SECTION G — PHYSICS

G21 NUCLEAR PHYSICS; NUCLEAR ENGINEERING

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

Subclass index

1/00 Reactor types [1, 2006.01]

1/02 • Fast fission reactors, i.e. reactors not using a moderator **[1, 2006.01]**

1/03 • • cooled by a coolant not essentially pressurised, e.g. pool-type reactors **[5, 2006.01]**

1/04 • Thermal reactors **[1, 2006.01]**

1/06 • • Heterogeneous reactors, i.e. in which fuel and moderator are separated **[1, 2006.01]**

1/07 • • • Pebble-bed reactors; Reactors with granular fuel **[5, 2006.01]**

1/08 • • • moderator being highly pressurised, e.g. boiling-water reactor, integral-superheat reactor, pressurised-water reactor (G21C 1/22 takes precedence) **[1, 2006.01]**

1/09 • • • • Pressure regulating arrangements, i.e. pressurisers **[5, 2006.01]**

1/10 • • • • moderator and coolant being different or separated **[1, 2006.01]**

1/12 • • • • • moderator being solid, e.g. Magnox reactor **[1, 2006.01]**

1/14 • • • moderator being substantially not pressurised, e.g. swimming-pool reactor (G21C 1/22 takes precedence) **[1, 2006.01]**

1/16 • • • • moderator and coolant being different or separated, e.g. sodium-graphite reactor **[1, 2006.01]**

1/18 • • • • • coolant being pressurised **[1, 2006.01]**

1/20 • • • • • • moderator being liquid, e.g. pressure-tube reactor **[1, 2006.01]**

1/22 • • • using liquid or gaseous fuel **[1, 2006.01]**

1/24 • • Homogeneous reactors, i.e. in which fuel and moderator present an effectively homogeneous medium to the neutrons **[1, 2006.01]**

1/26 • • • Single-region reactors **[1, 2006.01]**

1/28 • • • Two-region reactors **[1, 2006.01]**

1/30 • Subcritical reactors **[1, 2006.01]**

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) **[3, 2006.01]**

3/00 Reactor fuel elements or their assemblies; Selection of substances for use as reactor fuel elements [1, 2006.01]

3/02 • Fuel elements **[1, 2006.01]**

3/04 • • Constructional details **[1, 2006.01]**

3/06 • • • Casings; Jackets **[1, 2006.01]**

3/07 • • • • characterised by their material, e.g. alloys **[5, 2006.01]**

3/08 • • • • provided with external means to promote heat-transfer, e.g. fins, baffles, corrugations **[1, 2006.01]**

3/10 • • • • End closures **[1, 2006.01]**

3/12 • • • • Means forming part of the element for locating it within the reactor core; External spacers for this purpose **[1, 2006.01]**

3/14 • • • • Means forming part of the element for inserting it into, or removing it from, the core; Means for coupling adjacent elements **[1, 2006.01]**

3/16 • • • Details of the construction within the casing **[1, 2006.01]**

3/17 • • • • Means for storage or immobilisation of gases in fuel elements **[5, 2006.01]**

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) **[1, 2006.01]**

3/20 • • • • with coating on fuel or on inside of casing; with non-active interlayer between casing and active material **[1, 2006.01]**

3/22 • • with fissile or breeder material in contact with coolant **[1, 2006.01]**

3/24 • • with fissile or breeder material in fluid form within a non-active casing **[1, 2006.01]**

