

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