CPC COOPERATIVE PATENT CLASSIFICATION

G PHYSICS

(NOTES omitted)

NUCLEONICS

G21 NUCLEAR PHYSICS; NUCLEAR ENGINEERING

G21C NUCLEAR REACTORS (fusion reactors, hybrid fission-fusion reactors G21B; nuclear explosives G21J)

WARNINGS

1. The following IPC groups are not in the CPC scheme. The subject matter for these IPC groups is classified in the following CPC groups:
   G21C 19/33 covered by G21C 19/34
2. In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

1/00 Reactor types

1/02 . Fast fission reactors, i.e. reactors not using a moderator {; Metal cooled reactors; Fast breeders}

1/022 . . {characterised by the design or properties of the core}

1/024 . . . {where the core is divided in zones with fuel and zones with breeding material}

1/026 . . . {Reactors not needing refueling, i.e. reactors of the type breed-and-burn, e.g. travelling or deflagration wave reactors or seed-blanket reactors}

1/028 . . {cooled by a pressurised coolant (cooling arrangements G21C 15/00)}

1/03 . . cooled by a coolant not essentially pressurised, e.g. pool-type reactors

1/04 . Thermal reactors {; Epithermal reactors}

1/06 . . Heterogeneous reactors, i.e. in which fuel and moderator are separated

1/07 . . . Pebble-bed reactors; Reactors with granular fuel

1/08 . . . moderator being highly pressurised, e.g. boiling water reactor, integral super-heat reactor, pressurised water reactor (G21C 1/22 takes precedence)

1/082 . . . . {Reactors where the coolant is overheated}

1/084 . . . . {Boiling water reactors}

1/086 . . . . {Pressurised water reactors}

1/088 . . . . {Inherently safe boiling water reactors}

1/09 . . . . Pressure regulating arrangements, i.e. pressurisers

1/10 . . . . moderator and coolant being different or separated

1/12 . . . . . moderator being solid, e.g. Magnox reactor {or gas-graphite reactor}

1/14 . . . moderator being substantially not pressurised, e.g. swimming-pool reactor (G21C 1/22 takes precedence)

1/16 . . . . moderator and coolant being different or separated, e.g. sodium-graphite reactor {, sodium-heavy water reactor or organic coolant-heavy water reactor}

1/18 . . . . . coolant being pressurised

1/20 . . . . . moderator being liquid, e.g. pressure-tube reactor

1/22 . . . using liquid or gaseous fuel

1/24 . . Homogeneous reactors, i.e. in which the fuel and moderator present an effectively homogeneous medium to the neutrons

1/26 . . . Single-region reactors

1/28 . . . Two-region reactors

1/30 . Subcritical reactors {; Experimental reactors other than swimming-pool reactors or zero-energy reactors}

1/303 . . {Experimental or irradiation arrangements inside the reactor (irradiation loops G21C 1/306)}

1/306 . . {Irradiation loops}

1/32 . Integral reactors, i.e. reactors wherein parts functionally associated with the reactor but not essential to the reaction, e.g. heat exchangers, are disposed inside the enclosure with the core (G21C 1/02 - G21C 1/30 take precedence)

1/322 . . {wherein the heat exchanger is disposed above the core}

1/324 . . {wherein the heat exchanger is disposed beneath the core}

1/326 . . {wherein the heat exchanger is disposed next to or beside the core}

1/328 . . {wherein the prime mover is also disposed in the vessel}

3/00 Reactor fuel elements and their assemblies; Selection of substances for use as reactor fuel elements

3/02 . Fuel elements {(manufacture thereof G21C 21/02)}

3/04 . . Constructional details

3/041 . . . {Means for removal of gases from fuel elements}

3/042 . . . {Fuel elements comprising casings with a mass of granular fuel with coolant passages through them}