3/26 • • with fissile or breeder material in powder form within a non-active casing **[1, 2006.01]**
3/28 • • with fissile or breeder material in solid form within a non-active casing **[1, 2006.01]**
3/30 • Assemblies of a number of fuel elements in the form of a rigid unit **[1, 2006.01]**
3/32 • • Bundles of parallel pin-, rod-, or tube-shaped fuel elements **[1, 2006.01]**
3/322 • • • Means to influence the coolant flow through or around the bundles **[5, 2006.01]**
3/324 • • • Coats or envelopes for the bundles **[5, 2006.01]**
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 **[5, 2006.01]**
3/328 • • • • Relative disposition of the elements in the bundle lattice **[5, 2006.01]**
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 **[5, 2006.01]**
3/332 • • • • Supports for spacer grids **[5, 2006.01]**
3/334 • • • Assembling the bundles **[5, 2006.01]**
3/335 • • • Exchanging elements in irradiated bundles **[5, 2006.01]**
3/336 • • • Spacer elements for fuel rods in the bundle (spacer grids G21C 3/34) **[5, 2006.01]**
3/338 • • • • Helicoidal spacer elements **[5, 2006.01]**
3/34 • • • Spacer grids **[1, 2006.01]**
3/344 • • • • formed of assembled tubular elements **[5, 2006.01]**
3/348 • • • • formed of assembled non-intersecting strips **[5, 2006.01]**
3/352 • • • • formed of assembled intersecting strips **[5, 2006.01]**
3/356 • • • • being provided with fuel element supporting members **[5, 2006.01]**
3/36 • • Assemblies of plate-shaped fuel elements or coaxial tubes **[1, 2006.01]**
3/38 • Fuel units consisting of a single fuel element in a supporting sleeve **[1, 2006.01]**
3/40 • Structural combination of fuel element with thermoelectric element for direct production of electric energy from fission heat (structural combination of fuel element with instruments for temperature measurement G21C 17/112) **[1, 2006.01]**
3/42 • Selection of substances for use as reactor fuel **[1, 2006.01]**
3/44 • • Fluid or fluent reactor fuel **[1, 2006.01]**
3/46 • • • Aqueous compositions **[1, 2006.01]**
3/48 • • • • True or colloidal solutions of the active constituent **[1, 2006.01]**
3/50 • • • • Suspensions of the active constituent; Slurries **[1, 2006.01]**
3/52 • • • Liquid metal compositions **[1, 2006.01]**
3/54 • • • Fused salt, oxide, or hydroxide compositions **[1, 2006.01]**
3/56 • • • Gaseous compositions; Suspensions in a gaseous carrier **[1, 2006.01]**
3/58 • • Solid reactor fuel **[1, 2006.01]**
3/60 • • • Metallic fuel; Intermetallic dispersions **[1, 2006.01]**
3/62 • • • Ceramic fuel **[1, 2006.01]**
3/64 • • • • Ceramic dispersion fuel, e.g. cermet **[1, 2006.01]**

5/00 Moderator or core structure; Selection of materials for use as moderator [1, 2006.01]
5/02 • Details **[1, 2006.01]**
5/04 • • Spatial arrangements allowing for Wigner growth **[1, 2006.01]**
5/06 • • Means for locating or supporting fuel elements **[1, 2006.01]**
5/08 • • Means for preventing undesired asymmetric expansion of the complete structure **[1, 2006.01]**
5/10 • • Means for supporting the complete structure **[1, 2006.01]**
5/12 • characterised by composition, e.g. the moderator containing additional substances which ensure improved heat resistance of the moderator **[1, 2006.01]**
5/14 • characterised by shape **[1, 2006.01]**
5/16 • • Shape of its constituent parts **[1, 2006.01]**
5/18 • characterised by the provision of more than one active zone **[1, 2006.01]**
5/20 • • wherein one zone contains fissile material and another zone contains breeder material **[1, 2006.01]**
5/22 • • wherein one zone is a superheating zone **[1, 2006.01]**

7/00 Control of nuclear reaction [1, 2006.01]
7/02 • by using self-regulating properties of reactor materials (arrangements that involve temperature stability G21C 7/32) **[1, 2006.01]**
7/04 • • of burnable poisons (burnable poisons in fuel rods G21C 3/326) **[1, 5, 2006.01]**
7/06 • by application of neutron-absorbing material, i.e. material with absorption cross-section very much in excess of reflection cross-section **[1, 2006.01]**
7/08 • • by displacement of solid control elements, e.g. control rods **[1, 2006.01]**
7/10 • • • Construction of control elements **[1, 2006.01]**
7/103 • • • • Control assemblies containing one or more absorbants as well as other elements, e.g. fuel or moderator elements **[5, 2006.01]**
7/107 • • • • Control elements adapted for pebble-bed reactors **[5, 2006.01]**
7/11 • • • • Deformable control elements, e.g. flexible, telescopic, articulated **[5, 2006.01]**
7/113 • • • • Control elements made of flat elements; Control elements having cruciform cross-section **[5, 2006.01]**
7/117 • • • • Clusters of control rods; Spider construction **[5, 2006.01]**
7/12 • • • Means for moving control elements to desired position (dropping control rods into the reactor core in an emergency G21C 9/02) **[1, 2006.01]**
7/14 • • • • Mechanical drive arrangements **[1, 2006.01]**
7/16 • • • • Hydraulic or pneumatic drive arrangements **[1, 2006.01]**
7/18 • • • Means for obtaining differential movement of control elements **[1, 2006.01]**
7/20 • • • Disposition of shock-absorbing devices **[1, 2006.01]**
7/22 • • by displacement of a fluid or fluent neutron-absorbing material **[1, 2006.01]**
7/24 • • Selection of substances for use as neutron-absorbing material **[1, 2006.01]**

