

METALLURGY

C21 METALLURGY OF IRON

C21B MANUFACTURE OF IRON OR STEEL (preliminary treatment of ferrous ores or scrap C22B 1/00; electric heating H05B)

- (1) This subclass covers:
- the production of iron or steel from source materials, e.g. the production of pig-iron;
 - apparatus specially adapted therefor, e.g. blast furnaces, air heaters (furnaces in general F27).
- (2) Processes using enzymes or micro-organisms in order to:
- (i) liberate, separate or purify a pre-existing compound or composition, or to
 - (ii) treat textiles or clean solid surfaces of materials
- are further classified in subclass C12S. [5]

Subclass index

MAKING PIG-IRON		General features	3/00
In blast furnaces	5/00, 7/00, 9/00	MAKING IRON	13/00, 15/00
Other processes	11/00	MAKING LIQUID STEEL BY DIRECT PROCESSES	13/00

3/00 General features in the manufacture of pig-iron (mixers for pig-iron C21C 1/06)

- 3/02 . by applying additives, e.g. fluxing agents
- 3/04 . Recovery of by-products, e.g. slag
- 3/06 . . Treatment of liquid slag (slag wool C03B; slag stones C04B)
- 3/08 . . . Cooling slag
- 3/10 . . . Slag pots; Slag cars

5/00 Making pig-iron in the blast furnace

- 5/02 . Making special pig-iron, e.g. by applying additives, e.g. oxides of other metals
- 5/04 . Making slag of special composition
- 5/06 . using top gas in the blast furnace process (in coke ovens C10B)

7/00 Blast furnaces (lifts associated with blast furnaces B66B 9/06)

- 7/02 . Internal forms
- 7/04 . with special refractories (refractory materials C04B)
- 7/06 . . Linings for furnaces
- 7/08 . Top armourings
- 7/10 . Cooling; Devices therefor
- 7/12 . Opening or sealing the tap holes
- 7/14 . Discharging devices, e.g. for slag
- 7/16 . Tuyères
- 7/18 . Bell-and-hopper arrangements
- 7/20 . . with appliances for distributing the burden
- 7/22 . Dust arresters
- 7/24 . Test rods or other checking devices

9/00 Stoves for heating the blast in blast furnaces

- 9/02 . Brick hot-blast stoves
- 9/04 . . with combustion shaft
- 9/06 . . Linings
- 9/08 . Iron hot-blast stoves
- 9/10 . Other details, e.g. blast mains
- 9/12 . . Hot-blast valves or slides for blast furnaces (valves in general F16K)
- 9/14 . Preheating the combustion air
- 9/16 . Cooling or drying the hot-blast

11/00 Making pig-iron other than in blast furnaces

- 11/02 . in low shaft furnaces
- 11/06 . in rotary kilns
- 11/08 . in hearth-type furnaces
- 11/10 . in electric furnaces

13/00 Making spongy iron or liquid steel, by direct processes

- 13/02 . in shaft furnaces
- 13/04 . in retorts
- 13/06 . in multi-storied furnaces
- 13/08 . in rotary furnaces
- 13/10 . in hearth-type furnaces
- 13/12 . in electric furnaces
- 13/14 . Multi-stage processes

15/00 Other processes for the manufacture of iron from iron compounds (general methods of reducing to metal C22B 5/00; by electrolysis C25C 1/06)

- 15/02 . Metallothermic processes, e.g. thermit reduction
- 15/04 . from iron carbonyl

C21C PROCESSING OF PIG-IRON, E.G. REFINING, MANUFACTURE OF WROUGHT-IRON OR STEEL (refining or remelting metals in general C22B 9/00); **TREATMENT IN MOLTEN STATE OF FERROUS ALLOYS**

1/00	Refining of pig-iron; Cast iron	5/42	. . . Constructional features of converters
1/02	. Dephosphorising or desulfurising	5/44	. . . Refractory linings
1/04	. Removing impurities other than carbon, phosphorus, or sulfur	5/46	. . . Details or accessories
1/06	. Constructional features of mixers for pig-iron	5/48 Bottoms or tuyères of converters
1/08	. Manufacture of cast-iron	5/50 Tilting mechanisms for converters
1/10	. Making spheroidal graphite cast-iron	5/52	. Manufacture of steel in electric furnaces (electric heating <i>per se</i> H05B)
3/00	Manufacture of wrought-iron or wrought-steel	5/54	. . Processes yielding slags of special composition
5/00	Manufacture of carbon steel, e.g. plain mild steel, medium carbon steel, or cast-steel	5/56	. Manufacture of steel by other methods (making liquid steel by direct processes C21B 13/00)
5/02	. Crucible furnace processes	7/00	Treating molten ferrous alloys, e.g. steel, not covered by groups C21C 1/00 to C21C 5/00 (treating molten metals during moulding B22D 1/00, B22D 27/00; remelting ferrous metals C22B)
5/04	. Manufacture of hearth-furnace steel, e.g. Siemens-Martin steel	7/04	. Removing impurities by adding a treating agent
5/06	. . Processes yielding slags of special composition	7/06	. . Deoxidising, e.g. killing [2]
5/28	. Manufacture of steel in the converter	7/064	. . Dephosphorising; Desulfurising [3]
5/30	. . Regulating or controlling the blowing	7/068	. . Decarburising [3]
5/32	. . . Blowing from above (C21C 5/35 takes precedence) [5]	7/072	. . Treatment with gases (C21C 7/06, C21C 7/064, C21C 7/068 take precedence) [3]
5/34	. . . Blowing through the bath (C21C 5/35 takes precedence) [5]	7/076	. . Use of slags or fluxes as treating agents (C21C 7/06, C21C 7/064, C21C 7/068 take precedence) [3]
5/35	. . . Blowing from above and through the bath [5]	7/10	. Handling in vacuum
5/36	. . Processes yielding slags of special composition		
5/38	. . Removal of waste gases or dust		
5/40	. . . Offtakes or separating apparatus for converter waste gases or dust		

