Automotive Malleable Iron Castings — SAE J158a

SAE RECOMMENDED PRACTICE

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AUTOMOTIVE MALLEABLE IRON CASTINGS - SAE J158a

SAE Standard

Report of Iron and Steel Technical Committee approved June 1970 and last revised January 1975.

1. SCOPE-SAE J432 and J433 have been discontinued and replaced by this report. This SAE Standard covers castings of ferritic, pearlitic, tempered pearlite, and tempered martensitic grades of malleable iron used in products of the automotive and allied industries. Castings shall be heat treated to meet this SAE Standard

2. GRADES-The specified grades, hardness range and final heat treatment are shown in Table 1. The foundry may also produce grades M4504 and M5003 by liquid quenching and tempering and/or alloying.

3. HARDNESS-The foundry shall exercise the necessary controls and inspection procedures to insure compliance with the specified hardness range. Hardness readings shall be taken according to ASTM E10, Test for Brinell Hardness of Metallic Materials, after sufficient material has been removed from the casting surface to insure representative hardness readings. The area or areas on the casting where hardness is to be checked shall be established by agreement between supplier and purchaser and shown on the drawing.

TABLE 1 - GRADES OF MALLEABLE IRON

Grade	Casting Hardness Range[a]	Heat Treatment
M3210	156 Bhn, max 4.8 BID, min or as agreed	Annealed
M4504	163-217 BID 4.7 - 4.1 BID or as agreed	Air quenched and tempered
M5003	187-241 BID 4.4-3.9 BID or as agreed	Air quenched and tempered
M5003	187-241 Bhn 4.4-3.9 BID or as agreed	Liquid quenched and tempered
M7002	229-269 Bhn 4.0-3.7 BID or as agreed	Liquid quenched and tempered
M8501	269-302 Bhn 3.7-3.5 BID	Liquid quenched and tempered

[a] Brinell impression diameter (BID) is the diameter in millimeters (mm) of the impression of a 10 MM ball at 3000 kg load.

4. MICROSTRUCTURE

4.1 The microstructure of Grade M3210 malleable iron shall consist of temper carbon nodules distributed in a matrix of ferrite. The rim or surface layer shall not exceed 0.050 in (1.27mm). Unless otherwise specified, the material below the rim can contain some pearlite; however, it shall not exceed the amount shown in Fig 1.

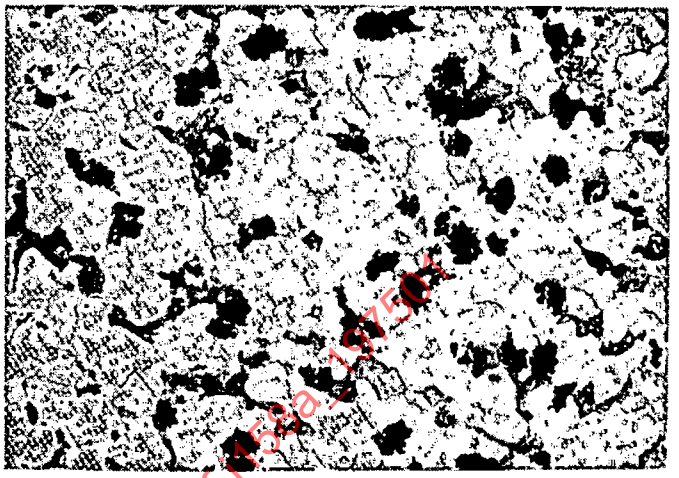

FIG. 1 - REFERENCE PHOTOMICROGRAPH OF ALLOWABLE MAXIMUM PEARLITE IN GRADE M3210 IRON (100X, 2% NITAL ETCH), TYPICAL MICROSTRUCTURES

4.2 The microstructure of the other grades shall consist of temper carbon nodules distributed in a matrix of ferrite and tempered pearlite in air quenched castings and in a matrix of tempered martensite in liquid quenched castings. All grades shall be substantially free of primary graphite or primary cementite.