3/044 . . . {Fuel elements with porous or capillary structure}

3/045 . . . {Pellets}

3/047 . . . . {Pellet-clad interaction}
3/048 . . . . {Shape of pellets}
3/06 . . . Casings; Jackets
3/07 . . . . characterised by their material, e.g. alloys
3/08 . . . . provided with external means to promote heat-transfer, e.g. fins, baffles
3/10 . . . . End closures {; Means for tight mounting therefor}
3/105 . . . . . {Flattened end-closures}
3/12 . . . . Means forming part of the element for locating it within the reactor core {(means not forming part of the element G21C 5/06)}
3/14 . . . . Means forming part of the element for inserting it into, or removing it from, the core; Means for coupling adjacent elements {, e.g. to form a stringer}
3/16 . . . Details of the construction within the casing
3/17 . . . . Means for storage or immobilisation of gases in fuel elements
3/18 . . . . Internal spacers or other non-active material within the casing, e.g. compensating for expansion of fuel rods or for compensating excess reactivity (interlayers G21C 3/20)
3/20 . . . . with coating on fuel or on inside of casing; with non-active interlayer between casing and active material {with multiple casings or multiple active layers}
3/22 . . with fissile or breeder material in contact with coolant
3/24 . . with fissile or breeder material in fluid form within a non-active casing
3/26 . . with fissile or breeder material in powder form within a non-active casing
3/28 . . with fissile or breeder material in solid form within a non-active casing
3/30 . Assemblies of a number of fuel elements in the form of a rigid unit
3/32 . . Bundles of parallel pin-, rod-, or tube-shaped fuel elements
3/3206 . . . {Means associated with the fuel bundle for filtering the coolant, e.g. nozzles, grids}
3/3213 . . . {Means for the storage or removal of fission gases (means for the storage of fission gases in the elements G21C 3/16; means for the removal of fission gases from elements G21C 3/04)}
3/322 . . . Means to influence the coolant flow through or around the bundles
3/3225 . . . . {by waterrods}
3/324 . . . Coats or envelopes for the bundles
3/3245 . . . . {made of moderator material}
3/326 . . . comprising fuel elements of different composition; comprising, in addition to the fuel elements, other pin-, rod-, or tube-shaped elements, e.g. control rods, grid support rods, fertile rods, poison rods or dummy rods
3/3262 . . . . {Enrichment distribution in zones}
3/3265 . . . . . {Radial distribution}
3/3267 . . . . . {Axial distribution}
3/328 . . . . Relative disposition of the elements in the bundle lattice
3/33 . . . Supporting or hanging of elements in the bundle (spacer grids G21C 3/34); Means forming part of the bundle for inserting it into, or removing it from, the core; Means for coupling adjacent bundles
3/3305 . . . . {Lower nozzle}
3/331 . . . . {Comprising hold-down means, e.g. springs}
3/3315 . . . . {Upper nozzle}
3/332 . . . . Supports for spacer grids
3/334 . . . Assembling {, maintenance or repair of} the bundles {(assembling, maintenance or repair of other reactor components G21C 19/207)}
3/335 . . . Exchanging elements in irradiated bundles
3/336 . . . Spacer elements for fuel rods in the bundle (spacer grids G21C 3/34)
3/338 . . . . Helicoidal spacer elements
3/34 . . . Spacer grids
3/3408 . . . . {Compact spacer grids, e.g. made of a plate or a blade}
3/3416 . . . . {Spacer grids formed by metallic wires, e.g. springs}
3/3424 . . . . {Fabrication of spacer grids}
3/3432 . . . . {Grids designed to influence the coolant, i.e. coolant mixing function}
3/344 . . . . formed of assembled tubular elements
3/348 . . . . formed of assembled non-intersecting strips
3/352 . . . . formed of assembled intersecting strips
3/356 . . . . being provided with fuel element supporting members
3/3563 . . . . . {Supporting members formed only by deformations in the strips}
3/3566 . . . . . {Supporting members formed only of elements fixed on the strips}
3/36 . . Assemblies of plate-shaped fuel elements or coaxial tubes
3/38 . Fuel units consisting of a single fuel element in a supporting sleeve {or in another supporting element}
3/40 . Structural combination of fuel element with thermoelectric element for direct production of electric energy from fission heat (for temperature measurement G21C 17/10) {or with another arrangement for direct production of electric energy, e.g. a thermionic device (combination with thermoelements for temperature measurements G21C 17/102)}
3/42 . Selection of substances for use as reactor fuel
3/44 . . Fluid or fluent reactor fuel
3/46 . . . Aqueous compositions
3/48 . . . . True or colloidal solutions of the active constituent
3/50 . . . . Suspensions of the active constituent; Slurries
3/52 . . . Liquid metal compositions
3/54 . . . Fused salt, oxide or hydroxide compositions
3/56 . . . Gaseous compositions; Suspensions in a gaseous carrier
3/58 . . Solid reactor fuel {Pellets made of fissile material}
3/60 . . . Metallic fuel; Intermetallic dispersions
3/62 . . . Ceramic fuel
3/623 . . . . {Oxide fuels}
3/626 . . . . {Coated fuel particles}

