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(21) International Application Number: PCT/US98/12705 (22) International Filing Date: 18 June 1998 (18.06.98) (30) Priority Data: 60/068,252 19 December 1997 (19.12.97) US (71) Applicant: EXXON PRODUCTION RESEARCH COMPANY [US/US]; 3120 Buffalo Speedway, P.O. Box 2189, Houston, TX 77252-2189 (US). (72) Inventors: KOO, Jayoung; 10 Gateshead Drive, Bridgewater, NJ 08807 (US). BANGARU, Narasimha-Rao; V.; 5 Revere Court, Annandale, NJ 08801 (US). VAUGHN, Glen, A.; 4211 Rice Boulevard, Houston, TX 77005 (US). (74) Agents: CASAMASSIMA, Salvatore, J. et al.; Exxon Pro- duction Research Company, P.O. Box 2189, Houston, TX 77252-2189 (US).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>	

(54) Title: **ULTRA-HIGH STRENGTH AUSAGED STEELS WITH EXCELLENT CRYOGENIC TEMPERATURE TOUGHNESS**

(57) Abstract

An ultra-high strength, weldable, low alloy steel with excellent cryogenic temperature toughness in the base plate and in the heat affected zone (HAZ) when welded, having a tensile strength greater than 830 MPa (120 ksi) and a micro-laminate microstructure comprising austenite film layers and fine-grained martensite/lower bainite laths, is prepared by heating a steel slab comprising iron and specified weight percentages of some or all of the additives carbon, manganese, nickel, nitrogen, copper, chromium, molybdenum, silicon, niobium, vanadium, titanium, aluminum, and boron; reducing the slab to form plate in one or more passes in a temperature range in which austenite

recrystallizes; finish rolling the plate in one or more passes in a temperature range below the austenite recrystallization temperature and above the A_{r3} transformation temperature; quenching the finish rolled plate to a suitable Quench Stop Temperature (QST); stopping the quenching; and either, for a period of time, holding the plate substantially isothermally at the QST or slow-cooling the plate before air cooling, or simply air cooling the plate to ambient temperature.

