodium chromate in glacial acetic acid (see Table 1 for composition). 100×

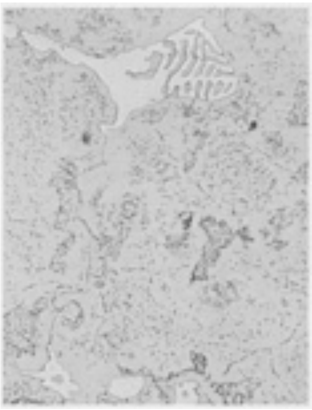

Fig. 8 ASTM A128 grade E2 alloy, aged at 595 °C (1100 °F) for 12 h, air cooled, then partially solutionized at 980 °C (1800 °F) for 2 h and water quenched. Microstructure consists of austenite grains with dispersions of undissolved carbide. This is the so-called "dispersion-hardened" grade of austenitic manganese steel. 4% picral. 500×

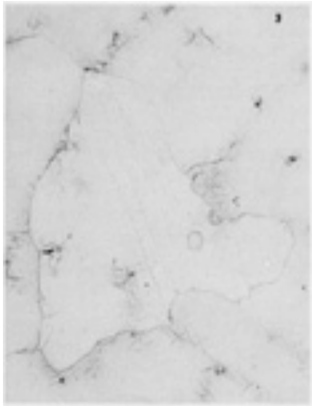

Fig. 9 ASTM A128 alloy, cast, heat treated at 1065 °C (1950 °F), and water quenched. Microstructure shows an austenite grain with continuous grain-boundary carbide films and carbide precipitates in interdendritic areas due to "slack" quenching. Some undissolved carbide is also visible in each grain. The grains also exhibit some twinning. This is an undesirable microstructure. 4% picral. 72×

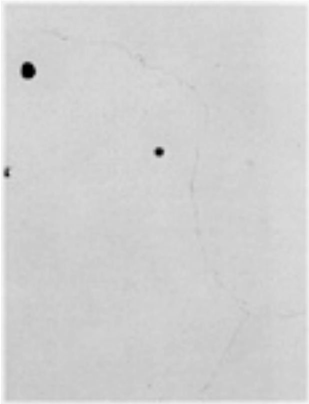

Fig. 10 ASTM A128 alloy, cast, solutionized at 1065 °C (1950 °F), and water quenched. Microstructure consists of austenite with faintly etched grain boundaries containing only traces of carbide precipitates. Some dispersed microporosity is visible within the austenite grains. This is an acceptable microstructure. 4% picral. 100×

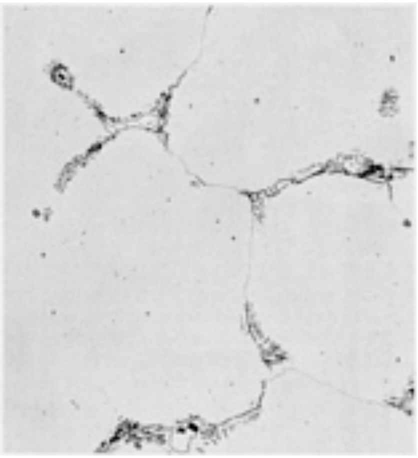

Fig. 11 ASTM A128 grade C alloy, cast, heat treated at 1095 °C (2000 °F) for 2 h, and water quenched. Microstructure consists of austenite grains, with undissolved carbides in interdendritic areas (including grain boundaries). Carbides surrounded by lamellae and spheroids indicate the successive steps in carbide dissolution. In general, this is an undesirable microstructure. Cyclic etch (see Table 1 for composition and method). 100×

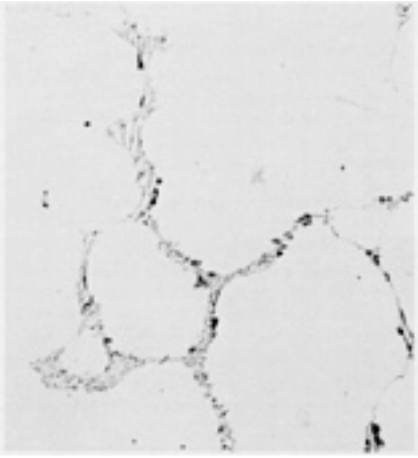

Fig. 12 ASTM A128 grade A alloy, cast, heat treated at 1150 °C (2100 °F) for 2 h, and water quenched. Photomicrograph shows austenite grains, with incipient fusion associated with grain-boundary carbide due to excessive solutionizing temperature. This is an unacceptable microstructure. Etchant: Same as Fig. 11. 100×

Fig. 13 ASTM A128 grade A alloy, cast and deliberately overheated to 1205 °C (2200 °F) for 1 h, then water quenched. Photomicrograph illustrates a triple point in the austenite grain structure, with detail of the eutectic pattern of incipient fusion associated with the carbide due to excessive solutionizing temperature. Cyclic etch (see Table 1 for composition and method). 500×

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