

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)
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- 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