7/26 • by displacement of the moderator or parts thereof **[1, 2006.01]**
7/27 • • Spectral shift control **[5, 2006.01]**
7/28 • by displacement of the reflector or parts thereof **[1, 2006.01]**
7/30 • by displacement of reactor fuel or fuel elements **[1, 2006.01]**
7/32 • by varying flow of coolant through the core **[1, 2006.01]**
7/34 • by utilisation of a primary neutron source **[1, 2006.01]**
7/36 • Control circuits **[1, 2006.01]**

9/00 Emergency protection arrangements structurally associated with the reactor (emergency cooling arrangements G21C 15/18) **[1, 2006.01]**
9/004 • Pressure suppression **[5, 2006.01]**
9/008 • • by rupture-discs or -diaphragms **[5, 2006.01]**
9/012 • • by thermal accumulation or by steam condensation, e.g. ice condensers **[5, 2006.01]**
9/016 • Core catchers **[5, 2006.01]**
9/02 • Means for effecting very rapid reduction of the reactivity factor under fault conditions, e.g. reactor fuse **[1, 2006.01]**
9/027 • • by fast movement of a solid, e.g. pebbles **[5, 2006.01]**
9/033 • • by an absorbent fluid **[5, 2006.01]**
9/04 • Means for suppressing fires **[1, 2006.01]**
9/06 • • Means for preventing accumulation of explosives gases, e.g. recombiners **[5, 2006.01]**

11/00 Shielding structurally associated with the reactor [1, 2006.01]
11/02 • Biological shielding **[1, 2006.01]**
11/04 • • on waterborne craft **[1, 2006.01]**
11/06 • Reflecting shields, i.e. for minimising loss of neutrons **[1, 2006.01]**
11/08 • Thermal shields; Thermal linings, i.e. for dissipating heat from gamma radiation which would otherwise heat an outer biological shield **[1, 2006.01]**

13/00 Pressure vessels; Containment vessels; Containment in general [1, 2006.01]
13/02 • Details **[1, 2006.01]**
13/024 • • Supporting constructions for pressure vessels or containment vessels **[5, 2006.01]**
13/028 • • Seals, e.g. for pressure vessels or containment vessels **[5, 2006.01]**
13/032 • • Joints between tubes and vessel walls, e.g. taking into account thermal stresses **[5, 2006.01]**
13/036 • • • the tube passing through the vessel wall, i.e. continuing on both sides of the wall **[5, 2006.01]**
13/04 • • Arrangements for expansion and contraction **[1, 2006.01]**
13/06 • • Sealing-plugs **[1, 2006.01]**
13/067 • • • for tubes, e.g. standpipes; Locking devices for plugs **[5, 2006.01]**
13/073 • • • Closures for reactor-vessels, e.g. rotatable **[5, 2006.01]**
13/08 • Vessels characterised by the material; Selection of materials for pressure vessels **[1, 2006.01]**
13/087 • • Metallic vessels **[5, 2006.01]**
13/093 • • Concrete vessels **[5, 2006.01]**
13/10 • Means for preventing contamination in event of leakage **[1, 2006.01]**

