

SECTION G — PHYSICS

G21 NUCLEAR PHYSICS; NUCLEAR ENGINEERING

G21C NUCLEAR REACTORS (analogue computers therefor G06G 7/54; fusion reactors, hybrid fission-fusion reactors G21B; nuclear explosives G21J)

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1/00 Reactors

- 1/01 • General details not provided for in groups G21C 3/00-G21C 19/00 [3]
- 1/02 • Fast fission reactors, i.e. reactors not using a moderator
- 1/03 • • cooled by a coolant not essentially pressurised, e.g. pool-type reactors [5]
- 1/04 • Thermal reactors
- 1/06 • • Heterogeneous reactors, i.e. in which fuel and moderator are separated
- 1/07 • • • Pebble-bed reactors; Reactors with granular fuel [5]
- 1/08 • • • moderator being highly pressurised, e.g. boiling-water reactor, integral-superheat reactor, pressurised-water reactor (G21C 1/22 takes precedence)
- 1/09 • • • • Pressure regulating arrangements, i.e. pressurisers [5]
- 1/10 • • • • moderator and coolant being different or separated
- 1/12 • • • • • moderator being solid, e.g. Magnox 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
- 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 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

- 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]
- 3/00 Reactor fuel elements or their assemblies; Selection of substances for use as reactor fuel elements**
- 3/02 • Fuel elements
- 3/04 • • Constructional details
- 3/06 • • • Casings; Jackets
- 3/07 • • • • characterised by their material, e.g. alloys [5]
- 3/08 • • • • provided with external means to promote heat-transfer, e.g. fins, baffles, corrugations
- 3/10 • • • • End closures
- 3/12 • • • • Means forming part of the element for locating it within the reactor core; External spacers for this purpose
- 3/14 • • • • Means forming part of the element for inserting it into, or removing it from, the core; Means for coupling adjacent elements
- 3/16 • • • Details of the construction within the casing
- 3/17 • • • • Means for storage or immobilisation of gases in fuel elements [5]
- 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
- 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
- 3/322 • • • Means to influence the coolant flow through or around the bundles [5]
- 3/324 • • • Coats or envelopes for the bundles [5]
- 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]
- 3/328 • • • • Relative disposition of the elements in the bundle lattice [5]
- 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]
- 3/332 • • • • Supports for spacer grids [5]
- 3/334 • • • Assembling the bundles [5]
- 3/335 • • • Exchanging elements in irradiated bundles [5]
- 3/336 • • • Spacer elements for fuel rods in the bundle (spacer grids G21C 3/34) [5]
- 3/338 • • • • Helicoidal spacer elements [5]
- 3/34 • • • Spacer grids
- 3/344 • • • • formed of assembled tubular elements [5]
- 3/348 • • • • formed of assembled non-intersecting strips [5]
- 3/352 • • • • formed of assembled intersecting strips [5]
- 3/356 • • • • being provided with fuel element supporting members [5]
- 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
- 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)
- 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
- 3/60 • • • Metallic fuel; Intermetallic dispersions
- 3/62 • • • Ceramic fuel
- 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
- 5/08 • • Means for preventing undesired asymmetric expansion of the complete structure
- 5/10 • • Means for supporting the complete structure

- 5/12 • characterised by composition, e.g. the moderator containing additional substances which ensure improved heat resistance of the moderator
- 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

- 7/02 • by using self-regulating properties of reactor materials (arrangements that involve temperature stability G21C 7/32)
- 7/04 • • of burnable poisons (burnable poisons in fuel rods G21C 3/326) [5]
- 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 [5]
- 7/107 • • • • Control elements adapted for pebble-bed reactors [5]
- 7/11 • • • • Deformable control elements, e.g. flexible, telescopic, articulated [5]
- 7/113 • • • • Control elements made of flat elements; Control elements having cruciform cross-section [5]
- 7/117 • • • • Clusters of control rods; Spider construction [5]
- 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 arrangements
- 7/18 • • • Means for obtaining differential movement of control elements
- 7/20 • • • Disposition of shock-absorbing devices (shock-absorbers in general F16F)
- 7/22 • • by displacement of a fluid or fluent neutron-absorbing material
- 7/24 • • Selection of substances for use as neutron-absorbing material
- 7/26 • by displacement of the moderator or parts thereof
- 7/27 • • Spectral shift control [5]
- 7/28 • by displacement of the reflector or parts thereof
- 7/30 • by displacement of reactor fuel or fuel elements
- 7/32 • by varying flow of coolant through the core
- 7/34 • by utilisation of a primary neutron source
- 7/36 • Control circuits

9/00 Emergency protection arrangements structurally associated with the reactor (emergency cooling arrangements G21C 15/18)

- 9/004 • Pressure suppression [5]
- 9/008 • • by rupture-discs or -diaphragms [5]
- 9/012 • • by thermal accumulation or by steam condensation, e.g. ice condensers [5]
- 9/016 • Core catchers [5]
- 9/02 • Means for effecting very rapid reduction of the reactivity factor under fault conditions, e.g. reactor fuse

