

## SECTION C — CHEMISTRY; METALLURGY

### C21 METALLURGY OF IRON

**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)

#### Note(s) [2012.01]

1. Cementation by diffusion processes is classified in C23C.
2. Surface treatments of metallic material involving at least one process provided for in class C23 and at least one process covered by this subclass are classified in group C23F 17/00.

#### Subclass index

##### HEAT TREATMENT

General methods or devices.....1/00, 11/00  
 of cast-iron, of iron alloys.....5/00, 6/00  
 adapted for particular articles.....9/00

##### MECHANICAL TREATMENT.....7/00

COMBINED MECHANICAL AND THERMAL TREATMENTS.....8/00

OTHER TREATMENTS.....10/00

DIFFUSION PROCESSES FOR EXTRACTION OF NON-METALS.....3/00

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|------|---|-------|---|
| 1/00 | <b>General methods or devices for heat treatment, e.g. annealing, hardening, quenching, tempering</b><br>(furnaces in general F27; electric heating H05B) | 1/44  | • • in heat-treatment baths   |
| 1/02 | • Hardening articles or materials formed by forging or rolling, with no further heating beyond that required for the formation                            | 1/46  | • • • Salt baths  |
| 1/04 | • with simultaneous application of supersonic waves, magnetic or electric fields  | 1/48  | • • • Metal baths   |
| 1/06 | • Surface hardening   | 1/50  | • • • Oil baths   |
| 1/08 | • • with flames   | 1/52  | • • with flames   |
| 1/09 | • • by direct application of electrical or wave energy; by particle radiation [3]   | 1/53  | • • Heating in fluidised beds [3]   |
| 1/10 | • • • by electric induction [3]   | 1/54  | • Determining when the hardening temperature has been reached by measurement of magnetic or electrical properties   |
| 1/18 | • Hardening (C21D 1/02 takes precedence); Quenching with or without subsequent tempering (quenching devices C21D 1/62) [3]                                | 1/55  | • Hardenability tests, e.g. end-quench tests (investigating or analysing materials by determining their chemical or physical properties, in general G01N) [3] |
| 1/19 | • • by interrupted quenching [3]  | 1/56  | • characterised by the quenching agents   |
| 1/20 | • • • Isothermal quenching, e.g. bainitic hardening [3]   | 1/58  | • • Oils  |
| 1/22 | • • • Martempering [3]  | 1/60  | • • Aqueous agents  |
| 1/25 | • • Hardening, combined with annealing between 300 °C and 600 °C, i.e. heat refining ("Vergüten") [3]   | 1/607 | • • Molten salts [3]  |
| 1/26 | • Methods of annealing  | 1/613 | • • Gases; Liquefied or solidified normally gaseous material [3]  |
| 1/28 | • • Normalising   | 1/62  | • Quenching devices   |
| 1/30 | • • Stress-relieving  | 1/63  | • • for bath quenching [3]  |
| 1/32 | • • Soft annealing, e.g. spheroidising  | 1/64  | • • • with circulating liquids (in general F28D) [3]  |
| 1/34 | • Methods of heating (C21D 1/06 takes precedence)   | 1/667 | • • for spray quenching [3]   |
| 1/38 | • • Heating by cathodic discharges  | 1/673 | • • for die quenching [3]   |
| 1/40 | • • Direct resistance heating   | 1/68  | • Temporary coatings or embedding materials applied before or during heat treatment   |
| 1/42 | • • Induction heating   | 1/70  | • • while heating or quenching  |
|      |   | 1/72  | • • during chemical change of surfaces  |

## C21D

- 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]

#### Note(s)

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-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".
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-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".

- 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]

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|-------|---------|---|-------|---|---|
| 9/673 | • • • • | Details, accessories, or equipment peculiar to bell-type furnaces [3] | 9/70  | • | Furnaces for ingots, i.e. soaking pits  |
| 9/675 | • • • • | Arrangements of charging or discharging devices [3]                   | 10/00 |   | <b>Modifying the physical properties by methods other than heat treatment or deformation [3]</b>        |
| 9/677 | • • • • | Arrangements of heating devices [3]                                   | 11/00 |   | <b>Process control or regulation for heat treatments (controlling or regulating in general G05) [2]</b> |
| 9/68  | • • •   | Furnace coilers; Hot coilers (cold coilers B21C)                      |       |   |   |