15/00 Cooling arrangements within the pressure vessel containing the core; Selection of specific coolants [1, 2006.01]
15/02 • Arrangement or disposition of passages in which heat is transferred to the coolant, e.g. for coolant circulation through the supports of the fuel elements **[1, 2006.01]**
15/04 • • from fissile or breeder material **[1, 2006.01]**
15/06 • • • in fuel elements **[1, 2006.01]**
15/08 • • from moderating material **[1, 2006.01]**
15/10 • • from reflector or thermal shield **[1, 2006.01]**
15/12 • • from pressure vessel; from containment vessel **[1, 2006.01]**
15/14 • • from ducts conducting a hot fluid; from ducts comprising auxiliary apparatus, e.g. pumps, cameras **[1, 2006.01]**
15/16 • comprising means for separating liquid and steam **[1, 2006.01]**
15/18 • Emergency cooling arrangements; Removing shut-down heat **[1, 2006.01]**
15/20 • Partitions or thermal insulation between fuel channel and moderator, e.g. in pressure tube reactors **[1, 2006.01]**
15/22 • Structural association of coolant tubes with headers or other pipes, e.g. in pressure tube reactors **[1, 4, 2006.01]**
15/24 • Promoting flow of the coolant **[1, 2006.01]**
15/243 • • for liquids **[5, 2006.01]**
15/247 • • • for liquid metals **[5, 2006.01]**
15/25 • • • using jet pumps **[5, 2006.01]**
15/253 • • for gases, e.g. blowers **[5, 2006.01]**
15/257 • • using heat-pipes **[5, 2006.01]**
15/26 • • by convection, e.g. using chimneys, using divergent channels **[1, 2006.01]**
15/28 • Selection of specific coolants (if serving as the moderator G21C 5/12) **[1, 2006.01]**

17/00 Monitoring; Testing [1, 2006.01]
17/003 • Remote inspection of vessels, e.g. pressure vessels **[5, 2006.01]**
17/007 • • Inspection of the outer surfaces of vessels **[5, 2006.01]**
17/01 • • Inspection of the inner surfaces of vessels **[5, 2006.01]**
17/013 • • Inspection vehicles **[5, 2006.01]**
17/017 • Inspection or maintenance of pipe-lines or tubes in nuclear installations **[5, 2006.01]**
17/02 • Devices or arrangements for monitoring coolant or moderator **[1, 2006.01]**
17/022 • • for monitoring liquid coolants or moderators **[5, 2006.01]**
17/025 • • • for monitoring liquid metal coolants **[5, 2006.01]**
17/028 • • for monitoring gaseous coolants **[5, 2006.01]**
17/032 • • Reactor-coolant flow measuring or monitoring **[5, 2006.01]**
17/035 • • Moderator- or coolant-level detecting devices **[5, 2006.01]**
17/038 • • Boiling detection in moderator or coolant **[5, 2006.01]**
17/04 • • Detecting burst slugs **[1, 2006.01]**
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) **[1, 2006.01]**

17/07 • • Leak testing **[5, 2006.01]**
17/08 • Structural combination of reactor core or moderator structure with viewing means, e.g. with television camera, periscope, window **[1, 2006.01]**
17/10 • Structural combination of fuel element, control rod, reactor core, or moderator structure with sensitive instruments, e.g. for measuring radioactivity, strain **[1, 2006.01]**
17/104 • • Measuring reactivity **[5, 2006.01]**
17/108 • • Measuring reactor flux **[5, 2006.01]**
17/112 • • Measuring temperature **[5, 2006.01]**
17/116 • • Passages or insulators, e.g. for electric cables **[5, 2006.01]**
17/12 • • Sensitive element forming part of control element **[1, 2006.01]**
17/14 • Period meters **[1, 2006.01]**

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 [1, 2, 2006.01]