3/64 . . . . Ceramic dispersion fuel, e.g. cermet

5/00 Moderator or core structure; Selection of materials for use as moderator

5/02 . Details
5/04 . . Spatial arrangements allowing for Wigner growth
5/06 . . Means for locating or supporting fuel elements {(means forming part of the element G21C 3/12)}
5/08 . . Means for preventing undesired asymmetric expansion of the complete structure {; Stretching devices, pins}
5/10 . . Means for supporting the complete structure {(arrangements for supporting vessels and core-structures G21C 13/024)}
5/12 . characterised by composition, e.g. the moderator containing additional substances which ensure improved heat resistance of the moderator {(purification of fluid moderators during the operation of the reactor G21C 19/30)}
5/123 . . {Moderators made of organic materials}
5/126 . . {Carbonic moderators (carbon and graphite in general C01B 32/00; refractory carbon-bulbs C04B 35/00; carbon electrodes C25B)}
5/14 . characterised by shape
5/16 . . Shape of its constituent parts
5/18 . characterised by the provision of more than one active zone
5/20 . . wherein one zone contains fissile material and another zone contains breeder material
5/22 . . wherein one zone is a superheating zone

7/00 Control of nuclear reaction

7/005 . {Flux flattening}
7/02 . by using self-regulating properties of reactor materials, {e.g. Doppler effect} (arrangements that involve temperature stability G21C 7/32)
7/04 . . of burnable poisons (burnable poisons in fuel rods G21C 3/326)
7/06 . by application of neutron-absorbing material, i.e. material with absorption cross-section very much in excess of reflection cross-section
7/08 . . by displacement of solid control elements, e.g. control rods
7/10 . . . Construction of control elements
7/103 . . . . Control assemblies containing one or more absorbants as well as other elements, e.g. fuel or moderator elements
7/107 . . . . Control elements adapted for pebble-bed reactors
7/11 . . . . Deformable control elements, e.g. flexible, telescopic, articulated
7/113 . . . . Control elements made of flat elements; Control elements having cruciform cross-section
7/117 . . . . Clusters of control rods; Spider construction
7/12 . . . Means for moving control elements to desired position (dropping rods in an emergency G21C 9/02)
7/14 . . . . Mechanical drive arrangements
7/16 . . . . Hydraulic or pneumatic drive
7/18 . . . Means for obtaining differential movement of control elements
7/20 . . . Disposition of shock-absorbing devices (shock-absorbers in general F16F) {; Braking arrangements}
7/22 . . by displacement of a fluid or fluent neutron-absorbing material {, e.g. by adding neutron-absorbing material to the coolant}
7/24 . . Selection of substances for use as neutron-absorbing material
7/26 . by displacement of the moderator or parts thereof {by changing the moderator concentration}
7/27 . . Spectral shift control
7/28 . by displacement of the reflector or parts thereof
7/30 . by displacement of the reactor fuel or fuel elements
7/32 . by varying flow of coolant through the core {by adjusting the coolant or moderator temperature}
7/34 . by utilisation of a primary neutron source
7/36 . Control circuits

9/00 Emergency protection arrangements structurally associated with the reactor {, e.g. safety valves provided with pressure equalisation devices} (emergency cooling arrangements G21C 15/18)