5. QUALITY ASSURANCE - Sampling plans are a matter of agreement between supplier and purchaser. The supplier shall employ adequate equipment and controls to insure that parts conform to the agreed upon requirements.

6. GENERAL

6.1 Castings furnished to this standard shall be representative of good foundry practice and shall conform to dimensions and tolerances specified on the casting drawing.

6.2 Minor imperfections usually not associated with the structural function may occur in castings. These imperfections often are repairable; however, repairs shall be made only in areas allowed by the purchaser and only be approved methods.

6.3 Additional casting requirements may be agreed upon by the purchaser and supplier. These should appear as additional product requirements on the casting drawing.

APPENDIX-MALLEABLE IRON

(A material description not a part of the standard)

7. DEFINITION AND CLASSIFICATION

Malleable iron is a cast iron in which the graphite is present as temper carbon nodules, instead of flakes as in gray iron or small spherulites as in ductile iron. The term malleable iron includes all grades of malleable iron, those with a ferritic, pearlitic, tempered pearlite, or tempered martensite matrix.

8. CHEMICAL COMPOSITION

The chemical composition range of malleable iron generally conforms to the following range:

Total carbon	2.20 - 2.90%
Silicon	0.90 - 1.90%
Manganese	0.15 - 1.25%
Sulfur	0.02 - 0.20%
Phosphorus	0.02 - 0.15%

Individual foundries will produce to narrower ranges than those shown above. The composition is controlled such that the molten iron solidifies with all the carbon in the combined form, producing a "white iron" structure which is heat treated to specifications.

9. MICROSTRUCTURE

9.1 The microstructure of malleable iron irons covered in this standard consist of temper carbon nodules in a matrix of ferrite, pearlite, tempered pearlite, or tempered martensite or combinations of these. The structure of the matrix is controlled by heat treatment and/or or compostion.

9.2 The matrix of the M 3210 grade of malleable iron is essentially ferritic but a small amount of pearlite is permitted. The matrices of the other grades of malleable iron contains combined carbon as pearlite, tempered pearlite, or tempered martensite.

9.3 Because of reaction with the annealing furnace atmosphere, some depletion of carbon and silicon occurs at the surface of the castings. This usually results in a