- 9/027 • • by fast movement of a solid, e.g. pebbles [5]
- 9/033 • • by an absorbent fluid [5]
- 9/04 • Means for suppressing fires
- 9/06 • • Means for preventing accumulation of explosives gases, e.g. recombiners [5]
- 11/00 Shielding structurally associated with the reactor**
- 11/02 • Biological shielding (in general G21F)
- 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
- 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
- 13/024 • • Supporting constructions for pressure vessels or containment vessels [5]
- 13/028 • • Seals, e.g. for pressure vessels or containment vessels [5]
- 13/032 • • Joints between tubes and vessel walls, e.g. taking into account thermal stresses [5]
- 13/036 • • • the tube passing through the vessel wall, i.e. continuing on both sides of the wall [5]
- 13/04 • • Arrangements for expansion and contraction
- 13/06 • • Sealing-plugs (for pressure vessels in general F16J 13/00)
- 13/067 • • • for tubes, e.g. standpipes; Locking devices for plugs [5]
- 13/073 • • • Closures for reactor-vessels, e.g. rotatable [5]
- 13/08 • Vessels characterised by the material; Selection of materials for pressure vessels
- 13/087 • • Metallic vessels [5]
- 13/093 • • Concrete vessels [5]
- 13/10 • Means for preventing contamination in event of leakage
- 15/00 Cooling arrangements within the pressure vessel containing the core; Selection of specific coolants**
- 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
- 15/04 • • from fissile or breeder material
- 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 ducts conducting a hot fluid; from ducts comprising auxiliary apparatus, e.g. pumps, cameras
- 15/16 • comprising means for separating liquid and steam (separating in general B01D; steam traps F16T)
- 15/18 • Emergency cooling arrangements; Removing shut-down heat
- 15/20 • Partitions or thermal insulation between fuel channel and moderator, e.g. in pressure tube reactors
- 15/22 • Structural association of coolant tubes with headers or other pipes, e.g. in pressure tube reactors (joints of tubes in general F16L) [4]
- 15/24 • Promoting flow of the coolant (electrodynamic pumps H02K 44/02)
- 15/243 • • for liquids [5]
- 15/247 • • • for liquid metals [5]
- 15/25 • • • using jet pumps [5]
- 15/253 • • for gases, e.g. blowers [5]
- 15/257 • • using heat-pipes [5]
- 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; heat-transfer or heat-exchange materials C09K 5/00)
- 17/00 Monitoring; Testing** (measuring in general G01)
- 17/003 • Remote inspection of vessels, e.g. pressure vessels [5]
- 17/007 • • Inspection of the outer surfaces of vessels [5]
- 17/01 • • Inspection of the inner surfaces of vessels [5]
- 17/013 • • Inspection vehicles [5]
- 17/017 • Inspection or maintenance of pipe-lines or tubes in nuclear installations [5]
- 17/02 • Devices or arrangements for monitoring coolant or moderator
- 17/022 • • for monitoring liquid coolants or moderators [5]
- 17/025 • • • for monitoring liquid metal coolants [5]
- 17/028 • • for monitoring gaseous coolants [5]
- 17/032 • • Reactor-coolant flow measuring or monitoring [5]
- 17/035 • • Moderator- or coolant-level detecting devices [5]
- 17/038 • • Boiling detection in moderator or coolant [5]
- 17/04 • • Detecting burst slugs
- 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)
- 17/07 • • Leak testing [5]
- 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
- 17/104 • • Measuring reactivity [5]
- 17/108 • • Measuring reactor flux [5]
- 17/112 • • Measuring temperature [5]
- 17/116 • • Passages or insulators, e.g. for electric cables [5]
- 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 [2]**
- 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
- 19/06 • • Means for supporting or storing fuel elements or control elements [4]
- 19/07 • • • Storage racks; Storage pools [5]
- 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 [5]
- 19/11 • • • with revolving coupling elements, e.g. socket coupling [5]
- 19/115 • • • with latching devices and ball couplings [5]

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- 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 [3]
- 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
- 19/22 • • 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
- 19/303 • • • specially adapted for gases (decontamination of gases G21F 9/02) [5]
- 19/307 • • • specially adapted for liquids (decontamination of liquids G21F 9/04) [5]
- 19/31 • • • • for molten metals [5]
- 19/313 • • • • using cold traps [5]
- 19/317 • • • Recombination devices for radiolytic dissociation products [5]
- 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)
- 19/33 • Apparatus or processes for dismantling strings of spent fuel elements (G21C 19/34 takes precedence) [2]
- 19/34 • Apparatus or processes for dismantling nuclear fuel, e.g. before reprocessing (shielded cells G21F 7/00) [5]
- 19/36 • • Mechanical means only
- 19/365 • • • Removing cannings or casings from fuel [5]
- 19/37 • • • • by separating into pieces both the canning or the casing and the fuel element, e.g. by cutting or shearing [5]
- 19/375 • • • Compacting devices, e.g. for fuel assemblies [5]
- 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
- 19/48 • • • Non-aqueous processes
- 19/50 • • of irradiated fluid fuel
- 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
- 21/06 • • by swaging
- 21/08 • • by a slip-fit cladding process
- 21/10 • • by extrusion, drawing, or stretching
- 21/12 • • by hydrostatic or thermo-pneumatic canning
- 21/14 • • by plating 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 [3]**