9/001 . {against explosions, e.g. blast shields}
9/002 . {against Na- or Ka- reactions}
9/004 . Pressure suppression
9/008 . . by rupture-discs or -diaphragms
9/012 . . by thermal accumulation or by steam condensation, e.g. ice condensers
9/016 . Core catchers
9/02 . Means for effecting very rapid reduction of the reactivity factor under fault conditions, e.g. reactor fuse; {Control elements having arrangements activated in an emergency} (control elements per se G21C 7/00)
9/022 . . {Reactor fuses}
9/024 . . {Rupture diaphragms}
9/027 . . by fast movement of a solid, e.g. pebbles
9/033 . . by an absorbent fluid
9/04 . Means for suppressing fires {Earthquake protection}
9/06 . . Means for preventing accumulation of explosives gases, e.g. recombiners

11/00 Shielding structurally associated with the reactor

11/02 . Biological shielding (in general G21F) {; Neutron or gamma shielding}
11/022 . . {inside the reactor vessel}
11/024 . . . {structurally combined with the casing}
11/026 . . {in apertures or channels through a wall}
11/028 . . {characterised by the form or by the material}
11/04 . . on waterborne craft
11/06 . Reflecting shields, i.e. for minimising loss of neutrons
11/08 . Thermal shields; Thermal linings, i.e. for dissipating heat from gamma radiation which would otherwise heat an outer biological shield {Thermal insulation}
11/081 . . {consisting of a non-metallic layer of insulating material}
11/083 . . {consisting of one or more metallic layers}
11/085 . . . {consisting exclusively of several metallic layers}
11/086 . . {consisting of a combination of non-metallic and metallic layers, e.g. metal-sand-metal-concrete}
11/088 . . {consisting of a stagnant or a circulating fluid}

13/00 **Pressure vessels; Containment vessels; Containment in general** (for chemical or physical processes B01J 3/00; pressure vessels in general F16J 12/00)

13/02 . Details
13/022 . . {Ventilating arrangements}
13/024 . . Supporting constructions for pressure vessels or containment vessels
13/028 . . Seals, e.g. for pressure vessels or containment vessels
13/0285 . . . {for container apertures}
13/032 . . Joints between tubes and vessel walls, e.g. taking into account thermal stresses
13/036 . . . the tube passing through the vessel wall, i.e. continuing on both sides of the wall
13/04 . . Arrangements for expansion and contraction
13/06 . . Sealing-plugs (for pressure vessels in general F16J 13/00)
13/063 . . . {Seals for closures or for rotatable closures}
13/067 . . . for tubes, e.g. standpipes; Locking devices for plugs
13/0675 . . . . {Seals for the plugs}
13/073 . . . Closures for reactor-vessels, e.g. rotatable
13/0735 . . . . {Seals for closures or for rotatable closures}
13/08 . Vessels characterised by the material; Selection of materials for pressure vessels
13/087 . . Metallic vessels
13/0875 . . . {Tube-type vessels, e.g. for not essentially pressurised coolants}
13/093 . . Concrete vessels
13/0933 . . . {made of prestressed concrete}
13/0936 . . . . {Particulars concerning prestressing devices and cables}
13/10 . Means for preventing contamination in the event of leakage, {e.g. double wall}

15/00 **Cooling arrangements within the pressure vessel containing the core; Selection of specific coolants**

15/02 . Arrangements or disposition of passages in which heat is transferred to the coolant; {Coolant flow control devices (G21C 19/04 takes precedence; coolant flow control through fuel assemblies, e.g. flow restrictors G21C 3/322)}
15/04 . . from fissile or breeder material {(G21C 3/32 takes precedence)}
15/06 . . . in fuel elements
15/08 . . from moderating material
15/10 . . from reflector or thermal shield
15/12 . . from pressure vessel; from containment vessel
15/14 . . from headers; from joints in ducts
15/16 . comprising means for separating liquid and steam (separating in general B01D; steam traps F16D)
15/18 . Emergency cooling arrangements; Removing shut-down heat
15/182 . . {comprising powered means, e.g. pumps}
15/185 . . . {using energy stored in reactor system}
15/187 . . . {using energy from the electric grid}
15/20 . Partitions or thermal insulation between fuel channel and moderator
15/22 . Structural association of coolant tubes with headers (joints of tubes in general F16L)
15/24 . Promoting flow of the coolant (electrodynamic pumps H02K 44/02)
15/243 . . for liquids
15/247 . . . for liquid metals
15/25 . . . using jet pumps
15/253 . . for gases, e.g. blowers
15/257 . . using heat-pipes {(in general F28D, F28F)}
15/26 . . by convection, e.g. using chimneys, using divergent channels
15/28 . Selection of specific coolants (if serving as the moderator G21C 5/12; compositions per se C09K 5/00; {organic coolants G21C 5/123}); {Additions to the reactor coolants, e.g. against moderator corrosion (purification and regeneration of the reactor coolants G21C 19/30)}

