

**CPC****COOPERATIVE PATENT CLASSIFICATION****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](#))

**C21D 1/00**

**General methods or devices for heat treatments, e.g. annealing, hardening, quenching, tempering** (furnaces in general [F27](#); electric heating per se [H05B](#))

**C21D 1/02**

- Hardening articles or materials formed by forging or rolling, with no further heating beyond that required for the formation

**C21D 1/04**

- with simultaneous application of supersonic waves, magnetic or electric fields

**C21D 1/06**

- Surface hardening

**C21D 1/08**

- . with flames

**C21D 1/09**

- . by direct application of electrical or wave energy; by particle radiation

**C21D 1/10**

- . . by electric induction

**C21D 1/18**

- Hardening ([C21D 1/02](#) takes precedence); Quenching with or without subsequent tempering (quenching devices [C21D 1/62](#))

**C21D 1/185**

- . {from an intercritical temperature}

**C21D 1/19**

- . by interrupted quenching

**C21D 1/20**

- . . Isothermal quenching, e.g. bainitic hardening

**C21D 1/22**

- . . Martempering

**C21D 1/25**

- . Hardening, combined with annealing between 300 degrees Celsius and 600 degrees Celsius, i.e. heat refining ("Vergüten")

**C21D 1/26**

- Methods of annealing

**C21D 1/28**

- . Normalising

**C21D 1/30**

- . Stress-relieving

**C21D 1/32**

- . Soft annealing, e.g. spheroidising

**C21D 1/34**

- Methods of heating ([C21D 1/06](#) takes precedence)

**C21D 1/38**

- . Heating by cathodic discharges

**C21D 1/40**

- . Direct resistance heating

**C21D 1/42**

- . Induction heating

**C21D 1/44**

- . in heat-treatment baths

**C21D 1/46**

- . . Salt baths

**C21D 1/48**

- . . Metal baths

**C21D 1/50**

- . . Oil baths

**C21D 1/52**

- . with flames

- C21D 1/53
  - . . Heating in fluidised beds
- C21D 1/54
  - . Determining when the hardening temperature has been reached by measurement of magnetic or electrical properties
- C21D 1/55
  - . Hardenability tests, e.g. end-quench tests ([investigating chemical or physical properties of materials in general G01N](#))
- C21D 1/56
  - . characterised by the quenching agents
- C21D 1/58
  - . . Oils
- C21D 1/60
  - . . Aqueous agents
- C21D 1/607
  - . . Molten salts
- C21D 1/613
  - . . Gases; Liquefied or solidified normally gaseous material
- C21D 1/62
  - . Quenching devices
- C21D 1/63
  - . . for bath quenching
- C21D 1/64
  - . . . with circulating liquids ([in general F28D](#))
- C21D 1/667
  - . . for spray quenching
- C21D 1/673
  - . . for die quenching
- C21D 1/68
  - . Temporary coatings or embedding materials applied before or during heat treatment
- C21D 1/70
  - . . while heating or quenching
- C21D 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](#))
- C21D 1/76
  - . . Adjusting the composition of the atmosphere
- C21D 1/763
  - . . . {[using a catalyst](#)}
- C21D 1/767
  - . . with forced gas circulation; Reheating thereof
- C21D 1/773
  - . . under reduced pressure or vacuum
- C21D 1/78
  - . Combined heat-treatments not provided for above
- C21D 1/785
  - . . {[Thermocycling](#)}
- C21D 1/82
  - . Descaling by thermal stresses ([mechanically B21](#), [B23](#); [chemically C23](#); [electrolytically C25F](#))
- C21D 1/84
  - . Controlled slow cooling ([cooling-beds for metal rolling B21B 43/00](#))
- C21D 3/00**
  - Diffusion processes for extraction of non-metals; Furnaces therefor ([local protective coatings C21D 1/72](#); [furnaces in general F27](#))**
- C21D 3/02
  - . Extraction of non-metals
- C21D 3/04
  - . . Decarburising
- C21D 3/06
  - . . Extraction of hydrogen
- C21D 3/08
  - . . Extraction of nitrogen
- C21D 3/10
  - . Furnaces therefor
- C21D 5/00**
  - Heat treatments of cast-iron**
- C21D 5/02
  - . improving the malleability of grey cast-iron
- C21D 5/04
  - . of white cast-iron