19/02 • Details of handling arrangements **[1, 2006.01]**
19/04 • • Means for controlling flow of coolant over objects being handled; Means for controlling flow of coolant through channel being serviced **[1, 2006.01]**
19/06 • • Means for supporting or storing fuel elements or control elements **[1, 4, 2006.01]**
19/07 • • • Storage racks; Storage pools **[5, 2006.01]**
19/08 • • Means for heating fuel elements before introduction into the core; Means for heating or cooling fuel elements after removal from the core **[1, 2006.01]**
19/10 • • Lifting devices or pulling devices adapted for co-operation with fuel elements or with control elements **[1, 2006.01]**
19/105 • • • with grasping or spreading coupling elements **[5, 2006.01]**
19/11 • • • with revolving coupling elements, e.g. socket coupling **[5, 2006.01]**
19/115 • • • with latching devices and ball couplings **[5, 2006.01]**
19/12 • • Arrangements for exerting direct hydraulic or pneumatic force on fuel element or on control element **[1, 2006.01]**
19/14 • characterised by their adaptation for use with horizontal channels in the reactor core **[1, 2006.01]**
19/16 • Articulated or telescopic chutes or tubes for connection to channels in the reactor core **[1, 2006.01]**
19/18 • Apparatus for bringing fuel elements to the reactor charge area, e.g. from a storage place **[1, 2006.01]**
19/19 • Reactor parts specifically adapted to facilitate handling, e.g. to facilitate charging or discharging of fuel elements **[3, 2006.01]**
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 **[1, 2006.01]**
19/22 • • Arrangements for obtaining access to the interior of a pressure vessel whilst the reactor is operating **[1, 2006.01]**
19/24 • • • by using an auxiliary vessel which is temporarily sealed to the pressure vessel **[1, 2006.01]**
19/26 • Arrangements for removing jammed or damaged fuel elements or control elements; Arrangements for moving broken parts thereof **[1, 2006.01]**
19/28 • Arrangements for introducing fluent material into the reactor core; Arrangements for removing fluent material from the reactor core **[1, 2006.01]**
19/30 • • with continuous purification of circulating fluent material, e.g. by extraction of fission products **[1, 2006.01]**
19/303 • • • specially adapted for gases (decontamination of gases G21F 9/02) **[5, 2006.01]**
19/307 • • • specially adapted for liquids (decontamination of liquids G21F 9/04) **[5, 2006.01]**
19/31 • • • • for molten metals **[5, 2006.01]**
19/313 • • • • • using cold traps **[5, 2006.01]**
19/317 • • • Recombination devices for radiolytic dissociation products **[5, 2006.01]**
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) **[1, 2006.01]**
19/33 • Apparatus or processes for dismantling strings of spent fuel elements (G21C 19/34 takes precedence) **[2, 2006.01]**
19/34 • Apparatus or processes for dismantling nuclear fuel, e.g. before reprocessing **[1, 5, 2006.01]**
19/36 • • Mechanical means only **[1, 2006.01]**
19/365 • • • Removing cannings or casings from fuel **[5, 2006.01]**
19/37 • • • • by separating into pieces both the canning or the casing and the fuel element, e.g. by cutting or shearing **[5, 2006.01]**
19/375 • • • Compacting devices, e.g. for fuel assemblies **[5, 2006.01]**
19/38 • • Chemical means only **[1, 2006.01]**
19/40 • Arrangements for preventing occurrence of critical conditions, e.g. during storage **[1, 2006.01]**
19/42 • Reprocessing of irradiated fuel **[1, 2006.01]**
19/44 • • of irradiated solid fuel **[1, 2006.01]**
19/46 • • • Aqueous processes **[1, 2006.01]**
19/48 • • • Non-aqueous processes **[1, 2006.01]**
19/50 • • of irradiated fluid fuel **[1, 2006.01]**

21/00 Apparatus or processes specially adapted to the manufacture of reactors or parts thereof [1, 2006.01]

21/02 • Manufacture of fuel elements or breeder elements contained in non-active casings **[1, 2006.01]**
21/04 • • by vibrational compaction or tamping **[1, 2006.01]**
21/06 • • by swaging **[1, 2006.01]**
21/08 • • by a slip-fit cladding process **[1, 2006.01]**
21/10 • • by extrusion, drawing, or stretching **[1, 2006.01]**
21/12 • • by hydrostatic or thermo-pneumatic canning **[1, 2006.01]**
21/14 • • by plating in a fluid **[1, 2006.01]**
21/16 • • by casting or dipping techniques **[1, 2006.01]**
21/18 • Manufacture of control elements covered by group G21C 7/00 **[1, 2006.01]**

23/00 Adaptations of reactors to facilitate experimentation or irradiation [3, 2006.01]