17/00 **Monitoring; Testing** (measuring in general G01); **{Maintaining}**

17/001 . {Mechanical simulators (electrical or magnetic simulators G06G 7/54)}
17/002 . {Detection of leaks (by testing the coolant or the moderator G21C 17/04)}
17/003 . Remote inspection of vessels, e.g. pressure vessels
17/007 . . Inspection of the outer surfaces of vessels
17/01 . . Inspection of the inner surfaces of vessels
17/013 . . Inspection vehicles
17/017 . Inspection or maintenance of pipe-lines or tubes in nuclear installations
17/02 . Devices or arrangements for monitoring coolant or moderator
17/021 . . {Solid moderators testing, e.g. graphite}
17/022 . . for monitoring liquid coolants or moderators
17/0225 . . . {Chemical surface treatment, e.g. corrosion (corrosion prevention in presence of water from scale removal or by modification of the properties of the liquid C02F 5/00; inhibiting corrosion by adding corrosion inhibitors C23F 11/00)}
17/025 . . . for monitoring liquid metal coolants {(molten metal sampling in general G01N 1/125)}
17/0255 . . . . {Liquid metal leaks detection (detecting leaks in pipe-line systems in general F17D 5/00)}
17/028 . . for monitoring gaseous coolants
17/032 . . Reactor-coolant flow measuring or monitoring {(measuring volume or mass flow in general G01F)}
17/035 . . Moderator- or coolant-level detecting devices {(indicating or measuring liquid level in general G01F 23/00)}
17/038 . . Boiling detection in moderator or coolant
17/04 . . Detecting burst slugs
17/041 . . . {characterised by systems for checking the coolant channels, e.g. matrix systems}
17/042 . . . {Devices for selective sampling, e.g. valves, shutters, rotatable selector valves}
17/044 . . . {Detectors and metering devices for the detection of fission products}
17/045 . . . . {Precipitation chambers}
17/047 . . . . {Detection and metering circuits}
17/048 . . . {characterised by a special construction of fuel elements, e.g. by a confined "tracer"}
17/06 . Devices or arrangements for monitoring or testing fuel or fuel elements outside the reactor core, e.g. for burn-up, for contamination (G21C 17/08, G21C 17/10 take precedence; detecting leaking fuel elements during reactor operation G21C 17/04)

17/063 . . {Burn-up control (G21C 17/066 takes precedence)}
17/066 . . {Control of spherical elements}
17/07 . . Leak testing
17/08 . Structural combination of reactor core or moderator structure with viewing means, e.g. with television camera, periscope, window
17/10 . Structural combination of fuel element, control rod, reactor core, or moderator structure with sensitive instruments, e.g. for measuring radioactivity, strain
17/102 . . {the sensitive element being part of a fuel element or a fuel assembly (structural combination with a thermoelectric element for direct production of electrical energy G21C 3/40)}
17/104 . . Measuring reactivity
17/108 . . Measuring reactor flux
17/112 . . Measuring temperature
17/116 . . Passages or insulators, e.g. for electric cables
17/12 . . Sensitive element forming part of control element
17/14 . Period meters

19/00 Arrangements for treating, for handling, or for facilitating the handling of, fuel or other materials which are used within the reactor, e.g. within its pressure vessel