- C21D 5/06 . . Malleabilising
- C21D 5/08 . . . with oxidation of carbon
- C21D 5/10 . . . . in gaseous agents
- C21D 5/12 . . . . in solid agents
- C21D 5/14 . . . Graphitising
- C21D 5/16 . . . . Packing agents

#### **C21D 6/00 Heat treatment of ferrous alloys**

- C21D 6/001 . {containing Ni ([C21D 6/004](#) takes precedence)}
- C21D 6/002 . {containing Cr ([C21D 6/004](#) takes precedence)}
- C21D 6/004 . {containing Cr and Ni}
- C21D 6/005 . {containing Mn}
- C21D 6/007 . {containing Co}
- C21D 6/008 . {containing Si}
- C21D 6/02 . Hardening by precipitation
- C21D 6/04 . Hardening by cooling below 0 degrees Celsius

#### **C21D 7/00 Modifying the physical properties of iron or steel by deformation ([apparatus for mechanical working of metal B21, B23, B24](#))**

- C21D 7/02 . by cold working
- C21D 7/04 . . of the surface
- C21D 7/06 . . . by shot-peening or the like
- C21D 7/08 . . . by burnishing or the like
- C21D 7/10 . . of the whole cross-section, e.g. of concrete reinforcing bars
- C21D 7/105 . . . {of concrete reinforcing bars}
- C21D 7/12 . . . by expanding tubular bodies
- C21D 7/13 . by hot working

#### **C21D 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](#))**

- C21D 8/005 . {of ferrous alloys ([C21D 8/02](#) to [C21D 8/12](#) take precedence)}
- C21D 8/02 . during manufacturing of plates or strips ([C21D 8/12](#) takes precedence)

##### **NOTE**

In this group classification is made according to the most important feature in one subgroup only; for other features indexing codes of [C21D](#) are added

- C21D 8/0205 . . {of ferrous alloys}
- C21D 8/021 . . {involving a particular fabrication or treatment of ingot or slab}
- C21D 8/0215 . . . {Rapid solidification; Thin strip casting}
- C21D 8/0221 . . {characterised by the working steps}
- C21D 8/0226 . . . {Hot rolling}

C21D 8/0231	. . . {Warm rolling}
C21D 8/0236	. . . {Cold rolling}
C21D 8/0242	. . . {Flattening; Dressing; Flexing}
C21D 8/0247	. . {characterised by the heat treatment}
C21D 8/0252	. . . {with application of tension}
C21D 8/0257	. . . {with diffusion of elements, e.g. decarburising, nitriding}
C21D 8/0263	. . . {following hot rolling}
C21D 8/0268	. . . {between cold rolling steps}
C21D 8/0273	. . . {Final recrystallisation annealing}
C21D 8/0278	. . {involving a particular surface treatment ( <a href="#">C21D 8/0294</a> takes precedence)}
C21D 8/0284	. . . {Application of a separating or insulating coating}
C21D 8/0289	. . . {Application of a tension-inducing coating}
C21D 8/0294	. . {involving a localised treatment}
C21D 8/04	. . to produce plates or strips for deep-drawing

**NOTE**

In this group classification is made according to the most important feature in one subgroup only; for other features indexing codes of [C21D](#) are added

C21D 8/0405	. . . {of ferrous alloys}
C21D 8/041	. . . {involving a particular fabrication or treatment of ingot or slab}
C21D 8/0415	. . . . {Rapid solidification; Thin strip casting}
C21D 8/0421	. . . {characterised by the working steps}
C21D 8/0426	. . . . {Hot rolling}
C21D 8/0431	. . . . {Warm rolling}
C21D 8/0436	. . . . {Cold rolling}
C21D 8/0442	. . . . {Flattening; Dressing; Flexing}
C21D 8/0447	. . . {characterised by the heat treatment}
C21D 8/0452	. . . . {with application of tension}
C21D 8/0457	. . . . {with diffusion of elements, e.g. decarburising, nitriding}
C21D 8/0463	. . . . {following hot rolling}
C21D 8/0468	. . . . {between cold rolling steps}
C21D 8/0473	. . . . {Final recrystallisation annealing}
C21D 8/0478	. . . {involving a particular surface treatment ( <a href="#">C21D 8/0494</a> takes precedence)}
C21D 8/0484	. . . . {Application of a separating or insulating coating}
C21D 8/0489	. . . . {Application of a tension-inducing coating}
C21D 8/0494	. . . {involving a localised treatment}
C21D 8/06	. during manufacturing of rods or wires
C21D 8/065	. . {of ferrous alloys}
C21D 8/08	. . for concrete reinforcement

