

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 | 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

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|---------------------------------|--|-------|
| 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
- 1/55 . 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]
- 3/00 Diffusion processes for extraction of non-metals; Furnaces therefor** (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
- 5/00 Heat treatment of cast-iron**
- 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
- 6/00 Heat treatment of ferrous alloys [2]**

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

C21D

- 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]**