C21D MODIFYING THE PHYSICAL STRUCTURE OF FERROUS METALS; GENERAL DEVICES FOR HEAT TREATMENT OF FERROUS OR NON-FERROUS METALS OR ALLOYS; MAKING METAL MALLEABLE BY DECARBURISATION, TEMPERING, OR OTHER TREATMENTS (cementation by diffusion processes C23C; surface treatment of metallic material involving at least one process provided for in class C23 and at least one process covered by this subclass C23F 17/00; unidirectional solidification of eutectic materials or unidirectional demixing of eutectoid materials C30B)

Subclass index

HEAT TREATMENT	COMBINED MECHANICAL AND THERMAL TREATMENTS.....	8/00
General methods or devices	OTHER TREATMENTS.....	10/00
of cast-iron, of iron alloys	DIFFUSION PROCESSES FOR	
adapted for particular articles.....	EXTRACTION OF NON-METALS	3/00
MECHANICAL TREATMENT		

1/00	General methods or devices for heat treatment, e.g. annealing, hardening, quenching, tempering (furnaces in general F27; electric heating H05B)	1/19	. . . by interrupted quenching [3]
1/02	. Hardening articles or materials formed by forging or rolling, with no further heating beyond that required for the formation	1/20	. . . Isothermal quenching, e.g. bainitic hardening [3]
1/04	. with simultaneous application of supersonic waves, magnetic or electric fields	1/22	. . . Martempering [3]
1/06	. Surface hardening	1/25	. . Hardening, combined with annealing between 300 °C and 600 °C, i.e. heat refining (“Vergüten”) [3]
1/08	. . with flames	1/26	. Methods of annealing
1/09	. . by direct application of electrical or wave energy; by particle radiation [3]	1/28	. . Normalising
1/10	. . . by electric induction [3]	1/30	. . Stress-relieving
1/18	. Hardening (C21D 1/02 takes precedence); Quenching with or without subsequent tempering (quenching devices C21D 1/62) [3]	1/32	. . Soft annealing, e.g. spheroidising
		1/34	. Methods of heating (C21D 1/06 takes precedence)
		1/38	. . Heating by cathodic discharges
		1/40	. . Direct resistance heating
		1/42	. . Induction heating
		1/44	. . in heat-treatment baths
		1/46	. . . Salt baths