- C21D 8/10 . during manufacturing of tubular bodies
- C21D 8/105 . . {of ferrous alloys}
- C21D 8/12 . during manufacturing of articles with special electromagnetic properties

**NOTE**

In this group classification is made according to the most important feature in one subgroup only; for other features indexing codes of [C21D](#) are added

- C21D 8/1205 . . {involving a particular fabrication or treatment of ingot or slab}
- C21D 8/1211 . . . {Rapid solidification; Thin strip casting}
- C21D 8/1216 . . {the working step(s) being of interest}
- C21D 8/1222 . . . {Hot rolling}
- C21D 8/1227 . . . {Warm rolling}
- C21D 8/1233 . . . {Cold rolling}
- C21D 8/1238 . . . {Flattening; Dressing; Flexing}
- C21D 8/1244 . . {the heat treatment(s) being of interest}
- C21D 8/125 . . . {with application of tension}
- C21D 8/1255 . . . {with diffusion of elements, e.g. decarburising, nitriding}
- C21D 8/1261 . . . {following hot rolling}
- C21D 8/1266 . . . {between cold rolling steps}
- C21D 8/1272 . . . {Final recrystallisation annealing}
- C21D 8/1277 . . {involving a particular surface treatment ([C21D 8/1294](#) takes precedence)}
- C21D 8/1283 . . . {Application of a separating or insulating coating}
- C21D 8/1288 . . . {Application of a tension-inducing coating}
- C21D 8/1294 . . {involving a localized treatment}

**C21D 9/00**

**Heat treatment, e.g. annealing, hardening, quenching, tempering, adapted for particular articles; Furnaces therefor** ([furnaces in general F27](#))

- C21D 9/0006 . {Details, accessories not peculiar to any of the following furnaces ([control devices C21D 11/00](#))}
- C21D 9/0012 . . {Rolls; Roll arrangements}
- C21D 9/0018 . . {for charging, discharging or manipulation of charge}
- C21D 9/0025 . . {Supports; Baskets; Containers; Covers}
- C21D 9/0031 . {Rotary furnaces with horizontal or slightly inclined axis}
- C21D 9/0037 . {Rotary furnaces with vertical axis; Furnaces with rotating floor}
- C21D 9/0043 . {Muffle furnaces; Retort furnaces}
- C21D 9/005 . {Furnaces in which the charge is moving up or down ([for wire, strip C21D 9/54](#))}
- C21D 9/0056 . {Furnaces through which the charge is moved in a horizontal straight path ([C21D 9/0043](#) takes precedence)}
- C21D 9/0062 . {Heat-treating apparatus with a cooling or quenching zone}
- C21D 9/0068 . {for particular articles not mentioned below}
- C21D 9/0075 . {for rods of limited length ([of unlimited length C21D 9/52](#))}

- C21D 9/0081 . {for slabs; for billets}
- C21D 9/0087 . {for chains, for chain links}
- C21D 9/0093 . {for screws; for bolts}
- C21D 9/02 . for springs
- C21D 9/04 . for rails (apparatus for heat treatment of railway rails on the spot [E01B 31/18](#))
- C21D 9/06 . . with diminished tendency to become wavy
- C21D 9/08 . for tubular bodies or pipes
- C21D 9/085 . . {Cooling or quenching}
- C21D 9/10 . . shotgun barrels
- C21D 9/12 . . barrels for ordnance
- C21D 9/14 . . wear- or pressure-resistant pipes
- C21D 9/16 . for explosive shells
- C21D 9/18 . for knives, scythes, scissors, or like hand cutting tools
- C21D 9/20 . for blades for skates
- C21D 9/22 . for drills; for milling cutters; for machine cutting tools
- C21D 9/24 . for saw blades
- C21D 9/26 . for needles; for teeth for card-clothing
- C21D 9/28 . for plain shafts
- C21D 9/30 . for crankshafts; for camshafts
- C21D 9/32 . for gear wheels, worm wheels, or the like
- C21D 9/34 . for tyres; for rims
- C21D 9/36 . for balls; for rollers
- C21D 9/38 . for roll bodies
- C21D 9/40 . for rings; for bearing races
- C21D 9/42 . for armour plate
- C21D 9/44 . for equipment for lining mine shafts, e.g. segments, rings, props
- C21D 9/46 . for sheet metals
- C21D 9/48 . . deep-drawing sheets
- C21D 9/50 . for welded joints
- C21D 9/505 . . {Cooling thereof}
- C21D 9/52 . for wires; for strips; {for rods of unlimited length}
- C21D 9/525 . . {for wire, for rods ([C21D 9/54](#) takes precedence)}
- C21D 9/54 . . Furnaces for treating strips or wire
- C21D 9/56 . . . Continuous furnaces for strip or wire
- C21D 9/561 . . . . {with a controlled atmosphere or vacuum}
- C21D 9/562 . . . . {Details}
- C21D 9/563 . . . . . {Rolls; Drums; Roll arrangements}
- C21D 9/564 . . . . . {Tension control}
- C21D 9/565 . . . . . {Sealing arrangements}
- C21D 9/567 . . . . with heating in fluidised beds

