

**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 [M21D](#) 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 ( [C21D 8/0294](#) 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 [M21D](#) 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 ( [C21D 8/0494](#) 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 [M21D](#) 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 ( <a href="#">cold coilers 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	. { <a href="#">by laser shock processing</a> }
<b>C21D 11/00</b>	<b>Process control or regulation for heat treatments ( <a href="#">controlling or regulating in general G05</a> )</b>
C21D 11/005	. { <a href="#">for cooling</a> }
<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

**C21D 2221/00      Treating localised areas of an article**

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

**C21D 2241/00      Treatments in a special environment**

C21D 2241/01 . under pressure

C21D 2241/02 . . Hot isostatic pressing

C21D 2241/03 . in zero gravity ( e.g. in spce )

**C21D 2251/00      Treating composite or clad material**

C21D 2251/02 . Clad material

C21D 2251/04 . Welded or brazed overlays

**C21D 2261/00      Machining or cutting being involved**

**C21D 2281/00      Making use of special physico-chemical means**

C21D 2281/01 . Seed crystals being used

C21D 2281/02 . temperature gradient