1/48	. . . Metal baths		
1/50	. . . Oil baths		
1/52	. . with flames		
1/53	. . Heating in fluidised beds [3]		
1/54	. Determining when the hardening temperature has been reached by measurement of magnetic or electrical properties	(1)	When classifying in group C21D 6/00, any aspect of the method for the heat treatment of ferrous alloys which is considered to represent information of interest for search may also be classified in groups C21D 1/02 to C21D 1/84. This can, for example, be the case when it is considered of interest to enable searching of heat treatment methods of ferrous alloys using a combination of classification symbols. Such non-obligatory classification should be given as "additional information". [8]
1/55	. Hardenability tests, e.g. end-quench tests (investigating or analysing materials by determining their chemical or physical properties, in general G01N) [3]	(2)	When classifying in group C21D 6/00, any alloying constituent which is considered to represent information of interest for search may also be classified in groups C22C 38/02 to C22C 38/60. This can, for example, be the case when it is considered of interest to enable searching of heat treatment of specific ferrous alloys using a combination of classification symbols. Such non-obligatory classification should be given as "additional information". [8]
1/56	. characterised by the quenching agents		
1/58	. . Oils		
1/60	. . Aqueous agents		
1/607	. . Molten salts [3]		
1/613	. . Gases; Liquefied or solidified normally gaseous material [3]		
1/62	. Quenching devices		
1/63	. . for bath quenching [3]		
1/64	. . . with circulating liquids (in general F28D) [3]		
1/667	. . for spray quenching [3]		
1/673	. . for die quenching [3]		
1/68	. Temporary coatings or embedding materials applied before or during heat treatment	6/02	. Hardening by precipitation [2]
1/70	. . while heating or quenching	6/04	. Hardening by cooling below 0° C [2]
1/72	. . during chemical change of surfaces		
1/74	. Methods of treatment in inert gas, controlled atmosphere, vacuum, or pulverulent material (production of gases C01, C10)	7/00	Modifying the physical properties of iron or steel by deformation (apparatus for mechanical working of metal B21, B23, B24)
1/76	. . Adjusting the composition of the atmosphere	7/02	. by cold working
1/767	. . with forced gas circulation; Reheating thereof [3]	7/04	. . of the surface
1/773	. . under reduced pressure or vacuum [3]	7/06	. . . by shot-peening or the like
1/78	. Combined heat-treatments not provided for above	7/08	. . . by burnishing or the like
1/82	. Descaling by thermal stresses (mechanically B21, B23; chemically C23; electrolytically C25F)	7/10	. . of the whole cross-section, e.g. of concrete reinforcing bars
1/84	. Controlled slow cooling (cooling-beds for metal rolling B21B 43/00) [3]	7/12	. . . by expanding tubular bodies
		7/13	. by hot working
3/00	Diffusion processes for extraction of non-metals; Furnaces therefor (local protective coatings C21D 1/72; furnaces in general F27)	8/00	Modifying the physical properties by deformation combined with, or followed by, heat treatment (hardening articles or materials formed by forging or rolling with no further heating beyond that required for the formation C21D 1/02) [3]
3/02	. Extraction of non-metals	8/02	. during manufacturing of plates or strips (C21D 8/12 takes precedence) [3]
3/04	. . Decarburising	8/04	. . to produce plates or strips for deep-drawing [3]
3/06	. . Extraction of hydrogen	8/06	. during manufacturing of rods or wires [3]
3/08	. . Extraction of nitrogen	8/08	. . for concrete reinforcement [3]
3/10	. Furnaces therefor	8/10	. during manufacturing of tubular bodies [3]
		8/12	. during manufacturing of articles with special electromagnetic properties [3]
5/00	Heat treatment of cast-iron	9/00	Heat treatment, e.g. annealing, hardening, quenching, tempering, adapted for particular articles; Furnaces therefor (furnaces in general F27)
5/02	. improving the malleability of grey cast-iron	9/02	. for springs
5/04	. of white cast-iron	9/04	. for rails (apparatus for heat treatment of railway rails on the spot E01B 31/18)
5/06	. . Malleabilising	9/06	. . with diminished tendency to become wavy
5/08	. . . with oxidation of carbon	9/08	. for tubular bodies or pipes
5/10 in gaseous agents	9/10	. . shotgun barrels
5/12 in solid agents	9/12	. . barrels for ordnance
5/14	. . . Graphitising	9/14	. . wear- or pressure-resistant pipes
5/16	. . . Packing agents	9/16	. for explosive shells
6/00	Heat treatment of ferrous alloys [2]	9/18	. for knives, scythes, scissors, or like hand cutting tools
		9/20	. for blades for skates
		9/22	. for drills; for milling cutters; for machine cutting tools
		9/24	. for saw blades

- 9/26 . for needles; for teeth for card-clothing
- 9/28 . for plain shafts
- 9/30 . for crankshafts; for camshafts
- 9/32 . for gear wheels, worm wheels, or the like
- 9/34 . for tyres; for rims
- 9/36 . for balls; for rollers
- 9/38 . for roll bodies
- 9/40 . for rings; for bearing races
- 9/42 . for armour plate
- 9/44 . for equipment for lining mine shafts, e.g. segments, rings, props
- 9/46 . for sheet metals
- 9/48 . . deep-drawing sheets
- 9/50 . for welded joints
- 9/52 . for wires; for strips
- 9/54 . . Furnaces for treating strips or wire
- 9/56 . . . Continuous furnaces for strip or wire
- 9/567 with heating in fluidised beds [3]
- 9/573 with cooling [3]
- 9/58 with heating by baths
- 9/60 with induction heating
- 9/62 with direct resistance heating
- 9/63 the strip being supported by a cushion of gas [3]
- 9/64 Patenting furnaces
- 9/66 Tower-type furnaces
- 9/663 Bell-type furnaces [3]
- 9/665 inverted or side-facing [3]
- 9/667 Multi-station furnaces [3]
- 9/67 adapted for treating the charge in vacuum or special atmosphere [3]
- 9/673 Details, accessories, or equipment peculiar to bell-type furnaces [3]
- 9/675 Arrangements of charging or discharging devices [3]
- 9/677 Arrangements of heating devices [3]
- 9/68 Furnace coilers; Hot coilers (cold coilers B21C)
- 9/70 . Furnaces for ingots, i.e. soaking pits
- 10/00 Modifying the physical properties by methods other than heat treatment or deformation [3]**
- 11/00 Process control or regulation for heat treatments (controlling or regulating in general G05) [2]**