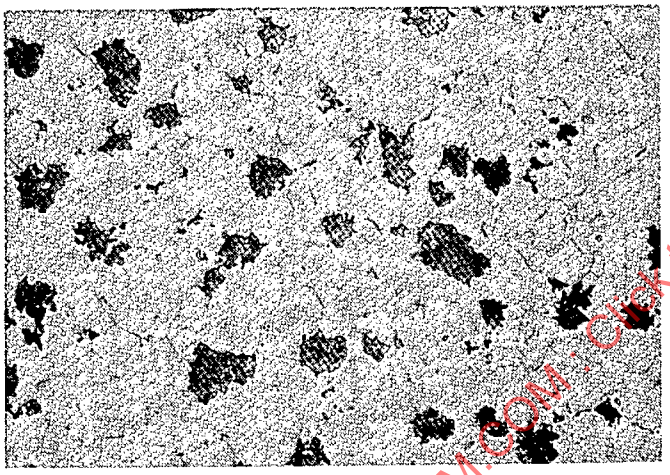

FIG. 2 - M3210, APPROXIMATE 143 BHN (100X), TYPICAL MICROSTRUCTURES

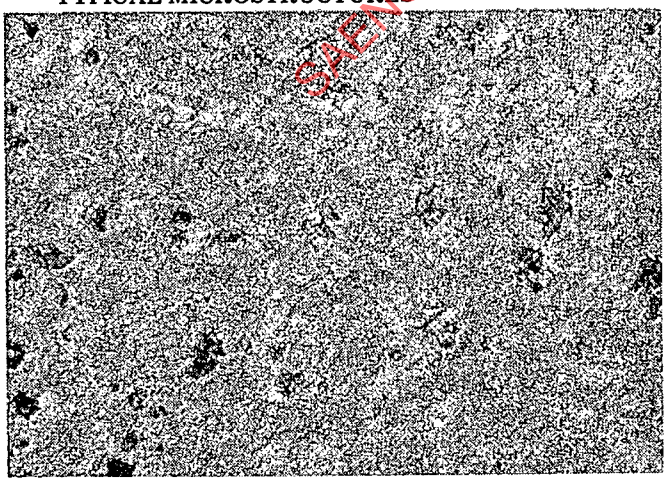

FIG. 4 - M5003, APPROXIMATE 229 BHN (100X), TYPICAL MICROSTRUCTURES

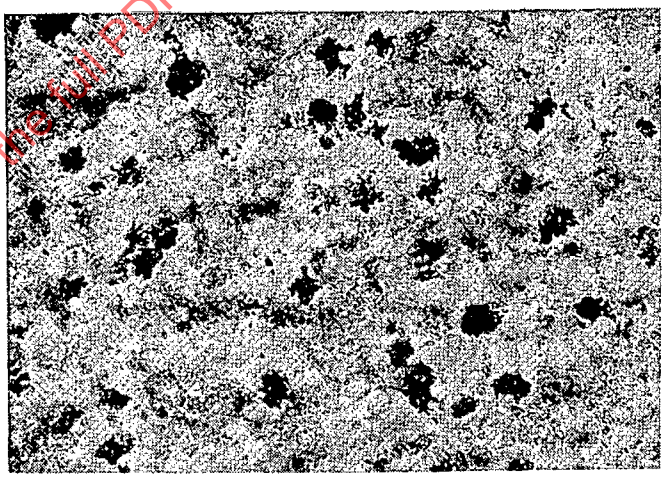

FIG. 3 - M4504, APPROXIMATE 207 BHN (100X), TYPICAL MICROSTRUCTURES

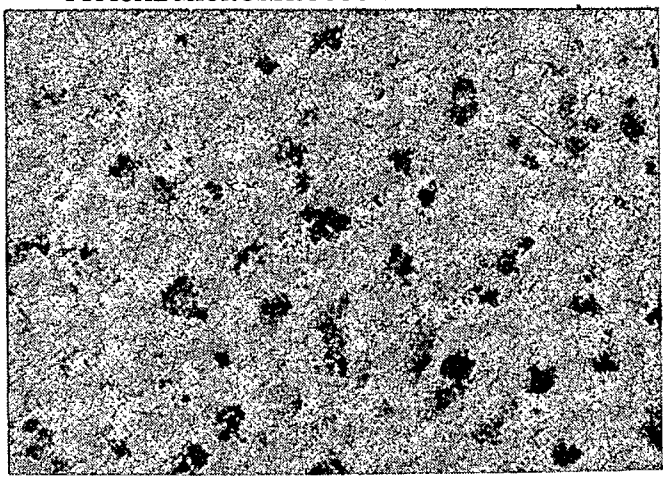

FIG. 5 - M5503, APPROXIMATE 229 BHN (100X), TYPICAL MICROSTRUCTURES

rim which, is excessive, can result in poor poor machinability. The rimm on M3210 malleable iron can consist of coarse pearlite underlying a graphite-free ferritic surface layer. The rim on the other grades can consist of a graphite-free layer sometimes containing more or less combined carbon than the underlyin material.