19/02 . Details of handling arrangements
19/04 . . Means for controlling flow of coolant over objects being handled; Means for controlling flow of coolant through channel being serviced {, e.g. for preventing "blow-out"}
19/06 . . Magazines for holding fuel elements or control elements
19/065 . . . {Rotatable magazines}
19/07 . . . Storage racks; Storage pools
19/08 . . Means for heating fuel elements before introduction into the core; Means for heating or cooling fuel elements after removal from the core
19/10 . . Lifting devices or pulling devices adapted for co-operation with fuel elements or with control elements (manipulators B25J)
19/105 . . . with grasping or spreading coupling elements
19/11 . . . with revolving coupling elements, e.g. socket coupling
19/115 . . . with latching devices and ball couplings
19/12 . . Arrangements for exerting direct hydraulic or pneumatic force on fuel element or on control element
19/14 . characterised by their adaptation for use with horizontal channels in the reactor core
19/16 . Articulated or telescopic chutes or tubes for connection to channels in the reactor core
19/18 . Apparatus for bringing fuel elements to the reactor charge area, e.g. from a storage place
19/19 . Reactor parts specifically adapted to facilitate handling, e.g. to facilitate charging or discharging of fuel elements
19/20 . Arrangements for introducing objects into the pressure vessel; Arrangements for handling objects within the pressure vessel; Arrangements for removing objects from the pressure vessel
19/202 . . {Arrangements for handling ball-form, i.e. pebble fuel}
19/205 . . {Interchanging of fuel elements in the core, i.e. fuel shuffling}
19/207 . . {Assembling, maintenance or repair of reactor components (G21C 3/334 takes precedence)}
19/22 . . Arrangements for obtaining access to the interior of a pressure vessel whilst the reactor is operating
19/24 . . . by using an auxiliary vessel which is temporarily sealed to the pressure vessel
19/26 . Arrangements for removing jammed or damaged fuel elements or control elements; Arrangements for moving broken parts thereof
19/28 . Arrangements for introducing fluent material into the reactor core; Arrangements for removing fluent material from the reactor core (pumping coolant G21D)
19/30 . . with continuous purification of circulating fluent material, e.g. by extraction of fission products {deterioration or corrosion products, impurities, e.g. by cold traps (purification of circulating fluid fuels G21C 19/50; separation in general B01D)}
19/303 . . . specially adapted for gases (decontamination of gases G21F 9/02)
19/307 . . . specially adapted for liquids (decontamination of liquids G21F 9/04)
19/31 . . . . for molten metals
19/313 . . . . . using cold traps
19/317 . . . Recombination devices for radiolytic dissociation products
19/32 . Apparatus for removing radioactive objects or materials from the reactor discharge area, e.g. to a storage place; Apparatus for handling radioactive objects or materials within a storage place or removing them therefrom (disposal of waste material G21F 9/00)
19/34 . Apparatus or processes for dismantling nuclear fuel, e.g. before reprocessing {; Apparatus or processes for dismantling strings of spent fuel elements} (shielded cells G21F 7/00)
19/36 . . Mechanical means only
19/365 . . . Removing cannings or casings from fuel
19/37 . . . . by separating into pieces both the canning or the casing and the fuel element, e.g. by cutting or shearing
19/375 . . . Compacting devices, e.g. for fuel assemblies
19/38 . . Chemical means only
19/40 . Arrangements for preventing occurrence of critical conditions, e.g. during storage
19/42 . Reprocessing of irradiated fuel
19/44 . . of irradiated solid fuel
19/46 . . . Aqueous processes {, e.g. by using organic extraction means, including the regeneration of these means}
19/48 . . . Non-aqueous processes
19/50 . . of irradiated fluid fuel {, e.g. regeneration of fuels while the reactor is in operation}

21/00 Apparatus or processes specially adapted to the manufacture of reactors or parts thereof (in general section B, e.g. B23)

21/02 . Manufacture of fuel elements or breeder elements contained in non-active casings
21/04 . . by vibrational compaction or tamping {of fuel in the jacket}
21/06 . . by {rotatable} swaging {of the jacket around the fuel}
21/08 . . by a slip-fit cladding process {by crimping the jacket around the fuel}

21/10 . . by extrusion, drawing, or stretching {by rolling, e.g. "picture frame" technique}

21/12 . . by hydrostatic or thermo-pneumatic canning {in general by pressing without lengthening, e.g. explosive coating}

21/14 . . by plating {the fuel} in a fluid

21/16 . . by casting or dipping techniques

21/18 . Manufacture of control elements covered by group G21C 7/00

23/00 Adaptations of reactors to facilitate experimentation or irradiation