

# METALLURGY

## C21 METALLURGY OF IRON

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

### Notes

- (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 .....	MAKING IRON .....	13/00, 15/00
5/00, 7/00, 9/00	MAKING LIQUID STEEL BY DIRECT	
Other processes .....	PROCESSES .....	13/00
11/00		

### 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**

<b>1/00</b>	<b>Refining of pig-iron; Cast iron</b>	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)
<b>3/00</b>	<b>Manufacture of wrought-iron or wrought-steel</b>	5/54	. . Processes yielding slags of special composition
<b>5/00</b>	<b>Manufacture of carbon steel, e.g. plain mild steel, medium carbon steel, or cast-steel</b>	5/56	. Manufacture of steel by other methods (making liquid steel by direct processes C21B 13/00)
5/02	. Crucible furnace processes	<b>7/00</b>	<b>Treating molten ferrous alloys, e.g. steel, not covered by groups C21C 1/00 to C21C 5/00</b> (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 .....1/00, 11/00	OTHER TREATMENTS..... 10/00
of cast-iron, of iron alloys ..... 5/00, 6/00	DIFFUSION PROCESSES FOR
adapted for particular articles.....9/00	EXTRACTION OF NON-METALS ..... 3/00
MECHANICAL TREATMENT .....7/00	

<b>1/00</b>	<b>General methods or devices for heat treatment, e.g. annealing, hardening, quenching, tempering</b> (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
1/55	. Hardenability tests, e.g. end-quench tests (investigating or analysing materials by determining their chemical or physical properties, in general G01N) [3]
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
1/70	. . while heating or quenching
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)
1/76	. . Adjusting the composition of the atmosphere
1/767	. . with forced gas circulation; Reheating thereof [3]
1/773	. . under reduced pressure or vacuum [3]
1/78	. Combined heat-treatments not provided for above
1/82	. Descaling by thermal stresses (mechanically B21, B23; chemically C23; electrolytically C25F)
1/84	. Controlled slow cooling (cooling-beds for metal rolling B21B 43/00) [3]
<b>3/00</b>	<b>Diffusion processes for extraction of non-metals; Furnaces therefor</b> (local protective coatings C21D 1/72; furnaces in general F27)
3/02	. Extraction of non-metals
3/04	. . Decarburising
3/06	. . Extraction of hydrogen
3/08	. . Extraction of nitrogen
3/10	. Furnaces therefor
<b>5/00</b>	<b>Heat treatment of cast-iron</b>
5/02	. improving the malleability of grey cast-iron
5/04	. of white cast-iron
5/06	. . Malleabilising
5/08	. . . with oxidation of carbon
5/10	. . . . in gaseous agents
5/12	. . . . in solid agents
5/14	. . . Graphitising
5/16	. . . Packing agents
<b>6/00</b>	<b>Heat treatment of ferrous alloys [2]</b>

**Notes**

- (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]*
- (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]*
- 6/02 . Hardening by precipitation [2]
- 6/04 . Hardening by cooling below 0° C [2]
- 7/00 Modifying the physical properties of iron or steel by deformation** (apparatus for mechanical working of metal B21, B23, B24)
- 7/02 . by cold working
- 7/04 . . of the surface
- 7/06 . . . by shot-peening or the like
- 7/08 . . . by burnishing or the like
- 7/10 . . of the whole cross-section, e.g. of concrete reinforcing bars
- 7/12 . . . by expanding tubular bodies
- 7/13 . by hot working
- 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]
- 8/02 . during manufacturing of plates or strips (C21D 8/12 takes precedence) [3]
- 8/04 . . to produce plates or strips for deep-drawing [3]
- 8/06 . during manufacturing of rods or wires [3]
- 8/08 . . for concrete reinforcement [3]
- 8/10 . during manufacturing of tubular bodies [3]
- 8/12 . during manufacturing of articles with special electromagnetic properties [3]
- 9/00 Heat treatment, e.g. annealing, hardening, quenching, tempering, adapted for particular articles; Furnaces therefor** (furnaces in general F27)
- 9/02 . for springs
- 9/04 . for rails (apparatus for heat treatment of railway rails on the spot E01B 31/18)
- 9/06 . . with diminished tendency to become wavy
- 9/08 . for tubular bodies or pipes
- 9/10 . . shotgun barrels
- 9/12 . . barrels for ordnance
- 9/14 . . wear- or pressure-resistant pipes
- 9/16 . for explosive shells
- 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]**