

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 (cold coilers B21C)
C21D 9/70	. Furnaces for ingots, i.e. soaking pits
C21D 10/00	Modifying the physical properties by methods other than heat treatment or deformation
C21D 10/005	. { by laser shock processing }
C21D 11/00	Process control or regulation for heat treatments (controlling or regulating in general G05)
C21D 11/005	. { for cooling }
C21D 2201/00	Treatment for obtaining particular effects
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
C21D 2211/00	Microstructure comprising significant phases
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