C21D 9/573	. . . . with cooling
C21D 9/5732	. . . . . {of wires; of rods}
C21D 9/5735	. . . . . {Details}
C21D 9/5737	. . . . . . {Rolls; Drums; Roll arrangements}
C21D 9/58	. . . . with heating by baths
C21D 9/60	. . . . with induction heating
C21D 9/62	. . . . with direct resistance heating
C21D 9/63	. . . . the strip being supported by a cushion of gas
C21D 9/64	. . . Patenting furnaces
C21D 9/66	. . . Tower-type furnaces
C21D 9/663	. . . Bell-type furnaces
C21D 9/665	. . . . inverted or side-facing
C21D 9/667	. . . . Multi-station furnaces
C21D 9/67	. . . . . adapted for treating the charge in vacuum or special atmosphere
C21D 9/673	. . . . Details, accessories, or equipment peculiar to bell-type furnaces
C21D 9/675	. . . . Arrangements of charging or discharging devices
C21D 9/677	. . . . Arrangements of heating devices
C21D 9/68	. . . Furnace coilers; hot coilers (cold coilers <a href="#">B21C</a> )
C21D 9/70	. Furnaces for ingots, i.e. soaking pits
<b>C21D 10/00</b>	<b>Modifying the physical properties by methods other than heat treatment or deformation</b>
C21D 10/005	. {by laser shock processing}
<b>C21D 11/00</b>	<b>Process control or regulation for heat treatments (controlling or regulating in general <a href="#">G05</a>)</b>
C21D 11/005	. {for cooling}
<b>C21D 2201/00</b>	<b>Treatment for obtaining particular effects</b>
C21D 2201/01	. Shape memory effect
C21D 2201/02	. Superplasticity
C21D 2201/03	. Amorphous or microcrystalline structure
C21D 2201/04	. Single or very large crystals
C21D 2201/05	. Grain orientation
<b>C21D 2211/00</b>	<b>Microstructure comprising significant phases</b>
C21D 2211/001	. Austenite
C21D 2211/002	. Bainite
C21D 2211/003	. Cementite
C21D 2211/004	. Dispersions; Precipitations
C21D 2211/005	. Ferrite
C21D 2211/006	. Graphite

C21D 2211/007	• Ledeburite
C21D 2211/008	• Martensite
C21D 2211/009	• Pearlite
<b>C21D 2221/00</b>	<b>Treating localised areas of an article</b>
C21D 2221/01	• End parts (e.g. leading, trailing end)
C21D 2221/02	• Edge parts
C21D 2221/10	• Differential treatment of inner with respect to outer regions, e.g. core and periphery, respectively
<b>C21D 2241/00</b>	<b>Treatments in a special environment</b>
C21D 2241/01	• under pressure
C21D 2241/02	• • Hot isostatic pressing
C21D 2241/03	• in zero gravity (e.g. in space)
<b>C21D 2251/00</b>	<b>Treating composite or clad material</b>
C21D 2251/02	• Clad material
C21D 2251/04	• Welded or brazed overlays
<b>C21D 2261/00</b>	<b>Machining or cutting being involved</b>
<b>C21D 2281/00</b>	<b>Making use of special physico-chemical means</b>
C21D 2281/01	• Seed crystals being used
C21D 2281/02	• temperature gradient