

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

[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

[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
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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