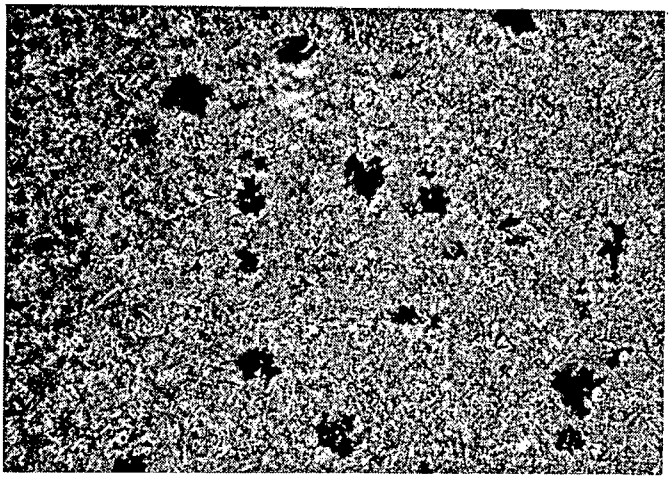

FIG. 6 - M7002, APPROXIMATE 262 BHN (100X), TYPICAL MICROSTRUCTURES

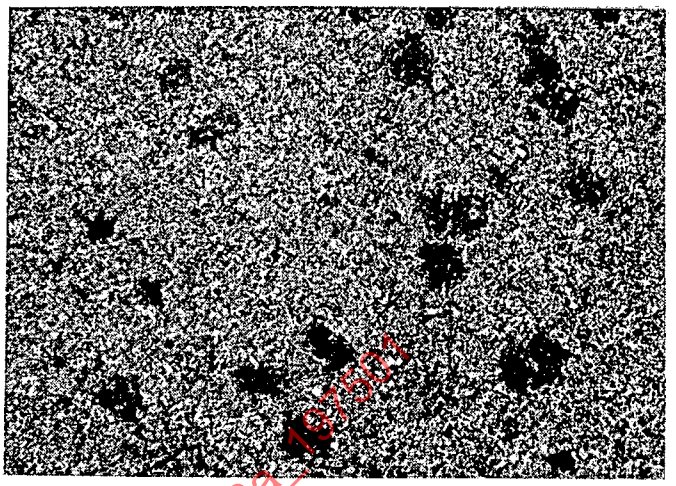

FIG. 7 - M8501, APPROXIMATE 285 BHN (100X), TYPICAL MICROSTRUCTURES

9.4 Typical microstructure of the various grades of malleable iron are shown in Figs. 2-7.

10. MECHANICAL PROPERTIES

The mechanical properties listed in Table A-1 can be used for design purposes, but the suitability of a particular metal for an intended use is best determined by laboratory or service tests. The mechanical properties vary with microstructure and hardness. For optimum mechanical properties, especially in the liquid quenched and tempered grade, section size should be limited to 3/4 in (19.05mm) to insure a uniform structure.

11. TYPICAL APPLICATIONS

11.1 M3210 is used where good machineability is important, such as steering gear housing, carriers, and mounting brackets.

11.2 M4504 is used where slightly higher strength and hardness than M3210 is required, such as certain compressor crankshafts and hubs.

11.3 M5003 is used where moderate strength and/or selective hardening are required for parts such as planet carriers, certain transmission gears, and differential cases.

11.4 M5503 is used where better machinability than M5003 and/or improved response to induction hardening is necessary for parts requiring moderate strength.

11.5 M7002 is used for parts where high strength is required such as connecting rods and universal joint yokes.

11.6 M8501 is used where high strength and wear resistance is required, such as certain gears.

12. ADDITIONAL INFORMATION

1. Cast Metals Handbook. American Foundrymen's Society, Des Plaines, Ill.

2. Malleable Iron Castings. Malleable Founders Society, Cleveland, Ohio.

3. Metals Handbook. Vol. 1, 8th Edition. American Society for Metals, Metals Park, Ohio.

4. Modern Pearlitic Malleable Castings Hankbook. Malleable Research and Development Foundation, Dayton Ohio.

5. H D Angus, Physical and Engineering Properties of Cast Iron. British Cast Iron Research Association, Birmingham, England, 1960.

6. G. N. J. Gilbert, Engineering Data on Malleable Cast Iron. British Cast Iron Research Association, Birmingham, England, 1968.

7. Gray, Ductile, and Malleable Iron Castings Current Capabilities. STP-455, American Society for Testing and Materials, 1916 Race Street, Philadelphia Pennsylvania 19103.